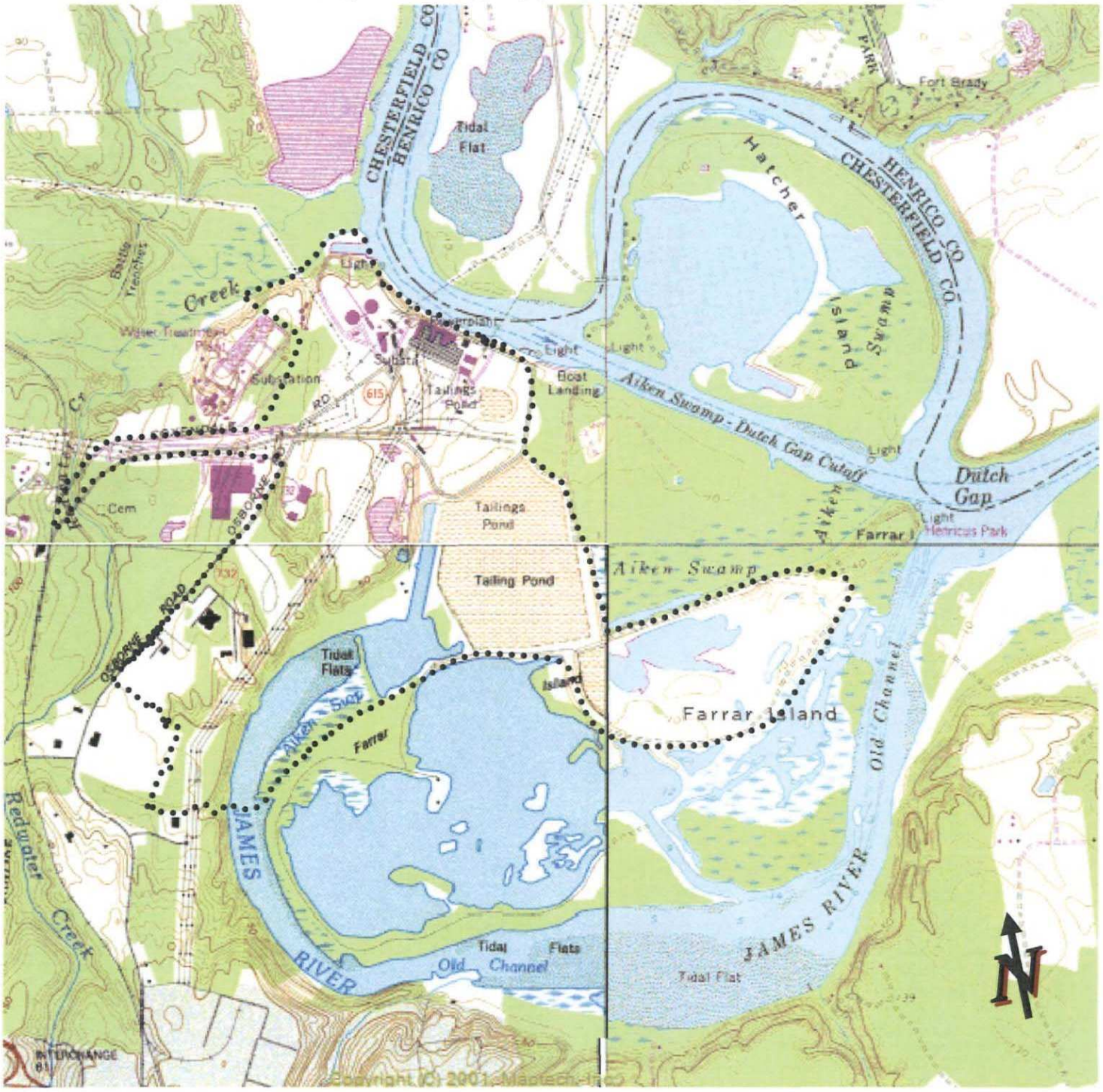
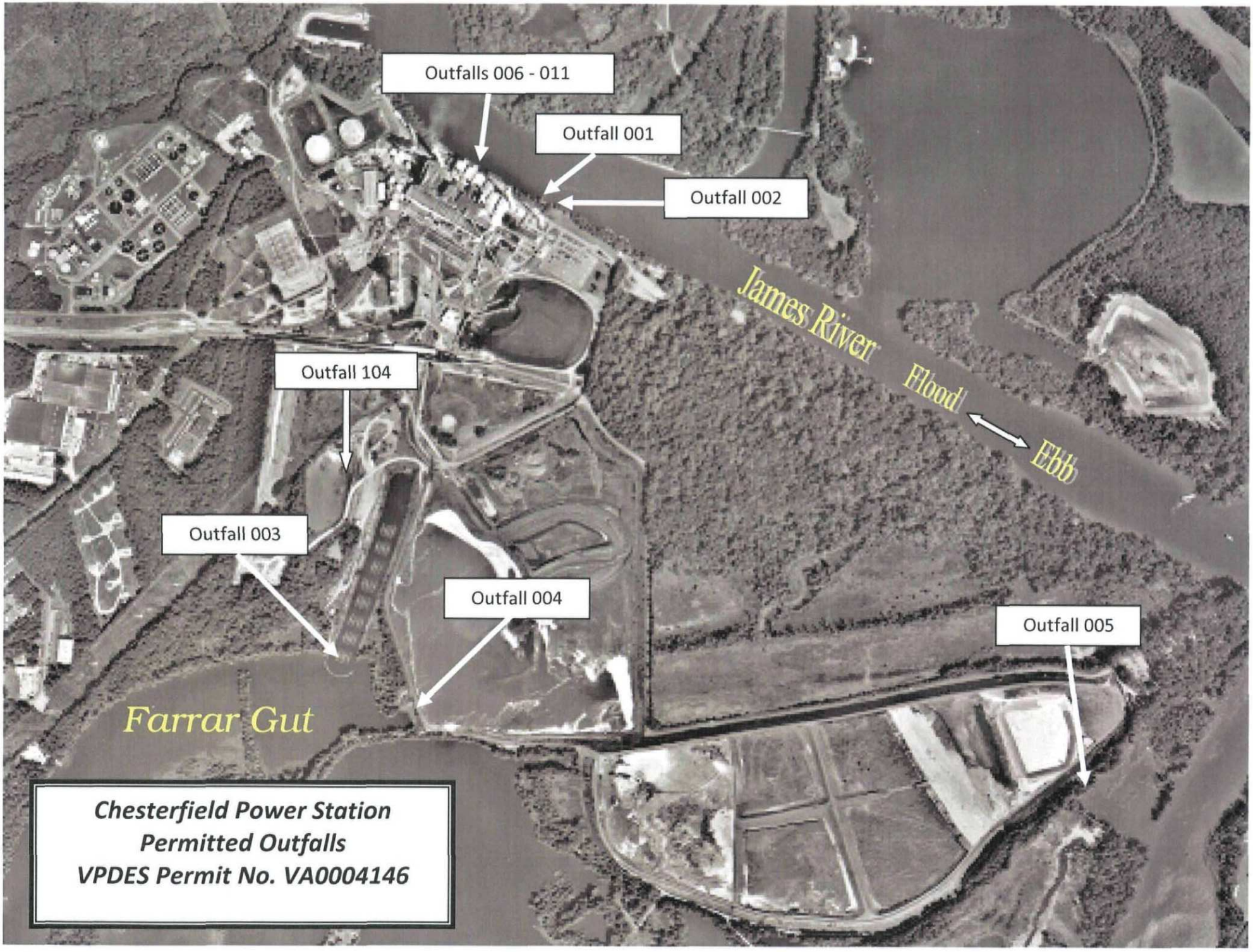
Attachment 1

Location and Site Maps

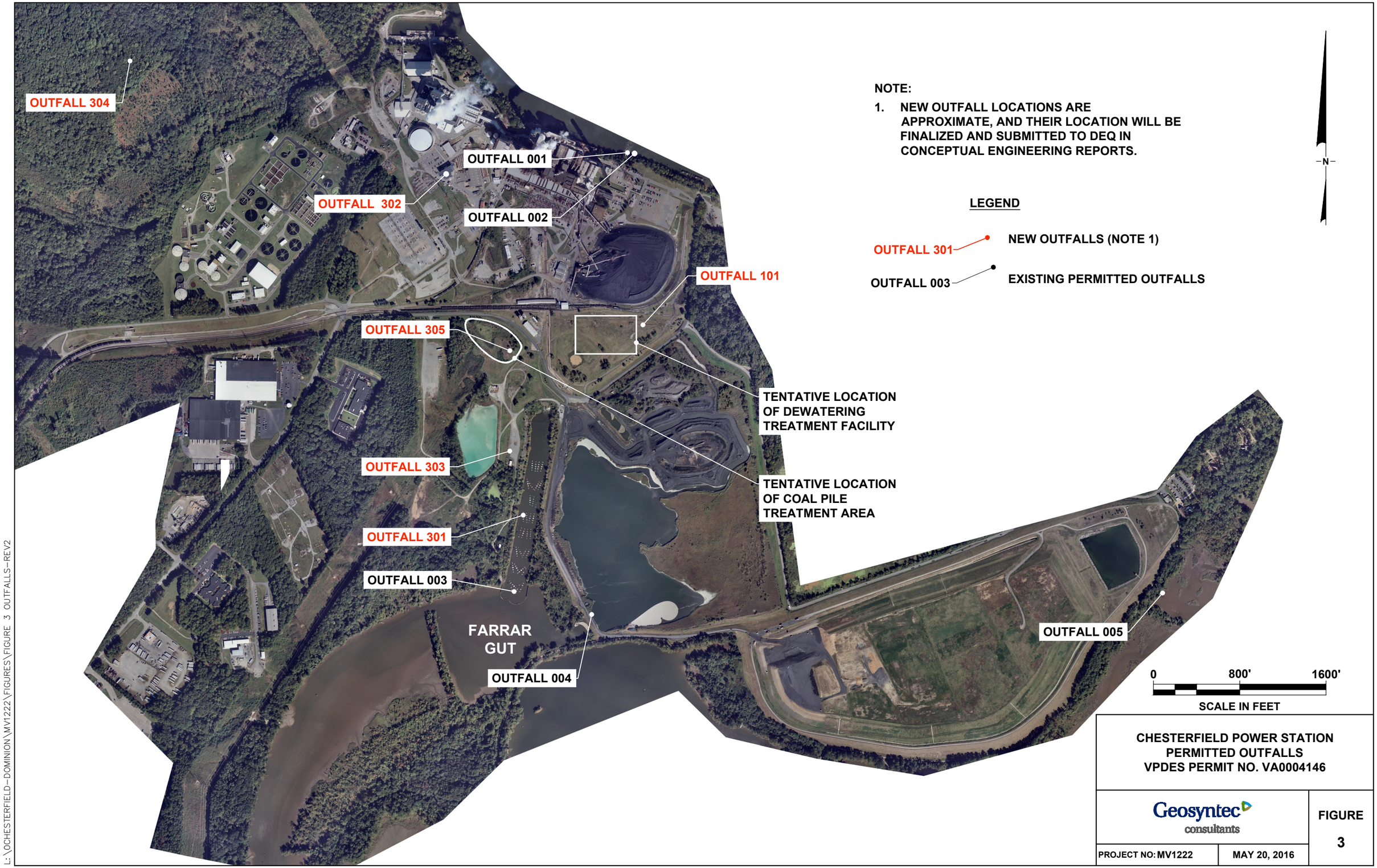
Chesterfield Power Station
Topographic Map Showing Approximate Property Boundary



USGS Drewrys Bluff (VA) Quadrangle
1" = 0.4 miles
Approximate Property Boundary
.....



Chesterfield Power Station
Permitted Outfalls
VPDES Permit No. VA0004146



NOTE:

1. NEW OUTFALL LOCATIONS ARE APPROXIMATE, AND THEIR LOCATION WILL BE FINALIZED AND SUBMITTED TO DEQ IN CONCEPTUAL ENGINEERING REPORTS.

LEGEND

OUTFALL 301 — NEW OUTFALLS (NOTE 1)

OUTFALL 003 — EXISTING PERMITTED OUTFALLS

CHESTERFIELD POWER STATION
PERMITTED OUTFALLS
VPDES PERMIT NO. VA0004146

Geosyntec consultants

FIGURE 3

PROJECT NO: MV1222 | MAY 20, 2016

L:\CHESTERFIELD-DOMINION\MV1222\FIGURES\FIGURE 3 OUTFALLS-REV2

Attachment 2

Ambient Stream Characterization

MEMORANDUM

DEPARTMENT OF ENVIRONMENTAL QUALITY
Piedmont Regional Office
4949-A Cox Road Glen Allen, Virginia 23060

SUBJECT: Flow Frequency Determination / 303(d) Status
Dominion Virginia Power - Chesterfield Power Station – VA0004146

TO: Joseph Bryan

FROM: Jennifer Palmore, P.G.

DATE: August 25, 2015
REVISED: February 29, 2016
REVISED: May 18, 2016

COPIES: File

Dominion Virginia Power's Chesterfield Power Station discharges to the James River and to an old channel of the James River also known as Farrar Gut. Flow frequencies have been requested for use in developing effluent limitations for the VPDES permit. The outfalls are located at the following rivermiles:

001: James River - 2CJMS097.59
002: James River - 2CJMS097.55
003: James River -Old Channel (a.k.a. Farrar Gut) - 2CJMC003.73
004: James River -Old Channel (a.k.a. Farrar Gut) - 2CJMC003.87
005: James River -Old Channel (a.k.a. Farrar Gut) - 2CJMC000.37

At the facility, the James River and Farrar Gut are tidally influenced; therefore, flow frequencies cannot be determined for outfalls 001, 002, 004 and 005. For outfall 003, which is the condenser cooling water from units 4, 5, & 6, the discharge flow overwhelms the tidal flow in Farrar Gut; therefore, the effluent from 003 should be evaluated as a dry ditch discharge (effluent-dominated stream).

During the 2012 305(b)/303(d) Integrated Water Quality Assessment Report, the James River was assessed as a Category 5D waterbody ("The Water Quality Standard is not attained where TMDLs for a pollutant(s) have been developed but one or more pollutants are still causing impairment requiring additional TMDL development.") The applicable fact sheets are attached. The Recreation Use is impaired due to E. coli violations, the Fish Consumption Use is impaired due to a VDH Fish Consumption Advisory for PCBs, and the Aquatic Life Use is impaired due to exceedance of the chlorophyll a standard, altered benthic community, and low dissolved oxygen and inadequate submerged aquatic vegetation (SAV) in the upper James River tidal freshwater estuary. In addition, there were screening level exceedances for mercury and arsenic in fish tissue, mercury in sediment, and a VDH Fish Consumption Advisory for kepone; these are considered non-impairing "observed effects". The Wildlife Use is fully supporting.

Farrar Gut was considered a Category 4A water ("Impaired or threatened for one or more designated uses but does not require a TMDL because the TMDL for specific pollutant(s) is complete and US EPA approved.") It is impaired of the Aquatic Life Use due to the low dissolved oxygen and inadequate SAV in the estuary. The Fish Consumption Use is considered fully supporting with observed effects due to the kepone advisory. There was insufficient information to assess the Recreation Use; however E.coli was considered a non-impairing observed effect. The Public Water Supply and Wildlife Uses were not assessed.

During the draft 2014 Integrated Report, the James River was assessed as a Category 5D waterbody ("The Water Quality Standard is not attained where TMDLs for a pollutant(s) have been developed but one or more pollutants are still causing impairment requiring additional TMDL development.") The applicable fact sheets are attached. The Recreation Use is impaired due to E. coli violations, the Fish Consumption Use is impaired due to a VDH Fish Consumption Advisory for PCBs, and the Aquatic Life Use is impaired due to exceedance of the chlorophyll a standard, altered benthic community, and inadequate submerged aquatic vegetation (SAV) in the upper James River tidal freshwater estuary. In addition, there were screening level exceedances for mercury and arsenic in fish tissue, mercury in sediment, and a VDH Fish Consumption Advisory for kepone; these are considered non-impairing "observed effects". The Wildlife Use is fully supporting.

Farrar Gut was considered a Category 4A water ("Impaired or threatened for one or more designated uses but does not require a TMDL because the TMDL for specific pollutant(s) is complete and US EPA approved.") It is impaired of the Aquatic Life Use due to the SAV impairment in the estuary. The Fish Consumption Use is considered fully supporting with observed effects due to the kepone advisory. There was insufficient information to assess the Recreation Use; however E.coli was considered a non-impairing observed effect. The Public Water Supply and Wildlife Uses were not assessed.

The James River and Farrar Gut are considered Tier 1 waters because the Richmond-Crater Water Quality Management Plan allows the dissolved oxygen in the river to drop to 5.0 mg/L, which was the water quality standard at the time that the plan was developed.

Water quality data from monitoring station 2-JMS099.30 is attached. The station is located at Buoy 157, which is approximately 1.8 miles upstream of Chesterfield Power Station's outfalls on the James River and 4 miles upstream of the confluence with Farrar Gut. The station represents background ambient conditions before interaction with the heated effluent from the facility.

As the Water Quality Standards designate this area as tidal freshwater, the freshwater Aquatic Life criteria should be applied.

The James River and Tributaries -City of Richmond Bacterial TMDL was approved by the EPA on 11/4/2010 and by the SWCB on 6/29/2012. The facility was included in the TMDL; however, the discharge was not assigned a bacteria wasteload allocation because it is not permitted for fecal coliform control.

Dominion – Chesterfield Power Station was also addressed in the Chesapeake Bay TMDL, which was approved by the EPA on 12/29/2010. The TMDL allocates loads for total nitrogen, total phosphorus, and total suspended solids to protect the dissolved oxygen and SAV criteria in the Chesapeake Bay and its tidal tributaries. The facility is considered a significant nutrient discharger and was included in the aggregated loads for significant wastewater dischargers in the upper tidal freshwater James River estuary (JMSTF2). The nutrient allocations are administered through the Watershed Nutrient General Permit; the TSS allocations are considered aggregated and facilities with technology-based TSS limits are considered to be in conformance with the TMDL.

If you have any questions concerning this analysis or need additional information, please let me know.

Station ID	Collection Date	Depth Desc	Depth	Temp Celcius	Field Ph	Do Probe	Do Winkler	Fdt Do Optical	Salinity	Secchi Depth
2-JMS099.30	7/22/1968	S	0.3	30	7		3.8			
2-JMS099.30	9/8/1968	S	0.3	27.22	7		3.9			
2-JMS099.30	3/20/1969	S	0.3	10	7.2		8.8			
2-JMS099.30	6/19/1969	S	0.3	25.56	6.3		4.7			
2-JMS099.30	10/2/1969	S	0.3	21.11	7.3		3.6			
2-JMS099.30	4/21/1970	S	0.3	17.78	7.3		6.8			
2-JMS099.30	5/5/1970	S	0.3	20	6.9		7.6			
2-JMS099.30	6/18/1970	S	0.3	28.33	6.8		4.4			
2-JMS099.30	7/2/1970	S	0.3	28.89			3.8			
2-JMS099.30	7/22/1970	S	0.3	27.78	7.2		1.6			
2-JMS099.30	8/15/1970	S	0.3	31.11	7.3		3.6			
2-JMS099.30	8/26/1970	S	0.3	28.89	6.9		3.2			
2-JMS099.30	9/9/1970	S	0.3	29.44			4.2			
2-JMS099.30	5/6/1971	S	0.3	17.22	7.3		6.2			
2-JMS099.30	6/13/1971	S	0.3	23.33	7.3		6			
2-JMS099.30	7/5/1971	S	0.3	28.89	8.6		8.2			
2-JMS099.30	7/23/1971	S	0.3	28.33	7.5		4			
2-JMS099.30	8/3/1971	S	0.3	29.44	7.3		5			
2-JMS099.30	8/31/1971	S	0.3	26.11	6.7		6.4			
2-JMS099.30	9/26/1971	S	0.3	23.89	7.5		6.4			
2-JMS099.30	10/27/1971	S	0.3	18.89	7		9			
2-JMS099.30	5/2/1972	S	0.3	20.56	7.3		6			
2-JMS099.30	7/8/1972	S	0.3	21.11	7.4		8.4			
2-JMS099.30	7/31/1972	S	0.3	25			8.4			
2-JMS099.30	8/9/1972	S	0.3	26.67	7.7		6.8			
2-JMS099.30	8/20/1972	S	0.3		7		6			
2-JMS099.30	9/5/1972	S	0.3	25.56	7		7.2			
2-JMS099.30	10/4/1972	S	0.3	21.11	7.7		7			
2-JMS099.30	5/3/1973	S	0.3	17.78	7		8.3			
2-JMS099.30	6/6/1973	S	0.3	26.11	7.8		7			
2-JMS099.30	6/9/1973	S	0.3	28.89	7.9		11.79			
2-JMS099.30	7/15/1973	S	0.3	28.33	7.3		4			
2-JMS099.30	9/29/1973	S	0.3	29.44	7		3.6			
2-JMS099.30	8/30/1974	S	0.3	28	7.5		7			
2-JMS099.30	9/26/1974	S	0.3	21	7.5		7.2			
2-JMS099.30	10/25/1974	S	0.3	15	8		11.19			
2-JMS099.30	5/1/1975	S	0.3	17.22	7.3		9.1			
2-JMS099.30	6/4/1975	S	0.3		7.3		7.9			
2-JMS099.30	6/24/1975	S	0.3	28.33	8		8			
2-JMS099.30	6/30/1975	S	0.3	26.67	7.5		7.8			
2-JMS099.30	7/28/1975	S	0.3	27.78	8		7.6			
2-JMS099.30	8/13/1975	S	0.3	27.78	7.5		7			
2-JMS099.30	8/16/1975	S	0.3	30	7.7		7.8			
2-JMS099.30	9/3/1975	S	0.3	23.89	7.4		7.7			
2-JMS099.30	10/1/1975	S	0.3	20	7.5		9.2			
2-JMS099.30	2/12/1976	S	0.3	5.56	7.5		12.69			
2-JMS099.30	3/11/1976	S	0.3	10	7.5		10			
2-JMS099.30	5/4/1976	S	0.3	20	7.5		8.4			
2-JMS099.30	6/7/1976	S	0.3	22.22	7.2		8.1			
2-JMS099.30	5/22/1978	S	0.3	20	8		9			
2-JMS099.30	6/15/1978	S	0.3	25	9		4.7			
2-JMS099.30	7/11/1978	S	0.3	8	8		6.1			
2-JMS099.30	8/3/1978	S	0.3	5	7		5.5			
2-JMS099.30	9/25/1978	S	0.3	26	8.5		7.1			
2-JMS099.30	12/12/1978	S	0.3	8	7.5		11.7			
2-JMS099.30	4/24/1979	S	0.3	19	7.7		8.7			
2-JMS099.30	5/19/1980	S	0.3	21	8.3		8.3			
2-JMS099.30	7/16/1980	S	0.3	28.5	8.3		7			
2-JMS099.30	10/20/1980	S	0.3	18	8		7.7			
2-JMS099.30	7/27/1981	S	0.3	29	8.7		7.8			
2-JMS099.30	9/8/1981	S	0.3	26	7.8		7			
2-JMS099.30	11/16/1981	S	0.3	11	7.2		6.9			
2-JMS099.30	5/13/1982	S	0.3	21.5	8.7		7.2			
2-JMS099.30	6/24/1982	S	0.3	25	7.5		7			
2-JMS099.30	8/9/1982	S	0.3	28	7.2		5.5			
2-JMS099.30	10/28/1982	S	0.3							
2-JMS099.30	11/18/1982	S	0.3	9	6.9		10.6			
2-JMS099.30	5/17/1983	S	0.3	19.5	7.9		8.5			
2-JMS099.30	6/28/1983	S	0.3	28.5	7		7.1			0.5
2-JMS099.30	8/30/1983	S	2.74							
2-JMS099.30	8/30/1983	B	32.92							
2-JMS099.30	9/20/1983	S	0.91	26.5	7.6		8			0.2
2-JMS099.30	9/20/1983	M	2.74							
2-JMS099.30	9/20/1983	B	42.98							
2-JMS099.30	10/3/1983	S	0.91	20	7.8		7.3			0.3

Station ID	Collection Date	Depth Desc	Depth	Temp Celcius	Field Ph	Do Probe	Do Winkler	Fdt Do Optical	Salinity	Secchi Depth
2-JMS099.30	10/3/1983	M	2.74							
2-JMS099.30	10/3/1983	B	31.7							
2-JMS099.30	10/12/1983	S	0.91							0.4
2-JMS099.30	7/12/1984	S	1	26	6.9	7.6				
2-JMS099.30	7/31/1984	S	11	24.5		7.2			0	
2-JMS099.30	7/31/1984	S	1	24.5	7.3	7.3			0	0.8
2-JMS099.30	8/15/1984	S	11	24	6.8	8.6				
2-JMS099.30	8/15/1984	S	1	24	7	8.6				0.2
2-JMS099.30	9/12/1984	S	1	24	7.8	7.6				0.7
2-JMS099.30	9/12/1984	B	11	23.5	7.7	7.2				
2-JMS099.30	9/25/1984	S	1	23.5		7.1				1
2-JMS099.30	9/25/1984	B	12	23.5		7.4				
2-JMS099.30	10/11/1984	S	3	19.5		8.3			0	
2-JMS099.30	10/11/1984	M	5	19.5		8.3			0	
2-JMS099.30	10/11/1984	M	7	19		8.3			0	
2-JMS099.30	10/11/1984	M	9	19		8.3			0	
2-JMS099.30	10/11/1984	B	10	19	6.6	8.3			0	
2-JMS099.30	10/11/1984	S	1	19.5	7	8.3			0	0.9
2-JMS099.30	10/18/1984	S	1	19.5	7.2	8.5				1
2-JMS099.30	10/18/1984	B	12	19.5	7.2	8.4				
2-JMS099.30	11/2/1984	S	1	20.5	7.1	7.9			0	1.1
2-JMS099.30	11/2/1984	M	3	20.5		7.8			0	
2-JMS099.30	11/2/1984	M	5	20.5		7.8			0	
2-JMS099.30	11/2/1984	M	7	20.5		7.8			0	
2-JMS099.30	11/2/1984	B	9	20.5	6.8	7.7			0	1.1
2-JMS099.30	11/16/1984	S	1	11	7.6	11			0	1.2
2-JMS099.30	11/16/1984	M	3	11		11			0	
2-JMS099.30	11/16/1984	M	5	11		11			0	
2-JMS099.30	11/16/1984	M	7	11		11			0	
2-JMS099.30	11/16/1984	M	9	11		11			0	
2-JMS099.30	11/16/1984	B	11	11	7.5	11			0	
2-JMS099.30	12/12/1984	S	1	5	6.9	12			0.2	1
2-JMS099.30	12/12/1984	M	3	5		12			0.2	
2-JMS099.30	12/12/1984	M	5	5		12			0.2	
2-JMS099.30	12/12/1984	M	7	5		12			0.2	
2-JMS099.30	12/12/1984	B	9	5	6.9	12.1			0.2	
2-JMS099.30	2/4/1985	S	1	1.5	6.6	14.4			0	0.3
2-JMS099.30	2/4/1985	M	3	1.5		14.4			0	
2-JMS099.30	2/4/1985	M	5	1.5		14.4			0	
2-JMS099.30	2/4/1985	M	7	2		14.4			0	
2-JMS099.30	2/4/1985	M	9	2		14.4			0	
2-JMS099.30	2/4/1985	M	11	2		14.4			0	
2-JMS099.30	2/4/1985	B	13	2	7	14.4			0	
2-JMS099.30	3/11/1985	S	1	10	6.9	11.6	11.2			1.1
2-JMS099.30	3/11/1985	M	3	10		11.5			0.1	
2-JMS099.30	3/11/1985	M	5	10		11.4			0.1	
2-JMS099.30	3/11/1985	M	7	10		11.4			0.1	
2-JMS099.30	3/11/1985	M	9	10		11.4			0.1	
2-JMS099.30	3/11/1985	B	11	10	6.8	11.3	11.1		0.1	
2-JMS099.30	3/27/1985	S	1	10.5	7.4	11			0	1.2
2-JMS099.30	3/27/1985	M	3	10.5		11			0	
2-JMS099.30	3/27/1985	M	5	10.5		11			0	
2-JMS099.30	3/27/1985	M	7	10.5		10.9			0	
2-JMS099.30	3/27/1985	M	9	10.5		10.9			0	
2-JMS099.30	3/27/1985	B	11	10.5	7.6	10.9	10.9		0	
2-JMS099.30	4/10/1985	S	1	12	7.5	10	9.7		0	10.2
2-JMS099.30	4/10/1985	M	3	12		10			0	
2-JMS099.30	4/10/1985	M	5	12		10			0	
2-JMS099.30	4/10/1985	M	7	12		10			0	
2-JMS099.30	4/10/1985	M	9	12		10.1			0	
2-JMS099.30	4/10/1985	B	10	12	7.3	10.1	9.7		0	
2-JMS099.30	4/24/1985	S	1	23	7.4	6.3	7.8		0	1.2
2-JMS099.30	4/24/1985	M	3	23		6.3			0	
2-JMS099.30	4/24/1985	M	5	23		6.3			0	
2-JMS099.30	4/24/1985	M	7	23		6.3			0	
2-JMS099.30	4/24/1985	M	9	23		6.2			0	
2-JMS099.30	4/24/1985	B	11	23	7.3	6.2	5.9		0	
2-JMS099.30	5/8/1985	S	1	21.5	7.4	8.2	7.8		0	1.3
2-JMS099.30	5/8/1985	M	3	21.5		8.1			0	
2-JMS099.30	5/8/1985	M	5	21.5		8.1			0	
2-JMS099.30	5/8/1985	M	7	21.5		8.1			0	
2-JMS099.30	5/8/1985	M	9	21		8.1			0	
2-JMS099.30	5/8/1985	M	11	21		8.1			0	
2-JMS099.30	5/8/1985	B	12	21	7.3	7.9	7.7		0	
2-JMS099.30	5/22/1985	S	1	22	7.3	7.7	7.2		0	0.8

Station ID	Collection Date	Depth Desc	Depth	Temp Celcius	Field Ph	Do Probe	Do Winkler	Fdt Do Optical	Salinity	Secchi Depth
2-JMS099.30	5/22/1985	M	3	22		7.6			0	
2-JMS099.30	5/22/1985	M	5	22		7.6			0	
2-JMS099.30	5/22/1985	M	7	22		7.6			0	
2-JMS099.30	5/22/1985	M	9	22		7.6			0	
2-JMS099.30	5/22/1985	B	11	22	7.2	7.6	7.5		0	
2-JMS099.30	6/19/1985	S	1	23.5	7.8	7.2	7.7		0	0.9
2-JMS099.30	6/19/1985	M	5	23.5		7.2			0	
2-JMS099.30	6/19/1985	M	7	23.5		7.2			0	
2-JMS099.30	6/19/1985	M	9	23.5		7.1			0	
2-JMS099.30	6/19/1985	B	11	23.5	7.57	7.1	7.8		0	
2-JMS099.30	7/2/1985	S	1	24	7.82	6.2			0.1	1
2-JMS099.30	7/2/1985	M	3	24		6.2			0.1	
2-JMS099.30	7/2/1985	M	5	24		6.2			0.1	
2-JMS099.30	7/2/1985	M	7	24		6.2			0.1	
2-JMS099.30	7/2/1985	M	9	24		6.2			0.1	
2-JMS099.30	7/2/1985	M	11	24		6.2			0.1	
2-JMS099.30	7/2/1985	B	12	24	7.84	6.2	5.6		0.1	
2-JMS099.30	7/17/1985	S	1	26	7.57	6.4	6.3		0	0.6
2-JMS099.30	7/17/1985	M	3	26		6.3			0	
2-JMS099.30	7/17/1985	M	5	26		6.3			0	
2-JMS099.30	7/17/1985	M	7	26		6.3			0	
2-JMS099.30	7/17/1985	M	9	26		6.3			0	
2-JMS099.30	7/17/1985	M	11	26		6.2			0	
2-JMS099.30	7/17/1985	B	12	26	7.4	6.2	5.8		0	
2-JMS099.30	8/5/1985	S	1	24.5	7.56	6.3			0	0.8
2-JMS099.30	8/5/1985	M	3	24.5		6.2			0	
2-JMS099.30	8/5/1985	M	5	24.5		6.2			0	
2-JMS099.30	8/5/1985	M	7	24.5		6.2			0	
2-JMS099.30	8/5/1985	M	9	24.5		6.1			0	
2-JMS099.30	8/5/1985	B	11	24.5	7.78	6.1			0	
2-JMS099.30	8/15/1985	S	1	28.5	8.07	8.2			0	1.2
2-JMS099.30	8/15/1985	M	3	28		7.2			0	
2-JMS099.30	8/15/1985	M	5	27.5		2.1			0	
2-JMS099.30	8/15/1985	M	7	27.5		7.1			0	
2-JMS099.30	8/15/1985	M	9	27		6.4			0	
2-JMS099.30	8/15/1985	M	11	27		6.1			0	
2-JMS099.30	8/15/1985	B	13	27	7.56	6.1				
2-JMS099.30	9/4/1985	S	3	25		7.3			0	
2-JMS099.30	9/4/1985	B	11	23		7.2			0	
2-JMS099.30	9/4/1985	S	1	25	7.61	7.6	6.7		0	
2-JMS099.30	9/4/1985	M	5	23		7.3			0	
2-JMS099.30	9/4/1985	M	7	23		7.3			0	
2-JMS099.30	9/4/1985	M	9	23		7.2			0	
2-JMS099.30	9/4/1985	M	11	23		7.2			0	
2-JMS099.30	9/4/1985	B	12	23	7.57	7.1	6.3		0	0.7
2-JMS099.30	9/17/1985	S	1	21	7.86	7.6			0	
2-JMS099.30	9/17/1985	M	3	20.5		7.7			0	
2-JMS099.30	9/17/1985	M	5	20.5		7.7			0	
2-JMS099.30	9/17/1985	M	7	20.5		7.6			0	
2-JMS099.30	9/17/1985	M	9	20.5		7.6			0	
2-JMS099.30	9/17/1985	B	11	20.5	7.93	7.6			0	
2-JMS099.30	10/2/1985	S	1	22	7.51	6.8	6.8		0	0.6
2-JMS099.30	10/2/1985	M	3	21.5		6.7			0	
2-JMS099.30	10/2/1985	M	5	21.5		6.7			0	
2-JMS099.30	10/2/1985	M	7	21.5		6.7			0	
2-JMS099.30	10/2/1985	M	9	21.5		6.7			0	
2-JMS099.30	10/2/1985	B	11	21.5	7.37	6.7	6.6		0	0.6
2-JMS099.30	10/16/1985	S	1	21	7.65	6.6	6.2		0	0.6
2-JMS099.30	10/16/1985	M	3	20.5		6.5			0	
2-JMS099.30	10/16/1985	M	5	20		6.4			0	
2-JMS099.30	10/16/1985	M	7	20		6.4			0	
2-JMS099.30	10/16/1985	M	9	20		6.4			0	
2-JMS099.30	10/16/1985	B	11	20	7.59	6.4			0	
2-JMS099.30	11/18/1985	S	1	14.5	7.92	9.5	8.8		0	0.6
2-JMS099.30	11/18/1985	M	3	14.5		9.4			0	
2-JMS099.30	11/18/1985	M	5	14.5		9.5			0	
2-JMS099.30	11/18/1985	M	7	14.5		9.5			0	
2-JMS099.30	11/18/1985	M	9	14.5		9.5			0	
2-JMS099.30	11/18/1985	B	11	14.5	7.9	9.4	8.8		0	
2-JMS099.30	12/4/1985	S	1	9	7.88	10.8	10.4		0	0.3
2-JMS099.30	12/4/1985	M	3	9		10.8			0	
2-JMS099.30	12/4/1985	M	5	9		10.8			0	
2-JMS099.30	12/4/1985	M	7	9		10.7			0	
2-JMS099.30	12/4/1985	M	9	9		10.7			0	
2-JMS099.30	12/4/1985	M	11	9		10.7			0	

Station ID	Collection Date	Depth Desc	Depth	Temp Celcius	Field Ph	Do Probe	Do Winkler	Fdt Do Optical	Salinity	Secchi Depth
2-JMS099.30	12/4/1985	B	12	9	7.86	10.7	10.6		0	
2-JMS099.30	1/15/1986	S	1	2.5	7.98	12.5	12.4		0	1
2-JMS099.30	1/15/1986	M	3	2.5		12.5			0	
2-JMS099.30	1/15/1986	M	5	2.5		12.4			0	
2-JMS099.30	1/15/1986	M	7	2.5		12.4			0	
2-JMS099.30	1/15/1986	M	9	2.5		12			0	
2-JMS099.30	1/15/1986	B	11	2.5	7.77	12.2			0	1
2-JMS099.30	2/12/1986	S	1	5	7.84	11.6	11.4		0	0.7
2-JMS099.30	2/12/1986	M	3	5		11.5			0	
2-JMS099.30	2/12/1986	M	5	5		11.5			0	
2-JMS099.30	2/12/1986	M	7	5		11.5			0	
2-JMS099.30	2/12/1986	M	9	5		11.5			0	
2-JMS099.30	2/12/1986	M	11	5		11.5			0	
2-JMS099.30	2/12/1986	B	12	5	7.64	11.4	11.6		0	
2-JMS099.30	3/12/1986	S	1	10	7.79	10.7	10		0	1.1
2-JMS099.30	3/12/1986	M	3	10		10.7			0	
2-JMS099.30	3/12/1986	M	5	10		10.7			0	
2-JMS099.30	3/12/1986	M	7	10		10.6			0	
2-JMS099.30	3/12/1986	M	9	10		10.6			0	
2-JMS099.30	3/12/1986	B	11	10	7.52	10.6	10		0	
2-JMS099.30	3/26/1986	S	1	12	8.08	10.6	10.3		0	0.9
2-JMS099.30	3/26/1986	M	3	12		10.6			0	
2-JMS099.30	3/26/1986	M	5	12		10.5			0	
2-JMS099.30	3/26/1986	M	7	12		10.5			0	
2-JMS099.30	3/26/1986	M	9	12		10.5			0	
2-JMS099.30	3/26/1986	B	11	12	7.79	10.5	10.4		0	
2-JMS099.30	4/10/1986	S	1	16.5	8.18		8.1		0	1
2-JMS099.30	4/10/1986	M	3	16.5					0	
2-JMS099.30	4/10/1986	M	5	16.5					0	
2-JMS099.30	4/10/1986	M	7	16.5					0	
2-JMS099.30	4/10/1986	M	9	16.5		7.4			0	
2-JMS099.30	4/10/1986	B	10	16.5	8.25	7.4	7.9		0	
2-JMS099.30	4/28/1986	S	1	18	8.54	7.7	6.9		0	1.3
2-JMS099.30	4/28/1986	M	3	18		7.6			0	
2-JMS099.30	4/28/1986	M	5	18		7.6			0	
2-JMS099.30	4/28/1986	M	7	18		7.5			0	
2-JMS099.30	4/28/1986	M	9	18		7.4			0	
2-JMS099.30	4/28/1986	M	11	18		7.4			0	
2-JMS099.30	4/28/1986	B	12	18	8.7	7.4	7.2			1.3
2-JMS099.30	5/8/1986	S	1	22	7.7	6.5	7.3		0	1
2-JMS099.30	5/8/1986	M	3	22		6.4			0	
2-JMS099.30	5/8/1986	M	5	22		6.4			0	
2-JMS099.30	5/8/1986	M	7	22		6.3			0	
2-JMS099.30	5/8/1986	B	9	22	7.31	5.9	6.6		0	
2-JMS099.30	5/27/1986	S	1	22.5	7.97	7.8	7.1		0	0.8
2-JMS099.30	5/27/1986	M	3	22		7.7			0	
2-JMS099.30	5/27/1986	M	5	22		7.6			0	
2-JMS099.30	5/27/1986	M	7	22		7.6			0	
2-JMS099.30	5/27/1986	M	9	22		7.6			0	
2-JMS099.30	5/27/1986	B	11	22	7.91	7.6	7.2		0	
2-JMS099.30	6/9/1986	S	1	27	7.84	6	6		0	1
2-JMS099.30	6/9/1986	M	3	27		5.8			0	
2-JMS099.30	6/9/1986	M	5	27		5.7			0	
2-JMS099.30	6/9/1986	M	7	27		5.7			0	
2-JMS099.30	6/9/1986	B	9	27	7.9	5.7	5		0	
2-JMS099.30	6/24/1986	S	1	27	7.88	6.3	5.5		0	0.8
2-JMS099.30	6/24/1986	M	3	27		6			0	
2-JMS099.30	6/24/1986	M	5	27		5.7			0	
2-JMS099.30	6/24/1986	M	7	27		5.5			0	
2-JMS099.30	6/24/1986	M	9	27		5.7			0	
2-JMS099.30	6/24/1986	B	10	27	7.81	5.7	5.2		0	
2-JMS099.30	7/8/1986	S	1	27	7.68	7.56	8.5		0	0.9
2-JMS099.30	7/8/1986	M	3	26.7		7			0	
2-JMS099.30	7/8/1986	M	5	26.7		6.97			0	
2-JMS099.30	7/8/1986	M	7	26.6		6.84			0	
2-JMS099.30	7/8/1986	B	9	26.6	8.23	6.76	4.6		0	
2-JMS099.30	7/22/1986	S	1	30.5	8.02	6.4	6.3		0	1.2
2-JMS099.30	7/22/1986	M	3	30.5		6.1			0	
2-JMS099.30	7/22/1986	M	5	30.5		5.8			0	
2-JMS099.30	7/22/1986	M	7	30.5		5.8			0	
2-JMS099.30	7/22/1986	M	9	30.5		5.8			0	
2-JMS099.30	7/22/1986	B	11	30.5	7.86	5.7	5.5		0	
2-JMS099.30	8/6/1986	S	1	30	7.83		6.9		0	1
2-JMS099.30	8/6/1986	M	3	30					0	
2-JMS099.30	8/6/1986	M	5	30					0	

Station ID	Collection Date	Depth Desc	Depth	Temp Celcius	Field Ph	Do Probe	Do Winkler	Fdt Do Optical	Salinity	Secchi Depth
2-JMS099.30	8/6/1986	M	7	29.5					0	
2-JMS099.30	8/6/1986	M	9	29.5					0	
2-JMS099.30	8/6/1986	B	10	29.5	7.76		5		0	1
2-JMS099.30	8/20/1986	S	1	27	7.35	5.1	5		0	0.8
2-JMS099.30	8/20/1986	M	3	27		5.1			0	
2-JMS099.30	8/20/1986	M	5	27		5			0	
2-JMS099.30	8/20/1986	M	7	27		5			0	
2-JMS099.30	8/20/1986	M	9	27		5			0	
2-JMS099.30	8/20/1986	M	11	27		5			0	
2-JMS099.30	8/20/1986	B	12	27	7.4	5	5.3		0	
2-JMS099.30	9/9/1986	S	1	24	8.1	8	7.8		0	1.4
2-JMS099.30	9/9/1986	M	3	23.5		7.7			0	
2-JMS099.30	9/9/1986	M	5	23.5		7.7			0	
2-JMS099.30	9/9/1986	M	7	23.5		7.7			0	
2-JMS099.30	9/9/1986	M	9	23.5		7.8			0	
2-JMS099.30	9/9/1986	B	10	23.5	7.96	7.8	7.2		0	
2-JMS099.30	9/23/1986	S	1	21.7	8.07		8.7		0	1.2
2-JMS099.30	9/23/1986	M	3	21.6					0	
2-JMS099.30	9/23/1986	M	5	21.4					0	
2-JMS099.30	9/23/1986	M	7	21.3					0	
2-JMS099.30	9/23/1986	M	9	21.3					0	
2-JMS099.30	9/23/1986	B	10	21.3	8.19		7.3		0	
2-JMS099.30	10/7/1986	S	1	25.6	7.82	4.9	6.5		0	1.2
2-JMS099.30	10/7/1986	M	3	25.4		4.6			0	
2-JMS099.30	10/7/1986	M	5	25.4		4.6			0	
2-JMS099.30	10/7/1986	M	7	25.4		4.6			0	
2-JMS099.30	10/7/1986	M	9	25.4		4.6			0	
2-JMS099.30	10/7/1986	B	11	25.4	7.83	4.6	6.2		0	
2-JMS099.30	10/28/1986	S	1	17.1	7.89	8	7.8		0	
2-JMS099.30	10/28/1986	M	3	17.1		7.9			0	
2-JMS099.30	10/28/1986	M	5	16.8		7.8			0	
2-JMS099.30	10/28/1986	M	7	16.8		7.8			0	
2-JMS099.30	10/28/1986	M	9	16.8		7.8			0	
2-JMS099.30	10/28/1986	B	11	16.8	7.98	7.7	7.5			
2-JMS099.30	11/25/1986	S	1	8.5	8.07	11.2			0	1.6
2-JMS099.30	11/25/1986	M	3	8.5		11.2			0	
2-JMS099.30	11/25/1986	M	5	8.5		11.2			0	
2-JMS099.30	11/25/1986	M	7	8		11.2			0	
2-JMS099.30	11/25/1986	M	9	8		11.1			0	
2-JMS099.30	11/25/1986	B	11	8	7.93	11.2			0	
2-JMS099.30	12/22/1986	S	1	7.5	8.18	12.1	12.1		0	1.3
2-JMS099.30	12/22/1986	M	3	4.5		12.1			0	
2-JMS099.30	12/22/1986	M	5	4.5		12.1			0	
2-JMS099.30	12/22/1986	M	7	4.5		12.1			0	
2-JMS099.30	12/22/1986	M	9	4.5		12.1			0	
2-JMS099.30	12/22/1986	B	11	4.5	8.1	12.1	12.5		0	
2-JMS099.30	1/5/1987	S	1	4	7.15	12.7	13		0	0.5
2-JMS099.30	1/5/1987	M	3	4		12.6			0	
2-JMS099.30	1/5/1987	M	5	4		12.6			0	
2-JMS099.30	1/5/1987	M	7	4		12.6			0	
2-JMS099.30	1/5/1987	M	9	4		12.6			0	
2-JMS099.30	1/5/1987	B	11	4	7.12	12.6	12.8		0	
2-JMS099.30	3/4/1987	S	1	7.2	7.81	12.4	12.2		0	0.4
2-JMS099.30	3/4/1987	M	3	7.2		12.3			0	
2-JMS099.30	3/4/1987	M	5	7.2		12.4			0	
2-JMS099.30	3/4/1987	M	7	7.2		12.4			0	
2-JMS099.30	3/4/1987	M	9	7.2		12.4			0	
2-JMS099.30	3/4/1987	M	11	7.2		12.4			0	
2-JMS099.30	3/4/1987	B	13	7.2	7.7	12.4	11.5		0	
2-JMS099.30	3/18/1987	S	1	9.1	7.87	12.1	11.1		0	1.7
2-JMS099.30	3/18/1987	M	3	8.9		12.1			0	
2-JMS099.30	3/18/1987	M	5	8.9		12.1			0	
2-JMS099.30	3/18/1987	M	7	8.9		12.1			0	
2-JMS099.30	3/18/1987	M	9	8.8		12.2			0	
2-JMS099.30	3/18/1987	B	11	8.9	7.78	12.2	11.9		0	
2-JMS099.30	4/8/1987	S	1	9.5	7.57	12.5	11.7		0	1.3
2-JMS099.30	4/8/1987	M	3	9.4		12.5			0	
2-JMS099.30	4/8/1987	M	5	9.4		12.4			0	
2-JMS099.30	4/8/1987	M	7	9.4		12.4			0	
2-JMS099.30	4/8/1987	M	9	9.4		12.4			0	
2-JMS099.30	4/8/1987	B	11	9.4	7.71	12.4	11.1		0	
2-JMS099.30	4/14/1987	S	1	12	6.84	7.6	8.9		0	1
2-JMS099.30	4/14/1987	M	3	12		7.6			0	
2-JMS099.30	4/14/1987	M	5	12		7.6			0	
2-JMS099.30	4/14/1987	M	7	12		7.5			0	

Station ID	Collection Date	Depth Desc	Depth	Temp Celcius	Field Ph	Do Probe	Do Winkler	Fdt Do Optical	Salinity	Secchi Depth
2-JMS099.30	4/14/1987	M	9	12		7.5			0	
2-JMS099.30	4/14/1987	B	11	12	7.02	7.5	8.2		0	
2-JMS099.30	5/6/1987	S	1	16.5	7.78	9.8	9.1		0	0.8
2-JMS099.30	5/6/1987	M	3	16.5		9.8			0	
2-JMS099.30	5/6/1987	M	5	16.5		9.7			0	
2-JMS099.30	5/6/1987	M	7	16.5		9.6			0	
2-JMS099.30	5/6/1987	M	9	16.5		9.6			0	
2-JMS099.30	5/6/1987	M	11	16.5		9.6			0	
2-JMS099.30	5/6/1987	B	12	16.5	7.61	9.6	9.5		0	
2-JMS099.30	5/18/1987	S	1	23.38	9.22	10	8.7		0	1.1
2-JMS099.30	5/18/1987	M	3	22.9		9.4			0	
2-JMS099.30	5/18/1987	M	5	22.6		9.1			0	
2-JMS099.30	5/18/1987	M	7	22.4		9.1			0	
2-JMS099.30	5/18/1987	M	9	22.3		9			0	
2-JMS099.30	5/18/1987	B	10	22	8.81	9	9.2		0	
2-JMS099.30	6/1/1987	S	1	28.4		7.63	7.4		0	
2-JMS099.30	6/1/1987	M	3	28		7.08			0	
2-JMS099.30	6/1/1987	M	5	28		7.1			0	
2-JMS099.30	6/1/1987	M	7	28		7.13			0	
2-JMS099.30	6/1/1987	M	9	28		7.16			0	
2-JMS099.30	6/1/1987	B	11	28	7.35	7.14	6.9		0	
2-JMS099.30	6/15/1987	S	1	27.1	7.96	6.6	5.7		0	0.8
2-JMS099.30	6/15/1987	M	3	26.8		6.3			0	
2-JMS099.30	6/15/1987	M	5	26.7		6.1			0	
2-JMS099.30	6/15/1987	M	7	26.6		5.9			0	
2-JMS099.30	6/15/1987	M	9	26.6		5.8			0	
2-JMS099.30	6/15/1987	B	11	26.6	7.96	6.1	5.5		0	
2-JMS099.30	6/29/1987	S	1	28	7.38	5.7	6.1		0	1
2-JMS099.30	6/29/1987	M	3	27.5		5.3			0	
2-JMS099.30	6/29/1987	M	5	27.5		5.3			0	
2-JMS099.30	6/29/1987	M	7	27.5		5.3			0	
2-JMS099.30	6/29/1987	M	9	27.5		5.3			0	
2-JMS099.30	6/29/1987	B	11	27.5	7.4	5.3	4.9		0	
2-JMS099.30	7/13/1987	S	1	32	8.24	5.8	5.7		0	1.2
2-JMS099.30	7/13/1987	M	3	31.5		5.4			0	
2-JMS099.30	7/13/1987	M	5	31		5.3			0	
2-JMS099.30	7/13/1987	M	7	31		5.3			0	
2-JMS099.30	7/13/1987	M	9	31		5.3			0	
2-JMS099.30	7/13/1987	B	11	31	8.2	5.2	5.2		0	
2-JMS099.30	8/11/1987	S	1	30.8		7.47	6.2		0	1
2-JMS099.30	8/11/1987	M	3	29.9		5.87			0	
2-JMS099.30	8/11/1987	M	5	29.8		5.76			0	
2-JMS099.30	8/11/1987	M	7	29.8		5.75			0	
2-JMS099.30	8/11/1987	B	9	29.8	8.28	5.66	5.3		0	
2-JMS099.30	8/25/1987	S	1	27.7	7.78	4	3.9		0	0.9
2-JMS099.30	8/25/1987	M	3	27.7		3.8			0	
2-JMS099.30	8/25/1987	M	5	27.7		3.9			0	
2-JMS099.30	8/25/1987	M	7	27.7		3.9			0	
2-JMS099.30	8/25/1987	M	9	27.6		3.9			0	
2-JMS099.30	8/25/1987	B	11	27.6	8.28	3.8	4		0	
2-JMS099.30	10/8/1987	S	1	17.3	7.38	8.4	8.9		0	0.8
2-JMS099.30	10/8/1987	M	3	17.3		8.4			0	
2-JMS099.30	10/8/1987	M	5	17.2		8.4			0	
2-JMS099.30	10/8/1987	M	7	17.2		8.4			0	
2-JMS099.30	10/8/1987	B	9	17.2	7.38	8.4	8.6		0	
2-JMS099.30	10/27/1987	S	1	14.4		9.8			0	1.1
2-JMS099.30	10/27/1987	M	3	14.4		9.5			0	
2-JMS099.30	10/27/1987	M	5	14.4		9.4			0	
2-JMS099.30	10/27/1987	M	7	14.4		9.4			0	
2-JMS099.30	10/27/1987	M	9	14.4		9.5			0	
2-JMS099.30	10/27/1987	B	10	14.4		9.5			0	
2-JMS099.30	11/9/1987	S	1	14	7.7	8.8	8.7		0	1
2-JMS099.30	11/9/1987	M	3	14		8.7			0	
2-JMS099.30	11/9/1987	M	5	14		8.8			0	
2-JMS099.30	11/9/1987	M	7	14		8.7			0	
2-JMS099.30	11/9/1987	M	9	14		8.7			0	
2-JMS099.30	11/9/1987	B	10	14	7.87	8.7	8.8		0	
2-JMS099.30	3/7/1988	S	1							
2-JMS099.30	5/16/1988	S	11							
2-JMS099.30	6/29/1988	S	1	25.5	7.83	5.01			0	0.6
2-JMS099.30	6/29/1988	M	3	25.5		5.02			0	
2-JMS099.30	6/29/1988	M	5	25.5		4.78			0	
2-JMS099.30	6/29/1988	M	7	25.3		5			0	
2-JMS099.30	6/29/1988	B	8	25.4	7.83	5.03			0	
2-JMS099.30	7/18/1988	S	1	30	7.47	6.9			0	

Station ID	Collection Date	Depth Desc	Depth	Temp Celcius	Field Ph	Do Probe	Do Winkler	Fdt Do Optical	Salinity	Secchi Depth
2-JMS099.30	7/18/1988	M	3	30		4.8			0	
2-JMS099.30	7/18/1988	M	5	30		4.5			0	
2-JMS099.30	7/18/1988	M	7	30		4.3			0	
2-JMS099.30	7/18/1988	M	9	30		4.4			0	
2-JMS099.30	7/18/1988	B	11	30	7.54	4.3			0	
2-JMS099.30	8/1/1988	S	1	28.4	7.38	6.47			0	0.7
2-JMS099.30	8/1/1988	M	3	28.3		6.45			0	
2-JMS099.30	8/1/1988	M	5	28.2		6.2			0	
2-JMS099.30	8/1/1988	M	7	28.1		6.1			0	
2-JMS099.30	8/1/1988	B	9	28	7.33	5.97			0	
2-JMS099.30	8/15/1988	S	1	29.2	7.84	7.28			0	0.6
2-JMS099.30	8/15/1988	M	3	28.5		5.2			0	
2-JMS099.30	8/15/1988	M	5	28.5		4.84			0	
2-JMS099.30	8/15/1988	M	7	28.4		4.78			0	
2-JMS099.30	8/15/1988	M	9	28.4		3.54			0	
2-JMS099.30	8/15/1988	B	10	28.4	7.66	3.37			0	
2-JMS099.30	9/12/1988	S	1	23.8	7.66	7.6			0	0.4
2-JMS099.30	9/12/1988	M	3	23.6		7.3			0	
2-JMS099.30	9/12/1988	M	5	23.6		7.3			0	
2-JMS099.30	9/12/1988	M	7	23.6		7.3			0	
2-JMS099.30	9/12/1988	M	9	23.5		7.2			0	
2-JMS099.30	9/12/1988	B	11	23.5	7.5	7.2			0	
2-JMS099.30	9/27/1988	S	1	23.7	7.38	6.1			0	1
2-JMS099.30	9/27/1988	M	3	23.6		5.9			0	
2-JMS099.30	9/27/1988	M	5	23.6		5.9			0	
2-JMS099.30	9/27/1988	M	7	23.6		5.9			0	
2-JMS099.30	9/27/1988	M	9	23.6		5.8			0	
2-JMS099.30	9/27/1988	B	11	23.6	7.31	5.8			0	
2-JMS099.30	10/11/1988	S	1	17.4	7.57	7.91			0	0.9
2-JMS099.30	10/11/1988	M	3	17.3		7.9			0	
2-JMS099.30	10/11/1988	M	5	17.3		7.92			0	
2-JMS099.30	10/11/1988	M	7	17.3		7.89			0	
2-JMS099.30	10/11/1988	B	9	17.3		7.89				
2-JMS099.30	10/26/1988	S	1	14	7.58	8.33			0	0.6
2-JMS099.30	10/26/1988	M	3	14		8.28			0	
2-JMS099.30	10/26/1988	M	5	13.9		8.31			0	
2-JMS099.30	10/26/1988	M	7	13.9		8.31			0	
2-JMS099.30	10/26/1988	M	9	13.9		8.76			0	
2-JMS099.30	10/26/1988	B	11	13.9	7.44	8.4			0	
2-JMS099.30	11/14/1988	S	1	12	7.52	9.92			0	0.7
2-JMS099.30	11/14/1988	M	3	11.9		9.94			0	
2-JMS099.30	11/14/1988	M	5	11.8		9.91			0	
2-JMS099.30	11/14/1988	M	7	11.8		9.9			0	
2-JMS099.30	11/14/1988	M	9	11.8		9.9			0	
2-JMS099.30	11/14/1988	B	11	11.8	7.49	9.91			0	
2-JMS099.30	12/20/1988	S	1	3.13	8.02	13.52			0	0.7
2-JMS099.30	12/20/1988	M	3	3.05		13.72			0	
2-JMS099.30	12/20/1988	M	5	3.05		13.66			0	
2-JMS099.30	12/20/1988	M	7	2.98		13.69			0	
2-JMS099.30	12/20/1988	M	9	2.97		13.65			0	
2-JMS099.30	12/20/1988	B	11	2.94	7.64	13.68			0	
2-JMS099.30	1/11/1989	S	1	6.12	7.45	12			0	1.3
2-JMS099.30	1/11/1989	M	3	6.1		12			0	
2-JMS099.30	1/11/1989	M	5	6.09		11.95			0	
2-JMS099.30	1/11/1989	M	7	6.07		11.96			0	
2-JMS099.30	1/11/1989	M	9	6.03		11.99			0	
2-JMS099.30	1/11/1989	B	11	6.02	7.45	12.01			0	
2-JMS099.30	2/8/1989	S	1	6.87	7.59	11.84			0	1.4
2-JMS099.30	2/8/1989	M	3	6.85		11.86			0	
2-JMS099.30	2/8/1989	M	5	6.84		11.86			0	
2-JMS099.30	2/8/1989	M	7	6.84		11.81			0	
2-JMS099.30	2/8/1989	M	9	6.84		11.81			0	
2-JMS099.30	2/8/1989	B	11	6.85	7.59	11.8			0	
2-JMS099.30	3/15/1989	S	1	8.26	7.22	11.63			0	0.7
2-JMS099.30	3/15/1989	M	3	8.14		11.63			0	
2-JMS099.30	3/15/1989	M	5	8.09		11.64			0	
2-JMS099.30	3/15/1989	M	7	8.05		11.67			0	
2-JMS099.30	3/15/1989	M	9	8.04		11.63			0	
2-JMS099.30	3/15/1989	M	11	8.08		11.54			0	
2-JMS099.30	3/15/1989	B	12	8.04	7.28	11.68			0	
2-JMS099.30	3/28/1989	S	1	13.03	7.37	10.4			0	0.6
2-JMS099.30	3/28/1989	M	3	12.94		10.4			0	
2-JMS099.30	3/28/1989	M	5	12.95		10.41			0	
2-JMS099.30	3/28/1989	M	7	12.88		10.41			0	
2-JMS099.30	3/28/1989	B	9	12.81	7.37	10.4			0	

Station ID	Collection Date	Depth Desc	Depth	Temp Celcius	Field Ph	Do Probe	Do Winkler	Fdt Do Optical	Salinity	Secchi Depth
2-JMS099.30	4/13/1989	S	1	12.12	7.13	10.52			0	1
2-JMS099.30	4/13/1989	M	3	11.99		10.52			0	
2-JMS099.30	4/13/1989	M	5	11.97		10.49			0	
2-JMS099.30	4/13/1989	M	7	11.89		10.49			0	
2-JMS099.30	4/13/1989	M	9	11.78		10.49			0	
2-JMS099.30	4/13/1989	B	10	11.68	7.21	10.49			0	
2-JMS099.30	2/13/1990	S	1	9.25	7.4	11.23			0	0.3
2-JMS099.30	2/13/1990	M	3	9.24		11.18			0	
2-JMS099.30	2/13/1990	M	5	9.22		11.19			0	
2-JMS099.30	2/13/1990	M	7	9.24		11.19			0	
2-JMS099.30	2/13/1990	M	9	9.27		11.17			0	
2-JMS099.30	2/13/1990	B	10	9.31	7.43	11.02			0	
2-JMS099.30	3/13/1990	S	1	15.18	7.95	10.21			0	1.4
2-JMS099.30	3/13/1990	M	3	14.83		10.16			0	
2-JMS099.30	3/13/1990	M	5	14.86		10.15			0	
2-JMS099.30	3/13/1990	M	7	14.88		10.17			0	
2-JMS099.30	3/13/1990	M	9	14.94		10.15			0	
2-JMS099.30	3/13/1990	B	11	14.9	7.72	10.1			0	
2-JMS099.30	3/28/1990	S	1	11.73	7.44	10.6			0	0.8
2-JMS099.30	3/28/1990	M	3	11.66		10.6			0	
2-JMS099.30	3/28/1990	M	5	11.74		10.65			0	
2-JMS099.30	3/28/1990	M	7	11.63		10.61			0	
2-JMS099.30	3/28/1990	M	9	11.63		10.63			0	
2-JMS099.30	3/28/1990	B	11	11.58	7.43	10.65			0	
2-JMS099.30	4/10/1990	S	1	12.11	7.15	10.58			0	0.6
2-JMS099.30	4/10/1990	M	3	12.09		10.57			0	
2-JMS099.30	4/10/1990	M	5	12.09		10.53			0	
2-JMS099.30	4/10/1990	M	7	12.06		10.55			0	
2-JMS099.30	4/10/1990	M	9	12.09		10.54			0	
2-JMS099.30	4/10/1990	B	10	12.08	7.16	10.45			0	
2-JMS099.30	4/25/1990	S	1	20.07	7.5	8.62			0	1
2-JMS099.30	4/25/1990	M	3	20.01		8.66			0	
2-JMS099.30	4/25/1990	M	5	19.99		8.71			0	
2-JMS099.30	4/25/1990	M	7	19.99		8.71			0	
2-JMS099.30	4/25/1990	M	9	20		8.7			0	
2-JMS099.30	4/25/1990	B	11	20	7.49	8.71			0	
2-JMS099.30	5/9/1990	S	1	21.95	7.6	8.12			0	0.9
2-JMS099.30	5/9/1990	M	3	21.85		8.11			0	
2-JMS099.30	5/9/1990	M	5	21.83		8.12			0	
2-JMS099.30	5/9/1990	M	7	21.78		8.13			0	
2-JMS099.30	5/9/1990	M	9	21.74		8.16			0	
2-JMS099.30	5/9/1990	B	11	21.63	7.5	8.19			0	
2-JMS099.30	5/31/1990	S	1	17.94	7.17	9.13			0	0.3
2-JMS099.30	5/31/1990	M	3	17.94		9.13			0	
2-JMS099.30	5/31/1990	M	5	17.95		9.16			0	
2-JMS099.30	5/31/1990	M	7	17.96		9.15			0	
2-JMS099.30	5/31/1990	M	9	17.92		9.16			0	
2-JMS099.30	5/31/1990	M	11	17.94		9.13			0	
2-JMS099.30	5/31/1990	B	12	17.94	7.3	9.15			0	
2-JMS099.30	6/14/1990	S	1	24.69	7.37	8.21			0	1
2-JMS099.30	6/14/1990	M	3	24.33		7.97			0	
2-JMS099.30	6/14/1990	M	5	24.24		7.88			0	
2-JMS099.30	6/14/1990	M	7	24.22		7.91			0	
2-JMS099.30	6/14/1990	M	9	24.24		7.9			0	
2-JMS099.30	6/14/1990	B	11	24.25	7.39	7.87			0	
2-JMS099.30	6/27/1990	S	1	28	7.25	6.9			0	
2-JMS099.30	6/27/1990	M	3	27.74		6.7			0	
2-JMS099.30	6/27/1990	M	5	27.73		6.67			0	
2-JMS099.30	6/27/1990	M	7	27.68		6.66			0	
2-JMS099.30	6/27/1990	M	9	27.66		6.64			0	
2-JMS099.30	6/27/1990	B	11	27.66	7.3	6.61			0	
2-JMS099.30	7/10/1990	S	1	29.95	7.27	7.39			0	0.7
2-JMS099.30	7/10/1990	M	3	29.65		6.75			0	
2-JMS099.30	7/10/1990	M	5	29.22		6.39			0	
2-JMS099.30	7/10/1990	M	7	29.2		6.38			0	
2-JMS099.30	7/10/1990	M	9	29.12		6.41			0	
2-JMS099.30	7/10/1990	B	11	29.12	7.38	6.36			0	
2-JMS099.30	7/24/1990	S	1	30.21	7.32	7.5			0	1.2
2-JMS099.30	7/24/1990	M	3	30.06		7.25			0	
2-JMS099.30	7/24/1990	M	5	30.07		7.33			0	
2-JMS099.30	7/24/1990	M	7	30.05		7.27			0	
2-JMS099.30	7/24/1990	M	9	30.03		7.02			0	
2-JMS099.30	7/24/1990	B	10	29.91	7.22	6.96			0	
2-JMS099.30	8/7/1990	S	1	27.8	6.81	6.42			0	0.8
2-JMS099.30	8/7/1990	M	3	27.69		6.09			0	

Station ID	Collection Date	Depth Desc	Depth	Temp Celcius	Field Ph	Do Probe	Do Winkler	Fdt Do Optical	Salinity	Secchi Depth
2-JMS099.30	8/7/1990	M	5	27.54		6			0	
2-JMS099.30	8/7/1990	M	7	27.46		6.08			0	
2-JMS099.30	8/7/1990	M	9	27.4		6.14			0	
2-JMS099.30	8/7/1990	B	11	27.42	6.95	6.46			0	
2-JMS099.30	8/23/1990	S	1	27.47	6.97	5.79			0	1.1
2-JMS099.30	8/23/1990	M	3	27.23		5.8			0	
2-JMS099.30	8/23/1990	M	5	27.01		5.72			0	
2-JMS099.30	8/23/1990	M	7	26.79		5.8			0	
2-JMS099.30	8/23/1990	M	9	26.75		5.92			0	
2-JMS099.30	8/23/1990	M	11	26.71		6.07			0	
2-JMS099.30	8/23/1990	B	12	26.73	7.03	6.26			0	
2-JMS099.30	9/6/1990	S	1	27.96	7.12	7.08			0	1.4
2-JMS099.30	9/6/1990	M	3	27.86		6.79			0	
2-JMS099.30	9/6/1990	M	5	27.79		6.73			0	
2-JMS099.30	9/6/1990	M	7	27.82		6.78			0	
2-JMS099.30	9/6/1990	M	9	27.8		6.73			0	
2-JMS099.30	9/6/1990	B	11	27.78	7.16	6.72			0	
2-JMS099.30	9/24/1990	S	1	22.25	7.4	8.86			0	1.3
2-JMS099.30	9/24/1990	M	3	21.9		7.92			0	
2-JMS099.30	9/24/1990	M	5	21.77		7.73			0	
2-JMS099.30	9/24/1990	M	7	21.76		7.71			0	
2-JMS099.30	9/24/1990	M	9	21.76		7.66			0	
2-JMS099.30	9/24/1990	B	11	21.74		7.65			0	
2-JMS099.30	10/9/1990	S	1	23.06	7.08	7.79			0	1.3
2-JMS099.30	10/9/1990	M	3	22.8		7.35			0	
2-JMS099.30	10/9/1990	M	5	22.45		7.14			0	
2-JMS099.30	10/9/1990	M	7	22.45		7.09			0	
2-JMS099.30	10/9/1990	M	9	22.46		7.11			0	
2-JMS099.30	10/9/1990	B	11	22.48	7.24	7.08			0	
2-JMS099.30	10/25/1990	S	1	15.94	7.27	9.2			0	0.1
2-JMS099.30	10/25/1990	M	3	15.94		9.21			0	
2-JMS099.30	10/25/1990	M	5	15.94		9.23			0	
2-JMS099.30	10/25/1990	M	7	15.94		9.19			0	
2-JMS099.30	10/25/1990	M	9	15.95		9.15			0	
2-JMS099.30	10/25/1990	B	11	15.95	7.29	9.11			0	
2-JMS099.30	11/7/1990	S	1	14.88	7.1	9.42			0	1.1
2-JMS099.30	11/7/1990	M	3	14.86		9.43			0	
2-JMS099.30	11/7/1990	M	5	14.77		9.41			0	
2-JMS099.30	11/7/1990	M	7	14.77		9.42			0	
2-JMS099.30	11/7/1990	M	9	14.8		9.4			0	
2-JMS099.30	11/7/1990	B	11	14.8	7.1	9.45			0	
2-JMS099.30	12/12/1990	S	1	6.57	7.04	12.85			0	2
2-JMS099.30	12/12/1990	M	3	6.57		12.86			0	
2-JMS099.30	12/12/1990	M	5	6.56		12.85			0	
2-JMS099.30	12/12/1990	M	7	6.56		13.1			0	
2-JMS099.30	12/12/1990	M	9	6.53		13.06			0	
2-JMS099.30	12/12/1990	B	10	6.56	7	13.1			0	
2-JMS099.30	1/14/1991	S	1	6.35	7.14	11.81			0	0.2
2-JMS099.30	1/14/1991	M	3	6.35		12.17			0	
2-JMS099.30	1/14/1991	B	10	6.36	7.2	12.12			0	
2-JMS099.30	2/25/1991	S	1	7.36	7.25	12.21			0	1.1
2-JMS099.30	2/25/1991	M	3	7.32		12.29			0	
2-JMS099.30	2/25/1991	M	5	7.33		12.3			0	
2-JMS099.30	2/25/1991	M	7	7.34		12.36			0	
2-JMS099.30	2/25/1991	M	9	7.33		12.47			0	
2-JMS099.30	2/25/1991	B	11	7.36	7.24	12.57			0	
2-JMS099.30	3/6/1991	S	1	10.05	7.11	11.09			0	0.1
2-JMS099.30	3/6/1991	M	3	10.06		11.09			0	
2-JMS099.30	3/6/1991	M	5	10.06		11.08			0	
2-JMS099.30	3/6/1991	M	7	10.07		11.17			0	
2-JMS099.30	3/6/1991	M	9	10.08		11.25			0	
2-JMS099.30	3/6/1991	B	11	10.08	7.1	11.43			0	
2-JMS099.30	3/20/1991	S	1	10.19	6.94	10.88			0	0.5
2-JMS099.30	3/20/1991	M	3	10.19		10.89			0	
2-JMS099.30	3/20/1991	M	5	10.15		10.91			0	
2-JMS099.30	3/20/1991	M	7	10.16		10.89			0	
2-JMS099.30	3/20/1991	M	9	10.17		10.89			0	
2-JMS099.30	3/20/1991	B	10	10.18	6.95	10.88			0	
2-JMS099.30	4/3/1991	S	1	11.47	6.86	11.17			0	0.4
2-JMS099.30	4/3/1991	M	3	11.46		11.18			0	
2-JMS099.30	4/3/1991	M	5	11.46		11.24			0	
2-JMS099.30	4/3/1991	M	7	11.48		11.27			0	
2-JMS099.30	4/3/1991	M	9	11.48		11.33			0	
2-JMS099.30	4/3/1991	B	10	11.48	6.84	11.38			0	
2-JMS099.30	4/23/1991	S	1	14.06	6.99	10.13			0	1.3

Station ID	Collection Date	Depth Desc	Depth	Temp Celcius	Field Ph	Do Probe	Do Winkler	Fdt Do Optical	Salinity	Secchi Depth
2-JMS099.30	4/23/1991	M	3	14		10.19			0	
2-JMS099.30	4/23/1991	M	5	13.9		10.2			0	
2-JMS099.30	4/23/1991	M	7	13.9		10.25			0	
2-JMS099.30	4/23/1991	M	9	13.91		10.36			0	
2-JMS099.30	4/23/1991	B	10	13.91	6.98	10.38			0	
2-JMS099.30	5/2/1991	S	1	21.79	7.29	8.38			0	1.5
2-JMS099.30	5/2/1991	M	3	21.79		8.36			0	
2-JMS099.30	5/2/1991	M	5	21.78		8.39			0	
2-JMS099.30	5/2/1991	M	7	21.78		8.42			0	
2-JMS099.30	5/2/1991	M	9	21.79		8.44			0	
2-JMS099.30	5/2/1991	B	11	21.82	7.14	8.51			0	
2-JMS099.30	5/16/1991	S	1	25.7	7.21	6.97			0	
2-JMS099.30	5/16/1991	M	3	25.52		7			0	
2-JMS099.30	5/16/1991	M	5	25.41		7.06			0	
2-JMS099.30	5/16/1991	M	7	25.41		7.01			0	
2-JMS099.30	5/16/1991	M	9	25.33		7.01			0	
2-JMS099.30	5/16/1991	B	11	25.3	7.27	7.02			0	
2-JMS099.30	6/13/1991	S	1	26.83	7.29	7.31			0	1
2-JMS099.30	6/13/1991	M	3	26.81		7.17			0	
2-JMS099.30	6/13/1991	M	5	26.8		7.14			0	
2-JMS099.30	6/13/1991	M	7	26.8		7.13			0	
2-JMS099.30	6/13/1991	B	8	26.78	7.27	7.1			0	
2-JMS099.30	6/27/1991	S	1	25.94	7.06	7.13			0	1
2-JMS099.30	6/27/1991	M	3	25.22		7.02			0	
2-JMS099.30	6/27/1991	M	5	25.13		7.04			0	
2-JMS099.30	6/27/1991	M	7	25.06		7.07			0	
2-JMS099.30	6/27/1991	B	9	24.94	7.13	7.07			0	
2-JMS099.30	7/16/1991	S	1	28.78	7.14	6.3			0	0.7
2-JMS099.30	7/16/1991	M	3	28.57		6.35			0	
2-JMS099.30	7/16/1991	M	5	28.52		6.31			0	
2-JMS099.30	7/16/1991	M	7	28.66		6.34			0	
2-JMS099.30	7/16/1991	M	9	28.32		6.21			0	
2-JMS099.30	7/16/1991	B	10	28.33	7.25	6.24			0	
2-JMS099.30	7/30/1991	S	1	24.61	6.73	7.11			0	0.4
2-JMS099.30	7/30/1991	M	3	24.57		7.11			0	
2-JMS099.30	7/30/1991	M	5	24.56		7.13			0	
2-JMS099.30	7/30/1991	M	7	24.56		7.17			0	
2-JMS099.30	7/30/1991	M	9	24.56		7.23			0	
2-JMS099.30	7/30/1991	B	10	24.56	6.79	7.38			0	
2-JMS099.30	8/13/1991	S	1	26.32	6.74	7.59			0	0.6
2-JMS099.30	8/13/1991	M	3	26.05		7.61			0	
2-JMS099.30	8/13/1991	M	5	26.02		7.66			0	
2-JMS099.30	8/13/1991	M	7	26.04		7.68			0	
2-JMS099.30	8/13/1991	M	9	26.05		7.72			0	
2-JMS099.30	8/13/1991	B	10	26.07	6.82	7.78			0	
2-JMS099.30	8/27/1991	S	1	28.16	7.07	6.38			0	1.6
2-JMS099.30	8/27/1991	M	3	27.89		6.21			0	
2-JMS099.30	8/27/1991	M	5	27.69		6.19			0	
2-JMS099.30	8/27/1991	M	7	27.73		6.22			0	
2-JMS099.30	8/27/1991	M	9	27.68		6.23			0	
2-JMS099.30	8/27/1991	B	11	27.57	6.94	6.46			0	
2-JMS099.30	9/12/1991	S	1	27.4	7.4	8.64			0	1
2-JMS099.30	9/12/1991	M	3	27.2		8.21			0	
2-JMS099.30	9/12/1991	M	5	27.22		8.26			0	
2-JMS099.30	9/12/1991	M	7	27.12		8.1			0	
2-JMS099.30	9/12/1991	M	9	27.13		8.23			0	
2-JMS099.30	9/12/1991	B	10	27.14		8.12			0	
2-JMS099.30	10/1/1991	S	1	22.11	7.13	7.73			0	1
2-JMS099.30	10/1/1991	M	3	21.86		7.38			0	
2-JMS099.30	10/1/1991	M	5	21.72		7.35			0	
2-JMS099.30	10/1/1991	M	7	21.67		7.3			0	
2-JMS099.30	10/1/1991	B	9	21.69	7.21	7.3			0	
2-JMS099.30	10/10/1991	S	1	21	7.22	7.34			0	1.1
2-JMS099.30	10/10/1991	M	3	20.92		7.37			0	
2-JMS099.30	10/10/1991	M	5	20.8		7.73			0	
2-JMS099.30	10/10/1991	M	7	20.72		7.96			0	
2-JMS099.30	10/10/1991	M	9	20.69		7.86			0	
2-JMS099.30	10/10/1991	B	11	20.7	7.21	8.13			0	
2-JMS099.30	10/28/1991	S	1	10	6.94	8			0	1.4
2-JMS099.30	10/28/1991	M	3	18.2		8.05			0	
2-JMS099.30	10/28/1991	M	5	18.19		8.09			0	
2-JMS099.30	10/28/1991	M	7	18.19		8.14			0	
2-JMS099.30	10/28/1991	M	9	18.2		8.22			0	
2-JMS099.30	10/28/1991	B	11	18.17	7.02	8.29			0	
2-JMS099.30	11/18/1991	S	1	9.9	7.34	10.52			0	1.4

Station ID	Collection Date	Depth Desc	Depth	Temp Celcius	Field Ph	Do Probe	Do Winkler	Fdt Do Optical	Salinity	Secchi Depth
2-JMS099.30	11/18/1991	M	3	9.72		10.78			0	
2-JMS099.30	11/18/1991	M	5	9.67		10.88			0	
2-JMS099.30	11/18/1991	M	7	9.64		10.95			0	
2-JMS099.30	11/18/1991	M	9	9.64		11.11			0	
2-JMS099.30	11/18/1991	B	10	9.64	7.55	11.45			0	
2-JMS099.30	12/11/1991	S	1	9.91	7.12	10.41			0	0.7
2-JMS099.30	12/11/1991	M	3	9.86		10.4			0	
2-JMS099.30	12/11/1991	M	5	9.81		10.38			0	
2-JMS099.30	12/11/1991	M	7	9.81		10.81			0	
2-JMS099.30	12/11/1991	M	9	9.81		10.77			0	
2-JMS099.30	12/11/1991	B	11	9.81	7.26	10.77			0	
2-JMS099.30	1/9/1992	S	1	7	7.05	13.29			0	0.4
2-JMS099.30	1/9/1992	M	3	7		13.19			0	
2-JMS099.30	1/9/1992	M	5	7		13.3			0	
2-JMS099.30	1/9/1992	M	7	7		13.51			0	
2-JMS099.30	1/9/1992	M	9	6.98		13.52			0	
2-JMS099.30	1/9/1992	B	11	7	7.11	13.41			0	
2-JMS099.30	2/10/1992	S	1	5.27	7.25	12.43			0	1.9
2-JMS099.30	2/10/1992	M	3	5.26		12.43			0	
2-JMS099.30	2/10/1992	M	5	5.26		12.44			0	
2-JMS099.30	2/10/1992	M	7	5.26		12.44			0	
2-JMS099.30	2/10/1992	M	9	5.26		12.37			0	
2-JMS099.30	2/10/1992	B	11	5.26	7.05	12.37			0	
2-JMS099.30	3/24/1992	S	1	8.74	7.17	11.4			0	1.1
2-JMS099.30	3/24/1992	M	3	8.72		12.25			0	
2-JMS099.30	3/24/1992	M	5	8.68		12.25			0	
2-JMS099.30	3/24/1992	M	7	8.68		12.19			0	
2-JMS099.30	3/24/1992	M	9	8.68		12.19			0	
2-JMS099.30	3/24/1992	B	10	8.68	7.14	12.14			0	
2-JMS099.30	4/7/1992	S	1	10.76	7	11.16			0	1.5
2-JMS099.30	4/7/1992	M	3	10.72		11.13			0	
2-JMS099.30	4/7/1992	M	5	10.74		11.25			0	
2-JMS099.30	4/7/1992	M	7	10.74		11.36			0	
2-JMS099.30	4/7/1992	M	9	10.76		11.84			0	
2-JMS099.30	4/7/1992	B	11	10.81	6.85	11.8			0	
2-JMS099.30	4/21/1992	S	1	19.78	7.48	8			0	1.3
2-JMS099.30	4/21/1992	M	3	19.77		7.98			0	
2-JMS099.30	4/21/1992	M	5	19.77		7.91			0	
2-JMS099.30	4/21/1992	M	7	19.74		7.95			0	
2-JMS099.30	4/21/1992	M	9	19.73		7.88			0	
2-JMS099.30	4/21/1992	B	11	19.75	7.43	7.95			0	
2-JMS099.30	5/6/1992	S	1	18.03	7.39	8.71			0	1.5
2-JMS099.30	5/6/1992	M	3	18.01		8.72			0	
2-JMS099.30	5/6/1992	M	5	17.99		8.72			0	
2-JMS099.30	5/6/1992	M	7	17.98		8.72			0	
2-JMS099.30	5/6/1992	M	9	17.97		8.73			0	
2-JMS099.30	5/6/1992	M	11	17.96		8.73			0	
2-JMS099.30	5/6/1992	B	12	17.95	7.22	8.74			0	
2-JMS099.30	5/27/1992	S	1	19.39	7.33	8.39			0	1.6
2-JMS099.30	5/27/1992	M	3	19.3		8.35			0	
2-JMS099.30	5/27/1992	M	5	19.27		8.37			0	
2-JMS099.30	5/27/1992	M	7	19.26		8.37			0	
2-JMS099.30	5/27/1992	M	9	19.26		8.37			0	
2-JMS099.30	5/27/1992	M	11	19.27		8.36			0	
2-JMS099.30	5/27/1992	B	12	19.29	7.19	8.39			0	
2-JMS099.30	5/27/1992	S	0.3							
2-JMS099.30	6/18/1992	S	0.3							
2-JMS099.30	6/18/1992	S	1	24.34	7.73	8.16			0	1.2
2-JMS099.30	6/18/1992	M	3	24.05		8.06			0	
2-JMS099.30	6/18/1992	M	5	23.94		8.04			0	
2-JMS099.30	6/18/1992	M	7	23.86		8.01			0	
2-JMS099.30	6/18/1992	M	9	23.83		7.99			0	
2-JMS099.30	6/18/1992	B	11	23.77	7.54	7.98			0	
2-JMS099.30	7/6/1992	S	1	27.95	7.66	7.28			0	1.3
2-JMS099.30	7/6/1992	M	3	27.91		7.29			0	
2-JMS099.30	7/6/1992	M	5	27.87		7.31			0	
2-JMS099.30	7/6/1992	M	7	27.85		7.3			0	
2-JMS099.30	7/6/1992	M	9	27.85		7.32			0	
2-JMS099.30	7/6/1992	B	11	27.84	7.5	7.34			0	
2-JMS099.30	7/20/1992	S	1	30.58	7.2	6.37			0	1.2
2-JMS099.30	7/20/1992	M	3	30.4		6.15			0	
2-JMS099.30	7/20/1992	M	5	30.25		5.89			0	
2-JMS099.30	7/20/1992	M	7	30.21		6.22			0	
2-JMS099.30	7/20/1992	B	9	30.22	7.1	6.25			0	
2-JMS099.30	7/20/1992	S	0.3	30.5	7.2	6.3				

Station ID	Collection Date	Depth Desc	Depth	Temp Celcius	Field Ph	Do Probe	Do Winkler	Fdt Do Optical	Salinity	Secchi Depth
2-JMS099.30	9/1/1992	S	1	26.74	7.45	7.84			0	1.2
2-JMS099.30	9/1/1992	M	3	26.58		7.57			0	
2-JMS099.30	9/1/1992	M	5	26.39		7.09			0	
2-JMS099.30	9/1/1992	M	7	26.39		7.13			0	
2-JMS099.30	9/1/1992	M	9	26.39		7.13			0	
2-JMS099.30	9/1/1992	B	10	26.39	7.28	7.17			0	
2-JMS099.30	9/1/1992	S	0.3							
2-JMS099.30	10/8/1992	S	0.3							
2-JMS099.30	10/8/1992	M	1	18.21	7.29	8.39			0	1.4
2-JMS099.30	10/8/1992	M	3	17.94		8.43			0	
2-JMS099.30	10/8/1992	M	5	17.84		8.49			0	
2-JMS099.30	10/8/1992	M	7	17.69		8.5			0	
2-JMS099.30	10/8/1992	M	9	17.69		8.66			0	
2-JMS099.30	10/8/1992	M	11	17.65		8.73			0	
2-JMS099.30	10/8/1992	B	12	17.66	7.29	8.87			0	
2-JMS099.30	11/2/1992	S	1	14.91	7.15	9.22			0	1.6
2-JMS099.30	11/2/1992	M	3	14.9		9.22			0	
2-JMS099.30	11/2/1992	M	5	14.9		9.22			0	
2-JMS099.30	11/2/1992	M	7	14.9		9.27			0	
2-JMS099.30	11/2/1992	M	9	14.9		9.27			0	
2-JMS099.30	11/2/1992	B	11	14.91	7.08	9.35			0	
2-JMS099.30	11/17/1992	S	1	9.43	7.48	11.35			0	0.5
2-JMS099.30	11/17/1992	M	3	9.4		11.37			0	
2-JMS099.30	11/17/1992	M	5	9.38		11.33			0	
2-JMS099.30	11/17/1992	M	7	9.36		11.35			0	
2-JMS099.30	11/17/1992	M	9	9.31		11.37			0	
2-JMS099.30	11/17/1992	B	11	9.35	7.45	11.42			0	
2-JMS099.30	11/17/1992	S	0.3							
2-JMS099.30	12/15/1992	S	1	5.18	7.26	12.78			0	0.3
2-JMS099.30	12/15/1992	M	3	5.18		12.79			0	
2-JMS099.30	12/15/1992	M	5	5.18		12.86			0	
2-JMS099.30	12/15/1992	M	7	5.19		12.86			0	
2-JMS099.30	12/15/1992	M	9	5.18		12.92			0	
2-JMS099.30	12/15/1992	B	11	5.19	7.19	12.95			0	
2-JMS099.30	12/15/1992	S	0.3							
2-JMS099.30	1/14/1993	S	1	6.62	7.49	12.06			0	0.8
2-JMS099.30	1/14/1993	M	3	6.62		12.12			0	
2-JMS099.30	1/14/1993	M	5	6.62		12.12			0	
2-JMS099.30	1/14/1993	M	7	6.62		12.12			0	
2-JMS099.30	1/14/1993	M	9	6.62		12.19			0	
2-JMS099.30	1/14/1993	B	11	6.63	7.47	12.37			0	
2-JMS099.30	1/14/1993	S	0.3							
2-JMS099.30	2/9/1993	S	1	5.14	7.43	13.27			0	1.9
2-JMS099.30	2/9/1993	M	3	5.07		13.33			0	
2-JMS099.30	2/9/1993	M	5	5.06		13.34			0	
2-JMS099.30	2/9/1993	M	7	5.05		13.43			0	
2-JMS099.30	2/9/1993	M	9	5.02		13.5			0	
2-JMS099.30	2/9/1993	B	10	5.02	7.29	13.6			0	
2-JMS099.30	2/9/1993	S	0.3							
2-JMS099.30	3/10/1993	S	1	7.68	7.21	11.85			0	0.4
2-JMS099.30	3/10/1993	M	3	7.67		11.87			0	
2-JMS099.30	3/10/1993	M	5	7.66		11.94			0	
2-JMS099.30	3/10/1993	M	7	7.67		11.93			0	
2-JMS099.30	3/10/1993	M	9	7.69		12.02			0	
2-JMS099.30	3/10/1993	B	11	7.7	6.9	12.2			0	
2-JMS099.30	4/8/1993	S	1	10.69	7.2	11.04			0	0.9
2-JMS099.30	4/8/1993	M	3	10.67		11.04			0	
2-JMS099.30	4/8/1993	M	5	10.7		11.03			0	
2-JMS099.30	4/8/1993	M	7	10.69		11.04			0	
2-JMS099.30	4/8/1993	M	9	10.71		11.13			0	
2-JMS099.30	4/8/1993	B	11	10.74	7.1	11.2			0	
2-JMS099.30	4/28/1993	S	1	16.1	7.32	9.65			0	1.1
2-JMS099.30	4/28/1993	M	3	16.05		9.63			0	
2-JMS099.30	4/28/1993	M	5	15.92		9.64			0	
2-JMS099.30	4/28/1993	M	7	15.94		9.68			0	
2-JMS099.30	4/28/1993	M	9	15.97		9.7			0	
2-JMS099.30	4/28/1993	B	11	15.97	7.25	9.82			0	
2-JMS099.30	5/6/1993	S	1	21.38	7.49	8.63			0	1.4
2-JMS099.30	5/6/1993	M	3	21.19		8.59			0	
2-JMS099.30	5/6/1993	M	5	21.12		8.59			0	
2-JMS099.30	5/6/1993	M	7	21.09		8.86			0	
2-JMS099.30	5/6/1993	M	9	21.07		8.86			0	
2-JMS099.30	5/6/1993	B	11	21.07	7.33	8.93			0	
2-JMS099.30	6/2/1993	S	1	23.9	7.28	7.63			0	1
2-JMS099.30	6/2/1993	M	3	23.91		7.62			0	

Station ID	Collection Date	Depth Desc	Depth	Temp Celcius	Field Ph	Do Probe	Do Winkler	Fdt Do Optical	Salinity	Secchi Depth
2-JMS099.30	6/2/1993	M	5	23.83		7.59			0	
2-JMS099.30	6/2/1993	M	7	23.73		7.59			0	
2-JMS099.30	6/2/1993	M	9	23.58		7.61			0	
2-JMS099.30	6/2/1993	B	11	23.52	7.18	7.66			0	
2-JMS099.30	6/2/1993	S	0.3							
2-JMS099.30	6/7/1993	S	1	24.43	7.24	7.88			0	1.2
2-JMS099.30	6/7/1993	M	3	24.24		7.87			0	
2-JMS099.30	6/7/1993	M	5	23.98		7.78			0	
2-JMS099.30	6/7/1993	M	7	23.89		7.8			0	
2-JMS099.30	6/7/1993	M	9	23.86		7.85			0	
2-JMS099.30	6/7/1993	B	10	23.83	7.11	7.91			0	
2-JMS099.30	6/22/1993	S	1	29.83	7.6	7.23			0	1.3
2-JMS099.30	6/22/1993	M	3	29.78		7.26			0	
2-JMS099.30	6/22/1993	M	5	29.75		7.25			0	
2-JMS099.30	6/22/1993	M	7	29.56		7.18			0	
2-JMS099.30	6/22/1993	M	9	29.56		7.15			0	
2-JMS099.30	6/22/1993	B	10	29.53	7.34	7.19			0	
2-JMS099.30	7/7/1993	S	0.3							
2-JMS099.30	7/7/1993	S	1	31.16	7.73	8.28			0	1.3
2-JMS099.30	7/7/1993	M	3	30.46		6.6			0	
2-JMS099.30	7/7/1993	M	5	30.46		6.3			0	
2-JMS099.30	7/7/1993	M	7	30.48		6.34			0	
2-JMS099.30	7/7/1993	M	9	30.48		6.41			0	
2-JMS099.30	7/7/1993	B	11	30.49	7.22	6.35			0	
2-JMS099.30	7/21/1993	B	1							
2-JMS099.30	7/21/1993	S	1	30.56	7.36	6.95			0	0.9
2-JMS099.30	7/21/1993	M	3	30.27		6.4			0	
2-JMS099.30	7/21/1993	M	5	30.11		6.25			0	
2-JMS099.30	7/21/1993	M	7	30.1		6.38			0	
2-JMS099.30	7/21/1993	M	9	30.07		6.33			0	
2-JMS099.30	7/21/1993	M	11	30.04	7.19	6.35			0	
2-JMS099.30	7/21/1993	S	0.3							
2-JMS099.30	8/4/1993	S	1	29.14	7.43	6.88			0	1.3
2-JMS099.30	8/4/1993	M	3	29.13		6.85			0	
2-JMS099.30	8/4/1993	M	5	29.09		6.79			0	
2-JMS099.30	8/4/1993	M	7	29.05		6.74			0	
2-JMS099.30	8/4/1993	M	9	29.04		6.73			0	
2-JMS099.30	8/4/1993	B	11	29.01	7.34	6.74			0	
2-JMS099.30	8/4/1993	S	0.3							
2-JMS099.30	8/18/1993	S	1	29.24	7.32	7.58				1.1
2-JMS099.30	8/18/1993	M	3	29.15		7.42				
2-JMS099.30	8/18/1993	M	5	28.99		7.27				
2-JMS099.30	8/18/1993	M	7	28.82		7.1				
2-JMS099.30	8/18/1993	M	9	28.71		6.94				
2-JMS099.30	8/18/1993	B	11	28.67	7.09	6.8				
2-JMS099.30	8/18/1993	S	0.3							
2-JMS099.30	8/18/1993	B	1							
2-JMS099.30	9/2/1993	S	1	31.44	7.64	7.55			0	1.1
2-JMS099.30	9/2/1993	M	3	30.11		7.11			0	
2-JMS099.30	9/2/1993	M	5	30.86		7.1			0	
2-JMS099.30	9/2/1993	M	7	30.62		6.89			0	
2-JMS099.30	9/2/1993	B	9	30.54	7.23	6.63			0	
2-JMS099.30	9/20/1993	S	0.3							
2-JMS099.30	9/20/1993	S	1	25.84	7.64	6.9			0	1.4
2-JMS099.30	9/20/1993	M	3	25.52		6.39			0	
2-JMS099.30	9/20/1993	M	5	25.48		6.36			0	
2-JMS099.30	9/20/1993	M	7	25.49		6.63			0	
2-JMS099.30	9/20/1993	M	9	25.46		7.03			0	
2-JMS099.30	9/20/1993	B	11	25.44	7.42	6.69			0	
2-JMS099.30	10/5/1993	S	0.3							
2-JMS099.30	10/5/1993	B	1							
2-JMS099.30	10/5/1993	M	1	20.01	8.18	8.8			0	1.5
2-JMS099.30	10/5/1993	M	3	19.85		8.72			0	
2-JMS099.30	10/5/1993	M	5	19.63		8.62			0	
2-JMS099.30	10/5/1993	M	7	19.61		8.63			0	
2-JMS099.30	10/5/1993	M	9	19.6		8.67			0	
2-JMS099.30	10/5/1993	M	11	19.59	8.13	8.67			0	
2-JMS099.30	11/17/1993	S	0.3							
2-JMS099.30	11/17/1993	B	1							
2-JMS099.30	12/2/1993	B	0.3							
2-JMS099.30	12/2/1993	S	0.3							
2-JMS099.30	12/2/1993	M	1	8.3	6.96	11.63			0	0.3
2-JMS099.30	12/2/1993	M	3	8.27		11.71			0	
2-JMS099.30	12/2/1993	M	5	8.2		11.75			0	
2-JMS099.30	12/2/1993	M	7	8.18		11.82			0	

Station ID	Collection Date	Depth Desc	Depth	Temp Celcius	Field Ph	Do Probe	Do Winkler	Fdt Do Optical	Salinity	Secchi Depth
2-JMS099.30	12/2/1993	M	9	8.22		11.86			0	
2-JMS099.30	12/2/1993	M	11	8.21	6.78	11.9			0	
2-JMS099.30	2/17/1994	S	1	4.33	7.34	13.01			0	0.7
2-JMS099.30	2/17/1994	M	3	4.34		12.99			0	
2-JMS099.30	2/17/1994	M	5	4.33		12.98			0	
2-JMS099.30	2/17/1994	M	7	4.33		12.93			0	
2-JMS099.30	2/17/1994	M	9	4.34		12.89			0	
2-JMS099.30	2/17/1994	B	10	4.34	7.3	12.87			0	
2-JMS099.30	3/21/1994	S	1	9.49	7.54	11.1			0	1.4
2-JMS099.30	3/21/1994	M	3	9.45		11.05			0	
2-JMS099.30	3/21/1994	M	5	9.45		11.05			0	
2-JMS099.30	3/21/1994	M	7	9.44		11.05			0	
2-JMS099.30	3/21/1994	M	9	9.44		11.07			0	
2-JMS099.30	3/21/1994	B	10	9.44	7.52	11.1			0	
2-JMS099.30	4/14/1994	S	1	16.66	7.67	9.6			0	1.4
2-JMS099.30	4/14/1994	M	3	16.51		9.58			0	
2-JMS099.30	4/14/1994	M	5	16.3		9.59			0	
2-JMS099.30	4/14/1994	M	7	16.3		9.65			0	
2-JMS099.30	4/14/1994	M	9	16.3		9.73			0	
2-JMS099.30	4/14/1994	B	11	16.35	7.43	9.7			0	
2-JMS099.30	5/23/1994	S	1	19.49	8.94	10.21			0	0.8
2-JMS099.30	5/23/1994	M	3	19.15		9.68			0	
2-JMS099.30	5/23/1994	M	5	19.16		9.66			0	
2-JMS099.30	5/23/1994	M	7	19.23		9.77			0	
2-JMS099.30	5/23/1994	M	9	19.1		9.5			0	
2-JMS099.30	5/23/1994	B	11	19.08	8.72	9.52			0	
2-JMS099.30	6/9/1994	S	1	26.16	7.63	7.35			0	1
2-JMS099.30	6/9/1994	M	3	25.93		6.93			0	
2-JMS099.30	6/9/1994	M	5	25.86		6.41			0	
2-JMS099.30	6/9/1994	M	7	25.8		6.24			0	
2-JMS099.30	6/9/1994	M	9	25.7		6.11			0	
2-JMS099.30	6/9/1994	M	11	25.66		6.09			0	
2-JMS099.30	6/9/1994	B	12	25.65	7.34	6.13			0	
2-JMS099.30	6/28/1994	S	0.3	29.55	8.34	9.36				
2-JMS099.30	7/7/1994	S	1	31.85	7.83	8.36			0	1
2-JMS099.30	7/7/1994	M	3	30.89		7.5			0	
2-JMS099.30	7/7/1994	M	5	30.54		7.37			0	
2-JMS099.30	7/7/1994	M	7	30.04		6.9			0	
2-JMS099.30	7/7/1994	M	9	29.86		6.81			0	
2-JMS099.30	7/7/1994	M	11	29.86		6.78			0	
2-JMS099.30	7/7/1994	B	12	29.84	7.33	6.76			0	
2-JMS099.30	7/14/1994	S	0.3	30.58	7.33	6.31				
2-JMS099.30	7/28/1994	S	0.3	29.2	7.39	6.3				
2-JMS099.30	8/11/1994	S	1	27.6	7.72	8.19			0	1.3
2-JMS099.30	8/11/1994	M	3	27.43		7.98			0	
2-JMS099.30	8/11/1994	M	5	27.14		7.68			0	
2-JMS099.30	8/11/1994	M	7	27.06		7.58			0	
2-JMS099.30	8/11/1994	M	9	27.01		7.58			0	
2-JMS099.30	8/11/1994	B	11	27	7.57	7.61			0	
2-JMS099.30	8/18/1994	S	0.3	26.47	7.47	7.12				
2-JMS099.30	8/30/1994	S	0.3	27.67	7.77	7.9				
2-JMS099.30	9/8/1994	S	12	24.17	7.93	8.25			0	
2-JMS099.30	9/8/1994	S	1	24.35	8.1	8.68			0	1.3
2-JMS099.30	9/8/1994	M	3	24.28		8.33			0	
2-JMS099.30	9/8/1994	M	5	24.25		8.28			0	
2-JMS099.30	9/8/1994	M	7	24.23		8.28			0	
2-JMS099.30	9/8/1994	M	9	24.21		8.25			0	
2-JMS099.30	9/8/1994	B	11	24.21		8.25			0	
2-JMS099.30	9/13/1994	S	0.3	25.55	8.15	8.86				
2-JMS099.30	9/26/1994	S	0.3	21.8	7.5	7.93				
2-JMS099.30	10/12/1994	S	0.3	18.6	7.88	8.9				
2-JMS099.30	10/17/1994	S	10	16.72	7.75	7.87				
2-JMS099.30	10/17/1994	S	1	17.41	7.87	8.82				
2-JMS099.30	10/17/1994	M	3	16.94		8.71				
2-JMS099.30	10/17/1994	M	5	16.95		8.68				
2-JMS099.30	10/17/1994	M	7	16.73		8.47				
2-JMS099.30	10/17/1994	B	9	16.73		8.27				
2-JMS099.30	10/25/1994	S	0.3	17.16	7.71	9.22				
2-JMS099.30	11/30/1994	S	11	9.14	7.36	10.82			0	
2-JMS099.30	11/30/1994	S	1	9.3	7.38	10.88			0	1.3
2-JMS099.30	11/30/1994	M	3	9.24		10.85			0	
2-JMS099.30	11/30/1994	M	5	9.19		10.84			0	
2-JMS099.30	11/30/1994	M	7	9.17		10.83			0	
2-JMS099.30	11/30/1994	B	9	9.12		10.82			0	
2-JMS099.30	12/6/1994	S	10	9.12	7.55	10.51			0	

Station ID	Collection Date	Depth Desc	Depth	Temp Celcius	Field Ph	Do Probe	Do Winkler	Fdt Do Optical	Salinity	Secchi Depth
2-JMS099.30	12/6/1994	S	1	9.37	7.52	11.17			0	1.6
2-JMS099.30	12/6/1994	M	3	9.43		11.15			0	
2-JMS099.30	12/6/1994	M	5	9.37		11.23			0	
2-JMS099.30	12/6/1994	M	7	9.12		11.28			0	
2-JMS099.30	12/6/1994	B	9	9.12		10.61			0	
2-JMS099.30	1/25/1995	S	11	5.3	7.54	12.8			0	
2-JMS099.30	1/25/1995	S	1	5.25	7.6	12.73			0	0.8
2-JMS099.30	1/25/1995	M	3	5.26		12.75			0	
2-JMS099.30	1/25/1995	M	5	5.27		12.77			0	
2-JMS099.30	1/25/1995	M	7	5.26		12.75			0	
2-JMS099.30	1/25/1995	B	9	5.27		12.78			0	
2-JMS099.30	2/27/1995	S	11	7.89	7.65	11.84			0	
2-JMS099.30	2/27/1995	S	1	8.5	7.72	11.9			0	1.2
2-JMS099.30	2/27/1995	M	3	8.07		11.9			0	
2-JMS099.30	2/27/1995	M	5	7.96		11.89			0	
2-JMS099.30	2/27/1995	M	7	7.92		11.89			0	
2-JMS099.30	2/27/1995	B	9	7.91		11.88			0	
2-JMS099.30	3/23/1995	S	1	14.56	7.67	10.26			0	1.1
2-JMS099.30	3/23/1995	M	3	14.58		10.27			0	
2-JMS099.30	3/23/1995	M	5	14.56		10.25			0	
2-JMS099.30	3/23/1995	M	7	14.54		10.25			0	
2-JMS099.30	3/23/1995	B	9	14.54		10.24			0	
2-JMS099.30	3/23/1995	S	10	14.56	7.65	10.21			0	
2-JMS099.30	4/18/1995	S	1	16.9	7.73	9.4			0	1.6
2-JMS099.30	4/18/1995	M	3	16.78		9.39			0	
2-JMS099.30	4/18/1995	M	5	16.73		9.34			0	
2-JMS099.30	4/18/1995	M	7	16.73		9.33			0	
2-JMS099.30	4/18/1995	B	9	16.53		9.29			0	
2-JMS099.30	4/18/1995	S	11	16.53	7.62	9.27			0	
2-JMS099.30	5/3/1995	S	0.3	15.81	7.25	8.81				
2-JMS099.30	5/18/1995	S	0.3	21.22	7.19	7.92				
2-JMS099.30	5/23/1995	S	1	24.3	7.6	8.4			0	1.5
2-JMS099.30	5/23/1995	S	11	23.22	7.35	8.21			0	
2-JMS099.30	6/1/1995	S	0.3	24.51	7.36	8.42				
2-JMS099.30	6/20/1995	S	1	24.88	7.33	7.88			0	1
2-JMS099.30	6/20/1995	M	3	24.49		7.74			0	
2-JMS099.30	6/20/1995	M	5	24.51		7.77			0	
2-JMS099.30	6/20/1995	M	7	24.5		7.68			0	
2-JMS099.30	6/20/1995	M	9	24.4		7.6			0	
2-JMS099.30	6/20/1995	B	11	24.4		7.53			0	
2-JMS099.30	6/20/1995	S	12	24.36	7.25	7.38			0	
2-JMS099.30	7/18/1995	S	1	29.95	7.3	7.31			0	0.7
2-JMS099.30	7/18/1995	M	3	29.87		7.19			0	
2-JMS099.30	7/18/1995	M	5	29.52		6.92			0	
2-JMS099.30	7/18/1995	M	7	29.45		6.84			0	
2-JMS099.30	7/18/1995	B	9	29.45		6.76			0	
2-JMS099.30	7/18/1995	S	11	29.45	7.28	6.78			0	
2-JMS099.30	7/31/1995	S	0.3	31.35	7.89	5.84			0	
2-JMS099.30	8/23/1995	S	1	32.11	8.23	8.68			0	0.8
2-JMS099.30	8/23/1995	M	3	30.78		7.25			0	
2-JMS099.30	8/23/1995	M	5	29.6		7.08			0	
2-JMS099.30	8/23/1995	M	7	29.5		6.89			0	
2-JMS099.30	8/23/1995	M	9	29.41		6.77			0	
2-JMS099.30	8/23/1995	B	11	29.4		6.73			0	
2-JMS099.30	8/23/1995	S	12	29.37	7.65	6.75			0	
2-JMS099.30	8/28/1995	S	0.3	28.6	7.48	7.17				
2-JMS099.30	9/11/1995	S	0.3	26.77	7.66	8.87				
2-JMS099.30	9/20/1995	S	0.3							
2-JMS099.30	9/21/1995	S	1	25.14	7.82	7.74			0	1.1
2-JMS099.30	9/21/1995	M	3	23.92		7.27			0	
2-JMS099.30	9/21/1995	M	5	23.77		7.22			0	
2-JMS099.30	9/21/1995	M	7	23.55		7.12			0	
2-JMS099.30	9/21/1995	M	9	23.47		7.08			0	
2-JMS099.30	9/21/1995	B	11	23.48		7.05			0	
2-JMS099.30	9/21/1995	S	12	23.48	7.54	7.05			0	
2-JMS099.30	10/5/1995	S	0.3	21.67	7.69	7.95				
2-JMS099.30	10/19/1995	S	1	18.3	7.42	8.72			0	1.1
2-JMS099.30	10/19/1995	M	3	18.05		8.7			0	
2-JMS099.30	10/19/1995	M	5	17.9		8.7			0	
2-JMS099.30	10/19/1995	M	7	17.84		8.69			0	
2-JMS099.30	10/19/1995	B	9	17.69	7.42	8.66			0	
2-JMS099.30	10/19/1995	S	12							
2-JMS099.30	10/24/1995	S	0.3	15.22	7.14	9.86				
2-JMS099.30	11/20/1995	S	1	6.64	7.37	12.22			0	0.7
2-JMS099.30	11/20/1995	M	3	6.65		12.21			0	

Station ID	Collection Date	Depth Desc	Depth	Temp Celcius	Field Ph	Do Probe	Do Winkler	Fdt Do Optical	Salinity	Secchi Depth
2-JMS099.30	11/20/1995	M	5	6.65		12.24			0	
2-JMS099.30	11/20/1995	M	7	6.63		12.25			0	
2-JMS099.30	11/20/1995	B	9	6.63		12.25			0	
2-JMS099.30	11/20/1995	S	11	6.61	7.36	11.75			0	
2-JMS099.30	12/14/1995	S	1	2.82	7.33	13.61			0	1.3
2-JMS099.30	12/14/1995	M	3	2.82		13.58			0	
2-JMS099.30	12/14/1995	M	5	2.82		13.57			0	
2-JMS099.30	12/14/1995	M	7	2.8		13.52			0	
2-JMS099.30	12/14/1995	B	9	2.8		13.52			0	
2-JMS099.30	12/14/1995	S	10	2.81	7.33	13.52			0	
2-JMS099.30	1/29/1996	S	11	4.32	7.27	13.28			0	
2-JMS099.30	1/29/1996	S	1	4.33	7.29	13.11			0	0.1
2-JMS099.30	1/29/1996	M	3	4.33		13.2			0	
2-JMS099.30	1/29/1996	M	5	4.33		13.25			0	
2-JMS099.30	1/29/1996	M	7	4.33		13.27			0	
2-JMS099.30	1/29/1996	B	9	4.35		13.3			0	
2-JMS099.30	2/20/1996	S	1	3.86	7.43	13.36			0	0.9
2-JMS099.30	2/20/1996	M	3	3.81		13.4			0	
2-JMS099.30	2/20/1996	M	5	3.81		13.4			0	
2-JMS099.30	2/20/1996	M	7	3.81		13.4			0	
2-JMS099.30	2/20/1996	B	9	3.81		13.43			0	
2-JMS099.30	2/20/1996	S	11	3.78	7.39	13.5			0	
2-JMS099.30	3/25/1996	S	10	8.75	7.22	11.45			0	
2-JMS099.30	3/25/1996	S	1	8.81	7.24	11.63			0	0.5
2-JMS099.30	3/25/1996	M	3	8.76		11.62			0	
2-JMS099.30	3/25/1996	M	5	8.75		11.57			0	
2-JMS099.30	3/25/1996	M	7	8.75		11.48			0	
2-JMS099.30	3/25/1996	B	9	8.75		11.43			0	
2-JMS099.30	4/29/1996	S	10	17.8	7.59	8.98			0	
2-JMS099.30	4/29/1996	S	1	18.45	8.08	9.45			0	1.2
2-JMS099.30	4/29/1996	M	3	18.01		9.03			0	
2-JMS099.30	4/29/1996	M	5	17.95		9.03			0	
2-JMS099.30	4/29/1996	M	7	17.94		9			0	
2-JMS099.30	4/29/1996	B	9	17.82		8.96			0	
2-JMS099.30	5/6/1996	S	0.3	22	8.82	8.62				
2-JMS099.30	5/15/1996	S	10	19.83	7.88	9.74			0	
2-JMS099.30	5/15/1996	S	1	20.16	8.32	10.3			0	1.1
2-JMS099.30	5/15/1996	M	3	20		10.17			0	
2-JMS099.30	5/15/1996	M	5	19.88		10.01			0	
2-JMS099.30	5/15/1996	M	7	19.86		9.94			0	
2-JMS099.30	5/15/1996	B	9	19.83		9.85			0	
2-JMS099.30	5/28/1996	S	0.3	19.89	7.43	8.86				
2-JMS099.30	6/3/1996	S	0.3	21.47	7.97	9.31				
2-JMS099.30	6/12/1996	S	0.3	24.68	7.19	7.9				
2-JMS099.30	6/18/1996	S	1	27.97	7.51	7.6			0	1
2-JMS099.30	6/18/1996	M	3	27.97		7.6			0	
2-JMS099.30	6/18/1996	M	5	27.65		7.45			0	
2-JMS099.30	6/18/1996	M	7	27.63		7.46			0	
2-JMS099.30	6/18/1996	B	9	27.61		7.43			0	
2-JMS099.30	6/18/1996	S	11	27.53	7.38	7.39				
2-JMS099.30	6/18/1996	B	12	27.53	7.38	7.39			0	
2-JMS099.30	7/1/1996	S	0.3	27.97	7.9	7.09				
2-JMS099.30	7/15/1996	S	0.3	27.01	7.3	7.06				
2-JMS099.30	7/23/1996	S	11	28.16	7.21	6.38			0	
2-JMS099.30	7/23/1996	S	1	28.45	7.42	6.79			0	1.1
2-JMS099.30	7/23/1996	M	3	28.4		6.67			0	
2-JMS099.30	7/23/1996	M	5	28.3		6.5			0	
2-JMS099.30	7/23/1996	M	7	28.2		6.4			0	
2-JMS099.30	7/23/1996	B	9	28.18		6.41			0	
2-JMS099.30	8/1/1996	S	0.3	28.05	7.49	6.94				
2-JMS099.30	8/15/1996	S	0.3	24.91	7.41	7.91				
2-JMS099.30	8/20/1996	S	1	27.32	7.55	7.47			0	1.3
2-JMS099.30	8/20/1996	M	3	26.98		7.27			0	
2-JMS099.30	8/20/1996	M	5	26.97		7.27			0	
2-JMS099.30	8/20/1996	M	7	26.96		7.25			0	
2-JMS099.30	8/20/1996	M	9	26.96		7.25			0	
2-JMS099.30	8/20/1996	B	11	26.96		7.24			0	
2-JMS099.30	8/20/1996	S	12	26.95	7.47	7.24			0	
2-JMS099.30	9/16/1996	S	0.3	22.25	7.62	8				
2-JMS099.30	9/24/1996	S	12	20.41	7.69	8.54			0	
2-JMS099.30	9/24/1996	S	1	20.87	7.78	8.62			0	0.9
2-JMS099.30	9/24/1996	M	3	20.64		8.61			0	
2-JMS099.30	9/24/1996	M	5	20.52		8.58			0	
2-JMS099.30	9/24/1996	M	7	20.43		8.56			0	
2-JMS099.30	9/24/1996	M	9	20.4		8.54			0	

Station ID	Collection Date	Depth Desc	Depth	Temp Celcius	Field Ph	Do Probe	Do Winkler	Fdt Do Optical	Salinity	Secchi Depth
2-JMS099.30	9/24/1996	B	11	20.4		8.54			0	
2-JMS099.30	9/30/1996	S	0.3	21.74	7.92	8.1				
2-JMS099.30	10/9/1996	S	0.3	15.82	7.34	9.23				
2-JMS099.30	10/22/1996	S	1	15.06	7.14	9.42			0	0.5
2-JMS099.30	10/22/1996	M	3	14.54		9.44			0	
2-JMS099.30	10/22/1996	M	5	14.45		9.43			0	
2-JMS099.30	10/22/1996	M	7	14.45		9.4			0	
2-JMS099.30	10/22/1996	M	9	14.45		9.41			0	
2-JMS099.30	10/22/1996	B	11	14.45		9.41			0	
2-JMS099.30	10/22/1996	S	12	14.45	7.13	9.41			0	
2-JMS099.30	10/30/1996	S	0.3	17.11	7.88	10.05				
2-JMS099.30	11/19/1996	S	11	6.04	7.38	12.33			0	
2-JMS099.30	11/19/1996	S	1	6.04	7.44	12.33			0	2
2-JMS099.30	11/19/1996	M	3	6.02		12.35			0	
2-JMS099.30	11/19/1996	M	5	6.02		12.33			0	
2-JMS099.30	11/19/1996	M	7	6.02		12.34			0	
2-JMS099.30	11/19/1996	B	9	6.04		12.33			0	
2-JMS099.30	12/10/1996	S	12	5.14	6.98	12.4			0	
2-JMS099.30	12/10/1996	S	1	5.14	7.12	12.56			0	0.5
2-JMS099.30	12/10/1996	M	3	5.14		12.57			0	
2-JMS099.30	12/10/1996	M	5	5.14		12.63			0	
2-JMS099.30	12/10/1996	M	7	5.14		12.61			0	
2-JMS099.30	12/10/1996	M	9	5.14		12.61			0	
2-JMS099.30	12/10/1996	B	11	5.14		12.47			0	
2-JMS099.30	2/18/1997	S	3	5.71		13.58			0	
2-JMS099.30	2/18/1997	M	5	5.69		13.66			0	
2-JMS099.30	2/18/1997	M	7	5.69		13.67			0	
2-JMS099.30	2/18/1997	M	9	5.69		13.73			0	
2-JMS099.30	2/18/1997	B	11	5.71	7.24	14.08			0	
2-JMS099.30	2/18/1997	S	1	5.74	7.24	13.57			0	0.6
2-JMS099.30	3/18/1997	S	10	10.07	7.65	11.28			0	
2-JMS099.30	3/18/1997	S	1	10.15	7.71	11.09			0	1.1
2-JMS099.30	3/18/1997	M	3	10.14		11.1			0	
2-JMS099.30	3/18/1997	M	5	10.09		11.13			0	
2-JMS099.30	3/18/1997	M	7	10.07		11.15			0	
2-JMS099.30	3/18/1997	B	9	10.07		11.24			0	
2-JMS099.30	4/22/1997	S	1	14.04	7.61	9.75			0	1.2
2-JMS099.30	4/22/1997	M	3	14.01		9.73			0	
2-JMS099.30	4/22/1997	M	5	13.99		9.73			0	
2-JMS099.30	4/22/1997	M	7	13.98		9.74			0	
2-JMS099.30	4/22/1997	B	9	13.98		9.76			0	
2-JMS099.30	4/22/1997	S	10	13.98	7.5	9.78			0	
2-JMS099.30	5/21/1997	S	0.3	22.1	7.34	7.18				
2-JMS099.30	5/27/1997	S	0.3	21.94	7.32	7.02				
2-JMS099.30	5/28/1997	S	1	21.72	7.27	7.13			0	1.5
2-JMS099.30	5/28/1997	M	3	21.62		7.14			0	
2-JMS099.30	5/28/1997	M	5	21.57		7.15			0	
2-JMS099.30	5/28/1997	M	7	21.44		7.17			0	
2-JMS099.30	5/28/1997	M	9	21.28		7.15			0	
2-JMS099.30	5/28/1997	B	11	21.27		7.16			0	
2-JMS099.30	5/28/1997	S	12	21.27	7.23	7.19			0	
2-JMS099.30	6/3/1997	S	0.3	22.37	7.07	6.92				
2-JMS099.30	6/23/1997	S	0.3	28.76	7.76	6.8				
2-JMS099.30	6/24/1997	S	1	30.26	7.93	6.76			0	1
2-JMS099.30	6/24/1997	M	3	29.37		6.31			0	
2-JMS099.30	6/24/1997	M	5	29.35		6.31			0	
2-JMS099.30	6/24/1997	M	7	29.31		6.31			0	
2-JMS099.30	6/24/1997	B	9	29.31		6.32			0	
2-JMS099.30	6/24/1997	S	10	29.31	7.7	6.33			0	
2-JMS099.30	7/9/1997	S	0.3	29.33	7.67	6.87				
2-JMS099.30	7/15/1997	S	1	30.53	8.45					
2-JMS099.30	7/15/1997	S	11	28.91	7.6					
2-JMS099.30	7/23/1997	S	0.3	29.3	7.42					
2-JMS099.30	8/7/1997	S	0.3	28.42	7.47	6.27				
2-JMS099.30	8/19/1997	S	1	30.83	7.49	6.58			0	1
2-JMS099.30	8/19/1997	S	11	30.3	7.38	6.25			0	
2-JMS099.30	8/21/1997	S	0.3	29.6	7.38	6.7				
2-JMS099.30	9/4/1997	S	0.3	26.36	7.75	7				
2-JMS099.30	9/23/1997	S	1	24.74	7.76	7.67			0	1.1
2-JMS099.30	9/23/1997	S	11	24.46	7.59	7.37			0	
2-JMS099.30	10/2/1997	S	0.3	21.31	7.66	8				
2-JMS099.30	10/20/1997	S	0.3	16.89	7.61	8.51				
2-JMS099.30	10/21/1997	S	1	16.12	7.68	9.02			0	1.2
2-JMS099.30	10/21/1997	B	3	16.07		9				
2-JMS099.30	10/21/1997	S	9	16.07	7.67	9.04			0	

Station ID	Collection Date	Depth Desc	Depth	Temp Celcius	Field Ph	Do Probe	Do Winkler	Fdt Do Optical	Salinity	Secchi Depth
2-JMS099.30	11/18/1997	S	1	7.97	7.56	11.44				1.3
2-JMS099.30	11/18/1997	S	11	7.89	7.53	11.39				
2-JMS099.30	12/10/1997	S	1	5.86	7.62	10.92				1.7
2-JMS099.30	12/10/1997	M	3	5.86		10.9			0	
2-JMS099.30	12/10/1997	B	5	5.86		10.9			0	
2-JMS099.30	12/10/1997	S	7	5.95	7.61	10.88				
2-JMS099.30	1/21/1998	S	1	5.56	7.81	11.16				0.5
2-JMS099.30	1/21/1998	M	3	5.56		11.18				
2-JMS099.30	1/21/1998	M	5	5.55		11.19				
2-JMS099.30	1/21/1998	M	7	5.56		11.16				
2-JMS099.30	1/21/1998	M	9	5.57		11.17				
2-JMS099.30	1/21/1998	B	11	5.57		11.2				
2-JMS099.30	1/21/1998	S	12	5.56	7.8	11.25				
2-JMS099.30	2/18/1998	S	1	7.24	7.2	11.96				0.2
2-JMS099.30	2/18/1998	M	3	7.24		11.96				
2-JMS099.30	2/18/1998	M	5	7.24		11.96				
2-JMS099.30	2/18/1998	M	7	7.24		11.95				
2-JMS099.30	2/18/1998	M	9	7.24		11.97				
2-JMS099.30	2/18/1998	B	11	7.24		11.96				
2-JMS099.30	2/18/1998	S	12	7.24	7.2	12.03			0	
2-JMS099.30	3/17/1998	S	1	6.93	7.57	12.85				1.1
2-JMS099.30	3/17/1998	M	3	6.93		12.83				
2-JMS099.30	3/17/1998	B	5	6.91		12.84				
2-JMS099.30	3/17/1998	S	7	6.91	7.57	12.81				
2-JMS099.30	4/21/1998	S	1	14.58	7.43	10.9				0.3
2-JMS099.30	4/21/1998	M	3	14.57		10.9				
2-JMS099.30	4/21/1998	M	5	14.57		10.9				
2-JMS099.30	4/21/1998	B	7	14.57		10.9				
2-JMS099.30	4/21/1998	S	9	14.57		10.9				
2-JMS099.30	4/21/1998	B	10	14.57	7.4	10.9				
2-JMS099.30	5/18/1998	S	0.3	22.17	7.87	8.46				
2-JMS099.30	5/19/1998	S	1	23.27	7.74	8.56				0.8
2-JMS099.30	5/19/1998	M	3	22.96		8.46				
2-JMS099.30	5/19/1998	M	5	22.71		8.46				
2-JMS099.30	5/19/1998	B	7	22.68		8.47				
2-JMS099.30	5/19/1998	S	9	22.66	7.66	8.52				
2-JMS099.30	5/27/1998	S	0.3	24.21	8.35	8.61				
2-JMS099.30	6/17/1998	S	0.3	25.75	7.66	7.53				
2-JMS099.30	6/23/1998	S	14	27.28	7.78	7.69				
2-JMS099.30	6/23/1998	S	1	28	8.14	8.75				0.7
2-JMS099.30	6/23/1998	M	3	27.73		8.68				
2-JMS099.30	6/23/1998	M	5	27.56		8.03				
2-JMS099.30	6/23/1998	M	7	27.43		7.98				
2-JMS099.30	6/23/1998	M	9	27.34		7.8				
2-JMS099.30	6/23/1998	M	11	27.31		7.73				
2-JMS099.30	6/23/1998	B	13	27.79		7.69				
2-JMS099.30	6/30/1998	S	0.3	29.45	7.5	6.94				
2-JMS099.30	7/14/1998	S	0.3	28.4	7.75	8.5				
2-JMS099.30	7/21/1998	S	1	33.07	8.6	8.9				
2-JMS099.30	7/21/1998	M	3	31.02		7.45				
2-JMS099.30	7/21/1998	M	5	30.65		7.25				
2-JMS099.30	7/21/1998	M	7	30.39		7				
2-JMS099.30	7/21/1998	M	9	30.04		6.75				
2-JMS099.30	7/21/1998	B	11	30.02		6.68				
2-JMS099.30	7/21/1998	S	12	30	8.01	6.65				
2-JMS099.30	7/28/1998	S	0.3	29.73	7.8	7.62				
2-JMS099.30	8/11/1998	S	0.3	28.61	7.66	7.21				
2-JMS099.30	8/18/1998	S	10	28.3	7.62	6.43			0	
2-JMS099.30	8/18/1998	S	1	28.73	7.73	6.8				1
2-JMS099.30	8/18/1998	M	3	28.66		6.82				
2-JMS099.30	8/18/1998	M	5	28.44		6.71				
2-JMS099.30	8/18/1998	M	7	28.31		6.57				
2-JMS099.30	8/18/1998	B	9	28.3		6.49				
2-JMS099.30	8/25/1998	S	0.3	28.26	8.13	7.4				
2-JMS099.30	9/14/1998	S	0.3	28.45	8.3	9.37				
2-JMS099.30	9/22/1998	S	1	28.75	7.87	7.1			0	0.8
2-JMS099.30	9/22/1998	M	3	28.4		6.85				
2-JMS099.30	9/22/1998	M	5	28		6.64				
2-JMS099.30	9/22/1998	M	7	27.95		6.55				
2-JMS099.30	9/22/1998	B	9	27.88		6.59				
2-JMS099.30	9/22/1998	S	11	27.79	7.69	6.48			0	
2-JMS099.30	9/29/1998	S	0.3	28.91	8.24	8.31				
2-JMS099.30	10/13/1998	S	0.3	20.28	7.86	8.4				
2-JMS099.30	10/20/1998	S	9	19.92	7.7	8.2				
2-JMS099.30	10/20/1998	S	1	20.75	7.76	8.47				0.8

Station ID	Collection Date	Depth Desc	Depth	Temp Celcius	Field Ph	Do Probe	Do Winkler	Fdt Do Optical	Salinity	Secchi Depth
2-JMS099.30	10/20/1998	M	3	20.85		8.41				
2-JMS099.30	10/20/1998	M	5	20.75		8.41				
2-JMS099.30	10/20/1998	B	7	20.61		8.38				
2-JMS099.30	10/26/1998	S	0.3	17.8	7.76	8.9				
2-JMS099.30	11/18/1998	S	1	13.81	7.54	10.49			0.2	1.2
2-JMS099.30	11/18/1998	M	3	12.57		10.51			0.2	
2-JMS099.30	11/18/1998	M	5	12.41		10.51			0.2	
2-JMS099.30	11/18/1998	M	7	12.28		10.53			0.2	
2-JMS099.30	11/18/1998	M	9	12.29		10.52			0.2	
2-JMS099.30	11/18/1998	B	11	12.23		10.55			0.2	
2-JMS099.30	11/18/1998	S	12	12.21	7.53	10.56			0.2	
2-JMS099.30	12/15/1998	S	9	9.82		11.32				
2-JMS099.30	12/15/1998	B	11	9.82		11.46				
2-JMS099.30	12/15/1998	S	12	9.82	7.17	11.46				
2-JMS099.30	12/15/1998	S	1	10.18	7.21	11.2				0.7
2-JMS099.30	12/15/1998	M	3	10		11.27				
2-JMS099.30	12/15/1998	M	5	9.83		11				
2-JMS099.30	12/15/1998	B	7	9.82		11.22				
2-JMS099.30	1/19/1999	S	1	6.09	7.33	12.26				0.5
2-JMS099.30	1/19/1999	M	3	6.05		12.27				
2-JMS099.30	1/19/1999	M	5	6.02		12.29				
2-JMS099.30	1/19/1999	M	7	6		12.31				
2-JMS099.30	1/19/1999	M	9	6		12.31				
2-JMS099.30	1/19/1999	B	10	6.05	7.34	12.35				
2-JMS099.30	2/23/1999	B	10	6.2	7.61	12.7				
2-JMS099.30	2/23/1999	S	1	6.32	7.73	12.65			0	1.3
2-JMS099.30	2/23/1999	M	3	6.28		12.65				
2-JMS099.30	2/23/1999	M	5	6.26		12.78				
2-JMS099.30	2/23/1999	M	7	6.21		12.79				
2-JMS099.30	2/23/1999	M	9	6.24		12.7				
2-JMS099.30	3/23/1999	S	1	9.52	7.1	11.12				0.7
2-JMS099.30	3/23/1999	M	3	9.55		11.06				
2-JMS099.30	3/23/1999	M	5	9.54		11.11				
2-JMS099.30	3/23/1999	M	7	9.51		11.14				
2-JMS099.30	3/23/1999	M	9	9.51		11.08				
2-JMS099.30	3/23/1999	B	10							
2-JMS099.30	4/20/1999	B	9	16.11	7.58	8.59			0.1	
2-JMS099.30	4/20/1999	S	1	16.41	7.75	8.79			0.1	0.5
2-JMS099.30	4/20/1999	M	3	16.31		8.64			0.1	
2-JMS099.30	4/20/1999	M	5	16.32		8.64			0.1	
2-JMS099.30	4/20/1999	M	7	16.29		8.7			0.1	
2-JMS099.30	5/11/1999	S	0.3							
2-JMS099.30	5/20/1999	B	8	21.88	7.43	8				
2-JMS099.30	5/20/1999	S	1	22.08	7.45	8				
2-JMS099.30	5/20/1999	M	3	21.96		8				
2-JMS099.30	5/20/1999	M	5	21.92		8.01				
2-JMS099.30	5/20/1999	M	7	21.86		8				
2-JMS099.30	5/25/1999	S	0.3	23.97	7.24	6.64				
2-JMS099.30	6/7/1999	S	0.3	28.88	8.81	10.2				
2-JMS099.30	6/21/1999	S	0.3	24.58	6.98	5.45				
2-JMS099.30	6/22/1999	B	9	23.63	7.05	6.34			0	
2-JMS099.30	6/22/1999	S	1	24.4	7.19	7.19				1.1
2-JMS099.30	6/22/1999	M	3	24.28		7.03				
2-JMS099.30	6/22/1999	M	5	23.77		6.46				
2-JMS099.30	6/22/1999	M	7	23.73		6.44				
2-JMS099.30	7/7/1999	S	0.3	34.67	8.05	7.89				
2-JMS099.30	7/20/1999	S	1	30.36	8.3	10.42				1
2-JMS099.30	7/20/1999	M	3	29.94		9.71				
2-JMS099.30	7/20/1999	M	5	29.5		9.03				
2-JMS099.30	7/20/1999	M	7	29.16		8.62				
2-JMS099.30	7/20/1999	B	8	29.15	7.75	8.6				
2-JMS099.30	7/21/1999	S	0.3	31.57	7.95	7.95				
2-JMS099.30	8/10/1999	S	0.3	31.8	7.89	7.05				
2-JMS099.30	8/17/1999	S	1	31.36	8.06	9.14			0.2	0.8
2-JMS099.30	8/17/1999	M	3	30.57		7.92			0.2	
2-JMS099.30	8/17/1999	M	5	30.31		7.3			0.2	
2-JMS099.30	8/17/1999	M	7	30.17		7.32			0.2	
2-JMS099.30	8/17/1999	B	9	30.15	7.53	7.1			0.2	
2-JMS099.30	8/31/1999	S	0.3	26.84	7.61	7.13			0	
2-JMS099.30	9/13/1999	S	0.3	25.57	7.63	7.62				
2-JMS099.30	9/21/1999	S	1	21.11	7.03	8.6			0	
2-JMS099.30	9/21/1999	M	3	21.04		8.62			0	
2-JMS099.30	9/21/1999	M	5	21.02		8.61			0	
2-JMS099.30	9/21/1999	M	7	21.02		8.61			0	
2-JMS099.30	9/21/1999	M	9	21.02		8.61			0	

Station ID	Collection Date	Depth Desc	Depth	Temp Celcius	Field Ph	Do Probe	Do Winkler	Fdt Do Optical	Salinity	Secchi Depth
2-JMS099.30	9/21/1999	B	11	21.02	7.02	8.61			0	
2-JMS099.30	9/29/1999	S	0.3	22.15	7.28	8.3			0	
2-JMS099.30	10/13/1999	S	0.3	18.98	7.41	8.79			0	
2-JMS099.30	10/26/1999	S	0.3	13.98	7.54	10			0	
2-JMS099.30	10/28/1999	B	9	13.89	7.61	9.3			0.1	
2-JMS099.30	10/28/1999	S	1	13.89	7.64	14.24			0.1	1.4
2-JMS099.30	10/28/1999	M	3	13.96		9.41			0.1	
2-JMS099.30	10/28/1999	M	5	13.84		9.43			0.1	
2-JMS099.30	10/28/1999	M	7	13.8		9.36			0.1	
2-JMS099.30	11/18/1999	S	1							
2-JMS099.30	11/18/1999	M	3	11.69		9.75			0.1	
2-JMS099.30	11/18/1999	M	5	11.63		9.7			0.1	
2-JMS099.30	11/18/1999	M	7	11.63		9.77			0.1	
2-JMS099.30	11/18/1999	M	9	11.61		9.72			0.1	
2-JMS099.30	11/18/1999	B	10	11.62	7.68	9.78			0.1	
2-JMS099.30	11/18/1999	S	1							
2-JMS099.30	11/18/1999	S	1							
2-JMS099.30	11/18/1999	S	1							
2-JMS099.30	11/18/1999	S	1							
2-JMS099.30	11/18/1999	S	1							
2-JMS099.30	11/18/1999	S	1							
2-JMS099.30	11/18/1999	S	1							
2-JMS099.30	11/18/1999	S	1							
2-JMS099.30	11/18/1999	S	1							
2-JMS099.30	11/18/1999	S	1	11.8	7.7	9.8			0.1	1.8
2-JMS099.30	12/21/1999	B	7	7.23	7.35	11.43			0	
2-JMS099.30	12/21/1999	S	1	7.27	7.36	11.55			0	0.7
2-JMS099.30	12/21/1999	M	3	7.27		11.63			0	
2-JMS099.30	12/21/1999	M	5	7.27		11.71			0	
2-JMS099.30	12/21/1999	S	0.1							
2-JMS099.30	12/21/1999	B	0.5							
2-JMS099.30	1/18/2000	B	10	4.08	7.36	12.94			0	
2-JMS099.30	1/18/2000	S	1							
2-JMS099.30	1/18/2000	M	3	4.07		12.36			0	
2-JMS099.30	1/18/2000	M	5	4.08		12.45			0	
2-JMS099.30	1/18/2000	M	7	4.07		12.66			0	
2-JMS099.30	1/18/2000	M	9	4.07		12.72			0	
2-JMS099.30	1/18/2000	S	0.1							
2-JMS099.30	1/18/2000	B	0.5							
2-JMS099.30	2/23/2000	B	11	7.33	7.35	11.97			0	
2-JMS099.30	2/23/2000	S	1	7.35	7.45	11.93			0	0.4
2-JMS099.30	2/23/2000	M	3	7.33		11.93			0	
2-JMS099.30	2/23/2000	M	5	7.33		11.95			0	
2-JMS099.30	2/23/2000	M	7	7.32		11.97			0	
2-JMS099.30	2/23/2000	M	9	7.32		11.99			0	
2-JMS099.30	3/28/2000	B	10	14.01	7.27	9.49			0	
2-JMS099.30	3/28/2000	S	0.1							
2-JMS099.30	3/28/2000	M	0.5							
2-JMS099.30	3/28/2000	S	1	14.02	7.32	9.54			0	0.8
2-JMS099.30	3/28/2000	M	1							
2-JMS099.30	3/28/2000	M	1.5							
2-JMS099.30	3/28/2000	B	2							
2-JMS099.30	3/28/2000	M	3	14		9.52			0	
2-JMS099.30	3/28/2000	M	5	14		9.49			0	
2-JMS099.30	3/28/2000	M	7	14		9.49			0	
2-JMS099.30	3/28/2000	M	9	13.99		9.48			0	
2-JMS099.30	4/24/2000	B	12	16.31	7.18	9.22			0	
2-JMS099.30	4/24/2000	S	1	16.32	7.26	9.15			0	0.5
2-JMS099.30	4/24/2000	M	3	16.31		9.14			0	
2-JMS099.30	4/24/2000	M	5	16.32		9.14			0	
2-JMS099.30	4/24/2000	M	7	16.33		9.18			0	
2-JMS099.30	4/24/2000	M	9	16.33		9.15			0	
2-JMS099.30	4/24/2000	M	11	16.33		9.23			0	
2-JMS099.30	4/24/2000	S	0.1							
2-JMS099.30	4/24/2000	M	0.5							
2-JMS099.30	4/24/2000	M	1							
2-JMS099.30	4/24/2000	B	1.5							
2-JMS099.30	5/1/2000	S	0.3	17.49	7.48	9.44			0	
2-JMS099.30	5/22/2000	S	0.3	24.1	7.12	6			0	
2-JMS099.30	5/23/2000	B	7	23.2	7.3	5.3			0.1	
2-JMS099.30	5/23/2000	S	1	23.34	7.29	6.3			0.1	1
2-JMS099.30	5/23/2000	M	3	23.3		6.06			0.1	
2-JMS099.30	5/23/2000	M	5	23.28		5.6			0.1	
2-JMS099.30	5/23/2000	S	0.1							
2-JMS099.30	5/23/2000	M	0.5							

Station ID	Collection Date	Depth Desc	Depth	Temp Celcius	Field Ph	Do Probe	Do Winkler	Fdt Do Optical	Salinity	Secchi Depth
2-JMS099.30	5/23/2000	M	1							
2-JMS099.30	5/23/2000	M	1.5							
2-JMS099.30	5/23/2000	M	2							
2-JMS099.30	5/23/2000	B	2.5							
2-JMS099.30	6/5/2000	S	0.3	24.32	7.63	7.78			0	
2-JMS099.30	6/20/2000	B	5	28.99	7.39	6.03			0.1	
2-JMS099.30	6/20/2000	S	1	29.24	7.4	5.87			0.1	
2-JMS099.30	6/20/2000	M	3	29.08		6.03			0.1	
2-JMS099.30	6/22/2000	S	0.3							
2-JMS099.30	6/22/2000	S	0.3	28.16	7.51	7.1			0	
2-JMS099.30	7/11/2000	S	0.3	30.43	8.26	8.8			0	
2-JMS099.30	7/18/2000	B	6	28.93	7.54	7.69			0.1	
2-JMS099.30	7/18/2000	S	1	30.02	7	9.42			0.1	0.9
2-JMS099.30	7/18/2000	M	3	29.01		7.81			0.1	
2-JMS099.30	7/18/2000	M	5	28.88		7.71			0.1	
2-JMS099.30	7/18/2000	S	0.1							
2-JMS099.30	7/18/2000	M	0.5							
2-JMS099.30	7/18/2000	M	1							
2-JMS099.30	7/18/2000	M	1.5							
2-JMS099.30	7/18/2000	B	2							
2-JMS099.30	7/26/2000	S	0.3	26.15	7.32	6.68			0	
2-JMS099.30	8/7/2000	S	0.3	28.64	7.62	7.25			0	
2-JMS099.30	8/22/2000	B	14	26.6	7.58	7.04			0	
2-JMS099.30	8/22/2000	S	1	26.86	7.76	7.54			0	0.6
2-JMS099.30	8/22/2000	M	3	26.7		7.25			0	
2-JMS099.30	8/22/2000	M	5	26.64		7.11			0	
2-JMS099.30	8/22/2000	M	7	26.63		7.11			0	
2-JMS099.30	8/22/2000	S	0.1							
2-JMS099.30	8/22/2000	M	0.5							
2-JMS099.30	8/22/2000	M	1							
2-JMS099.30	8/22/2000	M	1.5							
2-JMS099.30	8/22/2000	M	2							
2-JMS099.30	8/22/2000	M	2.5							
2-JMS099.30	8/22/2000	M	3							
2-JMS099.30	8/22/2000	B	3.5							
2-JMS099.30	8/23/2000	S	0.3	28.43	8.03	8.41				
2-JMS099.30	9/13/2000	S	0.3	25.95	7.51	7.88			0	
2-JMS099.30	9/26/2000	B	5	21.69	7.54	7.53			0.1	
2-JMS099.30	9/26/2000	S	1	21.66	7.55	7.45			0.1	1.1
2-JMS099.30	9/26/2000	M	3	21.68		7.66			0.1	
2-JMS099.30	9/26/2000	S	0.1							
2-JMS099.30	9/26/2000	M	0.5							
2-JMS099.30	9/26/2000	M	1							
2-JMS099.30	9/26/2000	M	1.5							
2-JMS099.30	9/26/2000	B	2							
2-JMS099.30	10/2/2000	S	0.3	20.01	7.63	8.47			0	
2-JMS099.30	10/16/2000	S	0.3	17.13	7.75	8.97			0	
2-JMS099.30	10/24/2000	B	10	18.74	7.72	8.14			0	
2-JMS099.30	10/24/2000	S	1	20.05		9.37			0	0.9
2-JMS099.30	10/24/2000	M	3	18.99		8.37			0	
2-JMS099.30	10/24/2000	M	5	18.84		8.21			0	
2-JMS099.30	10/24/2000	M	7	18.82		8.34			0	
2-JMS099.30	10/24/2000	M	9	18.76		8.25			0	
2-JMS099.30	10/24/2000	S	0.1							
2-JMS099.30	10/24/2000	M	0.5							
2-JMS099.30	10/24/2000	M	1							
2-JMS099.30	10/24/2000	M	1.5							
2-JMS099.30	10/24/2000	M	2							
2-JMS099.30	10/24/2000	B	2.5							
2-JMS099.30	10/30/2000	S	0.3	17.5	7.55	8.22			0	
2-JMS099.30	11/28/2000	S	1							1
2-JMS099.30	11/28/2000	M	3							
2-JMS099.30	11/28/2000	M	5							
2-JMS099.30	11/28/2000	M	7							
2-JMS099.30	11/28/2000	B	9							
2-JMS099.30	11/28/2000	S	0.1							
2-JMS099.30	1/23/2001	S	0.1							
2-JMS099.30	1/23/2001	M	0.5							
2-JMS099.30	1/23/2001	S	1	3.16	6.98	13.55			0	0.3
2-JMS099.30	1/23/2001	M	1							
2-JMS099.30	1/23/2001	B	1.5							
2-JMS099.30	1/23/2001	M	3	3.11		13.61			0	
2-JMS099.30	1/23/2001	B	4	3.08	7	13.78			0	
2-JMS099.30	2/20/2001	S	0.1							
2-JMS099.30	2/20/2001	M	0.5							

Station ID	Collection Date	Depth Desc	Depth	Temp Celcius	Field Ph	Do Probe	Do Winkler	Fdt Do Optical	Salinity	Secchi Depth
2-JMS099.30	2/20/2001	M	1							
2-JMS099.30	2/20/2001	S	1	8.52	7.49	11.53			0.1	0.8
2-JMS099.30	2/20/2001	M	1.5							
2-JMS099.30	2/20/2001	M	2							
2-JMS099.30	2/20/2001	M	2.5							
2-JMS099.30	2/20/2001	B	3							
2-JMS099.30	2/20/2001	M	3	8.26		11.53			0.1	
2-JMS099.30	2/20/2001	M	5	8.11		11.51			0.1	
2-JMS099.30	2/20/2001	M	7	7.98		11.52			0.1	
2-JMS099.30	2/20/2001	M	9	7.76		11.43			0.1	
2-JMS099.30	2/20/2001	B	10	7.96	7.6	11.56			0.1	
2-JMS099.30	3/27/2001	S	0.1							
2-JMS099.30	3/27/2001	M	0.5							
2-JMS099.30	3/27/2001	S	1	9.31	6.86	12.18			0.1	0.5
2-JMS099.30	3/27/2001	M	1							
2-JMS099.30	3/27/2001	M	1.5							
2-JMS099.30	3/27/2001	B	2							
2-JMS099.30	3/27/2001	M	3	9.28		12.26			0.1	
2-JMS099.30	3/27/2001	M	5	9.21		12.28			0.1	
2-JMS099.30	3/27/2001	M	7	9		12.36			0.1	
2-JMS099.30	3/27/2001	B	8	8.98	6.67	12.6			0.1	
2-JMS099.30	4/24/2001	S	1	19.57	7.97	9.63			0	0.7
2-JMS099.30	4/24/2001	M	3	19.44		9.37			0	
2-JMS099.30	4/24/2001	M	5	19.44		9.33			0	
2-JMS099.30	4/24/2001	M	7	19.42		9.36			0	
2-JMS099.30	4/24/2001	M	9	19.4		9.31			0	
2-JMS099.30	4/24/2001	B	10	19.4	7.9	9.39			0	
2-JMS099.30	4/24/2001	S	0.1							
2-JMS099.30	4/24/2001	M	0.5							
2-JMS099.30	4/24/2001	M	1							
2-JMS099.30	4/24/2001	M	1.5							
2-JMS099.30	4/24/2001	M	2							
2-JMS099.30	4/24/2001	M	2.5							
2-JMS099.30	4/24/2001	B	3							
2-JMS099.30	5/7/2001	S	0.3	24.21	8.64	10.31				
2-JMS099.30	5/30/2001	S	0.3	19.2	7.4	9.1				
2-JMS099.30	6/13/2001	S	0.3	28.02	8.43	9.47			0	
2-JMS099.30	6/19/2001	S	0.1							
2-JMS099.30	6/19/2001	M	0.5							
2-JMS099.30	6/19/2001	S	1	28.43	8.28	9.14			0.1	0.8
2-JMS099.30	6/19/2001	M	1							
2-JMS099.30	6/19/2001	M	1.5							
2-JMS099.30	6/19/2001	M	2							
2-JMS099.30	6/19/2001	M	2.5							
2-JMS099.30	6/19/2001	M	3	27.82		8.06			0.1	
2-JMS099.30	6/19/2001	B	3.5							
2-JMS099.30	6/19/2001	M	5	27.57		7.83			0.1	
2-JMS099.30	6/19/2001	M	7	27.49		7.66			0.1	
2-JMS099.30	6/19/2001	B	8	27.49	7.67	7.66			0.1	
2-JMS099.30	6/28/2001	S	0.3	29.79	7.5	7.84				
2-JMS099.30	7/5/2001	S	0.3	28.96	6.82	5.38				
2-JMS099.30	7/24/2001	S	0.1							
2-JMS099.30	7/24/2001	M	0.5							
2-JMS099.30	7/24/2001	S	1	28.29	7.33	7.34			0	0.8
2-JMS099.30	7/24/2001	M	1							
2-JMS099.30	7/24/2001	M	1.5							
2-JMS099.30	7/24/2001	M	2							
2-JMS099.30	7/24/2001	M	2.5							
2-JMS099.30	7/24/2001	M	3	28.03	7.27	7.06			0	
2-JMS099.30	7/24/2001	M	3.5							
2-JMS099.30	7/24/2001	B	4							
2-JMS099.30	7/24/2001	M	5	27.84	7.29	6.68			0	
2-JMS099.30	7/24/2001	M	7	27.73	7.23	6.94			0	
2-JMS099.30	7/24/2001	B	8	27.61	7.19	6.85			0	
2-JMS099.30	7/30/2001	S	0.3	26.8	7.17	6.06				
2-JMS099.30	8/6/2001	S	0.3	28.46	7.94	7.52				
2-JMS099.30	8/21/2001	S	0.1							
2-JMS099.30	8/21/2001	M	0.5							
2-JMS099.30	8/21/2001	S	1	27.65	7.49	6.64			0	0.7
2-JMS099.30	8/21/2001	M	1							
2-JMS099.30	8/21/2001	M	1.5							
2-JMS099.30	8/21/2001	B	2							
2-JMS099.30	8/21/2001	M	3	29.54		6.83			0	
2-JMS099.30	8/21/2001	M	5	29.53		6.66			0	
2-JMS099.30	8/21/2001	M	7	29.51		6.59			0	

Station ID	Collection Date	Depth Desc	Depth	Temp Celcius	Field Ph	Do Probe	Do Winkler	Fdt Do Optical	Salinity	Secchi Depth
2-JMS099.30	8/21/2001	M	9	29.46		6.5			0	
2-JMS099.30	8/21/2001	B	10	29.43	7.47	6.42			0	
2-JMS099.30	8/23/2001	S	0.3	29.21	7.36	6.15				
2-JMS099.30	9/18/2001	S	0.1							
2-JMS099.30	9/18/2001	M	0.5							
2-JMS099.30	9/18/2001	M	1							
2-JMS099.30	9/18/2001	S	1	27.25	8.1	8.02			0.3	0.9
2-JMS099.30	9/18/2001	M	1.5							
2-JMS099.30	9/18/2001	M	2							
2-JMS099.30	9/18/2001	M	3	26.4		7.35			0.3	
2-JMS099.30	9/18/2001	M	5	26.04		8.03			0.2	
2-JMS099.30	9/18/2001	M	7	25.72		7.89			0.2	
2-JMS099.30	9/18/2001	M	9	25.61		7.32			0.2	
2-JMS099.30	9/18/2001	B	10	25.51	7.88	7.52			0.2	
2-JMS099.30	10/16/2001	S	0							
2-JMS099.30	10/16/2001	S	0.1							
2-JMS099.30	10/16/2001	M	0.5							
2-JMS099.30	10/16/2001	M	1							
2-JMS099.30	10/16/2001	S	1	22.64	8.16	9.43			0.3	0.6
2-JMS099.30	10/16/2001	M	1.5							
2-JMS099.30	10/16/2001	M	2							
2-JMS099.30	10/16/2001	M	2.5							
2-JMS099.30	10/16/2001	M	3	22.01		8.92			0.3	
2-JMS099.30	10/16/2001	M	5	21.62		8.63			0.3	
2-JMS099.30	10/16/2001	M	7	21.32		8.61			0.3	
2-JMS099.30	10/16/2001	M	9	21.25		8.57			0.3	
2-JMS099.30	10/16/2001	M	11	21.18		8.55			0.3	
2-JMS099.30	10/16/2001	B	12	21.18	7.89	8.58			0.3	
2-JMS099.30	11/27/2001	S	0.1							
2-JMS099.30	11/27/2001	M	0.5							
2-JMS099.30	11/27/2001	B	1							
2-JMS099.30	11/27/2001	S	1	15.22	7.67	8.96			0	0.9
2-JMS099.30	11/27/2001	M	3	14.24		8.84			0	
2-JMS099.30	11/27/2001	M	5	14.03		9			0	
2-JMS099.30	11/27/2001	M	7	13.55		9.12			0	
2-JMS099.30	11/27/2001	M	9	13.46		9.3			0	
2-JMS099.30	11/27/2001	B	10	13.44	7.65	9.4			0	
2-JMS099.30	12/12/2001	S	0.1							
2-JMS099.30	12/12/2001	M	0.5							
2-JMS099.30	12/12/2001	B	1							
2-JMS099.30	12/12/2001	S	1	15.3	7.43	8.4			0	1
2-JMS099.30	12/12/2001	M	3	13.68		8.6			0	
2-JMS099.30	12/12/2001	M	5	13.41		8.78			0	
2-JMS099.30	12/12/2001	M	7	13.51		8.93			0.2	
2-JMS099.30	12/12/2001	B	9	13.38	7.34	9.23			0.2	
2-JMS099.30	1/22/2002	S	0.1							
2-JMS099.30	1/22/2002	M	0.5							
2-JMS099.30	1/22/2002	S	1	6.11	7.54	11.98			0	1.7
2-JMS099.30	1/22/2002	M	1							
2-JMS099.30	1/22/2002	M	1.5							
2-JMS099.30	1/22/2002	M	2							
2-JMS099.30	1/22/2002	M	2.5							
2-JMS099.30	1/22/2002	M	3	6.14		12.02			0	
2-JMS099.30	1/22/2002	B	3.5							
2-JMS099.30	1/22/2002	M	5	6.06		12.04			0	
2-JMS099.30	1/22/2002	M	7	6.05		12.09			0	
2-JMS099.30	1/22/2002	M	9	5.98		12.3			0	
2-JMS099.30	1/22/2002	B	11	6.01	7.14	12.9			0	
2-JMS099.30	2/19/2002	S	0.1							
2-JMS099.30	2/19/2002	M	0.5							
2-JMS099.30	2/19/2002	S	1	8.05	7.61	11.05			0.14	1.5
2-JMS099.30	2/19/2002	M	1							
2-JMS099.30	2/19/2002	M	1.5							
2-JMS099.30	2/19/2002	M	2							
2-JMS099.30	2/19/2002	M	2.5							
2-JMS099.30	2/19/2002	M	3	7.64		11.06			0.13	
2-JMS099.30	2/19/2002	M	3.5							
2-JMS099.30	2/19/2002	B	4							
2-JMS099.30	2/19/2002	M	5	7.66		11.28			0.13	
2-JMS099.30	2/19/2002	M	7	7.68		11.17			0.14	
2-JMS099.30	2/19/2002	M	9	7.68		11.09			0.14	
2-JMS099.30	2/19/2002	M	11	7.69		11.19			0.14	
2-JMS099.30	2/19/2002	B	12	7.68	7.51	11.28			0.13	
2-JMS099.30	3/19/2002	S	0.1							
2-JMS099.30	3/19/2002	M	0.5							

Station ID	Collection Date	Depth Desc	Depth	Temp Celcius	Field Ph	Do Probe	Do Winkler	Fdt Do Optical	Salinity	Secchi Depth
2-JMS099.30	3/19/2002	B	1							
2-JMS099.30	3/19/2002	S	1	13.4	7.54	8.27			0.15	1
2-JMS099.30	3/19/2002	M	3	13.39		8.48			0.15	
2-JMS099.30	3/19/2002	M	5	13.34		8.28			0.15	
2-JMS099.30	3/19/2002	M	7	13.29		8.3			0.15	
2-JMS099.30	3/19/2002	M	9	13.28		8.27			0.15	
2-JMS099.30	3/19/2002	M	11	13.27		8.36			0.15	
2-JMS099.30	3/19/2002	B	12	13.26	7.5	8.19			0.15	
2-JMS099.30	4/16/2002	S	0.1							
2-JMS099.30	4/16/2002	M	0.5							
2-JMS099.30	4/16/2002	S	1	21.7	7.4	7.91			0.8	1.5
2-JMS099.30	4/16/2002	M	1							
2-JMS099.30	4/16/2002	M	1.5							
2-JMS099.30	4/16/2002	M	2							
2-JMS099.30	4/16/2002	M	2.5							
2-JMS099.30	4/16/2002	M	3	21.21		7.79			0.8	
2-JMS099.30	4/16/2002	M	3.5							
2-JMS099.30	4/16/2002	M	4							
2-JMS099.30	4/16/2002	B	4.5							
2-JMS099.30	4/16/2002	M	5	21.05		7.81			0.8	
2-JMS099.30	4/16/2002	M	7	20.86		7.79			0.8	
2-JMS099.30	4/16/2002	B	8	20.78	7.35	7.68			0.8	
2-JMS099.30	5/30/2002	S	0.1							
2-JMS099.30	5/30/2002	M	0.5							
2-JMS099.30	5/30/2002	S	1	26.41	8.19	8.12			0	0.9
2-JMS099.30	5/30/2002	M	1							
2-JMS099.30	5/30/2002	M	1.5							
2-JMS099.30	5/30/2002	M	2							
2-JMS099.30	5/30/2002	B	2.5							
2-JMS099.30	5/30/2002	M	3	26.01	7.99	7.67			0	
2-JMS099.30	5/30/2002	M	5	25.44	7.74	7.25			0	
2-JMS099.30	5/30/2002	M	7	25.31	7.6	6.54			0	
2-JMS099.30	5/30/2002	M	9	25.32	7.52	6.53			0	
2-JMS099.30	5/30/2002	B	10	25.31	7.48	6.43			0	
2-JMS099.30	6/25/2002	S	0.1							
2-JMS099.30	6/25/2002	M	0.5							
2-JMS099.30	6/25/2002	M	1							
2-JMS099.30	6/25/2002	S	1	31.26	8.19				0	0.4
2-JMS099.30	6/25/2002	M	1.5							
2-JMS099.30	6/25/2002	B	2							
2-JMS099.30	6/25/2002	M	3	30.54	7.94				0	
2-JMS099.30	6/25/2002	M	5	30.51	7.94				0	
2-JMS099.30	6/25/2002	M	7	30.33	7.89				0	
2-JMS099.30	6/25/2002	M	9	29.94	7.81				0	
2-JMS099.30	6/25/2002	B	10	29.94	7.73				0	
2-JMS099.30	7/23/2002	S	0.1							
2-JMS099.30	7/23/2002	M	0.5							
2-JMS099.30	7/23/2002	M	1							
2-JMS099.30	7/23/2002	S	1	32.08	7.86	7.89			0	0.9
2-JMS099.30	7/23/2002	M	1.5							
2-JMS099.30	7/23/2002	M	2							
2-JMS099.30	7/23/2002	M	2.5							
2-JMS099.30	7/23/2002	M	3	31.05	7.64	6.8			0	
2-JMS099.30	7/23/2002	B	3							
2-JMS099.30	7/23/2002	M	5	30.94	7.62	6.77			0	
2-JMS099.30	7/23/2002	M	7	30.7	7.56	6.68			0	
2-JMS099.30	7/23/2002	M	9	30.68	7.59	6.69			0	
2-JMS099.30	7/23/2002	M	11	30.74	7.58	4.35			0	
2-JMS099.30	7/23/2002	B	12	30.6	7.2	4.35			0	
2-JMS099.30	8/13/2002	S	0.1							
2-JMS099.30	8/13/2002	M	0.5							
2-JMS099.30	8/13/2002	S	1	30.51	7.92	7.55			0	0.9
2-JMS099.30	8/13/2002	M	1							
2-JMS099.30	8/13/2002	M	1.5							
2-JMS099.30	8/13/2002	M	2							
2-JMS099.30	8/13/2002	M	2.5							
2-JMS099.30	8/13/2002	M	3	30.11	7.81	7.14			0	
2-JMS099.30	8/13/2002	B	3.5							
2-JMS099.30	8/13/2002	M	5	29.67	7.68	6.73			0	
2-JMS099.30	8/13/2002	M	7	29.64	7.69	6.76			0	
2-JMS099.30	8/13/2002	M	9	29.62	7.68	6.85			0	
2-JMS099.30	8/13/2002	B	11	29.64	7.69	6.86			0	
2-JMS099.30	9/24/2002	S	0.1							
2-JMS099.30	9/24/2002	M	0.5							
2-JMS099.30	9/24/2002	M	1							

Station ID	Collection Date	Depth Desc	Depth	Temp Celcius	Field Ph	Do Probe	Do Winkler	Fdt Do Optical	Salinity	Secchi Depth
2-JMS099.30	9/24/2002	S	1	28.76	7.85	7.76			0	0.8
2-JMS099.30	9/24/2002	M	1.5							
2-JMS099.30	9/24/2002	B	2							
2-JMS099.30	9/24/2002	M	3	28.19	7.45	6.34			0	
2-JMS099.30	9/24/2002	M	5	28.06	7.38	6.26			0	
2-JMS099.30	9/24/2002	M	7	27.92	7.37	6.36			0	
2-JMS099.30	9/24/2002	B	9	27.75	7.37	6.61			0	
2-JMS099.30	10/22/2002	S	0.1							
2-JMS099.30	10/22/2002	M	0.5							
2-JMS099.30	10/22/2002	M	1							
2-JMS099.30	10/22/2002	M	1.5							
2-JMS099.30	10/22/2002	M	2							
2-JMS099.30	10/22/2002	M	2.5							
2-JMS099.30	10/22/2002	M	3							
2-JMS099.30	10/22/2002	B	3.5							
2-JMS099.30	10/22/2002	S	1	17.65	7.8	7.65			0	1.5
2-JMS099.30	10/22/2002	M	3	17.68	7.77	7.68			0	
2-JMS099.30	10/22/2002	M	5	17.33	7.78	7.5			0	
2-JMS099.30	10/22/2002	M	7	17.39	7.79	7.31			0	
2-JMS099.30	10/22/2002	M	9	17.34	7.8	7.44			0	
2-JMS099.30	10/22/2002	B	10	17.3	7.8	7.61			0	
2-JMS099.30	11/19/2002	S	0.1							
2-JMS099.30	11/19/2002	M	0.5							
2-JMS099.30	11/19/2002	B	1							
2-JMS099.30	11/19/2002	S	1	10.01	7.05	12.35			0	0.4
2-JMS099.30	11/19/2002	M	3	10.01	7.06	11.65			0	
2-JMS099.30	11/19/2002	M	5	10.01	7.05	12.32			0	
2-JMS099.30	11/19/2002	M	7	10.01	7.05	13.17			0	
2-JMS099.30	11/19/2002	M	9	10.03	7.05	11.83			0	
2-JMS099.30	11/19/2002	B	10	10.03	7.05	12.04			0	
2-JMS099.30	12/10/2002	S	0.1							
2-JMS099.30	12/10/2002	M	0.5							
2-JMS099.30	12/10/2002	M	1							
2-JMS099.30	12/10/2002	S	1	2.53	7.46	14.38			0	2.5
2-JMS099.30	12/10/2002	M	1.5							
2-JMS099.30	12/10/2002	B	2							
2-JMS099.30	12/10/2002	M	3	2.53	7.46	15.45			0	
2-JMS099.30	12/10/2002	M	5	2.52	7.45	14.58			0	
2-JMS099.30	12/10/2002	M	7	2.53	7.46	15.41			0	
2-JMS099.30	12/10/2002	B	9	2.54	7.46	14.97			0	
2-JMS099.30	1/21/2003	S	0.1							
2-JMS099.30	1/21/2003	M	0.5							
2-JMS099.30	1/21/2003	M	1							
2-JMS099.30	1/21/2003	S	1	1.48	7.68	15.03			0	1.4
2-JMS099.30	1/21/2003	M	1.5							
2-JMS099.30	1/21/2003	M	2							
2-JMS099.30	1/21/2003	B	2.5							
2-JMS099.30	1/21/2003	M	3	1.48	7.55	15.18			0	
2-JMS099.30	1/21/2003	M	5	1.49	7.6	14.98			0	
2-JMS099.30	1/21/2003	M	7	1.49	7.56	15.37			0	
2-JMS099.30	1/21/2003	B	9	1.49	7.54	15.14			0	
2-JMS099.30	2/25/2003	S	0.1							
2-JMS099.30	2/25/2003	S	1	4.46	6.8	12.9			0	0.1
2-JMS099.30	2/25/2003	M	2	4.46	6.81	12.79			0	
2-JMS099.30	2/25/2003	M	3	4.46	6.72	12.79			0	
2-JMS099.30	2/25/2003	M	4	4.46	6.96	12.69			0	
2-JMS099.30	2/25/2003	B	5	4.46	6.85	12.67			0	
2-JMS099.30	3/18/2003	S	0.1							
2-JMS099.30	3/18/2003	M	0.5							
2-JMS099.30	3/18/2003	S	1	11.73	7.8	10.35			0	0.1
2-JMS099.30	3/18/2003	M	1							
2-JMS099.30	3/18/2003	M	1.5							
2-JMS099.30	3/18/2003	M	2							
2-JMS099.30	3/18/2003	M	3	11.47	7.77	10.8			0	
2-JMS099.30	3/18/2003	M	5	11.27	7.75	10.63			0	
2-JMS099.30	3/18/2003	M	7	11.45	7.75	10.85			0	
2-JMS099.30	3/18/2003	M	9	11.31	7.74	10.95			0	
2-JMS099.30	3/18/2003	M	11	11.23	7.74	10.96			0	
2-JMS099.30	3/18/2003	B	12	11.2	7.74	10.98			0	
2-JMS099.30	4/15/2003	S	1	13.31	6.86	11.27			0	
2-JMS099.30	4/15/2003	B	3	13.4	7.35	11.23			0	
2-JMS099.30	5/27/2003	S	0.1							
2-JMS099.30	5/27/2003	S	1	17.21	6.9	9.37			0	0.5
2-JMS099.30	5/27/2003	M	3	17.32	6.85	9.36			0	
2-JMS099.30	5/27/2003	M	5	17.22	6.94	9			0	

Station ID	Collection Date	Depth Desc	Depth	Temp Celcius	Field Ph	Do Probe	Do Winkler	Fdt Do Optical	Salinity	Secchi Depth
2-JMS099.30	5/27/2003	B	6	17.22	6.96	9.04			0	
2-JMS099.30	6/24/2003	S	0.1							
2-JMS099.30	6/24/2003	M	0.5							
2-JMS099.30	6/24/2003	S	1	21.07	7.59	8.35			0	0.6
2-JMS099.30	6/24/2003	M	1							
2-JMS099.30	6/24/2003	M	1.5							
2-JMS099.30	6/24/2003	M	2							
2-JMS099.30	6/24/2003	M	3	21.04	7.58	8.36			0	
2-JMS099.30	6/24/2003	M	5	21.03	7.58	8.37			0	
2-JMS099.30	6/24/2003	M	7	21.07	7.57	8.43			0	
2-JMS099.30	6/24/2003	M	9	21.06	7.57	8.55			0	
2-JMS099.30	6/24/2003	M	11	21.07	7.58	8.67			0	
2-JMS099.30	6/24/2003	B	12	21.06	7.58	8.66			0	
2-JMS099.30	7/15/2003	S	0.1							
2-JMS099.30	7/15/2003	M	0.5							
2-JMS099.30	7/15/2003	S	1	27.76	8.25	8.89			0	0.6
2-JMS099.30	7/15/2003	M	1							
2-JMS099.30	7/15/2003	M	1.5							
2-JMS099.30	7/15/2003	M	2							
2-JMS099.30	7/15/2003	M	2.5							
2-JMS099.30	7/15/2003	M	3	27.18	7.81	7.91			0	
2-JMS099.30	7/15/2003	M	5	27.07	7.72	7.77			0	
2-JMS099.30	7/15/2003	B	7	26.95	7.67	7.71			0	
2-JMS099.30	8/26/2003	S	0.1							
2-JMS099.30	8/26/2003	M	0.5							
2-JMS099.30	8/26/2003	S	1	29.41	8.19	8.41			0	0.7
2-JMS099.30	8/26/2003	M	1							
2-JMS099.30	8/26/2003	M	1.5							
2-JMS099.30	8/26/2003	M	2							
2-JMS099.30	8/26/2003	M	2.5							
2-JMS099.30	8/26/2003	M	3	28.45	7.99	7.82			0	
2-JMS099.30	8/26/2003	B	3							
2-JMS099.30	8/26/2003	M	5	28.1	7.83	7.48			0	
2-JMS099.30	8/26/2003	M	7	28	7.78	7.33			0	
2-JMS099.30	8/26/2003	M	9	27.97	7.78	7.24			0	
2-JMS099.30	8/26/2003	M	11	27.95	7.77	7.15			0	
2-JMS099.30	8/26/2003	B	12	27.95	7.77	7.2			0	
2-JMS099.30	9/24/2003	S	0.1							
2-JMS099.30	9/24/2003	S	1	21.04	7.2	8.81			0	0.2
2-JMS099.30	9/24/2003	B	3	21.01	7.31	8.69			0	
2-JMS099.30	10/28/2003	S	0.1							
2-JMS099.30	10/28/2003	B	0.5							
2-JMS099.30	10/28/2003	S	1	15.22	7.71	9.56			0	1
2-JMS099.30	10/28/2003	M	3	15.22	7.71	9.56			0	
2-JMS099.30	10/28/2003	M	5	15.23	7.7	9.47			0	
2-JMS099.30	10/28/2003	M	7	15.23	7.7	9.55			0	
2-JMS099.30	10/28/2003	B	9	15.19	7.69	9.78			0	
2-JMS099.30	11/18/2003	S	0.1							
2-JMS099.30	11/18/2003	M	0.5							
2-JMS099.30	11/18/2003	S	1	10.4	7.57	10.34			0	0.5
2-JMS099.30	11/18/2003	M	1							
2-JMS099.30	11/18/2003	B	1.5							
2-JMS099.30	11/18/2003	M	3	10.4	7.53	10.58			0	
2-JMS099.30	11/18/2003	M	5	10.39	7.51	10.55			0	
2-JMS099.30	11/18/2003	M	7	10.38	7.49	10.44			0	
2-JMS099.30	11/18/2003	M	9	10.36	7.5	10.31			0	
2-JMS099.30	11/18/2003	M	11	10.4	7.5	10.31			0	
2-JMS099.30	11/18/2003	B	12	10.41	7.5	10.37			0	
2-JMS099.30	12/16/2003	S	0.1							
2-JMS099.30	12/16/2003	M	0.5							
2-JMS099.30	12/16/2003	M	1							
2-JMS099.30	12/16/2003	S	1	4.23	7.26	12.72			0	0.4
2-JMS099.30	12/16/2003	M	3	4.21	7.24	12.5			0	
2-JMS099.30	12/16/2003	M	5	4.21	7.22	12.58			0	
2-JMS099.30	12/16/2003	M	7	4.22	7.2	12.7			0	
2-JMS099.30	12/16/2003	M	9	4.24	7.21	12.55			0	
2-JMS099.30	12/16/2003	B	10	4.26	7.21	12.66			0	
2-JMS099.30	2/25/2004	S	0.1							
2-JMS099.30	2/25/2004	M	0.5							
2-JMS099.30	2/25/2004	M	1							
2-JMS099.30	2/25/2004	S	1	6.37	7.67	12.32			0	1.3
2-JMS099.30	2/25/2004	M	1.5							
2-JMS099.30	2/25/2004	M	2							
2-JMS099.30	2/25/2004	M	2.5							
2-JMS099.30	2/25/2004	M	3	6.36	7.67	12.33			0	

Station ID	Collection Date	Depth Desc	Depth	Temp Celcius	Field Ph	Do Probe	Do Winkler	Fdt Do Optical	Salinity	Secchi Depth
2-JMS099.30	2/25/2004	M	3.5							
2-JMS099.30	2/25/2004	M	4							
2-JMS099.30	2/25/2004	M	4.5							
2-JMS099.30	2/25/2004	M	5	6.36	7.64	12.33			0	
2-JMS099.30	2/25/2004	M	7	6.37	7.65	12.35			0	
2-JMS099.30	2/25/2004	B	9	6.39	7.64	12.41			0	
2-JMS099.30	3/23/2004	S	0.1							
2-JMS099.30	3/23/2004	M	0.5							
2-JMS099.30	3/23/2004	S	1	11.69	8.29	10.84			0	
2-JMS099.30	3/23/2004	M	1							
2-JMS099.30	3/23/2004	M	1.5							
2-JMS099.30	3/23/2004	M	2							
2-JMS099.30	3/23/2004	M	2.5							
2-JMS099.30	3/23/2004	M	3	11.55	8.26	10.93			0	
2-JMS099.30	3/23/2004	M	3.5							
2-JMS099.30	3/23/2004	M	4							
2-JMS099.30	3/23/2004	M	5	11.7	8.27	10.81			0	
2-JMS099.30	3/23/2004	M	7	11.66	8.27	10.95			0	
2-JMS099.30	3/23/2004	B	8	11.64	8.25	11.17			0	
2-JMS099.30	4/20/2004	S	0.1							
2-JMS099.30	4/20/2004	M	0.5							
2-JMS099.30	4/20/2004	M	1							
2-JMS099.30	4/20/2004	S	1	17.16	7.32	9.41			0	0.7
2-JMS099.30	4/20/2004	M	1.5							
2-JMS099.30	4/20/2004	B	2							
2-JMS099.30	4/20/2004	M	3	16.91	7.32	9.39			0	
2-JMS099.30	4/20/2004	M	5	16.85	7.32	9.49			0	
2-JMS099.30	4/20/2004	B	7	16.83	7.33	9.52			0	
2-JMS099.30	5/18/2004	S	0.1							
2-JMS099.30	5/18/2004	M	0.5							
2-JMS099.30	5/18/2004	S	1		7.43					
2-JMS099.30	5/18/2004	M	1							
2-JMS099.30	5/18/2004	M	1.5							
2-JMS099.30	5/18/2004	M	2							
2-JMS099.30	5/18/2004	M	2.5							
2-JMS099.30	5/18/2004	M	3		7.45					
2-JMS099.30	5/18/2004	M	3.5							
2-JMS099.30	5/18/2004	M	5		7.39					
2-JMS099.30	5/18/2004	M	7		7.38					
2-JMS099.30	5/18/2004	M	9		7.32					
2-JMS099.30	5/18/2004	B	11		7.3					
2-JMS099.30	6/15/2004	S	0.1							
2-JMS099.30	6/15/2004	M	0.5							
2-JMS099.30	6/15/2004	M	1							
2-JMS099.30	6/15/2004	S	1	26.02	7.37	7.75			0	0.8
2-JMS099.30	6/15/2004	M	1.5							
2-JMS099.30	6/15/2004	M	2							
2-JMS099.30	6/15/2004	M	2.5							
2-JMS099.30	6/15/2004	M	3	24.96	7.37	7.59			0	
2-JMS099.30	6/15/2004	M	5	24.9	7.33	7.51			0	
2-JMS099.30	6/15/2004	M	7	24.79	7.33	7.47			0	
2-JMS099.30	6/15/2004	M	9	24.69	7.34	7.4			0	
2-JMS099.30	6/15/2004	B	11	24.65	7.34	7.32			0	
2-JMS099.30	7/20/2004	S	0.1							
2-JMS099.30	7/20/2004	M	0.5							
2-JMS099.30	7/20/2004	M	1							
2-JMS099.30	7/20/2004	S	1	28.35	7.78	7.2			0	0.9
2-JMS099.30	7/20/2004	M	1.5							
2-JMS099.30	7/20/2004	M	2							
2-JMS099.30	7/20/2004	M	3	27.7	7.67	6.8			0	
2-JMS099.30	7/20/2004	M	5	27.63	7.67	6.49			0	
2-JMS099.30	7/20/2004	M	7	27.6	7.68	6.78			0	
2-JMS099.30	7/20/2004	M	9	27.57	7.66	6.64			0	
2-JMS099.30	7/20/2004	B	11	27.58	7.65	6.45			0	
2-JMS099.30	8/17/2004	S	1	22.91	7.14	6.97			0	0.3
2-JMS099.30	8/17/2004	M	3	22.92	7.12	6.93			0	
2-JMS099.30	8/17/2004	M	5	22.89	7.12	7.23			0	
2-JMS099.30	8/17/2004	B	6	22.9	7.13	7.2			0	
2-JMS099.30	9/21/2004	S	0.1							
2-JMS099.30	9/21/2004	M	0.5							
2-JMS099.30	9/21/2004	M	1							
2-JMS099.30	9/21/2004	S	1	20.53	7.56	8.55			0	0.4
2-JMS099.30	9/21/2004	B	1.5							
2-JMS099.30	9/21/2004	M	3	20.52	7.55	8.54			0	
2-JMS099.30	9/21/2004	M	5	20.52	7.55	8.51			0	

Station ID	Collection Date	Depth Desc	Depth	Temp Celcius	Field Ph	Do Probe	Do Winkler	Fdt Do Optical	Salinity	Secchi Depth
2-JMS099.30	9/21/2004	M	7	20.48	7.56	8.63			0	
2-JMS099.30	9/21/2004	M	9	20.47	7.55	8.57			0	
2-JMS099.30	9/21/2004	M	11	20.46	7.64	8.65			0	
2-JMS099.30	9/21/2004	B	12	20.47	7.63	8.64			0	
2-JMS099.30	10/19/2004	S	0.1							
2-JMS099.30	10/19/2004	M	0.5							
2-JMS099.30	10/19/2004	M	1							
2-JMS099.30	10/19/2004	S	1	15.56	7.75	9.07			0	0.9
2-JMS099.30	10/19/2004	M	1.5							
2-JMS099.30	10/19/2004	M	2							
2-JMS099.30	10/19/2004	M	3	15.56	7.75	9.12			0	
2-JMS099.30	10/19/2004	M	5	15.54	7.71	9.26			0	
2-JMS099.30	10/19/2004	M	7	15.48	7.68	9.35			0	
2-JMS099.30	10/19/2004	B	9	15.42	7.69	9.56			0	
2-JMS099.30	11/16/2004	S	1	9.19	7.47	11.32			0	0.4
2-JMS099.30	11/16/2004	M	3	9.17	7.49	11.32			0	
2-JMS099.30	11/16/2004	M	5	9.19	7.49	11.33			0	
2-JMS099.30	11/16/2004	M	7	9.16	7.48	11.35			0	
2-JMS099.30	11/16/2004	M	9	9.12	7.39	11.43			0	
2-JMS099.30	11/16/2004	M	11	9.13	7.38	11.42			0	
2-JMS099.30	11/16/2004	B	12	9.14	7.44	11.49			0	
2-JMS099.30	12/14/2004	S	0.1							
2-JMS099.30	12/14/2004	M	0.5							
2-JMS099.30	12/14/2004	S	1	8.29	7.74	11.33			0	0.6
2-JMS099.30	12/14/2004	B	1							
2-JMS099.30	12/14/2004	M	3	8.29	7.72	11.36			0	
2-JMS099.30	12/14/2004	M	5	8.28	7.73	11.27			0	
2-JMS099.30	12/14/2004	M	7	8.28	7.71	11.3			0	
2-JMS099.30	12/14/2004	B	8	8.29	7.73	11.51			0	
2-JMS099.30	1/26/2005	S	1	1.26	7.66	13.83			0	0.9
2-JMS099.30	1/26/2005	M	3	1.27	7.66	13.81			0	
2-JMS099.30	1/26/2005	M	5	1.27	7.65	13.75			0	
2-JMS099.30	1/26/2005	M	7	1.31	7.63	13.9			0	
2-JMS099.30	1/26/2005	M	9	1.31	7.63	13.93			0	
2-JMS099.30	1/26/2005	M	11	1.35	7.66	13.96			0	
2-JMS099.30	1/26/2005	B	12	1.33	7.7	14.13			0	
2-JMS099.30	2/15/2005	S	0.1							
2-JMS099.30	2/15/2005	M	0.5							
2-JMS099.30	2/15/2005	M	1							
2-JMS099.30	2/15/2005	S	1	7.23	7.81	11.88			0	1.8
2-JMS099.30	2/15/2005	M	1.5							
2-JMS099.30	2/15/2005	M	2							
2-JMS099.30	2/15/2005	M	2.5							
2-JMS099.30	2/15/2005	M	3	7.2	7.75	11.89			0	
2-JMS099.30	2/15/2005	M	3.5							
2-JMS099.30	2/15/2005	M	4							
2-JMS099.30	2/15/2005	M	5	7.1	7.78	11.85			0	
2-JMS099.30	2/15/2005	M	7	7.17	7.8	11.87			0	
2-JMS099.30	2/15/2005	M	9	7.17	7.76	11.91			0	
2-JMS099.30	2/15/2005	B	11	7.13	7.8	12.03			0	
2-JMS099.30	3/22/2005	S	0.1							
2-JMS099.30	3/22/2005	M	0.5							
2-JMS099.30	3/22/2005	S	1	11.92	8.57	11.29			0	1.5
2-JMS099.30	3/22/2005	M	1							
2-JMS099.30	3/22/2005	M	1.5							
2-JMS099.30	3/22/2005	M	2							
2-JMS099.30	3/22/2005	M	2.5							
2-JMS099.30	3/22/2005	M	3	11.5	8.5	11.26			0	
2-JMS099.30	3/22/2005	M	3.5							
2-JMS099.30	3/22/2005	M	4							
2-JMS099.30	3/22/2005	B	4.5							
2-JMS099.30	3/22/2005	M	5	11.22	8.55	11.47			0	
2-JMS099.30	3/22/2005	M	7	11.16	8.5	11.41			0	
2-JMS099.30	3/22/2005	M	9	11.15	8.51	11.52			0	
2-JMS099.30	3/22/2005	B	11	11.12	8.54	11.78			0	
2-JMS099.30	4/19/2005	S	0.1							
2-JMS099.30	4/19/2005	M	0.5							
2-JMS099.30	4/19/2005	M	1							
2-JMS099.30	4/19/2005	S	1	17.8	8.09	9.41			0	0.8
2-JMS099.30	4/19/2005	M	1.5							
2-JMS099.30	4/19/2005	M	2							
2-JMS099.30	4/19/2005	B	2.5							
2-JMS099.30	4/19/2005	M	3	17.4	8	9.6			0	
2-JMS099.30	4/19/2005	M	5	17.2	7.94	9.6			0	
2-JMS099.30	4/19/2005	M	7	17	7.92	9.6			0	

Station ID	Collection Date	Depth Desc	Depth	Temp Celcius	Field Ph	Do Probe	Do Winkler	Fdt Do Optical	Salinity	Secchi Depth
2-JMS099.30	4/19/2005	M	9	16.8	7.85	9.79			0	
2-JMS099.30	4/19/2005	M	11	16.1	7.82	9.87			0	
2-JMS099.30	4/19/2005	B	12	16.1	7.84	9.95			0	
2-JMS099.30	5/24/2005	S	0.1							
2-JMS099.30	5/24/2005	M	0.5							
2-JMS099.30	5/24/2005	M	1							
2-JMS099.30	5/24/2005	S	1	21.01	7.22	7.51				0.7
2-JMS099.30	5/24/2005	M	3	21.06	7.47	7.71			0	
2-JMS099.30	5/24/2005	M	5	21.02	7.45	7.69			0	
2-JMS099.30	5/24/2005	M	7	21	7.43	7.76				
2-JMS099.30	5/24/2005	M	9	20.97	7.41	7.75			0	
2-JMS099.30	5/24/2005	B	11	20.97	7.51	7.75			0	
2-JMS099.30	6/21/2005	S	0.1							
2-JMS099.30	6/21/2005	M	0.5							
2-JMS099.30	6/21/2005	M	1							
2-JMS099.30	6/21/2005	S	1	27.6	7.68	6.77			0	0.8
2-JMS099.30	6/21/2005	M	1.5							
2-JMS099.30	6/21/2005	M	2							
2-JMS099.30	6/21/2005	M	3	27.4	7.62	6.48			0	
2-JMS099.30	6/21/2005	M	5	27.2	7.58	6.33			0	
2-JMS099.30	6/21/2005	M	7	27.2	7.57	6.31			0	
2-JMS099.30	6/21/2005	M	9	27.2	7.54	6.29			0	
2-JMS099.30	6/21/2005	B	10	27.1	7.52	6.32			0	
2-JMS099.30	7/19/2005	S	0.1							
2-JMS099.30	7/19/2005	S	0.3							
2-JMS099.30	7/19/2005	M	0.5							
2-JMS099.30	7/19/2005	S	1	31.19	7.68	6.97			0	0.8
2-JMS099.30	7/19/2005	M	1							
2-JMS099.30	7/19/2005	M	1.5							
2-JMS099.30	7/19/2005	M	2							
2-JMS099.30	7/19/2005	M	2.5							
2-JMS099.30	7/19/2005	M	3	30.74	7.62	6.69			0	
2-JMS099.30	7/19/2005	M	3.5							
2-JMS099.30	7/19/2005	B	4							
2-JMS099.30	7/19/2005	M	5	30.66	7.59	6.58			0	
2-JMS099.30	7/19/2005	M	7	30.53	7.54	6.44			0	
2-JMS099.30	7/19/2005	M	9	30.49	7.51	6.48			0	
2-JMS099.30	7/19/2005	M	11	30.49	7.44	6.3			0	
2-JMS099.30	7/19/2005	B	12	30.46	7.44	6.35			0	
2-JMS099.30	8/23/2005	S	0.1							
2-JMS099.30	8/23/2005	S	0.3							
2-JMS099.30	8/23/2005	M	0.5							
2-JMS099.30	8/23/2005	M	1							
2-JMS099.30	8/23/2005	S	1	29.9	7.36	6.22			0	1
2-JMS099.30	8/23/2005	M	1.5							
2-JMS099.30	8/23/2005	M	2							
2-JMS099.30	8/23/2005	M	2.5							
2-JMS099.30	8/23/2005	M	3	29.8	7.4	6.01			0	
2-JMS099.30	8/23/2005	M	5	29.8	7.4	6.06			0	
2-JMS099.30	8/23/2005	M	7	29.9	7.48	6.13			0	
2-JMS099.30	8/23/2005	M	9	29.8	7.43	6.09			0	
2-JMS099.30	8/23/2005	B	10	29.8	7.43	6.06			0	
2-JMS099.30	9/20/2005	S	0.1							
2-JMS099.30	9/20/2005	M	0.5							
2-JMS099.30	9/20/2005	M	1							
2-JMS099.30	9/20/2005	S	1	27.9	7.8	7.7			0	0.7
2-JMS099.30	9/20/2005	M	1.5							
2-JMS099.30	9/20/2005	M	3	27.5	7.63	7.06			0	
2-JMS099.30	9/20/2005	M	5	27.5	7.63	7.14			0	
2-JMS099.30	9/20/2005	M	7	27.6	7.77	7.34			0	
2-JMS099.30	9/20/2005	M	9	27.6	7.71	7.23			0	
2-JMS099.30	9/20/2005	M	11	27.6	7.7	7.25			0	
2-JMS099.30	9/20/2005	B	12	27.6	7.72	7.24			0	
2-JMS099.30	10/18/2005	S	0.3							
2-JMS099.30	10/18/2005	S	1	19.1	7.31	8.43			0	1.2
2-JMS099.30	10/18/2005	M	3	19	7.38	8.34			0	
2-JMS099.30	10/18/2005	M	5	18.9	7.41	8.3			0	
2-JMS099.30	10/18/2005	M	7	18.9	7.41	8.19			0	
2-JMS099.30	10/18/2005	M	9	18.9	7.42	7.75			0	
2-JMS099.30	10/18/2005	M	11	18.9	7.38	6.08			0	
2-JMS099.30	10/18/2005	B	12	19	7.36	4.54			0	
2-JMS099.30	11/15/2005	S	0.3		7.67	9.22				
2-JMS099.30	11/15/2005	S	0.1							
2-JMS099.30	11/15/2005	M	0.5							
2-JMS099.30	11/15/2005	S	1	15.4	7.67	9.22			0	1

Station ID	Collection Date	Depth Desc	Depth	Temp Celcius	Field Ph	Do Probe	Do Winkler	Fdt Do Optical	Salinity	Secchi Depth
2-JMS099.30	11/15/2005	M	1							
2-JMS099.30	11/15/2005	M	1.5							
2-JMS099.30	11/15/2005	M	2							
2-JMS099.30	11/15/2005	M	2.5							
2-JMS099.30	11/15/2005	B	3							
2-JMS099.30	11/15/2005	M	3	14.9	7.65	9.17			0	
2-JMS099.30	11/15/2005	M	5	14.9	7.65	9.16			0	
2-JMS099.30	11/15/2005	M	7	14.7	7.61	9.13			0	
2-JMS099.30	11/15/2005	M	9	14.7	7.56	9.03			0	
2-JMS099.30	11/15/2005	M	11	14.7	7.56	8.97			0	
2-JMS099.30	11/15/2005	B	12	14.7	7.59	9.01			0	
2-JMS099.30	12/13/2005	S	1							
2-JMS099.30	12/13/2005	S	0.3	4.05	7.21	12.8				
2-JMS099.30	12/21/2005	S	0.1							
2-JMS099.30	12/21/2005	M	0.5							
2-JMS099.30	12/21/2005	S	1	3.91	7.49	13.06			0	0.6
2-JMS099.30	12/21/2005	M	1							
2-JMS099.30	12/21/2005	M	1.5							
2-JMS099.30	12/21/2005	B	2							
2-JMS099.30	12/21/2005	M	3	3.91	7.51	13.02			0	
2-JMS099.30	12/21/2005	M	5	3.91	7.51	12.96			0	
2-JMS099.30	12/21/2005	M	7	3.91	7.48	12.95			0	
2-JMS099.30	12/21/2005	M	9	3.92	7.45	12.92			0	
2-JMS099.30	12/21/2005	B	11	3.94	7.45	12.9			0	
2-JMS099.30	1/17/2006	S	0							
2-JMS099.30	1/17/2006	S	0.1							
2-JMS099.30	1/17/2006	M	0.5							
2-JMS099.30	1/17/2006	M	1							
2-JMS099.30	1/17/2006	S	1	5.9	7.47	12.52			0	0.4
2-JMS099.30	1/17/2006	M	3	5.9	7.46	12.57			0	
2-JMS099.30	1/17/2006	M	5	5.9	7.44	12.61			0	
2-JMS099.30	1/17/2006	M	7	5.9	7.33	12.64			0	
2-JMS099.30	1/17/2006	M	9	5.9	7.26	12.63			0	
2-JMS099.30	1/17/2006	B	10	5.9	7.26	12.67			0	
2-JMS099.30	1/17/2006	S	0							
2-JMS099.30	2/21/2006	S	0.1							
2-JMS099.30	2/21/2006	M	0.5							
2-JMS099.30	2/21/2006	S	1	6.4	7.5	12.9			0	2
2-JMS099.30	2/21/2006	M	1							
2-JMS099.30	2/21/2006	M	1.5							
2-JMS099.30	2/21/2006	M	2							
2-JMS099.30	2/21/2006	M	2.5							
2-JMS099.30	2/21/2006	M	3	6.3	7.61	12.91			0	
2-JMS099.30	2/21/2006	M	3.5							
2-JMS099.30	2/21/2006	B	4	6.3	7.5	13			0	
2-JMS099.30	2/21/2006	M	4							
2-JMS099.30	2/21/2006	M	4.5							
2-JMS099.30	2/21/2006	M	5							
2-JMS099.30	2/21/2006	B	5.5							
2-JMS099.30	3/20/2006	S	0.1							
2-JMS099.30	3/20/2006	M	0.5							
2-JMS099.30	3/20/2006	S	1	12.9	7.9	10.1				1.7
2-JMS099.30	3/20/2006	M	1							
2-JMS099.30	3/20/2006	M	1.5							
2-JMS099.30	3/20/2006	M	2							
2-JMS099.30	3/20/2006	M	2.5							
2-JMS099.30	3/20/2006	M	3	12.9	7.9	10.1				
2-JMS099.30	3/20/2006	M	3.5							
2-JMS099.30	3/20/2006	M	5	12.8	7.9	10.1				
2-JMS099.30	3/20/2006	M	7	12.8	7.9	10.1				
2-JMS099.30	3/20/2006	M	9	12.8	7.9	10.2				
2-JMS099.30	3/20/2006	B	11	12.8	7.8	10.2				
2-JMS099.30	4/26/2006	S	0.1							
2-JMS099.30	4/26/2006	M	0.5							
2-JMS099.30	4/26/2006	S	1	21.4	7.5	7.6			0	1.4
2-JMS099.30	4/26/2006	M	1							
2-JMS099.30	4/26/2006	M	1.5							
2-JMS099.30	4/26/2006	M	2							
2-JMS099.30	4/26/2006	M	2.5							
2-JMS099.30	4/26/2006	B	3							
2-JMS099.30	4/26/2006	M	3	21.3	7.5	7.6			0	
2-JMS099.30	4/26/2006	M	5	21.3	7.5	7.6			0	
2-JMS099.30	4/26/2006	M	7	21.2	7.5	7.6			0	
2-JMS099.30	4/26/2006	M	9	21.2	7.5	7.7			0	
2-JMS099.30	4/26/2006	B	11	21.2	7.5	7.6			0	

Station ID	Collection Date	Depth Desc	Depth	Temp Celcius	Field Ph	Do Probe	Do Winkler	Fdt Do Optical	Salinity	Secchi Depth
2-JMS099.30	5/15/2006	S	0.1							
2-JMS099.30	5/15/2006	M	0.5							
2-JMS099.30	5/15/2006	S	1	21	7.8	7.2			0	1
2-JMS099.30	5/15/2006	M	1							
2-JMS099.30	5/15/2006	M	1.5							
2-JMS099.30	5/15/2006	M	2							
2-JMS099.30	5/15/2006	M	2.5							
2-JMS099.30	5/15/2006	M	3	21.1	7.7	7.2			0	
2-JMS099.30	5/15/2006	M	3.5							
2-JMS099.30	5/15/2006	M	4							
2-JMS099.30	5/15/2006	B	4.5							
2-JMS099.30	5/15/2006	M	5	20.9	7.7	7.2			0	
2-JMS099.30	5/15/2006	B	6	20.9	7.7	7.1			0	
2-JMS099.30	6/21/2006	S	0.3	27.8	7.6	7.2			0	
2-JMS099.30	6/29/2006	S	0.1							
2-JMS099.30	6/29/2006	S	1							
2-JMS099.30	7/24/2006	S	0.1							
2-JMS099.30	7/24/2006	M	0.5							
2-JMS099.30	7/24/2006	S	1	30.5	7.6	6.2			0	
2-JMS099.30	7/24/2006	M	1							
2-JMS099.30	7/24/2006	M	1.5							
2-JMS099.30	7/24/2006	M	2							
2-JMS099.30	7/24/2006	M	2.5							
2-JMS099.30	7/24/2006	M	3	30	7.5	5.8			0	
2-JMS099.30	7/24/2006	B	3.5							
2-JMS099.30	7/24/2006	M	5	29.5	7.5	5.7			0	
2-JMS099.30	7/24/2006	M	7	29.3	7.5	5.6			0	
2-JMS099.30	7/24/2006	M	9	29.3	7.5	5.7			0	
2-JMS099.30	7/24/2006	B	10	29.3	7.5	5.7			0	
2-JMS099.30	8/22/2006	S	0.1							
2-JMS099.30	8/22/2006	M	0.5							
2-JMS099.30	8/22/2006	S	1	31.3	7.7	7.3			0	0.6
2-JMS099.30	8/22/2006	B	1							
2-JMS099.30	8/22/2006	M	3	30.5	7.6	7.1			0	
2-JMS099.30	8/22/2006	M	5	29.9	7.6	6.9			0	
2-JMS099.30	8/22/2006	M	7	30	7.6	7.1			0	
2-JMS099.30	8/22/2006	B	9	29.6	7.4	6.3			0	
2-JMS099.30	9/27/2006	S	0.1							
2-JMS099.30	9/27/2006	S	1	23.3	7.6	8.2			0	
2-JMS099.30	10/30/2006	S	0.1							
2-JMS099.30	10/30/2006	M	0.5							
2-JMS099.30	10/30/2006	M	1							
2-JMS099.30	10/30/2006	S	1	11.8	7.4	10			0	0.5
2-JMS099.30	10/30/2006	M	1.5							
2-JMS099.30	10/30/2006	M	3	11.8	7.4	10			0	
2-JMS099.30	10/30/2006	M	5	11.8	7.4	10.1			0	
2-JMS099.30	10/30/2006	M	7	11.8	7.4	10.1			0	
2-JMS099.30	10/30/2006	M	9	11.8	7.4	10.2			0	
2-JMS099.30	10/30/2006	B	10	11.8	7.4	10.4			0	
2-JMS099.30	11/15/2006	S	0.1							
2-JMS099.30	11/15/2006	M	0.5							
2-JMS099.30	11/15/2006	M	1							
2-JMS099.30	11/15/2006	S	1	12.7	7.3	9.7			0	0.5
2-JMS099.30	11/15/2006	M	3	12.7	7.3	9.6			0	
2-JMS099.30	11/15/2006	M	5	12.6	7.3	9.7			0	
2-JMS099.30	11/15/2006	M	7	12.7	7.3	9.7			0	
2-JMS099.30	11/15/2006	M	9	12.7	7.3	9.8			0	
2-JMS099.30	11/15/2006	B	10	12.7	7.4	9.9			0	
2-JMS099.30	12/18/2006	S	1	7.5	7.2	12.2			0	
2-JMS099.30	1/24/2007	S	0.1							
2-JMS099.30	1/24/2007	M	0.5							
2-JMS099.30	1/24/2007	S	1	5.2	7.8	12.2			0	1.3
2-JMS099.30	1/24/2007	M	1							
2-JMS099.30	1/24/2007	M	1.5							
2-JMS099.30	1/24/2007	M	2							
2-JMS099.30	1/24/2007	M	2.5							
2-JMS099.30	1/24/2007	M	3	5.2	7.8	12.2			0	
2-JMS099.30	1/24/2007	M	3.5							
2-JMS099.30	1/24/2007	M	4							
2-JMS099.30	1/24/2007	M	4.5							
2-JMS099.30	1/24/2007	M	5	5.2	7.8	12.3			0	
2-JMS099.30	1/24/2007	M	7	5.2	7.8	12.2			0	
2-JMS099.30	1/24/2007	M	9	5.2	7.8	12.2			0	
2-JMS099.30	1/24/2007	B	10	5.2	7.8	12.3			0	
2-JMS099.30	2/20/2007	S	0.1							

Station ID	Collection Date	Depth Desc	Depth	Temp Celcius	Field Ph	Do Probe	Do Winkler	Fdt Do Optical	Salinity	Secchi Depth
2-JMS099.30	2/20/2007	M	0.5							
2-JMS099.30	2/20/2007	M	1							
2-JMS099.30	2/20/2007	S	1	3.3	7.5	13.1			0	0.4
2-JMS099.30	2/20/2007	M	1.5							
2-JMS099.30	2/20/2007	M	2							
2-JMS099.30	2/20/2007	M	3	3.2	7.5	13.1			0	
2-JMS099.30	2/20/2007	M	5	3.1	7.5	13.2			0	
2-JMS099.30	2/20/2007	M	7	3.1	7.5	13.3			0	
2-JMS099.30	2/20/2007	B	8	3.2	7.4	13.3			0	
2-JMS099.30	3/19/2007	S	0.1							
2-JMS099.30	3/19/2007	M	0.5							
2-JMS099.30	3/19/2007	S	1	8.3	7.2	11.6			0	0.2
2-JMS099.30	3/19/2007	M	1							
2-JMS099.30	3/19/2007	M	3	8.3	7.2	11.6			0	
2-JMS099.30	3/19/2007	M	5	8.3	7.2	11.5			0	
2-JMS099.30	3/19/2007	M	7	8.3	7.1	11.6			0	
2-JMS099.30	3/19/2007	M	9	8.3	7.1	11.6			0	
2-JMS099.30	3/19/2007	B	11	8.3	7.1	11.6			0	
2-JMS099.30	4/30/2007	S	1	21.3	8.1	9			0	1.2
2-JMS099.30	4/30/2007	M	3	20.1	8	8.9			0	
2-JMS099.30	4/30/2007	M	5	20	7.9	8.8			0	
2-JMS099.30	4/30/2007	M	7	19.9	7.9	8.8			0	
2-JMS099.30	4/30/2007	M	9	19.9	7.8	8.8			0	
2-JMS099.30	4/30/2007	B	10	19.9	7.8	8.9			0	
2-JMS099.30	5/30/2007	S	1	27.7	7.7	7			0	1.2
2-JMS099.30	5/30/2007	M	2	27.5	7.6	6.7			0	
2-JMS099.30	5/30/2007	M	3	27.2	7.5	6.4			0	
2-JMS099.30	5/30/2007	M	4	27.1	7.5	6.4			0	
2-JMS099.30	5/30/2007	M	5	27	7.5	6.4			0	
2-JMS099.30	5/30/2007	M	6	27	7.5	6.1			0	
2-JMS099.30	5/30/2007	M	7	26.9	7.5	6.1			0	
2-JMS099.30	5/30/2007	M	8	26.9	7.5	6.1			0	
2-JMS099.30	5/30/2007	M	9	26.9	7.5	6			0	
2-JMS099.30	5/30/2007	B	10	26.9	7.5	6.1			0	
2-JMS099.30	6/18/2007	S	1	26.4	7.7	7.6			0	1
2-JMS099.30	6/18/2007	M	2	25.9	7.6	7.2			0	
2-JMS099.30	6/18/2007	M	3	25.6	7.5	7.1			0	
2-JMS099.30	6/18/2007	M	4	25.5	7.5	7			0	
2-JMS099.30	6/18/2007	M	5	25.4	7.5	7			0	
2-JMS099.30	6/18/2007	M	6	25.3	7.5	7			0	
2-JMS099.30	6/18/2007	M	7	25.3	7.5	6.9			0	
2-JMS099.30	6/18/2007	M	8	25.3	7.4	6.9			0	
2-JMS099.30	6/18/2007	M	9	25.2	7.4	6.9			0	
2-JMS099.30	6/18/2007	B	10	25.2	7.4	6.9			0	
2-JMS099.30	7/23/2007	S	1	28.7	7.6	6.5		7	0	1.1
2-JMS099.30	7/23/2007	M	2	28.6	7.6	6.3		6.7	0	
2-JMS099.30	7/23/2007	M	3	28.6	7.6	6.2		6.5	0	
2-JMS099.30	7/23/2007	M	4	28.5	7.5	6.1		6.4	0	
2-JMS099.30	7/23/2007	M	5	28.5	7.5	6		6.3	0	
2-JMS099.30	7/23/2007	M	6	28.5	7.5	6		6.3	0	
2-JMS099.30	7/23/2007	M	7	28.4	7.5	5.9		6.2	0	
2-JMS099.30	7/23/2007	M	8	28.4	7.5	5.7		6.1	0	
2-JMS099.30	7/23/2007	M	9	28.4	7.5	5.7		6.1	0	
2-JMS099.30	7/23/2007	M	10	28.4	7.5	5.8		6	0	
2-JMS099.30	7/23/2007	B	11	28.3	7.4	5.7		5.9	0	
2-JMS099.30	8/20/2007	S	1	27.7	7.1	4.1		4.3	0	0.7
2-JMS099.30	8/20/2007	M	2	27.7	7.1	4.1		4.3	0	
2-JMS099.30	8/20/2007	M	3	27.7	7.1	4.1		4.3	0	
2-JMS099.30	8/20/2007	M	4	27.7	7	4.2		4.3	0	
2-JMS099.30	8/20/2007	M	5	27.7	7.1	4.1		4.3	0	
2-JMS099.30	8/20/2007	M	6	27.7	7.1	4.1		4.3	0	
2-JMS099.30	8/20/2007	M	7	27.7	7.1	4.1		4.3	0	
2-JMS099.30	8/20/2007	M	8	27.7	7.1	4.2		4.3	0	
2-JMS099.30	8/20/2007	B	9	27.7	7	4.2		4.3	0	
2-JMS099.30	9/24/2007	S	1	29.8	8.6	10.2			0	0.6
2-JMS099.30	9/24/2007	M	2	28.1	8.3	9.4			0	
2-JMS099.30	9/24/2007	M	3	27.5	8.4	10			0	
2-JMS099.30	9/24/2007	M	4	26.9	8.2	9.1			0	
2-JMS099.30	9/24/2007	M	5	26.7	8.2	9			0	
2-JMS099.30	9/24/2007	M	6	26.7	8.1	8.7			0	
2-JMS099.30	9/24/2007	M	7	25.2	7.8	7.4			0	
2-JMS099.30	9/24/2007	M	8	25.1	7.8	7.4			0	
2-JMS099.30	9/24/2007	M	9	25.1	7.8	7.5			0	
2-JMS099.30	9/24/2007	B	10	25	7.8	7.5			0	
2-JMS099.30	10/22/2007	S	1	26.3	8.4	9.4				0.5

Station ID	Collection Date	Depth Desc	Depth	Temp Celcius	Field Ph	Do Probe	Do Winkler	Fdt Do Optical	Salinity	Secchi Depth
2-JMS099.30	10/22/2007	M	2	25	8	8.5				
2-JMS099.30	10/22/2007	M	3	24.5	8	8.3				
2-JMS099.30	10/22/2007	M	4	24	7.8	7.7				
2-JMS099.30	10/22/2007	M	5	23.7	7.8	7.6				
2-JMS099.30	10/22/2007	M	6	23.4	7.8	7.5				
2-JMS099.30	10/22/2007	M	7	23.3	7.8	7.5				
2-JMS099.30	10/22/2007	M	8	23.3	7.8	7.5				
2-JMS099.30	10/22/2007	M	9	23.3	7.8	7.5				
2-JMS099.30	10/22/2007	M	10	23.3	7.8	7.6				
2-JMS099.30	10/22/2007	B	11	23.3	7.8	7.6				
2-JMS099.30	11/13/2007	S	1	11.9	7.6	9.5			0	1.4
2-JMS099.30	11/13/2007	M	2	11.8	7.6	9.6			0	
2-JMS099.30	11/13/2007	M	3	11.8	7.6	9.6			0	
2-JMS099.30	11/13/2007	M	4	11.7	7.6	9.6			0	
2-JMS099.30	11/13/2007	M	5	11.7	7.6	9.6			0	
2-JMS099.30	11/13/2007	M	6	11.7	7.6	9.6			0	
2-JMS099.30	11/13/2007	M	7	11.7	7.6	9.6			0	
2-JMS099.30	11/13/2007	M	8	11.7	7.6	9.7			0	
2-JMS099.30	11/13/2007	M	9	11.7	7.6	9.7			0	
2-JMS099.30	11/13/2007	B	10	11.6	7.6	9.8			0	
2-JMS099.30	12/10/2007	S	1	7.6	7.4	11.2			0	1.5
2-JMS099.30	12/10/2007	M	2	7.7	7.4	11.1			0	
2-JMS099.30	12/10/2007	M	3	7.6	7.4	11			0	
2-JMS099.30	12/10/2007	M	4	7.5	7.4	11.1			0	
2-JMS099.30	12/10/2007	M	5	7.5	7.4	11			0	
2-JMS099.30	12/10/2007	M	6	7.6	7.4	11			0	
2-JMS099.30	12/10/2007	M	7	7.6	7.4	11			0	
2-JMS099.30	12/10/2007	M	8	7.6	7.4	11			0	
2-JMS099.30	12/10/2007	M	9	7.7	7.4	11.1			0	
2-JMS099.30	12/10/2007	B	10	7.8	7.4	11.2			0	
2-JMS099.30	1/23/2008	S	0							
2-JMS099.30	1/23/2008	S	1	3.4	7.2	13.1			0	1.4
2-JMS099.30	1/23/2008	M	2	3.4	7.2	13.1			0	
2-JMS099.30	1/23/2008	M	3	3.4	7.2	13.1			0	
2-JMS099.30	1/23/2008	M	4	3.4	7.2	13.1			0	
2-JMS099.30	1/23/2008	M	5	3.4	7.2	13.2			0	
2-JMS099.30	1/23/2008	M	6	3.4	7.2	13.2			0	
2-JMS099.30	1/23/2008	M	7	3.4	7.2	13.2			0	
2-JMS099.30	1/23/2008	M	8	3.4	7.2	13.4			0	
2-JMS099.30	1/23/2008	M	9	3.4	7.2	13.4			0	
2-JMS099.30	1/23/2008	B	10	3.4	7.3	13.4			0	
2-JMS099.30	2/14/2008	S	1	6.2	6.9	11.8			0	1.2
2-JMS099.30	2/14/2008	M	2	6.1	6.9	11.8			0	
2-JMS099.30	2/14/2008	M	3	6.1	6.9	11.8			0	
2-JMS099.30	2/14/2008	M	4	6.1	6.8	11.8			0	
2-JMS099.30	2/14/2008	M	5	6.1	6.8	11.8			0	
2-JMS099.30	2/14/2008	B	6	6.2	6.9	11.9			0	
2-JMS099.30	3/18/2008	S	1	12	6.9	10.2			0	1.6
2-JMS099.30	3/18/2008	M	2	12	6.8	10.2			0	
2-JMS099.30	3/18/2008	M	3	11.9	6.8	10.2			0	
2-JMS099.30	3/18/2008	M	4	11.7	6.8	10.2			0	
2-JMS099.30	3/18/2008	M	5	11.7	6.8	10.2			0	
2-JMS099.30	3/18/2008	M	6	11.7	6.8	10.2			0	
2-JMS099.30	3/18/2008	M	7	11.7	6.8	10.2			0	
2-JMS099.30	3/18/2008	M	8	11.6	6.8	10.2			0	
2-JMS099.30	3/18/2008	M	9	11.6	6.8	10.2			0	
2-JMS099.30	3/18/2008	B	10	11.6	6.7	10.3			0	
2-JMS099.30	4/15/2008	S	1	16.2	6.8	8.7			0	1.2
2-JMS099.30	4/15/2008	M	2	16	6.7	8.7			0	
2-JMS099.30	4/15/2008	M	3	16	6.7	8.7			0	
2-JMS099.30	4/15/2008	M	4	16	6.7	8.6			0	
2-JMS099.30	4/15/2008	M	5	16	6.7	8.6			0	
2-JMS099.30	4/15/2008	M	6	16	6.7	8.6			0	
2-JMS099.30	4/15/2008	M	7	15.9	6.7	8.6			0	
2-JMS099.30	4/15/2008	B	8	15.9	6.6				0	
2-JMS099.30	5/22/2008	S	1	20	7.7	8.7				0.9
2-JMS099.30	5/22/2008	M	2	19.9	7.7	8.7				
2-JMS099.30	5/22/2008	M	3	19.8	7.7	8.7				
2-JMS099.30	5/22/2008	M	4	19.8	7.7	8.7				
2-JMS099.30	5/22/2008	M	5	19.8	7.7	8.7				
2-JMS099.30	5/22/2008	M	6	19.8	7.7	8.7				
2-JMS099.30	5/22/2008	M	7	19.7	7.7	8.7				
2-JMS099.30	5/22/2008	M	8	19.7	7.7	8.7				
2-JMS099.30	5/22/2008	M	9	19.7	7.7	8.7				
2-JMS099.30	5/22/2008	B	10	19.7	7.7	8.7				

Station ID	Collection Date	Depth Desc	Depth	Temp Celcius	Field Ph	Do Probe	Do Winkler	Fdt Do Optical	Salinity	Secchi Depth
2-JMS099.30	6/17/2008	S	1	30.8	7.5	6.2			0	1
2-JMS099.30	6/17/2008	M	2	30.4	7.3	5.1			0	
2-JMS099.30	6/17/2008	M	3	30.4	7.4	5.2			0	
2-JMS099.30	6/17/2008	M	4	30.3	7.3	5			0	
2-JMS099.30	6/17/2008	M	5	30.3	7.3	4.9			0	
2-JMS099.30	6/17/2008	M	6	30.3	7.3	4.9			0	
2-JMS099.30	6/17/2008	M	7	30.3	7.3	4.9			0	
2-JMS099.30	6/17/2008	M	8	30.3	7.3	5			0	
2-JMS099.30	6/17/2008	M	9	30.3	7.3	5			0	
2-JMS099.30	6/17/2008	M	10	30.3	7.3	5.1			0	
2-JMS099.30	6/17/2008	B	11	30.3	7.3	5.1			0	
2-JMS099.30	7/15/2008	S	1	29.4	7.7	6.5			0	0.8
2-JMS099.30	7/15/2008	M	2	28.8	7.6	6.5			0	
2-JMS099.30	7/15/2008	M	3	28.5	7.5	5.8			0	
2-JMS099.30	7/15/2008	M	4	28.4	7.5	5.8			0	
2-JMS099.30	7/15/2008	M	5	28.3	7.5	5.7			0	
2-JMS099.30	7/15/2008	M	6	28.3	7.5	5.6			0	
2-JMS099.30	7/15/2008	M	7	28.3	7.5	5.6			0	
2-JMS099.30	7/15/2008	M	8	28.3	7.5	5.6			0	
2-JMS099.30	7/15/2008	M	9	28.3	7.5	5.6			0	
2-JMS099.30	7/15/2008	B	10	28.3	7.5	5.7			0	
2-JMS099.30	9/16/2008	S	1	26.8	7.2	6			0	0.7
2-JMS099.30	9/16/2008	M	2	26.7	7.2	6			0	
2-JMS099.30	9/16/2008	M	3	26.7	7.2	6			0	
2-JMS099.30	9/16/2008	M	4	26.7	7.2	6			0	
2-JMS099.30	9/16/2008	M	5	26.7	7.2	6			0	
2-JMS099.30	9/16/2008	B	6	26.6	7.2	5.9			0	
2-JMS099.30	10/21/2008	S	1	19.3	7.7	8			0	0.9
2-JMS099.30	10/21/2008	M	2	19.2	7.7	7.8			0	
2-JMS099.30	10/21/2008	M	3	19.2	7.7	7.7			0	
2-JMS099.30	10/21/2008	M	4	19.2	7.7	7.6			0	
2-JMS099.30	10/21/2008	M	5	19.2	7.7	7.5			0	
2-JMS099.30	10/21/2008	M	6	19.2	7.7	7.5			0	
2-JMS099.30	10/21/2008	M	7	19.2	7.7	7.6			0	
2-JMS099.30	10/21/2008	M	8	19.2	7.7	7.7			0	
2-JMS099.30	10/21/2008	M	9	19.2	7.6	7.9			0	
2-JMS099.30	10/21/2008	B	10	19.1	7.6	8.1			0	
2-JMS099.30	11/24/2008	S	1	8	7.8	11.8			0	1.3
2-JMS099.30	11/24/2008	M	2	8.1	7.8	11.8			0	
2-JMS099.30	11/24/2008	M	3	7.8	7.8	11.8			0	
2-JMS099.30	11/24/2008	M	4	7.7	7.8	11.8			0	
2-JMS099.30	11/24/2008	M	5	7.6	7.8	11.9			0	
2-JMS099.30	11/24/2008	M	6	7.6	7.8	12			0	
2-JMS099.30	11/24/2008	M	7	7.6	7.8	11.9			0	
2-JMS099.30	11/24/2008	M	8	7.6	7.8	11.9			0	
2-JMS099.30	11/24/2008	M	9	7.6	7.9	11.9			0	
2-JMS099.30	11/24/2008	M	10	7.6	7.9	12			0	
2-JMS099.30	11/24/2008	M	11	7.5	7.9	12			0	
2-JMS099.30	11/24/2008	B	12	7.5	7.9	12.1			0	
2-JMS099.30	12/9/2008	S	1	5.6	7.9	13.1			0	1.8
2-JMS099.30	12/9/2008	M	2	5.5	7.9	13.1			0	
2-JMS099.30	12/9/2008	M	3	5.4	7.9	13.1			0	
2-JMS099.30	12/9/2008	M	4	5.4	7.9	13.1			0	
2-JMS099.30	12/9/2008	M	5	5.4	8	13.2			0	
2-JMS099.30	12/9/2008	M	6	5.3	8	13.2			0	
2-JMS099.30	12/9/2008	M	7	5.3	8	13.4			0	
2-JMS099.30	12/9/2008	M	8	5.3	8.1	13.4			0	
2-JMS099.30	12/9/2008	B	9	5.3	8.1	13.4			0	
2-JMS099.30	1/21/2009	S	1	1	7.4	13.7			0	0.7
2-JMS099.30	1/21/2009	M	2	1	7.4	13.8			0	
2-JMS099.30	1/21/2009	M	3	1	7.4	13.8			0	
2-JMS099.30	1/21/2009	M	4	1	7.4	13.8			0	
2-JMS099.30	1/21/2009	M	5	1	7.4	13.9			0	
2-JMS099.30	1/21/2009	M	6	1	7.4	14			0	
2-JMS099.30	1/21/2009	M	7	1	7.4	14			0	
2-JMS099.30	1/21/2009	M	8	1	7.4	14			0	
2-JMS099.30	1/21/2009	B	9	1	7.4	14			0	
2-JMS099.30	2/19/2009	S	1	7.5	6.3	11.3			0	1.1
2-JMS099.30	2/19/2009	M	2	7.5	6.3	11.3			0	
2-JMS099.30	2/19/2009	M	3	7.5	6.2	11.3			0	
2-JMS099.30	2/19/2009	M	4	7.5	6.1	11.3			0	
2-JMS099.30	2/19/2009	M	5	7.5	6	11.3			0	
2-JMS099.30	2/19/2009	M	6	7.5	5.8	11.3			0	
2-JMS099.30	2/19/2009	M	7	7.5	5.8	11.3			0	
2-JMS099.30	2/19/2009	M	8	7.4	5.6	11.2			0	

Station ID	Collection Date	Depth Desc	Depth	Temp Celcius	Field Ph	Do Probe	Do Winkler	Fdt Do Optical	Salinity	Secchi Depth
2-JMS099.30	2/19/2009	M	9	7.4	4.8	10.6			0	
2-JMS099.30	2/19/2009	M	10	7.3	4.8	10.5			0	
2-JMS099.30	2/19/2009	B	11	7.4	4.7	10.6			0	
2-JMS099.30	3/17/2009	S	1	9.6	7.4	10.5			0	1.1
2-JMS099.30	3/17/2009	M	2	9.6	7.4	10.6			0	
2-JMS099.30	3/17/2009	M	3	9.6	7.5	10.6			0	
2-JMS099.30	3/17/2009	M	4	9.6	7.5	10.7			0	
2-JMS099.30	3/17/2009	M	5	9.5	7.5	10.7			0	
2-JMS099.30	3/17/2009	M	6	9.5	7.5	10.8			0	
2-JMS099.30	3/17/2009	M	7	9.5	7.5	10.8			0	
2-JMS099.30	3/17/2009	M	8	9.5	7.5	11			0	
2-JMS099.30	3/17/2009	M	9	9.5	7.5	10.9			0	
2-JMS099.30	3/17/2009	B	10	9.5	7.4	11.1			0	
2-JMS099.30	4/30/2009	S	1	21.1	7.4	8.4				1.2
2-JMS099.30	4/30/2009	M	2	21	7.4	8.4				
2-JMS099.30	4/30/2009	M	3	21	7.4	8.4				
2-JMS099.30	4/30/2009	M	4	21	7.4	8.5				
2-JMS099.30	4/30/2009	M	5	21	7.4	8.5				
2-JMS099.30	4/30/2009	M	6	21	7.4	8.5				
2-JMS099.30	4/30/2009	M	7	20.9	7.4	8.5				
2-JMS099.30	4/30/2009	B	8	20.9	7.4	8.5				
2-JMS099.30	5/19/2009	S	1	18.9	7.6	9.1				0.2
2-JMS099.30	5/19/2009	M	2	18.9	7.6	9				
2-JMS099.30	5/19/2009	M	3	18.9	7.6	9.2				
2-JMS099.30	5/19/2009	M	4	18.9	7.6	9.3				
2-JMS099.30	5/19/2009	M	5	18.9	7.7	9.3				
2-JMS099.30	5/19/2009	M	6	18.9	7.7	9.3				
2-JMS099.30	5/19/2009	M	7	18.8	7.7	9.4				
2-JMS099.30	5/19/2009	M	8	18.8	7.7	9.4				
2-JMS099.30	5/19/2009	B	9	18.8	7.7	9.5				
2-JMS099.30	6/16/2009	S	1	26.7	7.4	7.4				0.8
2-JMS099.30	6/16/2009	M	2	26.7	7.4	7.4				
2-JMS099.30	6/16/2009	M	3	26.7	7.4	7.4				
2-JMS099.30	6/16/2009	M	4	26.7	7.4	7.4				
2-JMS099.30	6/16/2009	M	5	26.7	7.4	7.4				
2-JMS099.30	6/16/2009	M	6	26.7	7.4	7.4				
2-JMS099.30	6/16/2009	M	7	26.6	7.4	7.4				
2-JMS099.30	6/16/2009	M	8	26.6	7.4	7.4				
2-JMS099.30	6/16/2009	M	9	26.6	7.4	7.4				
2-JMS099.30	6/16/2009	B	10	26.6	7.4	7.4				
2-JMS099.30	7/21/2009	S	1	28.5	7.2	5.7				1.2
2-JMS099.30	7/21/2009	M	2	28.4	7.2	5.7				
2-JMS099.30	7/21/2009	M	3	28.4	7.2	5.7				
2-JMS099.30	7/21/2009	M	4	28.4	7.2	5.7				
2-JMS099.30	7/21/2009	M	5	28.4	7.2	5.7				
2-JMS099.30	7/21/2009	M	6	28.3	7.2	5.6				
2-JMS099.30	7/21/2009	M	7	28.1	7.1	5.4				
2-JMS099.30	7/21/2009	M	8	28	7.1	5.3				
2-JMS099.30	7/21/2009	M	9	28	7.1	5.3				
2-JMS099.30	7/21/2009	B	10	28	7.1	5.4				
2-JMS099.30	8/18/2009	S	1	32.4	8.2	7.2				1.1
2-JMS099.30	8/18/2009	M	2	31.8	8.2	7				
2-JMS099.30	8/18/2009	M	3	31.3	8.1	6.8				
2-JMS099.30	8/18/2009	M	4	30.8	8	6.5				
2-JMS099.30	8/18/2009	M	5	30.6	8	6.4				
2-JMS099.30	8/18/2009	M	6	30.3	7.9	6.3				
2-JMS099.30	8/18/2009	M	7	30.3	7.9	6.3				
2-JMS099.30	8/18/2009	M	8	30.2	7.9	6.2				
2-JMS099.30	8/18/2009	M	9	30.1	7.9	6.2				
2-JMS099.30	8/18/2009	M	10	30.1	7.9	6.2				
2-JMS099.30	8/18/2009	M	11	30	7.9	6.2				
2-JMS099.30	8/18/2009	B	12	30	7.9	6.2				
2-JMS099.30	9/15/2009	S	1	28.3	8.4					0.8
2-JMS099.30	9/15/2009	M	2	26.9	7.9					
2-JMS099.30	9/15/2009	M	3	25.7	7.7					
2-JMS099.30	9/15/2009	M	4	25.5	7.6					
2-JMS099.30	9/15/2009	M	5	25.5	7.6					
2-JMS099.30	9/15/2009	M	6	25.5	7.6					
2-JMS099.30	9/15/2009	M	7	25.4	7.6					
2-JMS099.30	9/15/2009	B	8	24.7	7.6					
2-JMS099.30	10/28/2009	S	1	16.8	7.7	8.4				1.6
2-JMS099.30	10/28/2009	M	2	16.7	7.7	8.4				
2-JMS099.30	10/28/2009	M	3	16.7	7.7	8.3				
2-JMS099.30	10/28/2009	M	4	16.7	7.7	8.3				
2-JMS099.30	10/28/2009	M	5	16.6	7.7	8.3				

Station ID	Collection Date	Depth Desc	Depth	Temp Celcius	Field Ph	Do Probe	Do Winkler	Fdt Do Optical	Salinity	Secchi Depth
2-JMS099.30	10/28/2009	M	6	16.6	7.7	8.3				
2-JMS099.30	10/28/2009	M	7	16.6	7.7	8.3				
2-JMS099.30	10/28/2009	M	8	16.6	7.7	8.4				
2-JMS099.30	10/28/2009	M	9	16.6	7.7	8.5				
2-JMS099.30	10/28/2009	B	10	16.6	7.7	8.5				
2-JMS099.30	11/9/2009	S	1	13.1	7.7					1.1
2-JMS099.30	11/9/2009	M	2	12.9	7.7					
2-JMS099.30	11/9/2009	M	3	12.9	7.7					
2-JMS099.30	11/9/2009	M	4	12.8	7.7					
2-JMS099.30	11/9/2009	M	5	12.8	7.7					
2-JMS099.30	11/9/2009	M	6	12.8	7.8					
2-JMS099.30	11/9/2009	M	7	12.8	7.8					
2-JMS099.30	11/9/2009	M	8	12.8	7.9					
2-JMS099.30	11/9/2009	B	9	12.9	7.9					
2-JMS099.30	12/8/2009	S	1	6.8	6.9	11.9				0.5
2-JMS099.30	12/8/2009	M	2	6.8	6.8	11.9				
2-JMS099.30	12/8/2009	M	3	6.8	6.8	11.9				
2-JMS099.30	12/8/2009	M	4	6.8	6.8	11.9				
2-JMS099.30	12/8/2009	M	5	6.8	6.8	11.9				
2-JMS099.30	12/8/2009	M	6	6.8	6.8	12				
2-JMS099.30	12/8/2009	M	7	6.8	6.7	11.9				
2-JMS099.30	12/8/2009	B	8	6.8	6.7	11.9				
2-JMS099.30	1/25/2010	S	0							
2-JMS099.30	1/25/2010	S	1	7.4	7.5	11.4				0.3
2-JMS099.30	1/25/2010	M	2	7.4	7.5	11.3				
2-JMS099.30	1/25/2010	M	3	7.3	7.5	11.3				
2-JMS099.30	1/25/2010	M	4	7.3	7.4	11.1				
2-JMS099.30	1/25/2010	M	5	7.3	7.4	11.1				
2-JMS099.30	1/25/2010	M	6	7.3	7.4	11				
2-JMS099.30	1/25/2010	M	7	7.3	7.4	10.9				
2-JMS099.30	1/25/2010	M	8	7.3	7.4	10.9				
2-JMS099.30	1/25/2010	M	9	7.3	7.4	10.9				
2-JMS099.30	1/25/2010	M	10	7.4	7.4	10.9				
2-JMS099.30	1/25/2010	B	11	7.4	7.4	10.7				
2-JMS099.30	2/17/2010	S	1	3.5	7.6	12.4				1
2-JMS099.30	2/17/2010	M	2	3.5	7.6	12.4				
2-JMS099.30	2/17/2010	M	3	3.5	7.6	12.4				
2-JMS099.30	2/17/2010	M	4	3.5	7.6	12.3				
2-JMS099.30	2/17/2010	M	5	3.5	7.5	12.3				
2-JMS099.30	2/17/2010	M	6	3.5	7.5	12.3				
2-JMS099.30	2/17/2010	M	7	3.5	7.5	12.3				
2-JMS099.30	2/17/2010	M	8	3.6	7.5	12.3				
2-JMS099.30	2/17/2010	B	9	3.7	7.5	12.3				
2-JMS099.30	3/4/2010	S	1	5.7	7.6	12.6				1.2
2-JMS099.30	3/4/2010	M	2	5.7	7.6	12.7				
2-JMS099.30	3/4/2010	M	3	5.7	7.5	12.7				
2-JMS099.30	3/4/2010	M	4	5.7	7.5	12.7				
2-JMS099.30	3/4/2010	M	5	5.7	7.5	12.7				
2-JMS099.30	3/4/2010	M	6	5.7	7.5	12.7				
2-JMS099.30	3/4/2010	M	7	5.6	7.5	12.7				
2-JMS099.30	3/4/2010	M	8	5.6	7.4	12.8				
2-JMS099.30	3/4/2010	M	9	5.6	7.4	12.8				
2-JMS099.30	3/4/2010	B	10	5.6	7.4	12.8				
2-JMS099.30	4/6/2010	S	1	18.1	7.5	9.3				1.1
2-JMS099.30	4/6/2010	M	2	18	7.5	9.4				
2-JMS099.30	4/6/2010	M	3	18.1	7.5	9.4				
2-JMS099.30	4/6/2010	M	4	17.7	7.4	9.4				
2-JMS099.30	4/6/2010	M	5	17.7	7.4	9.4				
2-JMS099.30	4/6/2010	M	6	17.7	7.4	9.4				
2-JMS099.30	4/6/2010	M	7	17.7	7.4	9.4				
2-JMS099.30	4/6/2010	M	8	17.7	7.4	9.4				
2-JMS099.30	4/6/2010	M	9	17.7	7.4	9.4				
2-JMS099.30	4/6/2010	B	10	17.7	7.4	9.4				
2-JMS099.30	5/4/2010	S	1	23.7	8					0.7
2-JMS099.30	5/4/2010	M	2	23.6	8					
2-JMS099.30	5/4/2010	M	3	23.5	7.9					
2-JMS099.30	5/4/2010	M	4	23.5	7.9					
2-JMS099.30	5/4/2010	M	5	23.3	7.9					
2-JMS099.30	5/4/2010	M	6	23.3	7.9					
2-JMS099.30	5/4/2010	M	7	23.3	7.8					
2-JMS099.30	5/4/2010	M	8	23.3	7.8					
2-JMS099.30	5/4/2010	B	9	23.3	7.8					
2-JMS099.30	6/2/2010	S	1	27.5	7.5					0.5
2-JMS099.30	6/2/2010	M	2	27.1	7.5					
2-JMS099.30	6/2/2010	M	3	26.8	7.4					

Station ID	Collection Date	Depth Desc	Depth	Temp Celcius	Field Ph	Do Probe	Do Winkler	Fdt Do Optical	Salinity	Secchi Depth
2-JMS099.30	6/2/2010	M	4	26.8	7.3					
2-JMS099.30	6/2/2010	M	5	26.8	7.3					
2-JMS099.30	6/2/2010	M	6	26.8	7.3					
2-JMS099.30	6/2/2010	M	7	26.7	7.3					
2-JMS099.30	6/2/2010	B	8	26.6	7.3					
2-JMS099.30	7/7/2010	S	1	33.7	8.1	8.6				0.9
2-JMS099.30	7/7/2010	M	2	32.9	7.9	8.1				
2-JMS099.30	7/7/2010	M	3	32.5	7.6	7.6				
2-JMS099.30	7/7/2010	M	4	30.8	7.4	6				
2-JMS099.30	7/7/2010	M	5	30	7.3	5.6				
2-JMS099.30	7/7/2010	M	6	29.6	7.3	5.3				
2-JMS099.30	7/7/2010	M	7	29.5	7.3	5.4				
2-JMS099.30	7/7/2010	M	8	29.5	7.3	5.4				
2-JMS099.30	7/7/2010	M	9	29.5	7.3	5.4				
2-JMS099.30	7/7/2010	B	10	29.4	7.3	5.4				
2-JMS099.30	8/3/2010	S	1	29.9	7.5	6.2				0.9
2-JMS099.30	8/3/2010	M	2	29.7	7.5	5.9				
2-JMS099.30	8/3/2010	M	3	29.7	7.5	5.8				
2-JMS099.30	8/3/2010	M	4	29.7	7.5	5.8				
2-JMS099.30	8/3/2010	M	5	29.7	7.5	5.8				
2-JMS099.30	8/3/2010	M	6	29.7	7.5	5.8				
2-JMS099.30	8/3/2010	M	7	29.7	7.5	5.7				
2-JMS099.30	8/3/2010	M	8	29.7	7.5	5.6				
2-JMS099.30	8/3/2010	B	9	29.6	7.5	5.6				
2-JMS099.30	9/8/2010	S	1	29.2	8	7.4				0.7
2-JMS099.30	9/8/2010	M	2	28.9	7.7	6.7				
2-JMS099.30	9/8/2010	M	3	28.8	7.7	6.5				
2-JMS099.30	9/8/2010	M	4	28.8	7.7	6.4				
2-JMS099.30	9/8/2010	M	5	28.8	7.7	6.6				
2-JMS099.30	9/8/2010	M	6	28.8	7.7	6.6				
2-JMS099.30	9/8/2010	M	7	28.8	7.7	6.7				
2-JMS099.30	9/8/2010	M	8	28.8	7.7	6.7				
2-JMS099.30	9/8/2010	M	9	28.9	7.8	6.7				
2-JMS099.30	9/8/2010	B	10	28.9	7.8	6.7				
2-JMS099.30	10/5/2010	S	1	18.5	7.7			9.2		0.6
2-JMS099.30	10/5/2010	M	2	18.4	7.7			9.2		
2-JMS099.30	10/5/2010	M	3	18.4	7.7			9.1		
2-JMS099.30	10/5/2010	M	4	18.4	7.7			9.1		
2-JMS099.30	10/5/2010	M	5	18.4	7.7			9.1		
2-JMS099.30	10/5/2010	M	6	18.4	7.7			9.1		
2-JMS099.30	10/5/2010	M	7	18.4	7.7			9.1		
2-JMS099.30	10/5/2010	M	8	18.4	7.7			9.1		
2-JMS099.30	10/5/2010	M	9	18.4	7.8			9.1		
2-JMS099.30	10/5/2010	M	10	18.3	7.8			9		
2-JMS099.30	10/5/2010	B	11	18.3	7.7			9		
2-JMS099.30	11/2/2010	S	1	16.1	7.7	9.8			0	1.4
2-JMS099.30	11/2/2010	M	2	16	7.7	9.8			0	
2-JMS099.30	11/2/2010	M	3	15.9	7.7	9.8			0	
2-JMS099.30	11/2/2010	M	4	15.9	7.7	9.9			0	
2-JMS099.30	11/2/2010	M	5	15.8	7.7	10			0	
2-JMS099.30	11/2/2010	M	6	15.8	7.7	10			0	
2-JMS099.30	11/2/2010	M	7	15.8	7.7	10			0	
2-JMS099.30	11/2/2010	M	8	15.8	7.7	10.2			0	
2-JMS099.30	11/2/2010	M	9	15.7	7.7	10.4			0	
2-JMS099.30	11/2/2010	M	10	15.7	7.7	10.5			0	
2-JMS099.30	11/2/2010	M	11	15.7	7.7	10.5			0	
2-JMS099.30	11/2/2010	B	12	15.7	7.8	10.5			0	
2-JMS099.30	1/4/2011	S	1	3.7	7.6	13.3				1.8
2-JMS099.30	1/4/2011	M	2	3.7	7.6	13.4				
2-JMS099.30	1/4/2011	M	3	3.6	7.6	13.4				
2-JMS099.30	1/4/2011	M	4	3.6	7.6	13.4				
2-JMS099.30	1/4/2011	M	5	3.6	7.6	13.4				
2-JMS099.30	1/4/2011	M	6	3.6	7.6	13.4				
2-JMS099.30	1/4/2011	M	7	3.6	7.6	13.4				
2-JMS099.30	1/4/2011	M	8	3.6	7.6	13.5				
2-JMS099.30	1/4/2011	M	9	3.6	7.6	13.5				
2-JMS099.30	1/4/2011	M	10	3.6	7.6	13.5				
2-JMS099.30	1/4/2011	B	11	3.6	7.6	13.5				
2-JMS099.30	2/1/2011	S	1	3.8	7.4	12.8				1.3
2-JMS099.30	2/1/2011	M	2	3.7	7.4	12.8				
2-JMS099.30	2/1/2011	M	3	3.7	7.4	12.8				
2-JMS099.30	2/1/2011	M	4	3.7	7.4	12.8				
2-JMS099.30	2/1/2011	M	5	3.7	7.4	12.8				
2-JMS099.30	2/1/2011	M	6	3.7	7.4	12.8				
2-JMS099.30	2/1/2011	M	7	3.7	7.4	12.9				

Station ID	Collection Date	Depth Desc	Depth	Temp Celcius	Field Ph	Do Probe	Do Winkler	Fdt Do Optical	Salinity	Secchi Depth
2-JMS099.30	2/1/2011	M	8	3.7	7.4	12.8				
2-JMS099.30	2/1/2011	M	9	3.7	7.3	12.8				
2-JMS099.30	2/1/2011	B	10	3.7	7.3	12.9				
2-JMS099.30	3/1/2011	S	1	10.8	7.4	10.6				1.2
2-JMS099.30	3/1/2011	M	2	10.7	7.4	10.7				
2-JMS099.30	3/1/2011	M	3	10.4	7.4	10.6				
2-JMS099.30	3/1/2011	M	4	10.1	7.4	10.5				
2-JMS099.30	3/1/2011	M	5	10.1	7.4	10.6				
2-JMS099.30	3/1/2011	M	6	10	7.3	10.5				
2-JMS099.30	3/1/2011	M	7	10	7.3	10.5				
2-JMS099.30	3/1/2011	M	8	10	7.3	10.6				
2-JMS099.30	3/1/2011	M	9	10	7.3	10.6				
2-JMS099.30	3/1/2011	M	10	10	7.3	10.6				
2-JMS099.30	3/1/2011	B	11	10	7.2	10.6				
2-JMS099.30	4/14/2011	S	1	16.3	7.6	9.7				1.3
2-JMS099.30	4/14/2011	M	2	16.3	7.6	9.7				
2-JMS099.30	4/14/2011	M	3	16.4	7.6	9.7				
2-JMS099.30	4/14/2011	M	4	16.4	7.6	9.8				
2-JMS099.30	4/14/2011	M	5	16.4	7.6	9.8				
2-JMS099.30	4/14/2011	M	6	16.4	7.6	9.8				
2-JMS099.30	4/14/2011	M	7	16.3	7.6	9.8				
2-JMS099.30	4/14/2011	B	8	16.2	7.6	9.7				
2-JMS099.30	5/3/2011	S	1	19.2	7.4	9.5				0.1
2-JMS099.30	5/3/2011	M	2	19.1	7.4	9.5				
2-JMS099.30	5/3/2011	M	3	18.8	7.4	9.5				
2-JMS099.30	5/3/2011	M	4	18.6	7.3	9.6				
2-JMS099.30	5/3/2011	M	5	18.6	7.3	9.6				
2-JMS099.30	5/3/2011	M	6	18.6	7.3	9.5				
2-JMS099.30	5/3/2011	M	7	18.6	7.4	9.6				
2-JMS099.30	5/3/2011	M	8	18.6	7.4	9.6				
2-JMS099.30	5/3/2011	M	9	18.6	7.4	9.6				
2-JMS099.30	5/3/2011	B	10	18.6	7.4	9.6				
2-JMS099.30	7/19/2011	S	1	30	7.7	7.1				0.5
2-JMS099.30	7/19/2011	M	2	29.9	7.6	6.6				
2-JMS099.30	7/19/2011	M	3	29.8	7.6	6.3				
2-JMS099.30	7/19/2011	M	4	29.7	7.5	6.1				
2-JMS099.30	7/19/2011	M	5	29.6	7.5	5.8				
2-JMS099.30	7/19/2011	M	6	29.6	7.5	5.7				
2-JMS099.30	7/19/2011	M	7	29.6	7.5	5.8				
2-JMS099.30	7/19/2011	M	8	29.6	7.5	5.9				
2-JMS099.30	7/19/2011	M	9	29.6	7.5	5.9				
2-JMS099.30	7/19/2011	M	10	29.6	7.5	5.9				
2-JMS099.30	7/19/2011	B	11	29.6	7.5	5.7				
2-JMS099.30	8/2/2011	S	1	32.8	7.6	5.7				0.9
2-JMS099.30	8/2/2011	M	2	32.5	7.5	5.4				
2-JMS099.30	8/2/2011	M	3	32.3	7.5	5.2				
2-JMS099.30	8/2/2011	M	4	32.2	7.5	4.8				
2-JMS099.30	8/2/2011	M	5	32.1	7.5	4.7				
2-JMS099.30	8/2/2011	M	6	32.1	7.5	4.7				
2-JMS099.30	8/2/2011	M	7	32.1	7.5	4.7				
2-JMS099.30	8/2/2011	M	8	32.1	7.5	4.7				
2-JMS099.30	8/2/2011	B	9	32	7.5	4.5				
2-JMS099.30	9/22/2011	S	1	23.1	7.7	7.9				1.2
2-JMS099.30	9/22/2011	M	2	22.9	7.7	7.9				
2-JMS099.30	9/22/2011	M	3	22.8	7.7	7.8				
2-JMS099.30	9/22/2011	M	4	22.5	7.7	7.7				
2-JMS099.30	9/22/2011	M	5	22.4	7.6	7.7				
2-JMS099.30	9/22/2011	M	6	22.3	7.6	7.6				
2-JMS099.30	9/22/2011	M	7	22.3	7.6	7.6				
2-JMS099.30	9/22/2011	M	8	22.3	7.6	7.6				
2-JMS099.30	9/22/2011	M	9	22.3	7.6	7.5				
2-JMS099.30	9/22/2011	M	10	22.3	7.6	7.5				
2-JMS099.30	9/22/2011	B	11	22.3	7.6	7.5				
2-JMS099.30	10/4/2011	S	1	21.3	7.6	7.2				1.2
2-JMS099.30	10/4/2011	M	2	21.3	7.6	7.2				
2-JMS099.30	10/4/2011	M	3	21.3	7.6	7.2				
2-JMS099.30	10/4/2011	M	4	21.3	7.6	7.2				
2-JMS099.30	10/4/2011	M	5	21.3	7.6	7.2				
2-JMS099.30	10/4/2011	M	6	21.3	7.6	7.1				
2-JMS099.30	10/4/2011	M	7	21.3	7.6	7.2				
2-JMS099.30	10/4/2011	M	8	21.2	7.6	7.2				
2-JMS099.30	10/4/2011	M	9	21.2	7.6	7.2				
2-JMS099.30	10/4/2011	B	10	21.2	7.6	7.2				
2-JMS099.30	11/1/2011	S	1	12.8	7.6	10.6				1.1
2-JMS099.30	11/1/2011	M	2	12.7	7.6	10.6				

Station ID	Collection Date	Depth Desc	Depth	Temp Celcius	Field Ph	Do Probe	Do Winkler	Fdt Do Optical	Salinity
2-JMS099.30	11/1/2011	M	3	12.7	7.6	10.6			
2-JMS099.30	11/1/2011	M	4	12.6	7.5	10.6			
2-JMS099.30	11/1/2011	M	5	12.5	7.5	10.6			
2-JMS099.30	11/1/2011	M	6	12.5	7.5	10.7			
2-JMS099.30	11/1/2011	M	7	12.5	7.5	10.7			
2-JMS099.30	11/1/2011	M	8	12.5	7.5	10.7			
2-JMS099.30	11/1/2011	B	9	12.5	7.5	10.7			
2-JMS099.30	12/6/2011	S	1	9.56	7.47	11.14	2-JMS099.30	12/6/2011	S
2-JMS099.30	12/6/2011	M	2	9.24	7.46	11.23	2-JMS099.30	12/6/2011	M
2-JMS099.30	12/6/2011	M	3	9.24	7.46	11.21	2-JMS099.30	12/6/2011	M
2-JMS099.30	12/6/2011	M	4	9.02	7.46	11.25	2-JMS099.30	12/6/2011	M
2-JMS099.30	12/6/2011	M	5	9	7.47	11.26	2-JMS099.30	12/6/2011	M
2-JMS099.30	12/6/2011	M	6	9	7.48	11.26	2-JMS099.30	12/6/2011	M
2-JMS099.30	12/6/2011	M	7	9.01	7.49	11.3	2-JMS099.30	12/6/2011	M
2-JMS099.30	12/6/2011	M	8	9.01	7.48	11.3	2-JMS099.30	12/6/2011	M
2-JMS099.30	12/6/2011	M	9	9.01	7.49	11.32	2-JMS099.30	12/6/2011	M
2-JMS099.30	12/6/2011	M	10	9.01	7.49	11.32	2-JMS099.30	12/6/2011	M
2-JMS099.30	12/6/2011	M	11	9.02	7.5	11.33	2-JMS099.30	12/6/2011	M
2-JMS099.30	12/6/2011	B	12	9.02	7.51	11.35	2-JMS099.30	12/6/2011	B
2-JMS099.30	1/5/2012	S	1	4.43	7.67	13.4	2-JMS099.30	1/5/2012	S
2-JMS099.30	1/5/2012	M	2	4.4	7.65	13.45	2-JMS099.30	1/5/2012	M
2-JMS099.30	1/5/2012	M	3	4.4	7.65	13.52	2-JMS099.30	1/5/2012	M
2-JMS099.30	1/5/2012	M	4	4.44	7.65	13.49	2-JMS099.30	1/5/2012	M
2-JMS099.30	1/5/2012	M	5	4.36	7.66	13.52	2-JMS099.30	1/5/2012	M
2-JMS099.30	1/5/2012	M	6	4.38	7.65	13.53	2-JMS099.30	1/5/2012	M
2-JMS099.30	1/5/2012	M	7	4.41	7.64	13.51	2-JMS099.30	1/5/2012	M
2-JMS099.30	1/5/2012	M	8	4.41	7.65	13.54	2-JMS099.30	1/5/2012	M
2-JMS099.30	1/5/2012	M	9	4.39	7.64	13.62	2-JMS099.30	1/5/2012	M
2-JMS099.30	1/5/2012	M	10	4.4	7.64	13.69	2-JMS099.30	1/5/2012	M
2-JMS099.30	1/5/2012	B	11	4.37	7.63	13.68	2-JMS099.30	1/5/2012	B
2-JMS099.30	2/7/2012	S	1	7.97	7.7	11.79	2-JMS099.30	2/7/2012	S
2-JMS099.30	2/7/2012	M	2	7.93	7.72	11.86	2-JMS099.30	2/7/2012	M
2-JMS099.30	2/7/2012	M	3	7.85	7.72	11.8	2-JMS099.30	2/7/2012	M
2-JMS099.30	2/7/2012	M	4	7.84	7.7	11.79	2-JMS099.30	2/7/2012	M
2-JMS099.30	2/7/2012	M	5	7.8	7.67	11.75	2-JMS099.30	2/7/2012	M
2-JMS099.30	2/7/2012	M	6	7.81	7.69	11.8	2-JMS099.30	2/7/2012	M
2-JMS099.30	2/7/2012	M	7	7.8	7.68	11.83	2-JMS099.30	2/7/2012	M
2-JMS099.30	2/7/2012	M	8	7.79	7.67	11.84	2-JMS099.30	2/7/2012	M
2-JMS099.30	2/7/2012	M	9	7.75	7.66	11.85	2-JMS099.30	2/7/2012	M
2-JMS099.30	2/7/2012	M	10	7.75	7.61	11.7	2-JMS099.30	2/7/2012	M
2-JMS099.30	2/7/2012	B	11	7.72	7.52	11.62	2-JMS099.30	2/7/2012	B
2-JMS099.30	3/6/2012	S	1	8.41	7.74	12.1	2-JMS099.30	3/6/2012	S
2-JMS099.30	3/6/2012	M	2	8.38	7.72	12.06	2-JMS099.30	3/6/2012	M
2-JMS099.30	3/6/2012	M	3	8.38	7.72	12.07	2-JMS099.30	3/6/2012	M
2-JMS099.30	3/6/2012	M	4	8.37	7.72	12	2-JMS099.30	3/6/2012	M
2-JMS099.30	3/6/2012	M	5	8.38	7.72	12.01	2-JMS099.30	3/6/2012	M
2-JMS099.30	3/6/2012	M	6	8.38	7.72	12.22	2-JMS099.30	3/6/2012	M
2-JMS099.30	3/6/2012	M	7	8.37	7.72	12.22	2-JMS099.30	3/6/2012	M
2-JMS099.30	3/6/2012	M	8	8.37	7.71	12.2	2-JMS099.30	3/6/2012	M
2-JMS099.30	3/6/2012	M	9	8.37	7.71	12.22	2-JMS099.30	3/6/2012	M
2-JMS099.30	3/6/2012	M	10	8.37	7.71	12.23	2-JMS099.30	3/6/2012	M
2-JMS099.30	3/6/2012	M	11	8.37	7.7	12.36	2-JMS099.30	3/6/2012	M
2-JMS099.30	3/6/2012	B	12	8.36	7.7	12.38	2-JMS099.30	3/6/2012	B
2-JMS099.30	4/12/2012	S	1	15.52	7.78	9.11	2-JMS099.30	4/12/2012	S
2-JMS099.30	4/12/2012	M	2	15.52	7.78	9.07	2-JMS099.30	4/12/2012	M
2-JMS099.30	4/12/2012	M	3	15.4	7.77	9.1	2-JMS099.30	4/12/2012	M
2-JMS099.30	4/12/2012	M	4	15.09	7.77	9.1	2-JMS099.30	4/12/2012	M
2-JMS099.30	4/12/2012	M	5	15.07	7.76	9	2-JMS099.30	4/12/2012	M
2-JMS099.30	4/12/2012	M	6	15.06	7.77	9.08	2-JMS099.30	4/12/2012	M
2-JMS099.30	4/12/2012	M	7	15.07	7.77	9.16	2-JMS099.30	4/12/2012	M
2-JMS099.30	4/12/2012	M	8	15.06	7.76	9.12	2-JMS099.30	4/12/2012	M
2-JMS099.30	4/12/2012	M	9	15.05	7.76	9.16	2-JMS099.30	4/12/2012	M
2-JMS099.30	4/12/2012	B	10	15.05	7.76	9.27	2-JMS099.30	4/12/2012	B
2-JMS099.30	5/3/2012	S	1	20.94	7.7	8.21	2-JMS099.30	5/3/2012	S
2-JMS099.30	5/3/2012	M	2	20.61	7.69	8.25	2-JMS099.30	5/3/2012	M
2-JMS099.30	5/3/2012	M	3	20.57	7.68	8.24	2-JMS099.30	5/3/2012	M
2-JMS099.30	5/3/2012	M	4	20.52	7.68	8.24	2-JMS099.30	5/3/2012	M
2-JMS099.30	5/3/2012	M	5	20.47	7.67	8.21	2-JMS099.30	5/3/2012	M
2-JMS099.30	5/3/2012	M	6	20.47	7.67	8.25	2-JMS099.30	5/3/2012	M
2-JMS099.30	5/3/2012	M	7	20.47	7.67	8.22	2-JMS099.30	5/3/2012	M

Station ID	Collection Date	Depth Desc	Depth	Temp Celcius	Field Ph	Do Probe	Do Winkler	Fdt Do Optical	Salinity
2-JMS099.30	5/3/2012	M	8	20.45	7.67	8.18	2-JMS099.30	5/3/2012	M
2-JMS099.30	5/3/2012	M	9	20.36	7.67	8.17	2-JMS099.30	5/3/2012	M
2-JMS099.30	5/3/2012	M	10	20.01	7.64	8.11	2-JMS099.30	5/3/2012	M
2-JMS099.30	5/3/2012	M	11	20	7.64	8.14	2-JMS099.30	5/3/2012	M
2-JMS099.30	5/3/2012	B	12	20.02	7.65	8.1	2-JMS099.30	5/3/2012	B
2-JMS099.30	6/14/2012	S	1	26.42	7.85	6.51	2-JMS099.30	6/14/2012	S
2-JMS099.30	6/14/2012	M	2	26.29	7.81	6.37	2-JMS099.30	6/14/2012	M
2-JMS099.30	6/14/2012	M	3	26.27	7.78	6.45	2-JMS099.30	6/14/2012	M
2-JMS099.30	6/14/2012	M	4	26.26	7.78	6.49	2-JMS099.30	6/14/2012	M
2-JMS099.30	6/14/2012	M	5	26.25	7.78	6.46	2-JMS099.30	6/14/2012	M
2-JMS099.30	6/14/2012	M	6	26.24	7.78	6.42	2-JMS099.30	6/14/2012	M
2-JMS099.30	6/14/2012	M	7	26.24	7.78	6.43	2-JMS099.30	6/14/2012	M
2-JMS099.30	6/14/2012	M	8	26.23	7.77	6.45	2-JMS099.30	6/14/2012	M
2-JMS099.30	6/14/2012	M	9	26.23	7.77	6.41	2-JMS099.30	6/14/2012	M
2-JMS099.30	6/14/2012	M	10	26.22	7.77	6.42	2-JMS099.30	6/14/2012	M
2-JMS099.30	6/14/2012	M	11	26.22	7.77	6.44	2-JMS099.30	6/14/2012	M
2-JMS099.30	6/14/2012	B	12	26.22	7.76	6.5	2-JMS099.30	6/14/2012	B
2-JMS099.30	7/19/2012	S	1	31.57	7.7	6.83	2-JMS099.30	7/19/2012	S
2-JMS099.30	7/19/2012	M	2	31.39	7.65	6.44	2-JMS099.30	7/19/2012	M
2-JMS099.30	7/19/2012	M	3	31.37	7.66	6.35	2-JMS099.30	7/19/2012	M
2-JMS099.30	7/19/2012	M	4	31.05	7.56	5.73	2-JMS099.30	7/19/2012	M
2-JMS099.30	7/19/2012	M	5	30.66	7.53	5.49	2-JMS099.30	7/19/2012	M
2-JMS099.30	7/19/2012	M	6	30.56	7.5	5.34	2-JMS099.30	7/19/2012	M
2-JMS099.30	7/19/2012	M	7	30.56	7.51	5.36	2-JMS099.30	7/19/2012	M
2-JMS099.30	7/19/2012	M	8	30.52	7.49	5.24	2-JMS099.30	7/19/2012	M
2-JMS099.30	7/19/2012	M	9	30.52	7.49	5.26	2-JMS099.30	7/19/2012	M
2-JMS099.30	7/19/2012	M	10	30.51	7.49	5.33	2-JMS099.30	7/19/2012	M
2-JMS099.30	7/19/2012	B	11	30.51	7.49	5.29	2-JMS099.30	7/19/2012	B
2-JMS099.30	8/7/2012	S	1	30.43	7.6	5.45	2-JMS099.30	8/7/2012	S
2-JMS099.30	8/7/2012	M	2	30.35	7.6	5.48	2-JMS099.30	8/7/2012	M
2-JMS099.30	8/7/2012	M	3	30.32	7.58	5.21	2-JMS099.30	8/7/2012	M
2-JMS099.30	8/7/2012	M	4	30.23	7.56	5.12	2-JMS099.30	8/7/2012	M
2-JMS099.30	8/7/2012	M	5	30.25	7.56	5.09	2-JMS099.30	8/7/2012	M
2-JMS099.30	8/7/2012	M	6	30.25	7.55	5.02	2-JMS099.30	8/7/2012	M
2-JMS099.30	8/7/2012	M	7	30.23	7.54	5.32	2-JMS099.30	8/7/2012	M
2-JMS099.30	8/7/2012	B	8	30.22	7.55	5.18	2-JMS099.30	8/7/2012	B
2-JMS099.30	9/20/2012	S	1	24.04	7.76	6.65	2-JMS099.30	9/20/2012	S
2-JMS099.30	9/20/2012	M	2	24.03	7.76	6.64	2-JMS099.30	9/20/2012	M
2-JMS099.30	9/20/2012	M	3	24.02	7.75	6.69	2-JMS099.30	9/20/2012	M
2-JMS099.30	9/20/2012	M	4	23.88	7.72	6.54	2-JMS099.30	9/20/2012	M
2-JMS099.30	9/20/2012	M	5	23.87	7.72	6.56	2-JMS099.30	9/20/2012	M
2-JMS099.30	9/20/2012	M	6	23.84	7.71	6.48	2-JMS099.30	9/20/2012	M
2-JMS099.30	9/20/2012	M	7	23.82	7.7	6.49	2-JMS099.30	9/20/2012	M
2-JMS099.30	9/20/2012	M	8	23.82	7.69	6.48	2-JMS099.30	9/20/2012	M
2-JMS099.30	9/20/2012	M	9	23.83	7.7	6.47	2-JMS099.30	9/20/2012	M
2-JMS099.30	9/20/2012	B	10	23.84	7.69	6.55	2-JMS099.30	9/20/2012	B
2-JMS099.30	10/23/2012	S	1	18.58	7.96	8.18	2-JMS099.30	10/23/2012	S
2-JMS099.30	10/23/2012	M	2	18.4	7.95	8.21	2-JMS099.30	10/23/2012	M
2-JMS099.30	10/23/2012	M	3	18.37	7.94	8.32	2-JMS099.30	10/23/2012	M
2-JMS099.30	10/23/2012	B	4	18.35	7.93	8.66	2-JMS099.30	10/23/2012	B
2-JMS099.30	11/6/2012	S	1	11.23	7.93	10.02	2-JMS099.30	11/6/2012	S
2-JMS099.30	11/6/2012	M	2	11.24	7.93	10.01	2-JMS099.30	11/6/2012	M
2-JMS099.30	11/6/2012	M	3	11.24	7.93	10.04	2-JMS099.30	11/6/2012	M
2-JMS099.30	11/6/2012	M	4	11.24	7.93	10.04	2-JMS099.30	11/6/2012	M
2-JMS099.30	11/6/2012	M	5	11.23	7.93	10.05	2-JMS099.30	11/6/2012	M
2-JMS099.30	11/6/2012	M	6	11.26	7.93	10.06	2-JMS099.30	11/6/2012	M
2-JMS099.30	11/6/2012	M	7	11.27	7.92	10.12	2-JMS099.30	11/6/2012	M
2-JMS099.30	11/6/2012	M	8	11.24	7.92	10.11	2-JMS099.30	11/6/2012	M
2-JMS099.30	11/6/2012	M	9	11.24	7.92	10.23	2-JMS099.30	11/6/2012	M
2-JMS099.30	11/6/2012	M	10	11.25	7.9	10.37	2-JMS099.30	11/6/2012	M
2-JMS099.30	11/6/2012	B	11	11.25	7.92	10.73	2-JMS099.30	11/6/2012	B
2-JMS099.30	12/4/2012	S	1	8.44	7.98	11.75	2-JMS099.30	12/4/2012	S
2-JMS099.30	12/4/2012	M	2	8.43	7.98	11.81	2-JMS099.30	12/4/2012	M
2-JMS099.30	12/4/2012	M	3	8.44	7.98	11.84	2-JMS099.30	12/4/2012	M
2-JMS099.30	12/4/2012	M	4	8.37	7.97	11.5	2-JMS099.30	12/4/2012	M
2-JMS099.30	12/4/2012	M	5	8.22	7.99	11.86	2-JMS099.30	12/4/2012	M
2-JMS099.30	12/4/2012	M	6	8.21	7.99	11.84	2-JMS099.30	12/4/2012	M
2-JMS099.30	12/4/2012	M	7	8.19	7.99	11.85	2-JMS099.30	12/4/2012	M
2-JMS099.30	12/4/2012	M	8	8.2	7.99	11.86	2-JMS099.30	12/4/2012	M
2-JMS099.30	12/4/2012	M	9	8.2	7.99	11.9	2-JMS099.30	12/4/2012	M

Station ID	Collection Date	Depth Desc	Depth	Temp Celcius	Field Ph	Do Probe	Do Winkler	Fdt Do Optical	Salinity
2-JMS099.30	12/4/2012	M	10	8.2	7.99	11.91	2-JMS099.30	12/4/2012	M
2-JMS099.30	12/4/2012	B	11	8.2	7.98	11.99	2-JMS099.30	12/4/2012	B
2-JMS099.30	1/8/2013	S	1	5.16	7.98	13.41	2-JMS099.30	1/8/2013	S
2-JMS099.30	1/8/2013	M	2	5.14	7.98	13.3	2-JMS099.30	1/8/2013	M
2-JMS099.30	1/8/2013	M	3	5.12	7.98	13.29	2-JMS099.30	1/8/2013	M
2-JMS099.30	1/8/2013	M	4	5.11	7.98	13.29	2-JMS099.30	1/8/2013	M
2-JMS099.30	1/8/2013	M	5	5.13	7.98	13.3	2-JMS099.30	1/8/2013	M
2-JMS099.30	1/8/2013	M	6	5.12	7.98	13.35	2-JMS099.30	1/8/2013	M
2-JMS099.30	1/8/2013	M	7	5.11	7.97	13.36	2-JMS099.30	1/8/2013	M
2-JMS099.30	1/8/2013	M	8	5.11	7.97	13.37	2-JMS099.30	1/8/2013	M
2-JMS099.30	1/8/2013	M	9	5.1	7.98	13.39	2-JMS099.30	1/8/2013	M
2-JMS099.30	1/8/2013	M	10	5.09	7.98	13.53	2-JMS099.30	1/8/2013	M
2-JMS099.30	1/8/2013	B	11	5.1	7.98	13.54	2-JMS099.30	1/8/2013	B
2-JMS099.30	2/5/2013	S	1	4.79	7.82	13.31	2-JMS099.30	2/5/2013	S
2-JMS099.30	2/5/2013	M	2	4.78	7.82	13.34	2-JMS099.30	2/5/2013	M
2-JMS099.30	2/5/2013	M	3	4.69	7.83	13.44	2-JMS099.30	2/5/2013	M
2-JMS099.30	2/5/2013	M	4	4.69	7.83	13.46	2-JMS099.30	2/5/2013	M
2-JMS099.30	2/5/2013	M	5	4.69	7.83	13.49	2-JMS099.30	2/5/2013	M
2-JMS099.30	2/5/2013	M	6	4.69	7.83	13.45	2-JMS099.30	2/5/2013	M
2-JMS099.30	2/5/2013	M	7	4.69	7.83	13.46	2-JMS099.30	2/5/2013	M
2-JMS099.30	2/5/2013	M	8	4.69	7.83	13.4	2-JMS099.30	2/5/2013	M
2-JMS099.30	2/5/2013	M	9	4.71	7.84	13.4	2-JMS099.30	2/5/2013	M
2-JMS099.30	2/5/2013	B	10	4.7		13.42	2-JMS099.30	2/5/2013	B
2-JMS099.30	3/5/2013	S	1	6.27	8.07	12.79	2-JMS099.30	3/5/2013	S
2-JMS099.30	3/5/2013	M	2	6.28	8.06	12.75	2-JMS099.30	3/5/2013	M
2-JMS099.30	3/5/2013	M	3	6.26	8.06	12.8	2-JMS099.30	3/5/2013	M
2-JMS099.30	3/5/2013	M	4	6.24	8.07	12.78	2-JMS099.30	3/5/2013	M
2-JMS099.30	3/5/2013	M	5	6.22	8.06	12.78	2-JMS099.30	3/5/2013	M
2-JMS099.30	3/5/2013	M	6	6.17	8.04	12.82	2-JMS099.30	3/5/2013	M
2-JMS099.30	3/5/2013	M	7	6.2	8.06	12.84	2-JMS099.30	3/5/2013	M
2-JMS099.30	3/5/2013	M	8	6.17	8.05	12.81	2-JMS099.30	3/5/2013	M
2-JMS099.30	3/5/2013	B	9	6.15	8.03	12.9	2-JMS099.30	3/5/2013	B
2-JMS099.30	4/2/2013	S	1	11.43	7.95	11.2	2-JMS099.30	4/2/2013	S
2-JMS099.30	4/2/2013	M	2	11.42	7.95	11.2	2-JMS099.30	4/2/2013	M
2-JMS099.30	4/2/2013	M	3	11.41	7.96	11.36	2-JMS099.30	4/2/2013	M
2-JMS099.30	4/2/2013	M	4	11.47	7.96	11.42	2-JMS099.30	4/2/2013	M
2-JMS099.30	4/2/2013	M	5	11.51	7.96	11.41	2-JMS099.30	4/2/2013	M
2-JMS099.30	4/2/2013	M	6	11.52	7.96	11.41	2-JMS099.30	4/2/2013	M
2-JMS099.30	4/2/2013	M	7	11.51	7.93	11.39	2-JMS099.30	4/2/2013	M
2-JMS099.30	4/2/2013	B	8	11.51	7.91	11.38	2-JMS099.30	4/2/2013	B
2-JMS099.30	5/9/2013	S	1	15.81	7.96		2-JMS099.30	5/9/2013	S
2-JMS099.30	5/9/2013	M	2	15.79	7.96		2-JMS099.30	5/9/2013	M
2-JMS099.30	5/9/2013	M	3	15.79	7.96		2-JMS099.30	5/9/2013	M
2-JMS099.30	5/9/2013	M	4	15.78	7.96		2-JMS099.30	5/9/2013	M
2-JMS099.30	5/9/2013	M	5	15.78	7.96		2-JMS099.30	5/9/2013	M
2-JMS099.30	5/9/2013	M	6	15.78	7.95		2-JMS099.30	5/9/2013	M
2-JMS099.30	5/9/2013	M	7	15.77	7.95		2-JMS099.30	5/9/2013	M
2-JMS099.30	5/9/2013	M	8	15.78	7.95		2-JMS099.30	5/9/2013	M
2-JMS099.30	5/9/2013	M	9	15.78	7.95		2-JMS099.30	5/9/2013	M
2-JMS099.30	5/9/2013	M	10	15.77	7.94		2-JMS099.30	5/9/2013	M
2-JMS099.30	5/9/2013	M	11	15.78	7.95		2-JMS099.30	5/9/2013	M
2-JMS099.30	5/9/2013	B	12	15.77	7.97		2-JMS099.30	5/9/2013	B
2-JMS099.30	6/6/2013	S	1	26.65	8.41	7.43	2-JMS099.30	6/6/2013	S
2-JMS099.30	6/6/2013	M	2	26.66	8.41	7.45	2-JMS099.30	6/6/2013	M
2-JMS099.30	6/6/2013	M	3	26.66	8.4	7.42	2-JMS099.30	6/6/2013	M
2-JMS099.30	6/6/2013	B	4	26.64	8.4	7.39	2-JMS099.30	6/6/2013	B
2-JMS099.30	7/18/2013	S	1	29.47	7.87	7.01	2-JMS099.30	7/18/2013	S
2-JMS099.30	7/18/2013	M	2	29.26	7.86	7.04	2-JMS099.30	7/18/2013	M
2-JMS099.30	7/18/2013	M	3	29.13	7.86	7.07	2-JMS099.30	7/18/2013	M
2-JMS099.30	7/18/2013	M	4	29.21	7.86	7.14	2-JMS099.30	7/18/2013	M
2-JMS099.30	7/18/2013	M	5	29.01	7.84	7.02	2-JMS099.30	7/18/2013	M
2-JMS099.30	7/18/2013	M	6	29.05	7.85	7	2-JMS099.30	7/18/2013	M
2-JMS099.30	7/18/2013	M	7	28.99	7.84	6.94	2-JMS099.30	7/18/2013	M
2-JMS099.30	7/18/2013	M	8	28.99	7.84	6.9	2-JMS099.30	7/18/2013	M
2-JMS099.30	7/18/2013	M	9	28.98	7.84	6.98	2-JMS099.30	7/18/2013	M
2-JMS099.30	7/18/2013	B	10	28.97	7.84	7.15	2-JMS099.30	7/18/2013	B
2-JMS099.30	8/15/2013	B	11	27.48	7.34	6.33	2-JMS099.30	8/15/2013	B
2-JMS099.30	9/4/2013	S	1	28.94	8.17	6.64	2-JMS099.30	9/4/2013	S
2-JMS099.30	9/4/2013	M	2	28.69	8.12	6.67	2-JMS099.30	9/4/2013	M
2-JMS099.30	9/4/2013	M	3	28.6	8.11	6.67	2-JMS099.30	9/4/2013	M

Station ID	Collection Date	Depth Desc	Depth	Temp Celcius	Field Ph	Do Probe	Do Winkler	Fdt Do Optical	Salinity
2-JMS099.30	9/4/2013	M	4	28.47	8.09	6.52	2-JMS099.30	9/4/2013	M
2-JMS099.30	9/4/2013	M	5	28.46	8.09	6.49	2-JMS099.30	9/4/2013	M
2-JMS099.30	9/4/2013	M	6	28.41	8.08	6.53	2-JMS099.30	9/4/2013	M
2-JMS099.30	9/4/2013	M	7	28.38	8.08	6.65	2-JMS099.30	9/4/2013	M
2-JMS099.30	9/4/2013	M	8	28.35	8.07	6.63	2-JMS099.30	9/4/2013	M
2-JMS099.30	9/4/2013	M	9	28.29	8.06	6.59	2-JMS099.30	9/4/2013	M
2-JMS099.30	9/4/2013	M	10	28.28	8.06	6.64	2-JMS099.30	9/4/2013	M
2-JMS099.30	9/4/2013	B	11	28.25	8.05	6.6	2-JMS099.30	9/4/2013	B
2-JMS099.30	10/1/2013	S	1	22.67	8.16	8.21	2-JMS099.30	10/1/2013	S
2-JMS099.30	10/1/2013	M	2	22.07	8.09	7.84	2-JMS099.30	10/1/2013	M
2-JMS099.30	10/1/2013	M	3	21.79	8.04	7.68	2-JMS099.30	10/1/2013	M
2-JMS099.30	10/1/2013	M	4	21.72	8.03	7.64	2-JMS099.30	10/1/2013	M
2-JMS099.30	10/1/2013	M	5	21.63	8.02	7.53	2-JMS099.30	10/1/2013	M
2-JMS099.30	10/1/2013	M	6	21.51	8.01	7.52	2-JMS099.30	10/1/2013	M
2-JMS099.30	10/1/2013	M	7	21.51	8.01	7.52	2-JMS099.30	10/1/2013	M
2-JMS099.30	10/1/2013	M	8	21.51	8	7.52	2-JMS099.30	10/1/2013	M
2-JMS099.30	10/1/2013	M	9	21.49	8.01	7.52	2-JMS099.30	10/1/2013	M
2-JMS099.30	10/1/2013	B	10	21.47	8.01	7.44	2-JMS099.30	10/1/2013	B
2-JMS099.30	11/5/2013	S	1	15.56	7.96	8.9	2-JMS099.30	11/5/2013	S
2-JMS099.30	11/5/2013	M	2	15.52	7.96	8.88	2-JMS099.30	11/5/2013	M
2-JMS099.30	11/5/2013	M	3	15.46	7.95	8.85	2-JMS099.30	11/5/2013	M
2-JMS099.30	11/5/2013	M	4	15.48	7.95	8.81	2-JMS099.30	11/5/2013	M
2-JMS099.30	11/5/2013	M	5	15.48	7.95	8.81	2-JMS099.30	11/5/2013	M
2-JMS099.30	11/5/2013	M	6	15.46	7.95	8.84	2-JMS099.30	11/5/2013	M
2-JMS099.30	11/5/2013	M	7	15.45	7.95	8.8	2-JMS099.30	11/5/2013	M
2-JMS099.30	11/5/2013	M	8	15.47	7.95	8.84	2-JMS099.30	11/5/2013	M
2-JMS099.30	11/5/2013	M	9	15.47	7.95	8.87	2-JMS099.30	11/5/2013	M
2-JMS099.30	11/5/2013	M	10	15.46	7.95	8.87	2-JMS099.30	11/5/2013	M
2-JMS099.30	11/5/2013	M	11	15.47	7.95	8.87	2-JMS099.30	11/5/2013	M
2-JMS099.30	11/5/2013	B	12	15.46	7.96	8.86	2-JMS099.30	11/5/2013	B
2-JMS099.30	12/3/2013	S	1	4.57	8.1	12.82	2-JMS099.30	12/3/2013	S
2-JMS099.30	12/3/2013	M	2	4.58	8.1	12.81	2-JMS099.30	12/3/2013	M
2-JMS099.30	12/3/2013	M	3	4.61	8.11	12.82	2-JMS099.30	12/3/2013	M
2-JMS099.30	12/3/2013	M	4	4.6	8.12	12.81	2-JMS099.30	12/3/2013	M
2-JMS099.30	12/3/2013	M	5	4.56	8.12	12.85	2-JMS099.30	12/3/2013	M
2-JMS099.30	12/3/2013	M	6	4.55	8.13	12.85	2-JMS099.30	12/3/2013	M
2-JMS099.30	12/3/2013	M	7	4.53	8.14	12.86	2-JMS099.30	12/3/2013	M
2-JMS099.30	12/3/2013	M	8	4.54	8.15	12.9	2-JMS099.30	12/3/2013	M
2-JMS099.30	12/3/2013	M	9	4.54	8.16	12.93	2-JMS099.30	12/3/2013	M
2-JMS099.30	12/3/2013	M	10	4.56	8.19	13.02	2-JMS099.30	12/3/2013	M
2-JMS099.30	12/3/2013	B	11	4.55	8.17	13.11	2-JMS099.30	12/3/2013	B
2-JMS099.30	1/15/2014	S	1	5.39	7.75	12.6	2-JMS099.30	1/15/2014	S
2-JMS099.30	1/15/2014	M	2	5.37	7.75	12.6	2-JMS099.30	1/15/2014	M
2-JMS099.30	1/15/2014	M	3	5.35	7.75	12.57	2-JMS099.30	1/15/2014	M
2-JMS099.30	1/15/2014	M	4	5.34	7.77	12.58	2-JMS099.30	1/15/2014	M
2-JMS099.30	1/15/2014	M	5	5.35	7.76	12.56	2-JMS099.30	1/15/2014	M
2-JMS099.30	1/15/2014	M	6	5.36	7.76	12.54	2-JMS099.30	1/15/2014	M
2-JMS099.30	1/15/2014	M	7	5.37	7.76	12.6	2-JMS099.30	1/15/2014	M
2-JMS099.30	1/15/2014	M	8	5.39	7.73	12.6	2-JMS099.30	1/15/2014	M
2-JMS099.30	1/15/2014	M	9	5.36	7.78	12.65	2-JMS099.30	1/15/2014	M
2-JMS099.30	1/15/2014	M	10	5.36	7.78	12.53	2-JMS099.30	1/15/2014	M
2-JMS099.30	1/15/2014	M	11	5.39	7.76	12.57	2-JMS099.30	1/15/2014	M
2-JMS099.30	1/15/2014	B	12	5.38	7.75	12.64	2-JMS099.30	1/15/2014	B
2-JMS099.30	2/4/2014	S	1	3.61	7.81	13.33	2-JMS099.30	2/4/2014	S
2-JMS099.30	2/4/2014	M	2	3.61	7.81	13.29	2-JMS099.30	2/4/2014	M
2-JMS099.30	2/4/2014	M	3	3.6	7.81	13.27	2-JMS099.30	2/4/2014	M
2-JMS099.30	2/4/2014	M	4	3.61	7.81	13.27	2-JMS099.30	2/4/2014	M
2-JMS099.30	2/4/2014	M	5	3.62	7.81	13.33	2-JMS099.30	2/4/2014	M
2-JMS099.30	2/4/2014	M	6	3.61	7.8	13.4	2-JMS099.30	2/4/2014	M
2-JMS099.30	2/4/2014	M	7	3.61	7.81	13.43	2-JMS099.30	2/4/2014	M
2-JMS099.30	2/4/2014	M	8	3.62	7.81	13.5	2-JMS099.30	2/4/2014	M
2-JMS099.30	2/4/2014	M	9	3.61	7.8	13.57	2-JMS099.30	2/4/2014	M
2-JMS099.30	2/4/2014	M	10	3.61	7.8	13.63	2-JMS099.30	2/4/2014	M
2-JMS099.30	2/4/2014	B	11	3.62	7.8	13.65	2-JMS099.30	2/4/2014	B
2-JMS099.30	4/1/2014	S	1	10.85	7.51	10.42	2-JMS099.30	4/1/2014	S
2-JMS099.30	4/1/2014	M	2	10.81	7.52	10.58	2-JMS099.30	4/1/2014	M
2-JMS099.30	4/1/2014	M	3	10.88	7.54	10.56	2-JMS099.30	4/1/2014	M
2-JMS099.30	4/1/2014	M	4	10.78	7.55	10.58	2-JMS099.30	4/1/2014	M
2-JMS099.30	4/1/2014	M	5	10.78	7.56	10.54	2-JMS099.30	4/1/2014	M
2-JMS099.30	4/1/2014	M	6	10.71	7.57	10.4	2-JMS099.30	4/1/2014	M

Station ID	Collection Date	Depth Desc	Depth	Temp Celcius	Field Ph	Do Probe	Do Winkler	Fdt Do Optical	Salinity
2-JMS099.30	4/1/2014	M	7	10.75	7.58	10.36	2-JMS099.30	4/1/2014	M
2-JMS099.30	4/1/2014	M	8	10.71	7.6	10.56	2-JMS099.30	4/1/2014	M
2-JMS099.30	4/1/2014	M	9	10.71	7.62	10.61	2-JMS099.30	4/1/2014	M
2-JMS099.30	4/1/2014	M	10	10.72	7.65	10.45	2-JMS099.30	4/1/2014	M
2-JMS099.30	4/1/2014	M	11	10.71	7.67	10.5	2-JMS099.30	4/1/2014	M
2-JMS099.30	4/1/2014	B	12	10.71	7.7	10.63	2-JMS099.30	4/1/2014	B
2-JMS099.30	5/6/2014	S	1	17.57	8.5	8.81	2-JMS099.30	5/6/2014	S
2-JMS099.30	5/6/2014	M	2	17.56	8.49	9.08	2-JMS099.30	5/6/2014	M
2-JMS099.30	5/6/2014	M	3	17.59	8.5	8.97	2-JMS099.30	5/6/2014	M
2-JMS099.30	5/6/2014	M	4	17.56	8.5	9	2-JMS099.30	5/6/2014	M
2-JMS099.30	5/6/2014	M	5	17.52	8.47	9.04	2-JMS099.30	5/6/2014	M
2-JMS099.30	5/6/2014	B	6	17.53	8.44	9.03	2-JMS099.30	5/6/2014	B
2-JMS099.30	6/3/2014	S	1	24.72	9.02	10.32	2-JMS099.30	6/3/2014	S
2-JMS099.30	6/3/2014	M	2	24.71	9.05	10.12	2-JMS099.30	6/3/2014	M
2-JMS099.30	6/3/2014	M	3	23.8	8.8	9.44	2-JMS099.30	6/3/2014	M
2-JMS099.30	6/3/2014	M	4	23.69	8.73	9.13	2-JMS099.30	6/3/2014	M
2-JMS099.30	6/3/2014	M	5	23.67	8.62	9.19	2-JMS099.30	6/3/2014	M
2-JMS099.30	6/3/2014	M	6	23.58	8.59	9.11	2-JMS099.30	6/3/2014	M
2-JMS099.30	6/3/2014	M	7	23.29	8.54	9.13	2-JMS099.30	6/3/2014	M
2-JMS099.30	6/3/2014	M	8	23.03	8.32	9.15	2-JMS099.30	6/3/2014	M
2-JMS099.30	6/3/2014	M	9	23	8.26	9.2	2-JMS099.30	6/3/2014	M
2-JMS099.30	6/3/2014	M	10	23	8.28	9.12	2-JMS099.30	6/3/2014	M
2-JMS099.30	6/3/2014	B	11	23.02	8.3	9.24	2-JMS099.30	6/3/2014	B
2-JMS099.30	7/1/2014	S	1	29.61	7.98	6.84	2-JMS099.30	7/1/2014	S
2-JMS099.30	7/1/2014	M	2	29.43	7.95	6.68	2-JMS099.30	7/1/2014	M
2-JMS099.30	7/1/2014	M	3	29.17	7.85	6.51	2-JMS099.30	7/1/2014	M
2-JMS099.30	7/1/2014	M	4	29.13	7.85	6.39	2-JMS099.30	7/1/2014	M
2-JMS099.30	7/1/2014	M	5	29.11	7.83	6.44	2-JMS099.30	7/1/2014	M
2-JMS099.30	7/1/2014	M	6	29.07	7.84	6.52	2-JMS099.30	7/1/2014	M
2-JMS099.30	7/1/2014	M	7	29.09	7.82	6.73	2-JMS099.30	7/1/2014	M
2-JMS099.30	7/1/2014	B	8	29.06	7.82	6.32	2-JMS099.30	7/1/2014	B
2-JMS099.30	8/5/2014	S	1	27.23	8.47	9.71	2-JMS099.30	8/5/2014	S
2-JMS099.30	8/5/2014	M	2	26.53	8.18	9.22	2-JMS099.30	8/5/2014	M
2-JMS099.30	8/5/2014	M	3	26.48	8.12	9.14	2-JMS099.30	8/5/2014	M
2-JMS099.30	8/5/2014	M	4	26.4	8.09	9.31	2-JMS099.30	8/5/2014	M
2-JMS099.30	8/5/2014	M	5	26.14	7.96	7.87	2-JMS099.30	8/5/2014	M
2-JMS099.30	8/5/2014	M	6	26.13	7.94	8.33	2-JMS099.30	8/5/2014	M
2-JMS099.30	8/5/2014	M	7	26.13	7.93	7.9	2-JMS099.30	8/5/2014	M
2-JMS099.30	8/5/2014	M	8	26.13	7.92	7.78	2-JMS099.30	8/5/2014	M
2-JMS099.30	8/5/2014	M	9	26.13	7.9	8.18	2-JMS099.30	8/5/2014	M
2-JMS099.30	8/5/2014	M	10	26.13	7.9	7.19	2-JMS099.30	8/5/2014	M
2-JMS099.30	8/5/2014	B	11	26.14	7.9	9.41	2-JMS099.30	8/5/2014	B
2-JMS099.30	9/3/2014	S	1	29.2	8.25	7.37	2-JMS099.30	9/3/2014	S
2-JMS099.30	9/3/2014	M	2	29.18	8.21	7.3	2-JMS099.30	9/3/2014	M
2-JMS099.30	9/3/2014	M	3	29.12	8.16	7.28	2-JMS099.30	9/3/2014	M
2-JMS099.30	9/3/2014	M	4	29.07	8.13	7.04	2-JMS099.30	9/3/2014	M
2-JMS099.30	9/3/2014	M	5	28.89	8.07	6.74	2-JMS099.30	9/3/2014	M
2-JMS099.30	9/3/2014	M	6	28.73	7.99	6.34	2-JMS099.30	9/3/2014	M
2-JMS099.30	9/3/2014	M	7	28.71	7.97	6.28	2-JMS099.30	9/3/2014	M
2-JMS099.30	9/3/2014	M	8	28.74	7.97	6.31	2-JMS099.30	9/3/2014	M
2-JMS099.30	9/3/2014	M	9	28.67	7.95	6.33	2-JMS099.30	9/3/2014	M
2-JMS099.30	9/3/2014	M	10	28.66	7.95	6.38	2-JMS099.30	9/3/2014	M
2-JMS099.30	9/3/2014	B	11	28.66	7.95	6.23	2-JMS099.30	9/3/2014	B
2-JMS099.30	10/7/2014	S	1	21.99	7.32	7.24	2-JMS099.30	10/7/2014	S
2-JMS099.30	10/7/2014	M	2	21.99	7.32	7.25	2-JMS099.30	10/7/2014	M
2-JMS099.30	10/7/2014	M	3	21.99	7.31	7.03	2-JMS099.30	10/7/2014	M
2-JMS099.30	10/7/2014	M	4	21.94	7.3	7.14	2-JMS099.30	10/7/2014	M
2-JMS099.30	10/7/2014	M	5	21.99	7.3	7.11	2-JMS099.30	10/7/2014	M
2-JMS099.30	10/7/2014	M	6	21.92	7.31	7.03	2-JMS099.30	10/7/2014	M
2-JMS099.30	10/7/2014	M	7	21.93	7.31	7.01	2-JMS099.30	10/7/2014	M
2-JMS099.30	10/7/2014	M	8	21.92	7.31	7	2-JMS099.30	10/7/2014	M
2-JMS099.30	10/7/2014	M	9	21.91	7.32	7.03	2-JMS099.30	10/7/2014	M
2-JMS099.30	10/7/2014	M	10	21.89	7.32	7.03	2-JMS099.30	10/7/2014	M
2-JMS099.30	10/7/2014	B	11	21.88	7.33	6.97	2-JMS099.30	10/7/2014	B
2-JMS099.30	11/4/2014	S	1	14.8	8.21	9.09	2-JMS099.30	11/4/2014	S
2-JMS099.30	11/4/2014	M	2	14.63	8.21	9.11	2-JMS099.30	11/4/2014	M
2-JMS099.30	11/4/2014	M	3	14.6	8.22	9.13	2-JMS099.30	11/4/2014	M
2-JMS099.30	11/4/2014	M	4	14.59	8.23	9.14	2-JMS099.30	11/4/2014	M
2-JMS099.30	11/4/2014	M	5	14.59	8.23	9.16	2-JMS099.30	11/4/2014	M
2-JMS099.30	11/4/2014	M	6	14.58	8.22	9.19	2-JMS099.30	11/4/2014	M

Station ID	Collection Date	Depth Desc	Depth	Temp Celcius	Field Ph	Do Probe	Do Winkler	Fdt Do Optical	Salinity
2-JMS099.30	11/4/2014	M	7	14.56	8.22	9.14	2-JMS099.30	11/4/2014	M
2-JMS099.30	11/4/2014	M	8	14.5	8.24	9.13	2-JMS099.30	11/4/2014	M
2-JMS099.30	11/4/2014	M	9	14.47	8.24	9.16	2-JMS099.30	11/4/2014	M
2-JMS099.30	11/4/2014	M	10	14.46	8.23	9.25	2-JMS099.30	11/4/2014	M
2-JMS099.30	11/4/2014	B	11	14.46	8.23	9.2	2-JMS099.30	11/4/2014	B
2-JMS099.30	12/2/2014	S	1	7.25	7.81	12.09	2-JMS099.30	12/2/2014	S
2-JMS099.30	12/2/2014	M	2	7.25	7.8	11.72	2-JMS099.30	12/2/2014	M
2-JMS099.30	12/2/2014	M	3	7.25	7.81	11.52	2-JMS099.30	12/2/2014	M
2-JMS099.30	12/2/2014	M	4	7.25	7.81	11.04	2-JMS099.30	12/2/2014	M
2-JMS099.30	12/2/2014	M	5	7.25	7.81	10.19	2-JMS099.30	12/2/2014	M
2-JMS099.30	12/2/2014	M	6	7.26	7.81	9.69	2-JMS099.30	12/2/2014	M
2-JMS099.30	12/2/2014	M	7	7.26	7.82	9.49	2-JMS099.30	12/2/2014	M
2-JMS099.30	12/2/2014	M	8	7.26	7.84	9.4	2-JMS099.30	12/2/2014	M
2-JMS099.30	12/2/2014	M	9	7.26	7.85	9.45	2-JMS099.30	12/2/2014	M
2-JMS099.30	12/2/2014	M	10	7.26	7.8	9.5	2-JMS099.30	12/2/2014	M
2-JMS099.30	12/2/2014	B	11	7.25	7.8	9.75	2-JMS099.30	12/2/2014	B
2-JMS099.30	1/6/2015	S	1	7.16	7.77	11.46	2-JMS099.30	1/6/2015	S
2-JMS099.30	1/6/2015	M	2	7.14	7.77	11.42	2-JMS099.30	1/6/2015	M
2-JMS099.30	1/6/2015	M	3	7.1	7.77	11.41	2-JMS099.30	1/6/2015	M
2-JMS099.30	1/6/2015	M	4	7.09	7.77	11.48	2-JMS099.30	1/6/2015	M
2-JMS099.30	1/6/2015	M	5	7.07	7.76	11.46	2-JMS099.30	1/6/2015	M
2-JMS099.30	1/6/2015	M	6	7.06	7.77	11.39	2-JMS099.30	1/6/2015	M
2-JMS099.30	1/6/2015	M	7	7.04	7.77	11.44	2-JMS099.30	1/6/2015	M
2-JMS099.30	1/6/2015	M	8	7.03	7.77	11.53	2-JMS099.30	1/6/2015	M
2-JMS099.30	1/6/2015	M	9	7.02	7.77	11.55	2-JMS099.30	1/6/2015	M
2-JMS099.30	1/6/2015	B	10	7.01	7.78	11.82	2-JMS099.30	1/6/2015	B
2-JMS099.30	2/3/2015	S	1	4.42	7.67	11.86	2-JMS099.30	2/3/2015	S
2-JMS099.30	2/3/2015	M	2	4.3	7.67	11.78	2-JMS099.30	2/3/2015	M
2-JMS099.30	2/3/2015	M	3	4.23	7.67	11.83	2-JMS099.30	2/3/2015	M
2-JMS099.30	2/3/2015	M	4	4.24	7.68	11.85	2-JMS099.30	2/3/2015	M
2-JMS099.30	2/3/2015	M	5	4.25	7.68	11.81	2-JMS099.30	2/3/2015	M
2-JMS099.30	2/3/2015	M	6	4.24	7.68	11.76	2-JMS099.30	2/3/2015	M
2-JMS099.30	2/3/2015	M	7	4.24	7.67	11.69	2-JMS099.30	2/3/2015	M
2-JMS099.30	2/3/2015	M	8	4.24	7.67	11.76	2-JMS099.30	2/3/2015	M
2-JMS099.30	2/3/2015	M	9	4.23	7.67	11.81	2-JMS099.30	2/3/2015	M
2-JMS099.30	2/3/2015	M	10	4.23	7.68	11.78	2-JMS099.30	2/3/2015	M
2-JMS099.30	2/3/2015	M	11	4.23	7.68	11.87	2-JMS099.30	2/3/2015	M
2-JMS099.30	2/3/2015	B	12	4.23	7.69	11.84	2-JMS099.30	2/3/2015	B
2-JMS099.30	3/12/2015	S	1	7.75	7.58	11.97	2-JMS099.30	3/12/2015	S
2-JMS099.30	3/12/2015	M	2	7.74	7.57	11.98	2-JMS099.30	3/12/2015	M
2-JMS099.30	3/12/2015	M	3	7.73	7.58	11.92	2-JMS099.30	3/12/2015	M
2-JMS099.30	3/12/2015	M	4	7.73	7.57	11.89	2-JMS099.30	3/12/2015	M
2-JMS099.30	3/12/2015	M	5	7.74	7.57	11.85	2-JMS099.30	3/12/2015	M
2-JMS099.30	3/12/2015	M	6	7.73	7.57	11.78	2-JMS099.30	3/12/2015	M
2-JMS099.30	3/12/2015	B	7	7.71	7.58	11.76	2-JMS099.30	3/12/2015	B
2-JMS099.30	5/5/2015	S	1	19.12	7.59	8.3	2-JMS099.30	5/5/2015	S
2-JMS099.30	5/5/2015	M	2	18.95	7.59	8.25	2-JMS099.30	5/5/2015	M
2-JMS099.30	5/5/2015	M	3	18.53	7.58	8.13	2-JMS099.30	5/5/2015	M
2-JMS099.30	5/5/2015	M	4	18.55	7.57	8.16	2-JMS099.30	5/5/2015	M
2-JMS099.30	5/5/2015	M	5	18.56	7.57	8.12	2-JMS099.30	5/5/2015	M
2-JMS099.30	5/5/2015	M	6	18.46	7.57	8.05	2-JMS099.30	5/5/2015	M
2-JMS099.30	5/5/2015	M	7	18.46	7.57	7.98	2-JMS099.30	5/5/2015	M
2-JMS099.30	5/5/2015	M	8	18.4	7.57	7.98	2-JMS099.30	5/5/2015	M
2-JMS099.30	5/5/2015	M	9	18.37	7.57	7.92	2-JMS099.30	5/5/2015	M
2-JMS099.30	5/5/2015	B	10	18.37	7.57	7.82	2-JMS099.30	5/5/2015	B
2-JMS099.30	6/18/2015	S	1	30.99	7.51		2-JMS099.30	6/18/2015	S
2-JMS099.30	6/18/2015	M	2	30.92	7.4		2-JMS099.30	6/18/2015	M
2-JMS099.30	6/18/2015	M	3	30.89	7.36		2-JMS099.30	6/18/2015	M
2-JMS099.30	6/18/2015	M	4	30.72	7.31		2-JMS099.30	6/18/2015	M
2-JMS099.30	6/18/2015	M	5	30.72	7.31		2-JMS099.30	6/18/2015	M
2-JMS099.30	6/18/2015	M	6	30.72	7.32		2-JMS099.30	6/18/2015	M
2-JMS099.30	6/18/2015	M	7	30.72	7.32		2-JMS099.30	6/18/2015	M
2-JMS099.30	6/18/2015	M	8	30.72	7.34		2-JMS099.30	6/18/2015	M
2-JMS099.30	6/18/2015	M	9	30.72	7.41		2-JMS099.30	6/18/2015	M
2-JMS099.30	6/18/2015	B	10	30.73	7.4		2-JMS099.30	6/18/2015	B
2-JMS099.30	7/7/2015	S	1	27.94	7.56	6.91	2-JMS099.30	7/7/2015	S
2-JMS099.30	7/7/2015	M	2	27.56	7.45	6.73	2-JMS099.30	7/7/2015	M
2-JMS099.30	7/7/2015	M	3	27.13	7.39	6.57	2-JMS099.30	7/7/2015	M
2-JMS099.30	7/7/2015	M	4	27.08	7.36	6.65	2-JMS099.30	7/7/2015	M
2-JMS099.30	7/7/2015	M	5	27.1	7.37	6.6	2-JMS099.30	7/7/2015	M

Station ID	Collection Date	Depth Desc	Depth	Temp Celcius	Field Ph	Do Probe	Do Winkler	Fdt Do Optical	Salinity
2-JMS099.30	7/7/2015	M	6	27.09	7.37	6.71	2-JMS099.30	7/7/2015	M
2-JMS099.30	7/7/2015	B	7	27.1	7.4	6.94	2-JMS099.30	7/7/2015	B
2-JMS099.30	8/6/2015	S	1	30.26	7.5	5.82	2-JMS099.30	8/6/2015	S
2-JMS099.30	8/6/2015	M	2	30.16	7.47	5.74	2-JMS099.30	8/6/2015	M
2-JMS099.30	8/6/2015	M	3	30.14	7.49	5.63	2-JMS099.30	8/6/2015	M
2-JMS099.30	8/6/2015	M	4	30.12	7.46	5.56	2-JMS099.30	8/6/2015	M
2-JMS099.30	8/6/2015	M	5	30.11	7.45	5.53	2-JMS099.30	8/6/2015	M
2-JMS099.30	8/6/2015	M	6	30.09	7.43	5.52	2-JMS099.30	8/6/2015	M
2-JMS099.30	8/6/2015	M	7	30.07	7.44	5.58	2-JMS099.30	8/6/2015	M
2-JMS099.30	8/6/2015	M	8	30.07	7.43	5.59	2-JMS099.30	8/6/2015	M
2-JMS099.30	8/6/2015	B	9	30.05	7.43	5.63	2-JMS099.30	8/6/2015	B
90th Percentile				**29.3**	**8.0**		**90th Percentile**		
10th Percentile				**5.4**	**7.2**		**10th Percentile**		

					00900	
					HARDNESS, TOTAL (MG/L AS CACO3)	
Sta Id	Collection Date Time	Depth Desc	Depth	Container Id Desc	Value	Com Code
2-JMS099.30	06/18/1992 16:50	S	0.3	R	68	
	07/20/1992 15:30	S	0.3	R	82	
	09/01/1992 14:35	S	0.3	R	88	
	11/17/1992 14:48	S	0.3	R	62	
	12/15/1992 15:25	S	0.3	R	33	
	01/14/1993 14:50	S	0.3	R	46	
	02/09/1993 14:15	S	0.3	R	58	
	06/02/1993 13:30	S	0.3	R	0	
	08/18/1993 14:10	S	0.3	R	70	
	09/20/1993 14:15	S	0.3	R	98	
	10/05/1993 14:20	S	0.3	R	96	
	11/17/1993 14:00	S	0.3	R	94	
	12/02/1993 15:05	S	0.3	R	56	
	02/17/1994 15:35	S	1	R	42	
	03/21/1994 14:55	B	10	R	54	
		S	1	R	54	
	04/14/1994 15:20	S	1	R	53	
	05/23/1994 16:05	S	1	R	68	
	06/09/1994 15:15	S	1	R	72	
	09/08/1994 15:00	S	1	R	75	
	10/17/1994 15:45	S	1	R	87	
	11/30/1994 15:15	S	1	R	75	
	12/06/1994 15:55	S	1	R	75	
	01/25/1995 15:05	S	1	R	55	
	02/27/1995 15:05	S	1	R	60	
	03/23/1995 15:50	S	1	R	58	
	04/18/1995 15:30	S	1	R	67	
	05/23/1995 15:10	S	1	R	45	
	06/20/1995 15:40	S	1	R	59	
	07/18/1995 15:25	S	1	R	66	
	08/23/1995 16:00	S	1	R	90	
	09/21/1995 14:45	S	1	R	115	
	10/19/1995 15:25	S	1	R	74	
	11/20/1995 15:35	S	1	R	73	
	12/14/1995 16:00	S	1	R	48	
	01/29/1996 15:30	S	1	R	28	
	02/20/1996 15:10	S	1	R	56	
	03/25/1996 15:10	S	1	R	60	
	04/29/1996 11:20	S	1	R	61	
	05/15/1996 14:35	S	1	R	56	
	06/18/1996 14:50	S	1	R	50	
	07/23/1996 15:35	S	1	R	70	
	08/20/1996 14:50	S	1	R	89	
	09/24/1996 14:55	S	1	R	64	
	10/22/1996 14:30	S	1	R	51	
	11/19/1996 15:15	S	1	R	61	
	12/10/1996 15:25	S	1	R	41	
	02/18/1997 15:50	S	1	R	43.3	
	03/18/1997 15:20	S	1	R	54	
	04/22/1997 15:25	S	1	R	79.9	
	05/28/1997 16:00	S	1	R	62.2	

					00900	
					HARDNESS, TOTAL (MG/L AS CACO3)	
Sta Id	Collection Date Time	Depth Desc	Depth	Container Id Desc	Value	Com Code
	06/24/1997 15:30	S	1	R	66.1	
	07/15/1997 15:30	S	1	R	79.4	
	08/19/1997 15:10	S	1	R	62.6	
	09/23/1997 15:05	S	1	R	75.7	
	10/21/1997 15:00	S	1	R	79.1	
	11/18/1997 15:15	S	1	R	68.3	
	12/10/1997 15:45	S	1	R	74.3	
	01/21/1998 15:45	S	1	R	46.8	
	02/18/1998 15:00	S	1	R	40.8	
	03/17/1998 15:30	S	1	R	44.1	
	04/21/1998 15:20	S	1	R	35.1	
	05/19/1998 15:25	S	1	R	47.1	
	06/23/1998 16:05	S	1	R	64.4	
	07/21/1998 15:15	S	1	R	69.6	
	08/18/1998 15:25	S	1	R	77.5	
	09/22/1998 17:30	S	1	R	89.3	
	10/20/1998 16:30	S	1	R	126	
	11/18/1998 15:15	S	1	R	102	
	12/15/1998 15:30	S	1	R	90	
	01/19/1999 15:20	S	1	R	76	
	02/23/1999 15:10	S	1	R	60	
	03/23/1999 15:30	S	1	R	68	
	04/20/1999 16:35	S	1	R	84	
	05/20/1999 15:20	S	1	R	60	
	06/22/1999 15:15	S	1	R	80.1	
	07/20/1999 16:15	S	1	R	96	
	08/17/1999 16:00	S	1	R	109	
	09/21/1999 16:20	S	1	R	40.9	
	10/28/1999 15:10	S	1	R	74.6	
	11/18/1999 15:27	S	1	R	62.7	
	12/21/1999 15:05	S	1	R	54.1	
	01/18/2000 16:15	S	1	S1	55.8	
	02/23/2000 14:15	S	1	R	54	
	03/28/2000 15:30	S	1	S1	43	
	04/24/2000 15:55	S	1	R	40	
	05/23/2000 17:20	S	1	R	57	
	06/20/2000 16:05	S	1	R	65.6	
	07/18/2000 16:35	S	1	R	76	
	08/22/2000 15:20	S	1	R	76.4	
	09/26/2000 16:20	S	1	R	65.1	
	10/24/2000 15:20	S	1	R	86.9	
	11/28/2000 16:50	S	1	R	123	
	01/23/2001 14:00	S	1	R	47.8	
	02/20/2001 13:20	S	1	R	58.9	
	03/27/2001 15:00	S	1	R	25.1	
	04/24/2001 13:50	S	1	R	47.2	
	06/19/2001 14:30	S	1	R	30.9	
	07/24/2001 14:40	S	1	R	77.8	
	08/21/2001 15:20	S	1	R	62.6	
	09/18/2001 16:20	S	1	R	28.3	
	10/16/2001 15:00	S	1	S1	200.6	

					00900	
					HARDNESS, TOTAL (MG/L AS CACO3)	
Sta Id	Collection Date Time	Depth Desc	Depth	Container Id Desc	Value	Com Code
	11/27/2001 15:30	S	1	R	132	
	12/12/2001 14:50	S	1	R	137	
	01/22/2002 15:25	S	1	R	78.8	
	02/19/2002 15:15	S	1	R	54	
	03/19/2002 15:30	S	1	R	37.3	
	04/16/2002 15:40	S	1	R	57.9	
	05/30/2002 16:20	S	1	R	68	
	06/25/2002 15:20	S	1	R	94.2	
	07/23/2002 15:00	S	1	R	124	
	08/13/2002 15:40	S	1	R	151	
	09/24/2002 15:40	S	1	R	95.5	
	10/22/2002 15:50	S	1	R	121	
	11/19/2002 16:10	S	1	R	30.5	
	12/10/2002 15:15	S	1	R	34.8	
	01/21/2003 15:45	S	1	R	67.9	
	02/25/2003 11:13	S	1	R	51.3	
	03/18/2003 15:40	S	1	R	48.8	
	04/15/2003 17:00	S	1	R	47	
	05/27/2003 14:19	S	1	R	43.8	
	06/24/2003 14:50	S	1	R	58.7	
	07/15/2003 15:00	S	1	R	48.8	
	08/26/2003 16:00	S	1	R	52.8	
	09/24/2003 15:37	S	1	R	24.9	
	10/28/2003 15:30	S	1	R	72.8	
	11/18/2003 15:00	S	1	R	50	
	12/16/2003 15:00	S	1	R	42	
	02/25/2004 15:00	S	1	R	56.4	
	03/23/2004 15:20	S	1	R	62.9	
	04/20/2004 14:40	S	1	R	51	
	05/18/2004 15:00	S	1	R	60	
	06/15/2004 15:00	S	1	R	51	
	07/20/2004 14:45	S	1	R	66.9	
	08/17/2004 15:00	S	1	R	45.5	
	09/21/2004 14:45	S	1	R	47.8	
	10/19/2004 14:20	S	1	R	36	
	11/16/2004 14:45	S	1	R	43	
	12/14/2004 15:25	S	1	R	57	
	01/26/2005 15:00	S	1	R	56	
	02/15/2005 14:40	S	1	R	72	
	03/22/2005 15:15	S	1	R	60	
	04/19/2005 15:40	S	1	R	54.7	
	05/24/2005 14:45	S	1	R	46	
	06/21/2005 14:50	S	1	R	74	
	07/19/2005 15:00	S	1	R	76	
	08/23/2005 15:30	S	1	R	74	
	09/20/2005 15:00	S	1	R	114	
	10/18/2005 15:20	S	1	R	56	
	11/15/2005 14:30	S	1	R	94	
	12/21/2005 15:00	S	1	R	53	
	01/17/2006 14:45	S	1	S1	69	
	02/21/2006 15:10	S	1	R	59	

					00900	
					HARDNESS, TOTAL (MG/L AS CACO3)	
Sta Id	**Collection Date Time**	**Depth Desc**	**Depth**	**Container Id Desc**	**Value**	**Com Code**
	03/20/2006 15:15	S	1	R	72	
	04/26/2006 15:00	S	1	R	52	
	05/15/2006 15:00	S	1	R	62	
	07/24/2006 14:25	S	1	R	78	
	08/22/2006 15:00	S	1	R	88	
	10/30/2006 15:10	S	1	R	52	
	11/15/2006 14:30	S	1	R	38	
	01/24/2007 14:45	S	1	R	58	
Average					**66**	

2014 Fact Sheets for 303(d) Waters

RIVER BASIN: James River Basin

HYDROLOGIC UNIT: 02080206

STREAM NAME: **James River**

TMDL ID: **G01E-01-BAC**

2014 IMPAIRED AREA ID: CB-JMSTFU

ASSESSMENT CATEGORY: 4A

TMDL DUE DATE: 2010

IMPAIRED SIZE: 6.1682 - Sq. Mi.

Watershed: VAP-G01E

INITIAL LISTING: 1996

UPSTREAM LIMIT: Fall Line (Mayos Bridge)

DOWNSTREAM LIMIT: Appomattox River

Estuarine James River from the fall line at Mayos Bridge downstream to the Appomattox River.

CLEAN WATER ACT GOAL AND USE SUPPORT:

Recreation Use - Not Supporting

IMPAIRMENT: E.coli

The James River from the fall line to the Appomattox River was initially assessed as not supporting of the Recreation Use based on the results of a summer special study in the fall zone. The special study was designed to monitor the effects of summertime rain and combined sewer overflow (CSO) events on water quality in the James River and to monitor the effects of Richmond's CSO abatement efforts. The segment has been included on the Impaired Waters list for fecal coliform since 1996.

During the 2004 and 2006 cycles, the bacteria standard changed to E.coli for those stations with enough data. During the 2008 cycle, the impairment was converted solely to E. coli.

Bacteria impairment is noted at multiple stations in the river during the 2014 cycle.

The James River and Tributaries - City of Richmond Bacterial TMDL was approved by the EPA on 11/4/2010. The river is considered Category 4A.

IMPAIRMENT SOURCE Nonpoint Sources, CSOs, Point Sources, MS4s

Bacteria were allocated to point and nonpoint sources, including CSOs, and MS4s.

RECOMMENDATION: Implementation

2014 Fact Sheets for 303(d) Waters

RIVER BASIN: James River Basin

HYDROLOGIC UNIT: 02080206

STREAM NAME: **James River**

TMDL ID: **G01E-02-CHLA**

2014 IMPAIRED AREA ID: CB-JMSTFU

ASSESSMENT CATEGORY: 4A

TMDL DUE DATE: 2010

IMPAIRED SIZE: 5.5352 - Sq. Mi.

Watershed: VAP-G01E

INITIAL LISTING: 2008

UPSTREAM LIMIT: Fall Line (Mayos Bridge)

DOWNSTREAM LIMIT: Appomattox River

Mainstem James River from the fall line at Mayos Bridge downstream to the JMSTFu/JMSTFl boundary at the Appomattox River.

CLEAN WATER ACT GOAL AND USE SUPPORT:

Aquatic Life Use - Not Supporting, Open Water Subuse - Not Supporting

IMPAIRMENT: Chlorophyll

The James River from the Appomattox River to the Chickahominy River was originally listed on the 1998 list as fully supporting but threatened of the Aquatic Life Use goal based on chlorophyll a exceedances. During the 1998 cycle, EPA extended the segment upstream to the fall line and downgraded the river to not supporting the Aquatic Life Use, citing nutrient concerns.

A special site-specific chlorophyll standard for the mainstem James River was adopted during the 2008 cycle. During the 2012 cycle, the upper tidal freshwater segment exceeded the summer seasonal mean however it was in compliance with the spring mean criterion. The segment violated both WQS during the 2014 cycle.

The Chesapeake Bay TMDL was approved by the EPA on 12/29/2010, therefore the impairment is considered Category 4A.

IMPAIRMENT SOURCE Point sources, Nonpoint Sources

The Chesapeake Bay TMDL allocates total nitrogen, total phosphorus, and total suspended solids from point and nonpoint sources across the Bay watershed as well as atmospheric sources.

RECOMMENDATION: Implementation

2014 Fact Sheets for 303(d) Waters

RIVER BASIN: James River Basin **HYDROLOGIC UNIT:** 02080206

STREAM NAME: **James River**

TMDL ID: **G01E-02-EBEN** **2014 IMPAIRED AREA ID:** CB-JMSTFU

ASSESSMENT CATEGORY: 5A **TMDL DUE DATE:** 2024

IMPAIRED SIZE: 31.3629 - Sq. Mi. **Watershed:** VAP-G01E

INITIAL LISTING: 2012

UPSTREAM LIMIT: Fall Line (Mayos Bridge)

DOWNSTREAM LIMIT: Tidal Freshwater/Oligohaline Boundary

Mainstem James River from the fall line at Mayos Bridge downstream to the JMSTFI/JMSOH boundary.

CLEAN WATER ACT GOAL AND USE SUPPORT:

Aquatic Life Use - Not Supporting

IMPAIRMENT: Benthic Macroinvertebrates

During the 2012 and 2014 cycles, the mainstem of the tidal freshwater James River was impaired of the Aquatic Life Use due to an inadequate benthic community based on the Chesapeake Bay Benthic Index of Biological Integrity.

This is supported by benthic alteration at 2010 Coastal 2000 stations 2CJMS055.04 and 2CJMS084.70, which were considered Category 5A. The source is "possibly cumulative chronic effects of metals and PAHs in the sediment".

IMPAIRMENT SOURCE Unknown

The source of the impairment is unknown.

RECOMMENDATION: Problem Characterization

2014 Fact Sheets for 303(d) Waters

RIVER BASIN: James River Basin **HYDROLOGIC UNIT:** 02080206

STREAM NAME: **James River and Various Tributaries**

TMDL ID: **G01E-03-PCB** **2014 IMPAIRED AREA ID:** CB-JMSTFU

ASSESSMENT CATEGORY: 5A **TMDL DUE DATE:** 2014

IMPAIRED SIZE: ~325 - Stream mile **Watershed:** VAP-G01E

INITIAL LISTING: 2002

UPSTREAM LIMIT: Fall line

DOWNSTREAM LIMIT: Hampton Roads Bridge Tunnel

Estuarine James River from the fall line to the Hampton Roads Bridge Tunnel, including several tributaries listed below.

CLEAN WATER ACT GOAL AND USE SUPPORT:

Fish Consumption Use - Not Supporting

IMPAIRMENT: Fish Tissue - PCBs, VDH Fish Consumption Restriction

During the 2002 cycle, the James River from the fall line to Queens Creek was considered not supporting of the Fish Consumption Use due to PCBs in several fish species at multiple DEQ monitoring locations.

During the 2004 cycle, a VDH Fish Consumption Restriction was issued from the fall line to Flowerdew Hundred and the segment was adjusted slightly to match the restriction. In addition, in the 2004 cycle, the Chickahominy River from Walkers Dam to Diascund Creek was assessed as not supporting of the Fish Consumption Use because the DEQ screening value for PCBs was exceeded in 3 species during sampling in 2001.

The VDH restriction was extended on 12/13/2004 to stretch from the I-95 bridge downstream to the Hampton Roads Bridge Tunnel and include the tidal portions of the following tributaries:

Appomattox River up to Lake Chesdin Dam
Bailey Creek up to Route 630
Bailey Bay
Chickahominy River up to Walkers Dam
Skiffes Creek up to Skiffes Creek Dam
Pagan River and its tributary Jones Creek
Chuckatuck Creek
Nansemond River and its tributaries Bennett Creek and Star Creek
Hampton River
Willoughby Bay and the Elizabeth R. system (Western, Eastern, and Southern Branches and Lafayette R.) and tributaries St. Julian Creek, Deep Creek, and Broad Creek

The advisory was modified again on 10/10/2006 to add Poythress Run.

The impairments were combined. The TMDL for the lower extended portion is due in 2018.

PCB sampling in 2012 showed exceedances in 4 species at 2-JMS087.01, 3 species at 2-JMS097.77, 4 species at 2-JMS110.30, 2 species at 2-PTH000.23, 2 species at 2-BLY000.65, 3 species at 2-JMS074.44, 2 species at 2-JMS066.88, 2 species at 2-JMS057.69, 3 species at 2-JMS052.67, among others.

IMPAIRMENT SOURCE Unknown

The source of the PCBs is considered unknown.

RECOMMENDATION: Toxic Source Assessment

2014 Fact Sheets for 303(d) Waters

RIVER BASIN: James River Basin **HYDROLOGIC UNIT:** 02080206

STREAM NAME: **James River Tidal Freshwater (Upper) Estuary**

TMDL ID: **JMSTFU-SAV-BAY** **2014 IMPAIRED AREA ID:** CB-JMSTFU

ASSESSMENT CATEGORY: 4A **TMDL DUE DATE:** 2010

IMPAIRED SIZE: 7.7423 - Sq. Mi. **Watershed:** VAP-G01E

INITIAL LISTING: 1998

UPSTREAM LIMIT: Fall line

DOWNSTREAM LIMIT: Tidal Freshwater/Oligohaline Boundary

The James River Tidal Freshwater Upper estuary, which extends from the fall line to approximately the Appomattox River, including tributaries.

CLEAN WATER ACT GOAL AND USE SUPPORT:

Aquatic Life Use - Not Supporting, Shallow Water Use - Not Supporting

IMPAIRMENT: Aquatic Macrophytes

The mainstem James River from the Appomattox River to the Chickahominy River was originally listed on the 1998 list as fully supporting but threatened of the Aquatic Life Use goal based on chlorophyll a exceedances. During the 1998 cycle, EPA extended the segment upstream to the fall line and downgraded the river to not supporting of the Aquatic Life Use, citing nutrient concerns.

The Chesapeake Bay Water Quality Standards were implemented in the 2006 cycle.

During the 2014 cycle, the Upper Tidal Freshwater James River from the fall line to the Appomattox fails the Shallow Water Subuse's submerged aquatic vegetation (SAV) acreage criterion. There is insufficient information to assess the water clarity acreage criterion. The TMDL was approved by the EPA on 12/29/2010, therefore the segment is considered a Category 4A water.

IMPAIRMENT SOURCE Nonpoint Source, Point Source

The Chesapeake Bay TMDL allocates total nitrogen, total phosphorus, and total suspended solids to point- and nonpoint sources throughout the Bay watershed.

RECOMMENDATION: Implementation

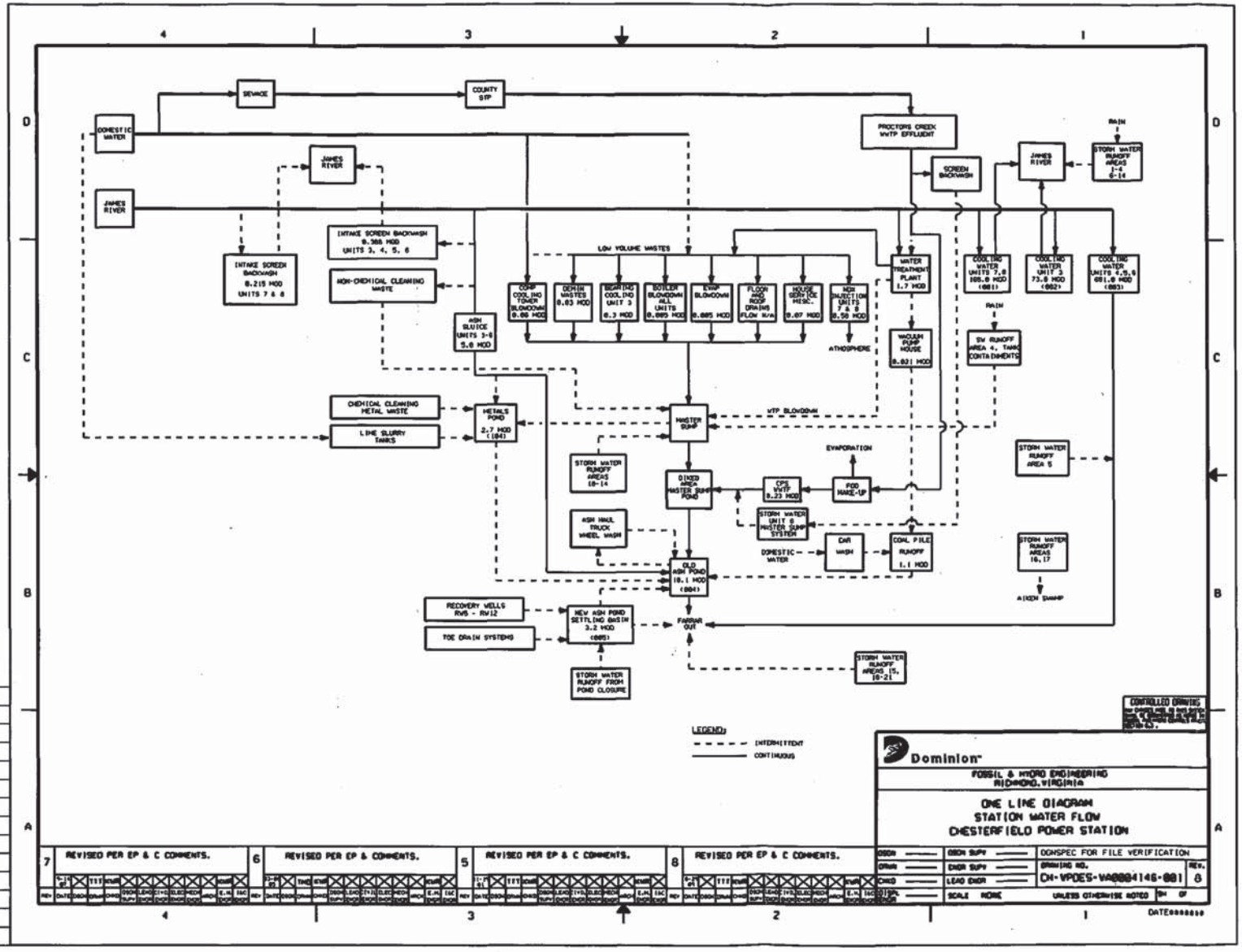
AMBIENT BACKGROUND CONCENTRATIONS FOR HUC 02080206

Source	Label		COUNT AND MEAN
STORET_01106_Mean	ALUMINUM, DISSOLVED (UG/L AS AL)_Mean		76.99
STORET_01106_N	ALUMINUM, DISSOLVED (UG/L AS AL)_N		23
STORET_01105_Mean	ALUMINUM, TOTAL (UG/L AS AL)_Mean		296.57
STORET_01105_N	ALUMINUM, TOTAL (UG/L AS AL)_N		8
STORET_01095_Mean	ANTIMONY, DISSOLVED (UG/L AS SB)_Mean		0.13
STORET_01095_N	ANTIMONY, DISSOLVED (UG/L AS SB)_N		17
STORET_01097_Mean	ANTIMONY, TOTAL (UG/L AS SB)_Mean		0.11
STORET_01097_N	ANTIMONY, TOTAL (UG/L AS SB)_N		6
STORET_01000_Mean	ARSENIC, DISSOLVED (UG/L AS AS)_Mean		0.62
STORET_01000_N	ARSENIC, DISSOLVED (UG/L AS AS)_N		23
STORET_01002_Mean	ARSENIC, TOTAL (UG/L AS AS)_Mean		1.06
STORET_01002_N	ARSENIC, TOTAL (UG/L AS AS)_N		8
STORET_01005_Mean	BARIUM, DISSOLVED (UG/L AS BA)_Mean		38.66
STORET_01005_N	BARIUM, DISSOLVED (UG/L AS BA)_N		17
STORET_01007_Mean	BARIUM, TOTAL (UG/L AS BA)_Mean		48.55
STORET_01007_N	BARIUM, TOTAL (UG/L AS BA)_N		4
STORET_01010_Mean	BERYLLIUM, DISSOLVED (UG/L AS BE)_Mean		0.10
STORET_01010_N	BERYLLIUM, DISSOLVED (UG/L AS BE)_N		15
STORET_01012_Mean	BERYLLIUM, TOTAL (UG/L AS BE)_Mean		0.11
STORET_01012_N	BERYLLIUM, TOTAL (UG/L AS BE)_N		2
STORET_01025_Mean	CADMIUM, DISSOLVED (UG/L AS CD)_Mean		0.12
STORET_01025_N	CADMIUM, DISSOLVED (UG/L AS CD)_N		22
STORET_01027_Mean	CADMIUM, TOTAL (UG/L AS CD)_Mean		0.33
STORET_01027_N	CADMIUM, TOTAL (UG/L AS CD)_N		8
STORET_00915_Mean	CALCIUM, DISSOLVED (MG/L AS CA)_Mean		10.60
STORET_00915_N	CALCIUM, DISSOLVED (MG/L AS CA)_N		23
STORET_00916_Mean	CALCIUM, TOTAL (MG/L AS CA)_Mean		13.12
STORET_00916_N	CALCIUM, TOTAL (MG/L AS CA)_N		8
STORET_00941_Mean	CHLORIDE, DISSOLVED IN WATER	MG/L_Mean	18.89
STORET_00941_N	CHLORIDE, DISSOLVED IN WATER	MG/L_N	8
STORET_00940_Mean	CHLORIDE,TOTAL IN WATER MG/L_Mean		14.48
STORET_00940_N	CHLORIDE,TOTAL IN WATER	MG/L_N	7
STORET_01030_Mean	CHROMIUM, DISSOLVED (UG/L AS CR)_Mean		0.89
STORET_01030_N	CHROMIUM, DISSOLVED (UG/L AS CR)_N		17
STORET_01034_Mean	CHROMIUM, TOTAL (UG/L AS CR)_Mean		1.81
STORET_01034_N	CHROMIUM, TOTAL (UG/L AS CR)_N		4
STORET_01040_Mean	COPPER, DISSOLVED (UG/L AS CU)_Mean		1.31
STORET_01040_N	COPPER, DISSOLVED (UG/L AS CU)_N		21
STORET_01042_Mean	COPPER, TOTAL (UG/L AS CU)_Mean		1.66
STORET_01042_N	COPPER, TOTAL (UG/L AS CU)_N		7
STORET_DHARD_Mean	HARDNESS, CA MG CALCULATED (MG/L AS CACO3) AS DISSOLVED_M		45.40
STORET_DHARD_N	HARDNESS, CA MG CALCULATED (MG/L AS CACO3) AS DISSOLVED_N		23
STORET_46570_Mean	HARDNESS, CA MG CALCULATED (MG/L AS CACO3)_Mean		73.50
STORET_46570_N	HARDNESS, CA MG CALCULATED (MG/L AS CACO3)_N		8
STORET_00900_Mean	HARDNESS, TOTAL (MG/L AS CACO3)_Mean		21.40
STORET_00900_N	HARDNESS, TOTAL (MG/L AS CACO3)_N		3
STORET_01046_Mean	IRON, DISSOLVED (UG/L AS FE)_Mean		725.00
STORET_01046_N	IRON, DISSOLVED (UG/L AS FE)_N		21
STORET_01045_Mean	IRON, TOTAL (UG/L AS FE)_Mean		2419.00
STORET_01045_N	IRON, TOTAL (UG/L AS FE)_N		8
STORET_01049_Mean	LEAD, DISSOLVED (UG/L AS PB)_Mean		0.30
STORET_01049_N	LEAD, DISSOLVED (UG/L AS PB)_N		21
STORET_01051_Mean	LEAD, TOTAL (UG/L AS PB)_Mean		1.11
STORET_01051_N	LEAD, TOTAL (UG/L AS PB)_N		6

STORET_00925_Mean	MAGNESIUM, DISSOLVED (MG/L AS MG)_Mean	4.73
STORET_00925_N	MAGNESIUM, DISSOLVED (MG/L AS MG)_N	23
STORET_00927_Mean	MAGNESIUM, TOTAL (MG/L AS MG)_Mean	9.89
STORET_00927_N	MAGNESIUM, TOTAL (MG/L AS MG)_N	8
STORET_01056_Mean	MANGANESE, DISSOLVED (UG/L AS MN)_Mean	266.58
STORET_01056_N	MANGANESE, DISSOLVED (UG/L AS MN)_N	23
STORET_01055_Mean	MANGANESE, TOTAL (UG/L AS MN)_Mean	666.29
STORET_01055_N	MANGANESE, TOTAL (UG/L AS MN)_N	8
STORET_50091_Mean	MERCURY-TL,FILTERED WATER,ULTRATRACE METHOD NG/L_Mean	2.69
STORET_50091_N	MERCURY-TL,FILTERED WATER,ULTRATRACE METHOD NG/L_N	22
STORET_50092_Mean	MERCURY-TL,UNFILTERED WATER,ULTRATRACE METHOD NG/L_Mean	7.19
STORET_50092_N	MERCURY-TL,UNFILTERED WATER,ULTRATRACE METHOD NG/L_N	6
STORET_01065_Mean	NICKEL, DISSOLVED (UG/L AS NI)_Mean	1.29
STORET_01065_N	NICKEL, DISSOLVED (UG/L AS NI)_N	21
STORET_01067_Mean	NICKEL, TOTAL (UG/L AS NI)_Mean	2.31
STORET_01067_N	NICKEL, TOTAL (UG/L AS NI)_N	6
STORET_00935_Mean	POTASSIUM, DISSOLVED (MG/L AS K)_Mean	3.49
STORET_00935_N	POTASSIUM, DISSOLVED (MG/L AS K)_N	15
STORET_00937_Mean	POTASSIUM, TOTAL MG/L AS K)_Mean	7.02
STORET_00937_N	POTASSIUM, TOTAL MG/L AS K)_N	4
STORET_01145_Mean	SELENIUM, DISSOLVED (UG/L AS SE)_Mean	0.26
STORET_01145_N	SELENIUM, DISSOLVED (UG/L AS SE)_N	17
STORET_01147_Mean	SELENIUM, TOTAL (UG/L AS SE)_Mean	0.50
STORET_01147_N	SELENIUM, TOTAL (UG/L AS SE)_N	5
STORET_01075_Mean	SILVER, DISSOLVED (UG/L AS AG)_Mean	0.03
STORET_01075_N	SILVER, DISSOLVED (UG/L AS AG)_N	17
STORET_01077_Mean	SILVER, TOTAL (UG/L AS AG)_Mean	0.01
STORET_01077_N	SILVER, TOTAL (UG/L AS AG)_N	3
STORET_00930_Mean	SODIUM, DISSOLVED (MG/L AS NA)_Mean	45.37
STORET_00930_N	SODIUM, DISSOLVED (MG/L AS NA)_N	15
STORET_00929_Mean	SODIUM, TOTAL (MG/L AS NA)_Mean	140.18
STORET_00929_N	SODIUM, TOTAL (MG/L AS NA)_N	4
STORET_00095_Mean	SPECIFIC CONDUCTANCE (UMHOS/CM @ 25C)_Mean	128.38
STORET_00095_N	SPECIFIC CONDUCTANCE (UMHOS/CM @ 25C)_N	20
STORET_34480_Mean	THALLIUM DRY WGTBOTMG/KG_Mean	3.35
STORET_34480_N	THALLIUM DRY WGTBOTMG/KG_N	6
STORET_01057_Mean	THALLIUM, DISSOLVED (UG/L AS TL)_Mean	0.04
STORET_01057_N	THALLIUM, DISSOLVED (UG/L AS TL)_N	15
STORET_01059_Mean	THALLIUM, TOTAL (UG/L AS TL)_Mean	-0.01
STORET_01059_N	THALLIUM, TOTAL (UG/L AS TL)_N	3
STORET_01085_Mean	VANADIUM, DISSOLVED (UG/L AS V)_Mean	7.00
STORET_01085_N	VANADIUM, DISSOLVED (UG/L AS V)_N	2
STORET_01087_Mean	VANADIUM, TOTAL (UG/L AS V)_Mean	7.26
STORET_01087_N	VANADIUM, TOTAL (UG/L AS V)_N	2
STORET_01090_Mean	ZINC, DISSOLVED (UG/L AS ZN)_Mean	6.23
STORET_01090_N	ZINC, DISSOLVED (UG/L AS ZN)_N	22
STORET_01092_Mean	ZINC, TOTAL (UG/L AS ZN)_Mean	6.96
STORET_01092_N	ZINC, TOTAL (UG/L AS ZN)_N	8

Attachment 3

- Water Flow Diagrams and Narrative (Present, Interim, and Final Conditions)
- Low Volume Wastewater Treatment System (LVWWTS) Phased Compliance and Design Narrative, Diagrams, and Gant Chart Schedules
- Lower and Upper Ash Pond Decanting/Dewatering Process and Existing Outfall Structure Diagrams
- Lower Ash Pond Drawdown and Discharge Rate Analysis
- List of Chemicals Present
- Map of Storage Tanks


SEWAGE
COUNTY STP
DOMESTIC WATER
JAMES RIVER
JAMES RIVER
INTAKE SCREEN BACKWASH 0.388 MGD UNITS 3, 4, 5, 6
INTAKE SCREEN BACKWASH 0.215 MGD UNITS 7 & 8
NON-CHEMICAL CLEANING WASTE
ASH SLUICE UNITS 3-8 5.0 MGD
LOW VOLUME WASTES
COMP COOLING TOWER BLOWDOWN 0.08 MGD
DEMIN WASTES 0.03 MGD
BEARING COOLING UNIT 3 0.3 MGD
BOILER BLOWDOWN ALL UNITS 0.085 MGD
EVAP BLOWDOWN 0.085 MGD
FLOOR AND ROOF DRAINS FLOW N/A
HOUSE SERVICE MISC. 0.07 MGD
NOX INJECTION UNITS 7 & 8 0.50 MGD
ATMOSPHERE
WATER TREATMENT PLANT 1.7 MGD
VACUUM PUMP HOUSE 0.021 MGD
PROCTORS CREEK WWTP EFFLUENT
SCREEN BACKWASH
JAMES RIVER
RAIN
STORM WATER RUNOFF AREAS 1-4 6-14
COOLING WATER UNITS 7,8 105.0 MGD (001)
COOLING WATER UNIT 3 73.0 MGD (002)
COOLING WATER UNITS 4,5,6 681.0 MGD (003)
RAIN
SW RUNOFF AREA 4, TANK CONTAINMENTS
CHEMICAL CLEANING METAL WASTE
LIME SLURRY TANKS
METALS POND 2.7 MGD (004)
MASTER SUMP
WWTP BLOWDOWN
EVAPORATION
STORM WATER RUNOFF AREAS 10-14
DIKED AREA MASTER SUMP POND
CPS WWTP 0.23 MGD
FGD MAKE-UP
STORM WATER RUNOFF AREA 5
ASH HAUL TRUCK WHEEL WASH
STORM WATER UNIT 8 MASTER SUMP SYSTEM
DOMESTIC WATER
CAR WASH
COAL PILE RUNOFF 1.1 MGD
STORM WATER RUNOFF AREAS 16,17
AIKEN SWAMP
OLD ASH POND 18.1 MGD (004)
RECOVERY WELLS RW5 - RW12
TOE DRAIN SYSTEMS
NEW ASH POND SETTLING BASIN 3.2 MGD (005)
FARMER OUT
STORM WATER RUNOFF FROM POND CLOSURE
STORM WATER RUNOFF AREAS 15, 18-21
LEGEND:
INTERMITTENT
CONTINUOUS
CONTROLLED DRAWING
Dominion
FOSSIL & HYDRO ENGINEERING
RICHMOND, VIRGINIA
ONE LINE DIAGRAM
STATION WATER FLOW
CHESTERFIELD POWER STATION
DGSN
DRWN
CHKD
DGSN SUPV
ENGR SUPV
LEAD ENGR
SCALE NONE
DGNSPEC FOR FILE VERIFICATION
DRAWING NO.
CH-WPDES-VA0004146-001
REV.
8
UNLESS OTHERWISE NOTED
SH OF
DATE
7 REVISED PER EP & C COMMENTS.
6 REVISED PER EP & COMMENTS.
5 REVISED PER EP & C COMMENTS.
8 REVISED PER EP & C COMMENTS.

FORM 2C - NPDES

Item II-A: LINE DRAWING

Steam and Evaporative Losses

A precise water balance cannot be provided as a considerable amount of water is released to the atmosphere as steam or evaporation, and we do not have estimates or measurements of these water losses, which can vary greatly with season and station operating conditions. The dashed lines on the drawing represent flows that occur on an intermittent basis. Rainfall runoff contributing to average flows of internal discharges is not available for several sources or treatment units.

Industrial Storm Water Discharges

Industrial storm water discharges from the station to the James River, Farrar Gut, and Aiken Swamp are identified for informational purposes only. These discharges are permitted under the VPDES General Storm Water Permit VAR051023

Item II-B: WASTEWATER SOURCES TO EACH OUTFALL

II-B.1: Existing Sources

Non-Process Water Discharges

- Intake screen backwash
- Occasional pumping of river water from intake screen wells to gain access for maintenance
- Discharges associated with the routine testing of the fire fighting system involving the withdrawal and direct return of water from the river
- The discharge from one sump pump each in the condenser cooling water intake pump rooms for Units 7 and 8.

Lower (Old) Ash Pond (Outfall 004)

The Lower (Old) Ash Pond is located across Coxendale Road south of the Chesterfield Power Station (CPS). Fly ash, bottom ash, and pyrites produced by generating units 3, 4, 5, and 6 are currently sluiced to the head of the ash pond using water withdrawn from the circulating river water system. The ash sluicing system typically operates 24 hours per day and alternates between bottom ash and fly ash as needed with the flow rate dependant on which generating units are on line. Wastewater treatment in the Lower Ash Pond (LAP) consists primarily of settling, and chemical coagulants may be added from time to time to facilitate this process. Chemicals may also be added as needed for pH adjustment to ensure that the discharge pH is within the allowable range. Ash that settles within the ash pond is manually removed and is transported via truck to the New Ash Pond, otherwise known as the Upper Ash Pond (UAP),

where it is used in the pond closure project. Bottom ash sluice may be directed to a processing area where a portion of the bottom ash is removed for beneficial reuse.

In addition to ash sluice water, the LAP also currently receives most of the station's low volume wastes, non-chemical cleaning wastes, chemical cleaning wastes (via the metals pond), and coal pile runoff. The ash pond also receives effluent from the FGD chloride purge stream wastewater treatment plant, screen backwash associated with the reuse of Proctors Creek WWTP effluent, wastewater from the station's car wash (non-chemical), and storm water from the Unit 6 FGD runoff collection system, from a portion of Drainage Area 4 (includes demineralizer building and associated ASTs), and from various other onsite tank containment areas including the station's light oil storage tank.

Metals Cleaning Waste Treatment Basin or Metals Pond (Newly Designated Internal Outfall 401)

The influent flows to the metals cleaning waste treatment basin (formerly referred to as Internal Outfall 104 and newly designated to Internal Outfall 401 as part of this permit renewal) consist of chemical cleaning wastes from periodic cleanings of the station's boilers, and non-chemical wastewater from precipitator and air preheater washes. Non-chemical cleaning wastewater from exterior boiler washes is typically routed directly to the ash pond via the master sump. The volume of wastewater generated by individual chemical and non-chemical washings is not measured. In addition, wastewater from the master sump may be routed to the metals cleaning waste treatment basin through the emergency sump line during maintenance periods. These wastewaters are generated infrequently, and the volume of water generated during a particular washing event is dependent on the amount, type, and condition of the equipment being cleaned.

Flue Gas Desulphurization Chloride Purge Stream Wastewater Treatment Plant (New Internal Outfall 402)

Flue gas desulphurization (FGD) is the state-of-the art technology used for removing sulfur dioxide (SO_2) from the exhaust flue gases from steam electric power plants that burn coal or oil. Dominion installed FGD technology at CPS to reduce SO_2 emissions from the four pulverized coal-fired generating units (Units 3, 4, 5, and 6). Installation of the FGD technology associated with Unit 6 was completed, and the unit became operational, during 2008. A second FGD was installed to handle the combined SO_2 emissions from Units 3, 4, and 5 through a common wet stack. The common scrubber became operational in 2011.

The FGD technology installed at CPS involves a wet scrubbing system where pulverized limestone is blended with water to form a slurry. The slurry is then sprayed into the exhaust flue gas and the calcium carbonate (CaCO3) in the slurry reacts with the SO2 in the flue gas to form calcium sulfate (CaSO4) or gypsum. The resulting gypsum is collected, and then dewatered using two stages of hydro-cyclones followed by vacuum filtration to separate and reclaim the gypsum. The remaining water is returned for reuse in the scrubber.

The primary source of make-up water to the FGD units is final effluent from the Proctors Creek Wastewater Treatment Plant (WWTP). Wastewater from the Proctors Creek WWTP is discharged to the James River through two pipes, which run along a Chesterfield County easement through Dominion property just west of the station's barge slip. The wastewater for reuse at CPS is diverted from the two discharge pipes via a pumping station located on Dominion property adjacent to the County's discharge pipes. James River water serves as a back-up water source to the FGD.

Each FGD unit requires approximately 1,400 gpm (2.016 mgd) of make-up water. The great majority of the make-up water to each FGD will be lost to the atmosphere through evaporation. Dominion may also use Proctors Creek effluent as make-up water to other plant processes that are currently supplied by water withdrawn from the James River.

Dominion currently reclaims gypsum that is suitable for use in the manufacture of commercial wallboard. The production of wallboard-quality gypsum requires the use of a high purity limestone in conjunction with a gypsum reclamation process designed to maintain a chloride concentration of less than 30,000 mg/L in the circulating FGD water system. Chloride concentration is controlled through the use of a blowdown (or purge) stream. Each FGD generates approximately 0.115 mgd that is directed to the station's FGD wastewater treatment plant (WWTP) located south of the Unit 6 FGD and just southeast of the station's fuel oil storage tank. The treated wastewater is then discharged through the new Internal Outfall 402 to the LAP.

Limestone for use in the FGD units is delivered to the station by barge. The limestone is unloaded at the station's existing barge slip and is transferred via conveyor to a covered storage area located just northwest of the station's existing fuel oil storage tank. Reclaimed gypsum is stored in a covered area located just south of the barge slip unloading area and is then loaded onto barges for delivery to a wallboard manufacturer. Reclaimed gypsum may also be placed, along with other coal combustion by-products, in the New (Upper) Ash Pond closure project at CPS.

Storm water runoff from the Unit 6 FGD site, including the limestone and gypsum storage areas and barge slip collection sump, is collected in three (3) separate yard sumps, Yard Sump #1, Yard Sump #2, and Yard Sump #3. Yard Sump #1 discharges to the FGD sump pipe which is routed to the LAP. Yard Sumps #2 and #3 and the effluent from the FGD WWTP tie into the FGD sump pipe.

The wastewater treatment and storm water management facilities associated with the FGD at CPS were described in detail in a Concept Engineering Report that was submitted to DEQ by letter dated October 23, 2007. The CER was approved by DEQ staff by letter dated March 5, 2008.

Proctors Creek Wastewater Reuse Screen Backwash

There has been some growth of algae on the discharge structure associated with the Proctors Creek WWTP and also within Dominion's sump that receives the Proctors

Creek effluent. Periodically, this algae sloughs off and clogs the strainers that are located downstream from the sump but prior to the FGD process. Historically, the station removed the material from the screens by hand (~ 1/2 of 55 gallon drum per week) but has now installed self cleaning screens, which use a backwash stream of about 180 gpm for 3 minutes and cycle at about 5 cycles per hour (~65,000 gpd). This backwash stream is routed to the Yard Sump #1.

The Old (Lower) Ash Pond will be closed in accordance with the EPA's Coal Combustion Residuals Rule and the Virginia Solid Waste Management Regulations as part of the station's conversion to a dry ash handling system. A new Low Volume Wastewater Treatment System (LVWWTS) will be constructed to replace the Old (Lower) Ash Pond for treatment of the station's low volume waste streams. The new Low Volume Wastewater and Coal Pile Treatment Systems will undergo commissioning prior to being placed into service. During commissioning, and prior to ceasing discharge through Outfall 004, either system may be discharged to the LAP until commissioning of the system is complete.

New (Upper) Ash Pond Sedimentation Basin (Outfall 005)

The New (Upper) Ash Pond (also referred to as the east ash pond) is being closed. The pond is currently being closed in accordance with the revised Ash Pond Closure Plan (September 2003), Phasing Plan (May 2003), and Construction Quality Assurance Plan (May 2003), approved by DEQ in September 2003 and amended in April 2015. An application has been submitted to DEQ for a solid waste permit to complete closure of the Upper Ash Pond (UAP) in accordance with EPA's Coal Combustion Residuals Rule and the Virginia Solid Waste Management Regulations. Closure of the Upper Ash Pond will transition from the VPDES permit to the solid waste permit in accordance with the terms of those permits.

As the UAP is closed, surface runoff is being channeled to a sedimentation basin located at the eastern end of the ash pond. This sedimentation basin discharges through the existing Outfall 005 to Farrar Gut. The retention time of the basin varies depending on the amount of rainfall that is received during a given period of time. During certain periods, the sedimentation pond may be routed to the Old (Lower) Ash Pond and discharged through existing Outfall 004 to Farrar Gut. Solids that accumulate in the basin are removed as needed and returned to the active cells associated with the UAP closure. In addition to surface runoff, the sedimentation pond also currently receives ground water collected in four (4) toe drains.

Intake Screen Backwash Discharges (Outfalls 006 – 011)

The cooling water intake structures at the CPS are equipped with trash bars, vertical traveling screens, and an intake screen backwash system (ISBS). Collectively the ISBS consists of 13 individual backwash flows (designated as Outfalls 006 – 011 in the current VPDES permit) to the main channel of the James River. Operation of the ISBS is on an "as needed" basis with the frequency of operation dependent on the amount of debris that is present in the river. Typically spring (March and April) and fall (October and November) are the periods of highest ISBS operation. During other periods of the year, the ISBS is operated approximately two hours per day.

The intake screen wash water for all units is James River water that is taken from the station's circulating water system before contact with industrial processes. Historically, chlorine was added to the circulating water system at points prior to removal of the water for use in the ISBS. As a result, monitoring data indicated that some residual chlorine was present in the ISBS discharges and, consequently, water quality-based effluent limits for total residual chlorine (TRC) were included on Outfalls 006 – 011 when the permit was reissued effective December 10, 2004. Also included in the permit was a four-year schedule requiring compliance with the TRC limits by December 10, 2008.

By letter dated June 8, 2006, Dominion submitted to DEQ a Plan of Action and Concept Engineering Report for achieving compliance with the TRC limits. The compliance method selected was to relocate the points for chlorine injection to locations downstream from where the water is withdrawn for use in the ISBS. The compliance plan was approved by DEQ on June 23, 2006, and Dominion began implementation of the plan in August 2006. Relocation of all chlorine injection points was officially completed during the fall of 2008 and there is no longer a station source of chlorine to the screen backwash discharges. Consequently, all ISBS discharges now consist of James River water that has not been contaminated by use in any plant processes, and these outfalls are being removed from the permit as part of this reissuance process.

II-B.2: Intermediate and Final Conditions

The CPS is currently undertaking an integrated ash project (IAP). The IAP is an extensive, multi-year project that is being driven by recently promulgated regulatory requirements that affect almost every aspect of how the station currently manages wastewater. The IAP includes the closure of the UAP and LAP, construction of a Fossil Fuel Combustion Product (FFCP) Management Facility, and conversion from a wet to dry ash management system. Wastewater management under the IAP involves: 1) construction of a new Low Volume Wastewater Treatment System (LVWWTS) to manage wastewaters that will remain following closure of the LAP and UAP and that will be generated by the new FFCP Management Facility; 2) management of wastewaters that will be produced during closure of the LAP and UAP; and 3) installation of a new wastewater treatment system to remove selenium from the station's FGD waste stream. The timing for construction and operation of the LVWWTS and the new FGD wastewater treatment system, as well as the process for management of wastewaters associated with the ash pond closures, was described in Dominion's May 5, 2016 VPDES permit application addendum.

II-B.2.a: Intermediate Condition

The intermediate wastewater condition represents wastewater configurations that are expected to exist during the process leading to completion of the IAP (see Intermediate Condition One-Line Diagram attached) and after cessation of discharge through Outfall 004. Wastewater sources that are expected to be discharged during the Intermediate Condition include those sources associated with the construction and operation of the new LVWWTS and FFCP Management Facility, and wastewaters that will be generated during closure of the UAP and

LAP. In addition to the existing Master Sump, FGD Yard Sump, New (Upper) Ash Pond Toe Drains, and S-Ditch pump station, the following are intermediate sources.

Low Volume Wastewater Treatment System (New Internal Outfall 301)

The LVWWTS will be constructed to manage the station's low volume wastewater streams. An equalization (EQ) basin will be constructed to receive the wastewater streams listed below and allow sufficient residence time for equalization of water quality constituents. Effluent from the EQ basin will be discharged into a new Discharge Basin. The effluent from the Discharge Basin will be discharged through a new Internal Outfall 301 via a diffuser into the Thermal Channel. The Thermal Channel will continue to discharge through the existing Outfall 003 to Farrar Gut. The approximate locations of Outfall 301 and the internal outfalls listed below are shown on Figure 3, and details will be provided in Concept Engineering Reports that will be submitted to DEQ for review and approval.

FGD Wastewater Treatment Plant (Internal Outfall 302)

The FGD WWTP will discharge through newly designated Internal Outfall 302. The outfall location will remain the same, and the discharge will still connect to the FGD Yard Sump discharge pipe; however, the outfall will discharge to the EQ basin and eventually to the Thermal Channel through Internal Outfall 301.

Metals Cleaning Waste Treatment Basin or Metals Pond (Internal Outfall 303)

The Metals Pond will discharge through newly designated Internal Outfall 303 to the EQ basin and eventually to the Thermal Channel through Internal Outfall 301.

Landfill Leachate (Internal Outfall 304)

The FFCP Management Facility (Landfill) will be constructed for the disposal of dry ash and other coal combustion residuals collected at the station. Leachate generated at the Landfill and collected by the leachate management system will be pumped to the EQ basin through a new Internal Outfall 304 and eventually discharge to the Thermal Channel through Internal Outfall 301. The approximate location of Internal Outfall 304 is shown on Figure 3. The Landfill leachate will not discharge to the EQ basin until the LVWWTS is in operation and discharging to Outfall 301.

Coal Pile Runoff Stormwater Treatment System (Internal Outfall 305)

The Coal Pile runoff will be collected in a new basin designed to manage a 25-year, 24-hour rain event. Effluent from the coal pile basin will then be directed to a new treatment system. The treatment system will discharge through a new Internal Outfall 305 to the EQ Basin and will eventually discharge to the Thermal Channel through Internal Outfall 301. The approximate location of Internal Outfall 305 is shown on Figure 3.

Landfill Contact Stormwater

During operation of the Landfill, stormwater runoff that comes into contact with coal combustion residuals will be collected in a contact stormwater basin. The basin will discharge through a pipe that will connect to the existing FGD Yard Sump discharge pipe and discharge to the EQ Basin. Prior to reaching the FGD Yard Sump pipe, the contact stormwater will combine with Fly Ash Silo stormwater runoff and wash down water described below.

Fly Ash Silo Stormwater and Wash Down Water

As part of the wet-to-dry ash management conversion, silos will be constructed to collect dry ash through a pneumatic delivery system. The fly ash will be deposited from the silos into haul trucks that will transport the ash, after being conditioned and covered, to the Landfill. Stormwater runoff collected in the fly ash silo drainage area and wash down water collected in fly ash silo area floor drains will be discharged to the EQ basin through a pipe that combines with the Landfill Contact Stormwater and eventually with the FGD Yard Sump pipe.

LAP Toe Drain

During closure of the LAP, a new toe drain will be created and will be directed to the EQ Basin. The toe drain will serve as a concentrated water collection system along the toe of the LAP's western embankment slope.

UAP Toe Drains

The existing UAP toe drains will be directed to the EQ Basin.

Bottom Ash Management Area Truck Wash

A truck wash is located adjacent to the closed loop bottom ash management system. Occasionally, the truck wash water will be discharged to the EQ Basin.

Lower and Upper Ash Pond Dewatering Treatment System (Internal Outfall 101/201)

As previously noted, both the Lower and Upper Ash Ponds will undergo closure to comply with EPA's Coal Combustion Residuals Rule and the Virginia Solid Waste Management Regulations. As part of the closure process, both the LAP and the UAP sedimentation basin will be dewatered to allow for the construction of subgrade to support the installation of the final cover system. The dewatering discharge from both the LAP and the UAP sedimentation basin will be treated at a Centralized Source Water Treatment System (CSWTS) that will discharge treated effluent through a new Internal Outfall 101. The approximate location of Internal Outfall 101 is shown on Figure 3. The treated effluent from Internal Outfall 101 will be discharged through existing Outfall 001 or 002 into the James River.

II-B.2.b: Final Condition

The final wastewater condition represents wastewater configurations that are expected to exist following completion of the IAP. Final Condition sources will include a new FGD wastewater treatment system, with removal of the ash pond dewatering system outfalls and the ash pond discharge outfalls. Other than the changes described below, the sources described in II-B.1 and II-B.2 remain the same.

FGD Wastewater Treatment Plant (Internal Outfall 302)

In order to achieve compliance with the Steam Electric Effluent Limitation Guidelines (ELG) limit for selenium, a selenium treatment system will be added to the existing FGD WWTP. The selenium treatment system and possible modifications to the existing FGD WWTP, as well as the final location of Internal Outfall 302, will be described in a Concept Engineering Report that will be submitted to DEQ for review and approval.

Removal of Ash Pond Dewatering Systems (Internal Outfall 101/201)

Once contact stormwater is no longer generated at either the Upper or Lower Ash Ponds, the CSWTS will cease treatment and be decommissioned. Outfall 101/201 will be removed, and treated effluent from the CSWTS will no longer discharge through Outfall 001 or 002.

Removal of Lower Ash Pond (Outfall 004)

During the LAP closure process, a stormwater management basin will be constructed to manage non-contact stormwater runoff. The basin will be activated once dewatering is complete and contact stormwater is no longer generated. At this point, Outfall 004 will be removed.

Removal of Upper Ash Pond (Outfall 005)

The UAP sedimentation basin will be filled and capped as one of the last closure tasks. Once contact stormwater is no longer generated, Outfall 005 will be removed.

ITEM II-C: INTERMITTENT AND/OR SEASONAL DISCHARGES

New (Upper) Ash Pond Sedimentation Basin (Outfall 005)

The UAP sedimentation basin associated with Outfall 005 is typically only discharged during two or three months out of the year, and the duration of each discharge is usually less than 5 days. The sedimentation basin will be closed as part the New (Upper) Pond closure.

Metals Cleaning Waste Treatment Basin or Metals Pond (Internal Outfall 401/303)

The Metals Cleaning Waste Treatment Basin is a batch operated system, which is designed for non-seasonal, intermittent use. Operations that contribute flows to the basin are shown on the

one-line drawings and as described in the narrative under Item 2-B.1 above. Typically, the valve is opened to begin the discharge and is not closed again until the pond is drained. A typical, average discharge flow is approximately 3 mgd. The pond level at the start of a discharge is not consistent from discharge to discharge and, therefore, the total volume discharged from the metals pond during any single discharge event can vary substantially depending on the volume present in the pond prior to discharge.

Landfill Leachate (Internal Outfall 304)

The leachate removal system for management of leachate at the FFCP Management Facility (Landfill) is designed to discharge leachate from a pump station when the liquid level within the pump station reaches a set liquid level. Influent into the pump station will occur when leachate is removed from sumps located within the Landfill footprint. During dry periods, the discharge from the Landfill will likely be intermittent. During wet periods, the maximum discharge of leachate is anticipated to be 0.19 mgd. The actual discharge volume will vary considerably based on weather conditions.

Outfall 305 (Coal Pile Discharge)

The coal pile discharge basin is designed to manage a 25-year, 24-hour storm event, and stormwater runoff from the coal pile is the only input to the basin and treatment system. Discharge from the treatment system is generally expected to occur during a precipitation event and shortly thereafter. During dry periods, discharge from the coal pile basin and treatment system will either be significantly reduced or it will cease until the next precipitation event. The actual discharge volume will vary considerably based on weather conditions.

ITEM IV-A: IMPROVEMENTS

FFCP Management Facility

The FFCP Management Facility (Landfill) is located on a parcel adjacent to and northwest of the CPS. The Landfill will be constructed with a composite geosynthetic base liner system, including leachate collection, and will be managed with a system consisting of permeable drainage material and piping. The piping will collect leachate and direct it to a pump station which ultimately discharges as described in II-B.2. Contact stormwater will be managed as described in II-B.2.

Wet-to-Dry Ash Management Conversion

The wet-to-dry ash conversion is designed to manage fly ash as a dry material rather than as a sluiced material. Fly ash will be blown from the collection area into storage silos. From the storage silos, ash will be moisturized and loaded into haul trucks that will carry the ash to the FFCP Management Facility. Stormwater runoff collected in and around the fly ash silo storage area, and water collected in the fly ash silo area floor drains, will be managed as described in II-B.2.

The wet-to-dry ash conversion also includes the construction of a closed loop bottom ash management system. Bottom ash will be conveyed from the station to a bottom ash management area utilizing a remote flight conveyor system to separate the coarse bottom ash from water. A mechanical system will remove bottom ash solids from the water prior to the water being recirculated back to the station. The bottom ash management area will include an impermeable pad on which bottom ash will be stacked for management. Storm water runoff, water from the stacked bottom ash that collects on the pad, and bottom ash blowdown from occasional maintenance will be collected and discharged to the LVWWTS.

Upper Ash Pond Closure (Outfall 005)

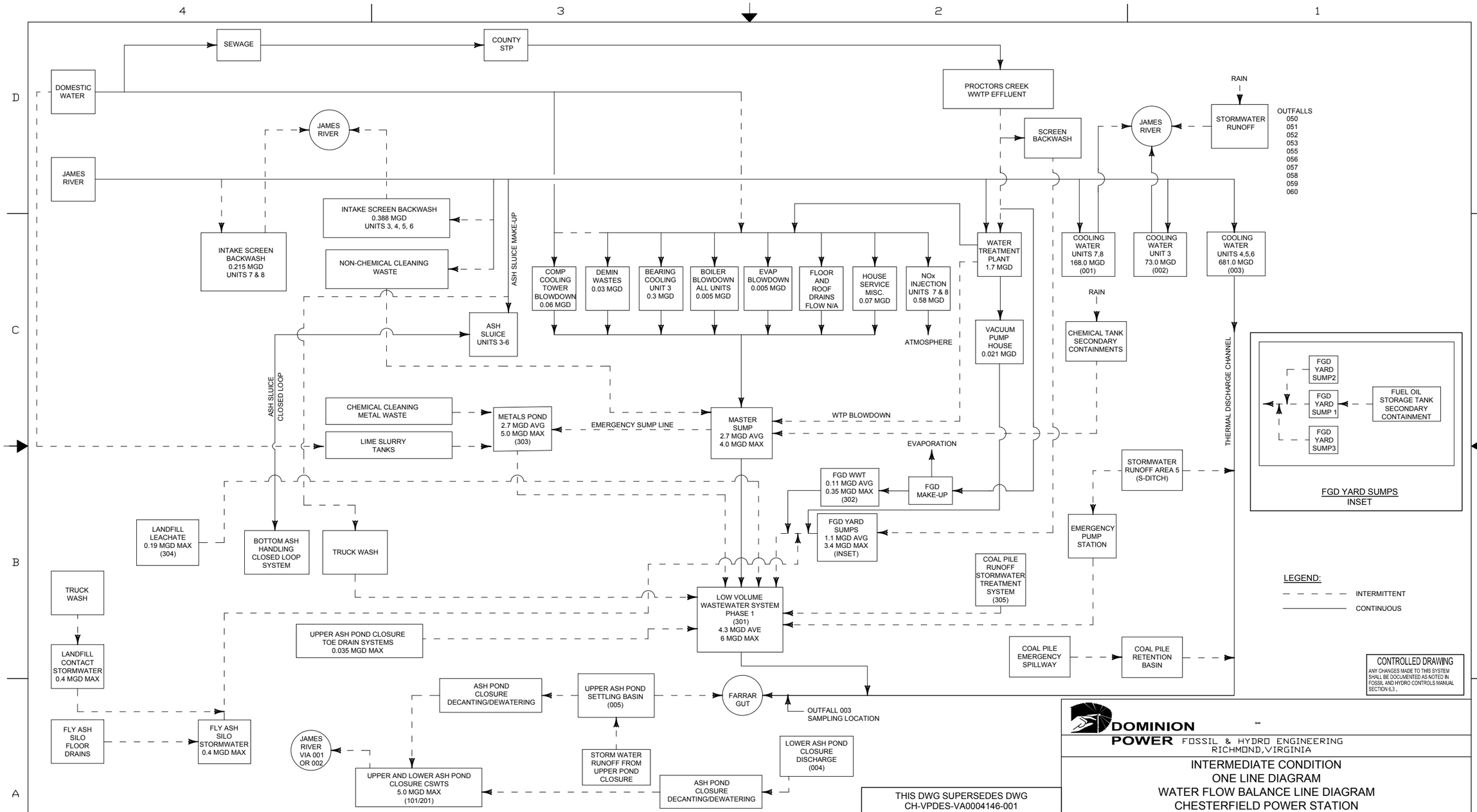
The closure of the UAP is an ongoing activity. The UAP will be closed in accordance with the EPA's Coal Combustion Residuals Rule and the Virginia Solid Waste Management Regulations. UAP toe drains will discharge as described in II-B.2. The final closure of the UAP will lead to the removal of Outfall 005 as described in II-B.2.b.

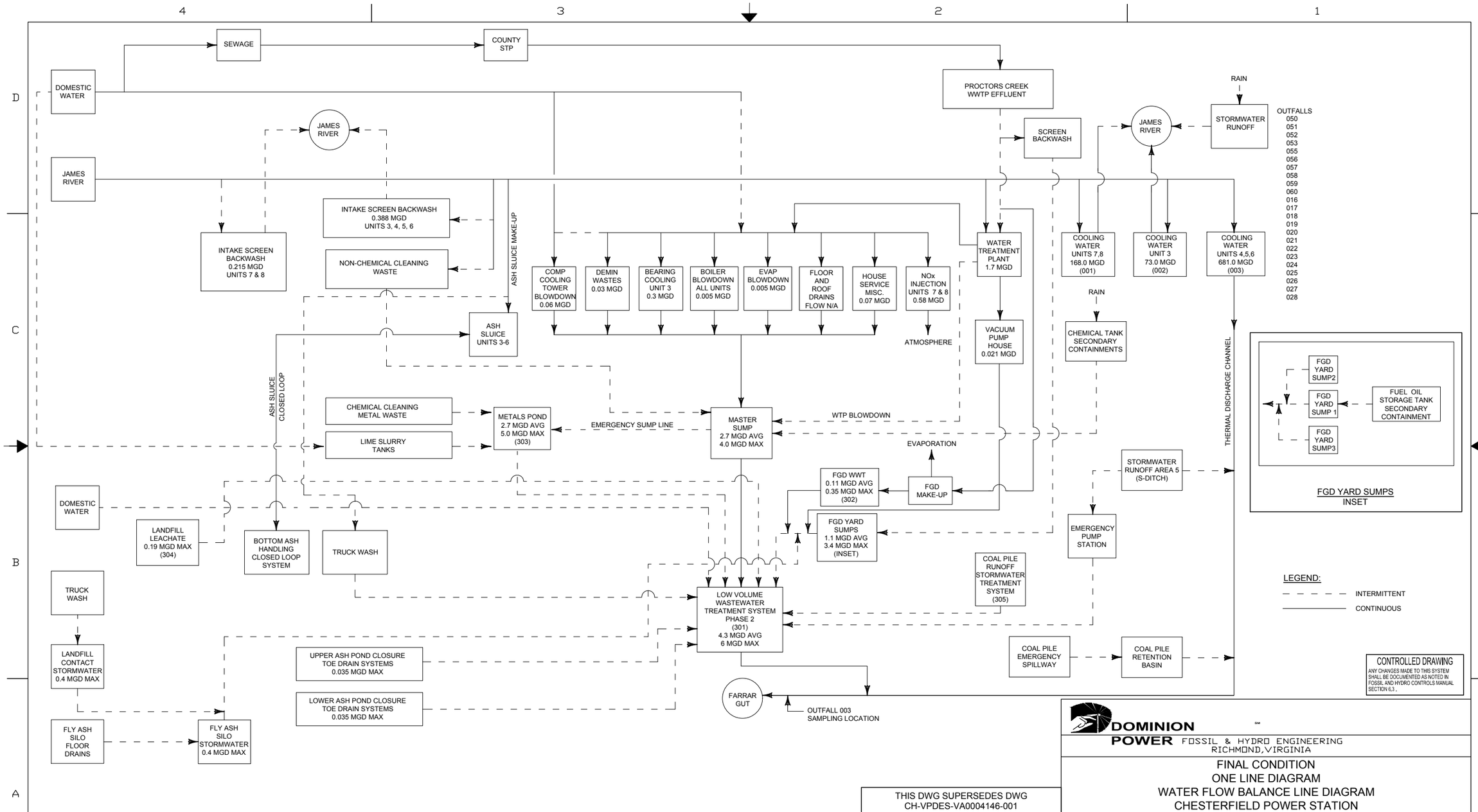
Lower Ash Pond Closure (Outfall 004)

The LAP currently receives sluiced fly ash and bottom ash from the station. The LAP also receives multiple low-volume wastewater streams associated with station operations, as well as storm water runoff. The LAP discharges by gravity through an engineered riser structure located in the southwestern corner of the facility, which is also the location of existing Outfall 004. The LAP will be closed in accordance with the EPA's Coal Combustion Residuals Rule and the Virginia Solid Waste Management Regulations as part of the station's conversion to a dry ash management system. The toe drain system will discharge as described in II-B.2. The final closure of the LAP will lead to the removal of Outfall 004 as described in II-B.2.b.

Low Volume Wastewater Treatment System (Internal Outfall 301)

The LVWWTS will be designed to manage the low volume waste streams described in II-B for Outfall 301. The LVWWTS will be implemented in a phased approach. The various components of the final LVWWTS will be described in Concept Engineering Reports to be submitted to DEQ for review and approval prior to their installation.


SEWAGE
COUNTY STP
DOMESTIC WATER
PROCTORS CREEK WWTP EFFLUENT
RAIN
STORMWATER RUNOFF
OUTFALLS
050
051
052
053
055
056
057
058
059
060
JAMES RIVER
SCREEN BACKWASH
JAMES RIVER
JAMES RIVER
INTAKE SCREEN BACKWASH 0.388 MGD UNITS 3, 4, 5, 6
INTAKE SCREEN BACKWASH 0.215 MGD UNITS 7 & 8
NON-CHEMICAL CLEANING WASTE
ASH SLUICE MAKE-UP
COMP COOLING TOWER BLOWDOWN 0.06 MGD
DEMIN WASTES 0.03 MGD
BEARING COOLING UNIT 3 0.3 MGD
BOILER BLOWDOWN ALL UNITS 0.005 MGD
EVAP BLOWDOWN 0.005 MGD
FLOOR AND ROOF DRAINS FLOW N/A
HOUSE SERVICE MISC. 0.07 MGD
NOx INJECTION UNITS 7 & 8 0.58 MGD
ATMOSPHERE
WATER TREATMENT PLANT 1.7 MGD
COOLING WATER UNITS 7,8 168.0 MGD (001)
COOLING WATER UNIT 3 73.0 MGD (002)
COOLING WATER UNITS 4,5,6 681.0 MGD (003)
RAIN
ASH SLUICE UNITS 3-6
VACUUM PUMP HOUSE 0.021 MGD
CHEMICAL TANK SECONDARY CONTAINMENTS
THERMAL DISCHARGE CHANNEL
ASH SLUICE CLOSED LOOP
CHEMICAL CLEANING METAL WASTE
METALS POND 2.7 MGD AVG 5.0 MGD MAX (303)
EMERGENCY SUMP LINE
MASTER SUMP 2.7 MGD AVG 4.0 MGD MAX
WTP BLOWDOWN
LIME SLURRY TANKS
EVAPORATION
FGD YARD SUMP2
FGD YARD SUMP 1
FGD YARD SUMP3
FUEL OIL STORAGE TANK SECONDARY CONTAINMENT
FGD YARD SUMPS INSET
STORMWATER RUNOFF AREA 5 (S-DITCH)
FGD WWT 0.11 MGD AVG 0.35 MGD MAX (302)
FGD MAKE-UP
FGD YARD SUMPS 1.1 MGD AVG 3.4 MGD MAX (INSET)
EMERGENCY PUMP STATION
LANDFILL LEACHATE 0.19 MGD MAX (304)
BOTTOM ASH HANDLING CLOSED LOOP SYSTEM
TRUCK WASH
COAL PILE RUNOFF STORMWATER TREATMENT SYSTEM (305)
TRUCK WASH
LOW VOLUME WASTEWATER SYSTEM PHASE 1 (301) 4.3 MGD AVE 6 MGD MAX
LEGEND:
INTERMITTENT
CONTINUOUS
UPPER ASH POND CLOSURE TOE DRAIN SYSTEMS 0.035 MGD MAX
COAL PILE EMERGENCY SPILLWAY
COAL PILE RETENTION BASIN
LANDFILL CONTACT STORMWATER 0.4 MGD MAX
CONTROLLED DRAWING
ANY CHANGES MADE TO THIS SYSTEM SHALL BE DOCUMENTED AS NOTED IN FOSSIL AND HYDRO CONTROLS MANUAL SECTION 6.3 .
ASH POND CLOSURE DECANTING/DEWATERING
UPPER ASH POND SETTLING BASIN (005)
FARRAR GUT
OUTFALL 003 SAMPLING LOCATION
FLY ASH SILO FLOOR DRAINS
FLY ASH SILO STORMWATER 0.4 MGD MAX
JAMES RIVER VIA 001 OR 002
STORM WATER RUNOFF FROM UPPER POND CLOSURE
LOWER ASH POND CLOSURE DISCHARGE (004)
UPPER AND LOWER ASH POND CLOSURE CSWTS 5.0 MGD MAX (101/201)
ASH POND CLOSURE DECANTING/DEWATERING
THIS DWG SUPERSEDES DWG CH-VPDES-VA0004146-001
DOMINION POWER
FOSSIL & HYDRO ENGINEERING
RICHMOND, VIRGINIA
INTERMEDIATE CONDITION
ONE LINE DIAGRAM
WATER FLOW BALANCE LINE DIAGRAM
CHESTERFIELD POWER STATION
3 LVWWTS REVISIONS
2 LVWWTS ADDITION
1 REVISED TO SHOW ENVIRONMENTAL REDLINE.
0 ORIGINAL ISSUE. CONVERTED TO ACAD 600 SERIES DRAWING.
DSGN
DRWN
CHKD
DSGN SUPV
ENGR SUPV
PROJ ENGR
DRAWING NO.
CH-0-SP-STA-600
REV.
SCALE
UNLESS OTHERWISE NOTED
SH
OF



DOMINION POWER FOSSIL & HYDRO ENGINEERING
RICHMOND, VIRGINIA

FINAL CONDITION
ONE LINE DIAGRAM
WATER FLOW BALANCE LINE DIAGRAM
CHESTERFIELD POWER STATION

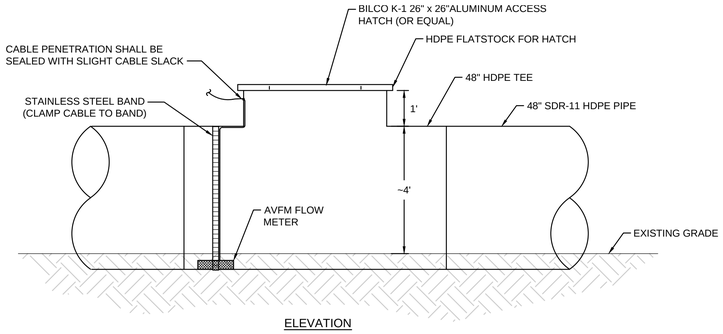
THIS DWG SUPERSEDES DWG CH-VPDES-VA0004146-001

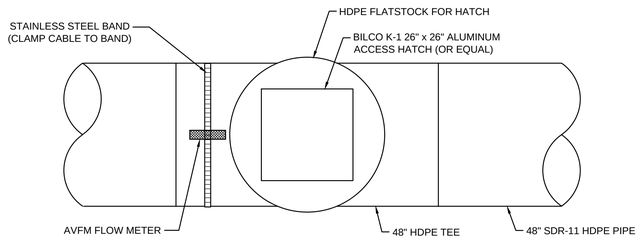
REV	DATE	DSGN	DRWN	CHKD	DSGN SUPV	PROJ ENGR	CIVIL ENGR	ELEC ENGR	MECH ENGR	ARCH	E.M. ENGR	I&C ENGR	DESCRIPTION
3	04-24 16		TAW	KEL	SKS								LVWWTS REVISIONS
2	06-24 15		KRP	KEL	SKS								LVWWTS ADDITION
1	03-04 15		CLW	RAW	RWM								REVISED TO SHOW ENVIRONMENTAL REDLINE.
0	12-30 10		KTC	RAW	RWM								ORIGINAL ISSUE. CONVERTED TO ACAD 600 SERIES DRAWING.

DSGN | DSGN SUPV | DRWN | ENGR SUPV | CHKD | PROJ ENGR | DISPL ENGR | SCALE | UNLESS OTHERWISE NOTED

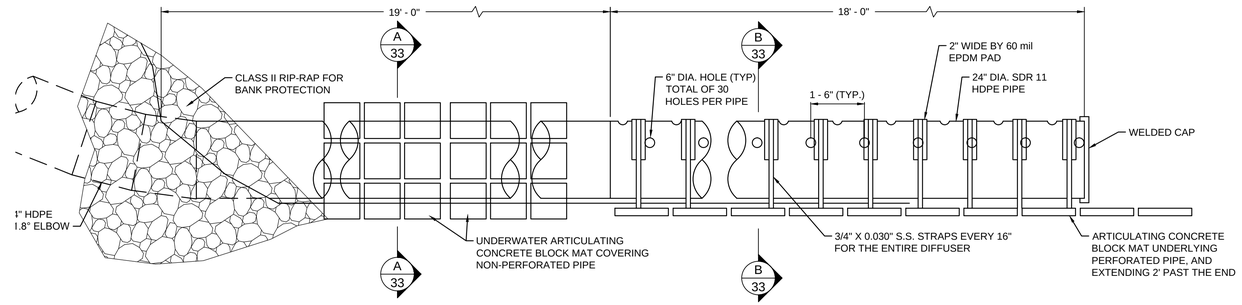
DRAWING NO. CH-0-SP-STA-601 REV.

SH OF

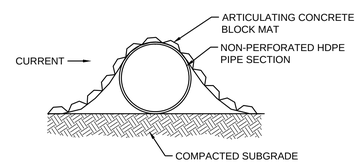




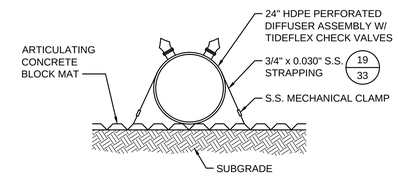
15/33 DETAIL
SAMPLING AND METER ACCESS
SCALE: 1"=2'
XREF: 1222xDTL_SAMPLE-METER ACCESS



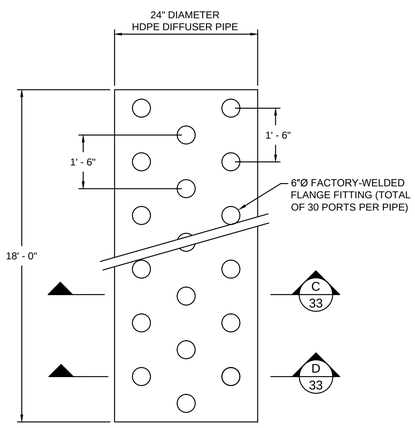
16/33 DETAIL
STORAGE BASIN - DISCHARGE DIFFUSER
SCALE: 1"=1'
XREF: 1222xDTL_SB BASIN DISCHARGE DIFFUSER



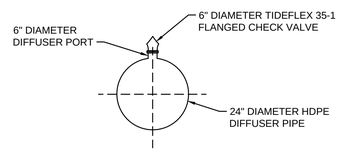
A/33 SECTION
SCALE: 1"=1'
XREF: 1222xDTL_SB BASIN DISCHARGE DIFFUSER



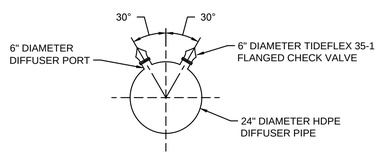
B/33 SECTION
SCALE: 1"=1'
XREF: 1222xDTL_SB BASIN DISCHARGE DIFFUSER



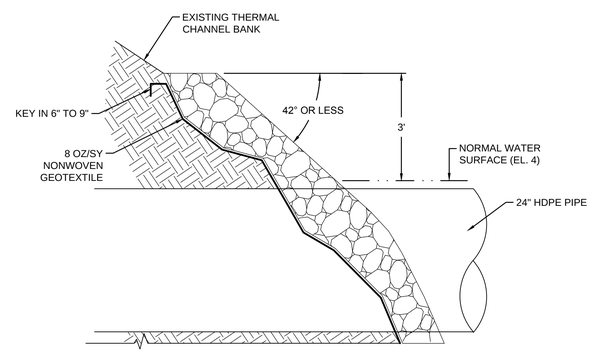
17/33 DETAIL
STORAGE BASIN - DISCHARGE DIFFUSER
SCALE: NTS
XREF: 1222xDTL_SB BASIN DISCHARGE DIFFUSER PLAN



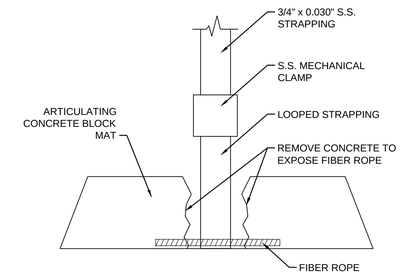
C/33 SECTION
SCALE: 1"=2'
XREF: 1222xDTL_SB BASIN DISCHARGE DIFFUSER PLAN



D/33 SECTION
SCALE: 1"=2'
XREF: 1222xDTL_SB BASIN DISCHARGE DIFFUSER PLAN



18/33 DETAIL
RIP RAP BANK PROTECTION
SCALE: 1"=2'
XREF: 1222xDTL_RIP RAP BANK PROTECTION



19/33 DETAIL
STAINLESS STEEL STRAPPING DETAIL
SCALE: 1"=1'
XREF: 1222xDTL_STAINLESS STEEL STRAPPING

BID SET ONLY
NOT FOR CONSTRUCTION

SITE PLAN #

Geosyntec consultants
9211 ARBORETUM PARKWAY, SUITE 200
RICHMOND, VA 23236 USA
PHONE: 804.767.2206

DOMINION℠
POWER GENERATION ENGINEERING
RICHMOND, VIRGINIA

DIFFUSER SYSTEM DETAILS

LOW VOLUME WASTEWATER TREATMENT SYSTEM
CHESTERFIELD POWER STATION

REV	DATE	DSGN	DRWN	CHKD	DSGN SUPV	PROJ ENGR	CIVIL ENGR	ELEC ENGR	MECH ENGR	ARCH	E.M. ENGR	I&C ENGR
0	11-13 2015		KRP	SKS		CMC	KEL					

ISSUED FOR BID

DSGN KEL	DSGN SUPV SKS		
DRWN KRP	ENGR SUPV -	DRAWING NUMBER	REV. 0
CHKD SKS	PROJ ENGR -		
DISPL ENGR KMH	SCALE: AS NOTED	UNLESS OTHERWISE NOTED	SH 33 OF

L:\DOMINION\CHESTERFIELD POWER STATION\LOW VOLUME WASTEWATER SYSTEM\V1222\PERMIT\DRAWINGS\PLANS\1222-027_28_29_33.DWG-11/13/2015-1:47:31 PM-Kalina Powell

Low Volume Wastewater Treatment System (LVWWTS)
Phased Compliance and Design Narrative

On July 20, 2015, Dominion submitted an application to address changes in wastewater management at the Chesterfield Power Station that were anticipated as a result of the Station's integrated ash project (IAP), as described below. This application addendum is intended to supplement our earlier application in order to reflect changes to previously proposed wastewater management processes that are necessary given recent regulatory developments.

The IAP is an extensive, multiyear project that is being driven by recently promulgated regulatory requirements that affect almost every aspect of how the Station currently manages wastewaters. The IAP includes the closure of the Lower Ash Pond (LAP) and the Upper Ash Pond (UAP), construction of a Fossil Fuel Combustion Product (FFCP) Management Facility, conversion from a wet to dry ash management system, installation of a new Low Volume Wastewater Treatment System (LVWWTS), and installation of a new wastewater treatment system to remove selenium from the Station's Flue Gas Desulfurization (FGD) waste stream. Closure of the LAP during the conversion from a wet to a dry ash management system will require an alternative process for the management of many wastewaters that are currently directed to the LAP. In addition, operation of the FFCP Management Facility will generate new waste streams that must be effectively managed, and substantial effort will be needed to select, design, construct, and commission new technologies that will be needed in order to comply with stringent technology-based limits on the FGD waste stream.

Following is a description of Dominion's phased strategy that will be implemented as part of the IAP to ensure compliance with the Virginia Pollutant Discharge Elimination System (VPDES) permit, including limits and conditions necessary to implement EPA's revised Steam Electric Power Generating Effluent Guidelines (ELG) for the discharge of low volume wastewater, landfill leachate, FGD wastewater treatment plant (WWTP) effluent, and coal pile runoff from the Chesterfield Power Station. The new LVWWTS will be used to collectively treat these wastewaters. A brief description of each effluent source to the LVWWTS and the effluent discharge location is provided below followed by a discussion of each phase. The project phasing is shown graphically in the diagrams provided in Attachment 1 and a Gantt chart schedule with anticipated milestones in Attachment 2. Lastly, a description of the LVWWTS design flow restrictions is provided.

LVWWTS EFFLUENT SOURCES AND OUTFALLS

As an initial step in the IAP, three new wastewater basins, an equalization (EQ) storage basin, a discharge basin, and a coal pile basin, will be constructed. With the exception of ash sluice water, all effluent sources that currently discharge to the LAP, as well as leachate and contact stormwater from the FFCP Management Facility and stormwater runoff from the fly ash silo storage area, will be routed for treatment through the LVWWTS and proposed internal Outfall 301. These wastewaters are listed below. The listed effluent sources correspond to those shown in the phase diagrams.

1. Coal pile runoff will discharge into a newly constructed coal pile basin and coal pile metals treatment system before discharging through a new internal outfall to the EQ basin and eventually internal Outfall 301.
2. The master sump will discharge directly to the EQ basin and eventually internal Outfall 301.
3. The emergency sump will discharge directly to the EQ basin and eventually internal Outfall 301.

4. The metals pond will discharge through internal Outfall 303 directly to the EQ basin and eventually internal Outfall 301.
5. The Lower Ash Pond toe drain will discharge directly to the EQ basin and eventually internal Outfall 301.
6. The Upper Ash Pond toe drain will discharge directly to the EQ basin and eventually internal Outfall 301.
7. The S-ditch stormwater overflow will discharge directly to the EQ basin and eventually internal Outfall 301.
8. FGD WWTP effluent will discharge through internal Outfall 302. From the internal outfall, it will discharge to the EQ basin and eventually internal Outfall 301. In Phase 3, selenium treatment will be added to the FGD WWTP.
9. FGD yard sumps will discharge directly to the EQ basin and eventually internal Outfall 301.
10. Landfill leachate from the FFCP Management Facility will be collected and discharged through a pipe that will tie into the FGD yard sump discharge pipe prior to discharge into the EQ basin.
11. Landfill contact stormwater will be collected and discharged through a pipe that will tie into the FGD yard sump discharge pipe prior to discharge into the EQ basin.
12. Fly ash silo area stormwater runoff will be collected and discharged through a pipe that will tie into the landfill contact stormwater discharge, which subsequently ties into the FGD yard sump discharge pipe prior to discharge into the EQ basin.

Updated one-line drawings showing proposed routing of wastewater and stormwater flows for the Station in intermediate and final time frames are provided in Attachment 3.

COMPLIANCE SEQUENCING

The compliance sequencing is broken into three phases described in more detail below. The first phase includes development of three basins to provide equalization of discharge streams for flow control, Total Suspended Solids (TSS) and pH treatment, and the ability to conduct representative treatability analyses. The second phase includes implementation of a metals treatment system for coal pile runoff and a possible metals polishing treatment system to treat the discharge between the EQ basin and the discharge basin. The third phase includes completion of the development, construction, and commissioning of the selenium treatment system for the FGD wastewater. Additional detail for each phase is presented below.

Phase 1

The initial phase of the LVWWTS construction will include construction of three basins: coal pile basin, EQ basin, and discharge basin. The basins will be constructed with both a wet volume and a dry volume storage for solids settling, as needed. The wet volume storage provides a continual pool of water to facilitate settling of suspended solids in the effluent. The dry volume storage provides storage of effluent sufficient to contain at least a 25-year, 24-hour storm event.

The coal pile basin will collect runoff from the coal pile and subsequently feed into the metals treatment system described below in Phase 2. The EQ basin will collect the low volume wastewater discharges as described above, with the exception of the coal pile runoff. For an initial intermediate period, the coal pile basin discharge will be directed to the LAP for the purposes of startup and commissioning. The purpose of the EQ basin is to provide moderation of the flows and water quality of the effluent waste streams, which is critical to efficient and reliable treatment of the combined waste streams to the required limits.

The EQ basin will be directed to the discharge basin. The purpose of the discharge basin is to maintain, in conjunction with the EQ basin, a flow below the maximum discharge rate. In addition, the discharge basin allows for the assimilation of treated effluent prior to discharge through internal Outfall 301 to ensure the permit limits are achieved. During commissioning of the Phase 1 systems, temporary connections between the EQ basin and the LAP will allow for the treated effluent from the EQ basin to discharge to the LAP, as needed. Phase 1 is estimated to be complete during Fall 2017.

Phase 2

Phase 2 consists of the design, construction, and commissioning of a coal pile runoff metals treatment system and a polishing metals treatment system, if needed, between the EQ basin and the discharge basin. A metals treatment system will be designed to reduce the concentration of metals within the coal pile runoff. The effluent from this system will be directed to the EQ basin constructed in Phase 1 through a new internal outfall. The design of the coal pile runoff metals treatment system and the location of the new internal outfall for the system will be provided in a Conceptual Engineering Report (CER) that will be prepared and submitted to DEQ.

In addition to the coal pile runoff treatment system, Phase 2 consists of the design and construction of a polishing metals treatment system, if needed, between the EQ basin and the discharge basin. After the coal pile runoff treatment system is commissioned, a treatability study will be conducted on the effluent from the EQ basin to determine if additional metals treatment is required to meet the final permit limits for internal Outfall 301. If required, the polishing metals treatment system will be designed to ensure compliance with the final discharge limits.

Phase 3

Phase 3 includes the construction and commissioning of the selenium removal system at the FGD WWTP. A treatability study will be conducted and a CER prepared and submitted to DEQ for review. The selenium treatment system will be constructed and commissioned by Spring 2022. Dominion's justification for the proposed date for applicability of the FGD ELGs was provided to DEQ by email on January 5, 2016 and is included as Attachment 4.

FLOW RESTRICTIONS

The design of the LVWWTS includes three flow restrictions that are described below.

- The LVWWTS will be designed to discharge no more than 6 million gallons per day (MGD). A maximum flow through the LVWWTS during a 25-year, 24-hour storm event is estimated to be 13.7 MGD. In order to maintain a flow below the maximum discharge rate, a minimum equalization volume of approximately 8 million gallons will be required to store the excess effluent volume from one day of maximum flow and allow for discharge of flows below 6 MGD. The LVWWTS will provide sufficient storage volume during maximum flow events through the use of the EQ basin and discharge basin described above.
- Internal Outfall 301 is a diffuser located in the thermal channel, and the thermal channel flow will be maintained at a minimum of 57.28 MGD. A narrative describing the minimum circulating water flow is provided in Attachment 5.
- Dominion will maintain zero discharge from Outfall 301 during periods when the thermal channel flows are less than 57.28 MGD. While these instances are very rare, the LVWWTS will be designed to provide sufficient storage in a zero discharge event.

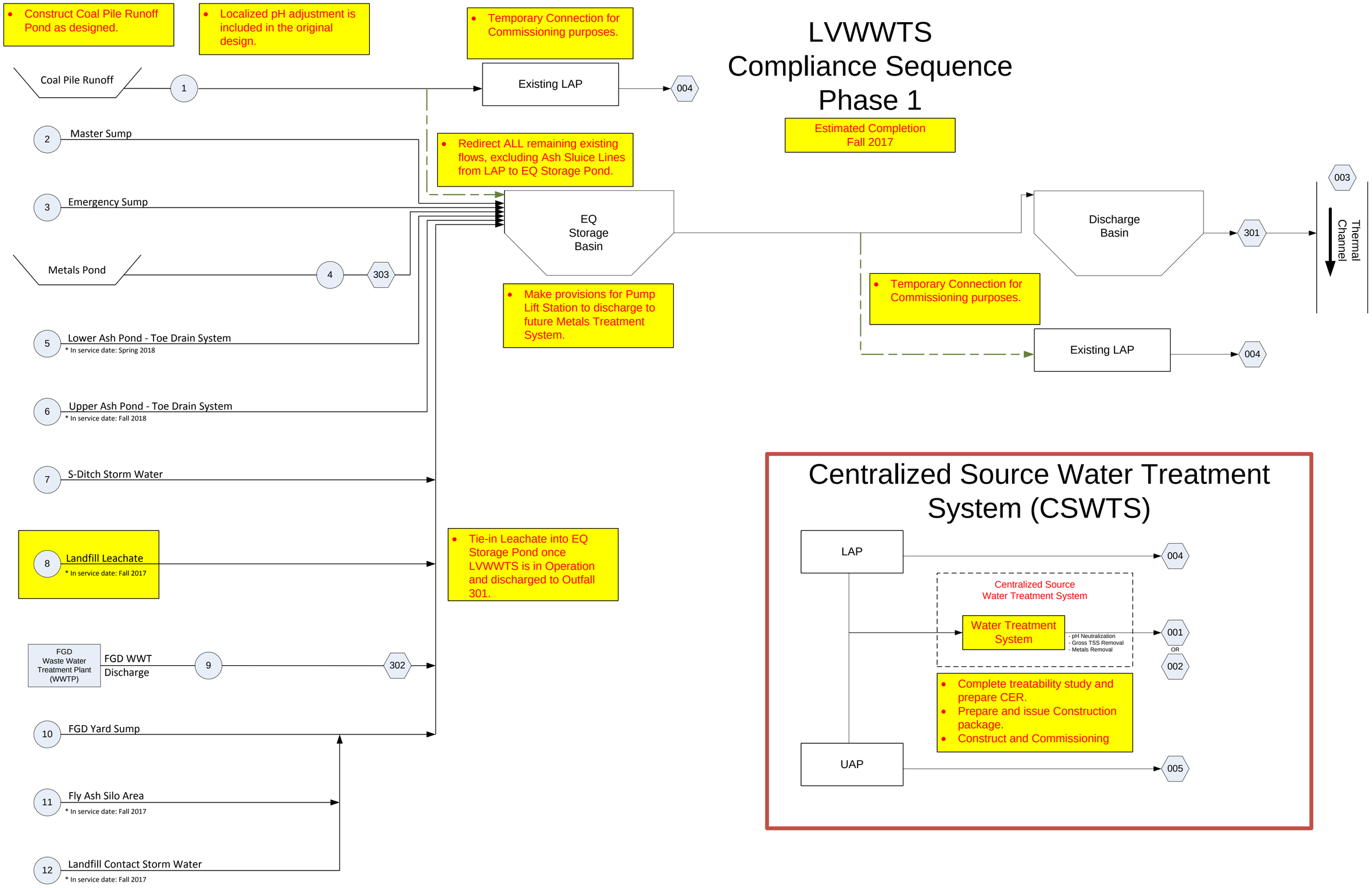
Compliance Sequence Phase Diagrams

LEGEND

Temporary Connection for Testing and Commissioning

LVWWTS Compliance Sequence Phase 1

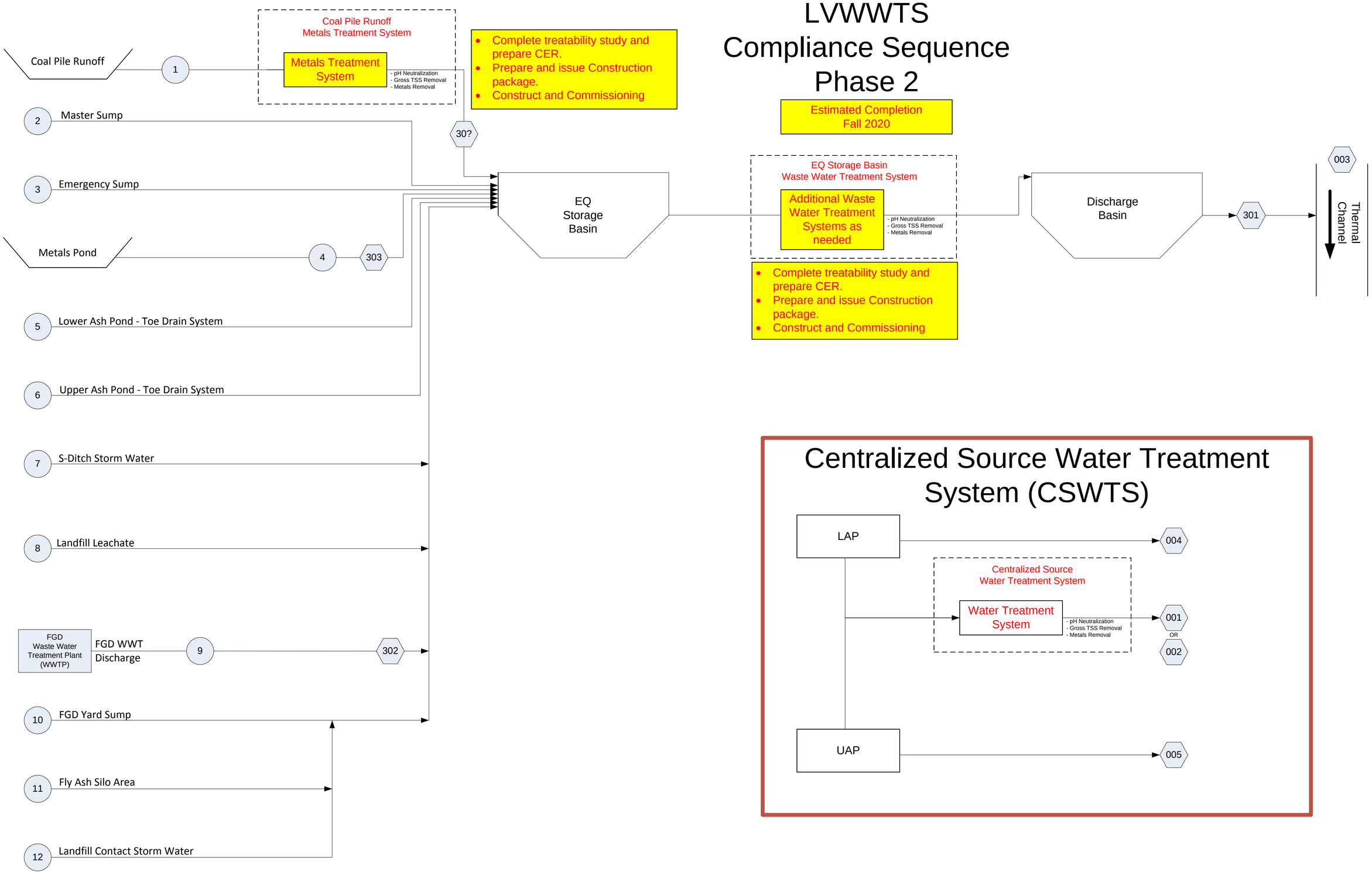
Estimated Completion Fall 2017



Centralized Source Water Treatment System (CSWTS)

Dominion	VIRGINIA ELECTRIC & POWER COMPANY DOMINION VIRGINIA POWER			
	CHIAP LVWWTS – CSWTS – FGD WWTP Compliance Sequence – Phase 1			
DRAWN BY: CHRIS NUNN	SIZE	PROJECT NO. CHIAP	DRAWING NUMBER LVWWTS-CSWTS-FGD WWTP-Phase 1	REV 0
ISSUED: 05/03/2016	SCALE NONE		SHEET 1 OF 3	

LVWWTS Compliance Sequence Phase 2

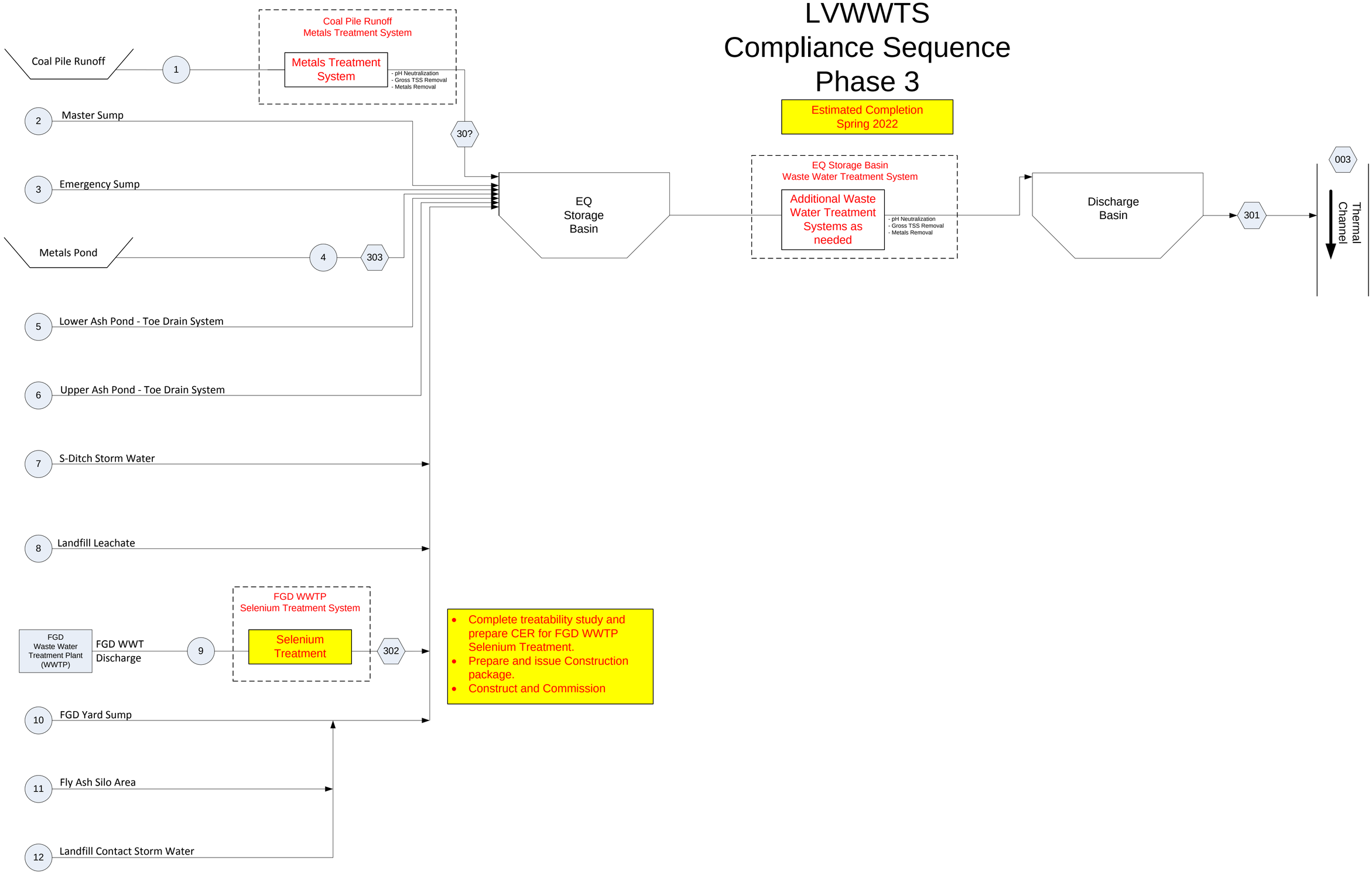


Centralized Source Water Treatment System (CSWTS)

Dominion	VIRGINIA ELECTRIC & POWER COMPANY DOMINION VIRGINIA POWER			
	CHIAP LVWWTS – CSWTS – FGD WWTP Compliance Sequence – Phase 2			
DRAWN BY: CHRIS NUNN	SIZE	PROJECT NO. CHIAP	DRAWING NUMBER LVWWTS-CSWTS-FGD WWTP-Phase 2	REV 0
ISSUED: 05/03/2016	SCALE NONE		SHEET 2 OF 3	

LVWWTS
Compliance Sequence
Phase 3

Estimated Completion
Spring 2022



- Complete treatability study and prepare CER for FGD WWTP Selenium Treatment.
- Prepare and issue Construction package.
- Construct and Commission

Dominion	VIRGINIA ELECTRIC & POWER COMPANY DOMINION VIRGINIA POWER			
	CHIAP LVWWTS – CSWTS – FGD WWTP Compliance Sequence – Phase 3			
DRAWN BY: CHRIS NUNN	SIZE	PROJECT NO. CHIAP	DRAWING NUMBER LVWWTS-CSWTS-FGD WWTP-Phase 3	REV 0
ISSUED: 05/03/2016	SCALE NONE		SHEET 3 OF 3	

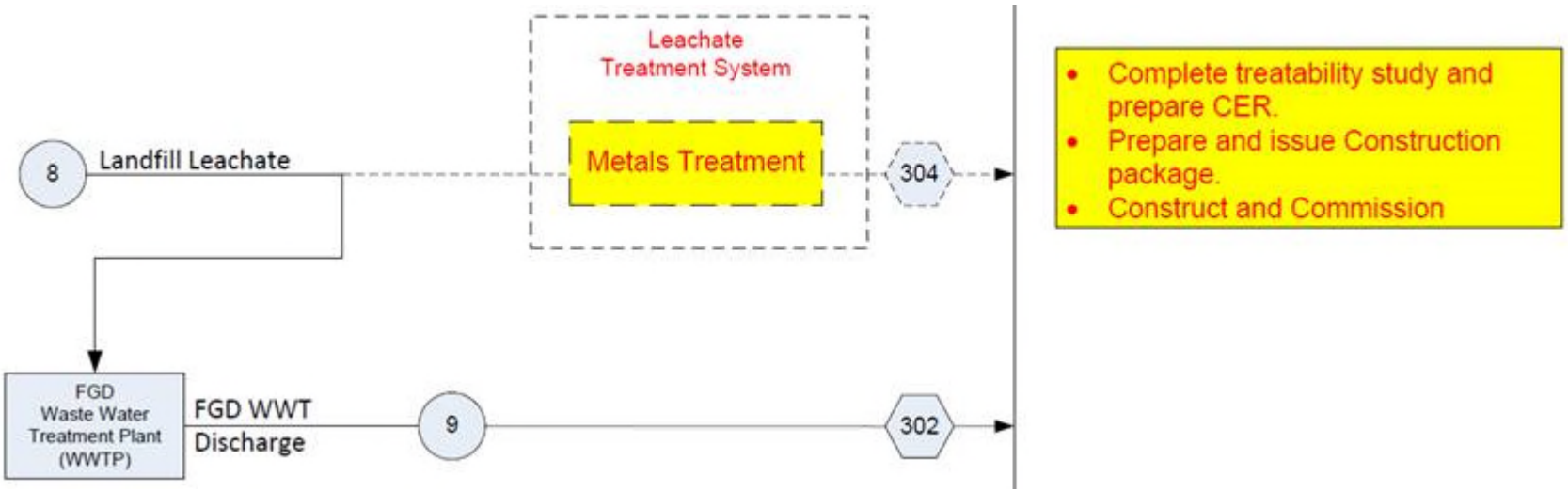
Bryan, Joseph (DEQ)

From: Kenneth Roller (Services - 6) <kenneth.roller@dom.com>
Sent: Thursday, June 02, 2016 4:14 PM
To: Adamson, Emilee (DEQ)
Cc: Bryan, Joseph (DEQ)
Subject: Gantt Chart for Landfill Leachate
Attachments: CHIAP - FFCP Leachate Treatment - Gantt Chart - Rev 0.pdf

Emilee,

Attached is the Gantt Chart for the Landfill Leachate Treatment System. Dominion currently plans to route the wastewater to the FGD WWTP. The effectiveness of the existing FGD WWTP to remove arsenic and mercury will then be evaluated. Following the evaluation, a decision will be made concerning the need for a separate metals treatment facility for the leachate. This process is shown in the diagram below.

Please let me know if you have any questions concerning this information.



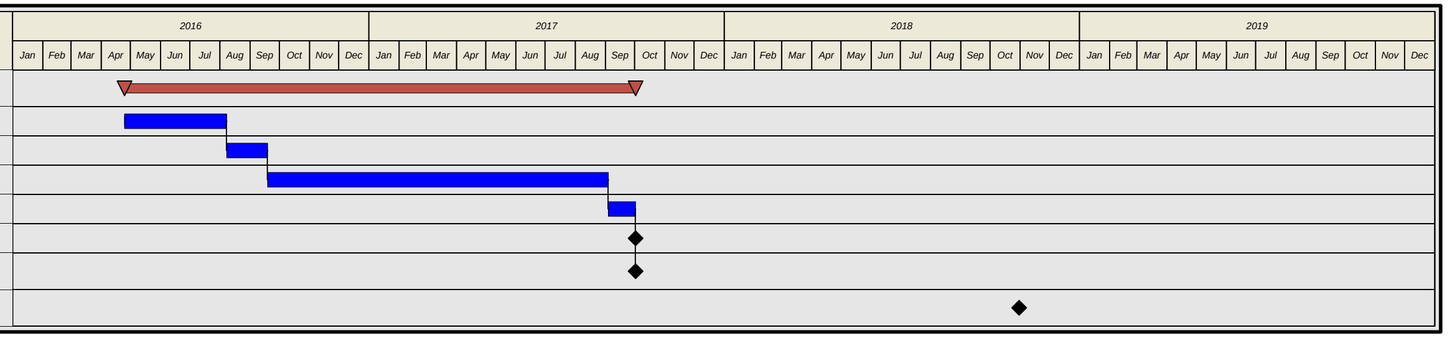
Ken Roller

Supervisor, Environmental Regulations
Dominion
Electric Environmental Services
(804) 273-3494 Office
(804) 592-7825 Cell

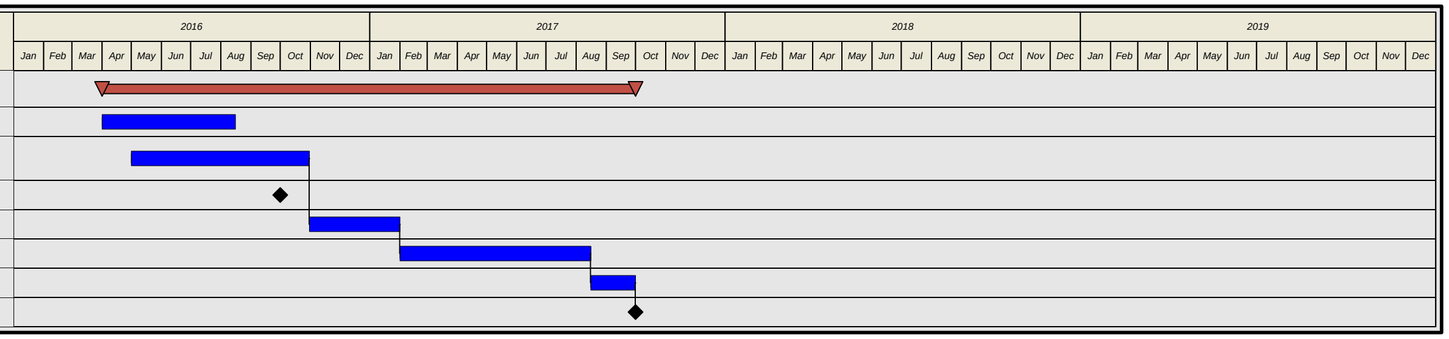
CONFIDENTIALITY NOTICE: This electronic message contains information which may be legally confidential and or privileged and does not in any case represent a firm ENERGY COMMODITY bid or offer relating thereto which binds the sender without an additional express written confirmation to that effect. The information is intended solely for the individual or entity named above and access by anyone else is unauthorized. If you are not the intended recipient, any disclosure, copying, distribution, or use of the contents of this information is prohibited and may be unlawful. If you have received this electronic transmission in error, please reply immediately to the sender that you have received the message in error, and delete it. Thank you.

Gantt Chart Schedules

ID	Task Name	Start	Finish	Duration
1	**LVWWTS – Phase 1 (Coal Pile Runoff, EQ Basin, Redirect Influent Lines, Discharge Basin)**	**4/25/2016**	**10/2/2017**	**75w**
2	Complete Engineering and Design (Update Construction Package)	4/25/2016	8/7/2016	15w
3	Bidding and Contractor Procurment	8/8/2016	9/18/2016	6w
4	Construction	9/19/2016	9/3/2017	50w
5	Commissioning	9/4/2017	10/1/2017	4w
6	Complete	10/2/2017	10/2/2017	0w
7	Cessation of Influents to LAP (Excluding Intermittent flow of Coal Pile Runoff)	10/2/2017	10/2/2017	0w
8	CCR Compliance Date	10/31/2018	10/31/2018	0w



ID	Task Name	Start	Finish	Duration
1	**Centralized Source Water Treatment System (CSWTS) – Phase 1 (Dewatering/Decanting System)**	**4/1/2016**	**10/1/2017**	**78.29w**
2	Treatability Study / Treatment Technology Selection	4/1/2016	8/15/2016	19.57w
3	Engineering and Design (CER, Performance Specification, Construction Package)	5/1/2016	10/30/2016	26.14w
4	Submit CER to DEQ	10/1/2016	10/1/2016	0w
5	Bidding and Contract Negotiation by RECON	10/31/2016	1/31/2017	13.29w
6	Construction	2/1/2017	8/15/2017	28w
7	Commissioning	8/16/2017	9/30/2017	6.57w
8	Completion (Start Decant/Dewatering Process)	10/1/2017	10/1/2017	0w



These dates and durations are estimated. While Dominion is committed to completing the project work as indicated above, permitting, engineering development, and operational conditions may affect the actual dates and durations.

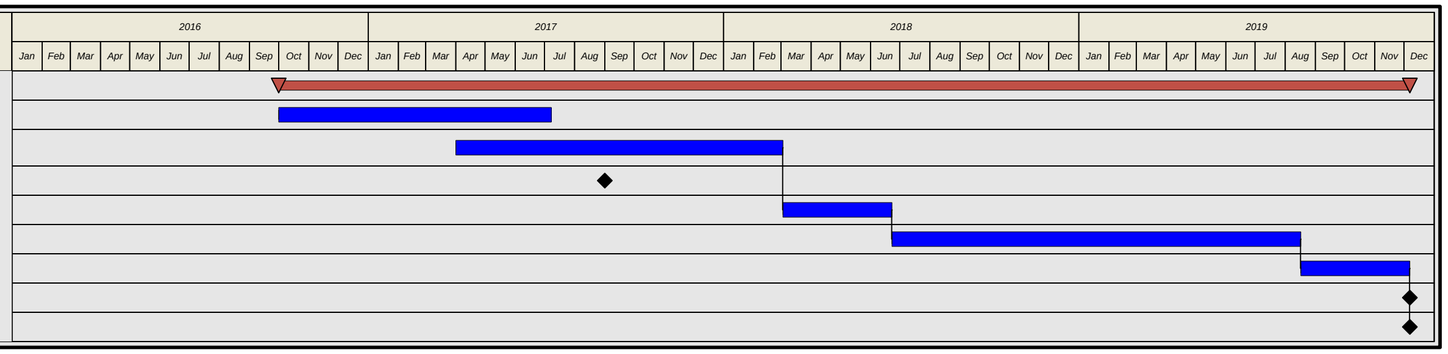
Dominion®

VIRGINIA ELECTRIC & POWER COMPANY
DOMINION VIRGINIA POWER

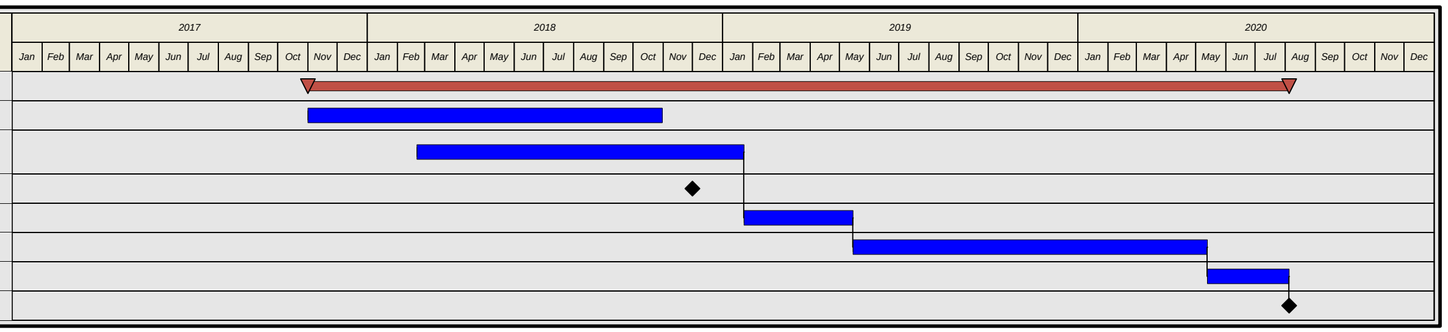
CHIAP
LVWWTS – CSWTS – FGD WWTP
Gantt Charts – Phase 1

DRAWN BY:	SIZE	PROJECT NO.	DRAWING NUMBER	REV
CHRIS NUNN		CHIAP	LVWWTS-CSWTS-FGD WWTP-Gantt - Phase 1	0
ISSUED: 05/03/2016	SCALE NONE		SHEET 1 OF 3	

ID	Task Name	Start	Finish	Duration
1	**LVWWTS – Phase 2 (Coal Pile Runoff – Metals Treatment)**	**10/1/2016**	**12/7/2019**	**166w**
2	Treatability Study / Technology Selection	10/1/2016	7/7/2017	40w
3	Engineering and Design (CER, Performance Specification, and Construction Package)	4/1/2017	3/2/2018	48w
4	Submit CER to DEQ	9/1/2017	9/1/2017	0w
5	Bidding and Contractor Procurement	3/3/2018	6/22/2018	16w
6	Construction	6/23/2018	8/16/2019	60w
7	Commissioning	8/17/2019	12/6/2019	16w
8	Completion	12/7/2019	12/7/2019	0w
9	Cessation of ALL Influents to LAP	12/7/2019	12/7/2019	0w



ID	Task Name	Start	Finish	Duration
1	**LVWWTS – Phase 2 (EQ Storage Basin – Metals Treatment)**	**11/1/2017**	**8/5/2020**	**144w**
2	Treatability Study and Technology Selection	11/1/2017	10/30/2018	52w
3	Engineering and Design (CER, Performance Specification, and Construction Package)	2/21/2018	1/22/2019	48w
4	Submit CER to DEQ	12/1/2018	12/1/2018	0w
5	Bidding and Contractor Procurment	1/23/2019	5/14/2019	16w
6	Construction	5/15/2019	5/12/2020	52w
7	Commissioning	5/13/2020	8/4/2020	12w
8	Complete	8/5/2020	8/5/2020	0w



These dates and durations are estimated. While Dominion is committed to completing the project work as indicated above, permitting, engineering development, and operational conditions may affect the actual dates and durations.

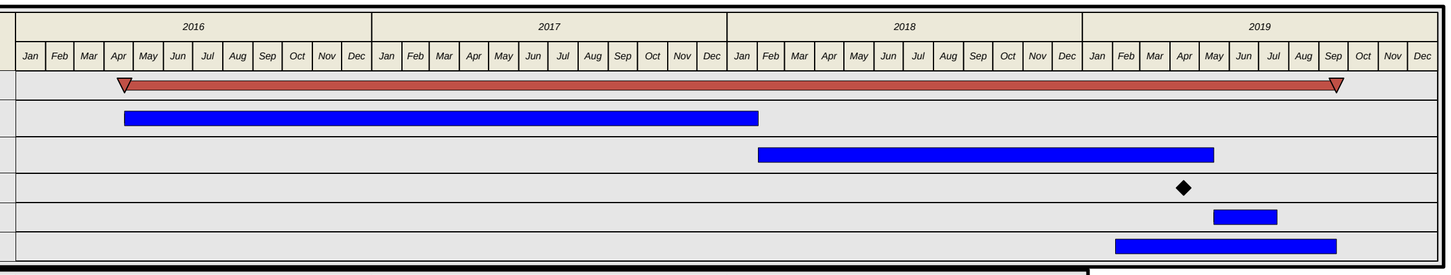
Dominion®

VIRGINIA ELECTRIC & POWER COMPANY
DOMINION VIRGINIA POWER

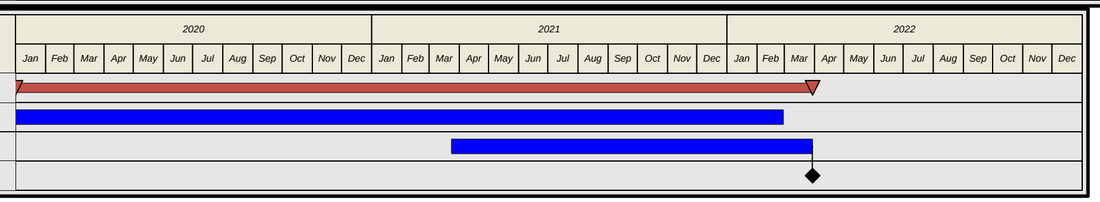
CHIAP
LVWWTS – CSWTS – FGD WWTP
Gantt Charts – Phase 2

DRAWN BY:	SIZE	PROJECT NO.	DRAWING NUMBER	REV
CHRIS NUNN		CHIAP	LVWWTS-CSWTS-FGD WWTP-Gantt - Phase 2	0
ISSUED: 05/03/2016	SCALE NONE		SHEET 2 OF 3	

ID	Task Name	Start	Finish	Duration
1	**FGD WWTP – Phase 3 (Selenium Treatment at FGD WWTP)**	**4/22/2016**	**9/18/2019**	**177.86w**
2	Treatment Technology Selection (Treatability Study and Pilot Plant)	4/22/2016	2/1/2018	93w
3	Engineering and Design (CER and Performance Specifications)	2/2/2018	5/15/2019	66.86w
4	Submit CER to DEQ	4/15/2019	4/15/2019	0w
5	Permitting	5/16/2019	7/19/2019	9.29w
6	Bidding and Contractor Procurement	2/4/2019	9/18/2019	32.43w



ID	Task Name	Start	Finish	Duration
1	**FGD WWTP – Phase 3 (Selenium Treatment at FGD WWTP)**	**1/1/2020**	**3/30/2022**	**117w**
2	Construction	1/1/2020	2/27/2022	112.71w
3	Commissioning	3/24/2021	3/29/2022	53w
4	Complete	3/30/2022	3/30/2022	0w



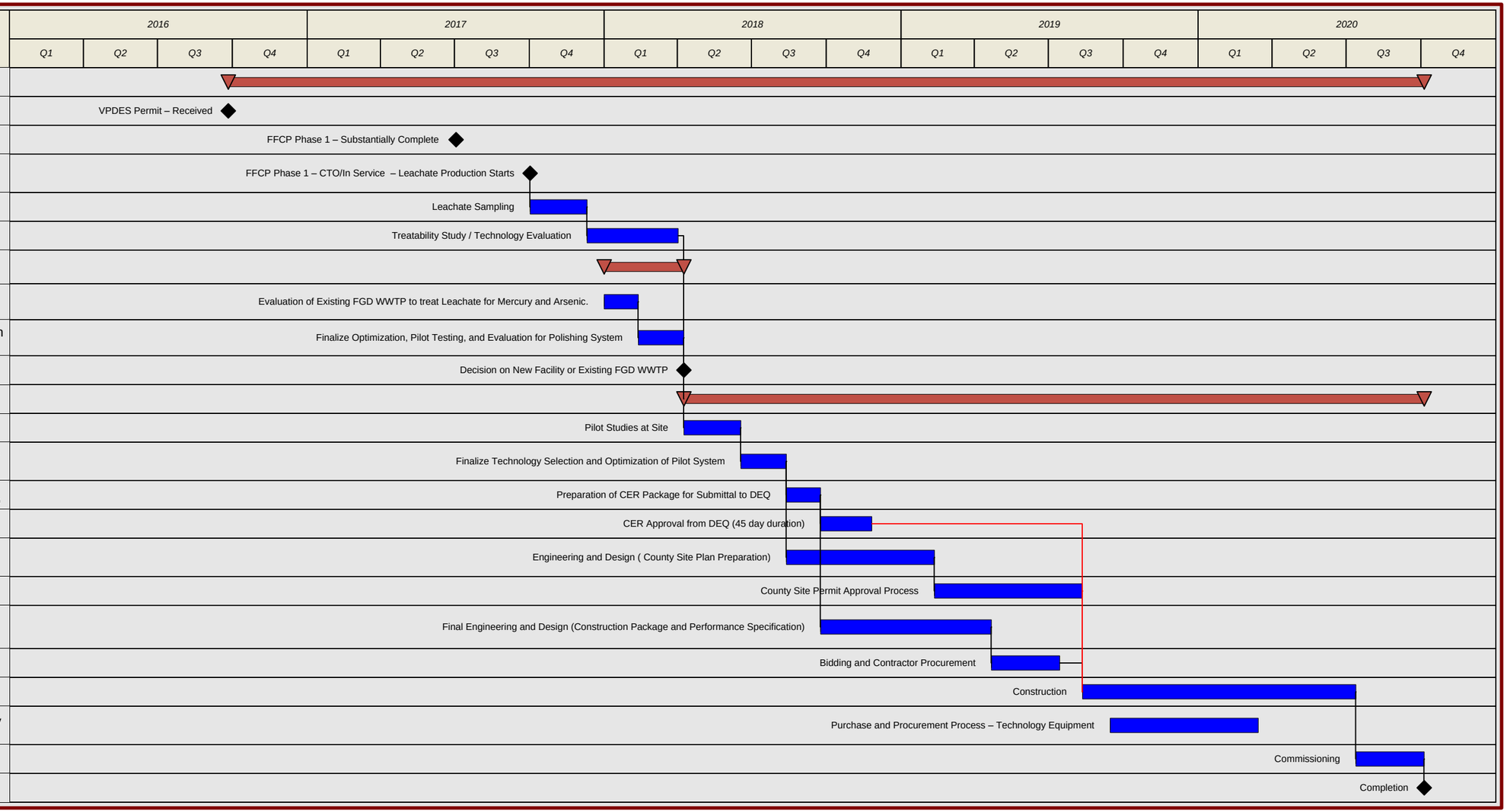
These dates and durations are estimated. While Dominion is committed to completing the project work as indicated above, permitting, engineering development, and operational conditions may affect the actual dates and durations.

VIRGINIA ELECTRIC & POWER COMPANY
DOMINION VIRGINIA POWER

CHIAP
LVWWTS – CSWTS – FGD WWTP
Gantt Charts – Phase 3

DRAWN BY:	SIZE	PROJECT NO.	DRAWING NUMBER	REV
CHRIS NUNN		CHIAP	LVWWTS-CSWTS-FGD WWTP-Gantt - Phase 3	0
ISSUED: 05/03/2016	SCALE NONE		SHEET 3 OF 3	

ID	Task Name
1	**LVWWTS – Leachate Treatment System (New Facility)**
2	VPDES Permit – Received
3	FFCP Phase 1 – Substantially Complete
4	FFCP Phase 1 – CTO/In Service – Leachate Production Starts
5	Leachate Sampling
6	Treatability Study / Technology Evaluation
7	**Evaluate FGD WWTP for Leachate Treatment**
8	Evaluation of Existing FGD WWTP to treat Leachate for Mercury and Arsenic.
9	Finalize Optimization, Pilot Testing, and Evaluation for Polishing System
10	Decision on New Facility or Existing FGD WWTP
11	**Proceed with New Leachate Treatment Facility**
12	Pilot Studies at Site
13	Finalize Technology Selection and Optimization of Pilot System
14	Preparation of CER Package for Submittal to DEQ
15	CER Approval from DEQ (45 day duration)
16	Engineering and Design (County Site Plan Preparation)
17	County Site Permit Approval Process
18	Final Engineering and Design (Construction Package and Performance Specification)
19	Bidding and Contractor Procurement
20	Construction
21	Purchase and Procurement Process – Technology Equipment
22	Commissioning
23	Completion



These dates and durations are estimated. While Dominion is committed to completing the project work as indicated above, permitting, engineering development, and operational conditions may affect the actual dates and durations.

Dominion®

VIRGINIA ELECTRIC & POWER COMPANY
DOMINION VIRGINIA POWER

CHIAP
LVWWTS – Leachate Treatment Facility
Gantt Charts

DRAWN BY:	SIZE	PROJECT NO.	DRAWING NUMBER	REV
CHRIS NUNN		CHIAP	LVWWTS-LEACHATE - Gantt	0
ISSUED: 06/02/2016	SCALE NONE		SHEET 1 OF 1	

Lower and Upper Ash Pond Decanting/Dewatering Process

The purpose of this narrative is to provide a description of the process for decanting and dewatering the Lower Ash Pond (LAP) and the Upper Ash Pond (UAP) sediment basin. Conceptual descriptions of the decanting and dewatering processes are provided in the sections below.

After ash sluicing water and low volume wastewater ceases to discharge into the LAP, water will be allowed to drain by gravity through the existing unmodified outfall structure (Outfall 004) until the water surface elevation equals the top of the outfall structure.

ASH POND DECANTING/DEWATERING

The decanting/dewatering process will commence when mechanical methods are used to remove water from the wet pool of the ash ponds for purposes of closure. At the LAP, prior to commencement of the decanting/dewatering process, the outfall structure for Outfall 004 will be plugged to prevent further discharge through the structure. The water being decanted/dewatered from the LAP wet pool and the UAP sediment basin will discharge to a Centralized Source Water Treatment System (CSWTS) for treatment of the water to the required discharge limits. Decanting/dewatering flows will be controlled such that drawdown of the water will not exceed two feet of elevation change per day.

Dewatering at the LAP is expected to commence in Fall 2017 after ash sluicing and low volume wastewater influents cease and water has been allowed to drain by gravity through the existing unmodified outfall structure. Decanting/dewatering will commence when mechanical methods are used to begin removing water from the pond for purposes of closure. The decanting/dewatering process will be accomplished by directing contact water to the wet pool and by lowering the water within the ash pond through the use of techniques such as trenches or well points. Discharge from the ash pore space will also be directed to the wet pool. As closure construction of the wet pool area commences, the decanting/dewatering of contact stormwater will continue until the ash is covered by at least two feet of soil. Once the ash is covered and contact stormwater is no longer being generated, the decanting/dewatering activities for the LAP will cease and stormwater will be handled in compliance with the general construction stormwater permit requirements.

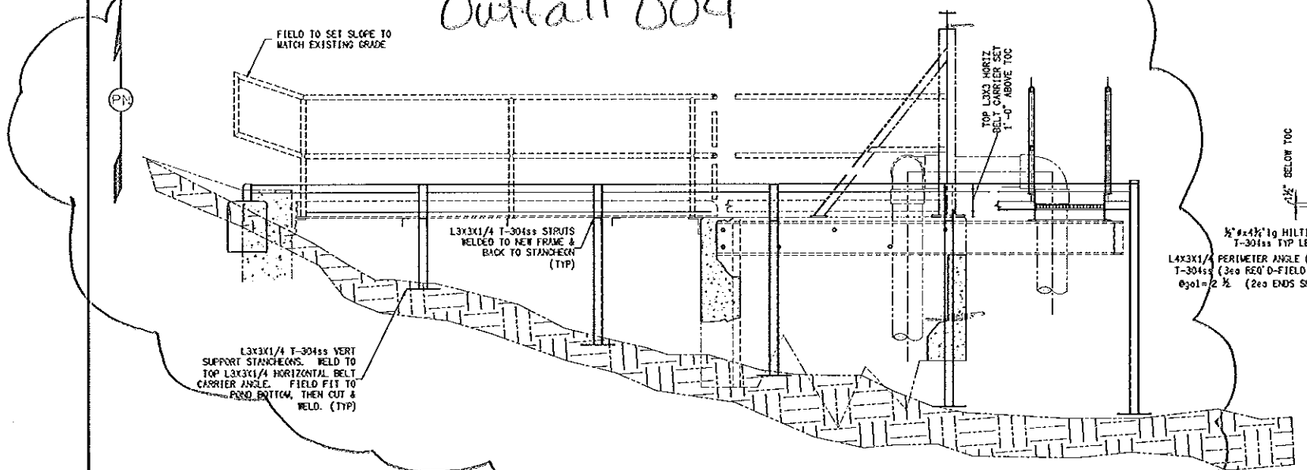
For the UAP sediment basin, decanting/dewatering is expected to commence towards the end of the UAP closure project once the majority of the UAP has been capped. Prior to commencement of the decanting/dewatering process of the UAP sediment basin, the outfall structure for Outfall 005 will be plugged to prevent further discharge through the structure. After removing the free water from the sediment basin, decanting/dewatering will be utilized to remove contact stormwater. Once the ash in the sediment basin is covered by at least two feet of soil and contact stormwater is no longer being generated, the decanting/dewatering activities for the UAP will cease and stormwater will be handled in compliance with the general construction stormwater permit requirements.

CENTRALIZED SOURCE WATER TREATMENT SYSTEM (CSWTS) DESCRIPTION

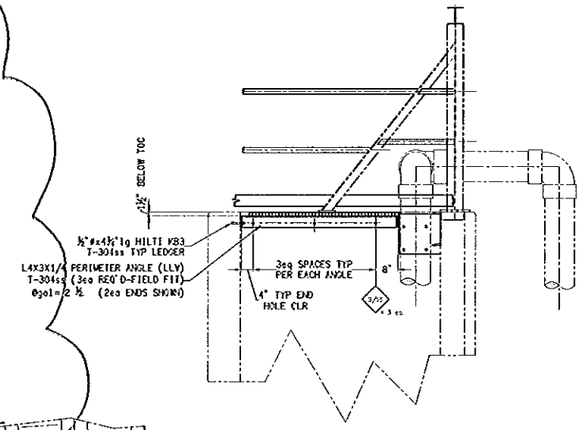
The CSWTS will be designed to provide the necessary treatment technologies to achieve compliance. As a means to verify compliance prior to discharging to the receiving water body, the system will include sufficient storage capacity to allow for batch analysis. The CSWTS will also be designed with a sample location for collection of treated effluent samples in accordance with the compliance testing frequency. A Conceptual Engineering Report (CER) will be submitted to DEQ for review prior to conducting decanting/dewatering activities.

Upon verification of the compliance of the treated effluent with the required limits, the treated effluent will be discharged to the James River via either Outfall 001 or 002 (existing industrial discharge outfalls). The actual outfall utilized for discharge of the CSWTS will be presented in the CER that will be submitted to DEQ.

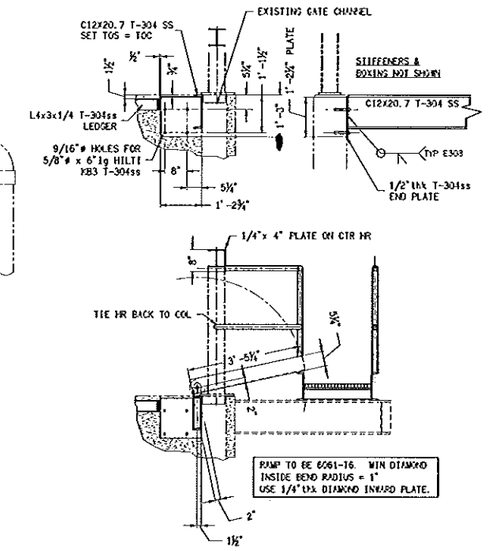
Decant Structure for
OutFall 004

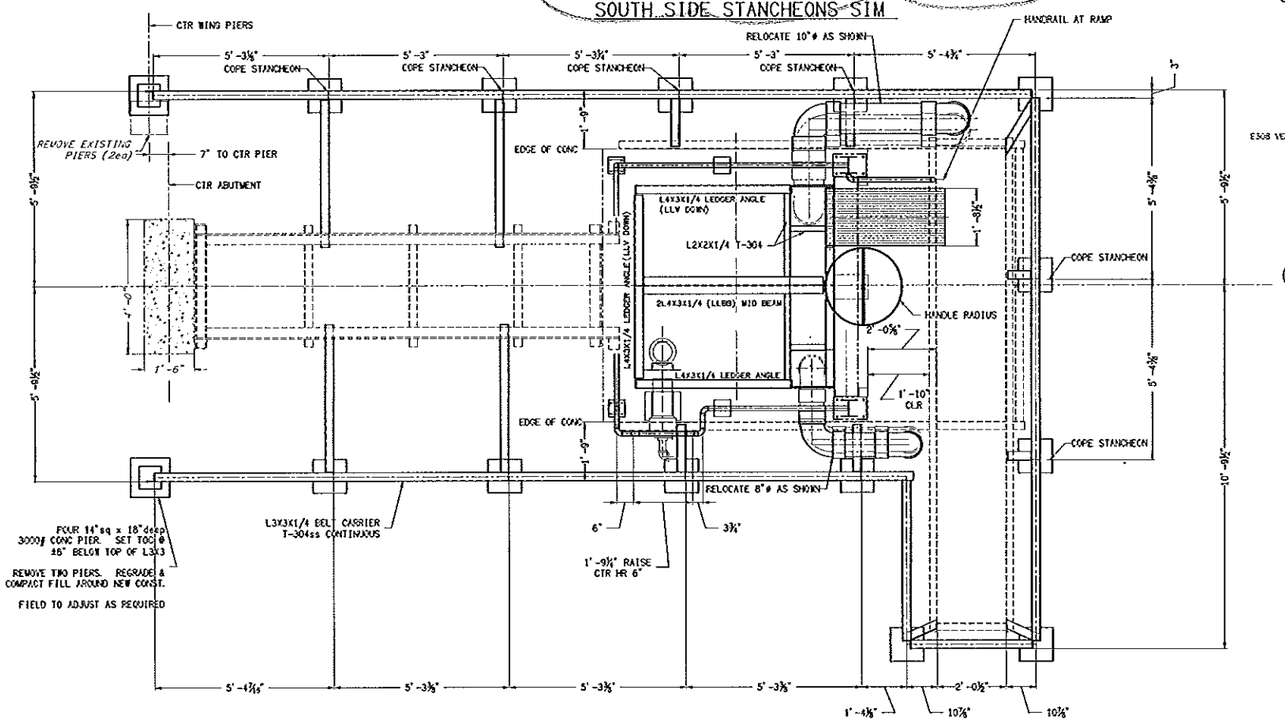


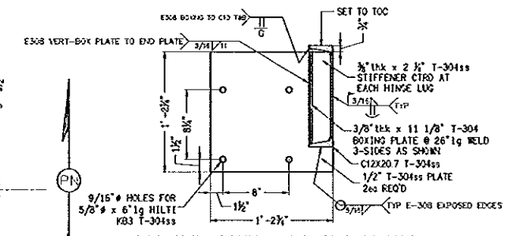
SIDE VIEW SHOWING STANCHEONS ON NORTH SIDE
SOUTH SIDE STANCHEONS SIM



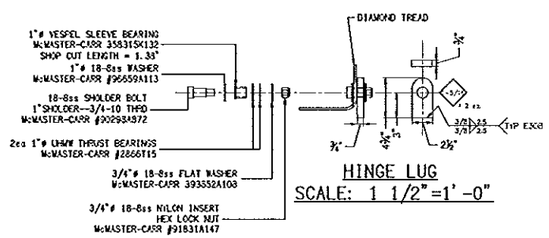
SECTION A S-2
SCALE: 1/2"=1'-0"
OPP SIDE SIM





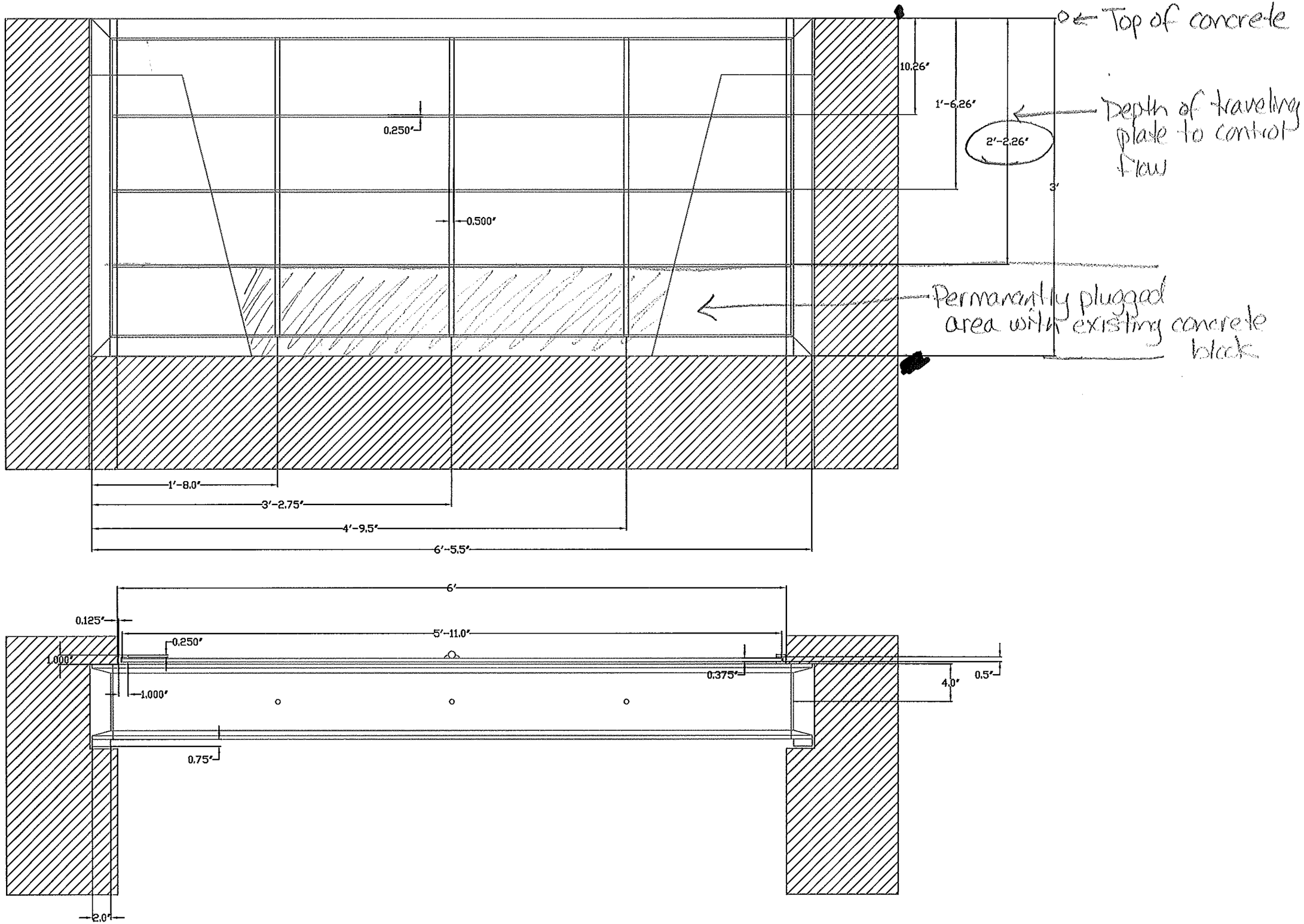


C10 END CONN & BOXING PLATE
SCALE: 1 1/2"=1'-0"



HINGE LUG
SCALE: 1 1/2"=1'-0"

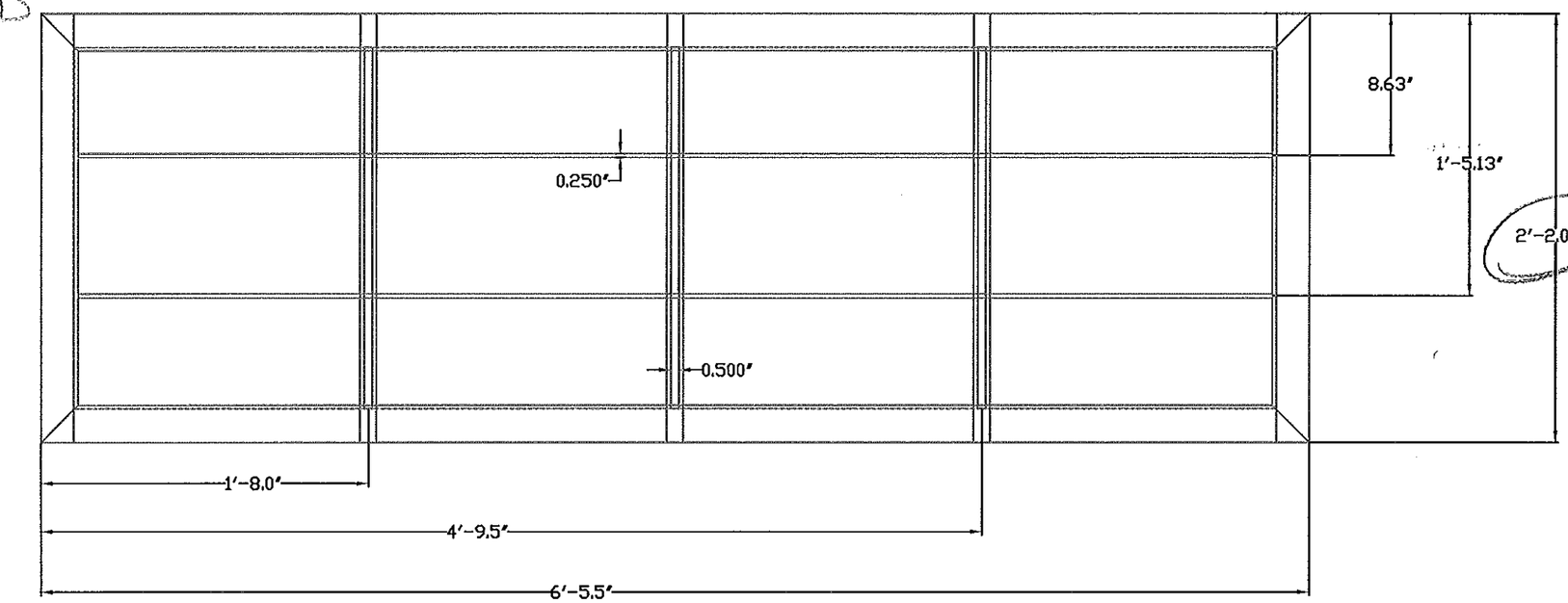
CHESTERFIELD POWER STATION
ASH POND OUTFALL #0004
RENOVATION OF ACCESS PLATFORMS AND OUTER WEIR
PERIMETER WEIR PLANS & SECTIONS
SCALE: 1/2"=1'-0"
DRAWING S-2 REV B, 10/26/10


0 ← Top of concrete
10.26"
1'-6.26"
2'-2.26"
3'
Depth of traveling plate to control flow
0.250"
0.500"
Permanently plugged area with existing concrete block
1'-8.0"
3'-2.75"
4'-9.5"
6'-5.5"
6'
0.125"
5'-11.0"
0.250"
1.000"
1.000"
0.375"
4.0"
0.5"
0.75"
2.0"

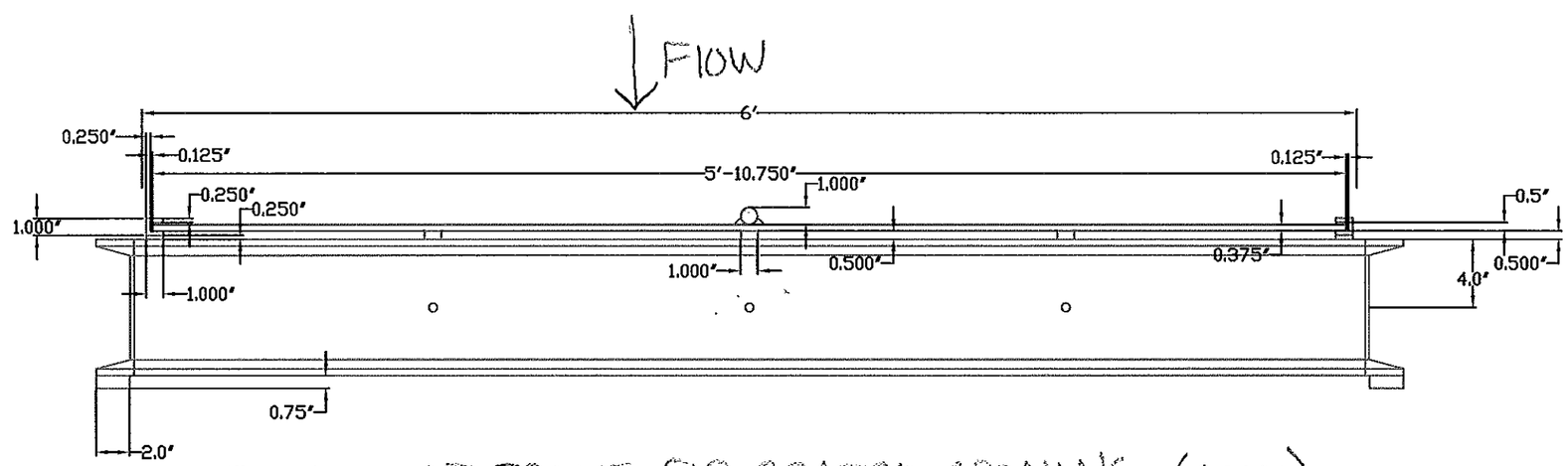
OUTFALL 004 DECANT STRUCTURE

GRATED OPENING WITH ADJUSTABLE PLATE TO CONTROL FLOW

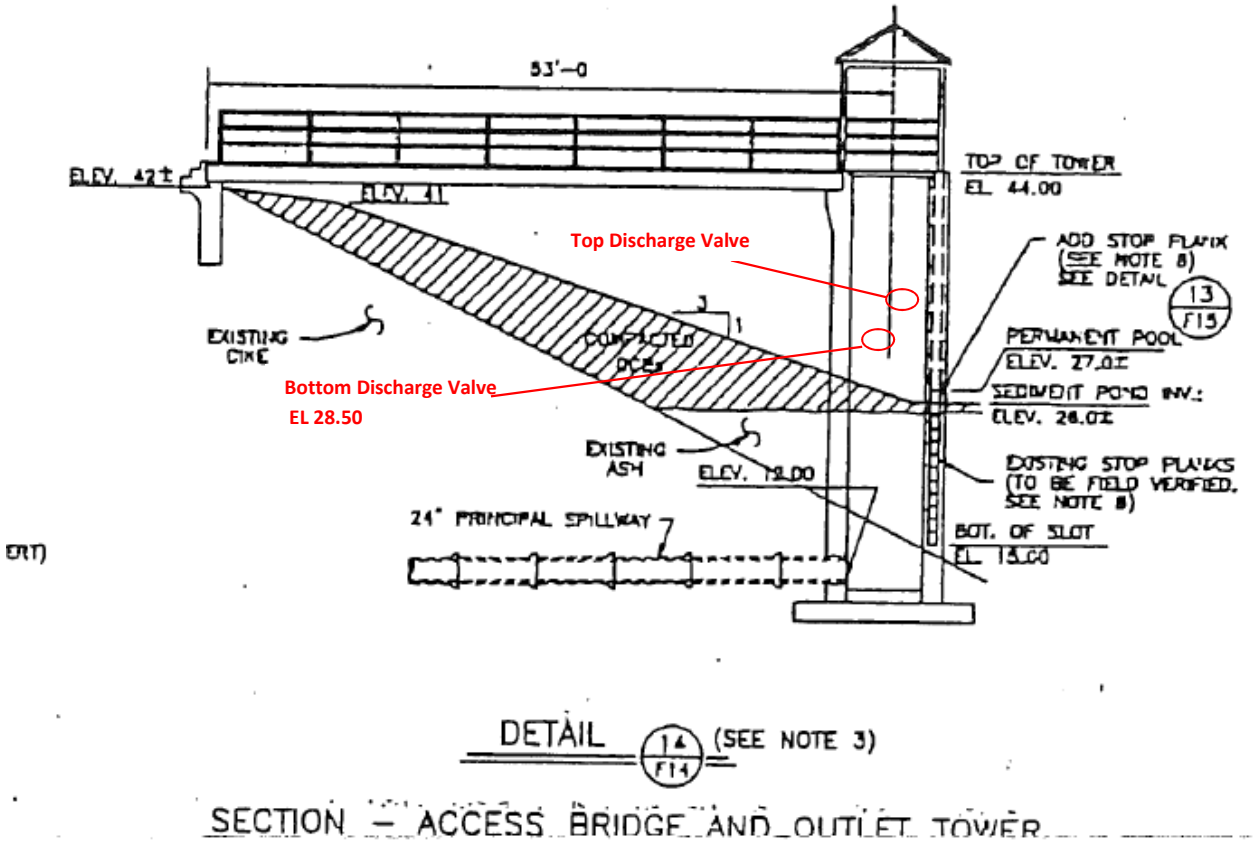
CHESTERFIELD POWER STATION



Maximum Opening Measured from Top of concrete



TOP VIEW OF FRAME FOR GRATED OPENING (green)
SHAFT WITH ADJUSTABLE PLATE (red)



Chesterfield Power Station Outfall 005 Structure

The above drawing illustrates the Outfall 005 structure and the operating discharge valves used to drain the pond under normal conditions. The bottom of the lowest operating discharge valve (Elevation 28.50) is 15'6" below the top of concrete structure (Elevation 44.00). In order to drain pond water level below this valve (Elevation 28.50), mechanical assistance is required. (e.g. portable pump, siphon system, etc.).

Geosyntec consultants

9211 Arboretum Parkway, Suite 200
Richmond, Virginia 23235
PH 804.767.2206
FAX 804.767.2182
www.geosyntec.com

Memorandum

Date:	1 December 2015
To:	Kimberly Lanterman
Copies to:	Christopher M. Gee, Kenneth Roller
From:	Scott Sheridan
Subject:	CPS Lower Ash Pond Drawdown and Discharge Rate Analysis

PURPOSE

The purpose of this analysis is to determine if the pond embankments will remain stable during a drawdown of water from the lower ash pond (LAP) at the rate of one foot per day. If excess pore pressure is not generated in the embankment by the maximum drawdown, then the condition of the embankments will not change and the embankments will remain stable. The rate of one foot per day is the maximum drawdown allowed in the draft Virginia Pollutant Discharge Elimination System permit for the Chesterfield Power Station (CPS) for decanting/dewatering of the LAP. The permitted rate corresponds to a maximum discharge flow of around 8,500 gallons per minute (gpm) when the first foot of water is lowered across the operational water area of approximately 38 acres. This analysis is based on the maximum potential discharge flow; however, Dominion's expected maximum discharge rate, on average, is 3,500 gpm or 5 million gallons per day (MGD). This rate is based on the estimated amount of water required to be discharged from the LAP during closure and an estimated schedule for discharge activities.

ANALYSIS DISCUSSION

The excess pore water pressure induced by drawdown of the water table in the LAP is illustrated in the sketch shown below as Figure 1. The shaded area is the excess pore water pressure caused by drawdown. The goal of this analysis is to determine how fast the excess pore water pressure will dissipate under the proposed drawdown rate of one foot per day. If this excess pore water pressure dissipates in less than a day, then the drawdown rate is slow enough that the condition of the embankments will not change, and the embankments will remain stable. If the excess pore pressure generated does not dissipate in less than a day, then further embankment stability analysis is required.

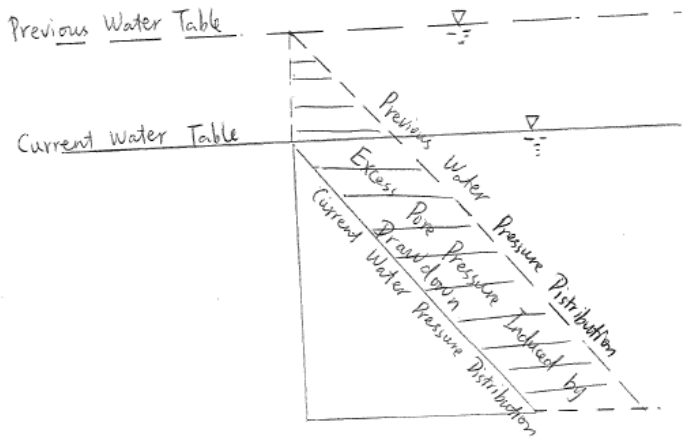


Figure 1. Excess Pore Pressure Sketch

For a critical case, we will assume that the water will be lowered by 10 feet in 10 days. At the end of the 10 days, it was estimated that if the coefficient of consolidation is greater than 2 ft^2/day, the degree of consolidation will reach a nearly fully drained condition (assuming a 5-foot drainage distance). In other words, excess pore pressure will dissipate quickly enough to maintain stability in the embankments.

Boring logs for borings located in the LAP embankment soils indicate the soils are mainly silt, silty/clayey sand, or low plasticity silt. The liquid limit of the embankment soil is less than 38%, based on available soil characterization tests conducted. Based on the empirical correlations shown in Figure 2 below, the coefficient of consolidation is estimated to be greater than 2 ft^2/day (use the lower bound reloading curve, considering that the stress increment induced by drawdown will be less than or equal to the pre-consolidation stress). Therefore, the excess pore water pressure induced by drawdown at the proposed rate will dissipate quickly enough for the embankments to remain stable.

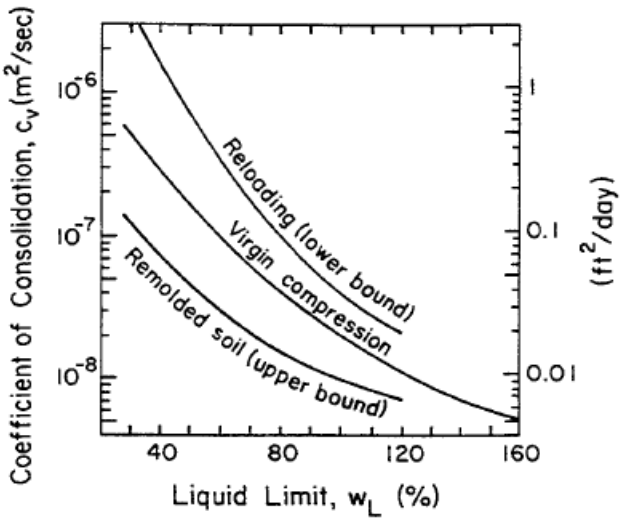


Figure 6-15. c_v versus w_L

Source: NAVFAC (21), p. 7.1-144.

Figure 2. Coefficient of Consolidation vs. Liquid Limit (NAVFAC, 1986)

CONCLUSION

Based on this preliminary engineering analysis, the excess pore pressure will almost fully dissipate within the LAP embankments, and the embankments will remain stable at a drawdown rate of one foot per day. This drawdown analysis was conducted for the maximum possible discharge rate of 8,500 gallons per minute (one foot of drawdown per day for the first foot of water). However, as stated previously, the maximum expected discharge rate from the LAP during closure is 3,500 gallons per minute, providing an additional factor of safety for embankment stability during drawdown.

REFERENCES

Naval Facilities Engineering Command. *DM-7.01 Soil Mechanics*. Naval Publications. September 1986

*****

MEMO

Date:	December 2, 2015
Project No. :	C150035.00
To:	Ms. Kimberly Lanterman
From:	GAI Consultants, Inc.; Mr. Trent Muraoka, Mr. Kevin M. Bortz, Mr. Michael B. Lott
Subject:	Dominion – Chesterfield Power Station Upper (East) Pond – Sediment Pond Water Drawdown – Stability Analysis

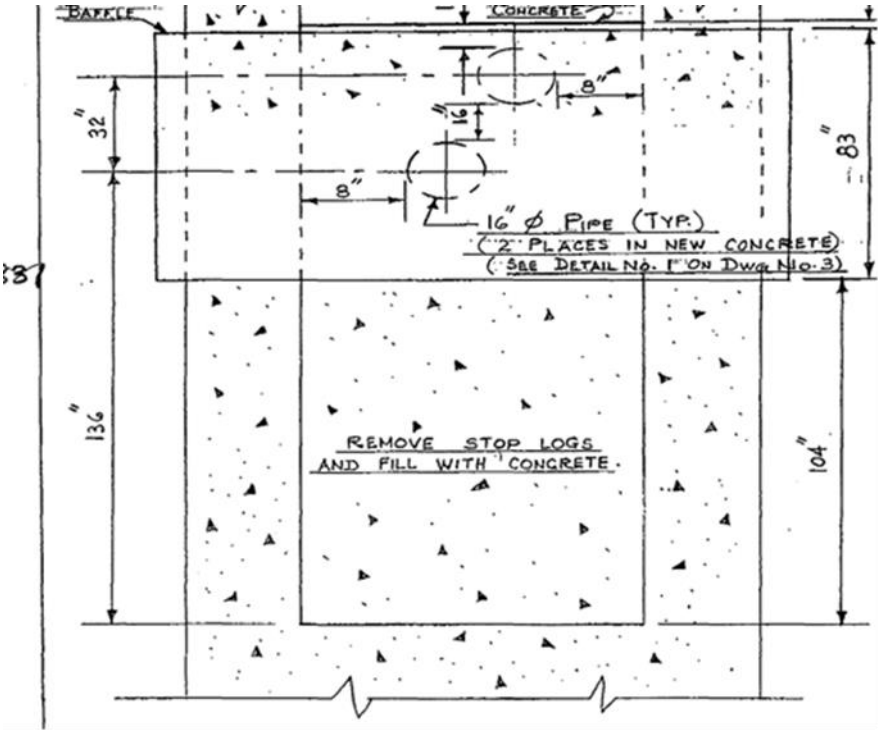
Introduction

The purpose of this analysis is to determine if the sediment pond embankments located in the Chesterfield Upper (East) Pond (UEP) Closure will remain stable during the drawdown of water from the sediment pond through outfall 005 at the rate of one foot per day. The drawdown rate of one foot per day from the UEP sediment pond equates to a maximum discharge flow of approximately 1,000 gallons per minute (GPM) or 1.5 million gallons per day (MGD). Therefore the expected maximum discharge rate from the UEP sediment pond during pond closure is 1.5 MGD.

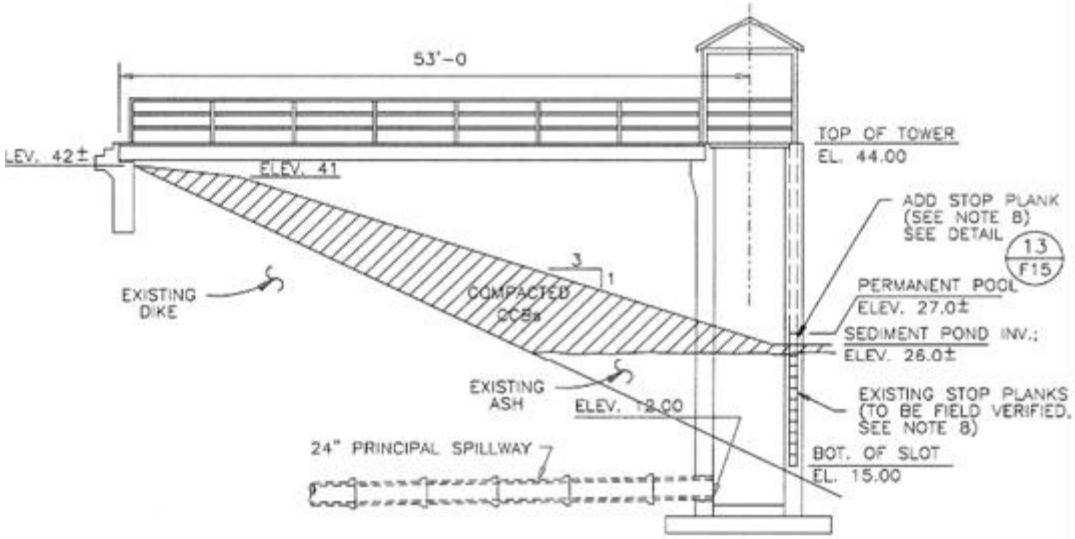
Analysis

The goal of this analysis is to determine how quickly the excess pore water pressure will dissipate under the proposed drawdown rate of one foot per day. If the pore water pressure dissipates in less than one day, then the drawdown rate is low enough that the stability of the embankment is not affected. If the dissipation of the pore water pressure takes longer than a day, then further stability analyses are required.

For the critical case, it is assumed that the lowest orifice in the UEP sediment pond outlet tower is located at invert elevation 25.67 feet (see DWG No. 2, Virginia Power Chesterfield Power Station Unit 00 New Ash Pond Stop Log Conversion DCR-91-20 January 1992). This orifice is valved shut and considered to be buried under sediment.



Dwg. No. 2 Virginia Power Chesterfield Power Station Unit 00 New Ash Pond Stop Log Conversion DCR-91-20 January 1992. The bottom of slot is elevation 15.0 feet



DWG V-96-410-F15, Detail 14, Section Access Bridge and Outlet Tower

© 2015 GAI Consultants, Inc.

The second lowest orifice is located at invert elevation 28.33 feet.

The sediment pond bottom is located at approximate elevation 26.0 feet.

At the end of the dewatering period, if the coefficient of consolidation is greater than 2 feet-squared/day, the degree of consolidation would reach a fully drained condition (assuming a drainage distance of 1.0 feet in one day).

Boring logs performed by Schnabel Engineers, Inc. for the UEP embankment show that the soils are mostly sandy silts or silty sands with low plasticity. The liquid limit of the embankment soil is 33%, based on the laboratory data. Based on the empirical correlations shown in the Figure below, the coefficient of consolidation is estimated to be greater than 2 feet-squared/day. The lower reloading curve used as the stress increase caused by the drawdown will be equal to or less than the pre-consolidation stress. Based on this information, the excess pore water pressure induced by the drawdown at the proposed rate of one foot per day will not affect the stability of the embankment

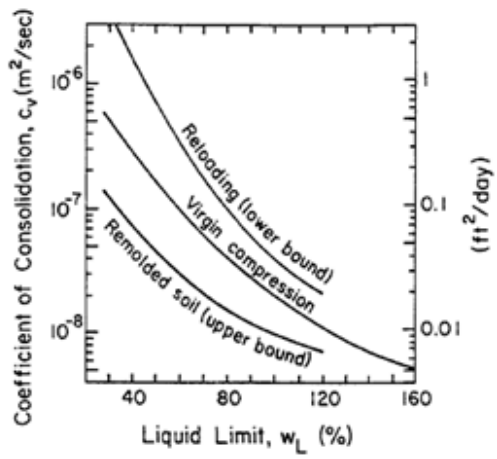


Figure 6-15. c_v versus w_L

Source: NAVFAC (21), p. 7.1-144.

Coefficient of Consolidation vs. Liquid Limit (NAVFAC, 1986)

Conclusion

Based on this preliminary engineering analysis, the excess pore water pressure will dissipate within the UEP sediment pond embankment, and the embankment will remain stable at a drawdown rate of one foot per day. This drawdown analysis was conducted for the maximum expected discharge rate of 1.5 MGD during closure. In addition, the sediment pond embankment slopes are lined with rip rap around the perimeter to provide an additional factor of safety for embankment stability during drawdown.

© 2015 GAI Consultants, Inc.

References

Naval Facilities Engineering Command. DM-7.01 Soil Mechanics. Naval Publications. September 1986

Virginia Power Chesterfield Power Station Unit 00 New Ash Pond Stop Log Conversion DCR-91-20 January 1992

GAI DWG V-96-410-F15, Closure Plan Sections and Details. Upper (East) Pond

© 2015 GAI Consultants, Inc.

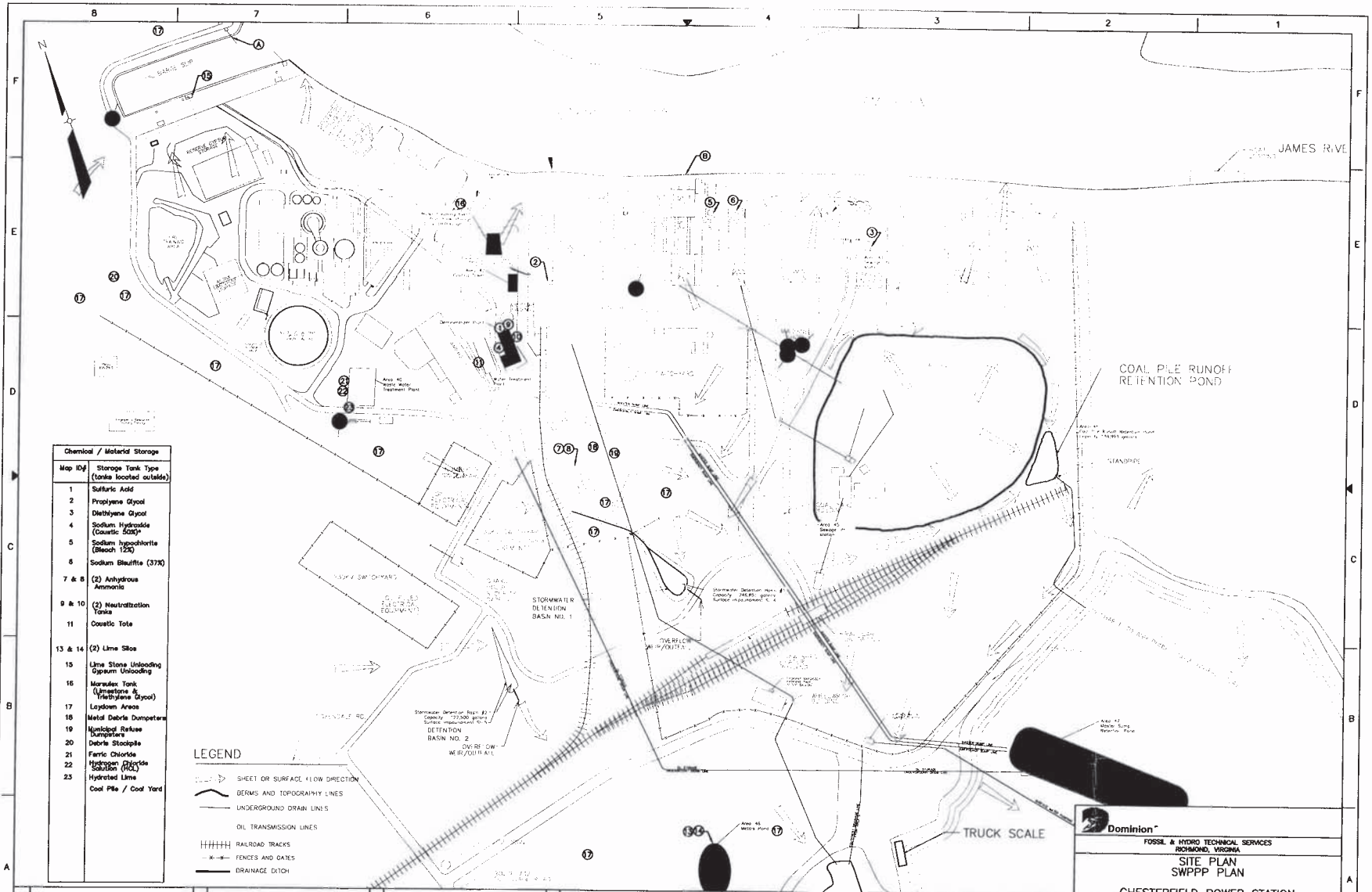
10.0 CHEMICALS & MISCELLANEOUS INFORMATION

10.1 AUTHORIZED BULK CHEMICALS

The bulk chemicals on the following list are authorized for use:

Chemical	Approximate Usage / Year	Purpose of Usage
Carbon Dioxide	~10 tons	Fire suppression systems and generator degassing
Propylene Glycol	Constant Use Makeup Only	Antifreeze in heat transfer systems for natural gas and unit combustion air.
Ethylene Glycol	Constant Use Makeup Only	Antifreeze in vehicles and equipment.
Diethylene Glycol/ Triethylene Glycol	Varies	Antifreeze in vehicles and equipment and freeze conditioning of coal. Grinding agent for Marsulex limestone.
Calcium Hydroxide Hydrated Lime	~408 tons	pH adjustment in settling ponds and FGD WWTP
BetzDearborn KlarAid PC 1195 (coagulant)	Varies	Settling aid (ash pond)
Unleaded Gasoline	Varies	Fuel
Diesel Fuel	Varies	Fuel
Sulfuric Acid	~478 tons	Regenerate chemical for demineralizer system
Sodium Hydroxide (Caustic 50%)	~923 tons	Regenerate chemical for demineralizer system
Sodium Hydroxide 25%	~108 tons	pH control in water plant
Sodium Chloride	~550 tons	Water treatment for softener regeneration
Sodium Hypochlorite (Bleach 12%)	~200 tons	Condenser cooling water chlorination, various sanitation activities
Sodium Bisulfite (37%)	~1,000 tons	De-chlorination of condenser cooling water/RO influent
Methoxypropylamine	~8 tons	Corrosion control in plant condensate system
Carbohydrazide	~8 tons	Corrosion control in plant condensate and boiler systems (reducing agent)
Trisodium Phosphate	~10 tons	Corrosion control in plant boilers
Anhydrous Ammonia	4,000 tons	SCR use
TMT 15	~21 tons	Heavy metal removal, Waste Water Treatment Plant
Hydrochloric Acid	~40 tons	pH control, Waste Water Treatment Plant, Boiler Chemical Cleaning.
Ferric Chloride	~41 tons	Coagulant, Waste Water Treatment Plant
Dibasic Acid &/or Formic Acid	Varies	Limestone slurry aid (FGD), Waste Water Treatment Plant
Nalco 7768	Varies	Floculant, Waste Water Treatment Plant

Chemical	Approximate Usage / Year	Purpose of Usage
Waste water sludge	14 tons (varies)	Transported off site
Limestone	150,000 tons	Scrubber absorber & Marsulex system
Gypsum	300,000 tons	Scrubber commercial product
Xylene	As needed	Paint ingredient only (not allowed as stand alone solvent)
Methyl Ethyl Ketone	N/A	Paint Solvent (Not allowed on Site as stand alone solvent)
Ammonium EDTA	Varies	Boiler cleaning
Aqueous Ammonia	Varies	Boiler cleaning
Thiourea	Varies	Boiler cleaning (copper complexor)
Ammonium Carbonate	N/A	Chemical cleaning of plant equipment
Sodium Nitrite	N/A	Chemical cleaning of plant equipment
Ammonium Bicarbonate	N/A	Chemical cleaning of plant equipment
Citric Acid	N/A	Chemical cleaning of plant equipment
Sodium Bromate	N/A	Chemical cleaning of plant equipment
Ammonium Bifluoride	N/A	Chemical cleaning of plant equipment
Wen Don CL89	Varies	General cleaning of various station equipment
Detergents / cleaning agents	Varies	General cleaning of various station equipment
Soda Ash (Sodium Carbonate)	Varies	General and chemical cleaning pH control
Denatured Alcohol	As needed	Various maintenance activities
Natural Gas Condensate	< 200 gals	Byproduct collected from use of Natural Gas
Tri-aryl Phosphate	N/A	Hydraulic fluid for turbine operation control
Mercury	N/A	Mercoid switches, thermometers, etc.
Nalco 3D Trasar 3DT189 aromatic amine	655 pounds	Cooling Tower treatment
Nalco 7330	varies	Cooling Tower treatment
Nalco Towerbrom991	225 pounds	Cooling Tower micro biocide
Nalco 8325 again	55 gallons	Cooling Tower treatment corrosion inhibitor
Mineral Oil	Varies	Equipment lubrication
Cement Kiln Dust	42,101 Tons	Refined Coal Operation
Calcium Bromide	6,500 Tons	Refined Coal Operation
F-500, Multi-Purpose Encapsulating Agent	Varies	Fire Suppression System
GE, Foamtrol AF2290	Varies	Anti Foaming Agent for the FGD System



Chemical / Material Storage	
Map ID#	Storage Tank Type (tanks located outside)
1	Sulfuric Acid
2	Propylene Glycol
3	Diethlyene Glycol
4	Sodium Hydroxide (Caustic 50%)*
5	Sodium hypochlorite (Bleach 12%)
6	Sodium Bisulfite (37%)
7 & 8	(2) Anhydrous Ammonia
9 & 10	(2) Neutralization Tanks
11	Caustic Tote
13 & 14	(2) Lime Silos
15	Lime Stone Unloading Gypsum Unloading
16	Marsulex Tank (Limestone & Triethylene Glycol)
17	Laydown Areas
18	Metal Debris Dumpsters
19	Municipal Refuse Dumpsters
20	Debris Stockpile
21	Ferric Chloride
22	Hydrogen Chloride Solution (HCL)
23	Hydrated Lime
	Coal Pile / Coal Yard

Dominion

FOSSIL & HYDRO TECHNICAL SERVICES
RICHMOND, VIRGINIA

SITE PLAN
SWPPP PLAN

CHESTERFIELD POWER STATION

REV	DATE	DRAWN	CHKD	DSGN	PROJ ENGR	ELEC ENGR	MECH ENGR	CHEM ENGR	E.&I. ENGR	MKT ENGR	REMARKS
0											ORIGINAL ISSUE

DSGN: DSGN SUPV
DRWN: SWC ENGR SUPV
CHKD: RAW PROJ ENGR
SCALE: N/A
DRAWING NUMBER: CH-0-SP-STA-621
REV. 0
UNLESS OTHERWISE NOTED
SH 1 OF 1

Attachment 4

Effluent Characterization

4.a DMR and Application Data

4.b Water Quality Criteria Monitoring Form Attachment A for Outfalls 001-003

4.c Outfall 301 Worst Case Concentrations

4.d Water Quality Criteria Monitoring Form Attachment A for Outfalls 004 and 005

4.e Dewatering Data for Outfalls 004 and 005

Attachment 4.a

DMR and Application Data

Chesterfield Power Station VA0004146
DMR Data
August 2012-July 2015

Outfall 001

Date	Flow (MGD) 30-day Max	Temp (°F)
10-Aug-12	212	115
10-Sep-12	212	111
10-Oct-12	212	99
10-Nov-12	212	93
10-Dec-12	212	78
10-Jan-13	212	78
10-Feb-13	212	72
10-Mar-13	212	76
10-Apr-13	212	73
10-May-13	212	90
10-Jun-13	212	95
10-Jul-13	212	110
10-Aug-13	212	109
10-Sep-13	212	108
10-Oct-13	212	112
10-Nov-13	212	104
10-Dec-13	212	81
10-Jan-14	212	99
10-Feb-14	212	74
10-Mar-14	212	72
10-Apr-14	212	77
10-May-14	212	91
10-Jun-14	212	99
10-Jul-14	212	117
10-Aug-14	212	105
10-Sep-14	212	107
10-Oct-14	212	103
10-Nov-14	212	89
10-Dec-14	212	81
10-Jan-15	212	64
10-Feb-15	212	88
10-Mar-15	212	72
10-Apr-15	212	87
10-May-15	212	99
10-Jun-15	212	120
10-Jul-15	212	113
Average	**212**	**93.4**
90th %	**212**	**113**

Outfall 002

Date	Flow (MGD) 30-day Max	Temp (°F)
10-Aug-12	89	124
10-Sep-12	89	119
10-Oct-12	89	106
10-Nov-12	89	78
10-Dec-12	89	68
10-Jan-13	45	60
10-Feb-13	89	128
10-Mar-13	89	51
10-Apr-13	89	104
10-May-13	45	72
10-Jun-13	89	107
10-Jul-13	89	110
10-Aug-13	89	116
10-Sep-13	89	89
10-Oct-13	89	113
10-Nov-13	45	82
10-Dec-13	45	74
10-Jan-14	45	54
10-Feb-14	89	71
10-Mar-14	89	69
10-Apr-14	89	75
10-May-14	45	69
10-Jun-14	89	105
10-Jul-14	89	92
10-Aug-14	89	115
10-Sep-14	89	115
10-Oct-14	45	91
10-Nov-14	45	79
10-Dec-14	89	86
10-Jan-15	45	53
10-Feb-15	89	82
10-Mar-15	89	78
10-Apr-15	45	71
10-May-15	45	73
10-Jun-15	89	111
10-Jul-15	89	118
Average	**75.6**	**89.1**
90th %	**89**	**117**

Chesterfield Power Station VA0004146
DMR Data
August 2012-July 2015

Outfall 003

Date	Flow (MGD) 30-day Max	Temp (°F)
10-Aug-12	757	125
10-Sep-12	757	125
10-Oct-12	556	116
10-Nov-12	469	78
10-Dec-12	469	78
10-Jan-13	700	86
10-Feb-13	556	91
10-Mar-13	757	85
10-Apr-13	757	96
10-May-13	499	102
10-Jun-13	757	115
10-Jul-13	757	121
10-Aug-13	757	123
10-Sep-13	757	116
10-Oct-13	757	122
10-Nov-13	538	122
10-Dec-13	757	116
10-Jan-14	757	97
10-Feb-14	757	77
10-Mar-14	757	105
10-Apr-14	757	113
10-May-14	325	120
10-Jun-14	757	125
10-Jul-14	757	129
10-Aug-14	757	117
10-Sep-14	757	115
10-Oct-14	757	119
10-Nov-14	757	99
10-Dec-14	700	107
10-Jan-15	757	101
10-Feb-15	757	111
10-Mar-15	757	117
10-Apr-15	757	129
10-May-15	643	92
10-Jun-15	757	115
10-Jul-15	757	120
Average	**698**	**109**
10th %	**519**	
90th %	**757**	**125**
Max		

Chesterfield Power Station VA0004146
DMR Data
August 2012-July 2015

Outfall 003 10 Year Flows

Date	Flow (MGD) 30-day Avg
10-Jan-06	693
10-Feb-06	654
10-Mar-06	623
10-Apr-06	695
10-May-06	495
10-Jun-06	757
10-Jul-06	751
10-Aug-06	741
10-Sep-06	742
10-Oct-06	721
10-Nov-06	656
10-Dec-06	664
10-Jan-07	629
10-Feb-07	740
10-Mar-07	757
10-Apr-07	503
10-May-07	601
10-Jun-07	743
10-Jul-07	757
10-Aug-07	757
10-Sep-07	751
10-Oct-07	--
10-Oct-07	752
10-Nov-07	567
10-Nov-07	--
10-Dec-07	701
10-Dec-07	--
10-Jan-08	--
10-Jan-08	731
10-Feb-08	718
10-Feb-08	--
10-Mar-08	662
10-Mar-08	--
10-Apr-08	309
10-May-08	486
10-Jun-08	642
10-Jul-08	757
10-Aug-08	757
10-Sep-08	755
10-Oct-08	665
10-Nov-08	587
10-Dec-08	595

Date	Flow (MGD) 30-day Avg
10-Jan-09	729
10-Feb-09	756
10-Mar-09	757
10-Apr-09	567
10-May-09	745
10-Jun-09	716
10-Jul-09	729
10-Aug-09	733
10-Sep-09	749
10-Oct-09	716
10-Nov-09	648
10-Dec-09	702
10-Jan-10	733
10-Feb-10	708
10-Mar-10	652
10-Apr-10	690
10-May-10	656
10-Jun-10	643
10-Jul-10	750
10-Aug-10	748
10-Sep-10	737
10-Oct-10	511
10-Nov-10	267
10-Dec-10	104
10-Jan-11	429
10-Feb-11	736
10-Mar-11	533
10-Apr-11	520
10-May-11	510
10-Jun-11	696
10-Jul-11	743
10-Aug-11	727
10-Sep-11	637
10-Oct-11	710
10-Nov-11	354
10-Dec-11	391
10-Jan-12	--
10-Feb-12	608
10-Mar-12	450
10-Apr-12	275
10-May-12	126
10-Jun-12	556

Date	Flow (MGD) 30-day Avg
10-Jul-12	750
10-Aug-12	741
10-Sep-12	682
10-Oct-12	361
10-Nov-12	268
10-Dec-12	272
10-Jan-13	429
10-Feb-13	480
10-Mar-13	598
10-Apr-13	706
10-May-13	198
10-Jun-13	539
10-Jul-13	740
10-Aug-13	741
10-Sep-13	749
10-Oct-13	519
10-Nov-13	448
10-Dec-13	638
10-Jan-14	682
10-Feb-14	729
10-Mar-14	656
10-Apr-14	564
10-May-14	202
10-Jun-14	323
10-Jul-14	745
10-Aug-14	753
10-Sep-14	740
10-Oct-14	631
10-Nov-14	633
10-Dec-14	629
10-Jan-15	677
10-Feb-15	729
10-Mar-15	742
10-Apr-15	560
10-May-15	246
10-Jun-15	505
10-Jul-15	654
10-Aug-15	711
10-Sep-15	719
10-Oct-15	672
10-Nov-15	668
10-Dec-15	569
Minimum	**104**

Chesterfield Power Station VA0004146
DMR Data
August 2012-July 2015

Outfall 004

Date	Flow (MGD) 30-day Max	pH (SU)	DO (mg/L)
10-Aug-12	18.99	8.8	9.1
10-Sep-12	18.08	8.5	8.2
10-Oct-12	12.99	8.3	7
10-Nov-12	8.53	8.3	7.7
10-Dec-12	9.46	8.1	10.5
10-Jan-13	10.54	8.1	11.8
10-Feb-13	16.58	8.5	11.7
10-Mar-13	17.88	7.9	11.2
10-Apr-13	22.41	7.8	10.5
10-May-13	10.85	8	10.2
10-Jun-13	18.45	8.4	9.3
10-Jul-13	16.95	7.9	7.8
10-Aug-13	15.2	7.5	7.5
10-Sep-13	17.69	8.2	7.2
10-Oct-13	11.97	8.2	8.2
10-Nov-13	13.72	8.3	10
10-Dec-13	20.56	8	9.9
10-Jan-14	18.51	7.6	11.9
10-Feb-14	21.69	8.4	11
10-Mar-14	22.23	7.9	12.7
10-Apr-14	20.63	8.3	14.7
10-May-14	11.34	8.5	17.2
10-Jun-14	14.11	8.1	10.9
10-Jul-14	22.06	8.1	9.7
10-Aug-14	15.77	8.5	10.6
10-Sep-14	12.63	8.6	10.2
10-Oct-14	13.62	8.4	8.5
10-Nov-14	11.64	8.2	10.7
10-Dec-14	12.01	8.2	10
10-Jan-15	10.33	7.9	17.9
10-Feb-15	11.23	7.9	13.5
10-Mar-15	12.96	7.8	15.3
10-Apr-15	10.24	7.7	14.9
10-May-15	8.13	8.1	8.8
10-Jun-15	10.54	8.2	8.7
10-Jul-15	12.26	8.2	9
Average	**14.8**	**8.2**	
10th %	**10.3**	**7.8**	
90th %		**8.5**	
Min			**7.0**
Max	**22.41**		

Outfall 005

Date	Flow (MGD) 30-day Max	pH (SU)	DO (mg/L)
10-Aug-12	--	--	--
10-Sep-12	--	--	--
10-Oct-12	--	--	--
10-Nov-12	--	--	--
10-Dec-12	--	--	--
10-Jan-13	--	--	--
10-Feb-13	--	--	--
10-Mar-13	4.05	8	12.7
10-Apr-13	--	--	--
10-May-13	--	--	--
10-Jun-13	--	--	--
10-Jul-13	--	--	--
10-Aug-13	2.93	8.2	7.6
10-Sep-13	--	--	--
10-Oct-13	--	--	--
10-Nov-13	--	--	--
10-Dec-13	--	--	--
10-Jan-14	--	--	--
10-Feb-14	2.49	8.8	11.8
10-Mar-14	--	--	--
10-Apr-14	--	--	--
10-May-14	1.64	8.1	14.5
10-Jun-14	--	--	--
10-Jul-14	--	--	--
10-Aug-14	--	--	--
10-Sep-14	--	--	--
10-Oct-14	--	--	--
10-Nov-14	--	--	--
10-Dec-14	--	--	--
10-Jan-15	--	--	--
10-Feb-15	2.93	7.7	15
10-Mar-15	--	--	--
10-Apr-15	0.96	8	10.3
10-May-15	--	--	--
10-Jun-15	--	--	--
10-Jul-15	--	--	--
Average	**2.5**	**8.1**	
10th %		**7.9**	
90th %		**8.5**	
Min			**7.6**
Max	**4.05**		

Outfall 003 Minimum Circulating Water Flow Below Which No Discharge from the Low Volume Waste Water Treatment System Would Occur

The once-through cooling water that contributes to Outfall 003 originates from pumps associated with generating Units 4, 5 and 6 at the Chesterfield Power Station. The cooling water for each unit is provided by the Station's circulating water system, which supplies cooling water for condensers and heat exchangers that are required when the generating units are starting up, operating, or shutting down. In addition, water taken from the Units 4, 5 and 6 circulating water system also supplies the following Station common equipment regardless of whether the units are operating:

1. Seal water for all 5 pumps at the master sump. The master sump collects blowdown for all 6 units at Chesterfield, water treatment waste streams and floor drains, rain fall for the unit's outside perimeter, and all internal Station drains. Therefore, the seal water is always required to be available so the master sump pumps can operate.
2. Back up to the fire system – If the fire pumps become unavailable or cannot keep desired header pressure on the fire system piping, there is a control valve that would allow circulating water to supply that water and maintain required pressure.
3. Back up feed to water treatment – If the raw water pumps are not available to supply water to the clarifier in the Station's water treatment plant, the circulating water is designed to be the back-up supply to run the plant.
4. Back up feed to Station air compressors.

The Station continuously runs at least one of the Units 4, 5, or 6 circulating water pumps in order to sustain operation and reliability of the unit common equipment, even if the units are not online. The circulating water system for Unit 3, which discharges to the James River through Outfall 002, may also be used to supply the above equipment if circulating water from Units 4, 5, or 6 is not available. However, the use of Unit 3 circulating water for this purpose is an extremely rare event and occurred on only five (5) days over the past 10 years during a brief period in November 2010 when Units 4, 5 and 6 were undergoing overlapping outages.

The Unit 4 circulating water pump operates at a daily flow rate of 57.28 MGD, which is the lowest flow for any of the Units 4, 5 and 6 circulating water pumps. Examination of the daily Outfall 003 flow records for the past 10 years shows that, with the exception of eight days, the lowest daily flow was 57.28 MGD. Of the eight days with lower flows, five days with zero (0) flow occurred during the November 2010 period noted above when Units 4, 5, and 6 were undergoing overlapping outages and Unit 3 circulating water was used to supply the station common equipment. The remaining three (3) days with flows less than 57.28 MGD occurred during brief periods when Units 4, 5, and 6 were all offline and one circulating water pump ran for less than 24 hours.

Based on the above, a daily flow of 57.28 MGD represents a reasonable, process-driven, minimum flow for Outfall 003 below which Dominion can commit to no discharge from the planned Low Volume Waste Water Treatment System.

Daily Discharge Flows from Outfall 003 - 10 Lowest Recorded Flows

Time	Outfall 003 Daily Flow	Rank
11/11/10	0.00	1
04/29/15	7.16	2
11/12/10	23.87	3
04/30/15	30.68	4
11/13/10	57.28	5
11/19/10	73.99	6
04/23/13	75.29	7
12/29/06	85.68	8
04/18/15	85.92	9
04/25/13	87.30	10

Daily Discharge Flows from Outfall 003 - Lowest 7-day Average

	Date	Outfall 003 Daily Flow	Rolling 7-Day Average
	11/07/10	0.00	177.82
	11/08/10	0.00	147.77
	11/09/10	0.00	117.71
	11/10/10	0.00	87.66
	11/11/10	0.00	57.60
	11/12/10	23.87	30.96
Lowest 7-day Average	11/13/10	57.28	11.59
	11/14/10	57.28	19.78
	11/15/10	57.28	27.96
	11/16/10	57.28	36.14
	11/17/10	57.28	44.32
	11/18/10	57.28	52.51
	11/19/10	73.99	59.67
	11/20/10	114.56	67.85
	11/21/10	114.56	76.03
	11/22/10	114.56	84.22
	11/23/10	114.56	92.40
	11/24/10	114.56	100.58
	11/25/10	114.56	108.76
	11/26/10	114.56	114.56
	11/27/10	114.56	114.56
	11/28/10	114.56	114.56
	11/29/10	210.62	128.28
	11/30/10	168.59	136.00
	12/01/10	258.65	156.59
	12/02/10	258.65	177.17
	03/27/12	144.09	158.67

Daily Discharge Flows from Outfall 003 - Lowest 30-day Average

Date	Outfall 003 Daily Flow	Rolling 30-Day Average
11/01/10	210.38	263.41
11/02/10	210.38	259.72
11/03/10	210.38	256.02
11/04/10	210.38	252.33
11/05/10	210.38	248.63
11/06/10	192.85	246.06
11/07/10	0.00	237.43
11/08/10	0.00	228.80
11/09/10	0.00	220.16
11/10/10	0.00	211.53
11/11/10	0.00	202.89
11/12/10	23.87	195.03
11/13/10	57.28	188.24
11/14/10	57.28	181.46
11/15/10	57.28	174.67

Date	Outfall 003 Daily Flow	Rolling 30-Day Average	
11/16/10	57.28	167.88	
11/17/10	57.28	161.10	
11/18/10	57.28	154.31	
11/19/10	73.99	147.45	
11/20/10	114.56	140.66	
11/21/10	114.56	133.87	
11/22/10	114.56	130.20	
11/23/10	114.56	127.80	
11/24/10	114.56	124.00	
11/25/10	114.56	119.06	
11/26/10	114.56	114.20	
11/27/10	114.56	111.11	
11/28/10	114.56	108.01	
11/29/10	210.62	108.02	
11/30/10	168.59	106.67	Lowest 30-day Average

Calculation of 30Q5 Flows for Outfall 003

Yearly lowest 30-day average	Rank	Probability	Return interval	30Q5
103.22	1	0.08	12.0	111.0673935
105.83	2	0.17	6.0	
113.68	3	0.25	4.0	
158.70	4	0.33	3.0	
178.73	5	0.42	2.4	
309.35	6	0.50	2.0	
342.66	7	0.58	1.7	
430.01	8	0.67	1.5	
487.27	9	0.75	1.3	
495.56	10	0.83	1.2	
563.04	11	0.92	1.1	

Observed Pollutatnts that are addressed in the Water Quality Standards (See Reasonable Potential Evaluations in Attachment 5)					
Pollutants	Outfall 001 (11/12/08)	Outfall 002 (11/12/08)	Outfall 003 (11/12/08)	Outfall 004 (1/26/09)	Outfall 005 (1/12/09)
Dissolved Antimony (ug/L)				8.00	
Dissolved Arsenic (ug/L)				41.00	5.00
Dissolved Cadmium(ug/L)				1.10	
Total Chromium (ug/L)				2.00	
Dissolved Copper (ug/L)	6.00, <1.0 *	13.00,4.00 *	2.00	8.00	
Dissolved Mercury (ug/L)	0.00064	0.00094	0.00116		
Dissolved Nickel (ug/L)				25.00	
Total Selenium (ug/L)				19	4
Dissolved Thallium				0.50	0.50
Dissolved Zinc (ug/L)	13.00	26.00		26.00	
Chloroform (ug/L)	1.88	1.60	1.89		
Beta Particle and Photon Activity (pCi/L)	3.69		3.23		2.88
Gross Alpha Particle Activity (pCi/L)				4.44	
Ammonia (ug/L)	100	70	80	2360	10.00
Sulfate (mg/L)	54.52	55.82	57.2	150.31	76.58
Total Iron (mg/L)	0.7	0.5	0.56	0.07	0.39
Total Manganese (mg/L)	0.06	0.05	0.06	0.08	0.08
Total Barium (mg/L)	0.105	0.1	0.121	0.343	0.177
Chlorides (ug/L)	30440	32010	32060	118320	4840
E. coli (N/CML)	50	30	30		
Tributyltin (ug/L)				0.032	0.030

*Sample collected 4/6/09

PWS only

PWS and Aquatic

PWS and HH

Aquatic

Aquatic, PWS and HH

Hardness (mg/L as $CaCO_3$) data 2012-2015

	Outfall				
Date	**001**	**002**	**003**	**004**	**005**
4/23/2012				133	
6/5/2012		106			
6/27/2012	86		96		
7/2/2012				467	
1/28/2013				423	
2/18/2013					52
7/9/2013	66	63	70	366	
10/14/2013				490	
1/6/2014				271	
1/10/2014					52
4/28/2014				282	
8/5/2014	99	97	111	427	
10/13/2014				493	
2/2/2015				567	
1/13/2015					64
5/11/2015				267	
Average	**84**	**89**	**92**	**381**	**56**

Attachment 4.b

Attachment A Data for Outfall 001-003

Outfall 001 Analytical Data for Water Quality Criteria Parameters

CHEMICAL	EPA ANALYSIS NO.	QUANTIFICATION LEVEL[1]	RESULT (ug/L)	SAMPLE TYPE[2]
METALS				
Antimony, dissolved	(3)	700	<1.00	G
Arsenic, dissolved	(3)	270	<3.00	G
Cadmium, dissolved	(3)	2.3	<0.30	G
Chromium III, dissolved [8]	(3)	360	<1.00[A]	G
Chromium VI, dissolved [8]	(3)	13	<1.00	G
Copper, dissolved	(3)	8.3	6.00 B <1.00	G
Lead, dissolved	(3)	67	<1.00	G
Mercury, dissolved	(3)	1.1	0.00064	G
Nickel, dissolved	(3)	120	<5.00	G
Selenium, dissolved	(3)	16	<3.00	G
Silver, dissolved	(3)	1.7	<0.10	G
Thallium, dissolved	(4)	320	<0.20	G
Zinc, dissolved	(3)	74	13.00	G
PESTICIDES / PCBs				
Aldrin	608	0.05	<0.016	G
Chlordane	608	0.2	<0.014	G
Chlorpyrifos (Dursban)	622	(5)	<0.014	G
DDD	608	0.1	<0.021	G
DDE	608	0.1	<0.017	G
DDT	608	0.1	<0.017	G
Demeton	(4)	(5)	<0.521	G
Dieldrin	608	0.1	<0.010	G
Alpha-Endosulfan	608	0.1	<0.014	G
Beta-Endosulfan	608	0.1	<0.017	G
Endosulfan Sulfate	608	0.1	<0.009	G
Endrin	608	0.1	<0.020	G
Endrin Aldehyde	(4)	(5)	<0.019	G

Outfall 001 Analytical Data for Water Quality Criteria Parameters

CHEMICAL	EPA ANALYSIS NO.	QUANTIFICATION LEVEL[1]	RESULT (ug/L)	SAMPLE TYPE[2]
Guthion	622	(5)	<0.3577	G
Heptachlor	608	0.05	<0.016	G
Heptachlor Epoxide	(4)	(5)	<0.012	G
Hexachlorocyclohexane Alpha-BHC	608	(5)	<0.007	G
Hexachlorocyclohexane Beta-BHC	608	(5)	<0.013	G
HexachlorocyclohexaneGamma-BHC (Lindane)	608	(5)	<0.011	G
Kepone	(9)	(5)	<0.015	G
Malathion	(4)	(5)	<0.123	G
Methoxychlor	(4)	(5)	<0.017	G
Mirex	(4)	(5)	<0.015	G
Parathion	(4)	(5)	<0.121	G
PCB 1260	608	1.0	<1.00	G
PCB 1254	608	1.0	<1.00	G
PCB 1248	608	1.0	<1.00	G
PCB 1242	608	1.0	<1.00	G
PCB 1232	608	1.0	<1.00	G
PCB 1221	608	1.0	<1.00	G
PCB 1016	608	1.0	<1.00	G
PCB Total	608	7.0	<7.00	G
Toxaphene	608	5.0	<0.057	G
BASE NEUTRALS				
Acenaphthene	625	10.0	<3.00	G
Anthracene	625	10.0	<1.90	G
Benzidine	(4)	(5)	<63.00	G
Benzo (a) anthracene	625	10.0	<7.80	G
Benzo (b) fluoranthene	625	10.0	<4.80	G
Benzo (k) fluoranthene	625	10.0	<2.50	G
Benzo (a) pyrene	625	10.0	<2.50	G

Outfall 001 Analytical Data for Water Quality Criteria Parameters

CHEMICAL	EPA ANALYSIS NO.	QUANTIFICATION LEVEL[1]	RESULT (ug/L)	SAMPLE TYPE[2]
Bis 2-Chloroethyl Ether	(4)	(5)	<5.70	G
Bis 2-Chloroisopropyl Ether	(4)	(5)	<5.70	G
Butyl benzyl phthalate	625	10.0	<2.50	G
2-Chloronaphthalene	(4)	(5)	<4.60	G
Chrysene	625	10.0	<2.50	G
Dibenz(a,h)anthracene	625	20.0	<2.50	G
Dibutyl phthalate (Di-n-Butyl Phthalate)	625	10.0	<6.40	G
1,2-Dichlorobenzene	624	10.0	<4.00	G
1,3-Dichlorobenzene	624	10.0	<3.10	G
1,4-Dichlorobenzene	624	10.0	<4.40	G
3,3-Dichlorobenzidine	(4)	(5)	<16.50	G
Diethyl phthalate	625	10.0	<7.40	G
Di-2-Ethylhexyl Phthalate	625	10.0	<2.50	G
Dimethyl phthalate	(4)	(5)	<7.50	G
2,4-Dinitrotoluene	625	10.0	<5.70	G
1,2-Diphenylhydrazine	(4)	(5)	<8.80	G
Fluoranthene	625	10.0	<2.20	G
Fluorene	625	10.0	<3.10	G
Hexachlorobenzene	(4)	(5)	<1.80	G
Hexachlorobutadiene	(4)	(5)	<10.00	G
Hexachlorocyclopentadiene	(4)	(5)	<2.40	G
Hexachloroethane	(4)	(5)	<3.70	G
Indeno(1,2,3-cd)pyrene	625	20.0	<3.70	G
Isophorone	625	10.0	<5.10	G
Nitrobenzene	625	10.0	<4.20	G
N-Nitrosodimethylamine	(4)	(5)	<6.20	G
N-Nitrosodi-n-propylamine	(4)	(5)	<3.60	G
N-Nitrosodiphenylamine	(4)	(5)	<2.70	G

Outfall 001 Analytical Data for Water Quality Criteria Parameters

CHEMICAL	EPA ANALYSIS NO.	QUANTIFICATION LEVEL[1]	RESULT (ug/L)	SAMPLE TYPE[2]
Pyrene	625	10.0	<3.80	G
1,2,4-Trichlorobenzene	625	10.0	<7.90	G
VOLATILES				
Acrolein	(4)	(5)	<10.00	G
Acrylonitrile	(4)	(5)	<1.50	G
Benzene	624	10.0	<4.40	G
Bromoform	624	10.0	<4.70	G
Chlorobenzene (monochlorobenzene)	624	50.0	<6.00	G
Chlorodibromomethane	624	10.0	<3.10	G
Chloroform	624	10.0	1.88	G
Dichloromethane (methylene chloride)	624	20.0	<2.80	G
Dichlorobromomethane	624	10.0	<2.20	G
1,2-Dichloroethane	624	10.0	<2.80	G
1,1-Dichloroethylene	624	10.0	<2.80	G
1,2-trans-dichloroethylene	(4)	(5)	<1.60	G
1,2-Dichloropropane	(4)	(5)	<6.00	G
1,3-Dichloropropene	(4)	(5)	<5.90	G
Ethylbenzene	624	10.0	<7.20	G
Methyl Bromide	(4)	(5)	<1.40	G
1,1,2,2-Tetrachloroethane	(4)	(5)	<6.90	G
Tetrachloroethylene	624	10.0	<4.10	G
Toluene	624	10.0	<6.00	G
1,1,2-Trichloroethane	(4)	(5)	<5.00	G
Trichloroethylene	624	10.0	<1.90	G
RADIONUCLIDES				
Strontium 90 (pCi/L)	(4)	(5)	<0.87	G
Tritium (pCi/L)	(4)	(5)	<217	G
Beta Particle & Photon Activity (pCi/L)	(4)	(5)	3.69	G

Outfall 001 Analytical Data for Water Quality Criteria Parameters

CHEMICAL	EPA ANALYSIS NO.	QUANTIFICATION LEVEL[1]	RESULT (ug/L)	SAMPLE TYPE[2]
Gross Alpha Particle Activity (pCi/L)	(4)	(5)	<0.98	G
ACIDS				
2-Chlorophenol	625	10.0	<3.30	G
2,4 Dichlorophenol	625	10.0	<5.60	G
2,4 Dimethylphenol	625	10.0	<5.20	G
2,4-Dinitrophenol	(4)	(5)	<42.00	G
2-Methyl-4,6-Dinitrophenol	(4)	(5)	<24.00	G
Pentachlorophenol	625	50.0	<3.60	G
Phenol	625	10.0	<2.70	G
2,4,6-Trichlorophenol	625	10.0	<2.70	G
MISCELLANEOUS				
Ammonia as NH3-N	350.1	200	100	G
Chlorides	(4)	(5)	30,440	G
Chlorine, Total Residual	(4)	100	< 100	G
Cyanide, Total	(4)	10.0	<10.00	G
E. coli / Enterococcus (N/CML)	(4)	(5)	50	G
Hydrogen Sulfide	(4)	(5)	<50	G
Tributyltin [7]	NBSR 85-3295	(5)	<0.030	G

A = Result is for total chromium
B = Samples for copper analysis were collected from Outfall 001 on 04/06/09 (<1.0 ug/L) and 11/12/09 (6.0 ug/L)

(1) Quantification level (QL) is defined as the lowest concentration used for the calibration of a measurement system when the calibration is in accordance with the procedures published for the required method.

The quantification levels indicated for the metals are actually Specific Target Values developed for this permit. The Specific Target Value is the approximate value that may initiate a wasteload allocation analysis. Target values are not wasteload allocations or effluent limitations. The Specific Target Values are subject to change based on additional information such as hardness data, receiving stream flow, and design flows.

Units for the quantification level are micrograms/liter unless otherwise specified.

Quality control and quality assurance information shall be submitted to document that the required quantification level has been attained.

(2) Sample Type

G = Grab = An individual sample collected in less than 15 minutes. Substances specified with "grab" sample type shall only be collected as grabs. The permittee may analyze multiple grabs and report the average results provided that the individual grab results are also reported. For grab metals samples, the individual samples shall be filtered and preserved immediately upon collection.

C = Composite = A 24-hour **(PW - Revise as required to require same composite duration as BOD_5)** composite unless otherwise specified. The composite shall be a combination of individual samples, taken proportional to flow, obtained at hourly or smaller time intervals. The individual samples may be of equal volume for flows that do not vary by +/- 10 percent over a 24-hour period.

SC = Special Composite = samples for base/neutral/acid compounds, PCBs, and pesticides must be collected as 4 individual grab samples taken proportional to flow at 6-hour intervals over the course of one day. The individual samples may be of equal volume for flows that do not vary by +/- 10 percent over a 24-hour period. Grab samples must be analyzed separately and the concentrations averaged. Alternately, grab samples may be collected in the field and composited in the laboratory if the compositing procedure produces results equivalent to results produced by arithmetic averaging of the results of analysis of individual grab samples.

(3) A specific analytical method is not specified; however a target value for each metal has been established. An appropriate method to meet the target value shall be selected from the following list of EPA methods (or any approved method presented in 40 CFR Part 136). If the test result is less than the method QL, a "<[QL]" shall be reported where the actual analytical test QL is substituted for [QL].

Metal	Analytical Method
Antimony	1638; 1639
Arsenic	206.5; 1632
Chromium[9]	1639
Cadmium	1637; 1638; 1639; 1640
Chromium VI	218.6; 1639
Copper	1638; 1640
Lead	1637; 1638; 1640
Mercury	245.7; 1631
Nickel	1638; 1639; 1640
Selenium	1638; 1639
Silver	1638
Zinc	1638; 1639

(4) Any approved method presented in 40 CFR Part 136.

(5) The QL is at the discretion of the permittee. For any substances addressed in 40 CFR Part 136, the permittee shall use one of the approved methods in 40 CFR Part 136.

(6) Testing for phenol requires continuous extraction.

(7) Analytical Methods: NBSR 85-3295 or DEQ's approved analysis for Tributyltin may also be used [See A Manual for the Analysis of Butyltins in Environmental Systems by the Virginia Institute of Marine Science, dated November 1996].

(8) Both Chromium III and Chromium VI may be measured by the total chromium analysis. If the result of the total chromium analysis is less than or equal to the lesser of the Chromium III or Chromium VI method QL, the results for both Chromium III and Chromium VI can be reported as "<[QL]", where the actual analytical test QL is substituted for [QL].

(9) The lab may use SW846 Method 8270D provided the lab has an Initial Demonstration of Capability, has passed a PT for Kepone, and meets the acceptance criteria for Kepone as given in Method 8270D

Outfall 002 Analytical Data for Water Quality Criteria Parameters

CHEMICAL	EPA ANALYSIS NO.	QUANTIFICATION LEVEL[1]	RESULT (ug/L)	SAMPLE TYPE[2]
METALS				
Antimony, dissolved	(3)	700	<1.00	G
Arsenic, dissolved	(3)	270	<3.00	G
Cadmium, dissolved	(3)	2.3	<0.30	G
Chromium III, dissolved [8]	(3)	360	<1.00 A	G
Chromium VI, dissolved [8]	(3)	13	<10.00	G
Copper, dissolved	(3)	8.3	13.00 B 4.00, 8, <5	G
Lead, dissolved	(3)	67	<1.00	G
Mercury, dissolved	(3)	1.1	0.00094	G
Nickel, dissolved	(3)	120	<5.00	G
Selenium, dissolved	(3)	16	<3.00	G
Silver, dissolved	(3)	1.7	<0.10	G
Thallium, dissolved	(4)	320	<0.20	G
Zinc, dissolved	(3)	74	26.00	G
PESTICIDES / PCBs				
Aldrin	608	0.05	<0.016	G
Chlordane	608	0.2	<0.014	G
Chlorpyrifos (Dursban)	622	(5)	<0.014	G
DDD	608	0.1	<0.021	G
DDE	608	0.1	<0.017	G
DDT	608	0.1	<0.017	G
Demeton	(4)	(5)	<0.521	G
Dieldrin	608	0.1	<0.010	G
Alpha-Endosulfan	608	0.1	<0.014	G
Beta-Endosulfan	608	0.1	<0.017	G
Endosulfan Sulfate	608	0.1	<0.009	G
Endrin	608	0.1	<0.020	G

Outfall 002 Analytical Data for Water Quality Criteria Parameters

CHEMICAL	EPA ANALYSIS NO.	QUANTIFICATION LEVEL[1]	RESULT (ug/L)	SAMPLE TYPE[2]
Endrin Aldehyde	(4)	(5)	<0.019	G
Guthion	622	(5)	<0.3577	G
Heptachlor	608	0.05	<0.016	G
Heptachlor Epoxide	(4)	(5)	<0.012	G
Hexachlorocyclohexane Alpha-BHC	608	(5)	<0.007	G
Hexachlorocyclohexane Beta-BHC	608	(5)	<0.013	G
HexachlorocyclohexaneGamma-BHC (Lindane)	608	(5)	<0.011	G
Kepone	(9)	(5)	<0.015	G
Malathion	(4)	(5)	<0.123	G
Methoxychlor	(4)	(5)	<0.017	G
Mirex	(4)	(5)	<0.015	G
Parathion	(4)	(5)	<0.121	G
PCB 1260	608	1.0	<1.00	G
PCB 1254	608	1.0	<1.00	G
PCB 1248	608	1.0	<1.00	G
PCB 1242	608	1.0	<1.00	G
PCB 1232	608	1.0	<1.00	G
PCB 1221	608	1.0	<1.00	G
PCB 1016	608	1.0	<1.00	G
PCB Total	608	7.0	<7.00	G
Toxaphene	608	5.0	<0.057	G
BASE NEUTRALS				
Acenaphthene	625	10.0	<3.00	G
Anthracene	625	10.0	<1.90	G
Benzidine	(4)	(5)	<63.00	G
Benzo (a) anthracene	625	10.0	<7.80	G
Benzo (b) fluoranthene	625	10.0	<4.80	G
Benzo (k) fluoranthene	625	10.0	<2.50	G

Outfall 002 Analytical Data for Water Quality Criteria Parameters

CHEMICAL	EPA ANALYSIS NO.	QUANTIFICATION LEVEL[1]	RESULT (ug/L)	SAMPLE TYPE[2]
Benzo (a) pyrene	625	10.0	<2.50	G
Bis 2-Chloroethyl Ether	(4)	(5)	<5.70	G
Bis 2-Chloroisopropyl Ether	(4)	(5)	<5.70	G
Butyl benzyl phthalate	625	10.0	<2.50	G
2-Chloronaphthalene	(4)	(5)	<4.60	G
Chrysene	625	10.0	<2.50	G
Dibenz(a,h)anthracene	625	20.0	<2.50	G
Dibutyl phthalate (Di-n-Butyl Phthalate)	625	10.0	<6.40	G
1,2-Dichlorobenzene	624	10.0	<4.00	G
1,3-Dichlorobenzene	624	10.0	<3.10	G
1,4-Dichlorobenzene	624	10.0	<4.40	G
3,3-Dichlorobenzidine	(4)	(5)	<16.50	G
Diethyl phthalate	625	10.0	<7.40	G
Di-2-Ethylhexyl Phthalate	625	10.0	<2.50	G
Dimethyl phthalate	(4)	(5)	<7.50	G
2,4-Dinitrotoluene	625	10.0	<5.70	G
1,2-Diphenylhydrazine	(4)	(5)	<8.80	G
Fluoranthene	625	10.0	<2.20	G
Fluorene	625	10.0	<3.10	G
Hexachlorobenzene	(4)	(5)	<1.80	G
Hexachlorobutadiene	(4)	(5)	<10.00	G
Hexachlorocyclopentadiene	(4)	(5)	<2.40	G
Hexachloroethane	(4)	(5)	<3.70	G
Indeno(1,2,3-cd)pyrene	625	20.0	<3.70	G
Isophorone	625	10.0	<5.10	G
Nitrobenzene	625	10.0	<4.20	G
N-Nitrosodimethylamine	(4)	(5)	<6.20	G
N-Nitrosodi-n-propylamine	(4)	(5)	<3.60	G

Outfall 002 Analytical Data for Water Quality Criteria Parameters

CHEMICAL	EPA ANALYSIS NO.	QUANTIFICATION LEVEL[1]	RESULT (ug/L)	SAMPLE TYPE[2]
N-Nitrosodiphenylamine	(4)	(5)	<2.70	G
Pyrene	625	10.0	<3.80	G
1,2,4-Trichlorobenzene	625	10.0	<7.90	G
VOLATILES				
Acrolein	(4)	(5)	<10.00	G
Acrylonitrile	(4)	(5)	<1.50	G
Benzene	624	10.0	<4.40	G
Bromoform	624	10.0	<4.70	G
Chlorobenzene (monochlorobenzene)	624	50.0	<6.00	G
Chlorodibromomethane	624	10.0	<3.10	G
Chloroform	624	10.0	1.60	G
Dichloromethane (methylene chloride)	624	20.0	<2.80	G
Dichlorobromomethane	624	10.0	<2.20	G
1,2-Dichloroethane	624	10.0	<2.80	G
1,1-Dichloroethylene	624	10.0	<2.80	G
1,2-trans-dichloroethylene	(4)	(5)	<1.60	G
1,2-Dichloropropane	(4)	(5)	<6.00	G
1,3-Dichloropropene	(4)	(5)	<5.90	G
Ethylbenzene	624	10.0	<7.20	G
Methyl Bromide	(4)	(5)	<1.40	G
1,1,2,2-Tetrachloroethane	(4)	(5)	<6.90	G
Tetrachloroethylene	624	10.0	<4.10	G
Toluene	624	10.0	<6.00	G
1,1,2-Trichloroethane	(4)	(5)	<5.00	G
Trichloroethylene	624	10.0	<1.90	G
RADIONUCLIDES				
Strontium 90 (pCi/L)	(4)	(5)	<0.92	G
Tritium (pCi/L)	(4)	(5)	<217	G

Outfall 002 Analytical Data for Water Quality Criteria Parameters

CHEMICAL	EPA ANALYSIS NO.	QUANTIFICATION LEVEL[1]	RESULT (ug/L)	SAMPLE TYPE[2]
Beta Particle & Photon Activity (pCi/L)	(4)	(5)	<0.013	G
Gross Alpha Particle Activity (pCi/L)	(4)	(5)	<0.007	G
ACIDS				
2-Chlorophenol	625	10.0	<3.30	G
2,4 Dichlorophenol	625	10.0	<5.60	G
2,4 Dimethylphenol	625	10.0	<5.20	G
2,4-Dinitrophenol	(4)	(5)	<42.00	G
2-Methyl-4,6-Dinitrophenol	(4)	(5)	<24.00	G
Pentachlorophenol	625	50.0	<3.60	G
Phenol	625	10.0	<2.70	G
2,4,6-Trichlorophenol	625	10.0	<2.70	G
MISCELLANEOUS				
Ammonia as NH3-N	350.1	200	70	C
Chlorides	(4)	(5)	32,010	C
Chlorine, Total Residual	(4)	100	< 100	G
Cyanide, Total	(4)	10.0	<10.00	G
E. coli / Enterococcus (N/CML)	(4)	(5)	30	G
Hydrogen Sulfide	(4)	(5)	<50.00	G
Tributyltin [7]	NBSR 85-3295	(5)	<0.030	G

A = Result is for Total Chromium

B = Samples for copper analysis were collected from Outfall 002 on 04/06/09 (4 ug/L) and on 11/12/08 (13 ug/L) and on 6/25/02 (8 ug/L) and on 1/14/04 (<5 ug/L)

(1) Quantification level (QL) is defined as the lowest concentration used for the calibration of a measurement system when the calibration is in accordance with the procedures published for the required method.

The quantification levels indicated for the metals are actually Specific Target Values developed for this permit. The Specific Target Value is the approximate value that may initiate a wasteload allocation analysis. Target values are not wasteload allocations or effluent limitations. The Specific Target Values are subject to change based on additional information such as hardness data, receiving stream flow, and design flows.

Units for the quantification level are micrograms/liter unless otherwise specified.

Quality control and quality assurance information shall be submitted to document that the required quantification level has been attained.

(2) Sample Type

G = Grab = An individual sample collected in less than 15 minutes. Substances specified with "grab" sample type shall only be collected as grabs. The permittee may analyze multiple grabs and report the average results provided that the individual grab results are also reported. For grab metals samples, the individual samples shall be filtered and preserved immediately upon collection.

C = Composite = A 24-hour **(PW - Revise as required to require same composite duration as BOD_5)** composite unless otherwise specified. The composite shall be a combination of individual samples, taken proportional to flow, obtained at hourly or smaller time intervals. The individual samples may be of equal volume for flows that do not vary by +/- 10 percent over a 24-hour period.

SC = Special Composite = samples for base/neutral/acid compounds, PCBs, and pesticides must be collected as 4 individual grab samples taken proportional to flow at 6-hour intervals over the course of one day. The individual samples may be of equal volume for flows that do not vary by +/- 10 percent over a 24-hour period. Grab samples must be analyzed separately and the concentrations averaged. Alternately, grab samples may be collected in the field and composited in the laboratory if the compositing procedure produces results equivalent to results produced by arithmetic averaging of the results of analysis of individual grab samples.

(3) A specific analytical method is not specified; however a target value for each metal has been established. An appropriate method to meet the target value shall be selected from the following list of EPA methods (or any approved method presented in 40 CFR Part 136). If the test result is less than the method QL, a "<[QL]" shall be reported where the actual analytical test QL is substituted for [QL].

Metal	Analytical Method
Antimony	1638; 1639
Arsenic	206.5; 1632
Chromium[9]	1639
Cadmium	1637; 1638; 1639; 1640
Chromium VI	218.6; 1639
Copper	1638; 1640
Lead	1637; 1638; 1640
Mercury	245.7; 1631
Nickel	1638; 1639; 1640
Selenium	1638; 1639
Silver	1638
Zinc	1638; 1639

(4) Any approved method presented in 40 CFR Part 136.

(5) The QL is at the discretion of the permittee. For any substances addressed in 40 CFR Part 136, the permittee shall use one of the approved methods in 40 CFR Part 136.

(6) Testing for phenol requires continuous extraction.

(7) Analytical Methods: NBSR 85-3295 or DEQ's approved analysis for Tributyltin may also be used [See A Manual for the Analysis of Butyltins in Environmental Systems by the Virginia Institute of Marine Science, dated November 1996].

(8) Both Chromium III and Chromium VI may be measured by the total chromium analysis. If the result of the total chromium analysis is less than or equal to the lesser of the Chromium III or Chromium VI method QL, the results for both Chromium III and Chromium VI can be reported as "<[QL]", where the actual analytical test QL is substituted for [QL].

(9) The lab may use SW846 Method 8270D provided the lab has an Initial Demonstration of Capability, has passed a PT for Kepone, and meets the acceptance criteria for Kepone as given in Method 8270D

Outfall 003 Analytical Data for Water Quality Criteria Parameters

CHEMICAL	EPA ANALYSIS NO.	QUANTIFICATION LEVEL[1]	RESULT (ug/L)	SAMPLE TYPE[2]
METALS				
Antimony, dissolved	(3)	14	<1.00	G
Arsenic, dissolved	(3)	10	<3.00	G
Cadmium, dissolved	(3)	0.55	<0.30	G
Chromium III, dissolved [8]	(3)	36	<1.00 A	G
Chromium VI, dissolved [8]	(3)	6.4	<1.00 A	G
Copper, dissolved	(3)	4.2	2.00	G
Lead, dissolved	(3)	5.7	<1.00	G
Mercury, dissolved	(3)	1.0	0.00116	G
Nickel, dissolved	(3)	9.6	<5.00	G
Selenium, dissolved	(3)	3.0	<3.00	G
Silver, dissolved	(3)	0.86	<0.10	G
Thallium, dissolved	(4)	6.3	<0.20	G
Zinc, dissolved	(3)	37	<10.00	G
PESTICIDES / PCBs				
Aldrin	608	0.05	<0.016	G
Chlordane	608	0.2	<0.014	G
Chlorpyrifos (Dursban)	622	(5)	<0.014	G
DDD	608	0.1	<0.021	G
DDE	608	0.1	<0.017	G
DDT	608	0.1	<0.017	G
Demeton	(4)	(5)	<0.521	G
Dieldrin	608	0.1	<0.010	G
Alpha-Endosulfan	608	0.1	<0.014	G
Beta-Endosulfan	608	0.1	<0.017	G
Endosulfan Sulfate	608	0.1	<0.009	G
Endrin	608	0.1	<0.020	G
Endrin Aldehyde	(4)	(5)	<0.019	G

Outfall 003 Analytical Data for Water Quality Criteria Parameters

CHEMICAL	EPA ANALYSIS NO.	QUANTIFICATION LEVEL[1]	RESULT (ug/L)	SAMPLE TYPE[2]
Guthion	622	(5)	<0.3577	G
Heptachlor	608	0.05	<0.016	G
Heptachlor Epoxide	(4)	(5)	<0.012	G
Hexachlorocyclohexane Alpha-BHC	608	(5)	<0.007	G
Hexachlorocyclohexane Beta-BHC	608	(5)	<0.013	G
HexachlorocyclohexaneGamma-BHC (Lindane)	608	(5)	<0.011	G
Kepone	(9)	(5)	<0.015	G
Malathion	(4)	(5)	<0.123	G
Methoxychlor	(4)	(5)	<0.017	G
Mirex	(4)	(5)	<0.015	G
Parathion	(4)	(5)	<0.121	G
PCB 1260	608	1.0	<1.00	G
PCB 1254	608	1.0	<1.00	G
PCB 1248	608	1.0	<1.00	G
PCB 1242	608	1.0	<1.00	G
PCB 1232	608	1.0	<1.00	G
PCB 1221	608	1.0	<1.00	G
PCB 1016	608	1.0	<1.00	G
PCB Total	608	7.0	<7.00	G
Toxaphene	608	5.0	<0.057	G
BASE NEUTRALS				
Acenaphthene	625	10.0	<3.00	G
Anthracene	625	10.0	<1.90	G
Benzidine	(4)	(5)	<63.00	G
Benzo (a) anthracene	625	10.0	<7.80	G
Benzo (b) fluoranthene	625	10.0	<4.80	G
Benzo (k) fluoranthene	625	10.0	<2.50	G
Benzo (a) pyrene	625	10.0	<2.50	G

Outfall 003 Analytical Data for Water Quality Criteria Parameters

CHEMICAL	EPA ANALYSIS NO.	QUANTIFICATION LEVEL[1]	RESULT (ug/L)	SAMPLE TYPE[2]
Bis 2-Chloroethyl Ether	(4)	(5)	<5.70	G
Bis 2-Chloroisopropyl Ether	(4)	(5)	<5.70	G
Butyl benzyl phthalate	625	10.0	<2.50	G
2-Chloronaphthalene	(4)	(5)	<4.60	G
Chrysene	625	10.0	<2.50	G
Dibenz(a,h)anthracene	625	20.0	<2.50	G
Dibutyl phthalate (Di-n-Butyl Phthalate)	625	10.0	<6.40	G
1,2-Dichlorobenzene	624	10.0	<4.00	G
1,3-Dichlorobenzene	624	10.0	<3.10	G
1,4-Dichlorobenzene	624	10.0	<4.40	G
3,3-Dichlorobenzidine	(4)	(5)	<16.50	G
Diethyl phthalate	625	10.0	<7.40	G
Di-2-Ethylhexyl Phthalate	625	10.0	<2.50	G
Dimethyl phthalate	(4)	(5)	<7.50	G
2,4-Dinitrotoluene	625	10.0	<5.70	G
1,2-Diphenylhydrazine	(4)	(5)	<8.80	G
Fluoranthene	625	10.0	<2.20	G
Fluorene	625	10.0	<3.10	G
Hexachlorobenzene	(4)	(5)	<1.80	G
Hexachlorobutadiene	(4)	(5)	<10.00	G
Hexachlorocyclopentadiene	(4)	(5)	<2.40	G
Hexachloroethane	(4)	(5)	<3.70	G
Indeno(1,2,3-cd)pyrene	625	20.0	<3.70	G
Isophorone	625	10.0	<5.10	G
Nitrobenzene	625	10.0	<4.20	G
N-Nitrosodimethylamine	(4)	(5)	<6.20	G
N-Nitrosodi-n-propylamine	(4)	(5)	<3.60	G
N-Nitrosodiphenylamine	(4)	(5)	<2.70	G

Outfall 003 Analytical Data for Water Quality Criteria Parameters

CHEMICAL	EPA ANALYSIS NO.	QUANTIFICATION LEVEL[1]	RESULT (ug/L)	SAMPLE TYPE[2]
Pyrene	625	10.0	<3.80	G
1,2,4-Trichlorobenzene	625	10.0	<7.90	G
VOLATILES				
Acrolein	(4)	(5)	<10.00	G
Acrylonitrile	(4)	(5)	<1.50	G
Benzene	624	10.0	<4.40	G
Bromoform	624	10.0	<4.70	G
Chlorobenzene (monochlorobenzene)	624	50.0	<6.00	G
Chlorodibromomethane	624	10.0	<3.10	G
Chloroform	624	10.0	1.89	G
Dichloromethane (methylene chloride)	624	20.0	<2.80	G
Dichlorobromomethane	624	10.0	<2.20	G
1,2-Dichloroethane	624	10.0	<2.80	G
1,1-Dichloroethylene	624	10.0	<2.80	G
1,2-trans-dichloroethylene	(4)	(5)	<1.60	G
1,2-Dichloropropane	(4)	(5)	<6.00	G
1,3-Dichloropropene	(4)	(5)	<5.90	G
Ethylbenzene	624	10.0	<7.20	G
Methyl Bromide	(4)	(5)	<1.40	G
1,1,2,2-Tetrachloroethane	(4)	(5)	<6.90	G
Tetrachloroethylene	624	10.0	<4.10	G
Toluene	624	10.0	<6.00	G
1,1,2-Trichloroethane	(4)	(5)	<5.00	G
Trichloroethylene	624	10.0	<1.90	G
RADIONUCLIDES				
Strontium 90 (pCi/L)	(4)	(5)	<0.90	G
Tritium (pCi/L)	(4)	(5)	<217	G
Beta Particle & Photon Activity (pCi/L)	(4)	(5)	3.23	G

Outfall 003 Analytical Data for Water Quality Criteria Parameters

CHEMICAL	EPA ANALYSIS NO.	QUANTIFICATION LEVEL[1]	RESULT (ug/L)	SAMPLE TYPE[2]
Gross Alpha Particle Activity (pCi/L)	(4)	(5)	<1.06	G
ACIDS				
2-Chlorophenol	625	10.0	<3.30	G
2,4 Dichlorophenol	625	10.0	<5.60	G
2,4 Dimethylphenol	625	10.0	<5.20	G
2,4-Dinitrophenol	(4)	(5)	<42.00	G
2-Methyl-4,6-Dinitrophenol	(4)	(5)	<24.00	G
Pentachlorophenol	625	50.0	<3.60	G
Phenol	625	10.0	<2.70	G
2,4,6-Trichlorophenol	625	10.0	<2.70	G
MISCELLANEOUS				
Ammonia as NH3-N	350.1	200	80	G
Chlorides	(4)	(5)	32,060	G
Chlorine, Total Residual	(4)	100	< 100	G
Cyanide, Total	(4)	10.0	<10.00	G
E. coli / Enterococcus (N/CML)	(4)	(5)	30	G
Hydrogen Sulfide	(4)	(5)	<0.05	G
Tributyltin [7]	NBSR 85-3295	(5)	<0.030	G

A = Result is for total chromium

(1) Quantification level (QL) is defined as the lowest concentration used for the calibration of a measurement system when the calibration is in accordance with the procedures published for the required method.

The quantification levels indicated for the metals are actually Specific Target Values developed for this permit. The Specific Target Value is the approximate value that may initiate a wasteload allocation analysis. Target values are not wasteload allocations or effluent limitations. The Specific Target Values are subject to change based on additional information such as hardness data, receiving stream flow, and design flows.

Units for the quantification level are micrograms/liter unless otherwise specified.

Quality control and quality assurance information shall be submitted to document that the required quantification level has been attained.

(2) Sample Type

G = Grab = An individual sample collected in less than 15 minutes. Substances specified with "grab" sample type shall only be collected as grabs. The permittee may analyze multiple grabs and report the average results provided that the individual grab results are also reported. For grab metals samples, the individual samples shall be filtered and preserved immediately upon collection.

C = Composite = A 24-hour **(PW - Revise as required to require same composite duration as BOD_5)** composite unless otherwise specified. The composite shall be a combination of individual samples, taken proportional to flow, obtained at hourly or smaller time intervals. The individual samples may be of equal volume for flows that do not vary by +/- 10 percent over a 24-hour period.

SC = Special Composite = samples for base/neutral/acid compounds, PCBs, and pesticides must be collected as 4 individual grab samples taken proportional to flow at 6-hour intervals over the course of one day. The individual samples may be of equal volume for flows that do not vary by +/- 10 percent over a 24-hour period. Grab samples must be analyzed separately and the concentrations averaged. Alternately, grab samples may be collected in the field and composited in the laboratory if the compositing procedure produces results equivalent to results produced by arithmetic averaging of the results of analysis of individual grab samples.

(3) A specific analytical method is not specified; however a target value for each metal has been established. An appropriate method to meet the target value shall be selected from the following list of EPA methods (or any approved method presented in 40 CFR Part 136). If the test result is less than the method QL, a "<[QL]" shall be reported where the actual analytical test QL is substituted for [QL].

Metal	Analytical Method
Antimony	1638; 1639
Arsenic	206.5; 1632
Chromium[9]	1639
Cadmium	1637; 1638; 1639; 1640
Chromium VI	218.6; 1639
Copper	1638; 1640
Lead	1637; 1638; 1640
Mercury	245.7; 1631
Nickel	1638; 1639; 1640
Selenium	1638; 1639
Silver	1638
Zinc	1638; 1639

(4) Any approved method presented in 40 CFR Part 136.

(5) The QL is at the discretion of the permittee. For any substances addressed in 40 CFR Part 136, the permittee shall use one of the approved methods in 40 CFR Part 136.

(6) Testing for phenol requires continuous extraction.

(7) Analytical Methods: NBSR 85-3295 or DEQ's approved analysis for Tributyltin may also be used [See A Manual for the Analysis of Butyltins in Environmental Systems by the Virginia Institute of Marine Science, dated November 1996].

(8) Both Chromium III and Chromium VI may be measured by the total chromium analysis. If the result of the total chromium analysis is less than or equal to the lesser of the Chromium III or Chromium VI method QL, the results for both Chromium III and Chromium VI can be reported as "<[QL]", where the actual analytical test QL is substituted for [QL].

(9) The lab may use SW846 Method 8270D provided the lab has an Initial Demonstration of Capability, has passed a PT for Kepone, and meets the acceptance criteria for Kepone as given in Method 8270D

4.c Outfall 301 Worst Case Concentration Scenarios

Because the LVWWTS has not been constructed, the permittee is unable to definitively characterize the wastewater via effluent sampling and analysis. Alternatively, worst case scenario concentrations were developed using a set of conservative assumptions for flow scenarios along with existing and simulated concentration data for the pertinent waste streams to be routed to the LVWWTS. The methodology for developing the worst case concentrations is presented below.

Flow Descriptions

Flow estimates were measured and estimated for the various process and stormwater runoff flows that discharge to the LVWWTS. The attached Table 1 presents a summary of the maximum and average process flows and the stormwater runoff flows for the various waste streams for two typical operating scenarios at the Chesterfield Power Station. The scenarios are presented in the following section.

The average and maximum process flows were estimated based on actual metered flow data (Master Sump, FGD Yard, and FGD Plant), design information such as pump capacities (LAP toe drain and UAP toe drain), design modeling (leachate), and previously reported flow data (metals pond). Other sources contribute stormwater only and have no process water contribution (bottom ash, S-ditch, and coal pile runoff).

Stormwater flows were generally calculated by modeling the runoff from a 25-year, 24-hour storm event (design storm) over the drainage area contributing to the source. The S-ditch stormwater flow is a manually controlled stormwater discharge, and the estimate is based on the operation of a 3,000 GPM pump.

In the application addendum received May 5, 2016, the permittee indicated a change in the LWWWTS design that involved adding an equalization volume of approximately 8 MGD to allow for effluent flows below 6.0 MGD. In light of this change, the evaluation was modified to reflect an effluent flow of 6.0 MGD and a maximum daily limitation of 6.0 MGD was added to Outfall 301. Because the reduction in flow is achieved via equalization, the characteristics of the wastewater determined in the aforementioned Worst Case Scenario evaluation remain representative of the discharge.

Scenario Descriptions

The scenarios described in the following discussion are based on realistic and possible operating conditions of the Chesterfield Power Station and are representative of actual conditions. The first scenario is the maximum process flow from the Station during dry weather. The second scenario is the maximum flow anticipated during a 25-year, 24-hour storm event, which is considered the design storm event for the LVWWTS. Scenario 1 is process flow only, and Scenario 2 represents both process and stormwater flow combined. It should be noted that in estimating Scenario 2 flows, the average process flow was added to the stormwater flow for discharges that include both process and stormwater flow. The average process flow was used since it most accurately represents the facility's operations during a major storm event.

Table 1 presents the individual flows for each internal discharge along with the flows for both scenarios. The Scenario 1 flow is equal to the Process Maximum flow. The Scenario 2 flow is equal to the sum of the Process Average flow and the Design Stormwater Runoff flow. A discussion of the worst case concentration calculations is provided below.

Worst Case Concentrations

The flow weighted average of the concentrations for the pollutants of concern in the waste streams that contribute to Outfall 301 are located in the following pages of this section. The worst case scenario was calculated by first dividing the flow of an individual waste stream for a particular scenario by the total flow of all waste streams for that scenario (see Table 1 for flows). Then, the resulting fraction of the total flow for the particular waste stream was multiplied by the maximum observed concentration for a particular pollutant. Finally, the products of the concentration and flow were summed for all the contributing waste streams as shown by the following equation:

Combined Discharge Concentration (mg/L) = (Q1/ΣQi) x Max Conc1 + (Q2/ΣQi) x Max Conc2 + ….. (Qn/ΣQi) x Max Concn)

Where: Qi is the expected maximum flow rate from each waste stream (i.e. Master Sump, FGD Plant, etc)

Max Conc is the maximum constituent concentration sampled from the waste stream.

ΣQi is the sum of the flows of the various waste streams.

This calculation was completed for all the contributeng waste streams for each scenario to determine the worst case concentrations for each scenario.

Table 1 – Individual Waste Streams and the Associated Flows for Scenarios 1 and 2

Waste Stream	Flows (Qi) (MGD)	
	Scenario 1[(1)]	Scenario 2[(2)]
Bottom Ash	--	0.8
S-Ditch	--	0.8
Master Sump	4.0	6.3
FGD Yard	3.4	2.0
FGD Plant	0.35	0.11
Leachate	0.19	0.08
LAP / UAP Toe Drains and Non- Contact Stormwater	0.8	0.8
Metals Pond	5.0	--
Coal Yard	--	2.4
Total (ΣQi)	13.74	13.29

(1) **Scenario 1 represents dry weather flows. Flows from the Bottom Ash area, S-Ditch, and Coal pile are zero because flows occur only during rain events.**

(2) **No flow will be sent to the LVWWTS from the metals pond during large storm events per the O&M Manual.**

The table that follows reflects the Worst Case concentrations for Scenario 1 and Scenario 2 for each pollutant and the maximum of those two values, which was used in the reasonable potential evaluation. Any data less than the Reporting Limit is considered absent for the purposes of this evaluation.

		SCENARIO 1 RESULTS	SCENARIO 2 RESULTS	MAX RESULTS
ChemName	Output Unit	Worst Case Concentration of the COC Expected in Outfall 301 Prior to Any Treatment (mg/L)	Worst Case Concentration of the COC Expected in Outfall 301 Prior to Any Treatment (mg/L)	Worst Case Concentration of the COC Expected in Outfall 301 Prior to Any Treatment in either Scenario (mg/L)
1,1,1-trichloroethane	mg/L	0.0003004	0.0002773	0.0003004
1,1,2,2-tetrachloroethane	mg/L	0.0002190	0.0001959	0.0002190
1,1,2-trichloroethane	mg/L	0.0002117	0.0001930	0.0002117
1,1-dichloroethane	mg/L	0.0001328	0.0001181	0.0001328
1,1-dichloroethene	mg/L	0.0003102	0.0002866	0.0003102
1,2,4-trichlorobenzene	mg/L	0.0007271	0.0006753	0.0007271
1,2-dichlorobenzene	mg/L	0.0001640	0.0001469	0.0001640
1,2-dichloroethane	mg/L	0.0002288	0.0002053	0.0002288
1,2-dichloropropane	mg/L	0.0001155	0.0000976	0.0001155
1,2-Trans-dichloroethene	mg/L	0.0001821	0.0001649	0.0001821
1,3-dichlorobenzene	mg/L	0.0001246	0.0001094	0.0001246
1,3-Dichloropropene	mg/L	0.0005073	0.0004738	0.0005073
1,4-dichlorobenzene	mg/L	0.0002231	0.0002030	0.0002231
2,3,7,8-Tetrachlorooxanthrene	mg/L	2.12E-11	8.43E-12	2.12E-11
2,4,6-trichlorophenol	mg/L	0.0017175	0.0016123	0.0017175
2,4-dichlorophenol	mg/L	0.0003424	0.0003167	0.0003424
2,4-dimethylphenol	mg/L	0.0008393	0.0007981	0.0008393
2,4-dinitrophenol	mg/L	0.0059730	0.0057243	0.0059730
2,4-Dinitrotoluene	mg/L	0.0005411	0.0005098	0.0005411
2,6-dichlorophenol	mg/L	0.0000162	0.0000065	0.0000162
2,6-dinitrotoluene	mg/L	0.0007955	0.0007530	0.0007955
2-Chloroethylvinyl ether	mg/L	0.0003194	0.0002631	0.0003194
2-chloronaphthalene	mg/L	0.0001625	0.0001482	0.0001625
2-chlorophenol	mg/L	0.0016497	0.0015644	0.0016497
2-methylphenol	mg/L	0.0000809	0.0000322	0.0000809
2-nitrophenol	mg/L	0.0016758	0.0015964	0.0016758
3,3-Dichlorobenzidine	mg/L	0.0011749	0.0010700	0.0011749
3,4-Benzo-fluoranthene	mg/L	0.0001697	0.0001546	0.0001697
4,4-DDE	mg/L	0.0000011	0.0000009	0.0000011
4,6-Dinitro-2-methylphenol	mg/L	0.0021685	0.0020644	0.0021685
4-bromophenyl phenyl ether	mg/L	0.0006355	0.0006019	0.0006355
4-chlorophenyl phenyl ether	mg/L	0.0005055	0.0004741	0.0005055
4-nitrophenol	mg/L	0.0063459	0.0060541	0.0063459
a-BHC	mg/L	0.0000032	0.0000023	0.0000032
Accrolein	mg/L	0.0027081	0.0024919	0.0027081
Acenaphthene	mg/L	0.0001568	0.0001390	0.0001568
Acenaphthylene	mg/L	0.0001625	0.0001482	0.0001625
Acrylonitrile	mg/L	0.0009274	0.0009534	0.0009534
Aldrin	mg/L	0.0000020	0.0000014	0.0000020
Alkalinity (Bicarbonate as CaCO3)	mg/L	93.0153174	82.2154070	93.0153174
Alkalinity (Carbonate as CaCO3)	mg/L	50.5530691	21.5794186	50.5530691
Alkalinity (total) as CaCO3	mg/L	148.3436151	101.3433140	148.3436151
Aluminium	mg/L	1.2137517	9.1982366	9.1982366
Ammonia as N	mg/L	1.7954554	1.1157267	1.7954554
Anthracene	mg/L	0.0001666	0.0001483	0.0001666
Antimony	mg/L	0.0041831	0.0023848	0.0041831
Arochlor 1016	mg/L	0.0000029	0.0000025	0.0000029
Arochlor 1221	mg/L	0.0000053	0.0000034	0.0000053
Arochlor 1232	mg/L	0.0000031	0.0000028	0.0000031
Arochlor 1242	mg/L	0.0000024	0.0000019	0.0000024
Arochlor 1248	mg/L	0.0000029	0.0000024	0.0000029
Arochlor 1254	mg/L	0.0000019	0.0000014	0.0000019
Arochlor 1260	mg/L	0.0000019	0.0000014	0.0000019
Arsenic	mg/L	0.0242846	0.0245589	0.0245589
Azinophos methyl	mg/L	0.0001125	0.0000571	0.0001125
Barium	mg/L	0.2281199	0.2351446	0.2351446
b-BHC	mg/L	0.0000042	0.0000026	0.0000042
Benz(a)anthracene	mg/L	0.0002248	0.0001711	0.0002248
Benzene	mg/L	0.0001262	0.0001097	0.0001262
Benzidine	mg/L	0.0339973	0.0324477	0.0339973
Benzo(a) pyrene	mg/L	0.0001469	0.0001296	0.0001469
Benzo(g,h,i)perylene	mg/L	0.0001625	0.0001482	0.0001625
Benzo(k)fluoranthene	mg/L	0.0005510	0.0005192	0.0005510
Beryllium	mg/L	0.0005723	0.0044892	0.0044892
Biochemical Oxygen Demand	mg/L	6.2786851	6.3954942	6.3954942
Bis(2-chloroethoxy) methane	mg/L	0.0005831	0.0005505	0.0005831
Bis(2-chloroethyl)ether	mg/L	0.0002610	0.0002403	0.0002610
Bis(2-chloroisopropyl) ether	mg/L	0.0002117	0.0001935	0.0002117

ChemName	Output Unit	Worst Case Concentration of the COC Expected in Outfall 301 Prior to Any Treatment (mg/L)	Worst Case Concentration of the COC Expected in Outfall 301 Prior to Any Treatment (mg/L)	Worst Case Concentration of the COC Expected in Outfall 301 Prior to Any Treatment in either Scenario (mg/L)
Bis(2-ethylhexyl) phthalate	mg/L	0.0124097	0.0118422	0.0124097
Bisphenol A	mg/L	0.0003112	0.0005227	0.0005227
Boron	mg/L	38.6533858	19.6088517	38.6533858
Bromide	mg/L	74.2301880	39.5070058	74.2301880
Bromoform	mg/L	0.0002091	0.0001866	0.0002091
Butyl benzyl phthalate	mg/L	0.0014192	0.0013307	0.0014192
Cadmium	mg/L	0.0005013	0.0013822	0.0013822
Carbon tetrachloride	mg/L	0.0001526	0.0001369	0.0001526
Chemical Oxygen Demand	mg/L	76.6634688	76.1203488	76.6634688
chlordane	mg/L	0.0000046	0.0000035	0.0000046
Chloride	mg/L	1286.3990862	965.5514535	1286.3990862
Chlorine, Total Residual	mg/L	0.6582562	0.5182267	0.6582562
Chlorobenzene	mg/L	0.0001453	0.0001340	0.0001453
Chlorodibromomethane	mg/L	0.0004125	0.0003704	0.0004125
Chloroethane	mg/L	0.0002215	0.0002024	0.0002215
Chloroform	mg/L	0.0092130	0.0088057	0.0092130
Chlorpyrifos	mg/L	0.0001127	0.0000559	0.0001127
Chromium (Hexavalent)	mg/L	0.0089701	0.0421279	0.0421279
Chromium (Total)	mg/L	0.0033224	0.0095347	0.0095347
Chrysene	mg/L	0.0001526	0.0001374	0.0001526
cis-1,3-dichloropropene	mg/L	0.0002018	0.0001837	0.0002018
Cobalt	mg/L	0.0036689	0.0550824	0.0550824
Color	o	0.1460154	0.0581395	0.1460154
Copper	mg/L	0.0196311	0.0852873	0.0852873
Cyanide (Total)	mg/L	0.0039990	0.0036875	0.0039990
d-BHC	mg/L	0.0000004	0.0000005	0.0000005
DDD	mg/L	0.0000007	0.0000010	0.0000010
DDT	mg/L	0.0000009	0.0000008	0.0000009
Demeton (total)	mg/L	0.0000314	0.0000304	0.0000314
Demeton-O	mg/L	0.0000949	0.0000378	0.0000949
Demeton-S	mg/L	0.0000949	0.0000378	0.0000949
Diazinon	mg/L	0.0001130	0.0000551	0.0001130
Dibenz(a,h)anthracene	mg/L	0.0001697	0.0001529	0.0001697
Dichlorobromomethane	mg/L	0.0015309	0.0016057	0.0016057
Dichlorodifluoromethane	mg/L	0.0000146	0.0000058	0.0000146
Dieldrin	mg/L	0.0000016	0.0000038	0.0000038
Diesel Range Organics	mg/L	0.2320876	0.2738372	0.2738372
Diethylphthalate	mg/L	0.0014526	0.0013772	0.0014526
Dimethyl phthalate	mg/L	0.0007659	0.0007249	0.0007659
Di-n-butyl phthalate	mg/L	0.0012410	0.0011507	0.0012410
Di-n-octyl phthalate	mg/L	0.0020673	0.0019526	0.0020673
Diphenylhydrazine	mg/L	0.0007222	0.0006462	0.0007222
E. Coli	cfu/100 ml	0.0146015	0.0058140	0.0146015
EC (field)	µS/cm	6505.8168439	2491.1468023	6505.8168439
Endosulfan I	mg/L	0.0000016	0.0000012	0.0000016
Endosulfan II	mg/L	0.0000075	0.0000076	0.0000076
Endosulfan sulphate	mg/L	0.0000364	0.0000202	0.0000364
Endrin	mg/L	0.0000017	0.0000013	0.0000017
Endrin aldehyde	mg/L	0.0000009	0.0000009	0.0000009
Enterococci	MPN/100 mL	0.0146015	0.0058140	0.0146015
Ethylbenzene	mg/L	0.0002463	0.0002219	0.0002463
Fecal Coliforms	MPN/100 mL	0.0292031	0.0116279	0.0292031
Fluoranthene	mg/L	0.0001724	0.0001576	0.0001724
Fluorene	mg/L	0.0002312	0.0002104	0.0002312
Fluoride	mg/L	1.4944091	0.8781468	1.4944091
Gasoline Range Organics	mg/L	0.0367344	0.0348183	0.0367344
g-BHC (Lindane)	mg/L	0.0000008	0.0000008	0.0000008
Hardness	mg/L	20.0041057	7.9651163	20.0041057
HEM	mg/L	1.2065481	1.1380814	1.2065481
Heptachlor	mg/L	0.0000275	0.0000150	0.0000275
Heptachlor epoxide	mg/L	0.0000015	0.0000012	0.0000015
Hexachlorobenzene	mg/L	0.0002154	0.0001856	0.0002154
Hexachlorobutadiene	mg/L	0.0001796	0.0001623	0.0001796
Hexachlorocyclopentadiene	mg/L	0.0005214	0.0004911	0.0005214
Hexachloroethane	mg/L	0.0006295	0.0005925	0.0006295
Indeno(1,2,3-c,d)pyrene	mg/L	0.0002117	0.0001935	0.0002117
Iron	mg/L	1.0666870	22.1858541	22.1858541
Isophorone	mg/L	0.0006423	0.0006066	0.0006423
Kepone	mg/L	0.0094587	0.0090538	0.0094587

ChemName	Output Unit	Worst Case Concentration of the COC Expected in Outfall 301 Prior to Any Treatment (mg/L)	Worst Case Concentration of the COC Expected in Outfall 301 Prior to Any Treatment (mg/L)	Worst Case Concentration of the COC Expected in Outfall 301 Prior to Any Treatment in either Scenario (mg/L)
Lead	mg/L	0.0031498	0.0049029	0.0049029
Lithium	mg/L	0.0727598	0.0747882	0.0747882
Magnesium	mg/L	120.6684244	79.4206686	120.6684244
Malathion	mg/L	0.0000356	0.0000259	0.0000356
Manganese	mg/L	0.1773479	0.7100262	0.7100262
Mercury	mg/L	0.0000800	0.0000696	0.0000800
Methoxychlor	mg/L	0.0000001	0.0000000	0.0000001
Methyl Bromide	mg/L	0.0003201	0.0002960	0.0003201
Methyl Chloride	mg/L	0.0002978	0.0002708	0.0002978
Methylene Chloride	mg/L	0.0002597	0.0011925	0.0011925
Mirex	mg/L	0.0000005	0.0000005	0.0000005
Molybdenum	mg/L	0.0266343	0.0185834	0.0266343
Naphthalene	mg/L	0.0002176	0.0004179	0.0004179
Nickel	mg/L	0.0221284	0.1064634	0.1064634
Nitrate	mg/L	0.0058406	0.0023256	0.0058406
Nitrate (as N)	mg/L	15.8133627	9.1848328	15.8133627
Nitrite	mg/L	0.0011681	0.0004651	0.0011681
Nitrite (as N)	mg/L	0.2273397	0.1911047	0.2273397
Nitrobenzene	mg/L	0.0009028	0.0008178	0.0009028
Nitrogen (Organic)	mg/L	0.0087609	0.0034884	0.0087609
Nitrogen (Total Oxidised)	mg/L	0.0058406	0.0023256	0.0058406
Nitrogen (Total)	mg/L	0.0449727	0.0179070	0.0449727
N-Nitrosodimethylamine	mg/L	0.0007526	0.0007033	0.0007526
N-nitrosodi-n-propylamine	mg/L	0.0003322	0.0003011	0.0003322
n-Nitrosodiphenylamine	mg/L	0.0009123	0.0008271	0.0009123
Nonylphenol	mg/L	0.0000730	0.0000291	0.0000730
Nonylphenol Diethoxylate (Technical mixture)	mg/L	0.0018989	0.0018023	0.0018989
Nonylphenol Monoethoxylate (Technical mixture)	mg/L	0.0031122	0.0029713	0.0031122
Oil and Grease	mg/L	1.0348437	1.5151163	1.5151163
para-tert-Octylphenol	mg/L	0.0003112	0.0002971	0.0003112
Parathion	mg/L	0.0000457	0.0000357	0.0000457
P-Chloro-M-Cresol	mg/L	0.0008180	0.0007368	0.0008180
Pentachlorophenol	mg/L	0.0007269	0.0006512	0.0007269
pH (Field)	SU	9.4331332	7.1937645	9.4331332
Phenanthrene	mg/L	0.0004989	0.0004313	0.0004989
Phenol	mg/L	0.0015861	0.0010981	0.0015861
Phenolics Total	mg/L	0.0087993	0.0090465	0.0090465
Phosphorus	mg/L	0.3960571	0.5706068	0.5706068
p-Nonylphenol (Technical mixture)	mg/L	0.0015382	0.0014977	0.0015382
Potassium	mg/L	31.2140604	22.8444041	31.2140604
Pyrene	mg/L	0.0002347	0.0001805	0.0002347
Radium-226	pCi/L	0.2363316	0.3728554	0.3728554
Radium-228	pCi/L	0.4067776	0.5953888	0.5953888
Redox	mV	135.9675050	200.3162791	200.3162791
Selenium	mg/L	0.0188901	0.0129347	0.0188901
Silver	mg/L	0.0002824	0.0001428	0.0002824
Sodium	mg/L	364.8100263	383.4978924	383.4978924
Specific Conductivity (lab)	µS/cm	0.0000000	0.0000000	0.0000000
Sulfate	mg/L	1085.2848089	1349.9789244	1349.9789244
Sulfide	mg/L	0.6372921	0.5872674	0.6372921
sulfide (as H2S)	mg/L	0.6135454	0.4460538	0.6135454
Surfactants	mg/L	0.0014602	0.0005814	0.0014602
Temperature	oC	28.1106950	28.0342878	28.1106950
Tetrachloroethene	mg/L	0.0001624	0.0001462	0.0001624
Thallium	mg/L	0.0050065	0.0013820	0.0050065
Tin	mg/L	0.0002920	0.0001163	0.0002920
Titanium	mg/L	0.0000730	0.0000291	0.0000730
Toluene	mg/L	0.0001624	0.0001480	0.0001624
Total Dissolved Solids	mg/L	4716.0378987	3501.6061047	4716.0378987
Total Kjeldahl Nitrogen	mg/L	8.5788578	8.8912064	8.8912064
Total Organic Carbon	mg/L	5.1142204	4.3504360	5.1142204
Total Suspended Solids	mg/L	93.5278524	176.4317587	176.4317587
Toxaphene	mg/L	0.0000207	0.0000180	0.0000207
trans-1,2-Dibromoethene	mg/L	0.0000146	0.0000058	0.0000146
trans-1,3-dichloropropene	mg/L	0.0001624	0.0001462	0.0001624
Tributyltin	mg/L	0.0000466	0.0000453	0.0000466
Trichloroethene	mg/L	0.0001526	0.0001369	0.0001526
Trichlorofluoromethane	mg/L	0.0000146	0.0000058	0.0000146
Turbidity	NTU	22.5550374	85.3857558	85.3857558

ChemName	Output Unit	Worst Case Concentration of the COC Expected in Outfall 301 Prior to Any Treatment (mg/L)	Worst Case Concentration of the COC Expected in Outfall 301 Prior to Any Treatment (mg/L)	Worst Case Concentration of the COC Expected in Outfall 301 Prior to Any Treatment in either Scenario (mg/L)
Vinyl chloride	mg/L	0.0002412	0.0002211	0.0002412
Zinc	mg/L	0.0782445	0.3751538	0.3751538

Note: The assumptions made in the flow-weighted calculations used to estimate worst case concentrations remain the same for both the 13.7 MDG and 6 MGD maximum discharge scenarios.

Legend	Description
	No color - < MDL in all waste streams.
	Blue - Parameter >= MDL and < RL in one or more waste streams.
	Yellow - Parameter >=RL in one or more waste streams

		RESULTS	BOTTOM ASH				METALS POND				COAL YARD				SIERRA DITCH				LEACHATE			
ChemName	Output Unit	Worst Case Concentration of the COC Expected in Outfall 301 Prior to Any Treatment (mg/L)	Worst Case Concentration (mg/l)	B/A_MDL	B/A_RL	Flow Weighted Average of the Source (mg/l)	Worst Case Concentration (mg/l)	Metals Pond_MDL	Metals Pond_RL	Flow Weighted Average of the Source (mg/l)	Worst Case Concentration (mg/l)	COAL YARD_MDL	COAL YARD_RL	Flow Weighted Average of the Source (mg/l)	Worst Case Concentration (mg/l)	SIERRA_MDL	SIERRA_RL	Flow Weighted Average of the Source (mg/l)	Worst Case Concentration (mg/l)	Leachate_MDL (LOD)	Leachate_RL (LOQ)	Flow Weighted Average of the Source (mg/l)
1,1,1-trichloroethane	mg/L	0.0003004	0.00029	0.00029	0.001	0.0000000	0.00029	0.00029	0.001	0.000111433	0.00029	0.00029	0.001	0	0.00029	0.00029	0.001	0	0.001	0.001	0.005	1.46015E-05
1,1,2,2-tetrachloroethane	mg/L	0.0002190	0.0002	0.0002	0.001	0.0000000	0.0002	0.0002	0.001	7.68502E-05	0.0002	0.0002	0.001	0	0.0002	0.0002	0.001	0	0.0015	0.0015	0.005	2.19023E-05
1,1,2-trichloroethane	mg/L	0.0002117	0.0002	0.0002	0.001	0.0000000	0.0002	0.0002	0.001	7.68502E-05	0.0002	0.0002	0.001	0	0.0002	0.0002	0.001	0	0.001	0.001	0.005	1.46015E-05
1,1-dichloroethane	mg/L	0.0001328	0.00012	0.00012	0.001	0.0000000	0.00012	0.00012	0.001	4.61101E-05	0.00012	0.00012	0.001	0	0.00012	0.00012	0.001	0	0.001	0.001	0.005	1.46015E-05
1,1-dichloroethene	mg/L	0.0003102	0.0003	0.0003	0.001	0.0000000	0.0003	0.0003	0.001	0.000115275	0.0003	0.0003	0.001	0	0.0003	0.0003	0.001	0	0.001	0.001	0.005	1.46015E-05
1,2,4-trichlorobenzene	mg/L	0.0007271	0.00068	0.00068	0.0019	0.0000000	0.00068	0.00068	0.0019	0.000261291	0.0007	0.0007	0.002	0	0.00068	0.00068	0.0019	0	0.00222	0.00222	0.005556	3.24154E-05
1,2-dichlorobenzene	mg/L	0.0001640	0.00015	0.00015	0.001	0.0000000	0.00015	0.00015	0.001	5.76376E-05	0.00015	0.00015	0.001	0	0.00015	0.00015	0.001	0	0.00111	0.00111	0.005556	1.62077E-05
1,2-dichloroethane	mg/L	0.0002288	0.00021	0.00021	0.001	0.0000000	0.00021	0.00021	0.001	8.06927E-05	0.00021	0.00021	0.001	0	0.00021	0.00021	0.001	0	0.0015	0.0015	0.005	2.19023E-05
1,2-dichloropropane	mg/L	0.0001155	0.000095	0.000095	0.001	0.0000000	0.000095	0.000095	0.001	3.65038E-05	0.000095	0.000095	0.001	0	0.000095	0.000095	0.001	0	0.0015	0.0015	0.005	2.19023E-05
1,2-Trans-dichloroethene	mg/L	0.0001821	0.00017	0.00017	0.001	0.0000000	0.00017	0.00017	0.001	6.53227E-05	0.00017	0.00017	0.001	0	0.00017	0.00017	0.001	0	0.001	0.001	0.005	1.46015E-05
1,3-dichlorobenzene	mg/L	0.0001246	0.00011	0.00011	0.001	0.0000000	0.00011	0.00011	0.001	4.22676E-05	0.00011	0.00011	0.001	0	0.00011	0.00011	0.001	0	0.00111	0.00111	0.005556	1.62077E-05
1,3-Dichloropropene	mg/L	0.0005073	0.0005	0.0005	0.002	0.0000000	0.0005	0.0005	0.002	0.000192125	0.0005	0.0005	0.002	0	0.0005	0.0005	0.002	0	0.001	0.001	0.01	1.46015E-05
1,4-dichlorobenzene	mg/L	0.0002231	0.00021	0.00021	0.001	0.0000000	0.00021	0.00021	0.001	8.06927E-05	0.00021	0.00021	0.001	0	0.00021	0.00021	0.001	0	0.00111	0.00111	0.005556	1.62077E-05
2,3,7,8-Tetrachlorooxanthrene	mg/L	2.12E-11				0				0				0				0	1.45E-09	1.45E-09	0.000000011	2.11722E-11
2,4,6-trichlorophenol	mg/L	0.0017175	0.0017	0.0017	0.0096	0.0000000	0.0017	0.0017	0.0095	0.000653227	0.0017	0.0017	0.0099	0	0.0017	0.0017	0.0096	0	0.00111	0.00111	0.005556	1.62077E-05
2,4-dichlorophenol	mg/L	0.0003424	0.00032	0.00032	0.0019	0.0000000	0.00032	0.00032	0.0019	0.00012296	0.00033	0.00033	0.002	0	0.00032	0.00032	0.0019	0	0.00111	0.00111	0.005556	1.62077E-05
2,4-dimethylphenol	mg/L	0.0008393	0.00082	0.00082	0.0096	0.0000000	0.00081	0.00081	0.0095	0.000311243	0.00084	0.00084	0.0099	0	0.00082	0.00082	0.0096	0	0.00056	0.00056	0.005556	8.17686E-06
2,4-dinitrophenol	mg/L	0.0059730	0.0059	0.0059	0.048	0.0000000	0.0058	0.0058	0.048	0.002228656	0.0061	0.0061	0.05	0	0.0059	0.0059	0.048	0	0.00056	0.00056	0.005556	8.17686E-06
2,4-Dinitrotoluene	mg/L	0.0005411	0.00052	0.00052	0.0096	0.0000000	0.00051	0.00051	0.0095	0.000195968	0.00053	0.00053	0.0099	0	0.00052	0.00052	0.0096	0	0.00111	0.00111	0.005556	1.62077E-05
2,6-dichlorophenol	mg/L	0.0000162				0				0				0				0	0.00111	0.00111	0.005556	1.62077E-05
2,6-dinitrotoluene	mg/L	0.0007955	0.00077	0.00077	0.0096	0.0000000	0.00076	0.00076	0.0095	0.000292031	0.00079	0.00079	0.0099	0	0.00077	0.00077	0.0096	0	0.00111	0.00111	0.005556	1.62077E-05
2-Chloroethylvinyl ether	mg/L	0.0003194	0.00025	0.00025	0.002	0.0000000	0.00025	0.00025	0.002	9.60627E-05	0.00025	0.00025	0.002	0	0.00025	0.00025	0.002	0	0.005	0.005	0.005	7.30077E-05
2-chloronaphthalene	mg/L	0.0001625	0.00015	0.00015	0.0019	0.0000000	0.00014	0.00014	0.0019	5.37951E-05	0.00015	0.00015	0.002	0	0.00015	0.00015	0.0019	0	0.00111	0.00111	0.005556	1.62077E-05
2-chlorophenol	mg/L	0.0016497	0.0016	0.0016	0.0096	0.0000000	0.0016	0.0016	0.0095	0.000614802	0.0016	0.0016	0.0099	0	0.0016	0.0016	0.0096	0	0.00111	0.00111	0.005556	1.62077E-05
2-methylphenol	mg/L	0.0000809				0				0				0				0	0.00554	0.00556	0.005556	8.08925E-05
2-nitrophenol	mg/L	0.0016758	0.0016	0.0016	0.0096	0.0000000	0.0016	0.0016	0.0095	0.000614802	0.0017	0.0017	0.0099	0	0.0016	0.0016	0.0096	0	0.00111	0.00111	0.005556	1.62077E-05
3,3-Dichlorobenzidine	mg/L	0.0011749	0.0011	0.0011	0.0096	0.0000000	0.0011	0.0011	0.0095	0.000422676	0.0011	0.0011	0.0099	0	0.0011	0.0011	0.0096	0	0.00444	0.00444	0.005556	6.48308E-05
3,4-Benzo-fluoranthene	mg/L	0.0001697	0.00015	0.00015	0.0019	0.0000000	0.00015	0.00015	0.0019	5.76376E-05	0.00016	0.00016	0.002	0	0.00015	0.00015	0.0019	0	0.00111	0.00111	0.005556	1.62077E-05
4,4-DDE	mg/L	0.0000011	0.00000076	0.00000076	0.0000013	0.00E+00	0.00000076	0.00000076	0.0000013	2.92031E-07	0.00000077	0.00000077	0.0000013	0	0.00000078	0.00000078	0.00000130	0	0.000005	0.000005	0.00005155	7.30077E-08
4,6-Dinitro-2-methylphenol	mg/L	0.0021685	0.0021	0.0021	0.048	0.0000000	0.0021	0.0021	0.048	0.000806927	0.0022	0.0022	0.05	0	0.0021	0.0021	0.048	0	0.00111	0.00111	0.005556	1.62077E-05
4-bromophenyl phenyl ether	mg/L	0.0006355	0.00061	0.00061	0.0096	0.0000000	0.0006	0.0006	0.0095	0.000230551	0.00063	0.00063	0.0099	0	0.00061	0.00061	0.0096	0	0.00111	0.00111	0.005556	1.62077E-05
4-chlorophenyl phenyl ether	mg/L	0.0005055	0.00048	0.00048	0.0096	0.0000000	0.00048	0.00048	0.0095	0.00018444	0.0005	0.0005	0.0099	0	0.00048	0.00048	0.0096	0	0.00111	0.00111	0.005556	1.62077E-05
4-nitrophenol	mg/L	0.0063459	0.0062	0.0062	0.048	0.0000000	0.0062	0.0062	0.048	0.002382356	0.0064	0.0064	0.05	0	0.0062	0.0062	0.048	0	0.00111	0.00111	0.005556	1.62077E-05
a-BHC	mg/L	0.0000032	0.00000063	0.00000063	0.0000013	0.00E+00	0.00000063	0.00000063	0.0000013	2.42078E-07	0.000001	0.00000063	0.0000012	0	0.0000021	0.00000065	0.0000013	0	0.00002	0.00005155	0.005	2.92031E-07
Accrolein	mg/L	0.0027081	0.0026	0.0026	0.02	0.0000000	0.0026	0.0026	0.02	0.000999053	0.0026	0.0026	0.02	0	0.0026	0.0026	0.02	0	0.01	0.01	0.01	0.000146015
Acenaphthene	mg/L	0.0001568	0.00014	0.00014	0.0019	0.0000000	0.00014	0.00014	0.0019	5.37951E-05	0.00014	0.00014	0.002	0	0.00014	0.00014	0.0019	0	0.00111	0.00111	0.005556	1.62077E-05
Acenaphthylene	mg/L	0.0001625	0.00015	0.00015	0.0019	0.0000000	0.00014	0.00014	0.0019	5.37951E-05	0.00015	0.00015	0.002	0	0.00015	0.00015	0.0019	0	0.00111	0.00111	0.005556	1.62077E-05
Acrylonitrile	mg/L	0.0009274	0.00055	0.00055	0.02	0.0000000	0.00055	0.00055	0.02	0.000211338	0.00055	0.00055	0.02	0	0.00055	0.00055	0.02	0	0.0085	0.0085	0.01	0.000124113
Aldrin	mg/L	0.0000020	0.0000008	0.0000008	0.0000013	0.00E+00	0.0000008	0.0000008	0.0000013	3.07401E-07	0.00000081	0.00000081	0.0000013	0	0.00000082	0.00000082	0.0000013	0	0.000005	0.000005	0.00005155	7.30077E-08
Alkalinity (Bicarbonate as CaCO3)	mg/L	93.0153174	60	0.41	5	0.0000000	0.41	0.41	5	0.157542899	0.41	0.41	5	0	110	0.41	5	0				0
Alkalinity (Carbonate as CaCO3)	mg/L	50.5530691	16	0.41	5	0.0000000	36	0.41	5	13.83303506	0.41	0.41	5	0	0.41	0.41	5	0				0
Alkalinity (total) as CaCO3	mg/L	148.3436151	64	0.41	5	0.0000000	56	0.41	5	21.51805453	0.41	0.41	5	0	110	0.41	5	0				0
Aluminium	mg/L	1.2137517	0.92	0.0024	0.03	0.0000000	0.42	0.0024	0.03	0.161385409	44	0.0024	0.03	0	0.98	0.0024	0.03	0	1.09	0.02	0.05	0.015915675
Ammonia as N	mg/L	1.7954554	0.65	0.086	0.1	0.0000000	2.6	0.086	0.1	0.999052532	0.99	0.086	0.1	0	0.4	0.086	0.1	0	3.03	0.05	0.1	0.044242657
Anthracene	mg/L	0.0001666	0.00015	0.00015	0.0019	0.0000000	0.00015	0.00015	0.0019	5.76376E-05	0.00015	0.00015	0.002	0	0.00015	0.00015	0.0019	0	0.00111	0.00111	0.005556	1.62077E-05
Antimony	mg/L	0.0041831	0.0011	0.00004	0.002	0.0000000	0.00032	0.00004	0.002	0.00012296	0.00058	0.00004	0.002	0	0.00049	0.00004	0.002	0	0.00344	0.00011	0.002	5.02293E-05
Arochlor 1016	mg/L	0.0000029	0.0000024	0.0000024	0.0000096	0.00E+00	0.0000024	0.0000024	0.0000096	9.22202E-07	0.0000024	0.0000024	0.0000097	0	0.0000025	0.0000025	0.0000099	0	0.00003	0.00003	0.0005155	4.38046E-07
Arochlor 1221	mg/L	0.0000053	0.0000024	0.0000024	0.0000096	0.00E+00	0.0000024	0.0000024	0.0000096	9.22202E-07	0.0000024	0.0000024	0.0000097	0	0.0000025	0.0000025	0.0000099	0	0.0002	0.0002	0.0005155	2.92031E-06
Arochlor 1232	mg/L	0.0000031	0.0000028	0.0000028	0.0000096	0.00E+00	0.0000028	0.0000028	0.0000096	1.0759E-06	0.0000028	0.0000028	0.0000097	0	0.0000029	0.0000029	0.0000099	0	0.00002	0.00002	0.0005155	2.92031E-07
Arochlor 1242	mg/L	0.0000024	0.0000018	0.0000018	0.0000096	0.00E+00	0.0000018	0.0000018	0.0000096	6.91652E-07	0.0000018	0.0000018	0.0000097	0	0.0000018	0.0000018	0.0000099	0	0.00004	0.00004	0.0005155	5.84061E-07
Arochlor 1248	mg/L	0.0000029	0.0000022	0.0000022	0.0000096	0.00E+00	0.0000022	0.0000022	0.0000096	8.45352E-07	0.0000022	0.0000022	0.0000097	0	0.0000023	0.0000023	0.0000099	0	0.00005	0.00005	0.0005155	7.30077E-07
Arochlor 1254	mg/L	0.0000019	0.0000013	0.0000013	0.0000096	0.00E+00	0.0000013	0.0000013	0.0000096	4.99526E-07	0.0000013	0.0000013	0.0000097	0	0.0000013	0.0000013	0.0000099	0	0.00004	0.00004	0.0005155	5.84061E-07
Arochlor 1260	mg/L	0.0000019	0.0000013	0.0000013	0.0000096	0.00E+00	0.0000013	0.0000013	0.0000096	4.99526E-07	0.0000013	0.0000013	0.0000097	0	0.0000013	0.0000013	0.0000099	0	0.00004	0.00004	0.0002062	5.84061E-07
Arsenic	mg/L	0.0242846	0.0072	0.00012	0.001	0.0000000	0.003	0.003	0.01	0.001152753	0.049	0.00012	0.001	0	0.034	0.00012	0.001	0	0.0495	0.00061	0.001	0.000722776
Azinophos methyl	mg/L	0.0001125	0.000022	0.000022	0.0002	0.0000000	0.000022	0.000022	0.00019	8.45352E-06	0.000022	0.000022	0.0002	0	0.000022	0.000022	0.0002	0	0.0062	0.0065	0.0065	9.05295E-05
Barium	mg/L	0.2281199	0.11	0.000088	0.01	0.0000000	0.08	0.000088	0.01	0.030740078	0.084	0.000088	0.01	0	0.1	0.000088	0.01	0	0.193	0.002	0.01	0.002818097
b-BHC	mg/L	0.0000042	0.00000096	0.00000096	0.0000013	0.00E+00	0.00000096	0.00000096	0.0000013	3.68881E-07	0.00000097	0.00000097	0.0000013	0	0.00000099	0.00000099	0.0000013	0	0.000005	0.000005	0.00005155	7.30077E-08
Benz(a)anthracene	mg/L	0.0002248	0.00014	0.00014	0.0019	0.0000000	0.00014	0.00014	0.0019	5.37951E-05	0.00015	0.00015	0.002	0	0.00014	0.00014	0.0019	0	0.00556	0.00556	0.00556	8.11845E-05
Benzene	mg/L	0.0001262	0.00011	0.00011	0.001	0.0000000	0.00011	0.00011	0.001	4.22676E-05	0.00011	0.00011	0.001	0	0.00011	0.00011	0.001	0	0.001	0.001	0.005	1.46015E-05
Benzidine	mg/L	0.0339973	0.033	0.033	0.19	0.0000000	0.033	0.033	0.19	0.012680282	0.034	0.034	0.2	0	0.033	0.033	0.19	0	0.00551	0.00556	0.005556	8.04545E-05
Benzo(a) pyrene	mg/L	0.0001469	0.00013	0.00013	0.0019	0.0000000	0.00013	0.00013	0.0019	4.99526E-05	0.00013	0.00013	0.002	0	0.00013	0.00013	0.0019	0	0.00111	0.00111	0.005556	1.62077E-05
Benzo(g,h,i)perylene	mg/L	0.0001625	0.00015	0.00015	0.0019	0.0000000	0.00014	0.00014	0.0019	5.37951E-05	0.00015	0.00015	0.002	0	0.00015	0.00015	0.0019	0	0.00111	0.00111	0.005556	1.62077E-05
Benzo(k)fluoranthene	mg/L	0.0005510	0.00053	0.00053	0.0019	0.0000000	0.00052	0.00052	0.0019	0.000199811	0.00054	0.00054	0.002	0	0.00053	0.00053	0.0019	0	0.00111	0.00111	0.005556	1.62077E-05
Beryllium	mg/L	0.0005723	0.00084	0.000036	0.001	0.0000000	0.000036	0.000036	0.001	1.3833E-05	0.022	0.000036	0.001	0	0.000095	0.000036	0.001	0	0.002	0.002	0.004	2.92031E-05
Biochemical Oxygen Demand	mg/L	6.2786851	2	2	2	2	2	2	2	0.768501948	2.2	2	2	0	6.2	2	2	0	2.9	0.2	2	0.042344457
Bis(2-chloroethoxy) methane	mg/L	0.0005831	0.00056	0.00056	0.0096	0.0000000	0.00055	0.00055	0.0095	0.000211338	0.00058	0.00058	0.0099	0	0.00056	0.00056	0.0096	0	0.00111	0.00111	0.005556	1.62077E-05
Bis(2-chloroethyl)ether	mg/L	0.0002610	0.00024	0.00024	0.0019	0.0000000	0.00024	0.00024	0.0019	9.22202E-05	0.00025	0.00025	0.002	0	0.00024	0.00024	0.0019	0	0.00111	0.00111	0.005556	1.62077E-05
Bis(2-chloroisopropyl) ether	mg/L	0.0002117	0.00019	0.00019	0.0019	0.0000000	0.00019	0.00019	0.0019	7.30077E-05	0.0002	0.0002	0.002	0	0.00019	0.00019	0.0019	0	0.00111	0.00111	0.005556	1.62077E-05
Bis(2-ethylhexyl) phthalate	mg/L	0.0124097	0.012	0.012	0.019	0.0000000	0.012	0.012	0.019	0.004611012	0.012	0.012	0.02	0	0.012	0.012	0.019	0	0.00111	0.00111	0.005556	1.62077E-05
Bisphenol A	mg/L	0.0003112	0.0042	0.00032	0.001	0.0000000	0.00031	0.00031	0.00097	0.000119118	0.00031	0.00031	0.00098	0	0.00031	0.00031	0.00097	0				0
Boron	mg/L	38.6533858	0.16	0.00046	0.005	0.0000000	2.6	0.00061	0.2	0.999052532	0.97	0.00046	0.005	0	0.49	0.00046	0.005	0	3.76	0.05	0.05	0.054901779
Bromide	mg/L	74.2301880	0.19	0.19	0.5	0.0000000	5.3	0.19	0.5	2.036530161	1.2	0.19	0.5	0	0.52	0.19	0.5	0	5	5	5	0.073007685
Bromoform	mg/L	0.0002091	0.00019	0.00019	0.001	0.0000000	0.00019	0.00019	0.001	7.30077E-05	0.00019	0.00019	0.001	0	0.00019	0.00019	0.001	0	0.0015	0.0015	0.005	2.19023E-05
Butyl benzyl phthalate	mg/L	0.0014192	0.0014	0.0014	0.0096	0.0000000	0.0014	0.0014	0.0095	0.000537951	0.0014	0.0014	0.0099	0	0.0014	0.0014	0.0096	0	0.00111	0.00111	0.005556	1.62077E-05
Cadmium	mg/L	0.0005013	0.00024	0.000074	0.001	0.0000000	0.00013	0.00013	0.005	4.99526E-05	0.0063	0.000074	0.001	0	0.00011	0.000074	0.001	0	0.00011	0.00011	0.0003	1.60617E-06
Carbon tetrachloride	mg/L	0.0001526	0.00014	0.00014	0.001	0.0000000	0.00014	0.00014	0.001	5.37951E-05	0.00014	0.00014	0.001	0	0.00014	0.00014	0.001	0	0.001	0.001	0.005	1.46015E-05
Chemical Oxygen Demand	mg/L	76.6634688	6.1	2	10	0.0000000	11	2	10	4.226760712	120	4	20	0	130	4	20	0	12.7	10	10	0.18543952
chlordane	mg/L	0.0000046	0.0000016	0.0000016	0.000012	0.00E+00	0.0000016	0.0000016	0.000012	6.14802E-07	0.0000061	0.0000016	0.000012	0	0.0000016	0.0000016	0.000012	0	0.000206	0.000206	0.0002062	3.00792E-06
Chloride	mg/L	1286.3990862	22	0.2	1	0.0000000	310	2	10	119.1178019	84	0.2	1	0	37	0.2	1	0	52.4	10	10	0.765120539
Chlorine, Total Residual	mg/L	0.6582562	0.04			0.0000000	0			0	0.44			0	0.04			0				0
Chlorobenzene	mg/L	0.0001453	0.00014	0.00014	0.001	0.0000000	0.00014	0.00014	0.001	5.37951E-05	0.00014	0.00014	0.001	0	0.00014	0.00014	0.001	0	0.0005	0.0005	0.005	7.30077E-06
Chlorodibromomethane	mg/L	0.0004125	0.00014	0.00014	0.001	0.0000000	0.00014	0.00014	0.001	5.37951E-05	0.00014	0.00014	0.001	0	0.00014	0.00014	0.001	0	0.001	0.001	0.005	1.46015E-05
Chloroethane	mg/L	0.0002215	0.00021	0.00021	0.001	0.0000000	0.00021	0.00021	0.001	8.06927E-05	0.00021	0.00021	0.001	0	0.00021	0.00021	0.001	0	0.001	0.001	0.005	1.46015E-05
Chloroform	mg/L	0.0092130	0.00017	0.00017	0.001	0.0000000	0.00035	0.00017	0.001	0.000134488	0.00017	0.00017	0.001	0	0.00018	0.00017	0.001	0	0.001	0.001	0.005	1.46015E-05
Chlorpyrifos	mg/L	0.0001127	0.00002	0.00002	0.0002	0.0000000	0.000019	0.000019	0.00019	7.30077E-06	0.00002	0.00002	0.0002	0	0.00002	0.00002	0.0002	0	0.0064	0.0065	0.0065	9.34498E-05
Chromium (Hexavalent)	mg/L	0.0089701	0.0023	0.0019	0.01	0.0000000	0.0019	0.0019	0.01	0.000730077	0.2	0.048	0.25	0	0.0019	0.0019	0.01	0	0.061	0.1	0.003	0.000890694
Chromium (Total)	mg/L	0.0033224	0.0013	0.00023	0.002	0.0000000	0.00092	0.00077	0.005	0.000353511	0.039	0.00023	0.002	0	0.0016	0.00023	0.002	0	0.0355	0.001	0.01	0.000518355
Chrysene	mg/L	0.0001526	0.00013	0.00013	0.0019	0.0000000	0.00013	0.00013	0.0019	4.99526E-05	0.00014	0.00014	0.002	0	0.00013	0.00013	0.0019	0	0.00111	0.00111	0.005556	1.62077E-05
cis-1,3-dichloropropene	mg/L	0.0002018	0.00019	0.00019	0.001	0.0000000	0.00019	0.00019	0.001	7.30077E-05	0.00019	0.00019	0.001	0	0.00019	0.00019	0.001	0	0.001	0.001	0.005	1.46015E-05
Cobalt	mg/L	0.0036689	0.00097	0.00005	0.0005	0.0000000	0.00063	0.00005	0.0005	0.000242078	0.3	0.00005	0.0005	0	0.0012	0.00005	0.0005	0	0.002	0.002	0.004	2.92031E-05
Color	o	0.1460154				0				0				0				0	10	10	10	0.14601537
Copper	mg/L	0.0196311	0.0029	0.00027	0.002	0.0000000	0.015	0.0015	0.025	0.005763765	0.38	0.00027	0.002	0	0.034	0.00027	0.002	0	0.00239	0.00022	0.001	3.48977E-05
Cyanide (Total)	mg/L	0.0039990	0.0025	0.0025	0.01	0.0000000	0.0025	0.0025	0.01	0.000960627	0.0025	0.0025	0.01	0	0.0025	0.0025	0.01	0	0.01	0.01	0.01	0.000146015
d-BHC	mg/L	0.0000004	0.00000037	0.00000037	0.0000013	0.00E+00	0.00000037	0.00000037	0.0000013	1.42173E-07	0.00000052	0.00000036	0.0000012	0	0.0000025	0.00000038	0.0000013	0	0.000005	0.000005	0.00005155	7.30077E-08
DDD	mg/L	0.0000007	0.00000064	0.00000064	0.0000013	0.00E+00	0.00000064	0.00000064	0.0000013	2.45921E-07	0.00000065	0.00000065	0.0000013	0	0.0000069	0.00000066	0.0000013	0	0.000005	0.000005	0.00005155	7.30077E-08
DDT	mg/L	0.0000009	0.00000071	0.00000071	0.0000013	0.00E+00	0.00000071	0.00000071	0.0000013	2.72818E-07	0.00000072	0.00000072	0.0000013	0	0.0000018	0.00000073	0.0000013	0	0.000005	0.000005	0.00005155	7.30077E-08
Demeton (total)	mg/L	0.0000314	0.000032	0.000032	0.00039	0.0000000	0.000031	0.000031	0.00038	1.19118E-05	0.000032	0.000032	0.00039	0	0.000032	0.000032	0.00039	0				0
Demeton-O	mg/L	0.0000949				0				0				0				0	0.0065	0.0065	0.0065	9.491E-05
Demeton-S	mg/L	0.0000949				0				0				0				0	0.0065	0.0065	0.0065	9.491E-05
Diazinon	mg/L	0.0001130	0.000018	0.000018	0.0002	0.0000000	0.000018	0.000018	0.00019	6.91652E-06	0.000018	0.000018	0.0002	0	0.000018	0.000018	0.0002	0	0.0065	0.0065	0.0065	9.491E-05
Dibenz(a,h)anthracene	mg/L	0.0001697	0.00015	0.00015	0.0019	0.0000000	0.00015	0.00015	0.0019	5.76376E-05	0.00015	0.00015	0.002	0	0.00015	0.00015	0.0019	0	0.00111	0.00111	0.005556	1.62077E-05
Dichlorobromomethane	mg/L	0.0015309	0.00013	0.00013	0.001	0.0000000	0.00013	0.00013	0.001	4.99526E-05	0.00013	0.00013	0.001	0	0.00013	0.00013	0.001	0	0.001	0.001	0.005	1.46015E-05
Dichlorodifluoromethane	mg/L	0.0000146				0				0				0				0	0.001	0.001	0.005	1.46015E-05
Dieldrin	mg/L	0.0000016	0.00000079	0.00000079	0.0000013	0.00E+00	0.00000079	0.00000079	0.0000013	3.03558E-07	0.0000008	0.0000008	0.0000013	0	0.000047	0.00000081	0.0000013	0	0.000005	0.000005	0.00005155	7.30077E-08
Diesel Range Organics	mg/L	0.2320876				0	0.22	0.22	0.46	0.084535214	0.31	0.24	0.5	0				0				0
Diethylphthalate	mg/L	0.0014526	0.0014	0.0014	0.0096	0.0000000	0.0014	0.0014	0.0095	0.000537951	0.0014	0.0014	0.0099	0	0.0014	0.0014	0.0096	0	0.00111	0.00111	0.005556	1.62077E-05
Dimethyl phthalate	mg/L	0.0007659	0.00074	0.00074	0.0096	0.0000000	0.00073	0.00073	0.0095	0.000280503	0.00076	0.00076	0.0099	0	0.00074	0.00074	0.0096	0	0.00111	0.00111	0.005556	1.62077E-05
Di-n-butyl phthalate	mg/L	0.0012410	0.0012	0.0012	0.0096	0.0000000	0.0012	0.0012	0.0095	0.000461101	0.0012	0.0012	0.0099	0	0.0012	0.0012	0.0096	0	0.00222	0.00222	0.005556	3.24154E-05
Di-n-octyl phthalate	mg/L	0.0020673	0.002	0.002	0.0096	0.0000000	0.002	0.002	0.0095	0.000768502	0.002	0.002	0.0099	0	0.002	0.002	0.0096	0	0.00111	0.00111	0.005556	1.62077E-05

		RESULTS	BOTTOM ASH				METALS POND				COAL YARD				SIERRA DITCH				LEACHATE			
ChemName	Output Unit	Worst Case Concentration of the COC Expected in Outfall 301 Prior to Any Treatment (mg/L)	Worst Case Concentration (mg/l)	B/A_MDL	B/A_RL	Flow Weighted Average of the Source (mg/l)	Worst Case Concentration (mg/l)	Metals Pond_MDL	Metals Pond_RL	Flow Weighted Average of the Source (mg/l)	Worst Case Concentration (mg/l)	COAL YARD_MDL	COAL YARD_RL	Flow Weighted Average of the Source (mg/l)	Worst Case Concentration (mg/l)	SIERRA_MDL	SIERRA_RL	Flow Weighted Average of the Source (mg/l)	Worst Case Concentration (mg/l)	Leachate_MDL (LOD)	Leachate_RL (LOQ)	Flow Weighted Average of the Source (mg/l)
Diphenylhydrazine	mg/L	0.0007222	0.00063	0.00063	0.0096	0.0000000	0.00063	0.00063	0.0095	0.000242078	0.00065	0.00065	0.0099	0	0.00063	0.00063	0.0096	0	0.00526	0.00526	0.005556	7.68041E-05
E. Coli	cfu/100 ml	0.0146015				0.000000				0.000000				0.000000				0.000000	1.000000	1.000000	1.000000	0.014602
EC (field)	µS/cm	6505.8168439	303			0.0000000	5695			2188.309296	1638			0	174			0				0
Endosulfan I	mg/L	0.0000016	0.0000009	0.0000009	0.0000013	0.00E+00	0.0000009	0.0000009	0.0000013	3.45826E-07	0.00000091	0.00000091	0.0000013	0	0.00000093	0.00000093	0.0000013	0	0.000005	0.000005	0.00005155	7.30077E-08
Endosulfan II	mg/L	0.0000075	0.0000028	0.00000094	0.0000013	0.00E+00	0.00000094	0.00000094	0.0000013	3.61196E-07	0.0000034	0.00000092	0.0000012	0	0.000039	0.00000097	0.0000013	0	0.000005	0.000005	0.00005155	7.30077E-08
Endosulfan sulphate	mg/L	0.0000364	0.00000055	0.00000055	0.0000013	0.00E+00	0.00000055	0.00000055	0.0000013	2.11338E-07	0.00000055	0.00000055	0.0000013	0	0.00000056	0.00000056	0.0000013	0	0.000005	0.000005	0.00005155	7.30077E-08
Endrin	mg/L	0.0000017	0.00000092	0.0000092	0.0000013	0.00E+00	0.00000092	0.0000092	0.0000013	3.53511E-07	0.00000093	0.00000093	0.0000013	0	0.00000095	0.00000095	0.0000013	0	0.000005	0.000005	0.00005155	7.30077E-08
Endrin aldehyde	mg/L	0.0000009	0.00000087	0.00000087	0.0000013	0.00E+00	0.00000087	0.00000087	0.0000013	3.34298E-07	0.00000087	0.00000087	0.0000013	0	0.00000089	0.00000089	0.0000013	0	0.000005	0.000005	0.00005155	7.30077E-08
Enterococci	MPN/100 ml	0.0146015				0				0				0				0	1	1	1	0.014601537
Ethylbenzene	mg/L	0.0002463	0.00023	0.00023	0.001	0.0000000	0.00023	0.00023	0.001	8.83777E-05	0.00023	0.00023	0.001	0	0.00023	0.00023	0.001	0	0.0005	0.0005	0.005	7.30077E-06
Fecal Coliforms	MPN/100 ml	0.0292031				0			0	0				0				0	2	2	2	0.029203074
Fluoranthene	mg/L	0.0001724	0.00016	0.00016	0.0019	0.0000000	0.00015	0.00015	0.0019	5.76376E-05	0.00016	0.00016	0.002	0	0.00016	0.00016	0.0019	0	0.00111	0.00111	0.005556	1.62077E-05
Fluorene	mg/L	0.0002312	0.00021	0.00021	0.0019	0.0000000	0.00021	0.00021	0.0019	8.06927E-05	0.00021	0.00021	0.002	0	0.00021	0.00021	0.0019	0	0.00111	0.00111	0.005556	1.62077E-05
Fluoride	mg/L	1.4944091	0.22	0.014	0.1	0.0000000	0.32	0.014	0.1	0.122960312	0.18	0.014	0.1	0	0.53	0.014	0.1	0	2.8	0.1	0.1	0.040884304
Gasoline Range Organics	mg/L	0.0367344				0	0.05	0.025	0.1	0.019212549	0.05	0.025	0.1	0				0				0
g-BHC (Lindane)	mg/L	0.0000008	0.00000077	0.00000077	0.0000013	0.00E+00	0.00000077	0.00000077	0.0000013	2.95873E-07	0.00000078	0.00000078	0.0000013	0	0.00000079	0.00000079	0.0000013	0	0.000005	0.000005	0.00005155	7.30077E-08
Hardness	mg/L	20.0041057				0				0				0				0	1370	0.766	12.5	20.0041057
HEM	mg/L	1.2065481				0	1.7	1.7	5.8	0.653226655	1.8	1.6	5.2	0				0				0
Heptachlor	mg/L	0.0000275	0.00000095	0.00000095	0.0000013	0.00E+00	0.00000095	0.00000095	0.0000013	3.65038E-07	0.00000096	0.00000096	0.0000013	0	0.00000098	0.00000098	0.0000013	0	0.000005	0.000005	0.00005155	7.30077E-08
Heptachlor epoxide	mg/L	0.0000015	0.00000093	0.00000093	0.0000013	0.00E+00	0.00000093	0.00000093	0.0000013	3.57353E-07	0.00000094	0.00000094	0.0000013	0	0.00000096	0.00000096	0.0000013	0	0.000005	0.000005	0.00005155	7.30077E-08
Hexachlorobenzene	mg/L	0.0002154	0.00018	0.00018	0.0019	0.0000000	0.00017	0.00017	0.0019	6.53227E-05	0.00018	0.00018	0.002	0	0.00018	0.00018	0.0019	0	0.00271	0.00278	0.002778	3.95702E-05
Hexachlorobutadiene	mg/L	0.0001796	0.00016	0.00016	0.0019	0.0000000	0.00016	0.00016	0.0019	6.14802E-05	0.00016	0.00016	0.002	0	0.00016	0.00016	0.0019	0	0.00111	0.00111	0.005556	1.62077E-05
Hexachlorocyclopentadiene	mg/L	0.0005214	0.0005	0.0005	0.0096	0.0000000	0.00049	0.00049	0.0095	0.000188283	0.00051	0.00051	0.0099	0	0.0005	0.0005	0.0096	0	0.00111	0.00111	0.005556	1.62077E-05
Hexachloroethane	mg/L	0.0006295	0.0006	0.0006	0.0096	0.0000000	0.0006	0.0006	0.0095	0.000230551	0.0006	0.0006	0.0099	0	0.0006	0.0006	0.0096	0	0.00111	0.00111	0.005556	1.62077E-05
Indeno(1,2,3-c,d)pyrene	mg/L	0.0002117	0.00019	0.00019	0.0019	0.0000000	0.00019	0.00019	0.0019	7.30077E-05	0.0002	0.0002	0.002	0	0.00019	0.00019	0.0019	0	0.00111	0.00111	0.005556	1.62077E-05
Iron	mg/L	1.0666870	0.37	0.0057	0.05	0.0000000	0.53	0.0095	0.1	0.203653016	120	0.0057	0.05	0	1.4	0.0057	0.05	0	0.0044	0.003	0.01	6.42468E-05
Isophorone	mg/L	0.0006423	0.00062	0.00062	0.0096	0.0000000	0.00061	0.00061	0.0095	0.000234393	0.00064	0.00064	0.0099	0	0.00062	0.00062	0.0096	0	0.00111	0.00111	0.005556	1.62077E-05
Kepone	mg/L	0.0094587	0.0093	0.0093	0.038	0.0000000	0.0092	0.0092	0.038	0.003535109	0.0096	0.0096	0.04	0	0.0093	0.0093	0.038	0	0.00222	0.00222	0.005556	3.24154E-05
Lead	mg/L	0.0031498	0.00051	0.000057	0.001	0.0000000	0.0012	0.0012	0.01	0.000461101	0.0075	0.0012	0.01	0	0.0032	0.000057	0.001	0	0.00016	0.00016	0.0005	2.33625E-06
Lithium	mg/L	0.0727598	0.02	0.00053	0.05	0.0000000	0.075	0.00053	0.05	0.028818823	0.25	0.00053	0.05	0	0.05	0.00053	0.05	0				0
Magnesium	mg/L	120.6684244	3.5	0.001	0.5	0.0000000	3.7	0.028	5	1.421728603	27	0.001	0.5	0	15	0.001	0.5	0	0.105	0.004	0.01	0.001533161
Malathion	mg/L	0.0000356	0.000021	0.000021	0.0002	0.0000000	0.000021	0.000021	0.00019	8.06927E-06	0.000021	0.000021	0.0002	0	0.000021	0.000021	0.0002	0	0.001	0.001	0.001	1.46015E-05
Manganese	mg/L	0.1773479	0.036	0.000046	0.005	0.0000000	0.024	0.00012	0.015	0.009222023	2.7	0.000046	0.005	0	1.3	0.000046	0.005	0	0.002	0.002	0.01	2.92031E-05
Mercury	mg/L	0.0000800	0.000045	0.000031	0.0002	0.0000000	0.000067	0.000031	0.0002	2.57448E-05	0.000085	0.000031	0.0002	0	0.000031	0.000031	0.0002	0	0.000023	0.000023	0.0002	3.35835E-07
Methoxychlor	mg/L	0.0000001				0				0				0				0	0.000005	0.000005	0.00005155	7.30077E-08
Methyl Bromide	mg/L	0.0003201	0.00031	0.00031	0.001	0.0000000	0.00031	0.00031	0.001	0.000119118	0.00031	0.00031	0.001	0	0.00031	0.00031	0.001	0	0.001	0.001	0.005	1.46015E-05
Methyl Chloride	mg/L	0.0002978	0.00028	0.00028	0.001	0.0000000	0.00028	0.00028	0.001	0.00010759	0.00028	0.00028	0.001	0	0.00028	0.00028	0.001	0	0.0015	0.0015	0.005	2.19023E-05
Methylene Chloride	mg/L	0.0002597	0.00016	0.00015	0.001	0.0000000	0.0002	0.00015	0.001	7.68502E-05	0.0059	0.00015	0.001	0	0.00015	0.00015	0.001	0	0.005	0.005	0.005	7.30077E-05
Mirex	mg/L	0.0000005	0.00000046	0.00000046	0.0000013	0.00E+00	0.00000046	0.00000046	0.0000013	1.76755E-07	0.00000047	0.00000047	0.0000013	0	0.00000048	0.00000048	0.0000013	0	0.000002	0.000002	0.00005155	2.92031E-08
Molybdenum	mg/L	0.0266343	0.023	0.00026	0.005	0.0000000	0.0027	0.00026	0.005	0.001037478	0.013	0.00026	0.005	0	0.014	0.00026	0.005	0	0.55	0.05	0.05	0.008030845
Naphthalene	mg/L	0.0002176	0.00013	0.00013	0.0019	0.0000000	0.00013	0.00013	0.0019	4.99526E-05	0.0016	0.00014	0.002	0	0.0016	0.00013	0.0019	0	0.00556	0.00556	0.00556	8.11845E-05
Nickel	mg/L	0.0221284	0.003	0.000093	0.001	0.0000000	0.0085	0.00051	0.04	0.003226133	0.54	0.000093	0.001	0	0.014	0.000093	0.001	0	0.00467	0.00032	0.001	6.81892E-05
Nitrate	mg/L	0.0058406				0				0				0				0	0.4			0.005840615
Nitrate (as N)	mg/L	15.8133627	0.22	0.0062	0.1	0.0000000	1	0.0062	0.1	0	0.64	0.0062	0.1	0	0.54	0.0062	0.1	0	0.4	0.07	0.15	0.005840615
Nitrite	mg/L	0.0011681				0				0				0				0	0.08			0.001168123
Nitrite (as N)	mg/L	0.2273397	0.15	0.024	0.05	0.0000000	0.44	0.024	0.05	0	0.026	0.024	0.05	0	0.024	0.024	0.05	0	0.08	0.05	0.05	0.001168123
Nitrobenzene	mg/L	0.0009028	0.00081	0.00081	0.019	0.0000000	0.0008	0.0008	0.019	0.000307401	0.00083	0.00083	0.02	0	0.00081	0.00081	0.019	0	0.00556	0.00556	0.005556	8.11845E-05
Nitrogen (Organic)	mg/L	0.0087609		0	0	0				0				0				0	0.6	0.6	0.6	0.008760922
Nitrogen (Total Oxidised)	mg/L	0.0058406				0				0				0				0	0.4	0.02	0.1	0.005840615
Nitrogen (Total)	mg/L	0.0449727				0				0				0				0	3.08	0.2	0.5	0.044972734
N-Nitrosodimethylamine	mg/L	0.0007526	0.00071	0.00071	0.0019	0.0000000	0.0007	0.0007	0.0019	0.000268976	0.00073	0.00073	0.002	0	0.00071	0.00071	0.0019	0	0.00222	0.00222	0.005556	3.24154E-05
N-nitrosodi-n-propylamine	mg/L	0.0003322	0.0003	0.0003	0.0019	0.0000000	0.00029	0.00029	0.0019	0.000111433	0.0003	0.0003	0.002	0	0.0003	0.0003	0.0019	0	0.00222	0.00222	0.005556	3.24154E-05
n-Nitrosodiphenylamine	mg/L	0.0009123	0.00082	0.00082	0.0096	0.0000000	0.00081	0.00081	0.0095	0.000311243	0.00084	0.00084	0.0099	0	0.00082	0.00082	0.0096	0	0.00556	0.00556	0.005556	8.11845E-05
Nonylphenol	mg/L	0.0000730				0				0				0				0	0.005	0.005	0.005	7.30077E-05
Nonylphenol Diethoxylate (Technica	mg/L	0.0018989	0.002	0.002	0.02	0.0000000	0.0019	0.0019	0.019	0.000730077	0.0019	0.0019	0.02	0	0.0019	0.0019	0.019	0				0
Nonylphenol Monoethoxylate (Tech	mg/L	0.0031122	0.0032	0.0032	0.01	0.0000000	0.0031	0.0031	0.0097	0.001191178	0.0031	0.0031	0.0098	0	0.0031	0.0031	0.0097	0				0
Oil and Grease	mg/L	1.0348437	1.5	1.5	4.3	0.0000000				0	1.6	1.6	4.5	0	1.5	1.5	4.3	0	5	5	5	0.073007685
para-tert-Octylphenol	mg/L	0.0003112	0.00032	0.00032	0.001	0.0000000	0.00031	0.00031	0.00097	0.000119118	0.00031	0.00031	0.00098	0	0.00031	0.00031	0.00097	0				0
Parathion	mg/L	0.0000457	0.000032	0.000032	0.0002	0.0000000	0.000031	0.000031	0.00019	1.19118E-05	0.000032	0.000032	0.0002	0	0.000032	0.000032	0.0002	0	0.001	0.001	0.001	1.46015E-05
P-Chloro-M-Cresol	mg/L	0.0008180	0.00073	0.00073	0.0096	0.0000000	0.00072	0.00072	0.0095	0.000276661	0.00075	0.00075	0.0099	0	0.00073	0.00073	0.0096	0	0.00556	0.00556	0.005556	8.11845E-05
Pentachlorophenol	mg/L	0.0007269	0.00064	0.00064	0.0096	0.0000000	0.00063	0.00063	0.0095	0.000242078	0.00066	0.00066	0.0099	0	0.00064	0.00064	0.0096	0	0.00556	0.00556	0.005556	8.11845E-05
pH (Field)	SU	9.4331332	9.24			0.0000000	10.97			4.215233182	3.38			0	9.12			0				0
Phenanthrene	mg/L	0.0004989	0.00041	0.00041	0.0019	0.0000000	0.00041	0.00041	0.0019	0.000157543	0.00042	0.00042	0.002	0	0.00041	0.00041	0.0019	0	0.00556	0.00556	0.005556	8.11845E-05
Phenol	mg/L	0.0015861	0.00056	0.00056	0.0019	0.0000000	0.00055	0.00055	0.0019	0.000211338	0.00058	0.00058	0.002	0	0.00056	0.00056	0.0019	0	0.00556	0.00556	0.005556	8.11845E-05
Phenolics Total	mg/L	0.0087993				0	0.0082	0.0082	0.01	0.003150858	0.0082	0.0082	0.01	0				0	0.05	0.05	0.05	0.000730077
Phosphorus	mg/L	0.3960571	0.081	0.05	0.1	0.0000000	0.057	0.05	0.1	0.021902306	0.45	0.05	0.1	0	0.2	0.05	0.1	0	0.03	0.01	0.02	0.000438046
p-Nonylphenol (Technical mixture)	mg/L	0.0015382	0.0016	0.0016	0.005	0.0000000	0.0015	0.0015	0.0048	0.000576376	0.0016	0.0016	0.0049	0	0.0016	0.0016	0.0049	0				0
Potassium	mg/L	31.2140604	2.7	0.017	0.5	0.0000000	6.9	0.017	0.5	2.651331719	4.9	0.017	0.5	0	6.1	0.017	0.5	0				0
Pyrene	mg/L	0.0002347	0.00015	0.00015	0.0019	0.0000000	0.00015	0.00015	0.0019	5.76376E-05	0.00016	0.00016	0.002	0	0.00015	0.00015	0.0019	0	0.00556	0.00556	0.00556	8.11845E-05
Radium-226	pCi/L	0.2363316	0.508	0.48	1	0.0000000	0.288	0.215	1	0.11066428	0.707	0.445	1	0	0.348	0.191	1	0				0
Radium-228	pCi/L	0.4067776	0.733	0.733	1	0.0000000	0.358	0.358	1	0.137561849	0.706	0.681	1	0	0.326	0.326	1	0				0
Redox	mV	135.9675050	92.3			0.0000000	92			35.35108959	520.5			0	240.5			0				0
Selenium	mg/L	0.0188901	0.0043	0.0002	0.005	0.0000000	0.012	0.0039	0.01	0.004611012	0.023	0.0002	0.005	0	0.00067	0.0002	0.005	0	0.344	0.0065	0.01	0.005022929
Silver	mg/L	0.0002824	0.000047	0.000047	0.001	0.0000000	0.000047	0.000047	0.001	1.80598E-05	0.000047	0.000047	0.001	0	0.000047	0.000047	0.001	0	0.000029	0.000029	0.0001	4.23445E-07
Sodium	mg/L	364.8100263	13	0.011	0.5	0.0000000	78	0.011	0.5	29.97157596	45	0.011	0.5	0	20	0.011	0.5	0				0
Specific Conductivity (lab)	µS/cm	0.0000000				0				0				0				0				0
Sulfate	mg/L	1085.2848089	52	0.21	1	0.0000000	300	1.1	5	115.2752921	1000	2.1	10	0	120	0.21	1	0	984	200	200	14.36791241
Sulfide	mg/L	0.6372921	0.41	0.41	1	0.0000000	0.41	0.41	1	0.157542899	0.47	0.47	3	0	1.5	0.47	3	0	0.05	0.05	0.05	0.000730077
sulfide (as H2S)	mg/L	0.6135454	0.41	0.41	1	0.0000000	0.41	0.41	1	0.157542899	0.41	0.41	1	0	0.41	0.41	1	0				0
Surfactants	mg/L	0.0014602				0				0				0				0	0.1	0.1	0.1	0.001460154
Temperature	oC	28.1106950	33.3			0.0000000	28.35			10.89351511	31.69			0	18.52			0				0
Tetrachloroethene	mg/L	0.0001624	0.00015	0.00015	0.001	0.0000000	0.00015	0.00015	0.001	5.76376E-05	0.00015	0.00015	0.001	0	0.00015	0.00015	0.001	0	0.001	0.001	0.005	1.46015E-05
Thallium	mg/L	0.0050065	0.00031	0.000013	0.001	0.0000000	0.011	0.000013	0.001	0.004226761	0.0018	0.0018	0.02	0	0.00017	0.000013	0.001	0	0.000058	0.000058	0.0001	8.46889E-07
Tin	mg/L	0.0002920				0				0				0				0	0.02	0.02	0.02	0.000292031
Titanium	mg/L	0.0000730				0				0				0				0	0.005	0.005	0.05	7.30077E-05
Toluene	mg/L	0.0001624	0.00015	0.00015	0.001	0.0000000	0.00015	0.00015	0.001	5.76376E-05	0.00016	0.00015	0.001	0	0.00015	0.00015	0.001	0	0.001	0.001	0.005	1.46015E-05
Total Dissolved Solids	mg/L	4716.0378987	150	10	10	0.0000000	1100	20	20	422.6760712	1500	20	20	0	330	10	10	0				0
Total Kjeldahl Nitrogen	mg/L	8.5788578	2.2	1.7	5	0.0000000	3.9	1.7	5	1.498578798	2.2	1.7	5	0	1.7	1.7	5	0				0
Total Organic Carbon	mg/L	5.1142204	1.6	0.19	1	0.0000000	1.7	0.19	1	0.653226655	4	0.19	1	0	7.3	0.19	1	0	1.8	1	1	0.026282767
Total Suspended Solids	mg/L	93.5278524	110	1	1	0.0000000	40	0.5	0.5	15.37003895	330	5	5	0	49	1	1	0	18.4	1	1	0.268668281
Toxaphene	mg/L	0.0000207	0.000018	0.000018	0.000048	0.0000000	0.000018	0.000018	0.000048	6.91652E-06	0.000018	0.000018	0.000049	0	0.000018	0.000018	0.00005	0	0.000206	0.000206	0.001031	3.00792E-06
trans-1,2-Dibromoethene	mg/L	0.0000146				0				0				0				0	0.001	0.001	0.005	1.46015E-05
trans-1,3-dichloropropene	mg/L	0.0001624	0.00015	0.00015	0.001	0.0000000	0.00015	0.00015	0.001	5.76376E-05	0.00015	0.00015	0.001	0	0.00015	0.00015	0.001	0	0.001	0.001	0.005	1.46015E-05
Tributyltin	mg/L	0.0000466	0.000043	0.000043	0.000043	0.0000000	0.000043	0.000043	0.000043	1.65228E-05	0.000044	0.000044	0.000044	0	0.000043	0.000043	0.000043	0	0.00003	0.00003	0.00003	4.38046E-07
Trichloroethene	mg/L	0.0001526	0.00014	0.00014	0.001	0.0000000	0.00014	0.00014	0.001	5.37951E-05	0.00014	0.00014	0.001	0	0.00014	0.00014	0.001	0	0.001	0.001	0.005	1.46015E-05
Trichlorofluoromethane	mg/L	0.0000146				0				0				0				0	0.001	0.001	0.005	1.46015E-05
Turbidity	NTU	22.5550374	170	0.25	4.3	0.0000000	19	0.05	0.85	7.300768502	320	1.3	21	0	77	0.25	4.3	0				0
Vinyl chloride	mg/L	0.0002412	0.00023	0.00023	0.001	0.0000000	0.00023	0.00023	0.001	8.83777E-05	0.00023	0.00023	0.001	0	0.00023	0.00023	0.001	0	0.001	0.001	0.005	1.46015E-05
Zinc	mg/L	0.0782445	0.02	0.0004	0.005	0.0000000	0.0063	0.0004	0.005	0.002420781	1.8	0.0004	0.005	0	0.094	0.0004	0.005	0	0.00571	0.0016	0.005	8.33748E-05

		RESULTS	TOE DRAIN				FGD PLANT				FGD YARD SUMP				MASTER SUMP				CONTACT STORMWATER			
ChemName	Output Unit	Worst Case Concentration of the COC Expected in Outfall 301 Prior to Any Treatment (mg/L)	Worst Case Concentration (mg/l)	P TOE DRAIN_MDL	P TOE DRAIN_RL	Flow Weighted Average of the Source (mg/l)	Worst Case Concentration (mg/l)	FGD Plant_MDL	FGD Plant_RL	Flow Weighted Average of the Source (mg/l)	Worst Case Concentration (mg/l)	FGD Yard_MDL	FGD Yard_RL	Flow Weighted Average of the Source (mg/l)	Worst Case Concentration (mg/l)	MAST_MDL	MAST_RL	Flow Weighted Average of the Source (mg/l)	Worst Case Concentration (mg/l)	CONT SW_MDL	CONT SW _RL	Flow Weighted Average of the Source (mg/l)
1,1,1-trichloroethane	mg/L	0.0003004	0.00029	0.00029	0.001	1.61196E-06	0.00029	0.00029	0.001	7.80029E-06	0.00029	0.00029	0.001	7.57743E-05	0.00029	0.00029	0.001	8.91462E-05				0
1,1,2,2-tetrachloroethane	mg/L	0.0002190	0.0002	0.0002	0.001	1.1117E-06	0.0002	0.0002	0.001	5.37951E-06	0.0002	0.0002	0.001	5.22581E-05	0.0002	0.0002	0.001	6.14802E-05				0
1,1,2-trichloroethane	mg/L	0.0002117	0.0002	0.0002	0.001	1.1117E-06	0.0002	0.0002	0.001	5.37951E-06	0.0002	0.0002	0.001	5.22581E-05	0.0002	0.0002	0.001	6.14802E-05				0
1,1-dichloroethane	mg/L	0.0001328	0.00012	0.00012	0.001	6.67018E-07	0.00012	0.00012	0.001	3.22771E-06	0.00012	0.00012	0.001	3.13549E-05	0.00012	0.00012	0.001	3.68881E-05				0
1,1-dichloroethene	mg/L	0.0003102	0.0003	0.0003	0.001	1.66754E-06	0.0003	0.0003	0.001	8.06927E-06	0.0003	0.0003	0.001	7.83872E-05	0.0003	0.0003	0.001	9.22202E-05				0
1,2,4-trichlorobenzene	mg/L	0.0007271	0.00068	0.00068	0.0019	3.77977E-06	0.00067	0.00067	0.0019	1.80214E-05	0.00074	0.00074	0.0021	0.000193355	0.00071	0.00071	0.002	0.000218255				0
1,2-dichlorobenzene	mg/L	0.0001640	0.00015	0.00015	0.001	8.33772E-07	0.00015	0.00015	0.001	4.03464E-06	0.00015	0.00015	0.001	3.91936E-05	0.00015	0.00015	0.001	4.61101E-05				0
1,2-dichloroethane	mg/L	0.0002288	0.00021	0.00021	0.001	1.16728E-06	0.00021	0.00021	0.001	5.64849E-06	0.00021	0.00021	0.001	5.4871E-05	0.00021	0.00021	0.001	6.45542E-05				0
1,2-dichloropropane	mg/L	0.0001155	0.000095	0.000095	0.001	5.28056E-07	0.000095	0.000095	0.001	2.55527E-06	0.000095	0.000095	0.001	2.48226E-05	0.000095	0.000095	0.001	2.92031E-05				0
1,2-Trans-dichloroethene	mg/L	0.0001821	0.00017	0.00017	0.001	9.44942E-07	0.00017	0.00017	0.001	4.57259E-06	0.00017	0.00017	0.001	4.44194E-05	0.00017	0.00017	0.001	5.22581E-05				0
1,3-dichlorobenzene	mg/L	0.0001246	0.00011	0.00011	0.001	6.11433E-07	0.00011	0.00011	0.001	2.95873E-06	0.00011	0.00011	0.001	2.8742E-05	0.00011	0.00011	0.001	3.38141E-05				0
1,3-Dichloropropene	mg/L	0.0005073	0.0005	0.0005	0.002	2.77924E-06	0.0005	0.0005	0.002	1.34488E-05	0.0005	0.0005	0.002	0.000130645	0.0005	0.0005	0.002	0.0001537				0
1,4-dichlorobenzene	mg/L	0.0002231	0.00021	0.00021	0.001	1.16728E-06	0.00021	0.00021	0.001	5.64849E-06	0.00021	0.00021	0.001	5.4871E-05	0.00021	0.00021	0.001	6.45542E-05				0
2,3,7,8-Tetrachlorooxanthrene	mg/L	2.12E-11				0				0				0				0				0
2,4,6-trichlorophenol	mg/L	0.0017175	0.0017	0.0017	0.0096	9.44942E-06	0.0017	0.0017	0.0094	4.57259E-05	0.0018	0.0018	0.01	0.000470323	0.0017	0.0017	0.01	0.000522581				0
2,4-dichlorophenol	mg/L	0.0003424	0.00032	0.00032	0.0019	1.77871E-06	0.00032	0.00032	0.0019	8.60722E-06	0.00035	0.00035	0.0021	9.14517E-05	0.00033	0.00033	0.002	0.000101442				0
2,4-dimethylphenol	mg/L	0.0008393	0.00082	0.00082	0.0096	4.55795E-06	0.0008	0.0008	0.0094	2.15181E-05	0.00089	0.00089	0.01	0.000232549	0.00085	0.00085	0.01	0.000261291				0
2,4-dinitrophenol	mg/L	0.0059730	0.0059	0.0059	0.048	3.2795E-05	0.0058	0.0058	0.047	0.000156006	0.0064	0.0064	0.052	0.00167226	0.0061	0.0061	0.05	0.001875145				0
2,4-Dinitrotoluene	mg/L	0.0005411	0.00052	0.00052	0.0096	2.89041E-06	0.00051	0.00051	0.0094	1.37178E-05	0.00056	0.00056	0.01	0.000146323	0.00054	0.00054	0.01	0.000165996				0
2,6-dichlorophenol	mg/L	0.0000162				0				0				0				0				0
2,6-dinitrotoluene	mg/L	0.0007955	0.00077	0.00077	0.0096	4.28003E-06	0.00075	0.00075	0.0094	2.01732E-05	0.00083	0.00083	0.01	0.000216871	0.0008	0.0008	0.01	0.000245921				0
2-Chloroethylvinyl ether	mg/L	0.0003194	0.00025	0.00025	0.002	1.38962E-06	0.00025	0.00025	0.002	6.72439E-06	0.00025	0.00025	0.002	6.53227E-05	0.00025	0.00025	0.002	7.68502E-05				0
2-chloronaphthalene	mg/L	0.0001625	0.00015	0.00015	0.0019	8.33772E-07	0.00014	0.00014	0.0019	3.76566E-06	0.00016	0.00016	0.0021	4.18065E-05	0.00015	0.00015	0.002	4.61101E-05				0
2-chlorophenol	mg/L	0.0016497	0.0016	0.0016	0.0096	8.89357E-06	0.0016	0.0016	0.0094	4.30361E-05	0.0017	0.0017	0.01	0.000444194	0.0017	0.0017	0.01	0.000522581				0
2-methylphenol	mg/L	0.0000809				0				0				0				0				0
2-nitrophenol	mg/L	0.0016758	0.0016	0.0016	0.0096	8.89357E-06	0.0016	0.0016	0.0094	4.30361E-05	0.0018	0.0018	0.01	0.000470323	0.0017	0.0017	0.01	0.000522581				0
3,3-Dichlorobenzidine	mg/L	0.0011749	0.0011	0.0011	0.0096	6.11433E-06	0.0011	0.0011	0.0094	2.95873E-05	0.0012	0.0012	0.01	0.000313549	0.0011	0.0011	0.01	0.000338141				0
3,4-Benzo-fluoranthene	mg/L	0.0001697	0.00015	0.00015	0.0019	8.33772E-07	0.00015	0.00015	0.0019	4.03464E-06	0.00016	0.00016	0.0021	4.18065E-05	0.00016	0.00016	0.002	4.91841E-05				0
4,4-DDE	mg/L	0.0000011	0.00000076	0.00000076	0.0000013	4.22444E-09	0.0000034	0.00000075	0.0000012	9.14517E-08	0.0000015	0.00000078	0.0000013	3.91936E-07	0.00000077	0.00000077	0.0000013	2.36699E-07				0
4,6-Dinitro-2-methylphenol	mg/L	0.0021685	0.0021	0.0021	0.048	1.16728E-05	0.0021	0.0021	0.047	5.64849E-05	0.0023	0.0023	0.052	0.000600969	0.0022	0.0022	0.05	0.000676282				0
4-bromophenyl phenyl ether	mg/L	0.0006355	0.00061	0.00061	0.0096	3.39067E-06	0.0006	0.0006	0.0094	1.61385E-05	0.00066	0.00066	0.01	0.000172452	0.00064	0.00064	0.01	0.000196736				0
4-chlorophenyl phenyl ether	mg/L	0.0005055	0.00048	0.00048	0.0096	2.66807E-06	0.00047	0.00047	0.0094	1.26419E-05	0.00052	0.00052	0.01	0.000135871	0.0005	0.0005	0.01	0.0001537				0
4-nitrophenol	mg/L	0.0063459	0.0062	0.0062	0.048	3.44626E-05	0.0061	0.0061	0.047	0.000164075	0.0067	0.0067	0.052	0.001750647	0.0065	0.0065	0.05	0.001998105				0
a-BHC	mg/L	0.0000032	0.00000063	0.00000063	0.0000013	3.50184E-09	0.0000098	0.00000063	0.0000012	2.63596E-07	0.0000074	0.00000063	0.0000013	1.93355E-06	0.0000014	0.00000063	0.0000012	4.30361E-07				0
Accrolein	mg/L	0.0027081	0.0026	0.0026	0.02	1.4452E-05	0.0026	0.0026	0.02	6.99337E-05	0.0026	0.0026	0.02	0.000679356	0.0026	0.0026	0.02	0.000799242				0
Acenaphthene	mg/L	0.0001568	0.00014	0.00014	0.0019	7.78187E-07	0.00014	0.00014	0.0019	3.76566E-06	0.00015	0.00015	0.0021	3.91936E-05	0.00014	0.00014	0.002	4.30361E-05				0
Acenaphthylene	mg/L	0.0001625	0.00015	0.00015	0.0019	8.33772E-07	0.00014	0.00014	0.0019	3.76566E-06	0.00016	0.00016	0.0021	4.18065E-05	0.00015	0.00015	0.002	4.61101E-05				0
Acrylonitrile	mg/L	0.0009274	0.00055	0.00055	0.02	3.05716E-06	0.00055	0.00055	0.02	1.47937E-05	0.00055	0.00055	0.02	0.00014371	0.0014	0.00055	0.02	0.000430361				0
Aldrin	mg/L	0.0000020	0.0000008	0.0000008	0.0000013	4.44678E-09	0.0000078	0.00000079	0.0000012	2.09801E-07	0.0000045	0.00000082	0.0000013	1.17581E-06	0.00000081	0.00000081	0.0000013	2.48995E-07				0
Alkalinity (Bicarbonate as CaCO3)	mg/L	93.0153174	170	0.41	5	0.944941573	600	0.41	5	16.1385409	210	0.41	5	54.87103906	68	0.41	5	20.90325297				0
Alkalinity (Carbonate as CaCO3)	mg/L	50.5530691	0.41	0.41	5	0.002278977	0.41	0.41	5	0.011028003	140	0.41	5	36.5806927	0.41	0.41	5	0.126034319				0
Alkalinity (total) as CaCO3	mg/L	148.3436151	170	0.41	5	0.944941573	600	0.41	5	16.1385409	340	0.41	5	88.83882514	68	0.41	5	20.90325297				0
Aluminium	mg/L	1.2137517	0.0088	0.0024	0.03	4.89146E-05	0.24	0.24	0.3	0.006455416	0.53	0.024	0.3	0.138484051	2.9	0.0024	0.03	0.891462259				0
Ammonia as N	mg/L	1.7954554	2.3	0.086	0.1	0.012784504	4.3	0.086	0.1	0.115659543	0.74	0.1	0.1	0.19335509	1.4	0.086	0.1	0.430361091	0.05	0.1	0.1	0
Anthracene	mg/L	0.0001666	0.00015	0.00015	0.0019	8.33772E-07	0.00015	0.00015	0.0019	4.03464E-06	0.00016	0.00016	0.0021	4.18065E-05	0.00015	0.00015	0.002	4.61101E-05				0
Antimony	mg/L	0.0041831	0.00012	0.00004	0.002	6.67018E-07	0.035	0.004	0.02	0.000941415	0.011	0.0004	0.02	0.002874197	0.00063	0.00004	0.002	0.000193662				0
Arochlor 1016	mg/L	0.0000029	0.0000024	0.0000024	0.0000096	1.33404E-08	0.0000024	0.0000024	0.0000095	6.45542E-08	0.0000025	0.0000025	0.0000099	6.53227E-07	0.0000025	0.0000025	0.0000098	7.68502E-07				0
Arochlor 1221	mg/L	0.0000053	0.0000024	0.0000024	0.0000096	1.33404E-08	0.0000024	0.0000024	0.0000095	6.45542E-08	0.0000025	0.0000025	0.0000099	6.53227E-07	0.0000024	0.0000024	0.0000098	7.37762E-07				0
Arochlor 1232	mg/L	0.0000031	0.0000028	0.0000028	0.0000096	1.55637E-08	0.0000028	0.0000028	0.0000095	7.53132E-08	0.0000029	0.0000029	0.0000099	7.57743E-07	0.0000029	0.0000029	0.0000098	8.91462E-07				0
Arochlor 1242	mg/L	0.0000024	0.0000018	0.0000018	0.0000096	1.00053E-08	0.0000018	0.0000018	0.0000095	4.84156E-08	0.0000018	0.0000018	0.0000099	4.70323E-07	0.0000018	0.0000018	0.0000098	5.53321E-07				0
Arochlor 1248	mg/L	0.0000029	0.0000022	0.0000022	0.0000096	1.22287E-08	0.0000022	0.0000022	0.0000095	5.91746E-08	0.0000023	0.0000023	0.0000099	6.00969E-07	0.0000022	0.0000022	0.0000098	6.76282E-07				0
Arochlor 1254	mg/L	0.0000019	0.0000013	0.0000013	0.0000096	7.22602E-09	0.0000013	0.0000013	0.0000095	3.49668E-08	0.0000013	0.0000013	0.0000099	3.39678E-07	0.0000013	0.0000013	0.0000098	3.99621E-07				0
Arochlor 1260	mg/L	0.0000019	0.0000013	0.0000013	0.0000096	7.22602E-09	0.0000013	0.0000013	0.0000095	3.49668E-08	0.0000013	0.0000013	0.0000099	3.39678E-07	0.0000013	0.0000013	0.0000098	3.99621E-07				0
Arsenic	mg/L	0.0242846	0.0013	0.00012	0.001	7.22602E-06	0.17	0.012	0.01	0.004572587	0.06	0.0012	0.01	0.01567744	0.007	0.003	0.001	0.002151805				0
Azinophos methyl	mg/L	0.0001125	0.000022	0.000022	0.00019	1.22287E-07	0.000022	0.000022	0.00019	5.91746E-07	0.000022	0.000022	0.0002	5.74839E-06	0.000023	0.000023	0.0002	7.07022E-06				0
Barium	mg/L	0.2281199	0.065	0.000088	0.01	0.000361301	0.5	0.0088	1	0.013448784	0.28	0.00088	0.1	0.073161385	0.35	0.000088	0.01	0.107590273				0
b-BHC	mg/L	0.0000042	0.00000096	0.00000096	0.0000013	5.33614E-09	0.000012	0.00000095	0.0000012	3.22771E-07	0.000012	0.00000099	0.0000013	3.13549E-06	0.00000098	0.00000098	0.0000013	3.01253E-07				0
Benz(a)anthracene	mg/L	0.0002248	0.00014	0.00014	0.0019	7.78187E-07	0.00014	0.00014	0.0019	3.76566E-06	0.00015	0.00015	0.0021	3.91936E-05	0.00015	0.00015	0.002	4.61101E-05				0
Benzene	mg/L	0.0001262	0.00011	0.00011	0.001	6.11433E-07	0.00023	0.00011	0.001	6.18644E-06	0.00011	0.00011	0.001	2.8742E-05	0.00011	0.00011	0.001	3.38141E-05				0
Benzidine	mg/L	0.0339973	0.033	0.033	0.19	0.00018343	0.033	0.033	0.19	0.00088762	0.036	0.036	0.21	0.009406464	0.035	0.035	0.2	0.010759027				0
Benzo(a) pyrene	mg/L	0.0001469	0.00013	0.00013	0.0019	7.22602E-07	0.00013	0.00013	0.0019	3.49668E-06	0.00014	0.00014	0.0021	3.65807E-05	0.00013	0.00013	0.002	3.99621E-05				0
Benzo(g,h,i)perylene	mg/L	0.0001625	0.00015	0.00015	0.0019	8.33772E-07	0.00014	0.00014	0.0019	3.76566E-06	0.00016	0.00016	0.0021	4.18065E-05	0.00015	0.00015	0.002	4.61101E-05				0
Benzo(k)fluoranthene	mg/L	0.0005510	0.00053	0.00053	0.0019	2.94599E-06	0.00052	0.00052	0.0019	1.39867E-05	0.00057	0.00057	0.0021	0.000148936	0.00055	0.00055	0.002	0.00016907				0
Beryllium	mg/L	0.0005723	0.000036	0.000036	0.001	2.00105E-07	0.0036	0.0036	0.01	9.68312E-05	0.00036	0.00036	0.01	9.40646E-05	0.0011	0.000036	0.001	0.000338141				0
Biochemical Oxygen Demand	mg/L	6.2786851	2	2	2	2	2	2	2	0.053795136	2	2	2	0.522581324	2.9	2	2	0.891462259				0
Bis(2-chloroethoxy) methane	mg/L	0.0005831	0.00056	0.00056	0.0096	3.11275E-06	0.00055	0.00055	0.0094	1.47937E-05	0.00061	0.00061	0.01	0.000159387	0.00058	0.00058	0.01	0.000178292				0
Bis(2-chloroethyl)ether	mg/L	0.0002610	0.00024	0.00024	0.0019	1.33404E-06	0.00024	0.00024	0.0019	6.45542E-06	0.00026	0.00026	0.0021	6.79356E-05	0.00025	0.00025	0.002	7.68502E-05				0
Bis(2-chloroisopropyl) ether	mg/L	0.0002117	0.00019	0.00019	0.0019	1.05611E-06	0.00019	0.00019	0.0019	5.11054E-06	0.00021	0.00021	0.0021	5.4871E-05	0.0002	0.0002	0.002	6.14802E-05				0
Bis(2-ethylhexyl) phthalate	mg/L	0.0124097	0.012	0.012	0.019	6.67018E-05	0.012	0.012	0.019	0.000322771	0.013	0.013	0.021	0.003396779	0.013	0.013	0.02	0.00399621				0
Bisphenol A	mg/L	0.0003112	0.00032	0.00032	0.001	1.77871E-06	0.00031	0.00031	0.00098	8.33825E-06	0.00032	0.00032	0.001	8.3613E-05	0.00032	0.00032	0.00099	9.83682E-05				0
Boron	mg/L	38.6533858	0.5	0.00046	0.005	0.00277924	230	0.46	0.5	6.186440678	120	0.046	0.5	31.35487946	0.18	0.00061	0.2	0.05533214				0
Bromide	mg/L	74.2301880	0.52	0.19	0.5	0.00289041	150	4.8		4.034635225	260	4.8	13	67.93557217	0.48	0.48	1.3	0.147552374				0
Bromoform	mg/L	0.0002091	0.00019	0.00019	0.001	1.05611E-06	0.00019	0.00019	0.001	5.11054E-06	0.00019	0.00019	0.001	4.96452E-05	0.00019	0.00019	0.001	5.84061E-05				0
Butyl benzyl phthalate	mg/L	0.0014192	0.0014	0.0014	0.0096	7.78187E-06	0.0013	0.0013	0.0094	3.49668E-05	0.0015	0.0015	0.01	0.000391936	0.0014	0.0014	0.01	0.000430361				0
Cadmium	mg/L	0.0005013	0.000087	0.000074	0.001	4.83588E-07	0.011	0.0074	0.1	0.000295873	0.000281	0.0002	0.001	7.34227E-05	0.00026	0.000074	0.001	7.99242E-05	0.0002	0.0002	0.001	0
Carbon tetrachloride	mg/L	0.0001526	0.00014	0.00014	0.001	7.78187E-07	0.00014	0.00014	0.001	3.76566E-06	0.00014	0.00014	0.001	3.65807E-05	0.00014	0.00014	0.001	4.30361E-05				0
Chemical Oxygen Demand	mg/L	76.6634688	16	2	10	0.088935677	300	20	100	8.06927045	210	20	100	54.87103906	30	2	10	9.222023371				0
chlordane	mg/L	0.0000046	0.0000016	0.0000016	0.000012	8.89357E-09	0.0000016	0.0000016	0.000012	4.30361E-08	0.0000016	0.0000016	0.000012	4.18065E-07	0.0000016	0.0000016	0.000012	4.91841E-07				0
Chloride	mg/L	1286.3990862	6.8	0.2	1	0.037797663	23100	49	250	621.3338246	204	100	100	53.30329508	1600	4.9	25	491.8412464	1	1	1	0
Chlorine, Total Residual	mg/L	0.6582562	0.02			0.00011117	0.24			0.006455416	2.2			0.574839457	0.25			0.076850195				0
Chlorobenzene	mg/L	0.0001453	0.00014	0.00014	0.001	7.78187E-07	0.00014	0.00014	0.001	3.76566E-06	0.00014	0.00014	0.001	3.65807E-05	0.00014	0.00014	0.001	4.30361E-05				0
Chlorodibromomethane	mg/L	0.0004125	0.00014	0.00014	0.001	7.78187E-07	0.00014	0.00014	0.001	3.76566E-06	0.00077	0.00014	0.001	0.000201194	0.00045	0.00014	0.001	0.00013833				0
Chloroethane	mg/L	0.0002215	0.00021	0.00021	0.001	1.16728E-06	0.00021	0.00021	0.001	5.64849E-06	0.00021	0.00021	0.001	5.4871E-05	0.00021	0.00021	0.001	6.45542E-05				0
Chloroform	mg/L	0.0092130	0.00017	0.00017	0.001	9.44942E-07	0.0038	0.00017	0.001	0.000102211	0.019	0.00017	0.001	0.004964523	0.013	0.00017	0.001	0.00399621				0
Chlorpyrifos	mg/L	0.0001127	0.000019	0.000019	0.00019	1.05611E-07	0.000019	0.000019	0.00019	5.11054E-07	0.00002	0.00002	0.0002	5.22581E-06	0.00002	0.00002	0.0002	6.14802E-06				0
Chromium (Hexavalent)	mg/L	0.0089701	0.044	0.0019	0.01	0.000244573	0.023	0.0019		0.000618644	0.02	0.005	0.005	0.005225813	0.0041		0.01	0.001260343	0.003	0.003	0.005	0
Chromium (Total)	mg/L	0.0033224	0.00023	0.00023	0.002	1.27845E-06	0.023	0.023	0.2	0.000618644	0.0023	0.0023	0.02	0.000600969	0.004	0.00023	0.002	0.001229603				0
Chrysene	mg/L	0.0001526	0.00013	0.00013	0.0019	7.22602E-07	0.00013	0.00013	0.0019	3.49668E-06	0.00015	0.00015	0.0021	3.91936E-05	0.00014	0.00014	0.002	4.30361E-05				0
cis-1,3-dichloropropene	mg/L	0.0002018	0.00019	0.00019	0.001	1.05611E-06	0.00019	0.00019	0.001	5.11054E-06	0.00019	0.00019	0.001	4.96452E-05	0.00019	0.00019	0.001	5.84061E-05				0
Cobalt	mg/L	0.0036689	0.0014	0.00005	0.0005	7.78187E-06	0.021	0.005	0.05	0.000564849	0.0074	0.0005	0.005	0.001933551	0.0029	0.00005	0.0005	0.000891462				0
Color	o	0.1460154				0				0				0				0				0
Copper	mg/L	0.0196311	0.00058	0.00027	0.002	3.22392E-06	0.027	0.027	0.2	0.000726234	0.0125	0.002	0.01	0.003266133	0.032	0.00027	0.002	0.009836825	0.0025	0.002	0.01	0
Cyanide (Total)	mg/L	0.0039990	0.0025	0.0025	0.01	1.38962E-05	0.0025	0.0025	0.01	6.72439E-05	0.0057	0.0025	0.01	0.001489357	0.0043	0.0019	0.01	0.001321823				0
d-BHC	mg/L	0.0000004	0.00000037	0.00000037	0.0000013	2.05664E-09	0.00000036	0.00000036	0.0000012	9.68312E-09	0.00000038	0.00000038	0.0000013	9.92905E-08	0.00000037	0.00000037	0.0000013	1.13738E-07				0
DDD	mg/L	0.0000007	0.00000064	0.00000064	0.0000013	3.55743E-09	0.00000064	0.00000064	0.0000012	1.72144E-08	0.00000066	0.00000066	0.0000013	1.72452E-07	0.00000066	0.00000066	0.0000013	2.02885E-07				0
DDT	mg/L	0.0000009	0.00000071	0.00000071	0.0000013	3.94652E-09	0.0000041	0.0000007	0.0000012	1.1028E-07	0.00000073	0.00000073	0.0000013	1.90742E-07	0.00000073	0.00000073	0.0000013	2.24403E-07				0
Demeton (total)	mg/L	0.0000314	0.000031	0.000031	0.00038	1.72313E-07	0.000031	0.000031	0.00038	8.33825E-07	0.000032	0.000032	0.00039	8.3613E-06	0.000033	0.000033	0.0004	1.01442E-05				0
Demeton-O	mg/L	0.0000949				0				0			0	0				0				0
Demeton-S	mg/L	0.0000949				0				0				0				0				0
Diazinon	mg/L	0.0001130	0.000018	0.000018	0.00019	1.00053E-07	0.000018	0.000018	0.00019	4.84156E-07	0.000018	0.000018	0.0002	4.70323E-06	0.000019	0.000019	0.0002	5.84061E-06				0
Dibenz(a,h)anthracene	mg/L	0.0001697	0.00015	0.00015	0.0019	8.33772E-07	0.00015	0.00015	0.0019	4.03464E-06	0.00016	0.00016	0.0021	4.18065E-05	0.00016	0.00016	0.002	4.91841E-05				0
Dichlorobromomethane	mg/L	0.0015309	0.00013	0.00013	0.001	7.22602E-07	0.00049	0.00013	0.001	1.31798E-05	0.0025	0.00013	0.001	0.000653227	0.0026	0.00013	0.001	0.000799242				0
Dichlorodifluoromethane	mg/L	0.0000146				0				0				0				0				0
Dieldrin	mg/L	0.0000016	0.00000079	0.00000079	0.0000013	4.3912E-09	0.0000051	0.00000078	0.0000012	1.37178E-07	0.0000032	0.00000081	0.0000013	8.3613E-07	0.0000008	0.0000008	0.0000013	2.45921E-07				0
Diesel Range Organics	mg/L	0.2320876				0				0				0	0.48	0.24	0.5	0.147552374				0
Diethylphthalate	mg/L	0.0014526	0.0014	0.0014	0.0096	7.78187E-06	0.0014	0.0014	0.0094	3.76566E-05	0.0015	0.0015	0.01	0.000391936	0.0015	0.0015	0.01	0.000461101				0
Dimethyl phthalate	mg/L	0.0007659	0.00074	0.00074	0.0096	4.11328E-06	0.00072	0.00072	0.0094	1.93662E-05	0.0008	0.0008	0.01	0.000209033	0.00077	0.00077	0.01	0.000236699				0
Di-n-butyl phthalate	mg/L	0.0012410	0.0012	0.0012	0.0096	6.67018E-06	0.0012	0.0012	0.0094	3.22771E-05	0.0013	0.0013	0.01	0.000339678	0.0012	0.0012	0.01	0.000368881				0
Di-n-octyl phthalate	mg/L	0.0020673	0.002	0.002	0.0096	1.1117E-05	0.0019	0.0019	0.0094	5.11054E-05	0.0022	0.0022	0.01	0.000574839	0.0021	0.0021	0.01	0.000645542				0

		RESULTS	TOE DRAIN				FGD PLANT				FGD YARD SUMP				MASTER SUMP				CONTACT STORMWATER			
ChemName	Output Unit	Worst Case Concentration of the COC Expected in Outfall 301 Prior to Any Treatment (mg/L)	Worst Case Concentration (mg/l)	P TOE DRAIN_MDL	P TOE DRAIN_RL	Flow Weighted Average of the Source (mg/l)	Worst Case Concentration (mg/l)	FGD Plant_MDL	FGD Plant_RL	Flow Weighted Average of the Source (mg/l)	Worst Case Concentration (mg/l)	FGD Yard_MDL	FGD Yard_RL	Flow Weighted Average of the Source (mg/l)	Worst Case Concentration (mg/l)	MAST_MDL	MAST_RL	Flow Weighted Average of the Source (mg/l)	Worst Case Concentration (mg/l)	CONT SW_MDL	CONT SW _RL	Flow Weighted Average of the Source (mg/l)
Diphenylhydrazine	mg/L	0.0007222	0.00063	0.00063	0.0096	3.50184E-06	0.00062	0.00062	0.0094	1.66765E-05	0.00069	0.00069	0.01	0.000180291	0.00066	0.00066	0.01	0.000202885				0
E. Coli	cfu/100 ml	0.0146015				0.000000				0.000000				0.000000				0.000000				0
EC (field)	µS/cm	6505.8168439	364			2.023286662	48670			1309.104643	11080			2895.100537	362			111.279082				0
Endosulfan I	mg/L	0.0000016	0.0000009	0.0000009	0.0000013	5.00263E-09	0.0000092	0.0000009	0.0000012	2.47458E-07	0.0000023	0.00000093	0.0000013	6.00969E-07	0.00000092	0.00000092	0.0000013	2.82809E-07				0
Endosulfan II	mg/L	0.0000075	0.0000065	0.00000094	0.0000013	3.61301E-08	0.000048	0.00000093	0.0000012	1.29108E-06	0.000019	0.00000097	0.0000013	4.96452E-06	0.0000026	0.00000093	0.0000012	7.99242E-07				0
Endosulfan sulphate	mg/L	0.0000364	0.0000076	0.00000055	0.0000013	4.22444E-08	0.000073	0.00000054	0.0000012	1.96352E-06	0.00013	0.00000055	0.0000013	3.39678E-05	0.00000056	0.00000056	0.0000013	1.72144E-07				0
Endrin	mg/L	0.0000017	0.00000092	0.00000092	0.0000013	5.1138E-09	0.0000028	0.00000091	0.0000012	7.53132E-08	0.0000033	0.00000095	0.0000013	8.62259E-07	0.00000094	0.00000094	0.0000013	2.88957E-07				0
Endrin aldehyde	mg/L	0.0000009	0.00000087	0.00000087	0.0000013	4.83588E-09	0.00000086	0.00000086	0.0000012	2.31319E-08	0.00000089	0.00000089	0.0000013	2.32549E-07	0.00000088	0.00000088	0.0000013	2.70513E-07				0
Enterococci	MPN/100 ml	0.0146015				0				0				0				0				0
Ethylbenzene	mg/L	0.0002463	0.00023	0.00023	0.001	1.27845E-06	0.00069	0.00023	0.001	1.85593E-05	0.00023	0.00023	0.001	6.00969E-05	0.00023	0.00023	0.001	7.07022E-05				0
Fecal Coliforms	MPN/100 ml	0.0292031				0				0				0				0				0
Fluoranthene	mg/L	0.0001724	0.00016	0.00016	0.0019	8.89357E-07	0.00015	0.00015	0.0019	4.03464E-06	0.00017	0.00017	0.0021	4.44194E-05	0.00016	0.00016	0.002	4.91841E-05				0
Fluorene	mg/L	0.0002312	0.00021	0.00021	0.0019	1.16728E-06	0.0002	0.0002	0.0019	5.37951E-06	0.00023	0.00023	0.0021	6.00969E-05	0.00022	0.00022	0.002	6.76282E-05				0
Fluoride	mg/L	1.4944091	0.19	0.014	0.1	0.001056111	3.2	0.35	2.5	0.086072218	4.5	0.35	2.5	1.17580798	0.22	0.035	0.25	0.067628171				0
Gasoline Range Organics	mg/L	0.0367344				0				0				0	0.057	0.025	0.1	0.017521844				0
g-BHC (Lindane)	mg/L	0.0000008	0.00000077	0.00000077	0.0000013	4.28003E-09	0.00000076	0.00000076	0.0000012	2.04422E-08	0.00000079	0.00000079	0.0000013	2.0642E-07	0.00000078	0.00000078	0.0000013	2.39773E-07				0
Hardness	mg/L	20.0041057				0				0				0				0				0
HEM	mg/L	1.2065481				0				0				0	1.8	1.8	6	0.553321402				0
Heptachlor	mg/L	0.0000275	0.00000095	0.00000095	0.0000013	5.28056E-09	0.0001	0.00000094	0.0000012	2.68976E-06	0.000092	0.00000098	0.0000013	2.40387E-05	0.00000097	0.00000097	0.0000013	2.98179E-07				0
Heptachlor epoxide	mg/L	0.0000015	0.00000093	0.00000093	0.0000013	5.16939E-09	0.0000045	0.00000092	0.0000012	1.21039E-07	0.0000024	0.00000093	0.0000013	6.27098E-07	0.00000095	0.00000095	0.0000013	2.92031E-07				0
Hexachlorobenzene	mg/L	0.0002154	0.00018	0.00018	0.0019	1.00053E-06	0.00017	0.00017	0.0019	4.57259E-06	0.00019	0.00019	0.0021	4.96452E-05	0.00018	0.00018	0.002	5.53321E-05				0
Hexachlorobutadiene	mg/L	0.0001796	0.00016	0.00016	0.0019	8.89357E-07	0.00016	0.00016	0.0019	4.30361E-06	0.00017	0.00017	0.0021	4.44194E-05	0.00017	0.00017	0.002	5.22581E-05				0
Hexachlorocyclopentadiene	mg/L	0.0005214	0.0005	0.0005	0.0096	2.77924E-06	0.00049	0.00049	0.0094	1.31798E-05	0.00054	0.00054	0.01	0.000141097	0.00052	0.00052	0.01	0.000159848				0
Hexachloroethane	mg/L	0.0006295	0.0006	0.0006	0.0096	3.33509E-06	0.00059	0.00059	0.0094	1.58691E-05	0.00065	0.00065	0.01	0.000169839	0.00063	0.00063	0.01	0.000193662				0
Indeno(1,2,3-c,d)pyrene	mg/L	0.0002117	0.00019	0.00019	0.0019	1.05611E-06	0.00019	0.00019	0.0019	5.11054E-06	0.00021	0.00021	0.0021	5.4871E-05	0.0002	0.0002	0.002	6.14802E-05				0
Iron	mg/L	1.0666870	4.4	0.0057	0.05	0.024457311	1.3	0.57	5	0.034966839	0.84	0.057	0.5	0.219484156	1.9	0.0057	0.05	0.58406148				0
Isophorone	mg/L	0.0006423	0.00062	0.00062	0.0096	3.44626E-06	0.00061	0.00061	0.0094	1.64075E-05	0.00067	0.00067	0.01	0.000175065	0.00064	0.00064	0.01	0.000196736				0
Kepone	mg/L	0.0094587	0.0093	0.0093	0.038	5.16939E-05	0.0091	0.0091	0.038	0.000244768	0.01	0.01	0.042	0.002612907	0.0097	0.0097	0.04	0.002981788				0
Lead	mg/L	0.0031498	0.000074	0.000057	0.001	4.11328E-07	0.0058	0.0057	0.1	0.000156006	0.0018	0.00057	0.01	0.000470323	0.0067	0.0012	0.01	0.002059585				0
Lithium	mg/L	0.0727598	0.0038	0.00053	0.05	2.11222E-05	0.21	0.0026	0.25	0.005648489	0.13	0.0011	0.1	0.033967786	0.014	0.00053	0.05	0.004303611				0
Magnesium	mg/L	120.6684244	16	0.001	0.5	0.088935677	670	0.1	5	18.02137067	340	0.01	5	88.83882514	40	0.001	0.5	12.29603116				0
Malathion	mg/L	0.0000356	0.000021	0.000021	0.00019	1.16728E-07	0.000021	0.000021	0.00019	5.64849E-07	0.000021	0.000021	0.0002	5.4871E-06	0.000022	0.000022	0.0002	6.76282E-06				0
Manganese	mg/L	0.1773479	1	0.000046	0.005	0.00555848	1.3	0.0046	0.5	0.034966839	0.3	0.00046	0.05	0.078387199	0.16	0.00012	0.015	0.049184125				0
Mercury	mg/L	0.0000800	0.000056	0.000031	0.0002	3.11275E-07	0.00022	0.000031	0.0002	5.91746E-06	0.0001	0.000031	0.0002	2.61291E-05	0.00007	0.000031	0.0002	2.15181E-05				0
Methoxychlor	mg/L	0.0000001				0				0				0				0				0
Methyl Bromide	mg/L	0.0003201	0.00031	0.00031	0.001	1.72313E-06	0.00031	0.00031	0.001	8.33825E-06	0.00031	0.00031	0.001	8.10001E-05	0.00031	0.00031	0.001	9.52942E-05				0
Methyl Chloride	mg/L	0.0002978	0.00028	0.00028	0.001	1.55637E-06	0.00028	0.00028	0.001	7.53132E-06	0.00028	0.00028	0.001	7.31614E-05	0.00028	0.00028	0.001	8.60722E-05				0
Methylene Chloride	mg/L	0.0002597	0.00015	0.00015	0.001	8.33772E-07	0.00015	0.00015	0.001	4.03464E-06	0.00019	0.00015	0.001	4.96452E-05	0.00018	0.00015	0.001	5.53321E-05				0
Mirex	mg/L	0.0000005	0.00000046	0.00000046	0.0000013	2.5569E-09	0.0000046	0.00000046	0.0000012	1.23729E-08	0.00000048	0.00000048	0.0000013	1.2542E-07	0.00000047	0.00000047	0.0000013	1.44478E-07				0
Molybdenum	mg/L	0.0266343	0.0031	0.00026	0.005	1.72313E-05	0.081	0.0026	0.05	0.002178703	0.052	0.0026	0.05	0.013587114	0.0058	0.00026	0.005	0.001782925				0
Naphthalene	mg/L	0.0002176	0.00013	0.00013	0.0019	7.22602E-07	0.00013	0.00013	0.0019	3.49668E-06	0.00015	0.00015	0.0021	3.91936E-05	0.00014	0.00014	0.002	4.30361E-05				0
Nickel	mg/L	0.0221284	0.00075	0.000093	0.001	4.16886E-06	0.18	0.0093	0.01	0.004841562	0.0455	0.002	0.01	0.011888725	0.0067	0.000093	0.001	0.002059585	0.002	0.002	0.01	0
Nitrate	mg/L	0.0058406				0				0				0				0				0
Nitrate (as N)	mg/L	15.8133627	0.59	0.0062	0.1	0.003279503	35	0.16		0.941414886	55	0.16	2.5	14.37098642	1.6		0.25	0.491841246				0
Nitrite	mg/L	0.0011681				0				0				0				0				0
Nitrite (as N)	mg/L	0.2273397	0.18	0.024	0.05	0.001000526	0.6	0.6	1.3	0.016138541	0.6	0.6	1.3	0.156774397	0.17		0.05	0.052258132				0
Nitrobenzene	mg/L	0.0009028	0.00081	0.00081	0.019	4.50237E-06	0.0008	0.0008	0.019	2.15181E-05	0.00088	0.00088	0.021	0.000229936	0.00084	0.00084	0.02	0.000258217				0
Nitrogen (Organic)	mg/L	0.0087609				0				0				0				0				0
Nitrogen (Total Oxidised)	mg/L	0.0058406				0				0				0				0				0
Nitrogen (Total)	mg/L	0.0449727				0				0				0				0				0
N-Nitrosodimethylamine	mg/L	0.0007526	0.00071	0.00071	0.0019	3.94652E-06	0.00069	0.00069	0.0019	1.85593E-05	0.00077	0.00077	0.0021	0.000201194	0.00074	0.00074	0.002	0.000227477				0
N-nitrosodi-n-propylamine	mg/L	0.0003322	0.0003	0.0003	0.0019	1.66754E-06	0.00029	0.00029	0.0019	7.80029E-06	0.00032	0.00032	0.0021	8.3613E-05	0.00031	0.00031	0.002	9.52942E-05				0
n-Nitrosodiphenylamine	mg/L	0.0009123	0.00082	0.00082	0.0096	4.55795E-06	0.0008	0.0008	0.0094	2.15181E-05	0.00089	0.00089	0.01	0.000232549	0.00085	0.00085	0.01	0.000261291				0
Nonylphenol	mg/L	0.0000730				0				0				0				0				0
Nonylphenol Diethoxylate (Technica	mg/L	0.0018989	0.002	0.002	0.02	1.1117E-05	0.0019	0.0019	0.02	5.11054E-05	0.002	0.002	0.02	0.000522581	0.0019	0.0019	0.02	0.000584061				0
Nonylphenol Monoethoxylate (Tech	mg/L	0.0031122	0.0032	0.0032	0.01	1.77871E-05	0.0031	0.0031	0.0098	8.33825E-05	0.0032	0.0032	0.01	0.00083613	0.0032	0.0032	0.0099	0.000983682				0
Oil and Grease	mg/L	1.0348437	1.6	1.6	4.5	0.008893568	1.6	1.6	4.6	0.043036109	1.6	1.6	4.5	0.418065059	1.6	1.6	4.6	0.491841246				0
para-tert-Octylphenol	mg/L	0.0003112	0.00032	0.00032	0.001	1.77871E-06	0.00031	0.00031	0.00098	8.33825E-06	0.00032	0.00032	0.001	8.3613E-05	0.00032	0.00032	0.00099	9.83682E-05				0
Parathion	mg/L	0.0000457	0.000031	0.000031	0.00019	1.72313E-07	0.000031	0.000031	0.00019	8.33825E-07	0.000032	0.000032	0.0002	8.3613E-06	0.000032	0.000032	0.0002	9.83682E-06				0
P-Chloro-M-Cresol	mg/L	0.0008180	0.00073	0.00073	0.0096	4.05769E-06	0.00071	0.00071	0.0094	1.90973E-05	0.00079	0.00079	0.01	0.00020642	0.00075	0.00075	0.01	0.000230551				0
Pentachlorophenol	mg/L	0.0007269	0.00064	0.00064	0.0096	3.55743E-06	0.00063	0.00063	0.0094	1.69455E-05	0.00069	0.00069	0.01	0.000180291	0.00066	0.00066	0.01	0.000202885				0
pH (Field)	SU	9.4331332	6.54			0.036352458	8.44			0.227015475	8.75			2.28293294	8.68			2.66823876				0
Phenanthrene	mg/L	0.0004989	0.00041	0.00041	0.0019	2.27898E-06	0.0004	0.0004	0.0019	1.0759E-05	0.00044	0.00044	0.0021	0.000114968	0.00043	0.00043	0.002	0.000132182				0
Phenol	mg/L	0.0015861	0.00056	0.00056	0.0019	3.11275E-06	0.00055	0.00055	0.0019	1.47937E-05	0.0042	0.00056	0.0019	0.001097421	0.00058	0.00058	0.002	0.000178292				0
Phenolics Total	mg/L	0.0087993				0				0				0	0.016	0.0082	0.01	0.004918412				0
Phosphorus	mg/L	0.3960571	0.075	0.05	0.1	0.000416886	0.61	0.05	0.1	0.016407517	0.26	0.05	0.1	0.067935572	0.94	0.05	0.1	0.288956732				0
p-Nonylphenol (Technical mixture)	mg/L	0.0015382	0.0016	0.0016	0.005	8.89357E-06	0.0016	0.0016	0.0049	4.30361E-05	0.0016	0.0016	0.005	0.000418065	0.0016	0.0016	0.0049	0.000491841				0
Potassium	mg/L	31.2140604	3.7	0.017	0.5	0.020566375	120	1.7	5	3.22770818	71	0.17	5	18.55163701	22	0.017	0.5	6.762817139				0
Pyrene	mg/L	0.0002347	0.00015	0.00015	0.0019	8.33772E-07	0.00015	0.00015	0.0019	4.03464E-06	0.00016	0.00016	0.0021	4.18065E-05	0.00016	0.00016	0.002	4.91841E-05				0
Radium-226	pCi/L	0.2363316	0.487	0.161	1	0.00270698	6.26	2.06	1	0	2.3	1.01	1	0	0.4	0.4	1	0.122960312				0
Radium-228	pCi/L	0.4067776	0.375	0.375	1	0.00208443	3.12	3.12	1	0	2.3	1	1	0	0.869	0.607	1	0.267131277				0
Redox	mV	135.9675050	5.1			0.028348247	147.5			3.967391304	225.9			59.02556059	122.3			37.59511528				0
Selenium	mg/L	0.0188901	0.00033	0.0002	0.005	1.8343E-06	0.044	0.002	0.05	0.001183493	0.0263	0.001	0.001	0.006871944	0.0039	0.0039	0.01	0.001198863	0.0114	0.001	0.001	0
Silver	mg/L	0.0002824	0.000047	0.000047	0.001	2.61249E-07	0.0047	0.0047	0.1	0.000126419	0.00047	0.00047	0.01	0.000122807	0.000047	0.000047	0.001	1.44478E-05				0
Sodium	mg/L	364.8100263	7.3	0.011	0.5	0.040576903	710	1.1	5	19.0972734	420	0.11	5	109.7420781	670	0.011	0.5	205.9585219				0
Specific Conductivity (lab)	µS/cm	0.0000000				0				0				0				0				0
Sulfate	mg/L	1085.2848089	57	0.21	1	0.316833351	660	5.4		17.75239499	1000	5.4	25	261.2906622	2200		25	676.2817139				0
Sulfide	mg/L	0.6372921	0.41	0.41	1	0.002278977	0.41	0.41	1	0.011028003	1.3	0.47	3	0.339677861	0.41	0.41	1	0.126034319				0
sulfide (as H2S)	mg/L	0.6135454	0.41	0.41	1	0.002278977	8.2	8.2	20	0.220560059	0.41	0.41	1	0.107129171	0.41	0.41	1	0.126034319				0
Surfactants	mg/L	0.0014602				0				0				0				0				0
Temperature	oC	28.1106950	19.24			0.106945152	38.8	1	1	1.043625645	22.16			5.790201074	33.43			10.27640804				0
Tetrachloroethene	mg/L	0.0001624	0.00015	0.00015	0.001	8.33772E-07	0.00015	0.00015	0.001	4.03464E-06	0.00015	0.00015	0.001	3.91936E-05	0.00015	0.00015	0.001	4.61101E-05				0
Thallium	mg/L	0.0050065	0.000063	0.000013	0.001	3.50184E-07	0.0038	0.0013	0.01	0.000102211	0	0.00013	0.01	0	0.0022	0.0018	0.02	0.000676282				0
Tin	mg/L	0.0002920				0				0				0				0				0
Titanium	mg/L	0.0000730				0				0				0				0				0
Toluene	mg/L	0.0001624	0.00015	0.00015	0.001	8.33772E-07	0.00015	0.00015	0.001	4.03464E-06	0.00015	0.00015	0.001	3.91936E-05	0.00015	0.00015	0.001	4.61101E-05				0
Total Dissolved Solids	mg/L	4716.0378987	230	10	10	1.278450363	31000	200	200	833.8246131	9000	100	100	2351.61596	3600	40	40	1106.642805				0
Total Kjeldahl Nitrogen	mg/L	8.5788578	3.4	1.7	5	0.018898831	9.5	1.7	5	0.255526898	8.4	1.7	5	2.194841562	15	1.7	5	4.611011685				0
Total Organic Carbon	mg/L	5.1142204	3.4	0.19	1	0.018898831	36	3.8	20	0.968312454	9.9	0.19	1	2.586777556	2.8	0.19	1	0.860722181				0
Total Suspended Solids	mg/L	93.5278524	7.8	1	1	0.043356143	3.3	0.52		0.088761975	27	1	1	7.054847879	230		5	70.70217918				0
Toxaphene	mg/L	0.0000207	0.000018	0.000018	0.000048	1.00053E-07	0.000018	0.000018	0.000048	4.84156E-07	0.000018	0.000018	0.00005	4.70323E-06	0.000018	0.000018	0.000049	5.53321E-06				0
trans-1,2-Dibromoethene	mg/L	0.0000146				0				0				0				0				0
trans-1,3-dichloropropene	mg/L	0.0001624	0.00015	0.00015	0.001	8.33772E-07	0.00015	0.00015	0.001	4.03464E-06	0.00015	0.00015	0.001	3.91936E-05	0.00015	0.00015	0.001	4.61101E-05				0
Tributyltin	mg/L	0.0000466	0.000043	0.000043	0.000043	2.39015E-07	0.000043	0.000043	0.000043	1.1566E-06	0.000047	0.000047	0.000047	1.22807E-05	0.000052	0.000052	0.000052	1.59848E-05				0
Trichloroethene	mg/L	0.0001526	0.00014	0.00014	0.001	7.78187E-07	0.00014	0.00014	0.001	3.76566E-06	0.00014	0.00014	0.001	3.65807E-05	0.00014	0.00014	0.001	4.30361E-05				0
Trichlorofluoromethane	mg/L	0.0000146				0				0				0				0				0
Turbidity	NTU	22.5550374	23	0.05	0.85	0.127845036	1.8	0.05	0.85	0.048415623	33	0.05	0.85	8.622591852	21	0.05	0.85	6.45541636				0
Vinyl chloride	mg/L	0.0002412	0.00023	0.00023	0.001	1.27845E-06	0.00023	0.00023	0.001	6.18644E-06	0.00023	0.00023	0.001	6.00969E-05	0.00023	0.00023	0.001	7.07022E-05				0
Zinc	mg/L	0.0782445	0.025	0.0004	0.005	0.000138962	0.061	0.04	0.5	0.001640752	0.236	0.01	0.01	0.061664596	0.04	0.001	0.02	0.012296031	0.01	0.01	0.01	0

		RESULTS	BOTTOM ASH				METALS POND				COAL YARD				SIERRA DITCH				LEACHATE			
ChemName	Output Unit	Worst Case Concentration of the COC Expected in Outfall 301 Prior to Any Treatment (mg/L)	Worst Case Concentration (mg/l)	B/A_MDL	B/A_RL	Flow Weighted Average of the Source (mg/l)	Worst Case Concentration (mg/l)	Metals Pond_MDL	Metals Pond_RL	Flow Weighted Average of the Source (mg/l)	Worst Case Concentration (mg/l)	COAL YARD_MDL	COAL YARD_RL	Flow Weighted Average of the Source (mg/l)	Worst Case Concentration (mg/l)	SIERRA_MDL	SIERRA_RL	Flow Weighted Average of the Source (mg/l)	Worst Case Concentration (mg/l)	Leachate_MDL (LOD)	Leachate_RL (LOQ)	Flow Weighted Average of the Source (mg/l)
1,1,1-trichloroethane	mg/L	0.0002773	0.00029	0.00029	0.001	0.0000169	0.00029	0.00029	0.001	0	0.00029	0.00029	0.001	5.05814E-05	0.00029	0.00029	0.001	1.68605E-05	0.001	0.001	0.005	5.81395E-06
1,1,2,2-tetrachloroethane	mg/L	0.0001959	0.0002	0.0002	0.001	0.0000116	0.0002	0.0002	0.001	0	0.0002	0.0002	0.001	3.48837E-05	0.0002	0.0002	0.001	1.16279E-05	0.0015	0.0015	0.005	8.72093E-06
1,1,2-trichloroethane	mg/L	0.0001930	0.0002	0.0002	0.001	0.0000116	0.0002	0.0002	0.001	0	0.0002	0.0002	0.001	3.48837E-05	0.0002	0.0002	0.001	1.16279E-05	0.001	0.001	0.005	5.81395E-06
1,1-dichloroethane	mg/L	0.0001181	0.00012	0.00012	0.001	0.0000070	0.00012	0.00012	0.001	0	0.00012	0.00012	0.001	2.09302E-05	0.00012	0.00012	0.001	6.97674E-06	0.001	0.001	0.005	5.81395E-06
1,1-dichloroethene	mg/L	0.0002866	0.0003	0.0003	0.001	0.0000174	0.0003	0.0003	0.001	0	0.0003	0.0003	0.001	5.23256E-05	0.0003	0.0003	0.001	1.74419E-05	0.001	0.001	0.005	5.81395E-06
1,2,4-trichlorobenzene	mg/L	0.0006753	0.00068	0.00068	0.0019	0.0000395	0.00068	0.00068	0.0019	0	0.0007	0.0007	0.002	0.000122093	0.00068	0.00068	0.0019	3.95349E-05	0.00222	0.00222	0.005556	1.2907E-05
1,2-dichlorobenzene	mg/L	0.0001469	0.00015	0.00015	0.001	0.0000087	0.00015	0.00015	0.001	0	0.00015	0.00015	0.001	2.61628E-05	0.00015	0.00015	0.001	8.72093E-06	0.00111	0.00111	0.005556	6.45349E-06
1,2-dichloroethane	mg/L	0.0002053	0.00021	0.00021	0.001	0.0000122	0.00021	0.00021	0.001	0	0.00021	0.00021	0.001	3.66279E-05	0.00021	0.00021	0.001	1.22093E-05	0.0015	0.0015	0.005	8.72093E-06
1,2-dichloropropane	mg/L	0.0000976	0.000095	0.000095	0.001	0.0000055	0.000095	0.000095	0.001	0	0.000095	0.000095	0.001	1.65698E-05	0.000095	0.000095	0.001	5.52326E-06	0.0015	0.0015	0.005	8.72093E-06
1,2-Trans-dichloroethene	mg/L	0.0001649	0.00017	0.00017	0.001	0.0000099	0.00017	0.00017	0.001	0	0.00017	0.00017	0.001	2.96512E-05	0.00017	0.00017	0.001	9.88372E-06	0.001	0.001	0.005	5.81395E-06
1,3-dichlorobenzene	mg/L	0.0001094	0.00011	0.00011	0.001	0.0000064	0.00011	0.00011	0.001	0	0.00011	0.00011	0.001	1.9186E-05	0.00011	0.00011	0.001	6.39535E-06	0.00111	0.00111	0.005556	6.45349E-06
1,3-Dichloropropene	mg/L	0.0004738	0.0005	0.0005	0.002	0.0000291	0.0005	0.0005	0.002	0	0.0005	0.0005	0.002	8.72093E-05	0.0005	0.0005	0.002	2.90698E-05	0.001	0.001	0.01	5.81395E-06
1,4-dichlorobenzene	mg/L	0.0002030	0.00021	0.00021	0.001	0.0000122	0.00021	0.00021	0.001	0	0.00021	0.00021	0.001	3.66279E-05	0.00021	0.00021	0.001	1.22093E-05	0.00111	0.00111	0.005556	6.45349E-06
2,3,7,8-Tetrachlorooxanthrene	mg/L	8.43E-12				0				0				0				0	1.45E-09	1.45E-09	0.000000011	8.43023E-12
2,4,6-trichlorophenol	mg/L	0.0016123	0.0017	0.0017	0.0096	0.0000988	0.0017	0.0017	0.0095	0	0.0017	0.0017	0.0099	0.000296512	0.0017	0.0017	0.0096	9.88372E-05	0.00111	0.00111	0.005556	6.45349E-06
2,4-dichlorophenol	mg/L	0.0003167	0.00032	0.00032	0.0019	0.0000186	0.00032	0.00032	0.0019	0	0.00033	0.00033	0.002	5.75581E-05	0.00032	0.00032	0.0019	1.86047E-05	0.00111	0.00111	0.005556	6.45349E-06
2,4-dimethylphenol	mg/L	0.0007981	0.00082	0.00082	0.0096	0.0000477	0.00081	0.00081	0.0095	0	0.00084	0.00084	0.0099	0.000146512	0.00082	0.00082	0.0096	4.76744E-05	0.00056	0.00056	0.005556	3.25581E-06
2,4-dinitrophenol	mg/L	0.0057243	0.0059	0.0059	0.048	0.0003430	0.0058	0.0058	0.048	0	0.0061	0.0061	0.05	0.001063953	0.0059	0.0059	0.048	0.000343023	0.00056	0.00056	0.005556	3.25581E-06
2,4-Dinitrotoluene	mg/L	0.0005098	0.00052	0.00052	0.0096	0.0000302	0.00051	0.00051	0.0095	0	0.00053	0.00053	0.0099	9.24419E-05	0.00052	0.00052	0.0096	3.02326E-05	0.00111	0.00111	0.005556	6.45349E-06
2,6-dichlorophenol	mg/L	0.0000065				0				0				0				0	0.00111	0.00111	0.005556	6.45349E-06
2,6-dinitrotoluene	mg/L	0.0007530	0.00077	0.00077	0.0096	0.0000448	0.00076	0.00076	0.0095	0	0.00079	0.00079	0.0099	0.000137791	0.00077	0.00077	0.0096	4.47674E-05	0.00111	0.00111	0.005556	6.45349E-06
2-Chloroethylvinyl ether	mg/L	0.0002631	0.00025	0.00025	0.002	0.0000145	0.00025	0.00025	0.002	0	0.00025	0.00025	0.002	4.36047E-05	0.00025	0.00025	0.002	1.45349E-05	0.005	0.005	0.005	2.90698E-05
2-chloronaphthalene	mg/L	0.0001482	0.00015	0.00015	0.0019	0.0000087	0.00014	0.00014	0.0019	0	0.00015	0.00015	0.002	2.61628E-05	0.00015	0.00015	0.0019	8.72093E-06	0.00111	0.00111	0.005556	6.45349E-06
2-chlorophenol	mg/L	0.0015644	0.0016	0.0016	0.0096	0.0000930	0.0016	0.0016	0.0095	0	0.0016	0.0016	0.0099	0.00027907	0.0016	0.0016	0.0096	9.30233E-05	0.00111	0.00111	0.005556	6.45349E-06
2-methylphenol	mg/L	0.0000322				0				0				0				0	0.00554	0.00556	0.005556	3.22093E-05
2-nitrophenol	mg/L	0.0015964	0.0016	0.0016	0.0096	0.0000930	0.0016	0.0016	0.0095	0	0.0017	0.0017	0.0099	0.000296512	0.0016	0.0016	0.0096	9.30233E-05	0.00111	0.00111	0.005556	6.45349E-06
3,3-Dichlorobenzidine	mg/L	0.0010700	0.0011	0.0011	0.0096	0.0000640	0.0011	0.0011	0.0095	0	0.0011	0.0011	0.0099	0.00019186	0.0011	0.0011	0.0096	6.39535E-05	0.00444	0.00444	0.005556	2.5814E-05
3,4-Benzo-fluoranthene	mg/L	0.0001546	0.00015	0.00015	0.0019	0.0000087	0.00015	0.00015	0.0019	0	0.00016	0.00016	0.002	2.7907E-05	0.00015	0.00015	0.0019	8.72093E-06	0.00111	0.00111	0.005556	6.45349E-06
4,4-DDE	mg/L	0.0000009	0.00000076	0.00000076	0.0000013	4.42E-08	0.00000076	0.00000076	0.0000013	0	0.00000077	0.00000077	0.0000013	1.34302E-07	0.00000078	0.00000078	0.00000130	4.53488E-08	0.000005	0.000005	0.00005155	2.90698E-08
4,6-Dinitro-2-methylphenol	mg/L	0.0020644	0.0021	0.0021	0.048	0.0001221	0.0021	0.0021	0.048	0	0.0022	0.0022	0.05	0.000383721	0.0021	0.0021	0.048	0.000122093	0.00111	0.00111	0.005556	6.45349E-06
4-bromophenyl phenyl ether	mg/L	0.0006019	0.00061	0.00061	0.0096	0.0000355	0.0006	0.0006	0.0095	0	0.00063	0.00063	0.0099	0.000109884	0.00061	0.00061	0.0096	3.54651E-05	0.00111	0.00111	0.005556	6.45349E-06
4-chlorophenyl phenyl ether	mg/L	0.0004741	0.00048	0.00048	0.0096	0.0000279	0.00048	0.00048	0.0095	0	0.0005	0.0005	0.0099	8.72093E-05	0.00048	0.00048	0.0096	2.7907E-05	0.00111	0.00111	0.005556	6.45349E-06
4-nitrophenol	mg/L	0.0060541	0.0062	0.0062	0.048	0.0003605	0.0062	0.0062	0.048	0	0.0064	0.0064	0.05	0.001116279	0.0062	0.0062	0.048	0.000360465	0.00111	0.00111	0.005556	6.45349E-06
a-BHC	mg/L	0.0000023	0.00000063	0.00000063	0.0000013	3.66E-08	0.00000063	0.00000063	0.0000013	0	0.000001	0.00000063	0.0000012	1.74419E-07	0.0000021	0.00000065	0.0000013	1.22093E-07	0.00002	0.00005155	0.005	1.16279E-07
Accrolein	mg/L	0.0024919	0.0026	0.0026	0.02	0.0001512	0.0026	0.0026	0.02	0	0.0026	0.0026	0.02	0.000453488	0.0026	0.0026	0.02	0.000151163	0.01	0.01	0.01	5.81395E-05
Acenaphthene	mg/L	0.0001390	0.00014	0.00014	0.0019	0.0000081	0.00014	0.00014	0.0019	0	0.00014	0.00014	0.002	2.44186E-05	0.00014	0.00014	0.0019	8.13953E-06	0.00111	0.00111	0.005556	6.45349E-06
Acenaphthylene	mg/L	0.0001482	0.00015	0.00015	0.0019	0.0000087	0.00014	0.00014	0.0019	0	0.00015	0.00015	0.002	2.61628E-05	0.00015	0.00015	0.0019	8.72093E-06	0.00111	0.00111	0.005556	6.45349E-06
Acrylonitrile	mg/L	0.0009534	0.00055	0.00055	0.02	0.0000320	0.00055	0.00055	0.02	0	0.00055	0.00055	0.02	9.59302E-05	0.00055	0.00055	0.02	3.19767E-05	0.0085	0.0085	0.01	4.94186E-05
Aldrin	mg/L	0.0000014	0.0000008	0.0000008	0.0000013	4.65E-08	0.0000008	0.0000008	0.0000013	0	0.00000081	0.00000081	0.0000013	1.41279E-07	0.00000082	0.00000082	0.0000013	4.76744E-08	0.000005	0.000005	0.00005155	2.90698E-08
Alkalinity (Bicarbonate as CaCO3)	mg/L	82.2154070	60	0.41	5	3.4883721	0.41	0.41	5	0	0.41	0.41	5	0.071511628	110	0.41	5	6.395348837				0
Alkalinity (Carbonate as CaCO3)	mg/L	21.5794186	16	0.41	5	0.9302326	36	0.41	5	0	0.41	0.41	5	0.071511628	0.41	0.41	5	0.023837209				0
Alkalinity (total) as CaCO3	mg/L	101.3433140	64	0.41	5	3.7209302	56	0.41	5	0	0.41	0.41	5	0.071511628	110	0.41	5	6.395348837				0
Aluminium	mg/L	9.1982366	0.92	0.0024	0.03	0.0534884	0.42	0.0024	0.03	0	44	0.0024	0.03	7.674418605	0.98	0.0024	0.03	0.056976744	1.09	0.02	0.05	0.006337209
Ammonia as N	mg/L	1.1157267	0.65	0.086	0.1	0.0377907	2.6	0.086	0.1	0	0.99	0.086	0.1	0.172674419	0.4	0.086	0.1	0.023255814	3.03	0.05	0.1	0.017616279
Anthracene	mg/L	0.0001483	0.00015	0.00015	0.0019	0.0000087	0.00015	0.00015	0.0019	0	0.00015	0.00015	0.002	2.61628E-05	0.00015	0.00015	0.0019	8.72093E-06	0.00111	0.00111	0.005556	6.45349E-06
Antimony	mg/L	0.0023848	0.0011	0.00004	0.002	0.0000640	0.00032	0.00004	0.002	0	0.00058	0.00004	0.002	0.000101163	0.00049	0.00004	0.002	2.84884E-05	0.00344	0.00011	0.002	0.00002
Arochlor 1016	mg/L	0.0000025	0.0000024	0.0000024	0.0000096	0.0000001	0.0000024	0.0000024	0.0000096	0	0.0000024	0.0000024	0.0000097	4.18605E-07	0.0000025	0.0000025	0.0000099	1.45349E-07	0.00003	0.00003	0.0005155	1.74419E-07
Arochlor 1221	mg/L	0.0000034	0.0000024	0.0000024	0.0000096	0.0000001	0.0000024	0.0000024	0.0000096	0	0.0000024	0.0000024	0.0000097	4.18605E-07	0.0000025	0.0000025	0.0000099	1.45349E-07	0.0002	0.0002	0.0005155	1.16279E-06
Arochlor 1232	mg/L	0.0000028	0.0000028	0.0000028	0.0000096	0.0000002	0.0000028	0.0000028	0.0000096	0	0.0000028	0.0000028	0.0000097	4.88372E-07	0.0000029	0.0000029	0.0000099	1.68605E-07	0.00002	0.00002	0.0005155	1.16279E-07
Arochlor 1242	mg/L	0.0000019	0.0000018	0.0000018	0.0000096	0.0000001	0.0000018	0.0000018	0.0000096	0	0.0000018	0.0000018	0.0000097	3.13953E-07	0.0000018	0.0000018	0.0000099	1.04651E-07	0.00004	0.00004	0.0005155	2.32558E-07
Arochlor 1248	mg/L	0.0000024	0.0000022	0.0000022	0.0000096	0.0000001	0.0000022	0.0000022	0.0000096	0	0.0000022	0.0000022	0.0000097	3.83721E-07	0.0000023	0.0000023	0.0000099	1.33721E-07	0.00005	0.00005	0.0005155	2.90698E-07
Arochlor 1254	mg/L	0.0000014	0.0000013	0.0000013	0.0000096	0.0000001	0.0000013	0.0000013	0.0000096	0	0.0000013	0.0000013	0.0000097	2.26744E-07	0.0000013	0.0000013	0.0000099	7.55814E-08	0.00004	0.00004	0.0005155	2.32558E-07
Arochlor 1260	mg/L	0.0000014	0.0000013	0.0000013	0.0000096	0.0000001	0.0000013	0.0000013	0.0000096	0	0.0000013	0.0000013	0.0000097	2.26744E-07	0.0000013	0.0000013	0.0000099	7.55814E-08	0.00004	0.00004	0.0002062	2.32558E-07
Arsenic	mg/L	0.0245589	0.0072	0.00012	0.001	0.0004186	0.003	0.003	0.01	0	0.049	0.00012	0.001	0.008546512	0.034	0.00012	0.001	0.001976744	0.0495	0.00061	0.001	0.000287791
Azinophos methyl	mg/L	0.0000571	0.000022	0.000022	0.0002	0.0000013	0.000022	0.000022	0.00019	0	0.000022	0.000022	0.0002	3.83721E-06	0.000022	0.000022	0.0002	1.27907E-06	0.0062	0.0065	0.0065	3.60465E-05
Barium	mg/L	0.2351446	0.11	0.000088	0.01	0.0063953	0.08	0.000088	0.01	0	0.084	0.000088	0.01	0.014651163	0.1	0.000088	0.01	0.005813953	0.193	0.002	0.01	0.001122093
b-BHC	mg/L	0.0000026	0.00000096	0.00000096	0.0000013	0.0000001	0.00000096	0.00000096	0.0000013	0	0.00000097	0.00000097	0.0000013	1.69186E-07	0.00000099	0.00000099	0.0000013	5.75581E-08	0.000005	0.000005	0.00005155	2.90698E-08
Benz(a)anthracene	mg/L	0.0001711	0.00014	0.00014	0.0019	0.0000081	0.00014	0.00014	0.0019	0	0.00015	0.00015	0.002	2.61628E-05	0.00014	0.00014	0.0019	8.13953E-06	0.00556	0.00556	0.00556	3.23256E-05
Benzene	mg/L	0.0001097	0.00011	0.00011	0.001	0.0000064	0.00011	0.00011	0.001	0	0.00011	0.00011	0.001	1.9186E-05	0.00011	0.00011	0.001	6.39535E-06	0.001	0.001	0.005	5.81395E-06
Benzidine	mg/L	0.0324477	0.033	0.033	0.19	0.0019186	0.033	0.033	0.19	0	0.034	0.034	0.2	0.005930233	0.033	0.033	0.19	0.001918605	0.00551	0.00556	0.005556	3.20349E-05
Benzo(a) pyrene	mg/L	0.0001296	0.00013	0.00013	0.0019	0.0000076	0.00013	0.00013	0.0019	0	0.00013	0.00013	0.002	2.26744E-05	0.00013	0.00013	0.0019	7.55814E-06	0.00111	0.00111	0.005556	6.45349E-06
Benzo(g,h,i)perylene	mg/L	0.0001482	0.00015	0.00015	0.0019	0.0000087	0.00014	0.00014	0.0019	0	0.00015	0.00015	0.002	2.61628E-05	0.00015	0.00015	0.0019	8.72093E-06	0.00111	0.00111	0.005556	6.45349E-06
Benzo(k)fluoranthene	mg/L	0.0005192	0.00053	0.00053	0.0019	0.0000308	0.00052	0.00052	0.0019	0	0.00054	0.00054	0.002	9.4186E-05	0.00053	0.00053	0.0019	3.0814E-05	0.00111	0.00111	0.005556	6.45349E-06
Beryllium	mg/L	0.0044892	0.00084	0.000036	0.001	0.0000488	0.000036	0.000036	0.001	0	0.022	0.000036	0.001	0.003837209	0.000095	0.000036	0.001	5.52326E-06	0.002	0.002	0.004	1.16279E-05
Biochemical Oxygen Demand	mg/L	6.3954942	2	2	2	2	2	2	2	0	2.2	2	2	0.38372093	6.2	2	2	0.360465116	2.9	0.2	2	0.016860465
Bis(2-chloroethoxy) methane	mg/L	0.0005505	0.00056	0.00056	0.0096	0.0000326	0.00055	0.00055	0.0095	0	0.00058	0.00058	0.0099	0.000101163	0.00056	0.00056	0.0096	3.25581E-05	0.00111	0.00111	0.005556	6.45349E-06
Bis(2-chloroethyl)ether	mg/L	0.0002403	0.00024	0.00024	0.0019	0.0000140	0.00024	0.00024	0.0019	0	0.00025	0.00025	0.002	4.36047E-05	0.00024	0.00024	0.0019	1.39535E-05	0.00111	0.00111	0.005556	6.45349E-06
Bis(2-chloroisopropyl) ether	mg/L	0.0001935	0.00019	0.00019	0.0019	0.0000110	0.00019	0.00019	0.0019	0	0.0002	0.0002	0.002	3.48837E-05	0.00019	0.00019	0.0019	1.10465E-05	0.00111	0.00111	0.005556	6.45349E-06

		RESULTS	BOTTOM ASH				METALS POND				COAL YARD				SIERRA DITCH				LEACHATE			
ChemName	Output Unit	Worst Case Concentration of the COC Expected in Outfall 301 Prior to Any Treatment (mg/L)	Worst Case Concentration (mg/l)	B/A_MDL	B/A_RL	Flow Weighted Average of the Source (mg/l)	Worst Case Concentration (mg/l)	Metals Pond_MDL	Metals Pond_RL	Flow Weighted Average of the Source (mg/l)	Worst Case Concentration (mg/l)	COAL YARD_MDL	COAL YARD_RL	Flow Weighted Average of the Source (mg/l)	Worst Case Concentration (mg/l)	SIERRA_MDL	SIERRA_RL	Flow Weighted Average of the Source (mg/l)	Worst Case Concentration (mg/l)	Leachate_MDL (LOD)	Leachate_RL (LOQ)	Flow Weighted Average of the Source (mg/l)
Bis(2-ethylhexyl) phthalate	mg/L	0.0118422	0.012	0.012	0.019	0.0006977	0.012	0.012	0.019	0	0.012	0.012	0.02	0.002093023	0.012	0.012	0.019	0.000697674	0.00111	0.00111	0.005556	6.45349E-06
Bisphenol A	mg/L	0.0005227	0.0042	0.00032	0.001	0.0002442	0.00031	0.00031	0.00097	0	0.00031	0.00031	0.00098	5.40698E-05	0.00031	0.00031	0.00097	1.80233E-05				0
Boron	mg/L	19.6088517	0.16	0.00046	0.005	0.0093023	2.6	0.00061	0.2	0	0.97	0.00046	0.005	0.169186047	0.49	0.00046	0.005	0.028488372	3.76	0.05	0.05	0.021860465
Bromide	mg/L	39.5070058	0.19	0.19	0.5	0.0110465	5.3	0.19	0.5	0	1.2	0.19	0.5	0.209302326	0.52	0.19	0.5	0.030232558	5	5	5	0.029069767
Bromoform	mg/L	0.0001866	0.00019	0.00019	0.001	0.0000110	0.00019	0.00019	0.001	0	0.00019	0.00019	0.001	3.31395E-05	0.00019	0.00019	0.001	1.10465E-05	0.0015	0.0015	0.005	8.72093E-06
Butyl benzyl phthalate	mg/L	0.0013307	0.0014	0.0014	0.0096	0.0000814	0.0014	0.0014	0.0095	0	0.0014	0.0014	0.0099	0.000244186	0.0014	0.0014	0.0096	8.13953E-05	0.00111	0.00111	0.005556	6.45349E-06
Cadmium	mg/L	0.0013822	0.00024	0.000074	0.001	0.0000140	0.00013	0.00013	0.005	0	0.0063	0.000074	0.001	0.001098837	0.00011	0.000074	0.001	6.39535E-06	0.00011	0.00011	0.0003	6.39535E-07
Carbon tetrachloride	mg/L	0.0001369	0.00014	0.00014	0.001	0.0000081	0.00014	0.00014	0.001	0	0.00014	0.00014	0.001	2.44186E-05	0.00014	0.00014	0.001	8.13953E-06	0.001	0.001	0.005	5.81395E-06
Chemical Oxygen Demand	mg/L	76.1203488	6.1	2	10	0.3546512	11	2	10	0	120	4	20	20.93023256	130	4	20	7.558139535	12.7	10	10	0.073837209
chlordane	mg/L	0.0000035	0.0000016	0.0000016	0.000012	0.0000001	0.0000016	0.0000016	0.000012	0	0.0000061	0.0000016	0.000012	1.06395E-06	0.0000016	0.0000016	0.000012	9.30233E-08	0.000206	0.000206	0.0002062	1.19767E-06
Chloride	mg/L	965.5514535	22	0.2	1	1.2790698	310	2	10	0	84	0.2	1	14.65116279	37	0.2	1	2.151162791	52.4	10	10	0.304651163
Chlorine, Total Residual	mg/L	0.5182267	0.04			0.0023256	0			0	0.44			0.076744186	0.04			0.002325581				0
Chlorobenzene	mg/L	0.0001340	0.00014	0.00014	0.001	0.0000081	0.00014	0.00014	0.001	0	0.00014	0.00014	0.001	2.44186E-05	0.00014	0.00014	0.001	8.13953E-06	0.0005	0.0005	0.005	2.90698E-06
Chlorodibromomethane	mg/L	0.0003704	0.00014	0.00014	0.001	0.0000081	0.00014	0.00014	0.001	0	0.00014	0.00014	0.001	2.44186E-05	0.00014	0.00014	0.001	8.13953E-06	0.001	0.001	0.005	5.81395E-06
Chloroethane	mg/L	0.0002024	0.00021	0.00021	0.001	0.0000122	0.00021	0.00021	0.001	0	0.00021	0.00021	0.001	3.66279E-05	0.00021	0.00021	0.001	1.22093E-05	0.001	0.001	0.005	5.81395E-06
Chloroform	mg/L	0.0088057	0.00017	0.00017	0.001	0.0000099	0.00035	0.00017	0.001	0	0.00017	0.00017	0.001	2.96512E-05	0.00018	0.00017	0.001	1.04651E-05	0.001	0.001	0.005	5.81395E-06
Chlorpyrifos	mg/L	0.0000559	0.00002	0.00002	0.0002	0.0000012	0.000019	0.000019	0.00019	0	0.00002	0.00002	0.0002	3.48837E-06	0.00002	0.00002	0.0002	1.16279E-06	0.0064	0.0065	0.0065	3.72093E-05
Chromium (Hexavalent)	mg/L	0.0421279	0.0023	0.0019	0.01	0.0001337	0.0019	0.0019	0.01	0	0.2	0.048	0.25	0.034883721	0.0019	0.0019	0.01	0.000110465	0.061	0.1	0.003	0.000354651
Chromium (Total)	mg/L	0.0095347	0.0013	0.00023	0.002	0.0000756	0.00092	0.00077	0.005	0	0.039	0.00023	0.002	0.006802326	0.0016	0.00023	0.002	9.30233E-05	0.0355	0.001	0.01	0.000206395
Chrysene	mg/L	0.0001374	0.00013	0.00013	0.0019	0.0000076	0.00013	0.00013	0.0019	0	0.00014	0.00014	0.002	2.44186E-05	0.00013	0.00013	0.0019	7.55814E-06	0.00111	0.00111	0.005556	6.45349E-06
cis-1,3-dichloropropene	mg/L	0.0001837	0.00019	0.00019	0.001	0.0000110	0.00019	0.00019	0.001	0	0.00019	0.00019	0.001	3.31395E-05	0.00019	0.00019	0.001	1.10465E-05	0.001	0.001	0.005	5.81395E-06
Cobalt	mg/L	0.0550824	0.00097	0.00005	0.0005	0.0000564	0.00063	0.00005	0.0005	0	0.3	0.00005	0.0005	0.052325581	0.0012	0.00005	0.0005	6.97674E-05	0.002	0.002	0.004	1.16279E-05
Color	o	0.0581395				0				0				0				0	10	10	10	0.058139535
Copper	mg/L	0.0852873	0.0029	0.00027	0.002	0.0001686	0.015	0.0015	0.025	0	0.38	0.00027	0.002	0.06627907	0.034	0.00027	0.002	0.001976744	0.00239	0.00022	0.001	1.38953E-05
Cyanide (Total)	mg/L	0.0036875	0.0025	0.0025	0.01	0.0001453	0.0025	0.0025	0.01	0	0.0025	0.0025	0.01	0.000436047	0.0025	0.0025	0.01	0.000145349	0.01	0.01	0.01	5.81395E-05
d-BHC	mg/L	0.0000005	0.00000037	0.00000037	0.0000013	2.15E-08	0.00000037	0.00000037	0.0000013	0	0.00000052	0.00000036	0.0000012	9.06977E-08	0.0000025	0.00000038	0.0000013	1.45349E-07	0.000005	0.000005	0.00005155	2.90698E-08
DDD	mg/L	0.0000010	0.00000064	0.00000064	0.0000013	3.72E-08	0.00000064	0.00000064	0.0000013	0	0.00000065	0.00000065	0.0000013	1.13372E-07	0.0000069	0.00000066	0.0000013	4.01163E-07	0.000005	0.000005	0.00005155	2.90698E-08
DDT	mg/L	0.0000008	0.00000071	0.00000071	0.0000013	4.13E-08	0.00000071	0.00000071	0.0000013	0	0.00000072	0.00000072	0.0000013	1.25581E-07	0.0000018	0.00000073	0.0000013	1.04651E-07	0.000005	0.000005	0.00005155	2.90698E-08
Demeton (total)	mg/L	0.0000304	0.000032	0.000032	0.00039	0.0000019	0.000031	0.000031	0.00038	0	0.000032	0.000032	0.00039	5.5814E-06	0.000032	0.000032	0.00039	1.86047E-06				0
Demeton-O	mg/L	0.0000378				0				0				0				0	0.0065	0.0065	0.0065	3.77907E-05
Demeton-S	mg/L	0.0000378				0				0				0				0	0.0065	0.0065	0.0065	3.77907E-05
Diazinon	mg/L	0.0000551	0.000018	0.000018	0.0002	0.0000010	0.000018	0.000018	0.00019	0	0.000018	0.000018	0.0002	3.13953E-06	0.000018	0.000018	0.0002	1.04651E-06	0.0065	0.0065	0.0065	3.77907E-05
Dibenz(a,h)anthracene	mg/L	0.0001529	0.00015	0.00015	0.0019	0.0000087	0.00015	0.00015	0.0019	0	0.00015	0.00015	0.002	2.61628E-05	0.00015	0.00015	0.0019	8.72093E-06	0.00111	0.00111	0.005556	6.45349E-06
Dichlorobromomethane	mg/L	0.0016057	0.00013	0.00013	0.001	0.0000076	0.00013	0.00013	0.001	0	0.00013	0.00013	0.001	2.26744E-05	0.00013	0.00013	0.001	7.55814E-06	0.001	0.001	0.005	5.81395E-06
Dichlorodifluoromethane	mg/L	0.0000058				0				0				0				0	0.001	0.001	0.005	5.81395E-06
Dieldrin	mg/L	0.0000038	0.00000079	0.00000079	0.0000013	4.59E-08	0.00000079	0.00000079	0.0000013	0	0.0000008	0.0000008	0.0000013	1.39535E-07	0.000047	0.00000081	0.0000013	2.73256E-06	0.000005	0.000005	0.00005155	2.90698E-08
Diesel Range Organics	mg/L	0.2738372				0	0.22	0.22	0.46	0	0.31	0.24	0.5	0.054069767				0				0
Diethylphthalate	mg/L	0.0013772	0.0014	0.0014	0.0096	0.0000814	0.0014	0.0014	0.0095	0	0.0014	0.0014	0.0099	0.000244186	0.0014	0.0014	0.0096	8.13953E-05	0.00111	0.00111	0.005556	6.45349E-06
Dimethyl phthalate	mg/L	0.0007249	0.00074	0.00074	0.0096	0.0000430	0.00073	0.00073	0.0095	0	0.00076	0.00076	0.0099	0.000132558	0.00074	0.00074	0.0096	4.30233E-05	0.00111	0.00111	0.005556	6.45349E-06
Di-n-butyl phthalate	mg/L	0.0011507	0.0012	0.0012	0.0096	0.0000698	0.0012	0.0012	0.0095	0	0.0012	0.0012	0.0099	0.000209302	0.0012	0.0012	0.0096	6.97674E-05	0.00222	0.00222	0.005556	1.2907E-05
Di-n-octyl phthalate	mg/L	0.0019526	0.002	0.002	0.0096	0.0001163	0.002	0.002	0.0095	0	0.002	0.002	0.0099	0.000348837	0.002	0.002	0.0096	0.000116279	0.00111	0.00111	0.005556	6.45349E-06
Diphenylhydrazine	mg/L	0.0006462	0.00063	0.00063	0.0096	0.0000366	0.00063	0.00063	0.0095	0	0.00065	0.00065	0.0099	0.000113372	0.00063	0.00063	0.0096	3.66279E-05	0.00526	0.00526	0.005556	3.05814E-05
E. Coli	cfu/100 ml	0.0058140				0				0				0				0	1.000000	1.000000	1.000000	0.005813953
EC (field)	µS/cm	2491.1468023	303			17.6162791	5695			0	1638			285.6976744	174			10.11627907				0
Endosulfan I	mg/L	0.0000012	0.0000009	0.0000009	0.0000013	0.0000001	0.0000009	0.0000009	0.0000013	0	0.00000091	0.00000091	0.0000013	1.58721E-07	0.00000093	0.00000093	0.0000013	5.40698E-08	0.000005	0.000005	0.00005155	2.90698E-08
Endosulfan II	mg/L	0.0000076	0.0000028	0.00000094	0.0000013	0.0000002	0.00000094	0.00000094	0.0000013	0	0.0000034	0.00000092	0.0000012	5.93023E-07	0.000039	0.00000097	0.0000013	2.26744E-06	0.000005	0.000005	0.00005155	2.90698E-08
Endosulfan sulphate	mg/L	0.0000202	0.00000055	0.00000055	0.0000013	3.20E-08	0.00000055	0.00000055	0.0000013	0	0.00000055	0.00000055	0.0000013	9.59302E-08	0.00000056	0.00000056	0.0000013	3.25581E-08	0.000005	0.000005	0.00005155	2.90698E-08
Endrin	mg/L	0.0000013	0.00000092	0.00000092	0.0000013	0.0000001	0.00000092	0.00000092	0.0000013	0	0.00000093	0.00000093	0.0000013	1.62209E-07	0.00000095	0.00000095	0.0000013	5.52326E-08	0.000005	0.000005	0.00005155	2.90698E-08
Endrin aldehyde	mg/L	0.0000009	0.00000087	0.00000087	0.0000013	0.0000001	0.00000087	0.00000087	0.0000013	0	0.00000087	0.00000087	0.0000013	1.51744E-07	0.00000089	0.00000089	0.0000013	5.17442E-08	0.000005	0.000005	0.00005155	2.90698E-08
Enterococci	MPN/100 m	0.0058140				0				0				0				0	1	1	1	0.005813953
Ethylbenzene	mg/L	0.0002219	0.00023	0.00023	0.001	0.0000134	0.00023	0.00023	0.001	0	0.00023	0.00023	0.001	4.01163E-05	0.00023	0.00023	0.001	1.33721E-05	0.0005	0.0005	0.005	2.90698E-06
Fecal Coliforms	MPN/100 m	0.0116279				0			0	0				0				0	2	2	2	0.011627907
Fluoranthene	mg/L	0.0001576	0.00016	0.00016	0.0019	0.0000093	0.00015	0.00015	0.0019	0	0.00016	0.00016	0.002	2.7907E-05	0.00016	0.00016	0.0019	9.30233E-06	0.00111	0.00111	0.005556	6.45349E-06
Fluorene	mg/L	0.0002104	0.00021	0.00021	0.0019	0.0000122	0.00021	0.00021	0.0019	0	0.00021	0.00021	0.002	3.66279E-05	0.00021	0.00021	0.0019	1.22093E-05	0.00111	0.00111	0.005556	6.45349E-06
Fluoride	mg/L	0.8781468	0.22	0.014	0.1	0.0127907	0.32	0.014	0.1	0	0.18	0.014	0.1	0.031395349	0.53	0.014	0.1	0.030813953	2.8	0.1	0.1	0.01627907
Gasoline Range Organics	mg/L	0.0348183				0	0.05	0.025	0.1	0	0.05	0.025	0.1	0.00872093				0				0
g-BHC (Lindane)	mg/L	0.0000008	0.00000077	0.00000077	0.0000013	4.48E-08	0.00000077	0.00000077	0.0000013	0	0.00000078	0.00000078	0.0000013	1.36047E-07	0.00000079	0.00000079	0.0000013	4.59302E-08	0.000005	0.000005	0.00005155	2.90698E-08
Hardness	mg/L	7.9651163				0				0				0				0	1370	0.766	12.5	7.965116279
HEM	mg/L	1.1380814				0	1.7	1.7	5.8	0	1.8	1.6	5.2	0.313953488				0				0
Heptachlor	mg/L	0.0000150	0.00000095	0.00000095	0.0000013	0.0000001	0.00000095	0.00000095	0.0000013	0	0.00000096	0.00000096	0.0000013	1.67442E-07	0.00000098	0.00000098	0.0000013	5.69767E-08	0.000005	0.000005	0.00005155	2.90698E-08
Heptachlor epoxide	mg/L	0.0000012	0.00000093	0.00000093	0.0000013	0.0000001	0.00000093	0.00000093	0.0000013	0	0.00000094	0.00000094	0.0000013	1.63953E-07	0.00000096	0.00000096	0.0000013	5.5814E-08	0.000005	0.000005	0.00005155	2.90698E-08
Hexachlorobenzene	mg/L	0.0001856	0.00018	0.00018	0.0019	0.0000105	0.00017	0.00017	0.0019	0	0.00018	0.00018	0.002	3.13953E-05	0.00018	0.00018	0.0019	1.04651E-05	0.00271	0.00278	0.002778	1.57558E-05
Hexachlorobutadiene	mg/L	0.0001623	0.00016	0.00016	0.0019	0.0000093	0.00016	0.00016	0.0019	0	0.00016	0.00016	0.002	2.7907E-05	0.00016	0.00016	0.0019	9.30233E-06	0.00111	0.00111	0.005556	6.45349E-06
Hexachlorocyclopentadiene	mg/L	0.0004911	0.0005	0.0005	0.0096	0.0000291	0.00049	0.00049	0.0095	0	0.00051	0.00051	0.0099	8.89535E-05	0.0005	0.0005	0.0096	2.90698E-05	0.00111	0.00111	0.005556	6.45349E-06
Hexachloroethane	mg/L	0.0005925	0.0006	0.0006	0.0096	0.0000349	0.0006	0.0006	0.0095	0	0.00062	0.00062	0.0099	0.00010814	0.0006	0.0006	0.0096	3.48837E-05	0.00111	0.00111	0.005556	6.45349E-06
Indeno(1,2,3-c,d)pyrene	mg/L	0.0001935	0.00019	0.00019	0.0019	0.0000110	0.00019	0.00019	0.0019	0	0.0002	0.0002	0.002	3.48837E-05	0.00019	0.00019	0.0019	1.10465E-05	0.00111	0.00111	0.005556	6.45349E-06
Iron	mg/L	22.1858541	0.37	0.0057	0.05	0.0215116	0.53	0.0095	0.1	0	120	0.0057	0.05	20.93023256	1.4	0.0057	0.05	0.081395349	0.0044	0.003	0.01	2.55814E-05
Isophorone	mg/L	0.0006066	0.00062	0.00062	0.0096	0.0000360	0.00061	0.00061	0.0095	0	0.00064	0.00064	0.0099	0.000111628	0.00062	0.00062	0.0096	3.60465E-05	0.00111	0.00111	0.005556	6.45349E-06
Kepone	mg/L	0.0090538	0.0093	0.0093	0.038	0.0005407	0.0092	0.0092	0.038	0	0.0096	0.0096	0.04	0.001674419	0.0093	0.0093	0.038	0.000540698	0.00222	0.00222	0.005556	1.2907E-05
Lead	mg/L	0.0049029	0.00051	0.000057	0.001	0.0000297	0.0012	0.0012	0.01	0	0.0075	0.0012	0.01	0.00130814	0.0032	0.000057	0.001	0.000186047	0.00016	0.00016	0.0005	9.30233E-07

		RESULTS	BOTTOM ASH				METALS POND				COAL YARD				SIERRA DITCH				LEACHATE			
ChemName	Output Unit	Worst Case Concentration of the COC Expected in Outfall 301 Prior to Any Treatment (mg/L)	Worst Case Concentration (mg/l)	B/A_MDL	B/A_RL	Flow Weighted Average of the Source (mg/l)	Worst Case Concentration (mg/l)	Metals Pond_MDL	Metals Pond_RL	Flow Weighted Average of the Source (mg/l)	Worst Case Concentration (mg/l)	COAL YARD_MDL	COAL YARD_RL	Flow Weighted Average of the Source (mg/l)	Worst Case Concentration (mg/l)	SIERRA_MDL	SIERRA_RL	Flow Weighted Average of the Source (mg/l)	Worst Case Concentration (mg/l)	Leachate_MDL (LOD)	Leachate_RL (LOQ)	Flow Weighted Average of the Source (mg/l)
Lithium	mg/L	0.0747882	0.02	0.00053	0.05	0.0011628	0.075	0.00053	0.05	0	0.25	0.00053	0.05	0.043604651	0.05	0.00053	0.05	0.002906977				0
Magnesium	mg/L	79.4206686	3.5	0.001	0.5	0.2034884	3.7	0.028	5	0	27	0.001	0.5	4.709302326	15	0.001	0.5	0.872093023	0.105	0.004	0.01	0.000610465
Malathion	mg/L	0.0000259	0.000021	0.000021	0.0002	0.0000012	0.000021	0.000021	0.00019	0	0.000021	0.000021	0.0002	3.66279E-06	0.000021	0.000021	0.0002	1.22093E-06	0.001	0.001	0.001	5.81395E-06
Manganese	mg/L	0.7100262	0.036	0.000046	0.005	0.0020930	0.024	0.00012	0.015	0	2.7	0.000046	0.005	0.470930233	1.3	0.000046	0.005	0.075581395	0.002	0.002	0.01	1.16279E-05
Mercury	mg/L	0.0000696	0.000045	0.000031	0.0002	0.0000026	0.000067	0.000031	0.0002	0	0.000085	0.000031	0.0002	1.48256E-05	0.000031	0.000031	0.0002	1.80233E-06	0.000023	0.000023	0.0002	1.33721E-07
Methoxychlor	mg/L	0.0000000				0				0				0				0	0.000005	0.000005	0.00005155	2.90698E-08
Methyl Bromide	mg/L	0.0002960	0.00031	0.00031	0.001	0.0000180	0.00031	0.00031	0.001	0	0.00031	0.00031	0.001	5.40698E-05	0.00031	0.00031	0.001	1.80233E-05	0.001	0.001	0.005	5.81395E-06
Methyl Chloride	mg/L	0.0002708	0.00028	0.00028	0.001	0.0000163	0.00028	0.00028	0.001	0	0.00028	0.00028	0.001	4.88372E-05	0.00028	0.00028	0.001	1.62791E-05	0.0015	0.0015	0.005	8.72093E-06
Methylene Chloride	mg/L	0.0011925	0.00016	0.00015	0.001	0.0000093	0.0002	0.00015	0.001	0	0.0059	0.00015	0.001	0.00102907	0.00015	0.00015	0.001	8.72093E-06	0.005	0.005	0.005	2.90698E-05
Mirex	mg/L	0.0000005	0.00000046	0.00000046	0.0000013	2.67E-08	0.00000046	0.00000046	0.0000013	0	0.00000047	0.00000047	0.0000013	8.19767E-08	0.00000048	0.00000048	0.0000013	2.7907E-08	0.000002	0.000002	0.00005155	1.16279E-08
Molybdenum	mg/L	0.0185834	0.023	0.00026	0.005	0.0013372	0.0027	0.00026	0.005	0	0.013	0.00026	0.005	0.002267442	0.014	0.00026	0.005	0.000813953	0.55	0.05	0.05	0.003197674
Naphthalene	mg/L	0.0004179	0.00013	0.00013	0.0019	0.0000076	0.00013	0.00013	0.0019	0	0.0016	0.00014	0.002	0.00027907	0.00013	0.00013	0.0019	7.55814E-06	0.00556	0.00556	0.00556	3.23256E-05
Nickel	mg/L	0.1064634	0.003	0.000093	0.001	0.0001744	0.0085	0.00051	0.04	0	0.54	0.000093	0.001	0.094186047	0.014	0.000093	0.001	0.000813953	0.00467	0.00032	0.001	2.71512E-05
Nitrate	mg/L	0.0023256				0				0				0				0	0.4			0.002325581
Nitrate (as N)	mg/L	9.1848328	0.22	0.0062	0.1	0.0127907	1	0.0062	0.1	0	0.64	0.0062	0.1	0.111627907	0.54	0.0062	0.1	0.031395349	0.4	0.07	0.15	0.002325581
Nitrite	mg/L	0.0004651				0				0				0				0	0.08			0.000465116
Nitrite (as N)	mg/L	0.1911047	0.15	0.024	0.05	0.0087209	0.44	0.024	0.05	0	0.026	0.024	0.05	0.004534884	0.024	0.024	0.05	0.001395349	0.08	0.05	0.05	0.000465116
Nitrobenzene	mg/L	0.0008178	0.00081	0.00081	0.019	0.0000471	0.0008	0.0008	0.019	0	0.00083	0.00083	0.02	0.000144767	0.00081	0.00081	0.019	4.7093E-05	0.00556	0.00556	0.005556	3.23256E-05
Nitrogen (Organic)	mg/L	0.0034884		0	0	0				0				0				0	0.6	0.6	0.6	0.003488372
Nitrogen (Total Oxidised)	mg/L	0.0023256				0				0				0				0	0.4	0.02	0.1	0.002325581
Nitrogen (Total)	mg/L	0.0179070				0				0				0				0	3.08	0.2	0.5	0.017906977
N-Nitrosodimethylamine	mg/L	0.0007033	0.00071	0.00071	0.0019	0.0000413	0.0007	0.0007	0.0019	0	0.00073	0.00073	0.002	0.000127326	0.00071	0.00071	0.0019	4.12791E-05	0.00222	0.00222	0.005556	1.2907E-05
N-nitrosodi-n-propylamine	mg/L	0.0003011	0.0003	0.0003	0.0019	0.0000174	0.00029	0.00029	0.0019	0	0.0003	0.0003	0.002	5.23256E-05	0.0003	0.0003	0.0019	1.74419E-05	0.00222	0.00222	0.005556	1.2907E-05
n-Nitrosodiphenylamine	mg/L	0.0008271	0.00082	0.00082	0.0096	0.0000477	0.00081	0.00081	0.0095	0	0.00084	0.00084	0.0099	0.000146512	0.00082	0.00082	0.0096	4.76744E-05	0.00556	0.00556	0.005556	3.23256E-05
Nonylphenol	mg/L	0.0000291				0				0				0				0	0.005	0.005	0.005	2.90698E-05
Nonylphenol Diethoxylate (Technic	mg/L	0.0018023	0.002	0.002	0.02	0.0001163	0.0019	0.0019	0.019	0	0.0019	0.0019	0.02	0.000331395	0.0019	0.0019	0.019	0.000110465				0
Nonylphenol Monoethoxylate (Tech	mg/L	0.0029713	0.0032	0.0032	0.01	0.0001860	0.0031	0.0031	0.0097	0	0.0031	0.0031	0.0098	0.000540698	0.0031	0.0031	0.0097	0.000180233				0
Oil and Grease	mg/L	1.5151163	1.5	1.5	4.3	0.0872093				0	1.6	1.6	4.5	0.279069767	1.5	1.5	4.3	0.087209302	5	5	5	0.029069767
para-tert-Octylphenol	mg/L	0.0002971	0.00032	0.00032	0.001	0.0000186	0.00031	0.00031	0.00097	0	0.00031	0.00031	0.00098	5.40698E-05	0.00031	0.00031	0.00097	1.80233E-05				0
Parathion	mg/L	0.0000357	0.000032	0.000032	0.0002	0.0000019	0.000031	0.000031	0.00019	0	0.000032	0.000032	0.0002	5.5814E-06	0.000032	0.000032	0.0002	1.86047E-06	0.001	0.001	0.001	5.81395E-06
P-Chloro-M-Cresol	mg/L	0.0007368	0.00073	0.00073	0.0096	0.0000424	0.00072	0.00072	0.0095	0	0.00075	0.00075	0.0099	0.000130814	0.00073	0.00073	0.0096	4.24419E-05	0.00556	0.00556	0.005556	3.23256E-05
Pentachlorophenol	mg/L	0.0006512	0.00064	0.00064	0.0096	0.0000372	0.00063	0.00063	0.0095	0	0.00066	0.00066	0.0099	0.000115116	0.00064	0.00064	0.0096	3.72093E-05	0.00556	0.00556	0.005556	3.23256E-05
pH (Field)	SU	7.1937645	9.24			0.5372093	10.97			0	3.38			0.589534884	9.12			0.530232558				0
Phenanthrene	mg/L	0.0004313	0.00041	0.00041	0.0019	0.0000238	0.00041	0.00041	0.0019	0	0.00042	0.00042	0.002	7.32558E-05	0.00041	0.00041	0.0019	2.38372E-05	0.00556	0.00556	0.005556	3.23256E-05
Phenol	mg/L	0.0010981	0.00056	0.00056	0.0019	0.0000326	0.00055	0.00055	0.0019	0	0.00058	0.00058	0.002	0.000101163	0.00056	0.00056	0.0019	3.25581E-05	0.00556	0.00556	0.005556	3.23256E-05
Phenolics Total	mg/L	0.0090465				0	0.0082	0.0082	0.01	0	0.0082	0.0082	0.01	0.001430233				0	0.05	0.05	0.05	0.000290698
Phosphorus	mg/L	0.5706068	0.081	0.05	0.1	0.0047093	0.057	0.05	0.1	0	0.45	0.05	0.1	0.078488372	0.2	0.05	0.1	0.011627907	0.03	0.01	0.02	0.000174419
p-Nonylphenol (Technical mixture)	mg/L	0.0014977	0.0016	0.0016	0.005	0.0000930	0.0015	0.0015	0.0048	0	0.0016	0.0016	0.0049	0.00027907	0.0016	0.0016	0.0049	9.30233E-05				0
Potassium	mg/L	22.8444041	2.7	0.017	0.5	0.1569767	6.9	0.017	0.5	0	4.9	0.017	0.5	0.854651163	6.1	0.017	0.5	0.354651163				0
Pyrene	mg/L	0.0001805	0.00015	0.00015	0.0019	0.0000087	0.00015	0.00015	0.0019	0	0.00016	0.00016	0.002	2.7907E-05	0.00015	0.00015	0.0019	8.72093E-06	0.00556	0.00556	0.00556	3.23256E-05
Radium-226	pCi/L	0.3728554	0.508	0.48	1	0.0295349	0.288	0.215	1	0	0.707	0.445	1	0.123313953	0.348	0.191	1	0.020232558				0
Radium-228	pCi/L	0.5953888	0.733	0.733	1	0.0426163	0.358	0.358	1	0	0.706	0.681	1	0.123139535	0.326	0.326	1	0.018953488				0
Redox	mV	200.3162791	92.3			5.3662791	92			0	520.5			90.78488372	240.5			13.98255814				0
Selenium	mg/L	0.0129347	0.0043	0.0002	0.005	0.0002500	0.012	0.0039	0.01	0	0.023	0.0002	0.005	0.004011628	0.00067	0.0002	0.005	3.89535E-05	0.344	0.0065	0.01	0.002
Silver	mg/L	0.0001428	0.000047	0.000047	0.001	0.0000027	0.000047	0.000047	0.001	0	0.000047	0.000047	0.001	8.19767E-06	0.000047	0.000047	0.001	2.73256E-06	0.000029	0.000029	0.0001	1.68605E-07
Sodium	mg/L	383.4978924	13	0.011	0.5	0.7558140	78	0.011	0.5	0	45	0.011	0.5	7.848837209	20	0.011	0.5	1.162790698				0
Specific Conductivity (lab)	µS/cm	0.0000000				0				0				0				0				0
Sulfate	mg/L	1349.9789244	52	0.21	1	3.0232558	300	1.1	5	0	1000	2.1	10	174.4186047	120	0.21	1	6.976744186	984	200	200	5.720930233
Sulfide	mg/L	0.5872674	0.41	0.41	1	0.0238372	0.41	0.41	1	0	0.47	0.47	3	0.081976744	1.5	0.47	3	0.087209302	0.05	0.05	0.05	0.000290698
sulfide (as H2S)	mg/L	0.4460538	0.41	0.41	1	0.0238372	0.41	0.41	1	0	0.41	0.41	1	0.071511628	0.41	0.41	1	0.023837209				0
Surfactants	mg/L	0.0005814				0.0000000				0				0				0	0.1	0.1	0.1	0.000581395
Temperature	oC	28.0342878	33.3			1.9360465	28.35			0	31.69			5.527325581	18.52			1.076744186				0
Tetrachloroethene	mg/L	0.0001462	0.00015	0.00015	0.001	0.0000087	0.00015	0.00015	0.001	0	0.00015	0.00015	0.001	2.61628E-05	0.00015	0.00015	0.001	8.72093E-06	0.001	0.001	0.005	5.81395E-06
Thallium	mg/L	0.0013820	0.00031	0.000013	0.001	0.0000180	0.011	0.000013	0.001	0	0.0018	0.0018	0.02	0.000313953	0.00017	0.000013	0.001	9.88372E-06	0.000058	0.000058	0.0001	3.37209E-07
Tin	mg/L	0.0001163				0				0				0				0	0.02	0.02	0.02	0.000116279
Titanium	mg/L	0.0000291				0				0				0				0	0.005	0.005	0.05	2.90698E-05
Toluene	mg/L	0.0001480	0.00015	0.00015	0.001	0.0000087	0.00015	0.00015	0.001	0	0.00016	0.00015	0.001	2.7907E-05	0.00015	0.00015	0.001	8.72093E-06	0.001	0.001	0.005	5.81395E-06
Total Dissolved Solids	mg/L	3501.6061047	150	10	10	8.7209302	1100	20	20	0	1500	20	20	261.627907	330	10	10	19.18604651				0
Total Kjeldahl Nitrogen	mg/L	8.8912064	2.2	1.7	5	0.1279070	3.9	1.7	5	0	2.2	1.7	5	0.38372093	1.7	1.7	5	0.098837209				0
Total Organic Carbon	mg/L	4.3504360	1.6	0.19	1	0.0930233	1.7	0.19	1	0	4	0.19	1	0.697674419	7.3	0.19	1	0.424418605	1.8	1	1	0.010465116
Total Suspended Solids	mg/L	176.4317587	110	1	1	6.3953488	40	0.5	0.5	0	330	5	5	57.55813953	49	1	1	2.848837209	18.4	1	1	0.106976744
Toxaphene	mg/L	0.0000180	0.000018	0.000018	0.000048	0.0000010	0.000018	0.000018	0.000048	0	0.000018	0.000018	0.000049	3.13953E-06	0.000018	0.000018	0.00005	1.04651E-06	0.000206	0.000206	0.001031	1.19767E-06
trans-1,2-Dibromoethene	mg/L	0.0000058				0.0000000				0				0				0	0.001	0.001	0.005	5.81395E-06
trans-1,3-dichloropropene	mg/L	0.0001462	0.00015	0.00015	0.001	0.0000087	0.00015	0.00015	0.001	0	0.00015	0.00015	0.001	2.61628E-05	0.00015	0.00015	0.001	8.72093E-06	0.001	0.001	0.005	5.81395E-06
Tributyltin	mg/L	0.0000453	0.000043	0.000043	0.000043	0.0000025	0.000043	0.000043	0.000043	0	0.000044	0.000044	0.000044	7.67442E-06	0.000043	0.000043	0.000043	0.0000025	0.00003	0.00003	0.00003	1.74419E-07
Trichloroethene	mg/L	0.0001369	0.00014	0.00014	0.001	0.0000081	0.00014	0.00014	0.001	0	0.00014	0.00014	0.001	2.44186E-05	0.00014	0.00014	0.001	8.13953E-06	0.001	0.001	0.005	5.81395E-06
Trichlorofluoromethane	mg/L	0.0000058				0				0				0				0	0.001	0.001	0.005	5.81395E-06
Turbidity	NTU	85.3857558	170	0.25	4.3	9.8837209	19	0.05	0.85	0	320	1.3	21	55.81395349	77	0.25	4.3	4.476744186				0
Vinyl chloride	mg/L	0.0002211	0.00023	0.00023	0.001	0.0000134	0.00023	0.00023	0.001	0	0.00023	0.00023	0.001	4.01163E-05	0.00023	0.00023	0.001	1.33721E-05	0.001	0.001	0.005	5.81395E-06
Zinc	mg/L	0.3751538	0.02	0.0004	0.005	0.0011628	0.0063	0.0004	0.005	0	1.8	0.0004	0.005	0.313953488	0.094	0.0004	0.005	0.005465116	0.00571	0.0016	0.005	3.31977E-05

		RESULTS	TOE DRAIN				FGD PLANT				FGD YARD SUMP				MASTER SUMP				CONTACT STORMWATER			
ChemName	Output Unit	Worst Case Concentration of the COC Expected in Outfall 301 Prior to Any Treatment (mg/L)	Worst Case Concentration (mg/l)	P TOE DRAIN_MDL	P TOE DRAIN_RL	Flow Weighted Average of the Source (mg/l)	Worst Case Concentration (mg/l)	FGD Plant_MDL	FGD Plant_RL	Flow Weighted Average of the Source (mg/l)	Worst Case Concentration (mg/l)	FGD Yard_MDL	FGD Yard_RL	Flow Weighted Average of the Source (mg/l)	Worst Case Concentration (mg/l)	MAST_MDL	MAST_RL	Flow Weighted Average of the Source (mg/l)	Worst Case Concentration (mg/l)	CONT SW_MDL	CONT SW _RL	Flow Weighted Average of the Source (mg/l)
1,1,1-trichloroethane	mg/L	0.0002773	0.00029	0.00029	0.001	9.90552E-06	0.00029	0.00029	0.001	2.31831E-06	0.00029	0.00029	0.001	4.21512E-05	0.00029	0.00029	0.001	0.000132776				0
1,1,2,2-tetrachloroethane	mg/L	0.0001959	0.0002	0.0002	0.001	6.8314E-06	0.0002	0.0002	0.001	1.59884E-06	0.0002	0.0002	0.001	2.90698E-05	0.0002	0.0002	0.001	9.15698E-05				0
1,1,2-trichloroethane	mg/L	0.0001930	0.0002	0.0002	0.001	6.8314E-06	0.0002	0.0002	0.001	1.59884E-06	0.0002	0.0002	0.001	2.90698E-05	0.0002	0.0002	0.001	9.15698E-05				0
1,1-dichloroethane	mg/L	0.0001181	0.00012	0.00012	0.001	4.09884E-06	0.00012	0.00012	0.001	9.59302E-07	0.00012	0.00012	0.001	1.74419E-05	0.00012	0.00012	0.001	5.49419E-05				0
1,1-dichloroethene	mg/L	0.0002866	0.0003	0.0003	0.001	1.02471E-05	0.0003	0.0003	0.001	2.39826E-06	0.0003	0.0003	0.001	4.36047E-05	0.0003	0.0003	0.001	0.000137355				0
1,2,4-trichlorobenzene	mg/L	0.0006753	0.00068	0.00068	0.0019	2.32267E-05	0.00067	0.00067	0.0019	5.3561E-06	0.00074	0.00074	0.0021	0.000107558	0.00071	0.00071	0.002	0.000325073				0
1,2-dichlorobenzene	mg/L	0.0001469	0.00015	0.00015	0.001	5.12355E-06	0.00015	0.00015	0.001	1.19913E-06	0.00015	0.00015	0.001	2.18023E-05	0.00015	0.00015	0.001	6.86773E-05				0
1,2-dichloroethane	mg/L	0.0002053	0.00021	0.00021	0.001	7.17297E-06	0.00021	0.00021	0.001	1.67878E-06	0.00021	0.00021	0.001	3.05233E-05	0.00021	0.00021	0.001	9.61483E-05				0
1,2-dichloropropane	mg/L	0.0000976	0.000095	0.000095	0.001	3.24491E-06	0.000095	0.000095	0.001	7.59448E-07	0.000095	0.000095	0.001	1.38081E-05	0.000095	0.000095	0.001	4.34956E-05				0
1,2-Trans-dichloroethene	mg/L	0.0001649	0.00017	0.00017	0.001	5.80669E-06	0.00017	0.00017	0.001	1.35901E-06	0.00017	0.00017	0.001	2.47093E-05	0.00017	0.00017	0.001	7.78343E-05				0
1,3-dichlorobenzene	mg/L	0.0001094	0.00011	0.00011	0.001	3.75727E-06	0.00011	0.00011	0.001	8.7936E-07	0.00011	0.00011	0.001	1.59884E-05	0.00011	0.00011	0.001	5.03634E-05				0
1,3-Dichloropropene	mg/L	0.0004738	0.0005	0.0005	0.002	1.70785E-05	0.0005	0.0005	0.002	3.99709E-06	0.0005	0.0005	0.002	7.26744E-05	0.0005	0.0005	0.002	0.000228924				0
1,4-dichlorobenzene	mg/L	0.0002030	0.00021	0.00021	0.001	7.17297E-06	0.00021	0.00021	0.001	1.67878E-06	0.00021	0.00021	0.001	3.05233E-05	0.00021	0.00021	0.001	9.61483E-05				0
2,3,7,8-Tetrachlorooxanthrene	mg/L	8.43E-12				0				0				0				0				0
2,4,6-trichlorophenol	mg/L	0.0016123	0.0017	0.0017	0.0096	5.80669E-05	0.0017	0.0017	0.0094	1.35901E-05	0.0018	0.0018	0.01	0.000261628	0.0017	0.0017	0.01	0.000778343				0
2,4-dichlorophenol	mg/L	0.0003167	0.00032	0.00032	0.0019	1.09302E-05	0.00032	0.00032	0.0019	2.55814E-06	0.00035	0.00035	0.0021	5.08721E-05	0.00033	0.00033	0.002	0.00015109				0
2,4-dimethylphenol	mg/L	0.0007981	0.00082	0.00082	0.0096	2.80087E-05	0.0008	0.0008	0.0094	6.39535E-06	0.00089	0.00089	0.01	0.00012936	0.00085	0.00085	0.01	0.000389172				0
2,4-dinitrophenol	mg/L	0.0057243	0.0059	0.0059	0.048	0.000201526	0.0058	0.0058	0.047	4.63663E-05	0.0064	0.0064	0.052	0.000930233	0.0061	0.0061	0.05	0.002792878				0
2,4-Dinitrotoluene	mg/L	0.0005098	0.00052	0.00052	0.0096	1.77616E-05	0.00051	0.00051	0.0094	4.07703E-06	0.00056	0.00056	0.01	8.13953E-05	0.00054	0.00054	0.01	0.000247238				0
2,6-dichlorophenol	mg/L	0.0000065				0				0				0				0				0
2,6-dinitrotoluene	mg/L	0.0007530	0.00077	0.00077	0.0096	2.63009E-05	0.00075	0.00075	0.0094	5.99564E-06	0.00083	0.00083	0.01	0.00012064	0.0008	0.0008	0.01	0.000366279				0
2-Chloroethylvinyl ether	mg/L	0.0002631	0.00025	0.00025	0.002	8.53924E-06	0.00025	0.00025	0.002	1.99855E-06	0.00025	0.00025	0.002	3.63372E-05	0.00025	0.00025	0.002	0.000114462				0
2-chloronaphthalene	mg/L	0.0001482	0.00015	0.00015	0.0019	5.12355E-06	0.00014	0.00014	0.0019	1.11919E-06	0.00016	0.00016	0.0021	2.32558E-05	0.00015	0.00015	0.002	6.86773E-05				0
2-chlorophenol	mg/L	0.0015644	0.0016	0.0016	0.0096	5.46512E-05	0.0016	0.0016	0.0094	1.27907E-05	0.0017	0.0017	0.01	0.000247093	0.0017	0.0017	0.01	0.000778343				0
2-methylphenol	mg/L	0.0000322				0				0				0				0				0
2-nitrophenol	mg/L	0.0015964	0.0016	0.0016	0.0096	5.46512E-05	0.0016	0.0016	0.0094	1.27907E-05	0.0018	0.0018	0.01	0.000261628	0.0017	0.0017	0.01	0.000778343				0
3,3-Dichlorobenzidine	mg/L	0.0010700	0.0011	0.0011	0.0096	3.75727E-05	0.0011	0.0011	0.0094	8.7936E-06	0.0012	0.0012	0.01	0.000174419	0.0011	0.0011	0.01	0.000503634				0
3,4-Benzo-fluoranthene	mg/L	0.0001546	0.00015	0.00015	0.0019	5.12355E-06	0.00015	0.00015	0.0019	1.19913E-06	0.00016	0.00016	0.0021	2.32558E-05	0.00016	0.00016	0.002	7.32558E-05				0
4,4-DDE	mg/L	0.0000009	0.00000076	0.00000076	0.0000013	2.59593E-08	0.0000034	0.00000075	0.0000012	2.71802E-08	0.0000015	0.00000078	0.0000013	2.18023E-07	0.00000077	0.00000077	0.0000013	3.52544E-07				0
4,6-Dinitro-2-methylphenol	mg/L	0.0020644	0.0021	0.0021	0.048	7.17297E-05	0.0021	0.0021	0.047	1.67878E-05	0.0023	0.0023	0.052	0.000334302	0.0022	0.0022	0.05	0.001007267				0
4-bromophenyl phenyl ether	mg/L	0.0006019	0.00061	0.00061	0.0096	2.08358E-05	0.0006	0.0006	0.0094	4.79651E-06	0.00066	0.00066	0.01	9.59302E-05	0.00064	0.00064	0.01	0.000293023				0
4-chlorophenyl phenyl ether	mg/L	0.0004741	0.00048	0.00048	0.0096	1.63953E-05	0.00047	0.00047	0.0094	3.75727E-06	0.00052	0.00052	0.01	7.55814E-05	0.0005	0.0005	0.01	0.000228924				0
4-nitrophenol	mg/L	0.0060541	0.0062	0.0062	0.048	0.000211773	0.0061	0.0061	0.047	4.87645E-05	0.0067	0.0067	0.052	0.000973837	0.0065	0.0065	0.05	0.002976017				0
a-BHC	mg/L	0.0000023	0.00000063	0.00000063	0.0000013	2.15189E-08	0.0000098	0.00000063	0.0000012	7.8343E-08	0.0000074	0.00000063	0.0000013	1.07558E-06	0.0000014	0.00000063	0.0000012	6.40988E-07				0
Accrolein	mg/L	0.0024919	0.0026	0.0026	0.02	8.88081E-05	0.0026	0.0026	0.02	2.07849E-05	0.0026	0.0026	0.02	0.000377907	0.0026	0.0026	0.02	0.001190407				0
Acenaphthene	mg/L	0.0001390	0.00014	0.00014	0.0019	4.78198E-06	0.00014	0.00014	0.0019	1.11919E-06	0.00015	0.00015	0.0021	2.18023E-05	0.00014	0.00014	0.002	6.40988E-05				0
Acenaphthylene	mg/L	0.0001482	0.00015	0.00015	0.0019	5.12355E-06	0.00014	0.00014	0.0019	1.11919E-06	0.00016	0.00016	0.0021	2.32558E-05	0.00015	0.00015	0.002	6.86773E-05				0
Acrylonitrile	mg/L	0.0009534	0.00055	0.00055	0.02	1.87863E-05	0.00055	0.00055	0.02	4.3968E-06	0.00055	0.00055	0.02	7.99419E-05	0.0014	0.00055	0.02	0.000640988				0
Aldrin	mg/L	0.0000014	0.0000008	0.0000008	0.0000013	2.73256E-08	0.0000078	0.00000079	0.0000012	6.23547E-08	0.0000045	0.00000082	0.0000013	6.5407E-07	0.00000081	0.00000081	0.0000013	3.70858E-07				0
Alkalinity (Bicarbonate as CaCO3)	mg/L	82.2154070	170	0.41	5	5.806686047	600	0.41	5	4.796511628	210	0.41	5	30.52325581	68	0.41	5	31.13372093				0
Alkalinity (Carbonate as CaCO3)	mg/L	21.5794186	0.41	0.41	5	0.01400436	0.41	0.41	5	0.003277616	140	0.41	5	20.34883721	0.41	0.41	5	0.187718023				0
Alkalinity (total) as CaCO3	mg/L	101.3433140	170	0.41	5	5.806686047	600	0.41	5	4.796511628	340	0.41	5	49.41860465	68	0.41	5	31.13372093				0
Aluminium	mg/L	9.1982366	0.0088	0.0024	0.03	0.000300581	0.24	0.24	0.3	0.001918605	0.53	0.024	0.3	0.077034884	2.9	0.0024	0.03	1.327761628				0
Ammonia as N	mg/L	1.1157267	2.3	0.086	0.1	0.078561047	4.3	0.086	0.1	0.034375	0.74	0.1	0.1	0.10755814	1.4	0.086	0.1	0.640988372	0.05	0.1	0.1	0.002906977
Anthracene	mg/L	0.0001483	0.00015	0.00015	0.0019	5.12355E-06	0.00015	0.00015	0.0019	1.19913E-06	0.00016	0.00016	0.0021	2.32558E-05	0.00015	0.00015	0.002	6.86773E-05				0
Antimony	mg/L	0.0023848	0.00012	0.00004	0.002	4.09884E-06	0.035	0.004	0.02	0.000279797	0.011	0.0004	0.02	0.001598837	0.00063	0.00004	0.002	0.000288445				0
Arochlor 1016	mg/L	0.0000025	0.0000024	0.0000024	0.0000096	8.19767E-08	0.0000024	0.0000024	0.0000095	1.9186E-08	0.0000025	0.0000025	0.0000099	3.63372E-07	0.0000025	0.0000025	0.0000098	1.14462E-06				0
Arochlor 1221	mg/L	0.0000034	0.0000024	0.0000024	0.0000096	8.19767E-08	0.0000024	0.0000024	0.0000095	1.9186E-08	0.0000025	0.0000025	0.0000099	3.63372E-07	0.0000024	0.0000024	0.0000098	1.09884E-06				0
Arochlor 1232	mg/L	0.0000028	0.0000028	0.0000028	0.0000096	9.56395E-08	0.0000028	0.0000028	0.0000095	2.23837E-08	0.0000029	0.0000029	0.0000099	4.21512E-07	0.0000029	0.0000029	0.0000098	1.32776E-06				0
Arochlor 1242	mg/L	0.0000019	0.0000018	0.0000018	0.0000096	6.14826E-08	0.0000018	0.0000018	0.0000095	1.43895E-08	0.0000018	0.0000018	0.0000099	2.61628E-07	0.0000018	0.0000018	0.0000098	8.24128E-07				0
Arochlor 1248	mg/L	0.0000024	0.0000022	0.0000022	0.0000096	7.51453E-08	0.0000022	0.0000022	0.0000095	1.75872E-08	0.0000023	0.0000023	0.0000099	3.34302E-07	0.0000022	0.0000022	0.0000098	1.00727E-06				0
Arochlor 1254	mg/L	0.0000014	0.0000013	0.0000013	0.0000096	4.44041E-08	0.0000013	0.0000013	0.0000095	1.03924E-08	0.0000013	0.0000013	0.0000099	1.88953E-07	0.0000013	0.0000013	0.0000098	5.95203E-07				0
Arochlor 1260	mg/L	0.0000014	0.0000013	0.0000013	0.0000096	4.44041E-08	0.0000013	0.0000013	0.0000095	1.03924E-08	0.0000013	0.0000013	0.0000099	1.88953E-07	0.0000013	0.0000013	0.0000098	5.95203E-07				0
Arsenic	mg/L	0.0245589	0.0013	0.00012	0.001	4.44041E-05	0.17	0.012	0.01	0.001359012	0.06	0.0012	0.01	0.00872093	0.007	0.003	0.001	0.003204942				0
Azinophos methyl	mg/L	0.0000571	0.000022	0.000022	0.00019	7.51453E-07	0.000022	0.000022	0.00019	1.75872E-07	0.000022	0.000022	0.0002	3.19767E-06	0.000023	0.000023	0.0002	1.05305E-05				0
Barium	mg/L	0.2351446	0.065	0.000088	0.01	0.002220203	0.5	0.0088	1	0.003997093	0.28	0.00088	0.1	0.040697674	0.35	0.000088	0.01	0.160247093				0
b-BHC	mg/L	0.0000026	0.00000096	0.00000096	0.0000013	3.27907E-08	0.000012	0.00000095	0.0000012	9.59302E-08	0.000012	0.00000099	0.0000013	1.74419E-06	0.00000098	0.00000098	0.0000013	4.48692E-07				0
Benz(a)anthracene	mg/L	0.0001711	0.00014	0.00014	0.0019	4.78198E-06	0.00014	0.00014	0.0019	1.11919E-06	0.00015	0.00015	0.0021	2.18023E-05	0.00015	0.00015	0.002	6.86773E-05				0
Benzene	mg/L	0.0001097	0.00011	0.00011	0.001	3.75727E-06	0.00023	0.00011	0.001	1.83866E-06	0.00011	0.00011	0.001	1.59884E-05	0.00011	0.00011	0.001	5.03634E-05				0
Benzidine	mg/L	0.0324477	0.033	0.033	0.19	0.00112718	0.033	0.033	0.19	0.000263808	0.036	0.036	0.21	0.005232558	0.035	0.035	0.2	0.016024709				0
Benzo(a) pyrene	mg/L	0.0001296	0.00013	0.00013	0.0019	4.44041E-06	0.00013	0.00013	0.0019	1.03924E-06	0.00014	0.00014	0.0021	2.03488E-05	0.00013	0.00013	0.002	5.95203E-05				0
Benzo(g,h,i)perylene	mg/L	0.0001482	0.00015	0.00015	0.0019	5.12355E-06	0.00014	0.00014	0.0019	1.11919E-06	0.00016	0.00016	0.0021	2.32558E-05	0.00015	0.00015	0.002	6.86773E-05				0
Benzo(k)fluoranthene	mg/L	0.0005192	0.00053	0.00053	0.0019	1.81032E-05	0.00052	0.00052	0.0019	4.15698E-06	0.00057	0.00057	0.0021	8.28488E-05	0.00055	0.00055	0.002	0.000251817				0
Beryllium	mg/L	0.0044892	0.000036	0.000036	0.001	1.22965E-06	0.0036	0.0036	0.01	2.87791E-05	0.00036	0.00036	0.01	5.23256E-05	0.0011	0.000036	0.001	0.000503634				0
Biochemical Oxygen Demand	mg/L	6.3954942	2	2	2	2	2	2	2	0.015988372	2	2	2	0.290697674	2.9	2	2	1.327761628				0
Bis(2-chloroethoxy) methane	mg/L	0.0005505	0.00056	0.00056	0.0096	1.91279E-05	0.00055	0.00055	0.0094	4.3968E-06	0.00061	0.00061	0.01	8.86628E-05	0.00058	0.00058	0.01	0.000265552				0
Bis(2-chloroethyl)ether	mg/L	0.0002403	0.00024	0.00024	0.0019	8.19767E-06	0.00024	0.00024	0.0019	1.9186E-06	0.00026	0.00026	0.0021	3.77907E-05	0.00025	0.00025	0.002	0.000114462				0
Bis(2-chloroisopropyl) ether	mg/L	0.0001935	0.00019	0.00019	0.0019	6.48983E-06	0.00019	0.00019	0.0019	1.5189E-06	0.00021	0.00021	0.0021	3.05233E-05	0.0002	0.0002	0.002	9.15698E-05				0

		RESULTS	TOE DRAIN				FGD PLANT				FGD YARD SUMP				MASTER SUMP				CONTACT STORMWATER			
ChemName	Output Unit	Worst Case Concentration of the COC Expected in Outfall 301 Prior to Any Treatment (mg/L)	Worst Case Concentration (mg/l)	P TOE DRAIN_MDL	P TOE DRAIN_RL	Flow Weighted Average of the Source (mg/l)	Worst Case Concentration (mg/l)	FGD Plant_MDL	FGD Plant_RL	Flow Weighted Average of the Source (mg/l)	Worst Case Concentration (mg/l)	FGD Yard_MDL	FGD Yard_RL	Flow Weighted Average of the Source (mg/l)	Worst Case Concentration (mg/l)	MAST_MDL	MAST_RL	Flow Weighted Average of the Source (mg/l)	Worst Case Concentration (mg/l)	CONT SW_MDL	CONT SW _RL	Flow Weighted Average of the Source (mg/l)
Bis(2-ethylhexyl) phthalate	mg/L	0.0118422	0.012	0.012	0.019	0.000409884	0.012	0.012	0.019	9.59302E-05	0.013	0.013	0.021	0.001889535	0.013	0.013	0.02	0.005952035				0
Bisphenol A	mg/L	0.0005227	0.00032	0.00032	0.001	1.09302E-05	0.00031	0.00031	0.00098	2.4782E-06	0.00032	0.00032	0.001	4.65116E-05	0.00032	0.00032	0.00099	0.000146512				0
Boron	mg/L	19.6088517	0.5	0.00046	0.005	0.017078488	230	0.46	0.5	1.838662791	120	0.046	0.5	17.44186047	0.18	0.00061	0.2	0.082412791				0
Bromide	mg/L	39.5070058	0.52	0.19	0.5	0.017761628	150	4.8		1.199127907	260	4.8	13	37.79069767	0.48	0.48	1.3	0.219767442				0
Bromoform	mg/L	0.0001866	0.00019	0.00019	0.001	6.48983E-06	0.00019	0.00019	0.001	1.5189E-06	0.00019	0.00019	0.001	2.76163E-05	0.00019	0.00019	0.001	8.69913E-05				0
Butyl benzyl phthalate	mg/L	0.0013307	0.0014	0.0014	0.0096	4.78198E-05	0.0013	0.0013	0.0094	1.03924E-05	0.0015	0.0015	0.01	0.000218023	0.0014	0.0014	0.01	0.000640988				0
Cadmium	mg/L	0.0013822	0.000087	0.000074	0.001	2.97166E-06	0.011	0.0074	0.1	8.7936E-05	0.000281	0.0002	0.001	4.0843E-05	0.00026	0.000074	0.001	0.000119041	0.0002	0.0002	0.001	1.16279E-05
Carbon tetrachloride	mg/L	0.0001369	0.00014	0.00014	0.001	4.78198E-06	0.00014	0.00014	0.001	1.11919E-06	0.00014	0.00014	0.001	2.03488E-05	0.00014	0.00014	0.001	6.40988E-05				0
Chemical Oxygen Demand	mg/L	76.1203488	16	2	10	0.546511628	300	20	100	2.398255814	210	20	100	30.52325581	30	2	10	13.73546512				0
chlordane	mg/L	0.0000035	0.0000016	0.0000016	0.000012	5.46512E-08	0.0000016	0.0000016	0.000012	1.27907E-08	0.0000016	0.0000016	0.000012	2.32558E-07	0.0000016	0.0000016	0.000012	7.32558E-07				0
Chloride	mg/L	965.5514535	6.8	0.2	1	0.232267442	23100	49	250	184.6656977	204	100	100	29.65116279	1600	4.9	25	732.5581395	1	1	1	0.058139535
Chlorine, Total Residual	mg/L	0.5182267	0.02			0.00068314	0.24			0.001918605	2.2			0.319767442	0.25			0.114462209				0
Chlorobenzene	mg/L	0.0001340	0.00014	0.00014	0.001	4.78198E-06	0.00014	0.00014	0.001	1.11919E-06	0.00014	0.00014	0.001	2.03488E-05	0.00014	0.00014	0.001	6.40988E-05				0
Chlorodibromomethane	mg/L	0.0003704	0.00014	0.00014	0.001	4.78198E-06	0.00014	0.00014	0.001	1.11919E-06	0.00077	0.00014	0.001	0.000111919	0.00045	0.00014	0.001	0.000206032				0
Chloroethane	mg/L	0.0002024	0.00021	0.00021	0.001	7.17297E-06	0.00021	0.00021	0.001	1.67878E-06	0.00021	0.00021	0.001	3.05233E-05	0.00021	0.00021	0.001	9.61483E-05				0
Chloroform	mg/L	0.0088057	0.00017	0.00017	0.001	5.80669E-06	0.0038	0.00017	0.001	3.03779E-05	0.019	0.00017	0.001	0.002761628	0.013	0.00017	0.001	0.005952035				0
Chlorpyrifos	mg/L	0.0000559	0.000019	0.000019	0.00019	6.48983E-07	0.000019	0.000019	0.00019	1.5189E-07	0.00002	0.00002	0.0002	2.90698E-06	0.00002	0.00002	0.0002	9.15698E-06				0
Chromium (Hexavalent)	mg/L	0.0421279	0.044	0.0019	0.01	0.001502907	0.023	0.0019		0.000183866	0.02	0.005	0.005	0.002906977	0.0041		0.01	0.00187718	0.003	0.003	0.005	0.000174419
Chromium (Total)	mg/L	0.0095347	0.00023	0.00023	0.002	7.8561E-06	0.023	0.023	0.2	0.000183866	0.0023	0.0023	0.02	0.000334302	0.004	0.00023	0.002	0.001831395				0
Chrysene	mg/L	0.0001374	0.00013	0.00013	0.0019	4.44041E-06	0.00013	0.00013	0.0019	1.03924E-06	0.00015	0.00015	0.0021	2.18023E-05	0.00014	0.00014	0.002	6.40988E-05				0
cis-1,3-dichloropropene	mg/L	0.0001837	0.00019	0.00019	0.001	6.48983E-06	0.00019	0.00019	0.001	1.5189E-06	0.00019	0.00019	0.001	2.76163E-05	0.00019	0.00019	0.001	8.69913E-05				0
Cobalt	mg/L	0.0550824	0.0014	0.00005	0.0005	4.78198E-05	0.021	0.005	0.05	0.000167878	0.0074	0.0005	0.005	0.001075581	0.0029	0.00005	0.0005	0.001327762				0
Color	o	0.0581395				0				0				0				0				0
Copper	mg/L	0.0852873	0.00058	0.00027	0.002	1.9811E-05	0.027	0.027	0.2	0.000215843	0.0125	0.002	0.01	0.00181686	0.032	0.00027	0.002	0.014651163	0.0025	0.002	0.01	0.000145349
Cyanide (Total)	mg/L	0.0036875	0.0025	0.0025	0.01	8.53924E-05	0.0025	0.0025	0.01	1.99855E-05	0.0057	0.0025	0.01	0.000828488	0.0043	0.0019	0.01	0.00196875				0
d-BHC	mg/L	0.0000005	0.00000037	0.00000037	0.0000013	1.26381E-08	0.00000036	0.00000036	0.0000012	2.87791E-09	0.00000038	0.00000038	0.0000013	5.52326E-08	0.00000037	0.00000037	0.0000013	1.69404E-07				0
DDD	mg/L	0.0000010	0.00000064	0.00000064	0.0000013	2.18605E-08	0.00000064	0.00000064	0.0000012	5.11628E-09	0.00000066	0.00000066	0.0000013	9.59302E-08	0.00000066	0.00000066	0.0000013	3.0218E-07				0
DDT	mg/L	0.0000008	0.00000071	0.00000071	0.0000013	2.42515E-08	0.0000041	0.0000007	0.0000012	3.27762E-08	0.00000073	0.00000073	0.0000013	1.06105E-07	0.00000073	0.00000073	0.0000013	3.3423E-07				0
Demeton (total)	mg/L	0.0000304	0.000031	0.000031	0.00038	1.05887E-06	0.000031	0.000031	0.00038	2.4782E-07	0.000032	0.000032	0.00039	4.65116E-06	0.000033	0.000033	0.0004	1.5109E-05				0
Demeton-O	mg/L	0.0000378				0				0			0	0				0				0
Demeton-S	mg/L	0.0000378				0				0				0				0				0
Diazinon	mg/L	0.0000551	0.000018	0.000018	0.00019	6.14826E-07	0.000018	0.000018	0.00019	1.43895E-07	0.000018	0.000018	0.0002	2.61628E-06	0.000019	0.000019	0.0002	8.69913E-06				0
Dibenz(a,h)anthracene	mg/L	0.0001529	0.00015	0.00015	0.0019	5.12355E-06	0.00015	0.00015	0.0019	1.19913E-06	0.00016	0.00016	0.0021	2.32558E-05	0.00016	0.00016	0.002	7.32558E-05				0
Dichlorobromomethane	mg/L	0.0016057	0.00013	0.00013	0.001	4.44041E-06	0.00049	0.00013	0.001	3.91715E-06	0.0025	0.00013	0.001	0.000363372	0.0026	0.00013	0.001	0.001190407				0
Dichlorodifluoromethane	mg/L	0.0000058				0				0				0				0				0
Dieldrin	mg/L	0.0000038	0.00000079	0.00000079	0.0000013	2.6984E-08	0.0000051	0.00000078	0.0000012	4.07703E-08	0.0000032	0.00000081	0.0000013	4.65116E-07	0.0000008	0.0000008	0.0000013	3.66279E-07				0
Diesel Range Organics	mg/L	0.2738372				0				0				0	0.48	0.24	0.5	0.219767442				0
Diethylphthalate	mg/L	0.0013772	0.0014	0.0014	0.0096	4.78198E-05	0.0014	0.0014	0.0094	1.11919E-05	0.0015	0.0015	0.01	0.000218023	0.0015	0.0015	0.01	0.000686773				0
Dimethyl phthalate	mg/L	0.0007249	0.00074	0.00074	0.0096	2.52762E-05	0.00072	0.00072	0.0094	5.75581E-06	0.0008	0.0008	0.01	0.000116279	0.00077	0.00077	0.01	0.000352544				0
Di-n-butyl phthalate	mg/L	0.0011507	0.0012	0.0012	0.0096	4.09884E-05	0.0012	0.0012	0.0094	9.59302E-06	0.0013	0.0013	0.01	0.000188953	0.0012	0.0012	0.01	0.000549419				0
Di-n-octyl phthalate	mg/L	0.0019526	0.002	0.002	0.0096	6.8314E-05	0.0019	0.0019	0.0094	1.5189E-05	0.0022	0.0022	0.01	0.000319767	0.0021	0.0021	0.01	0.000961483				0
Diphenylhydrazine	mg/L	0.0006462	0.00063	0.00063	0.0096	2.15189E-05	0.00062	0.00062	0.0094	4.9564E-06	0.00069	0.00069	0.01	0.000100291	0.00066	0.00066	0.01	0.00030218				0
E. Coli	cfu/100 ml	0.0058140				0				0				0				0				0
EC (field)	µS/cm	2491.1468023	364			12.43313953	48670			389.0770349	11080			1610.465116	362			165.7412791				0
Endosulfan I	mg/L	0.0000012	0.0000009	0.0000009	0.0000013	3.07413E-08	0.0000092	0.0000009	0.0000012	7.35465E-08	0.0000023	0.00000093	0.0000013	3.34302E-07	0.00000092	0.00000092	0.0000013	4.21221E-07				0
Endosulfan II	mg/L	0.0000076	0.0000065	0.00000094	0.0000013	2.2202E-07	0.000048	0.00000093	0.0000012	3.83721E-07	0.000019	0.00000097	0.0000013	2.76163E-06	0.0000026	0.00000093	0.0000012	1.19041E-06				0
Endosulfan sulphate	mg/L	0.0000202	0.0000076	0.00000055	0.0000013	2.59593E-07	0.000073	0.00000054	0.0000012	5.83576E-07	0.00013	0.00000055	0.0000013	1.88953E-05	0.00000056	0.00000056	0.0000013	2.56395E-07				0
Endrin	mg/L	0.0000013	0.00000092	0.00000092	0.0000013	3.14244E-08	0.0000028	0.00000091	0.0000012	2.23837E-08	0.0000033	0.00000095	0.0000013	4.79651E-07	0.00000094	0.00000094	0.0000013	4.30378E-07				0
Endrin aldehyde	mg/L	0.0000009	0.00000087	0.00000087	0.0000013	2.97166E-08	0.00000086	0.00000086	0.0000012	6.875E-09	0.00000089	0.00000089	0.0000013	1.2936E-07	0.00000088	0.00000088	0.0000013	4.02907E-07				0
Enterococci	MPN/100 m	0.0058140				0				0				0				0				0
Ethylbenzene	mg/L	0.0002219	0.00023	0.00023	0.001	7.8561E-06	0.00069	0.00023	0.001	5.51599E-06	0.00023	0.00023	0.001	3.34302E-05	0.00023	0.00023	0.001	0.000105305				0
Fecal Coliforms	MPN/100 m	0.0116279				0				0				0				0				0
Fluoranthene	mg/L	0.0001576	0.00016	0.00016	0.0019	5.46512E-06	0.00015	0.00015	0.0019	1.19913E-06	0.00017	0.00017	0.0021	2.47093E-05	0.00016	0.00016	0.002	7.32558E-05				0
Fluorene	mg/L	0.0002104	0.00021	0.00021	0.0019	7.17297E-06	0.0002	0.0002	0.0019	1.59884E-06	0.00023	0.00023	0.0021	3.34302E-05	0.00022	0.00022	0.002	0.000100727				0
Fluoride	mg/L	0.8781468	0.19	0.014	0.1	0.006489826	3.2	0.35	2.5	0.025581395	4.5	0.35	2.5	0.654069767	0.22	0.035	0.25	0.100726744				0
Gasoline Range Organics	mg/L	0.0348183				0				0				0	0.057	0.025	0.1	0.026097384				0
g-BHC (Lindane)	mg/L	0.0000008	0.00000077	0.00000077	0.0000013	2.63009E-08	0.00000076	0.00000076	0.0000012	6.07558E-09	0.00000079	0.00000079	0.0000013	1.14826E-07	0.00000078	0.00000078	0.0000013	3.57122E-07				0
Hardness	mg/L	7.9651163				0				0				0				0				0
HEM	mg/L	1.1380814				0				0				0	1.8	1.8	6	0.824127907				0
Heptachlor	mg/L	0.0000150	0.00000095	0.00000095	0.0000013	3.24491E-08	0.0001	0.00000094	0.0000012	7.99419E-07	0.000092	0.00000098	0.0000013	1.33721E-05	0.00000097	0.00000097	0.0000013	4.44113E-07				0
Heptachlor epoxide	mg/L	0.0000012	0.00000093	0.00000093	0.0000013	3.1766E-08	0.0000045	0.00000092	0.0000012	3.59738E-08	0.0000024	0.00000093	0.0000013	3.48837E-07	0.00000095	0.00000095	0.0000013	4.34956E-07				0
Hexachlorobenzene	mg/L	0.0001856	0.00018	0.00018	0.0019	6.14826E-06	0.00017	0.00017	0.0019	1.35901E-06	0.00019	0.00019	0.0021	2.76163E-05	0.00018	0.00018	0.002	8.24128E-05				0
Hexachlorobutadiene	mg/L	0.0001623	0.00016	0.00016	0.0019	5.46512E-06	0.00016	0.00016	0.0019	1.27907E-06	0.00017	0.00017	0.0021	2.47093E-05	0.00017	0.00017	0.002	7.78343E-05				0
Hexachlorocyclopentadiene	mg/L	0.0004911	0.0005	0.0005	0.0096	1.70785E-05	0.00049	0.00049	0.0094	3.91715E-06	0.00054	0.00054	0.01	7.84884E-05	0.00052	0.00052	0.01	0.000238081				0
Hexachloroethane	mg/L	0.0005925	0.0006	0.0006	0.0096	2.04942E-05	0.00059	0.00059	0.0094	4.71657E-06	0.00065	0.00065	0.01	9.44767E-05	0.00063	0.00063	0.01	0.000288445				0
Indeno(1,2,3-c,d)pyrene	mg/L	0.0001935	0.00019	0.00019	0.0019	6.48983E-06	0.00019	0.00019	0.0019	1.5189E-06	0.00021	0.00021	0.0021	3.05233E-05	0.0002	0.0002	0.002	9.15698E-05				0
Iron	mg/L	22.1858541	4.4	0.0057	0.05	0.150290698	1.3	0.57	5	0.010392442	0.84	0.057	0.5	0.122093023	1.9	0.0057	0.05	0.869912791				0
Isophorone	mg/L	0.0006066	0.00062	0.00062	0.0096	2.11773E-05	0.00061	0.00061	0.0094	4.87645E-06	0.00067	0.00067	0.01	9.73837E-05	0.00064	0.00064	0.01	0.000293023				0
Kepone	mg/L	0.0090538	0.0093	0.0093	0.038	0.00031766	0.0091	0.0091	0.038	7.27471E-05	0.01	0.01	0.042	0.001453488	0.0097	0.0097	0.04	0.004441134				0
Lead	mg/L	0.0049029	0.000074	0.000057	0.001	2.52762E-06	0.0058	0.0057	0.1	4.63663E-05	0.0018	0.00057	0.01	0.000261628	0.0067	0.0012	0.01	0.003067587				0

		RESULTS	TOE DRAIN				FGD PLANT				FGD YARD SUMP				MASTER SUMP				CONTACT STORMWATER			
ChemName	Output Unit	Worst Case Concentration of the COC Expected in Outfall 301 Prior to Any Treatment (mg/L)	Worst Case Concentration (mg/l)	P TOE DRAIN_MDL	P TOE DRAIN_RL	Flow Weighted Average of the Source (mg/l)	Worst Case Concentration (mg/l)	FGD Plant_MDL	FGD Plant_RL	Flow Weighted Average of the Source (mg/l)	Worst Case Concentration (mg/l)	FGD Yard_MDL	FGD Yard_RL	Flow Weighted Average of the Source (mg/l)	Worst Case Concentration (mg/l)	MAST_MDL	MAST_RL	Flow Weighted Average of the Source (mg/l)	Worst Case Concentration (mg/l)	CONT SW_MDL	CONT SW _RL	Flow Weighted Average of the Source (mg/l)
Lithium	mg/L	0.0747882	0.0038	0.00053	0.05	0.000129797	0.21	0.0026	0.25	0.001678779	0.13	0.0011	0.1	0.018895349	0.014	0.00053	0.05	0.006409884				0
Magnesium	mg/L	79.4206686	16	0.001	0.5	0.546511628	670	0.1	5	5.356104651	340	0.01	5	49.41860465	40	0.001	0.5	18.31395349				0
Malathion	mg/L	0.0000259	0.000021	0.000021	0.00019	7.17297E-07	0.000021	0.000021	0.00019	1.67878E-07	0.000021	0.000021	0.0002	3.05233E-06	0.000022	0.000022	0.0002	1.00727E-05				0
Manganese	mg/L	0.7100262	1	0.000046	0.005	0.034156977	1.3	0.0046	0.5	0.010392442	0.3	0.00046	0.05	0.043604651	0.16	0.00012	0.015	0.073255814				0
Mercury	mg/L	0.0000696	0.000056	0.000031	0.0002	1.91279E-06	0.00022	0.000031	0.0002	1.75872E-06	0.0001	0.000031	0.0002	1.45349E-05	0.00007	0.000031	0.0002	3.20494E-05				0
Methoxychlor	mg/L	0.0000000				0				0				0				0				0
Methyl Bromide	mg/L	0.0002960	0.00031	0.00031	0.001	1.05887E-05	0.00031	0.00031	0.001	2.4782E-06	0.00031	0.00031	0.001	4.50581E-05	0.00031	0.00031	0.001	0.000141933				0
Methyl Chloride	mg/L	0.0002708	0.00028	0.00028	0.001	9.56395E-06	0.00028	0.00028	0.001	2.23837E-06	0.00028	0.00028	0.001	4.06977E-05	0.00028	0.00028	0.001	0.000128198				0
Methylene Chloride	mg/L	0.0011925	0.00015	0.00015	0.001	5.12355E-06	0.00015	0.00015	0.001	1.19913E-06	0.00019	0.00015	0.001	2.76163E-05	0.00018	0.00015	0.001	8.24128E-05				0
Mirex	mg/L	0.0000005	0.00000046	0.00000046	0.0000013	1.57122E-08	0.00000046	0.00000046	0.0000012	3.67733E-09	0.00000048	0.00000048	0.0000013	6.97674E-08	0.00000047	0.00000047	0.0000013	2.15189E-07				0
Molybdenum	mg/L	0.0185834	0.0031	0.00026	0.005	0.000105887	0.081	0.0026	0.05	0.000647529	0.052	0.0026	0.05	0.00755814	0.0058	0.00026	0.005	0.002655523				0
Naphthalene	mg/L	0.0004179	0.00013	0.00013	0.0019	4.44041E-06	0.00013	0.00013	0.0019	1.03924E-06	0.00015	0.00015	0.0021	2.18023E-05	0.00014	0.00014	0.002	6.40988E-05				0
Nickel	mg/L	0.1064634	0.00075	0.000093	0.001	2.56177E-05	0.18	0.0093	0.01	0.001438953	0.0455	0.002	0.01	0.006613372	0.0067	0.000093	0.001	0.003067587	0.002	0.002	0.01	0.000116279
Nitrate	mg/L	0.0023256				0				0				0				0				0
Nitrate (as N)	mg/L	9.1848328	0.59	0.0062	0.1	0.020152616	35	0.16		0.279796512	55	0.16	2.5	7.994186047	1.6		0.25	0.73255814				0
Nitrite	mg/L	0.0004651				0				0				0				0				0
Nitrite (as N)	mg/L	0.1911047	0.18	0.024	0.05	0.006148256	0.6	0.6	1.3	0.004796512	0.6	0.6	1.3	0.087209302	0.17		0.05	0.077834302				0
Nitrobenzene	mg/L	0.0008178	0.00081	0.00081	0.019	2.76672E-05	0.0008	0.0008	0.019	6.39535E-06	0.00088	0.00088	0.021	0.000127907	0.00084	0.00084	0.02	0.000384593				0
Nitrogen (Organic)	mg/L	0.0034884				0				0				0				0				0
Nitrogen (Total Oxidised)	mg/L	0.0023256				0				0				0				0				0
Nitrogen (Total)	mg/L	0.0179070				0				0				0				0				0
N-Nitrosodimethylamine	mg/L	0.0007033	0.00071	0.00071	0.0019	2.42515E-05	0.00069	0.00069	0.0019	5.51599E-06	0.00077	0.00077	0.0021	0.000111919	0.00074	0.00074	0.002	0.000338808				0
N-nitrosodi-n-propylamine	mg/L	0.0003011	0.0003	0.0003	0.0019	1.02471E-05	0.00029	0.00029	0.0019	2.31831E-06	0.00032	0.00032	0.0021	4.65116E-05	0.00031	0.00031	0.002	0.000141933				0
n-Nitrosodiphenylamine	mg/L	0.0008271	0.00082	0.00082	0.0096	2.80087E-05	0.0008	0.0008	0.0094	6.39535E-06	0.00089	0.00089	0.01	0.00012936	0.00085	0.00085	0.01	0.000389172				0
Nonylphenol	mg/L	0.0000291				0				0				0				0				0
Nonylphenol Diethoxylate (Technic	mg/L	0.0018023	0.002	0.002	0.02	6.8314E-05	0.0019	0.0019	0.02	1.5189E-05	0.002	0.002	0.02	0.000290698	0.0019	0.0019	0.02	0.000869913				0
Nonylphenol Monoethoxylate (Tech	mg/L	0.0029713	0.0032	0.0032	0.01	0.000109302	0.0031	0.0031	0.0098	2.4782E-05	0.0032	0.0032	0.01	0.000465116	0.0032	0.0032	0.0099	0.001465116				0
Oil and Grease	mg/L	1.5151163	1.6	1.6	4.5	0.054651163	1.6	1.6	4.6	0.012790698	1.6	1.6	4.5	0.23255814	1.6	1.6	4.6	0.73255814				0
para-tert-Octylphenol	mg/L	0.0002971	0.00032	0.00032	0.001	1.09302E-05	0.00031	0.00031	0.00098	2.4782E-06	0.00032	0.00032	0.001	4.65116E-05	0.00032	0.00032	0.00099	0.000146512				0
Parathion	mg/L	0.0000357	0.000031	0.000031	0.00019	1.05887E-06	0.000031	0.000031	0.00019	2.4782E-07	0.000032	0.000032	0.0002	4.65116E-06	0.000032	0.000032	0.0002	1.46512E-05				0
P-Chloro-M-Cresol	mg/L	0.0007368	0.00073	0.00073	0.0096	2.49346E-05	0.00071	0.00071	0.0094	5.67587E-06	0.00079	0.00079	0.01	0.000114826	0.00075	0.00075	0.01	0.000343387				0
Pentachlorophenol	mg/L	0.0006512	0.00064	0.00064	0.0096	2.18605E-05	0.00063	0.00063	0.0094	5.03634E-06	0.00069	0.00069	0.01	0.000100291	0.00066	0.00066	0.01	0.00030218				0
pH (Field)	SU	7.1937645	6.54			0.223386628	8.44			0.06747093	8.75			1.271802326	8.68			3.974127907				0
Phenanthrene	mg/L	0.0004313	0.00041	0.00041	0.0019	1.40044E-05	0.0004	0.0004	0.0019	3.19767E-06	0.00044	0.00044	0.0021	6.39535E-05	0.00043	0.00043	0.002	0.000196875				0
Phenol	mg/L	0.0010981	0.00056	0.00056	0.0019	1.91279E-05	0.00055	0.00055	0.0019	4.3968E-06	0.0042	0.00056	0.0019	0.000610465	0.00058	0.00058	0.002	0.000265552				0
Phenolics Total	mg/L	0.0090465				0				0				0	0.016	0.0082	0.01	0.007325581				0
Phosphorus	mg/L	0.5706068	0.075	0.05	0.1	0.002561773	0.61	0.05	0.1	0.004876453	0.26	0.05	0.1	0.037790698	0.94	0.05	0.1	0.430377907				0
p-Nonylphenol (Technical mixture)	mg/L	0.0014977	0.0016	0.0016	0.005	5.46512E-05	0.0016	0.0016	0.0049	1.27907E-05	0.0016	0.0016	0.005	0.000232558	0.0016	0.0016	0.0049	0.000732558				0
Potassium	mg/L	22.8444041	3.7	0.017	0.5	0.126380814	120	1.7	5	0.959302326	71	0.17	5	10.31976744	22	0.017	0.5	10.07267442				0
Pyrene	mg/L	0.0001805	0.00015	0.00015	0.0019	5.12355E-06	0.00015	0.00015	0.0019	1.19913E-06	0.00016	0.00016	0.0021	2.32558E-05	0.00016	0.00016	0.002	7.32558E-05				0
Radium-226	pCi/L	0.3728554	0.487	0.161	1	0.016634448	6.26	2.06	1	0	2.3	1.01	1	0	0.4	0.4	1	0.183139535				0
Radium-228	pCi/L	0.5953888	0.375	0.375	1	0.012808866	3.12	3.12	1	0	2.3	1	1	0	0.869	0.607	1	0.39787064				0
Redox	mV	200.3162791	5.1			0.174200581	147.5			1.179142442	225.9			32.83430233	122.3			55.99491279				0
Selenium	mg/L	0.0129347	0.00033	0.0002	0.005	1.12718E-05	0.044	0.002	0.05	0.000351744	0.0263	0.001	0.001	0.003822674	0.0039	0.0039	0.01	0.00178561	0.0114	0.001	0.001	0.000662791
Silver	mg/L	0.0001428	0.000047	0.000047	0.001	1.60538E-06	0.0047	0.0047	0.1	3.75727E-05	0.00047	0.00047	0.01	6.8314E-05	0.000047	0.000047	0.001	2.15189E-05				0
Sodium	mg/L	383.4978924	7.3	0.011	0.5	0.24934593	710	1.1	5	5.675872093	420	0.11	5	61.04651163	670	0.011	0.5	306.7587209				0
Specific Conductivity (lab)	µS/cm	0.0000000				0				0				0				0				0
Sulfate	mg/L	1349.9789244	57	0.21	1	1.946947674	660	5.4		5.276162791	1000	5.4	25	145.3488372	2200		25	1007.267442				0
Sulfide	mg/L	0.5872674	0.41	0.41	1	0.01400436	0.41	0.41	1	0.003277616	1.3	0.47	3	0.188953488	0.41	0.41	1	0.187718023				0
sulfide (as H2S)	mg/L	0.4460538	0.41	0.41	1	0.01400436	8.2	8.2	20	0.065552326	0.41	0.41	1	0.059593023	0.41	0.41	1	0.187718023				0
Surfactants	mg/L	0.0005814				0				0				0				0				0
Temperature	oC	28.0342878	19.24			0.657180233	38.8	1	1	0.310174419	22.16			3.220930233	33.43			15.30588663				0
Tetrachloroethene	mg/L	0.0001462	0.00015	0.00015	0.001	5.12355E-06	0.00015	0.00015	0.001	1.19913E-06	0.00015	0.00015	0.001	2.18023E-05	0.00015	0.00015	0.001	6.86773E-05				0
Thallium	mg/L	0.0013820	0.000063	0.000013	0.001	2.15189E-06	0.0038	0.0013	0.01	3.03779E-05	0	0.00013	0.01	0	0.0022	0.0018	0.02	0.001007267				0
Tin	mg/L	0.0001163				0				0				0				0				0
Titanium	mg/L	0.0000291				0				0				0				0				0
Toluene	mg/L	0.0001480	0.00015	0.00015	0.001	5.12355E-06	0.00015	0.00015	0.001	1.19913E-06	0.00015	0.00015	0.001	2.18023E-05	0.00015	0.00015	0.001	6.86773E-05				0
Total Dissolved Solids	mg/L	3501.6061047	230	10	10	7.856104651	31000	200	200	247.8197674	9000	100	100	1308.139535	3600	40	40	1648.255814				0
Total Kjeldahl Nitrogen	mg/L	8.8912064	3.4	1.7	5	0.116133721	9.5	1.7	5	0.075944767	8.4	1.7	5	1.220930233	15	1.7	5	6.867732558				0
Total Organic Carbon	mg/L	4.3504360	3.4	0.19	1	0.116133721	36	3.8	20	0.287790698	9.9	0.19	1	1.438953488	2.8	0.19	1	1.281976744				0
Total Suspended Solids	mg/L	176.4317587	7.8	1	1	0.266424419	3.3	0.52		0.026380814	27	1	1	3.924418605	230		5	105.3052326				0
Toxaphene	mg/L	0.0000180	0.000018	0.000018	0.000048	6.14826E-07	0.000018	0.000018	0.000048	1.43895E-07	0.000018	0.000018	0.00005	2.61628E-06	0.000018	0.000018	0.000049	8.24128E-06				0
trans-1,2-Dibromoethene	mg/L	0.0000058				0				0				0				0				0
trans-1,3-dichloropropene	mg/L	0.0001462	0.00015	0.00015	0.001	5.12355E-06	0.00015	0.00015	0.001	1.19913E-06	0.00015	0.00015	0.001	2.18023E-05	0.00015	0.00015	0.001	6.86773E-05				0
Tributyltin	mg/L	0.0000453	0.000043	0.000043	0.000043	1.46875E-06	0.000043	0.000043	0.000043	3.4375E-07	0.000047	0.000047	0.000047	6.8314E-06	0.000052	0.000052	0.000052	2.38081E-05				0
Trichloroethene	mg/L	0.0001369	0.00014	0.00014	0.001	4.78198E-06	0.00014	0.00014	0.001	1.11919E-06	0.00014	0.00014	0.001	2.03488E-05	0.00014	0.00014	0.001	6.40988E-05				0
Trichlorofluoromethane	mg/L	0.0000058				0			0	0				0				0				0
Turbidity	NTU	85.3857558	23	0.05	0.85	0.785610465	1.8	0.05	0.85	0.014389535	33	0.05	0.85	4.796511628	21	0.05	0.85	9.614825581				0
Vinyl chloride	mg/L	0.0002211	0.00023	0.00023	0.001	7.8561E-06	0.00023	0.00023	0.001	1.83866E-06	0.00023	0.00023	0.001	3.34302E-05	0.00023	0.00023	0.001	0.000105305				0
Zinc	mg/L	0.3751538	0.025	0.0004	0.005	0.000853924	0.061	0.04	0.5	0.000487645	0.236	0.01	0.01	0.034302326	0.04	0.001	0.02	0.018313953	0.01	0.01	0.01	0.000581395

Attachment 4.d

Attachment A Data for Outfalls 004 and 005

Outfall 004 Analytical Data for Water Quality Criteria Parameters

CHEMICAL	EPA ANALYSIS NO.	QUANTIFICATION LEVEL[1]	RESULT (ug/L)	SAMPLE TYPE[2]
METALS				
Antimony, dissolved	(3)	130,000	8.00	G
Arsenic, dissolved	(3)	2,800	41.00	G
Cadmium, dissolved	(3)	17	1.10	G
Chromium III, dissolved [8]	(3)	1,100	2.00[A]	G
Chromium VI, dissolved [8]	(3)	200	<10.00	G
Copper, dissolved	(3)	130	8.00	G
Lead, dissolved	(3)	180	<1.00	G
Mercury, dissolved	(3)	1.6	<0.20	G
Nickel, dissolved	(3)	300	25.00	G
Selenium, dissolved	(3)	93	17.00	G
Silver, dissolved	(3)	27	<0.10	G
Thallium, dissolved	(4)	200	0.50	G
Zinc, dissolved	(3)	1,200	26.00	G
PESTICIDES / PCBs				
Aldrin	608	0.05	<0.016	G
Chlordane	608	0.2	<0.014	G
Chlorpyrifos (Dursban)	622	(5)	<0.014	G
DDD	608	0.1	<0.021	G
DDE	608	0.1	<0.017	G
DDT	608	0.1	<0.017	G
Demeton	(4)	(5)	<0.521	G
Dieldrin	608	0.1	<0.010	G
Alpha-Endosulfan	608	0.1	<0.014	G
Beta-Endosulfan	608	0.1	<0.017	G
Endosulfan Sulfate	608	0.1	<0.009	G
Endrin	608	0.1	<0.020	G
Endrin Aldehyde	(4)	(5)	<0.019	G

Outfall 004 Analytical Data for Water Quality Criteria Parameters

CHEMICAL	EPA ANALYSIS NO.	QUANTIFICATION LEVEL[1]	RESULT (ug/L)	SAMPLE TYPE[2]
Guthion	622	(5)	<0.3577	G
Heptachlor	608	0.05	<0.016	G
Heptachlor Epoxide	(4)	(5)	<0.012	G
Hexachlorocyclohexane Alpha-BHC	608	(5)	<0.007	G
Hexachlorocyclohexane Beta-BHC	608	(5)	<0.013	G
HexachlorocyclohexaneGamma-BHC (Lindane)	608	(5)	<0.011	G
Kepone	(9)	(5)	<0.015	G
Malathion	(4)	(5)	<0.123	G
Methoxychlor	(4)	(5)	<0.017	G
Mirex	(4)	(5)	<0.015	G
Parathion	(4)	(5)	<0.121	G
PCB 1260	608	1.0	<1.00	G
PCB 1254	608	1.0	<1.00	G
PCB 1248	608	1.0	<1.00	G
PCB 1242	608	1.0	<1.00	G
PCB 1232	608	1.0	<1.00	G
PCB 1221	608	1.0	<1.00	G
PCB 1016	608	1.0	<1.00	G
PCB Total	608	7.0	<7.00	G
Toxaphene	608	5.0	<0.057	G
BASE NEUTRALS				
Acenaphthene	625	10.0	<3.00	G
Anthracene	625	10.0	<1.90	G
Benzidine	(4)	(5)	<63.00	G
Benzo (a) anthracene	625	10.0	<7.80	G
Benzo (b) fluoranthene	625	10.0	<4.80	G
Benzo (k) fluoranthene	625	10.0	<2.50	G
Benzo (a) pyrene	625	10.0	<2.50	G

Outfall 004 Analytical Data for Water Quality Criteria Parameters

CHEMICAL	EPA ANALYSIS NO.	QUANTIFICATION LEVEL[1]	RESULT (ug/L)	SAMPLE TYPE[2]
Bis 2-Chloroethyl Ether	(4)	(5)	<5.70	G
Bis 2-Chloroisopropyl Ether	(4)	(5)	<5.70	G
Butyl benzyl phthalate	625	10.0	<2.50	G
2-Chloronaphthalene	(4)	(5)	<4.60	G
Chrysene	625	10.0	<2.50	G
Dibenz(a,h)anthracene	625	20.0	<2.50	G
Dibutyl phthalate (Di-n-Butyl Phthalate)	625	10.0	<6.40	G
1,2-Dichlorobenzene	624	10.0	<4.00	G
1,3-Dichlorobenzene	624	10.0	<3.10	G
1,4-Dichlorobenzene	624	10.0	<4.40	G
3,3-Dichlorobenzidine	(4)	(5)	<16.50	G
Diethyl phthalate	625	10.0	<7.40	G
Di-2-Ethylhexyl Phthalate	625	10.0	<2.50	G
Dimethyl phthalate	(4)	(5)	<7.50	G
2,4-Dinitrotoluene	625	10.0	<5.70	G
1,2-Diphenylhydrazine	(4)	(5)	<8.80	G
Fluoranthene	625	10.0	<2.20	G
Fluorene	625	10.0	<3.10	G
Hexachlorobenzene	(4)	(5)	<1.80	G
Hexachlorobutadiene	(4)	(5)	<10.00	G
Hexachlorocyclopentadiene	(4)	(5)	<2.40	G
Hexachloroethane	(4)	(5)	<3.70	G
Indeno(1,2,3-cd)pyrene	625	20.0	<3.70	G
Isophorone	625	10.0	<5.10	G
Nitrobenzene	625	10.0	<4.20	G
N-Nitrosodimethylamine	(4)	(5)	<6.20	G
N-Nitrosodi-n-propylamine	(4)	(5)	<3.60	G
N-Nitrosodiphenylamine	(4)	(5)	<2.70	G

Outfall 004 Analytical Data for Water Quality Criteria Parameters

CHEMICAL	EPA ANALYSIS NO.	QUANTIFICATION LEVEL[1]	RESULT (ug/L)	SAMPLE TYPE[2]
Pyrene	625	10.0	<3.80	G
1,2,4-Trichlorobenzene	625	10.0	<7.90	G
VOLATILES				
Acrolein	(4)	(5)	<10.00	G
Acrylonitrile	(4)	(5)	<1.50	G
Benzene	624	10.0	<4.40	G
Bromoform	624	10.0	<4.70	G
Chlorobenzene (monochlorobenzene)	624	50.0	<6.00	G
Chlorodibromomethane	624	10.0	<3.10	G
Chloroform	624	10.0	<1.60	G
Dichloromethane (methylene chloride)	624	20.0	<2.80	G
Dichlorobromomethane	624	10.0	<2.20	G
1,2-Dichloroethane	624	10.0	<2.80	G
1,1-Dichloroethylene	624	10.0	<2.80	G
1,2-trans-dichloroethylene	(4)	(5)	<1.60	G
1,2-Dichloropropane	(4)	(5)	<6.00	G
1,3-Dichloropropene	(4)	(5)	<5.90	G
Ethylbenzene	624	10.0	<7.20	G
Methyl Bromide	(4)	(5)	<1.40	G
1,1,2,2-Tetrachloroethane	(4)	(5)	<6.90	G
Tetrachloroethylene	624	10.0	<4.10	G
Toluene	624	10.0	<6.00	G
1,1,2-Trichloroethane	(4)	(5)	<5.00	G
Trichloroethylene	624	10.0	<1.90	G
RADIONUCLIDES				
Strontium 90 (pCi/L)	(4)	(5)	<0.498	G
Tritium (pCi/L)	(4)	(5)	<247	G
Beta Particle & Photon Activity (pCi/L)	(4)	(5)	<2.83	G

Outfall 004 Analytical Data for Water Quality Criteria Parameters

CHEMICAL	EPA ANALYSIS NO.	QUANTIFICATION LEVEL[1]	RESULT (ug/L)	SAMPLE TYPE[2]
Gross Alpha Particle Activity (pCi/L)	(4)	(5)	4.44	G
ACIDS				
2-Chlorophenol	625	10.0	<3.30	G
2,4 Dichlorophenol	625	10.0	<5.60	G
2,4 Dimethylphenol	625	10.0	<5.20	G
2,4-Dinitrophenol	(4)	(5)	<42.00	G
2-Methyl-4,6-Dinitrophenol	(4)	(5)	<24.00	G
Pentachlorophenol	625	50.0	<3.60	G
Phenol	625	10.0	<2.70	G
2,4,6-Trichlorophenol	625	10.0	<2.70	G
MISCELLANEOUS				
Ammonia as NH3-N	350.1	200	2,360	G
Chlorides	(4)	(5)	118,320	G
Chlorine, Total Residual	(4)	100	< 100	G
Cyanide, Total	(4)	10.0	<10.00	G
E. coli / Enterococcus (N/CML)	(4)	(5)	<2.00	G
Hydrogen Sulfide	(4)	(5)	<50.00	G
Tributyltin [7]	NBSR 85-3295	(5)	0.032	G

A = Result is for total chromium

(1) Quantification level (QL) is defined as the lowest concentration used for the calibration of a measurement system when the calibration is in accordance with the procedures published for the required method.

The quantification levels indicated for the metals are actually Specific Target Values developed for this permit. The Specific Target Value is the approximate value that may initiate a wasteload allocation analysis. Target values are not wasteload allocations or effluent limitations. The Specific Target Values are subject to change based on additional information such as hardness data, receiving stream flow, and design flows.

Units for the quantification level are micrograms/liter unless otherwise specified.

Quality control and quality assurance information shall be submitted to document that the required quantification level has been attained.

(2) Sample Type

G = Grab = An individual sample collected in less than 15 minutes. Substances specified with "grab" sample type shall only be collected as grabs. The permittee may analyze multiple grabs and report the average results provided that the individual grab results are also reported. For grab metals samples, the individual samples shall be filtered and preserved immediately upon collection.

C = Composite = A 24-hour **(PW - Revise as required to require same composite duration as BOD_5)** composite unless otherwise specified. The composite shall be a combination of individual samples, taken proportional to flow, obtained at hourly or smaller time intervals. The individual samples may be of equal volume for flows that do not vary by +/- 10 percent over a 24-hour period.

SC = Special Composite = samples for base/neutral/acid compounds, PCBs, and pesticides must be collected as 4 individual grab samples taken proportional to flow at 6-hour intervals over the course of one day. The individual samples may be of equal volume for flows that do not vary by +/- 10 percent over a 24-hour period. Grab samples must be analyzed separately and the concentrations averaged. Alternately, grab samples may be collected in the field and composited in the laboratory if the compositing procedure produces results equivalent to results produced by arithmetic averaging of the results of analysis of individual grab samples.

(3) A specific analytical method is not specified; however a target value for each metal has been established. An appropriate method to meet the target value shall be selected from the following list of EPA methods (or any approved method presented in 40 CFR Part 136). If the test result is less than the method QL, a "<[QL]" shall be reported where the actual analytical test QL is substituted for [QL].

Metal	Analytical Method
Antimony	1638; 1639
Arsenic	206.5; 1632
Chromium[9]	1639
Cadmium	1637; 1638; 1639; 1640
Chromium VI	218.6; 1639
Copper	1638; 1640
Lead	1637; 1638; 1640
Mercury	245.7; 1631
Nickel	1638; 1639; 1640
Selenium	1638; 1639
Silver	1638
Zinc	1638; 1639

(4) Any approved method presented in 40 CFR Part 136.

(5) The QL is at the discretion of the permittee. For any substances addressed in 40 CFR Part 136, the permittee shall use one of the approved methods in 40 CFR Part 136.

(6) Testing for phenol requires continuous extraction.

(7) Analytical Methods: NBSR 85-3295 or DEQ's approved analysis for Tributyltin may also be used [See A Manual for the Analysis of Butyltins in Environmental Systems by the Virginia Institute of Marine Science, dated November 1996].

(8) Both Chromium III and Chromium VI may be measured by the total chromium analysis. If the result of the total chromium analysis is less than or equal to the lesser of the Chromium III or Chromium VI method QL, the results for both Chromium III and Chromium VI can be reported as "<[QL]", where the actual analytical test QL is substituted for [QL].

(9) The lab may use SW846 Method 8270D provided the lab has an Initial Demonstration of Capability, has passed a PT for Kepone, and meets the acceptance criteria for Kepone as given in Method 8270D

EPA I.D. NUMBER= VA0004146

V. Intake and effluent characteristics (continued from page 3 of Form 2c) Outfall 004

Part A- You must provide the results of at least one analysis for every pollutant in this table. Complete one table for each outfall. See instructions for additional details.

	2. Effluent							3. Units	
	A. MAXIMUM DAILY VALUE		B. MAXIMUM 30 DAY VALUE		C. LONG TERM AVRG. VALUE				
	Concentration	Mass	Concentration	Mass	Concentration	Mass	No. of Analyses	Concentration	Mass
Biochemical Oxygen Demand	<3	<283.64655	.	.	.	.	1	PPM	LB/DAY
Chemical Oxygen Demand	<5	<472.74425	.	.	.	.	1	PPM	LB/DAY
Total Organic Carbon	13.3	1293.016025	13.3	1084.3576	<2.2833	<196.8967	36	PPM	LB/DAY
Total Suspended Solids	51.5	7447.870775	27.6	2393.6715	11.7629	1017.8366	70	PPM	LB/DAY
Ammonia,total	2.76	236.08005	2	165.6586	0.6357	54.3066	141	PPM	LB/DAY
Flow	21.25	.	13.13	.	10.0692	.	790	MGD	.
Temperature (Winter)	12.15	.	10.61	.	10.61	.	3	DEGREES C	.
Temperature (Summer)	32.2	.	30.6	.	30.6	.	3	DEGREES C	.
pH	6 (min)	8.4 (max)	N/A	N/A	N/A	N/A	70	STD. UNITS	.

PART B.

	Mark X		2. Effluent						3. Units	
			A. MAXIMUM DAILY VALUE		B. MAXIMUM 30 DAY VALUE		C. LONG TERM AVRG. VALUE			
	believed present	believed absent	Concentration	Mass	Concentration	Mass	Concentration	Mass	No. of Analyses	Concentration	Mass
Bromide,total (24959-67-6)	X		0.47	44.4379595	.	.	.	.	1	PPM	LB/DAY
Chlorine, Total Residual	X		<0.1	<9.454885	.	.	.	.	1	PPM	LB/DAY
Color	X		0	.	.	.	.	.	0	NTU	.
Fecal Coliform		X	No Sample	.	.	.	.	.	0	COL/100ML	.
Fluoride (16984-48-8)	X		0.399	37.72499115	.	.	.	.	1	PPM	LB/DAY
Nitrate + Nitrite	X		1.73	202.5389915	1.73	145.804	0.7786	67.3355	172	PPM	LB/DAY

Item V-B Continued Outfall 004
Part C.

1. POLLUTANT	Mark X believed present	Mark X believed absent	2. Effluent A. MAXIMUM DAILY VALUE Concentration	A. Mass	B. MAXIMUM 30 DAY VALUE Concentration	B. Mass	C. LONG TERM AVRG. VALUE Concentration	C. Mass	No. of Analyses	3. Units Concentration	Mass
Nitrogen, Total Org. As N	X		2.86	270.409711	.	.	.	.	1	PPM	LB/DAY
Oil & Grease	X		<5	<886.65625	<5	<568.5031	<5	<432.4364	70	PPM	LB/DAY
Phosphorus (As P), Total (07723-14-0)	X		0.49	47.6374325	0.16	13.0449	0.0372	3.1505	176	PPM	LB/DAY
j. Radioactivity **********											
Alpha, Total	X		<2.83	.	.	.	.	.	1	PCI/LITER	.
Beta, Total	X		4.44	.	.	.	.	.	1	PCI/LITER	.
Radium,total		X	No Sample	.	.	.	.	.	0	PCI/LITER	.
Radium 226 , Total		X	No Sample	.	.	.	.	.	0	PCI/LITER	.
Sulfate (As So4) (14808-79-8)	X		150.31	14211.6376435	.	.	.	.	1	PPM	LB/DAY
Sulfide (As S)	X		<0.01	<0.9454885	.	.	.	.	1	PPM	LB/DAY
Sulfite (As So3) (14265-45-3)		X	No Sample	.	.	.	.	.	0	PPM	LB/DAY
Surfactants	X		<0.025	<2.36372125	.	.	.	.	1	PPM	LB/DAY
Aluminum,total (07429-90-5)	X		0.24	22.691724	.	.	.	.	1	PPM	LB/DAY
Barium,total (07440-39-3)	X		0.343	32.43025555	.	.	.	.	1	PPM	LB/DAY
Boron,total (07440-42-8)	X		2.21	208.9529585	.	.	.	.	1	PPM	LB/DAY
Cobalt,total (07440-48-4)	X		0.006	0.5672931	.	.	.	.	1	PPM	LB/DAY
Iron,total (07439-89-6)	X		0.07	6.6184195	.	.	.	.	1	PPM	LB/DAY
Magnesium,total (07439-95-4)	X		9.7	917.123845	.	.	.	.	1	PPM	LB/DAY
Molybdenum,total (07439-98-7)	X		0.113	10.68402005	.	.	.	.	1	PPM	LB/DAY
Manganese,total (07439-96-5)	X		0.08	7.563908	.	.	.	.	1	PPM	LB/DAY
Tin,total (07440-31-5)	X		<0.005	<0.47274425	.	.	.	.	1	PPM	LB/DAY
Titanium,total (07440-32-6)	X		0.029	2.74191665	.	.	.	.	1	PPM	LB/DAY

Run on 05/08/2009

Continued from Page V2

Outfall 004

1. POLLUTANT	Mark X testing required	believed present	believed absent	2. Effluent A. MAXIMUM DAILY VALUE Concentration	Mass	B. MAXIMUM 30 DAY VALUE Concentration	Mass	C. LONG TERM AVRG. VALUE Concentration	Mass	No. of Analyses	3. Units Concentration	Mass
METALS, CYANIDE, AND TOTAL PHENOLS												
Antimony,total (07440-36-0)	X	X		0.008	0.7563908	.	.	.	.	1	PPM	LB/DAY
Arsenic,total (07440-38-2)	X	X		0.054	5.1056379	.	.	.	.	1	PPM	LB/DAY
Beryllium,total (07440-41-7)	X	X		0.0004	0.03781954	.	.	.	.	1	PPM	LB/DAY
Cadmium,total (07440-43-9)	X	X		0.0012	0.11345862	.	.	.	.	1	PPM	LB/DAY
Chromium,total (07440-47-3)	X	X		0.002	0.1890977	.	.	.	.	1	PPM	LB/DAY
Copper,total (07440-50-8)	X	X		0.009	0.85093965	.	.	.	.	1	PPM	LB/DAY
Lead,total (07439-92-1)	X	X		<0.001	<0.09454885	.	.	.	.	1	PPM	LB/DAY
Mercury,total (07439-97-6)	X	X		<0.0002	<0.01890977	.	.	.	.	1	PPM	LB/DAY
Nickel,total (07440-02-0)	X	X		0.025	2.36372125	.	.	.	.	1	PPM	LB/DAY
Selenium,total (07782-49-2)	X	X		0.019	1.79642815	.	.	.	.	1	PPM	LB/DAY
Silver,total (07440-22-4)	X	X		<0.0001	<0.009454885	.	.	.	.	1	PPM	LB/DAY
Thallium,total (07440-28-0)	X	X		0.0007	0.066184195	.	.	.	.	1	PPM	LB/DAY
Zinc,total (07440-66-6)	X	X		0.033	3.12011205	.	.	.	.	1	PPM	LB/DAY
Cyanide , Total (00057-12-5)	X	X		<0.01	<0.9454885	.	.	.	.	1	PPM	LB/DAY
Total Phenols	X	X		<0.01	<0.9454885	.	.	.	.	1	PPM	LB/DAY
DIOXIN												
Dioxin Screen			X	No Sample	.	.	.	.	.	.	PPM	LB/DAY

Run on 05/08/2009

Continued from Page V3

Outfall 004

1. POLLUTANT	Mark X testing required	believed present	believed absent	2. Effluent A. MAXIMUM DAILY VALUE Concentration	Mass	B. MAXIMUM 30 DAY VALUE Concentration	Mass	C. LONG TERM AVRG. VALUE Concentration	Mass	No. of Analyses	3. Units Concentration	Mass
GCMS FRACTION - VOLATILE COMPOUNDS												
Acrolein (00107-02-8)	X	X		<0.01	<0.9454885	.	.	.	.	1	PPM	LB/DAY
Acrylonitrile (00107-13-1)	X	X		<0.0015	<0.141823275	.	.	.	.	1	PPM	LB/DAY
Benzene (00071-43-2)	X	X		<0.0044	<0.41601494	.	.	.	.	1	PPM	LB/DAY
BIS (Chloromethyl) Ether (542-88-1)				not required		not required		not required				
Bromoform (00075-25-2)	X	X		<0.0047	<0.444379595	.	.	.	.	1	PPM	LB/DAY
Carbon Tetrachloride (00056-23-5)	X	X		<0.0028	<0.26473678	.	.	.	.	1	PPM	LB/DAY
Chlorobenzene (00108-90-7)	X	X		<0.006	<0.5672931	.	.	.	.	1	PPM	LB/DAY
Chlorodibromomethane (00124-48-1)	X	X		<0.0031	<0.293101435	.	.	.	.	1	PPM	LB/DAY
Chloroethane (00075-00-3)	X	X		<0.0011	<0.104003735	.	.	.	.	1	PPM	LB/DAY
2-Chloroethylvinyl Ether (00110-75-8)	X	X		<0.0012	<0.11345862	.	.	.	.	1	PPM	LB/DAY
Chloroform (00067-66-3)	X	X		<0.0016	<0.15127816	.	.	.	.	1	PPM	LB/DAY
Dichlorobromomethane (00075-27-4)	X	X		<0.0022	<0.20800747	.	.	.	.	1	PPM	LB/DAY
Dichlorodifluormethane (75-71-8)				not required		not required		not required				
1,1-Dichloroethane (00075-34-3)	X	X		<0.0047	<0.444379595	.	.	.	.	1	PPM	LB/DAY
1,2-Dichloroethane (00107-06-2)	X	X		<0.0028	<0.26473678	.	.	.	.	1	PPM	LB/DAY
1,1-Dichloroethylene (00075-35-4)	X	X		<0.0028	<0.26473678	.	.	.	.	1	PPM	LB/DAY
1,2-Dichloropropane (00078-87-5)	X	X		<0.006	<0.5672931	.	.	.	.	1	PPM	LB/DAY
1,3-Dichloropropylene (10061-02-6)	X	X		<0.005	<0.47274425	.	.	.	.	1	PPM	LB/DAY
Ethyl Benzene (00100-41-4)	X	X		<0.0072	<0.68075172	.	.	.	.	1	PPM	LB/DAY
Methyl Bromide (00074-83-9)	X	X		<0.0014	<0.13236839	.	.	.	.	1	PPM	LB/DAY
Methyl Chloride (00074-87-3)	X	X		<0.0011	<0.104003735	.	.	.	.	1	PPM	LB/DAY

Continued from Page V4

Outfall 004

1. POLLUTANT	Mark X testing required	believed present	believed absent	2. Effluent A. MAXIMUM DAILY VALUE Concentration	Mass	B. MAXIMUM 30 DAY VALUE Concentration	Mass	C. LONG TERM AVRG. VALUE Concentration	Mass	No. of Analyses	3. Units Concentration	Mass
GCMS FRACTION-VOLATILE COMPOUNDS (CONT.)												
Methylene Chloride (00075-09-2)	X	X		<0.0028	<0.26473678	.	.	.	.	1	PPM	LB/DAY
1,1,2,2-Tetrachloroethane (00079-34-5)	X	X		<0.0069	<0.652387065	.	.	.	.	1	PPM	LB/DAY
Tetrachloroethylene (00127-18-4)	X	X		<0.0041	<0.387650285	.	.	.	.	1	PPM	LB/DAY
Toluene (00108-88-3)	X	X		<0.006	<0.5672931	.	.	.	.	1	PPM	LB/DAY
1,2-Trans-Dichloroethylene (00156-60-5)	X	X		<0.0016	<0.15127816	.	.	.	.	1	PPM	LB/DAY
1,1,1-Trichloroethane (00071-55-6)	X	X		<0.0038	<0.35928563	.	.	.	.	1	PPM	LB/DAY
1,1,2-Trichloroethane (00079-00-5)	X	X		<0.005	<0.47274425	.	.	.	.	1	PPM	LB/DAY
Trichloroethylene (00079-01-6)	X	X		<0.0019	<0.179642815	.	.	.	.	1	PPM	LB/DAY
Trichlorofluoromethane (75-69-4)				not required		not required		not required				
Vinyl Chloride (00075-01-4)	X	X		<0.0018	<0.17018793	.	.	.	.	1	PPM	LB/DAY
GCMS FRACTION - ACID COMPOUNDS												
2-Chlorophenol (00095-57-8)	X	X		<0.0033	<0.312011205	.	.	.	.	1	PPM	LB/DAY
2,4-Dichlorophenol (00120-83-2)	X	X		<0.0056	<0.52947356	.	.	.	.	1	PPM	LB/DAY
2,4-Dimethylphenol (00105-67-9)	X	X		<0.0052	<0.49165402	.	.	.	.	1	PPM	LB/DAY
4,6-Dinotro-O-Cresol (00534-52-1)	X	X		<0.024	<2.2691724	.	.	.	.	1	PPM	LB/DAY
2,4-Dinitrophenol (00051-28-5)	X	X		<0.042	<3.9710517	.	.	.	.	1	PPM	LB/DAY
2-Nitrophenol (00088-75-5)	X	X		<0.0036	<0.34037586	.	.	.	.	1	PPM	LB/DAY
4-Nitrophenol (00100-02-7)	X	X		<0.0024	<0.22691724	.	.	.	.	1	PPM	LB/DAY
P-Chloro-M-Cresol (00059-50-7)	X	X		<0.0075	<0.709116375	.	.	.	.	1	PPM	LB/DAY
Pentachlorophenol (00087-86-5)	X	X		<0.0036	<0.34037586	.	.	.	.	1	PPM	LB/DAY
Phenol (00108-95-2)	X	X		<0.0027	<0.255281895	.	.	.	.	1	PPM	LB/DAY
2,4,6-Trichlorophenol (00088-06-2)	X	X		<0.0027	<0.255281895	.	.	.	.	1	PPM	LB/DAY

Continued from Page V5

Outfall 004

1. POLLUTANT	Mark X testing required	X believed present	X believed absent	2. Effluent A. MAXIMUM DAILY VALUE Concentration	A. Mass	B. MAXIMUM 30 DAY VALUE Concentration	B. Mass	C. LONG TERM AVRG. VALUE Concentration	C. Mass	No. of Analyses	3. Units Concentration	Mass
GCMS FRACTION - BASE/NEUTRAL COMPOUNDS												
Acenaphthene (00083-32-9)	X	X		<0.003	<0.28364655	.	.	.	.	1	PPM	LB/DAY
Acenaphthylene (00208-96-8)	X	X		<0.0035	<0.330920975	.	.	.	.	1	PPM	LB/DAY
Anthracene (00120-12-7)	X	X		<0.0019	<0.179642815	.	.	.	.	1	PPM	LB/DAY
Benzidine (00092-87-5)	X	X		<0.063	<5.95657755	.	.	.	.	1	PPM	LB/DAY
Benzo (A) Anthracene (00056-55-3)	X	X		<0.0078	<0.73748103	.	.	.	.	1	PPM	LB/DAY
Benzo (A) Pyrene (00050-32-8)	X	X		<0.0025	<0.236372125	.	.	.	.	1	PPM	LB/DAY
3,4-Benzofluoranthene (00205-99-2)	X	X		<0.0048	<0.45383448	.	.	.	.	1	PPM	LB/DAY
Benzo (G H I) Perylene (00191-24-2)	X	X		<0.0041	<0.387650285	.	.	.	.	1	PPM	LB/DAY
Benzo (K) Fluoranthene (00207-08-9)	X	X		<0.0025	<0.236372125	.	.	.	.	1	PPM	LB/DAY
Bis(2-Chloroethoxy) Methane (00111-91-1)	X	X		<0.0053	<0.501108905	.	.	.	.	1	PPM	LB/DAY
Bis(-2-Chloroethyl) Ether (00111-44-4)	X	X		<0.0057	<0.538928445	.	.	.	.	1	PPM	LB/DAY
Bis(2-Chloroisopropyl) Ether (00108-60-1)	X	X		<0.0057	<0.538928445	.	.	.	.	1	PPM	LB/DAY
Bis(2-Ethylhexyl) Phthalate (00117-81-7)	X	X		<0.0025	<0.236372125	.	.	.	.	1	PPM	LB/DAY
4-Bromophenyl-Phenylether (00101-55-3)	X	X		<0.003	<0.28364655	.	.	.	.	1	PPM	LB/DAY
Butylbenzyl Phthalate (00085-68-7)	X	X		<0.0025	<0.236372125	.	.	.	.	1	PPM	LB/DAY
2-Chloronaphthalene (00091-58-7)	X	X		<0.0046	<0.43492471	.	.	.	.	1	PPM	LB/DAY
4-Chlorophenyl-Phenyl Ether (07005-72-3)	X	X		<0.0042	<0.39710517	.	.	.	.	1	PPM	LB/DAY
Chrysene (00218-01-9)	X	X		<0.0025	<0.236372125	.	.	.	.	1	PPM	LB/DAY
Dibenzo (A H) Anthracene (00053-70-3)	X	X		<0.0025	<0.236372125	.	.	.	.	1	PPM	LB/DAY
1,2-Dichlorobenzene (00095-50-1)	X	X		<0.004	<0.3781954	.	.	.	.	1	PPM	LB/DAY
1,3-Dichlorobenzene (00541-73-1)	X	X		<0.0031	<0.293101435	.	.	.	.	1	PPM	LB/DAY

Continued from Page V6

Outfall 004

1. POLLUTANT	Mark X testing required	believed present	believed absent	2. Effluent A. MAXIMUM DAILY VALUE Concentration	Mass	B. MAXIMUM 30 DAY VALUE Concentration	Mass	C. LONG TERM AVRG. VALUE Concentration	Mass	No. of Analyses	3. Units Concentration	Mass
GCMS FRACTION - BASE/NEUTRAL COMP.(CONT)												
1,4-Dichlorobenzene (00106-46-7)	X	X		<0.0044	<0.41601494	.	.	.	.	1	PPM	LB/DAY
3,3''-Dichlorobenzidine (00091-94-1)	X	X		<0.0165	<1.560056025	.	.	.	.	1	PPM	LB/DAY
Diethyl Phthalate (00084-66-2)	X	X		<0.0074	<0.69966149	.	.	.	.	1	PPM	LB/DAY
Dimethyl Phthalate (00131-11-3)	X	X		<0.0075	<0.709116375	.	.	.	.	1	PPM	LB/DAY
Di-N-Butyl Phthalate (00084-74-2)	X	X		<0.0064	<0.60511264	.	.	.	.	1	PPM	LB/DAY
2,4-Dinitrotoluene (00121-14-2)	X	X		<0.0057	<0.538928445	.	.	.	.	1	PPM	LB/DAY
2,6-Dinitrotoluene (00606-20-2)	X	X		<0.0034	<0.32146609	.	.	.	.	1	PPM	LB/DAY
Di-N-Octyl Phthalate (00117-84-0)	X	X		<0.0025	<0.236372125	.	.	.	.	1	PPM	LB/DAY
1,2-Diphenylhydrazine (00122-66-7)	X	X		<0.0088	<0.83202988	.	.	.	.	1	PPM	LB/DAY
Fluoranthene (00206-44-0)	X	X		<0.0022	<0.20800747	.	.	.	.	1	PPM	LB/DAY
Fluorene (00086-73-7)	X	X		<0.0022	<0.20800747	.	.	.	.	1	PPM	LB/DAY
Hexachlorobenzene (00118-74-1)	X	X		<0.0031	<0.293101435	.	.	.	.	1	PPM	LB/DAY
Hexachlorobutadiene (00087-68-3)	X	X		<0.0018	<0.17018793	.	.	.	.	1	PPM	LB/DAY
Hexachlorocyclopentadiene (00077-47-4)	X	X		<0.01	<0.9454885	.	.	.	.	1	PPM	LB/DAY
Hexachloroethane (00067-72-1)	X	X		<0.0024	<0.22691724	.	.	.	.	1	PPM	LB/DAY
Indeno (1,2,3-Cd) Pyrene (00193-39-5)	X	X		<0.0037	<0.349830745	.	.	.	.	1	PPM	LB/DAY
Isophorone (00078-59-1)	X	X		<0.0051	<0.482199135	.	.	.	.	1	PPM	LB/DAY
Naphthalene (00091-20-3)	X	X		<0.0038	<0.35928563	.	.	.	.	1	PPM	LB/DAY
Nitrobenzene (00098-95-3)	X	X		<0.0042	<0.39710517	.	.	.	.	1	PPM	LB/DAY
N-Nitrosodimethylamine (00062-75-9)	X	X		<0.0062	<0.58620287	.	.	.	.	1	PPM	LB/DAY
N-Nitroso-Di-N-Propylamine (00621-64-7)	X	X		<0.0036	<0.34037586	.	.	.	.	1	PPM	LB/DAY

Continued from Page V7

Outfall 004

1. POLLUTANT	Mark X testing required	believed present	believed absent	2. Effluent A. MAXIMUM DAILY VALUE Concentration	Mass	B. MAXIMUM 30 DAY VALUE Concentration	Mass	C. LONG TERM AVRG. VALUE Concentration	Mass	No. of Analyses	3. Units Concentration	Mass
GCMS FRACTION - BASE/NEUTRAL COMP (CONT)												
N-Nitrosodiphenylamine (00086-30-6)	X	X		<0.0027	<0.255281895	.	.	.	.	1	PPM	LB/DAY
Phenanthrene (00085-01-8)	X	X		<0.0054	<0.51056379	.	.	.	.	1	PPM	LB/DAY
Pyrene (00129-00-0)	X	X		<0.0038	<0.35928563	.	.	.	.	1	PPM	LB/DAY
1,2,4-Trichlorobenzene (00120-82-1)	X	X		<0.0079	<0.746935915	.	.	.	.	1	PPM	LB/DAY
GCMS FRACTION - PESTICIDES												
Aldrin (00309-00-2)	X	X		<0.00005	<0.0047274425	.	.	.	.	1	PPM	LB/DAY
Alpha BHC (00319-84-6)	X	X		<0.0001	<0.009454885	.	.	.	.	1	PPM	LB/DAY
Beta BHC (00319-85-7)	X	X		<0.0001	<0.009454885	.	.	.	.	1	PPM	LB/DAY
Gamma BHC (00058-89-9)	X	X		<0.0005	<0.047274425	.	.	.	.	1	PPM	LB/DAY
Delta BHC (00319-86-8)	X	X		<0.0001	<0.009454885	.	.	.	.	1	PPM	LB/DAY
Chlordane (00057-74-9)	X	X		<0.0002	<0.01890977	.	.	.	.	1	PPM	LB/DAY
4,4pr DDT (00050-29-3)	X	X		<0.00005	<0.0047274425	.	.	.	.	1	PPM	LB/DAY
4,4pr DDE (00072-55-9)	X	X		<0.0001	<0.009454885	.	.	.	.	1	PPM	LB/DAY
4,4pr DDD (00072-54-8)	X	X		<0.0001	<0.009454885	.	.	.	.	1	PPM	LB/DAY
Dieldrin (00060-57-1)	X	X		<0.0001	<0.009454885	.	.	.	.	1	PPM	LB/DAY
Alpha-Endosulfan (00115-29-7)	X	X		<0.0001	<0.009454885	.	.	.	.	1	PPM	LB/DAY
Beta-Endosulfan (00115-29-7)	X	X		<0.0001	<0.009454885	.	.	.	.	1	PPM	LB/DAY
Endosulfan Sulfate (01031-07-8)	X	X		<0.0001	<0.009454885	.	.	.	.	1	PPM	LB/DAY
Endrin (00072-20-8)	X	X		<0.0001	<0.009454885	.	.	.	.	1	PPM	LB/DAY
Endrin Aldehyde (07421-93-4)	X	X		<0.0001	<0.009454885	.	.	.	.	1	PPM	LB/DAY
Heptachlor (00076-44-8)	X	X		<0.0005	<0.047274425	.	.	.	.	1	PPM	LB/DAY

Continued from Page V8

Outfall 004

1. POLLUTANT	Mark X testing required	X believed present	believed absent	2. Effluent A. MAXIMUM DAILY VALUE Concentration	Mass	B. MAXIMUM 30 DAY VALUE Concentration	Mass	C. LONG TERM AVRG. VALUE Concentration	Mass	No. of Analyses	3. Units Concentration	Mass
GCMS FRACTION - PESTICIDES (CONTINUED)												
Heptachlor-Epoxide (01024-57-3)	__X__	__X__	____	<0.0001	<0.009454885	.	.	.	.	1	PPM	LB/DAY
PCB 1242 (53469-21-9)	__X__	__X__	____	<0.001	<0.09454885	.	.	.	.	1	PPM	LB/DAY
PCB 1254 (11097-69-1)	__X__	__X__	____	<0.001	<0.09454885	.	.	.	.	1	PPM	LB/DAY
PCB 1221 (11104-28-2)	__X__	__X__	____	<0.001	<0.09454885	.	.	.	.	1	PPM	LB/DAY
PCB 1232 (11141-16-5)	__X__	__X__	____	<0.001	<0.09454885	.	.	.	.	1	PPM	LB/DAY
PCB 1248 (12672-29-6)	__X__	__X__	____	<0.001	<0.09454885	.	.	.	.	1	PPM	LB/DAY
PCB 1260 (11096-82-5)	__X__	__X__	____	<0.001	<0.09454885	.	.	.	.	1	PPM	LB/DAY
PCB 1016 (12674-11-2)	__X__	__X__	____	<0.001	<0.09454885	.	.	.	.	1	PPM	LB/DAY
Toxaphene (08001-35-2)	__X__	__X__	____	<0.005	<0.47274425	.	.	.	.	1	PPM	LB/DAY

Outfall 005 Analytical Data for Water Quality Criteria Parameters

CHEMICAL	EPA ANALYSIS NO.	QUANTIFICATION LEVEL[1]	RESULT (ug/L)	SAMPLE TYPE[2]
METALS				
Antimony, dissolved	(3)	130,000	<1.00	G
Arsenic, dissolved	(3)	2,800	5.00	G
Cadmium, dissolved	(3)	17	<0.30	G
Chromium III, dissolved [8]	(3)	1,100	<1.00[A]	G
Chromium VI, dissolved [8]	(3)	200	<10.00	G
Copper, dissolved	(3)	130	<1.00	G
Lead, dissolved	(3)	180	<1.00	G
Mercury, dissolved	(3)	1.6	<0.20	G
Nickel, dissolved	(3)	300	<5.00	G
Selenium, dissolved	(3)	93	4.00	G
Silver, dissolved	(3)	27	<0.10	G
Thallium, dissolved	(4)	200	0.50	G
Zinc, dissolved	(3)	1,200	<10.00	G
PESTICIDES / PCBs				
Aldrin	608	0.05	<0.016	G
Chlordane	608	0.2	<0.014	G
Chlorpyrifos (Dursban)	622	(5)	<0.014	G
DDD	608	0.1	<0.021	G
DDE	608	0.1	<0.017	G
DDT	608	0.1	<0.017	G
Demeton	(4)	(5)	<0.521	G
Dieldrin	608	0.1	<0.010	G
Alpha-Endosulfan	608	0.1	<0.014	G
Beta-Endosulfan	608	0.1	<0.017	G
Endosulfan Sulfate	608	0.1	<0.009	G
Endrin	608	0.1	<0.020	G
Endrin Aldehyde	(4)	(5)	<0.019	G

Outfall 005 Analytical Data for Water Quality Criteria Parameters

CHEMICAL	EPA ANALYSIS NO.	QUANTIFICATION LEVEL[1]	RESULT (ug/L)	SAMPLE TYPE[2]
Guthion	622	(5)	<0.3577	G
Heptachlor	608	0.05	<0.016	G
Heptachlor Epoxide	(4)	(5)	<0.012	G
Hexachlorocyclohexane Alpha-BHC	608	(5)	<0.007	G
Hexachlorocyclohexane Beta-BHC	608	(5)	<0.013	G
HexachlorocyclohexaneGamma-BHC (Lindane)	608	(5)	<0.011	G
Kepone	(9)	(5)	<0.015	G
Malathion	(4)	(5)	<0.123	G
Methoxychlor	(4)	(5)	<0.017	G
Mirex	(4)	(5)	<0.015	G
Parathion	(4)	(5)	<0.121	G
PCB 1260	608	1.0	<1.00	G
PCB 1254	608	1.0	<1.00	G
PCB 1248	608	1.0	<1.00	G
PCB 1242	608	1.0	<1.00	G
PCB 1232	608	1.0	<1.00	G
PCB 1221	608	1.0	<1.00	G
PCB 1016	608	1.0	<1.00	G
PCB Total	608	7.0	<7.00	G
Toxaphene	608	5.0	<0.057	G
BASE NEUTRALS				
Acenaphthene	625	10.0	<3.00	G
Anthracene	625	10.0	<1.90	G
Benzidine	(4)	(5)	<63.00	G
Benzo (a) anthracene	625	10.0	<7.80	G
Benzo (b) fluoranthene	625	10.0	<4.80	G
Benzo (k) fluoranthene	625	10.0	<2.50	G
Benzo (a) pyrene	625	10.0	<2.50	G

Outfall 005 Analytical Data for Water Quality Criteria Parameters

CHEMICAL	EPA ANALYSIS NO.	QUANTIFICATION LEVEL[1]	RESULT (ug/L)	SAMPLE TYPE[2]
Bis 2-Chloroethyl Ether	(4)	(5)	<5.70	G
Bis 2-Chloroisopropyl Ether	(4)	(5)	<5.70	G
Butyl benzyl phthalate	625	10.0	<2.50	G
2-Chloronaphthalene	(4)	(5)	<4.60	G
Chrysene	625	10.0	<2.50	G
Dibenz(a,h)anthracene	625	20.0	<2.50	G
Dibutyl phthalate (Di-n-Butyl Phthalate)	625	10.0	<6.40	G
1,2-Dichlorobenzene	624	10.0	<4.00	G
1,3-Dichlorobenzene	624	10.0	<3.10	G
1,4-Dichlorobenzene	624	10.0	<4.40	G
3,3-Dichlorobenzidine	(4)	(5)	<16.50	G
Diethyl phthalate	625	10.0	<7.40	G
Di-2-Ethylhexyl Phthalate	625	10.0	<2.50	G
Dimethyl phthalate	(4)	(5)	<7.50	G
2,4-Dinitrotoluene	625	10.0	<5.70	G
1,2-Diphenylhydrazine	(4)	(5)	<8.80	G
Fluoranthene	625	10.0	<2.20	G
Fluorene	625	10.0	<3.10	G
Hexachlorobenzene	(4)	(5)	<1.80	G
Hexachlorobutadiene	(4)	(5)	<10.00	G
Hexachlorocyclopentadiene	(4)	(5)	<2.40	G
Hexachloroethane	(4)	(5)	<3.70	G
Indeno(1,2,3-cd)pyrene	625	20.0	<3.70	G
Isophorone	625	10.0	<5.10	G
Nitrobenzene	625	10.0	<4.20	G
N-Nitrosodimethylamine	(4)	(5)	<6.20	G
N-Nitrosodi-n-propylamine	(4)	(5)	<3.60	G
N-Nitrosodiphenylamine	(4)	(5)	<2.70	G

Outfall 005 Analytical Data for Water Quality Criteria Parameters

CHEMICAL	EPA ANALYSIS NO.	QUANTIFICATION LEVEL[1]	RESULT (ug/L)	SAMPLE TYPE[2]
Pyrene	625	10.0	<3.80	G
1,2,4-Trichlorobenzene	625	10.0	<7.90	G
VOLATILES				
Acrolein	(4)	(5)	<10.00	G
Acrylonitrile	(4)	(5)	<1.50	G
Benzene	624	10.0	<4.40	G
Bromoform	624	10.0	<4.70	G
Chlorobenzene (monochlorobenzene)	624	50.0	<6.00	G
Chlorodibromomethane	624	10.0	<3.10	G
Chloroform	624	10.0	<1.60	G
Dichloromethane (methylene chloride)	624	20.0	<2.80	G
Dichlorobromomethane	624	10.0	<2.20	G
1,2-Dichloroethane	624	10.0	<2.80	G
1,1-Dichloroethylene	624	10.0	<2.80	G
1,2-trans-dichloroethylene	(4)	(5)	<1.60	G
1,2-Dichloropropane	(4)	(5)	<6.00	G
1,3-Dichloropropene	(4)	(5)	<5.90	G
Ethylbenzene	624	10.0	<7.20	G
Methyl Bromide	(4)	(5)	<1.40	G
1,1,2,2-Tetrachloroethane	(4)	(5)	<6.90	G
Tetrachloroethylene	624	10.0	<4.10	G
Toluene	624	10.0	<6.00	G
1,1,2-Trichloroethane	(4)	(5)	<5.00	G
Trichloroethylene	624	10.0	<1.90	G
RADIONUCLIDES				
Strontium 90 (pCi/L)	(4)	(5)	<0.771	G
Tritium (pCi/L)	(4)	(5)	977	G
Beta Particle & Photon Activity (pCi/L)	(4)	(5)	2.88	G

Outfall 005 Analytical Data for Water Quality Criteria Parameters				
CHEMICAL	EPA ANALYSIS NO.	QUANTIFICATION LEVEL[1]	RESULT (ug/L)	SAMPLE TYPE[2]
Gross Alpha Particle Activity (pCi/L)	(4)	(5)	<1.92	G
ACIDS				
2-Chlorophenol	625	10.0	<3.30	G
2,4 Dichlorophenol	625	10.0	<5.60	G
2,4 Dimethylphenol	625	10.0	<5.20	G
2,4-Dinitrophenol	(4)	(5)	<42.00	G
2-Methyl-4,6-Dinitrophenol	(4)	(5)	<24.00	G
Pentachlorophenol	625	50.0	<3.60	G
Phenol	625	10.0	<2.70	G
2,4,6-Trichlorophenol	625	10.0	<2.70	G
MISCELLANEOUS				
Ammonia as NH3-N	350.1	200	10.00	G
Chlorides	(4)	(5)	4,840	G
Chlorine, Total Residual	(4)	100	< 100	G
Cyanide, Total	(4)	10.0	<10.00	G
E. coli / Enterococcus (N/CML)	(4)	(5)	<2.00	G
Hydrogen Sulfide	(4)	(5)	<50.00	G
Tributyltin [7]	NBSR 85-3295	(5)	0.030	G

A = Result is for total chromium

(1) Quantification level (QL) is defined as the lowest concentration used for the calibration of a measurement system when the calibration is in accordance with the procedures published for the required method.

The quantification levels indicated for the metals are actually Specific Target Values developed for this permit. The Specific Target Value is the approximate value that may initiate a wasteload allocation analysis. Target values are not wasteload allocations or effluent limitations. The Specific Target Values are subject to change based on additional information such as hardness data, receiving stream flow, and design flows.

Units for the quantification level are micrograms/liter unless otherwise specified.

Quality control and quality assurance information shall be submitted to document that the required quantification level has been attained.

(2) Sample Type

G = Grab = An individual sample collected in less than 15 minutes. Substances specified with "grab" sample type shall only be collected as grabs. The permittee may analyze multiple grabs and report the average results provided that the individual grab results are also reported. For grab metals samples, the individual samples shall be filtered and preserved immediately upon collection.

C = Composite = A 24-hour **(PW - Revise as required to require same composite duration as BOD_5)** composite unless otherwise specified. The composite shall be a combination of individual samples, taken proportional to flow, obtained at hourly or smaller time intervals. The individual samples may be of equal volume for flows that do not vary by +/- 10 percent over a 24-hour period.

SC = Special Composite = samples for base/neutral/acid compounds, PCBs, and pesticides must be collected as 4 individual grab samples taken proportional to flow at 6-hour intervals over the course of one day. The individual samples may be of equal volume for flows that do not vary by +/- 10 percent over a 24-hour period. Grab samples must be analyzed separately and the concentrations averaged. Alternately, grab samples may be collected in the field and composited in the laboratory if the compositing procedure produces results equivalent to results produced by arithmetic averaging of the results of analysis of individual grab samples.

(3) A specific analytical method is not specified; however a target value for each metal has been established. An appropriate method to meet the target value shall be selected from the following list of EPA methods (or any approved method presented in 40 CFR Part 136). If the test result is less than the method QL, a "<[QL]" shall be reported where the actual analytical test QL is substituted for [QL].

Metal	Analytical Method
Antimony	1638; 1639
Arsenic	206.5; 1632
Chromium[9]	1639
Cadmium	1637; 1638; 1639; 1640
Chromium VI	218.6; 1639
Copper	1638; 1640
Lead	1637; 1638; 1640
Mercury	245.7; 1631
Nickel	1638; 1639; 1640
Selenium	1638; 1639
Silver	1638
Zinc	1638; 1639

(4) Any approved method presented in 40 CFR Part 136.

(5) The QL is at the discretion of the permittee. For any substances addressed in 40 CFR Part 136, the permittee shall use one of the approved methods in 40 CFR Part 136.

(6) Testing for phenol requires continuous extraction.

(7) Analytical Methods: NBSR 85-3295 or DEQ's approved analysis for Tributyltin may also be used [See A Manual for the Analysis of Butyltins in Environmental Systems by the Virginia Institute of Marine Science, dated November 1996].

(8) Both Chromium III and Chromium VI may be measured by the total chromium analysis. If the result of the total chromium analysis is less than or equal to the lesser of the Chromium III or Chromium VI method QL, the results for both Chromium III and Chromium VI can be reported as "<[QL]", where the actual analytical test QL is substituted for [QL].

(9) The lab may use SW846 Method 8270D provided the lab has an Initial Demonstration of Capability, has passed a PT for Kepone, and meets the acceptance criteria for Kepone as given in Method 8270D .

EPA I.D. NUMBER= VA0004146

V. Intake and effluent characteristics (continued from page 3 of Form 2c) Outfall 005

Part A- You must provide the results of at least one analysis for every pollutant in this table. Complete one table for each outfall. See instructions for additional details.

	2. Effluent							3. Units	
	A. MAXIMUM DAILY VALUE		B. MAXIMUM 30 DAY VALUE		C. LONG TERM AVRG. VALUE				
	Concentration	Mass	Concentration	Mass	Concentration	Mass	No. of Analyses	Concentration	Mass
Biochemical Oxygen Demand	<3	<101.39175	.	.	.	.	1	PPM	LB/DAY
Chemical Oxygen Demand	41.93	1417.1186925	.	.	.	.	1	PPM	LB/DAY
Total Organic Carbon	7	236.58075	.	.	.	.	1	PPM	LB/DAY
Total Suspended Solids	15.9	790.80558	12.8	340.209	9.8714	259.3173	7	PPM	LB/DAY
Ammonia,total	0.07	2.48681	0.07	1.7191	<0.0536	<1.4909	11	PPM	LB/DAY
Flow	5.96	.	3.2	.	3.21	.	9	MGD	.
Temperature (Winter)	5.7	.	.	.	.	.	1	DEGREES C	.
Temperature (Summer)	31.5	.	.	.	.	.	1	DEGREES C	.
pH	7.5 (min)	9.6 (max)	N/A	N/A	N/A	N/A	7	STD. UNITS	.

PART B.

	Mark X		2. Effluent						3. Units	
			A. MAXIMUM DAILY VALUE		B. MAXIMUM 30 DAY VALUE		C. LONG TERM AVRG. VALUE			
	believed present	believed absent	Concentration	Mass	Concentration	Mass	Concentration	Mass	No. of Analyses	Concentration	Mass
Bromide,total (24959-67-6)	X		0.2	6.75945	.	.	.	.	1	PPM	LB/DAY
Chlorine, Total Residual	X		<0.1	<3.379725	.	.	.	.	1	PPM	LB/DAY
Color	X		25	.	.	.	.	.	1	NTU	.
Fecal Coliform		X	No Sample	.	.	.	.	.	0	COL/100ML	.
Fluoride (16984-48-8)	X		0.184	6.218694	.	.	.	.	1	PPM	LB/DAY
Nitrate + Nitrite	X		0.03	1.492086	0.03	0.8595	0.0283	0.777	12	PPM	LB/DAY

Item V-B Continued
Part C.

Outfall 005

1. POLLUTANT	Mark X believed present	Mark X believed absent	2. Effluent A. MAXIMUM DAILY VALUE Concentration	A. Mass	B. MAXIMUM 30 DAY VALUE Concentration	B. Mass	C. LONG TERM AVRG. VALUE Concentration	C. Mass	No. of Analyses	3. Units Concentration	Mass
Nitrogen, Total Org. As N	X		0.33	11.1530925	.	.	.	.	1	PPM	LB/DAY
Oil & Grease	X		<5	<248.681	<5	<171.907	<5	<136.6494	7	PPM	LB/DAY
Phosphorus (As P), Total (07723-14-0)	X		0.12	2.934102	0.12	2.9341	0.0692	1.6667	13	PPM	LB/DAY
j. Radioactivity **********											
Alpha, Total	X		<1.92	.	.	.	.	.	1	PCI/LITER	.
Beta, Total	X		2.88	.	.	.	.	.	1	PCI/LITER	.
Radium,total		X	No Sample	.	.	.	.	.	0	PCI/LITER	.
Radium 226 , Total		X	No Sample	.	.	.	.	.	0	PCI/LITER	.
Sulfate (As So4) (14808-79-8)	X		76.58	2588.193405	.	.	.	.	1	PPM	LB/DAY
Sulfide (As S)	X		<0.01	<0.3379725	.	.	.	.	1	PPM	LB/DAY
Sulfite (As So3) (14265-45-3)		X	No Sample	.	.	.	.	.	0	PPM	LB/DAY
Surfactants	X		<0.025	<0.84493125	.	.	.	.	1	PPM	LB/DAY
Aluminum,total (07429-90-5)	X		0.26	8.787285	.	.	.	.	1	PPM	LB/DAY
Barium,total (07440-39-3)	X		0.177	5.98211325	.	.	.	.	1	PPM	LB/DAY
Boron,total (07440-42-8)	X		0.22	7.435395	.	.	.	.	1	PPM	LB/DAY
Cobalt,total (07440-48-4)	X		<0.003	<0.10139175	.	.	.	.	1	PPM	LB/DAY
Iron,total (07439-89-6)	X		0.39	13.1809275	.	.	.	.	1	PPM	LB/DAY
Magnesium,total (07439-95-4)	X		6.94	234.552915	.	.	.	.	1	PPM	LB/DAY
Molybdenum,total (07439-98-7)	X		0.01	0.3379725	.	.	.	.	1	PPM	LB/DAY
Manganese,total (07439-96-5)	X		0.08	2.70378	.	.	.	.	1	PPM	LB/DAY
Tin,total (07440-31-5)	X		0.005	0.16898625	.	.	.	.	1	PPM	LB/DAY
Titanium,total (07440-32-6)	X		0.004	0.135189	.	.	.	.	1	PPM	LB/DAY

Continued from Page V2

Outfall 005

1. POLLUTANT	Mark X testing required	believed present	believed absent	2. Effluent A. MAXIMUM DAILY VALUE Concentration	Mass	B. MAXIMUM 30 DAY VALUE Concentration	Mass	C. LONG TERM AVRG. VALUE Concentration	Mass	No. of Analyses	3. Units Concentration	Mass
METALS, CYANIDE, AND TOTAL PHENOLS												
Antimony,total (07440-36-0)	X	X		<0.001	<0.03379725	.	.	.	.	1	PPM	LB/DAY
Arsenic,total (07440-38-2)	X	X		0.006	0.2027835	.	.	.	.	1	PPM	LB/DAY
Beryllium,total (07440-41-7)	X	X		<0.0002	<0.00675945	.	.	.	.	1	PPM	LB/DAY
Cadmium,total (07440-43-9)	X	X		<0.0003	<0.010139175	.	.	.	.	1	PPM	LB/DAY
Chromium,total (07440-47-3)	X	X		<0.001	<0.03379725	.	.	.	.	1	PPM	LB/DAY
Copper,total (07440-50-8)	X	X		<0.001	<0.03379725	.	.	.	.	1	PPM	LB/DAY
Lead,total (07439-92-1)	X	X		<0.001	<0.03379725	.	.	.	.	1	PPM	LB/DAY
Mercury,total (07439-97-6)	X	X		<0.0002	<0.00675945	.	.	.	.	1	PPM	LB/DAY
Nickel,total (07440-02-0)	X	X		<0.005	<0.16898625	.	.	.	.	1	PPM	LB/DAY
Selenium,total (07782-49-2)	X	X		0.006	0.2027835	.	.	.	.	1	PPM	LB/DAY
Silver,total (07440-22-4)	X	X		<0.0001	<0.003379725	.	.	.	.	1	PPM	LB/DAY
Thallium,total (07440-28-0)	X	X		0.0006	0.02027835	.	.	.	.	1	PPM	LB/DAY
Zinc,total (07440-66-6)	X	X		<0.01	<0.3379725	.	.	.	.	1	PPM	LB/DAY
Cyanide , Total (00057-12-5)	X	X		<0.01	<0.3379725	.	.	.	.	1	PPM	LB/DAY
Total Phenols	X	X		0.01	0.3379725	.	.	.	.	1	PPM	LB/DAY
DIOXIN												
Dioxin Screen			X	No Sample	.	.	.	.	.	.	PPM	LB/DAY

Continued from Page V3 Outfall 005

1. POLLUTANT	Mark X testing required	Mark X believed present	Mark X believed absent	2. Effluent A. MAXIMUM DAILY VALUE Concentration	A. Mass	B. MAXIMUM 30 DAY VALUE Concentration	B. Mass	C. LONG TERM AVRG. VALUE Concentration	C. Mass	No. of Analyses	3. Units Concentration	Mass
GCMS FRACTION - VOLATILE COMPOUNDS												
Acrolein (00107-02-8)	__X__	__X__	____	<0.01	<0.3379725	.	.	.	.	1	PPM	LB/DAY
Acrylonitrile (00107-13-1)	__X__	__X__	____	<0.0015	<0.050695875	.	.	.	.	1	PPM	LB/DAY
Benzene (00071-43-2)	__X__	__X__	____	<0.0044	<0.1487079	.	.	.	.	1	PPM	LB/DAY
BIS (Chloromethyl) Ether (542-88-1)				not required		not required		not required				
Bromoform (00075-25-2)	__X__	__X__	____	<0.0047	<0.158847075	.	.	.	.	1	PPM	LB/DAY
Carbon Tetrachloride (00056-23-5)	__X__	__X__	____	<0.0028	<0.0946323	.	.	.	.	1	PPM	LB/DAY
Chlorobenzene (00108-90-7)	__X__	__X__	____	<0.006	<0.2027835	.	.	.	.	1	PPM	LB/DAY
Chlorodibromomethane (00124-48-1)	__X__	__X__	____	<0.0031	<0.104771475	.	.	.	.	1	PPM	LB/DAY
Chloroethane (00075-00-3)	__X__	__X__	____	<0.0011	<0.037176975	.	.	.	.	1	PPM	LB/DAY
2-Chloroethylvinyl Ether (00110-75-8)	__X__	__X__	____	<0.0012	<0.0405567	.	.	.	.	1	PPM	LB/DAY
Chloroform (00067-66-3)	__X__	__X__	____	<0.0016	<0.0540756	.	.	.	.	1	PPM	LB/DAY
Dichlorobromomethane (00075-27-4)	__X__	__X__	____	<0.0022	<0.07435395	.	.	.	.	1	PPM	LB/DAY
Dichlorodifluormethane (75-71-8)				not required		not required		not required				
1,1-Dichloroethane (00075-34-3)	__X__	__X__	____	<0.0047	<0.158847075	.	.	.	.	1	PPM	LB/DAY
1,2-Dichloroethane (00107-06-2)	__X__	__X__	____	<0.0028	<0.0946323	.	.	.	.	1	PPM	LB/DAY
1,1-Dichloroethylene (00075-35-4)	__X__	__X__	____	<0.0028	<0.0946323	.	.	.	.	1	PPM	LB/DAY
1,2-Dichloropropane (00078-87-5)	__X__	__X__	____	<0.006	<0.2027835	.	.	.	.	1	PPM	LB/DAY
1,3-Dichloropropylene (10061-02-6)	__X__	__X__	____	<0.005	<0.16898625	.	.	.	.	1	PPM	LB/DAY
Ethyl Benzene (00100-41-4)	__X__	__X__	____	<0.0072	<0.2433402	.	.	.	.	1	PPM	LB/DAY
Methyl Bromide (00074-83-9)	__X__	__X__	____	<0.0014	<0.04731615	.	.	.	.	1	PPM	LB/DAY
Methyl Chloride (00074-87-3)	__X__	__X__	____	<0.0011	<0.037176975	.	.	.	.	1	PPM	LB/DAY

Continued from Page V4

Outfall 005

1. POLLUTANT	Mark X testing required	believed present	believed absent	2. Effluent A. MAXIMUM DAILY VALUE Concentration	Mass	B. MAXIMUM 30 DAY VALUE Concentration	Mass	C. LONG TERM AVRG. VALUE Concentration	Mass	No. of Analyses	3. Units Concentration	Mass
GCMS FRACTION-VOLATILE COMPOUNDS (CONT.)												
Methylene Chloride (00075-09-2)	X	X		<0.0028	<0.0946323	.	.	.	.	1	PPM	LB/DAY
1,1,2,2-Tetrachloroethane (00079-34-5)	X	X		<0.0069	<0.233201025	.	.	.	.	1	PPM	LB/DAY
Tetrachloroethylene (00127-18-4)	X	X		<0.0041	<0.138568725	.	.	.	.	1	PPM	LB/DAY
Toluene (00108-88-3)	X	X		<0.006	<0.2027835	.	.	.	.	1	PPM	LB/DAY
1,2-Trans-Dichloroethylene (00156-60-5)	X	X		<0.0016	<0.0540756	.	.	.	.	1	PPM	LB/DAY
1,1,1-Trichloroethane (00071-55-6)	X	X		<0.0038	<0.12842955	.	.	.	.	1	PPM	LB/DAY
1,1,2-Trichloroethane (00079-00-5)	X	X		<0.005	<0.16898625	.	.	.	.	1	PPM	LB/DAY
Trichloroethylene (00079-01-6)	X	X		<0.0019	<0.064214775	.	.	.	.	1	PPM	LB/DAY
Trichlorofluoromethane (75-69-4)				not required		not required		not required				
Vinyl Chloride (00075-01-4)	X	X		<0.0018	<0.06083505	.	.	.	.	1	PPM	LB/DAY
GCMS FRACTION - ACID COMPOUNDS												
2-Chlorophenol (00095-57-8)	X	X		<0.0033	<0.111530925	.	.	.	.	1	PPM	LB/DAY
2,4-Dichlorophenol (00120-83-2)	X	X		<0.0056	<0.1892646	.	.	.	.	1	PPM	LB/DAY
2,4-Dimethylphenol (00105-67-9)	X	X		<0.0052	<0.1757457	.	.	.	.	1	PPM	LB/DAY
4,6-Dinotro-O-Cresol (00534-52-1)	X	X		<0.024	<0.811134	.	.	.	.	1	PPM	LB/DAY
2,4-Dinitrophenol (00051-28-5)	X	X		<0.042	<1.4194845	.	.	.	.	1	PPM	LB/DAY
2-Nitrophenol (00088-75-5)	X	X		<0.0036	<0.1216701	.	.	.	.	1	PPM	LB/DAY
4-Nitrophenol (00100-02-7)	X	X		<0.0024	<0.0811134	.	.	.	.	1	PPM	LB/DAY
P-Chloro-M-Cresol (00059-50-7)	X	X		<0.0075	<0.253479375	.	.	.	.	1	PPM	LB/DAY
Pentachlorophenol (00087-86-5)	X	X		<0.0036	<0.1216701	.	.	.	.	1	PPM	LB/DAY
Phenol (00108-95-2)	X	X		<0.0027	<0.091252575	.	.	.	.	1	PPM	LB/DAY
2,4,6-Trichlorophenol (00088-06-2)	X	X		<0.0027	<0.091252575	.	.	.	.	1	PPM	LB/DAY

Continued from Page V5

Outfall 005

1. POLLUTANT	Mark X testing required	believed present	believed absent	2. Effluent A. MAXIMUM DAILY VALUE Concentration	Mass	B. MAXIMUM 30 DAY VALUE Concentration	Mass	C. LONG TERM AVRG. VALUE Concentration	Mass	No. of Analyses	3. Units Concentration	Mass
GCMS FRACTION - BASE/NEUTRAL COMPOUNDS												
Acenaphthene (00083-32-9)	X	X		<0.003	<0.10139175	.	.	.	.	1	PPM	LB/DAY
Acenaphthylene (00208-96-8)	X	X		<0.0035	<0.118290375	.	.	.	.	1	PPM	LB/DAY
Anthracene (00120-12-7)	X	X		<0.0019	<0.064214775	.	.	.	.	1	PPM	LB/DAY
Benzidine (00092-87-5)	X	X		<0.063	<2.12922675	.	.	.	.	1	PPM	LB/DAY
Benzo (A) Anthracene (00056-55-3)	X	X		<0.0078	<0.26361855	.	.	.	.	1	PPM	LB/DAY
Benzo (A) Pyrene (00050-32-8)	X	X		<0.0025	<0.084493125	.	.	.	.	1	PPM	LB/DAY
3,4-Benzofluoranthene (00205-99-2)	X	X		<0.0048	<0.1622268	.	.	.	.	1	PPM	LB/DAY
Benzo (G H I) Perylene (00191-24-2)	X	X		<0.0041	<0.138568725	.	.	.	.	1	PPM	LB/DAY
Benzo (K) Fluoranthene (00207-08-9)	X	X		<0.0025	<0.084493125	.	.	.	.	1	PPM	LB/DAY
Bis(2-Chloroethoxy) Methane (00111-91-1)	X	X		<0.0053	<0.179125425	.	.	.	.	1	PPM	LB/DAY
Bis(-2-Chloroethyl) Ether (00111-44-4)	X	X		<0.0057	<0.192644325	.	.	.	.	1	PPM	LB/DAY
Bis(2-Chloroisopropyl) Ether (00108-60-1)	X	X		<0.0057	<0.192644325	.	.	.	.	1	PPM	LB/DAY
Bis(2-Ethylhexyl) Phthalate (00117-81-7)	X	X		<0.0025	<0.084493125	.	.	.	.	1	PPM	LB/DAY
4-Bromophenyl-Phenylether (00101-55-3)	X	X		<0.003	<0.10139175	.	.	.	.	1	PPM	LB/DAY
Butylbenzyl Phthalate (00085-68-7)	X	X		<0.0025	<0.084493125	.	.	.	.	1	PPM	LB/DAY
2-Chloronaphthalene (00091-58-7)	X	X		<0.0046	<0.15546735	.	.	.	.	1	PPM	LB/DAY
4-Chlorophenyl-Phenyl Ether (07005-72-3)	X	X		<0.0042	<0.14194845	.	.	.	.	1	PPM	LB/DAY
Chrysene (00218-01-9)	X	X		<0.0025	<0.084493125	.	.	.	.	1	PPM	LB/DAY
Dibenzo (A H) Anthracene (00053-70-3)	X	X		<0.0025	<0.084493125	.	.	.	.	1	PPM	LB/DAY
1,2-Dichlorobenzene (00095-50-1)	X	X		<0.004	<0.135189	.	.	.	.	1	PPM	LB/DAY
1,3-Dichlorobenzene (00541-73-1)	X	X		<0.0031	<0.104771475	.	.	.	.	1	PPM	LB/DAY

Continued from Page V6

Outfall 005

1. POLLUTANT	Mark X testing required	believed present	believed absent	2. Effluent A. MAXIMUM DAILY VALUE Concentration	Mass	B. MAXIMUM 30 DAY VALUE Concentration	Mass	C. LONG TERM AVRG. VALUE Concentration	Mass	No. of Analyses	3. Units Concentration	Mass
GCMS FRACTION - BASE/NEUTRAL COMP.(CONT)												
1,4-Dichlorobenzene (00106-46-7)	X	X		<0.0044	<0.1487079	.	.	.	.	1	PPM	LB/DAY
3,3''-Dichlorobenzidine (00091-94-1)	X	X		<0.0165	<0.557654625	.	.	.	.	1	PPM	LB/DAY
Diethyl Phthalate (00084-66-2)	X	X		<0.0074	<0.25009965	.	.	.	.	1	PPM	LB/DAY
Dimethyl Phthalate (00131-11-3)	X	X		<0.0075	<0.253479375	.	.	.	.	1	PPM	LB/DAY
Di-N-Butyl Phthalate (00084-74-2)	X	X		<0.0064	<0.2163024	.	.	.	.	1	PPM	LB/DAY
2,4-Dinitrotoluene (00121-14-2)	X	X		<0.0057	<0.192644325	.	.	.	.	1	PPM	LB/DAY
2,6-Dinitrotoluene (00606-20-2)	X	X		<0.0034	<0.11491065	.	.	.	.	1	PPM	LB/DAY
Di-N-Octyl Phthalate (00117-84-0)	X	X		<0.0025	<0.084493125	.	.	.	.	1	PPM	LB/DAY
1,2-Diphenylhydrazine (00122-66-7)	X	X		<0.0088	<0.2974158	.	.	.	.	1	PPM	LB/DAY
Fluoranthene (00206-44-0)	X	X		<0.0022	<0.07435395	.	.	.	.	1	PPM	LB/DAY
Fluorene (00086-73-7)	X	X		<0.0022	<0.07435395	.	.	.	.	1	PPM	LB/DAY
Hexachlorobenzene (00118-74-1)	X	X		<0.0031	<0.104771475	.	.	.	.	1	PPM	LB/DAY
Hexachlorobutadiene (00087-68-3)	X	X		<0.0018	<0.06083505	.	.	.	.	1	PPM	LB/DAY
Hexachlorocyclopentadiene (00077-47-4)	X	X		<0.01	<0.3379725	.	.	.	.	1	PPM	LB/DAY
Hexachloroethane (00067-72-1)	X	X		<0.0024	<0.0811134	.	.	.	.	1	PPM	LB/DAY
Indeno (1,2,3-Cd) Pyrene (00193-39-5)	X	X		<0.0037	<0.125049825	.	.	.	.	1	PPM	LB/DAY
Isophorone (00078-59-1)	X	X		<0.0051	<0.172365975	.	.	.	.	1	PPM	LB/DAY
Naphthalene (00091-20-3)	X	X		<0.0038	<0.12842955	.	.	.	.	1	PPM	LB/DAY
Nitrobenzene (00098-95-3)	X	X		<0.0042	<0.14194845	.	.	.	.	1	PPM	LB/DAY
N-Nitrosodimethylamine (00062-75-9)	X	X		<0.0062	<0.20954295	.	.	.	.	1	PPM	LB/DAY
N-Nitroso-Di-N-Propylamine (00621-64-7)	X	X		<0.0036	<0.1216701	.	.	.	.	1	PPM	LB/DAY

Continued from Page V7

Outfall 005

1. POLLUTANT	Mark X testing required	believed present	believed absent	2. Effluent A. MAXIMUM DAILY VALUE Concentration	Mass	B. MAXIMUM 30 DAY VALUE Concentration	Mass	C. LONG TERM AVRG. VALUE Concentration	Mass	No. of Analyses	3. Units Concentration	Mass
GCMS FRACTION - BASE/NEUTRAL COMP (CONT)												
N-Nitrosodiphenylamine (00086-30-6)	X	X		<0.0027	<0.091252575	.	.	.	.	1	PPM	LB/DAY
Phenanthrene (00085-01-8)	X	X		<0.0054	<0.18250515	.	.	.	.	1	PPM	LB/DAY
Pyrene (00129-00-0)	X	X		<0.0038	<0.12842955	.	.	.	.	1	PPM	LB/DAY
1,2,4-Trichlorobenzene (00120-82-1)	X	X		<0.0079	<0.266998275	.	.	.	.	1	PPM	LB/DAY
GCMS FRACTION - PESTICIDES												
Aldrin (00309-00-2)	X	X		<0.00005	<0.0016898625	.	.	.	.	1	PPM	LB/DAY
Alpha BHC (00319-84-6)	X	X		<0.0001	<0.003379725	.	.	.	.	1	PPM	LB/DAY
Beta BHC (00319-85-7)	X	X		<0.0001	<0.003379725	.	.	.	.	1	PPM	LB/DAY
Gamma BHC (00058-89-9)	X	X		<0.0005	<0.016898625	.	.	.	.	1	PPM	LB/DAY
Delta BHC (00319-86-8)	X	X		<0.0001	<0.003379725	.	.	.	.	1	PPM	LB/DAY
Chlordane (00057-74-9)	X	X		<0.0002	<0.00675945	.	.	.	.	1	PPM	LB/DAY
4,4pr DDT (00050-29-3)	X	X		<0.00005	<0.0016898625	.	.	.	.	1	PPM	LB/DAY
4,4pr DDE (00072-55-9)	X	X		<0.0001	<0.003379725	.	.	.	.	1	PPM	LB/DAY
4,4pr DDD (00072-54-8)	X	X		<0.0001	<0.003379725	.	.	.	.	1	PPM	LB/DAY
Dieldrin (00060-57-1)	X	X		<0.0001	<0.003379725	.	.	.	.	1	PPM	LB/DAY
Alpha-Endosulfan (00115-29-7)	X	X		<0.0001	<0.003379725	.	.	.	.	1	PPM	LB/DAY
Beta-Endosulfan (00115-29-7)	X	X		<0.0001	<0.003379725	.	.	.	.	1	PPM	LB/DAY
Endosulfan Sulfate (01031-07-8)	X	X		<0.0001	<0.003379725	.	.	.	.	1	PPM	LB/DAY
Endrin (00072-20-8)	X	X		<0.0001	<0.003379725	.	.	.	.	1	PPM	LB/DAY
Endrin Aldehyde (07421-93-4)	X	X		<0.0001	<0.003379725	.	.	.	.	1	PPM	LB/DAY
Heptachlor (00076-44-8)	X	X		<0.0005	<0.016898625	.	.	.	.	1	PPM	LB/DAY

Continued from Page V8

Outfall 005

1. POLLUTANT	Mark X testing required	believed present	believed absent	2. Effluent A. MAXIMUM DAILY VALUE Concentration	Mass	B. MAXIMUM 30 DAY VALUE Concentration	Mass	C. LONG TERM AVRG. VALUE Concentration	Mass	No. of Analyses	3. Units Concentration	Mass
GCMS FRACTION - PESTICIDES (CONTINUED)												
Heptachlor-Epoxide (01024-57-3)	__X__	__X__	____	<0.0001	<0.003379725	.	.	.	.	1	PPM	LB/DAY
PCB 1242 (53469-21-9)	__X__	__X__	____	<0.001	<0.03379725	.	.	.	.	1	PPM	LB/DAY
PCB 1254 (11097-69-1)	__X__	__X__	____	<0.001	<0.03379725	.	.	.	.	1	PPM	LB/DAY
PCB 1221 (11104-28-2)	__X__	__X__	____	<0.001	<0.03379725	.	.	.	.	1	PPM	LB/DAY
PCB 1232 (11141-16-5)	__X__	__X__	____	<0.001	<0.03379725	.	.	.	.	1	PPM	LB/DAY
PCB 1248 (12672-29-6)	__X__	__X__	____	<0.001	<0.03379725	.	.	.	.	1	PPM	LB/DAY
PCB 1260 (11096-82-5)	__X__	__X__	____	<0.001	<0.03379725	.	.	.	.	1	PPM	LB/DAY
PCB 1016 (12674-11-2)	__X__	__X__	____	<0.001	<0.03379725	.	.	.	.	1	PPM	LB/DAY
Toxaphene (08001-35-2)	__X__	__X__	____	<0.005	<0.16898625	.	.	.	.	1	PPM	LB/DAY

Attachment 4.e

Dewatering Data for Outfalls 004 and 005

Table 1 Dewatering Results Dominion Power Chesterfield Power Station		Units	RL	Location	DW P-TEST			
				Field ID	DW_P_TEST_12_05_15_S1	DW_P-TEST_06_05_15	DW_P-TEST_13_05_15_S1	DW-P-TEST-05-05-15
				Date	5/12/2015	5/6/2015	5/13/2015	5/5/2015
Inorganics	Total Organic Carbon	mg/L	1		3.1	3	-	3.3
	Nitrate (as N)	mg/L	0.1		0.018J	0.017J	-	0.02J,B
	Nitrite (as N)	mg/L	0.024		<0.024U	<0.024U	-	<0.024U
General Che	Biochemical Oxygen Demand	mg/L	2		<2U	<2U,H	<2U	<2U,cn
	Chemical Oxygen Demand	mg/L	2		4.1J	11	<2U	13
	Total Suspended Solids	mg/L	1		12	12	4.6	16
	Ammonia as N	mg/L	0.1		0.56	0.56	-	0.65
	pH (Lab)	SU	0.1		7.95HF	8.05HF	7.99HF	7.82HF
	Bromide	mg/L	0.5		2.2	2.4	2.3	2.5
	Chlorine, Total Residual	mg/L			0.01	-	0.02	0.01
	Fluoride	mg/L	0.1		2.5	2.8	2.5F1	2.9
	Total Kjeldahl Nitrogen	mg/L	1.7		<1.7U	<1.7U	<1.7U	<1.7U
	Phosphorus	mg/L	0.1		0.8	0.7	0.86	0.73
	Sulfate	mg/L	1		140	120	130	120
	Sulfide	mg/L	3		1.1J	1.3J	1.2J	1.4J
	Cyanide (Total)	mg/L	0.0025		<0.0025U	<0.0025U	<0.0025U	<0.0025U
	Specific Conductivity (lab)	µS/cm	1		1,100	970	1,100	1,000
	Alkalinity (Bicarbonate as CaCO3)	mg/L	5		450B	-	480B	390B
	Alkalinity (Carbonate as CaCO3)	mg/L	0.41		<0.41U	-	<0.41U	<0.41U
	Alkalinity (total) as CaCO3	mg/L	5		450B	450B	480B	390B
	Ammonia	mg/L	0.1		-	-	0.41	-
	Carbon	mg/L	1		-	-	3.1	-
	Chloride	mg/L	1		48	42	46	40
	Hardness as CaCO3	mg/L	25		-	-	580	560
	Hardness as CaCO3 (Filtered)	mg/L	33		-	-	580	-
	Nitrate	mg/L	0.1		-	-	0.013J,H,B	-
	Nitrite	mg/L	0.024		-	-	<0.024U,H	-
	Total Dissolved Solids	mg/L	10		760	690	750	680
	Turbidity	NTU	0.85		23	22H	23	51
Metals	Aluminium	mg/L	0.2		0.12J	0.17J	0.13J,B	0.83
	Aluminium (Filtered)	mg/L	0.03		0.02J	-	0.18J,B	2.2
	Barium	mg/L	0.2		0.58	0.55	0.59	0.58
	Barium (Filtered)	mg/L	0.01		0.47	-	0.59	0.6
	Boron	mg/L	0.2		4.6B	4.8	4.7	5.1
	Boron (Filtered)	mg/L	0.005		3.9B	4.9	4.7	5
	Cobalt	mg/L	0.05		0.0013J	0.0015J,B	0.0014J,B	0.0019J,B
	Cobalt (Filtered)	mg/L	0.0005		0.0012B	-	0.0013J,B	0.003J,B
	Iron	mg/L	0.1		4.2	3.9	3.8B	4.1
	Iron (Filtered)	mg/L	0.0057		<0.0057U	<0.0095U	4B	<0.0095U
	Magnesium	mg/L	5		38	35	38	37
	Magnesium (Filtered)	mg/L	0.5		35	35	38	35
	Molybdenum	mg/L	0.04		0.8B	0.79B	0.81	0.82B
	Molybdenum (Filtered)	mg/L	0.005		0.74	-	0.81	0.79B
	Manganese	mg/L	0.015		0.32	0.28	0.31B	0.28
	Manganese (Filtered)	mg/L	0.005		0.31B	0.14B	0.31B	0.23B
	Antimony	mg/L	0.0016		<0.0016U	<0.0016U	<0.0016U	<0.0016U
	Antimony (Filtered)	mg/L	0.0016		0.00026J	-	<0.0016U	<0.0016U
	Arsenic	mg/L	0.01		1.5	1.5	1.5	1.5
	Arsenic (Filtered)	mg/L	0.001		0.71	0.66	1.6	0.7
	Beryllium	mg/L	0.00012		<0.00012U	<0.00012U	<0.00012U	0.00021J

	Beryllium (Filtered)	mg/L	0.000036	<0.000036U	-	<0.00012U	0.00058J
	Cadmium	mg/L	0.00013	<0.00013U	<0.00027U	<0.00027U	<0.00027U
	Cadmium (Filtered)	mg/L	0.00013	0.00034J	<0.00013U	<0.00027U	<0.00013U
	Chromium (Total)	mg/L	0.00077	<0.00077U	0.0008J	<0.00077U	0.0014J
	Chromium (Total) (Filtered)	mg/L	0.00077	0.00055J	<0.00077U	<0.00077U	<0.00077U
	Chromium (Hexavalent)	mg/L	0.0019	0.0026J	<0.0019U	<0.0019U,H	<0.0019U
	Copper	mg/L	0.0015	<0.0015U	<0.0015U	0.0024J	0.0037J
	Copper (Filtered)	mg/L	0.0015	0.00051J	<0.0015U	<0.0015U	<0.0015U
	Lead	mg/L	0.0012	<0.0012U	<0.0012U	<0.0012U	<0.0012U
	Lead (Filtered)	mg/L	0.001	0.000071J,B	<0.0012U	<0.0012U	<0.0012U
	Mercury	mg/L	0.000031	<0.000031U	<0.000031U	<0.000031U	<0.000031U
	Mercury (Filtered)	mg/L	0.000031	-	<0.000031U,H	<0.000031U	-
	Nickel	mg/L	0.04	0.0037J,B	0.0032J	0.0032J	0.0046J
	Nickel (Filtered)	mg/L	0.001	0.0033	0.0026J	0.0041J	0.0023J
	Selenium	mg/L	0.0039	0.0062J	0.0063J	<0.0039U	0.0057J
	Selenium (Filtered)	mg/L	0.0039	0.00046J	0.0063J	<0.0039U	0.0056J
	Silver	mg/L	0.00073	<0.00073U	<0.00073U	<0.00073U	<0.00073U
	Silver (Filtered)	mg/L	0.000047	<0.000047U	-	<0.00073U	<0.00073U
	Thallium	mg/L	0.0018	0.0023J	<0.0018U	<0.0018U	<0.0018U
	Thallium (Filtered)	mg/L	0.000013	<0.000013U	0.0018J,B	<0.0018U	0.0021J,B
	Zinc	mg/L	0.02	0.0043J	0.012J	0.0039J	0.012J
	Zinc (Filtered)	mg/L	0.005	0.0019J	0.0024J,B	0.0069J	0.0015J,B
	Calcium	mg/L	5	170	160	170	160
	Calcium (Filtered)	mg/L	0.5	160B	140	170	150
	Lithium	mg/L	0.05	0.1	0.088	0.1	0.088
	Lithium (Filtered)	mg/L	0.05	0.1	-	0.1	0.089
	Potassium	mg/L	5	3.6J,B	2.4J	2.9J	2.6J
	Potassium (Filtered)	mg/L	0.5	2.4	-	3J	2.8J
	Sodium	mg/L	5	12	8.9	11	8.5
	Sodium (Filtered)	mg/L	0.5	11	-	12	8.3
Pesticides	Aldrin	µg/L	0.00078	<0.00083U	<0.00078U	<0.00078U	<0.0008U
	a-BHC	µg/L	0.00062	<0.00066U	0.0012	<0.00062U	<0.00063U
	b-BHC	µg/L	0.00094	<0.001U	<0.00094U	<0.00094U	<0.00096U
	g-BHC (Lindane)	µg/L	0.00075	<0.0008U	<0.00075U	<0.00075U	<0.00077U
	d-BHC	µg/L	0.00036	<0.00038U	0.00095J	<0.00036U	<0.00037U
	chlordane	µg/L	0.0016	<0.0017U	<0.0016U	<0.0016U	<0.0016U
	DDT	µg/L	0.0007	<0.00074U	<0.0007U	<0.0007U	<0.00071U
	4,4-DDE	µg/L	0.00075	<0.00079U	<0.00075U	<0.00075U	<0.00076U
	DDD	µg/L	0.00063	<0.00067U	<0.00063U	<0.00063U	<0.00064U
	Dieldrin	µg/L	0.00077	<0.00082U	<0.00077U	<0.00077U	<0.00079U
	Endosulfan I	µg/L	0.00089	<0.00094U	<0.00089U	<0.00089U	<0.0009U
	Endosulfan II	µg/L	0.00092	<0.00098U	<0.00092U	0.00093J,p	<0.00094U
	Endosulfan sulphate	µg/L	0.00054	<0.00057U	<0.00054U	<0.00054U	<0.00055U
	Endrin	µg/L	0.00091	<0.00096U	<0.00091U	<0.00091U	<0.00092U
	Endrin aldehyde	µg/L	0.00085	<0.0009U	<0.00085U	<0.00085U	<0.00087U
	Heptachlor	µg/L	0.00093	<0.00099U	<0.00093U	<0.00093U	<0.00095U
	Heptachlor epoxide	µg/L	0.00092	<0.00097U	<0.00092U	<0.00092U	<0.00093U
	Arochlor 1242	µg/L	0.0018	<0.0019U	<0.0018U	<0.0018U	<0.0028U
	Arochlor 1254	µg/L	0.0013	<0.0014U	<0.0013U	<0.0013U	<0.0028U
	Arochlor 1221	µg/L	0.0023	<0.0025U	<0.0023U	<0.0023U	<0.0028U
	Arochlor 1232	µg/L	0.0028	<0.0029U	<0.0028U	<0.0028U	<0.0028U
	Arochlor 1248	µg/L	0.0021	<0.0023U	<0.0021U	<0.0021U	<0.0028U
	Arochlor 1260	µg/L	0.0013	<0.0014U	<0.0013U	<0.0013U	<0.0028U
	Arochlor 1016	µg/L	0.0024	<0.0025U	<0.0024U	<0.0024U	<0.0028U
	Toxaphene	µg/L	0.018	<0.019U	<0.018U	<0.018U	-
	Malathion	µg/L	0.021	<0.021U	<0.021U	<0.021U	<0.021U

	Methoxychlor	µg/L	0.00088	-	-	-	<0.00088U
	Mirex	µg/L	0.00045	<0.00048U	0.00055J	<0.00045U	<0.00046U
	Parathion	µg/L	0.031	<0.031U	<0.031U	<0.031U	<0.031U
Radioactive	Radium-226	pCi/L	0.0701	0.405	0.282	0.377	0.313
	Radium-228	pCi/L	0.329	0.457	<0.329U	0.417	<0.349U
SVOCs	2-chlorophenol	µg/L	0.17	<0.17U	<1.6U,*	<1.6U	<1.6U,*
	2,4-dichlorophenol	µg/L	0.033	<0.033U	<0.32U,*	<0.32U	<0.33U,*
	2,4-dimethylphenol	µg/L	0.085	<0.085U	<0.8U,*	<0.8U	<0.84U,*
	4,6-Dinitro-2-methylphenol	µg/L	0.22	<0.22U	<2.1U,*	<2.1U	<2.2U,*
	2,4-dinitrophenol	µg/L	0.61	<0.61U	<5.8U,*	<5.8U	<6U,*
	2-nitrophenol	µg/L	0.17	<0.17U	<1.6U	<1.6U	<1.7U
	4-nitrophenol	µg/L	0.65	<0.65U	<6.1U,*	<6.1U	<6.3U,*
	P-Chloro-M-Cresol	µg/L	0.075	<0.075U	<0.71U	<0.71U	<0.74U
	Pentachlorophenol	µg/L	0.066	<0.066U	<0.63U,*	<0.63U	<0.65U,*
	Phenol	µg/L	0.058	<0.058U	<0.55U,*	<0.55U	<0.57U,*
	2,4,6-trichlorophenol	µg/L	0.17	<0.17U	<1.7U	<1.7U	<1.7U
	Acenaphthene	µg/L	0.014	<0.014U	<0.14U	<0.14U	<0.14U
	Acenaphthylene	µg/L	0.15	-	-	-	<0.15U
	Anthracene	µg/L	0.015	<0.015U	<0.15U	<0.15U	<0.15U
	Benzidine	µg/L	3.5	<3.5U	<33U	<33U	<34U
	Benz(a)anthracene	µg/L	0.015	<0.015U	<0.14U	<0.14U	<0.14U
	Benzo(a) pyrene	µg/L	0.013	<0.013U	<0.13U	<0.13U	<0.13U
	3,4-Benzo-fluoranthene	µg/L	0.016	<0.016U	<0.15U	<0.15U	<0.15U
	Benzo(g,h,i)perylene	µg/L	0.015	<0.015U	<0.14U	<0.14U	<0.15U
	Benzo(k)fluoranthene	µg/L	0.055	<0.055U	<0.52U	<0.52U	<0.54U
	Bis(2-chloroethoxy) methane	µg/L	0.058	<0.058U	<0.55U	<0.55U	<0.57U
	Bis(2-chloroethyl)ether	µg/L	0.025	<0.025U	<0.24U,*	<0.24U	<0.25U,*
	Bis(2-chloroisopropyl) ether	µg/L	0.02	<0.02U	<0.19U	<0.19U	<0.19U
	Bis(2-ethylhexyl) phthalate	µg/L	1.3	<1.3U	<12U	<12U	<12U
	4-bromophenyl phenyl ether	µg/L	0.064	<0.064U	<0.6U	<0.6U	<0.62U
	Butyl benzyl phthalate	µg/L	0.14	<0.14U	<1.3U	<1.3U	<1.4U
	2-chloronaphthalene	µg/L	0.015	<0.015U	<0.14U	<0.14U	<0.15U
	4-chlorophenyl phenyl ether	µg/L	0.05	<0.05U	<0.47U	<0.47U	<0.49U
	Chrysene	µg/L	0.014	<0.014U	<0.13U	<0.13U	<0.14U
	Dibenz(a,h)anthracene	µg/L	0.016	<0.016U	<0.15U	<0.15U	<0.15U
	3,3-Dichlorobenzidine	µg/L	0.11	<0.11U	<1.1U	<1.1U	<1.1U
	Diethylphthalate	µg/L	0.15	<0.15U	<1.4U	<1.4U	<1.4U
	Dimethyl phthalate	µg/L	0.077	<0.077U	<0.72U	<0.72U	<0.75U
	Di-n-butyl phthalate	µg/L	0.12	<0.12U	<1.2U	<1.2U	<1.2U
	2,4-Dinitrotoluene	µg/L	0.054	<0.054U	<0.51U,*	<0.51U	<0.53U,*
	2,6-dinitrotoluene	µg/L	0.08	<0.08U	<0.75U	<0.75U	<0.78U
	Di-n-octyl phthalate	µg/L	0.21	<0.21U	<1.9U,*	<1.9U	<2U,*
	Diphenylhydrazine	µg/L	0.066	<0.066U	<0.62U	<0.62U	<0.65U
	Fluoranthene	µg/L	0.016	<0.016U	<0.15U	<0.15U	<0.16U
	Fluorene	µg/L	0.022	<0.022U	<0.2U	<0.2U	<0.21U
	Hexachlorobenzene	µg/L	0.018	<0.018U	<0.17U	<0.17U	<0.18U
	Hexachlorobutadiene	µg/L	0.017	<0.017U	<0.16U	<0.16U	<0.16U
	Hexachlorocyclopentadiene	µg/L	0.052	<0.052U	<0.49U,*	<0.49U	<0.51U,*
	Hexachloroethane	µg/L	0.063	<0.063U	<0.59U,*	<0.59U	<0.62U,*
	Indeno(1,2,3-c,d)pyrene	µg/L	0.02	<0.02U	<0.19U	<0.19U	<0.2U
	Isophorone	µg/L	0.064	<0.064U	<0.61U	<0.61U	<0.63U
	Naphthalene	µg/L	0.014	<0.014U	<0.13U	<0.13U	<0.14U
	Nitrobenzene	µg/L	0.084	<0.084U	<0.8U	<0.8U	<0.83U
	N-Nitrosodimethylamine	µg/L	0.074	<0.074U	<0.69U,*	<0.69U	<0.72U,*
	N-nitrosodi-n-propylamine	µg/L	0.031	<0.031U	<0.29U	<0.29U	<0.3U
	n-Nitrosodiphenylamine	µg/L	0.085	<0.085U	<0.8U	<0.8U	<0.84U

	Phenanthrene	µg/L	0.043		<0.043U	<0.4U	<0.4U	<0.42U
	Pyrene	µg/L	0.016		<0.016U	<0.15U	<0.15U	<0.15U
	1,2,4-trichlorobenzene	µg/L	0.071		<0.071U	<0.67U	<0.67U	<0.7U
	Aroclor 1262	µg/L	0.0028		-	-	-	<0.0028U
	SVOCs							
	Azinophos methyl	µg/L	0.021		<0.022U	<0.022U	<0.021U	<0.022U
	Chlorpyrifos	µg/L	0.019		<0.019U	<0.019U	<0.019U	<0.02U
	Demeton (total)	µg/L	0.031		<0.031U	<0.031U	<0.031U	<0.032U
	Diazinon	µg/L	0.018		<0.018U	<0.018U	<0.018U	<0.018U
	Kepone	µg/L	0.97		<0.97U,cn	<9.1U	<9.1U,cn	<9.5U
	PCBs (Sum of total)	µg/L	0.0028		-	-	-	<0.0028U
	Arochlor 1268	mg/L	0.0000028		-	-	-	<0.0000028U
VOCs	Accrolein	µg/L	2.6		<2.6U	<2.6U	<2.6U	<4.5U
	Acrylonitrile	µg/L	0.55		<0.55U	<0.55U	<0.55U	<6.3U
	Benzene	µg/L	0.11		<0.11U	<0.11U	<0.11U	<0.35U
	Bromoform	µg/L	0.19		<0.19U	<0.19U	<0.19U	<0.56U
	Carbon tetrachloride	µg/L	0.14		<0.14U	<0.14U	<0.14U	<0.43U
	Chlorobenzene	µg/L	0.14		<0.14U	<0.14U	<0.14U	<0.25U
	Chlorodibromomethane	µg/L	0.14		<0.14U	<0.14U	<0.14U	<0.43U
	Chloroethane	µg/L	0.21		<0.21U	<0.21U	<0.21U	<0.32U
	2-Chloroethylvinyl ether	µg/L	0.25		<0.25U	<0.25U	<0.25U	<0.59U
	Chloroform	µg/L	0.17		<0.17U	<0.17U	<0.17U	<0.25U
	Dichlorobromomethane	µg/L	0.13		<0.13U	<0.13U	<0.13U	<0.29U
	1,1-dichloroethane	µg/L	0.12		<0.12U	<0.12U	<0.12U	<0.3U
	1,2-dichloroethane	µg/L	0.21		<0.21U	<0.21U	<0.21U	<0.23U
	1,1-dichloroethene	µg/L	0.3		<0.3U	<0.3U	<0.3U	<0.45U
	1,2-dichloropropane	µg/L	0.095		<0.095U	<0.095U	<0.095U	<0.25U
	Ethylbenzene	µg/L	0.23		<0.23U	<0.23U	<0.23U	<0.25U
	Methyl Bromide	µg/L	0.31		<0.31U	<0.31U	<0.31U	<0.44U
	Methyl Chloride	µg/L	0.28		<0.28U	<0.28U	<0.28U	<0.44U
	Methylene Chloride	µg/L	0.15		<0.15U	<0.15U	<0.15U	<0.33U
	1,1,2,2-tetrachloroethane	µg/L	0.2		<0.2U	<0.2U	<0.2U	<0.22U
	Tetrachloroethene	µg/L	0.15		<0.15U	<0.15U	<0.15U	<0.31U
	Toluene	µg/L	0.15		<0.15U	<0.15U	<0.15U	<0.23U
	1,2-Trans-dichloroethene	µg/L	0.17		<0.17U	<0.17U	<0.17U	<0.3U
	1,1,1-trichloroethane	µg/L	0.29		<0.29U	<0.29U	<0.29U	<0.44U
	1,1,2-trichloroethane	µg/L	0.2		<0.2U	<0.2U	<0.2U	<0.24U
	Trichloroethene	µg/L	0.14		<0.14U	<0.14U	<0.14U	<0.22U
	Vinyl chloride	µg/L	0.23		<0.23U	<0.23U	<0.23U	<0.29U
	1,2-dichlorobenzene	µg/L	0.15		<0.15U	<0.15U	<0.15U	<0.25U
	1,3-dichlorobenzene	µg/L	0.11		<0.11U	<0.11U	<0.11U	<0.19U
	1,4-dichlorobenzene	µg/L	0.21		<0.21U	<0.21U	<0.21U	<0.27U
	cis-1,3-dichloropropene	µg/L	0.19		<0.19U	<0.19U	<0.19U	<0.46U
	trans-1,3-dichloropropene	µg/L	0.15		<0.15U	<0.15U	<0.15U	<0.56U

Notes:

Qualifier	Explanation
U	Result is less than the sample detection limit.
B	Compound was found in the blank and sample.
H	Sample was prepped or analyzed beyond the specified holding time.
J	Result is less than the RL but greater than or equal to the MDL and the concentration is an approximate value.
HF	Field parameter requested by the laboratory.
*	RPD of the LCS and LCSD exceeds the control limits
-	Not analyzed.

Attachment 5

Effluent Limit Development

5.a Reasonable Potential Analysis for Outfalls 001 and 002
5.b Reasonable Potential Analysis for Outfall 003
5.c Reasonable Potential Analysis for Outfall 301
5.d Reasonable Potential Analysis for Outfall 004
5.e Reasonable Potential Analysis for Outfall 005
5.f Reasonable Potential Analysis for Outfall 101
5.g Ammonia Limitations
5.h Total Phosphorus
5.i Modeling Associated with SCR Addition
5.j 40CFR 423 – Steam Electric Power Generating Point Sources
5.k Outfalls 302 and 402 ELG Limits Applicability Date, Proposed Sampling Approach

a. Reasonable Potential Analysis for Outfalls 001 and 002

Effluent limitations for parameters submitted with the application were evaluated in accordance with DEQ Guidance Memo 00-2011. All observed pollutants and pollutants reported as less than QLs that exceeded the agency accepted values were evaluated for reasonable potential to violate in stream water quality standards. Pollutants that were reported as less than a DEQ accepted QL were considered absent for the purposes of this evaluation.

MSTRANTI (version 2b), a DEQ developed spreadsheet was used to calculate Waste Load Allocations (WLAs) based on mixed conditions. Stream data, effluent data and mixing ratios were entered into MSTRANTI to determine the WLAs.

Outfalls 001 and 002 discharge to the tidal James River. Because of the challenge in modeling tidal discharges, dilution ratios of 2:1 acute and 2:1 chronic were assumed. This is a change from previous permitting actions which used a chronic dilution ratio of 50:1. Mixing ratios were input in MSTRANTI as follows:

2:1 acute - A design flow of 1 MGD and 1Q10 flow of 1 MGD

2:1 chronic - A design flow of 1 MGD and 7Q10 flow of 1 MGD

STATS.EXE (version 2.0.4) was then used to evaluate reasonable potential and calculate limitations if needed. WLAs, monitoring frequencies and reported effluent pollutant concentrations were input in STATS.EXE to evaluate each pollutant individually. Because chlorine is purposefully introduced into the effluent, TRC limitations were forced at both Outfalls using an assumed datum. Supplemental data for Copper was provided by the permittee for Outfall 002 (see **Attachment 4.b**) which resulted in no reasonable potential. However, recognizing the limited data set available, it is the staff's professional judgment to include monitoring for this parameter to better characterize the pollutant in the wastestream. As shown in the STATS outputs included in this section, no other limitations are needed to protect ambient aquatic Water Quality Standards at Outfalls 001 and 002.

For parameters with standards based on Human Health (HH), the maximum observed values were compared to the HH WLAs calculated in MSTRANTI. The receiving stream is not designated as a PWS, so the HH PWS standards do not apply to these discharges. All of the observed values were substantially less than the WLAs; therefore, no limitations are needed for these parameters to protect human health. Pollutants without an applicable standard cannot be evaluated at this time.

Pollutant	Observed Value		Human Health WLA	Reasonable Potential (Y/N)
	Outfall 001	Outfall 002		
Dissolved Copper (µg/L)	6.00, <1.0	13.00, 4.00, 5.00, 8.00	-	N(1)
Dissolved Zinc (µg/L)	13.00	26.00	52,000	N
Chloroform (µg/L)	1.88	1.60	22,000	N
Beta Particle & Photon Activity (pCi/L)	3.69		-	N(1)
Chlorides (µg/L)	30,440	32,010	-	N(1)
Dissolved Barium (µg/L)	105	100	-	N(1)
Dissolved Iron (µg/L)	700	500	-	N(1)
Dissolved Manganese (µg/L)	60	50	-	N(1)
Sulfate (mg/L)	54.52	55.82	-	N(1)
E. coli (N/100mL)	50	30	126	N

* Observed values are expressed in terms of total rather than dissolve

(1)VAWQS for these parameters applicable only to receiving streams with a special standard for public water supply (PWS).

MSTRANTI DATA SOURCE REPORT
(Chesterfield Power Station: Outfalls 001 & 002)

Stream Information	
Mean Hardness	2-JMS099.30
90% Temperature (annual)	2-JMS099.30
90% Temperature (wet season)	NA
90% Maximum pH	2-JMS099.30
10% Maximum pH	2-JMS099.30
Tier Designation	Flow Frequency Memo (02/29/2016)
Stream Flows & Mixing Information	
All Data	Tidal Dilution and Mixing Ratios 2:1 acute and 2:1 chronic; 100% Mixing
Effluent Information	
Mean Hardness	Application and DMR Data
90% Temperature (annual)	
90% Temperature (wet season)	NA
90% Maximum pH	The ambient stream pH based on 40 years of sampling was used in lieu of the single effluent sample provided in the application. Because the effluent is non-contact cooling water withdrawn from the river and there is no chemical adjustment of pH, the stream values are considered a more conservative input. In addition, the single sample effluent value is within the ambient range.
10% Maximum pH	
Discharge Flow	Tidal Mixing Ratios

Data Location:

Flow Frequency Analysis — Attachment 3
Application and DMR Data — Attachment 4

FRESHWATER
WATER QUALITY CRITERIA / WASTELOAD ALLOCATION ANALYSIS

Facility Name: Chesterfield Power Station 001 Permit No.: VA0004146

Receiving Stream: James River Version: OWP Guidance Memo 00-2011 (8/24/00)

Stream Information		
Mean Hardness (as CaCO3) =	66	mg/L
90% Temperature (Annual) =	29.3	deg C
90% Temperature (Wet season) =		deg C
90% Maximum pH =	8	SU
10% Maximum pH =	7.2	SU
Tier Designation (1 or 2) =	1	
Public Water Supply (PWS) Y/N? =	n	
Trout Present Y/N? =	n	
Early Life Stages Present Y/N? =	y	

Stream Flows		
1Q10 (Annual) =	1	MGD
7Q10 (Annual) =	1	MGD
30Q10 (Annual) =	1	MGD
1Q10 (Wet season) =		MGD
30Q10 (Wet season) =		MGD
30Q5 =	1	MGD
Harmonic Mean =	1	MGD

Mixing Information		
Annual - 1Q10 Mix =	100	%
- 7Q10 Mix =	100	%
- 30Q10 Mix =	100	%
Wet Season - 1Q10 Mix =	100	%
- 30Q10 Mix =	100	%

Effluent Information		
Mean Hardness (as CaCO3) =	84	mg/L
90% Temp (Annual) =	45	deg C
90% Temp (Wet season) =		deg C
90% Maximum pH =	8	SU
10% Maximum pH =	7.2	SU
Discharge Flow =	1	MGD

Parameter	Background	Water Quality Criteria				Wasteload Allocations				Antidegradation Baseline				Antidegradation Allocations				**Most Limiting Allocations**			
(ug/l unless noted)	Conc.	Acute	Chronic	HH (PWS)	HH	Acute	Chronic	HH (PWS)	HH	Acute	Chronic	HH (PWS)	HH	Acute	Chronic	HH (PWS)	HH	**Acute**	**Chronic**	**HH (PWS)**	**HH**
Acenapthene	0	--	--	na	9.9E+02	--	--	na	2.0E+03	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**2.0E+03**
Acrolein	0	--	--	na	9.3E+00	--	--	na	1.9E+01	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.9E+01**
Acrylonitrile[C]	0	--	--	na	2.5E+00	--	--	na	5.0E+00	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**5.0E+00**
Aldrin [C]	0	3.0E+00	--	na	5.0E-04	6.0E+00	--	na	1.0E-03	--	--	--	--	--	--	--	--	**6.0E+00**	**--**	**na**	**1.0E-03**
Ammonia-N (mg/l) (Yearly)	0	8.41E+00	5.66E-01	na	--	1.68E+01	1.13E+00	na	--	--	--	--	--	--	--	--	--	**1.68E+01**	**1.13E+00**	**na**	**--**
Ammonia-N (mg/l) (High Flow)	0	8.41E+00	2.43E+00	na	--	8.41E+00	2.43E+00	na	--	--	--	--	--	--	--	--	--	**8.41E+00**	**2.43E+00**	**na**	**--**
Anthracene	0	--	--	na	4.0E+04	--	--	na	8.0E+04	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**8.0E+04**
Antimony	0.13	--	--	na	6.4E+02	--	--	na	1.3E+03	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.3E+03**
Arsenic	0.62	3.4E+02	1.5E+02	na	--	6.8E+02	3.0E+02	na	--	--	--	--	--	--	--	--	--	**6.8E+02**	**3.0E+02**	**na**	**--**
Barium	38.66	--	--	na	--	--	--	na	--	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**--**
Benzene [C]	0	--	--	na	5.1E+02	--	--	na	1.0E+03	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.0E+03**
Benzidine[C]	0	--	--	na	2.0E-03	--	--	na	4.0E-03	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**4.0E-03**
Benzo (a) anthracene [C]	0	--	--	na	1.8E-01	--	--	na	3.6E-01	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**3.6E-01**
Benzo (b) fluoranthene [C]	0	--	--	na	1.8E-01	--	--	na	3.6E-01	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**3.6E-01**
Benzo (k) fluoranthene [C]	0	--	--	na	1.8E-01	--	--	na	3.6E-01	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**3.6E-01**
Benzo (a) pyrene [C]	0	--	--	na	1.8E-01	--	--	na	3.6E-01	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**3.6E-01**
Bis2-Chloroethyl Ether [C]	0	--	--	na	5.3E+00	--	--	na	1.1E+01	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.1E+01**
Bis2-Chloroisopropyl Ether	0	--	--	na	6.5E+04	--	--	na	1.3E+05	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.3E+05**
Bis 2-Ethylhexyl Phthalate [C]	0	--	--	na	2.2E+01	--	--	na	4.4E+01	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**4.4E+01**
Bromoform [C]	0	--	--	na	1.4E+03	--	--	na	2.8E+03	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**2.8E+03**
Butylbenzylphthalate	0	--	--	na	1.9E+03	--	--	na	3.8E+03	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**3.8E+03**
Cadmium	0.12	2.8E+00	9.0E-01	na	--	5.6E+00	1.7E+00	na	--	--	--	--	--	--	--	--	--	**5.6E+00**	**1.7E+00**	**na**	**--**
Carbon Tetrachloride [C]	0	--	--	na	1.6E+01	--	--	na	3.2E+01	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**3.2E+01**
Chlordane [C]	0	2.4E+00	4.3E-03	na	8.1E-03	4.8E+00	8.6E-03	na	1.6E-02	--	--	--	--	--	--	--	--	**4.8E+00**	**8.6E-03**	**na**	**1.6E-02**
Chloride	14480	8.6E+05	2.3E+05	na	--	1.7E+06	4.5E+05	na	--	--	--	--	--	--	--	--	--	**1.7E+06**	**4.5E+05**	**na**	**--**
TRC	0	1.9E+01	1.1E+01	na	--	3.8E+01	2.2E+01	na	--	--	--	--	--	--	--	--	--	**3.8E+01**	**2.2E+01**	**na**	**--**
Chlorobenzene	0	--	--	na	1.6E+03	--	--	na	3.2E+03	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**3.2E+03**

Parameter	Background	Water Quality Criteria				Wasteload Allocations				Antidegradation Baseline				Antidegradation Allocations				**Most Limiting Allocations**			
(ug/l unless noted)	Conc.	Acute	Chronic	HH (PWS)	HH	Acute	Chronic	HH (PWS)	HH	Acute	Chronic	HH (PWS)	HH	Acute	Chronic	HH (PWS)	HH	**Acute**	**Chronic**	**HH (PWS)**	**HH**
Chlorodibromomethane[C]	0	--	--	na	1.3E+02	--	--	na	2.6E+02	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**2.6E+02**
Chloroform	0	--	--	na	1.1E+04	--	--	na	2.2E+04	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**2.2E+04**
2-Chloronaphthalene	0	--	--	na	1.6E+03	--	--	na	3.2E+03	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**3.2E+03**
2-Chlorophenol	0	--	--	na	1.5E+02	--	--	na	3.0E+02	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**3.0E+02**
Chlorpyrifos	0	8.3E-02	4.1E-02	na	--	1.7E-01	8.2E-02	na	--	--	--	--	--	--	--	--	--	**1.7E-01**	**8.2E-02**	**na**	**--**
Chromium III	0	4.5E+02	5.9E+01	na	--	9.0E+02	1.2E+02	na	--	--	--	--	--	--	--	--	--	**9.0E+02**	**1.2E+02**	**na**	**--**
Chromium VI	0	1.6E+01	1.1E+01	na	--	3.2E+01	2.2E+01	na	--	--	--	--	--	--	--	--	--	**3.2E+01**	**2.2E+01**	**na**	**--**
Chromium, Total	0	--	--	1.0E+02	--	--	--	na	--	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**--**
Chrysene [C]	0	--	--	na	1.8E-02	--	--	na	3.6E-02	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**3.6E-02**
Copper	1.31	1.0E+01	7.0E+00	na	--	1.9E+01	1.3E+01	na	--	--	--	--	--	--	--	--	--	**1.9E+01**	**1.3E+01**	**na**	**--**
Cyanide, Free	0	2.2E+01	5.2E+00	na	1.6E+04	4.4E+01	1.0E+01	na	3.2E+04	--	--	--	--	--	--	--	--	**4.4E+01**	**1.0E+01**	**na**	**3.2E+04**
DDD [C]	0	--	--	na	3.1E-03	--	--	na	6.2E-03	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**6.2E-03**
DDE [C]	0	--	--	na	2.2E-03	--	--	na	4.4E-03	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**4.4E-03**
DDT [C]	0	1.1E+00	1.0E-03	na	2.2E-03	2.2E+00	2.0E-03	na	4.4E-03	--	--	--	--	--	--	--	--	**2.2E+00**	**2.0E-03**	**na**	**4.4E-03**
Demeton	0	--	1.0E-01	na	--	--	2.0E-01	na	--	--	--	--	--	--	--	--	--	**--**	**2.0E-01**	**na**	**--**
Diazinon	0	1.7E-01	1.7E-01	na	--	3.4E-01	3.4E-01	na	--	--	--	--	--	--	--	--	--	**3.4E-01**	**3.4E-01**	**na**	**--**
Dibenz(a,h)anthracene [C]	0	--	--	na	1.8E-01	--	--	na	3.6E-01	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**3.6E-01**
1,2-Dichlorobenzene	0	--	--	na	1.3E+03	--	--	na	2.6E+03	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**2.6E+03**
1,3-Dichlorobenzene	0	--	--	na	9.6E+02	--	--	na	1.9E+03	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.9E+03**
1,4-Dichlorobenzene	0	--	--	na	1.9E+02	--	--	na	3.8E+02	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**3.8E+02**
3,3-Dichlorobenzidine[C]	0	--	--	na	2.8E-01	--	--	na	5.6E-01	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**5.6E-01**
Dichlorobromomethane [C]	0	--	--	na	1.7E+02	--	--	na	3.4E+02	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**3.4E+02**
1,2-Dichloroethane [C]	0	--	--	na	3.7E+02	--	--	na	7.4E+02	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**7.4E+02**
1,1-Dichloroethylene	0	--	--	na	7.1E+03	--	--	na	1.4E+04	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.4E+04**
1,2-trans-dichloroethylene	0	--	--	na	1.0E+04	--	--	na	2.0E+04	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**2.0E+04**
2,4-Dichlorophenol	0	--	--	na	2.9E+02	--	--	na	5.8E+02	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**5.8E+02**
2,4-Dichlorophenoxy acetic acid (2,4-D)	0	--	--	na	--	--	--	na	--	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**--**
1,2-Dichloropropane[C]	0	--	--	na	1.5E+02	--	--	na	3.0E+02	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**3.0E+02**
1,3-Dichloropropene [C]	0	--	--	na	2.1E+02	--	--	na	4.2E+02	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**4.2E+02**
Dieldrin [C]	0	2.4E-01	5.6E-02	na	5.4E-04	4.8E-01	1.1E-01	na	1.1E-03	--	--	--	--	--	--	--	--	**4.8E-01**	**1.1E-01**	**na**	**1.1E-03**
Diethyl Phthalate	0	--	--	na	4.4E+04	--	--	na	8.8E+04	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**8.8E+04**
2,4-Dimethylphenol	0	--	--	na	8.5E+02	--	--	na	1.7E+03	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.7E+03**
Dimethyl Phthalate	0	--	--	na	1.1E+06	--	--	na	2.2E+06	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**2.2E+06**
Di-n-Butyl Phthalate	0	--	--	na	4.5E+03	--	--	na	9.0E+03	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**9.0E+03**
2,4 Dinitrophenol	0	--	--	na	5.3E+03	--	--	na	1.1E+04	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.1E+04**
2-Methyl-4,6-Dinitrophenol	0	--	--	na	2.8E+02	--	--	na	5.6E+02	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**5.6E+02**
2,4-Dinitrotoluene [C]	0	--	--	na	3.4E+01	--	--	na	6.8E+01	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**6.8E+01**
Dioxin 2,3,7,8-tetrachlorodibenzo-p-dioxin	0	--	--	na	5.1E-08	--	--	na	1.0E-07	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.0E-07**
1,2-Diphenylhydrazine[C]	0	--	--	na	2.0E+00	--	--	na	4.0E+00	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**4.0E+00**
Alpha-Endosulfan	0	2.2E-01	5.6E-02	na	8.9E+01	4.4E-01	1.1E-01	na	1.8E+02	--	--	--	--	--	--	--	--	**4.4E-01**	**1.1E-01**	**na**	**1.8E+02**
Beta-Endosulfan	0	2.2E-01	5.6E-02	na	8.9E+01	4.4E-01	1.1E-01	na	1.8E+02	--	--	--	--	--	--	--	--	**4.4E-01**	**1.1E-01**	**na**	**1.8E+02**
Alpha + Beta Endosulfan	0	2.2E-01	5.6E-02	--	--	4.4E-01	1.1E-01	--	--	--	--	--	--	--	--	--	--	**4.4E-01**	**1.1E-01**	**--**	**--**
Endosulfan Sulfate	0	--	--	na	8.9E+01	--	--	na	1.8E+02	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.8E+02**
Endrin	0	8.6E-02	3.6E-02	na	6.0E-02	1.7E-01	7.2E-02	na	1.2E-01	--	--	--	--	--	--	--	--	**1.7E-01**	**7.2E-02**	**na**	**1.2E-01**
Endrin Aldehyde	0	--	--	na	3.0E-01	--	--	na	6.0E-01	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**6.0E-01**

Parameter	Background	Water Quality Criteria				Wasteload Allocations				Antidegradation Baseline				Antidegradation Allocations				**Most Limiting Allocations**			
(ug/l unless noted)	Conc.	Acute	Chronic	HH (PWS)	HH	Acute	Chronic	HH (PWS)	HH	Acute	Chronic	HH (PWS)	HH	Acute	Chronic	HH (PWS)	HH	**Acute**	**Chronic**	**HH (PWS)**	**HH**
Ethylbenzene	0	--	--	na	2.1E+03	--	--	na	4.2E+03	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**4.2E+03**
Fluoranthene	0	--	--	na	1.4E+02	--	--	na	2.8E+02	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**2.8E+02**
Fluorene	0	--	--	na	5.3E+03	--	--	na	1.1E+04	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.1E+04**
Foaming Agents	0	--	--	na	--	--	--	na	--	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**--**
Guthion	0	--	1.0E-02	na	--	--	2.0E-02	na	--	--	--	--	--	--	--	--	--	**--**	**2.0E-02**	**na**	**--**
Heptachlor [C]	0	5.2E-01	3.8E-03	na	7.9E-04	1.0E+00	7.6E-03	na	1.6E-03	--	--	--	--	--	--	--	--	**1.0E+00**	**7.6E-03**	**na**	**1.6E-03**
Heptachlor Epoxide[C]	0	5.2E-01	3.8E-03	na	3.9E-04	1.0E+00	7.6E-03	na	7.8E-04	--	--	--	--	--	--	--	--	**1.0E+00**	**7.6E-03**	**na**	**7.8E-04**
Hexachlorobenzene[C]	0	--	--	na	2.9E-03	--	--	na	5.8E-03	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**5.8E-03**
Hexachlorobutadiene[C]	0	--	--	na	1.8E+02	--	--	na	3.6E+02	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**3.6E+02**
Hexachlorocyclohexane Alpha-BHC[C]	0	--	--	na	4.9E-02	--	--	na	9.8E-02	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**9.8E-02**
Hexachlorocyclohexane Beta-BHC[C]	0	--	--	na	1.7E-01	--	--	na	3.4E-01	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**3.4E-01**
Hexachlorocyclohexane Gamma-BHC[C] (Lindane)	0	9.5E-01	na	na	1.8E+00	1.9E+00	--	na	3.6E+00	--	--	--	--	--	--	--	--	**1.9E+00**	**--**	**na**	**3.6E+00**
Hexachlorocyclopentadiene	0	--	--	na	1.1E+03	--	--	na	2.2E+03	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**2.2E+03**
Hexachloroethane[C]	0	--	--	na	3.3E+01	--	--	na	6.6E+01	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**6.6E+01**
Hydrogen Sulfide	0	--	2.0E+00	na	--	--	4.0E+00	na	--	--	--	--	--	--	--	--	--	**--**	**4.0E+00**	**na**	**--**
Indeno (1,2,3-cd) pyrene [C]	0	--	--	na	1.8E-01	--	--	na	3.6E-01	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**3.6E-01**
Iron	725	--	--	na	--	--	--	na	--	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**--**
Isophorone[C]	0	--	--	na	9.6E+03	--	--	na	1.9E+04	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.9E+04**
Kepone	0	--	0.0E+00	na	--	--	0.0E+00	na	--	--	--	--	--	--	--	--	--	**--**	**0.0E+00**	**na**	**--**
Lead	0.3	8.2E+01	9.4E+00	na	--	1.6E+02	1.8E+01	na	--	--	--	--	--	--	--	--	--	**1.6E+02**	**1.8E+01**	**na**	**--**
Malathion	0	--	1.0E-01	na	--	--	2.0E-01	na	--	--	--	--	--	--	--	--	--	**--**	**2.0E-01**	**na**	**--**
Manganese	266.58	--	--	na	--	--	--	na	--	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**--**
Mercury	0.00269	1.4E+00	7.7E-01	- -	- -	2.8E+00	1.5E+00	- -	- -	--	--	--	--	--	--	--	--	**2.8E+00**	**1.5E+00**	**- -**	**- -**
Methyl Bromide	0	--	--	na	1.5E+03	--	--	na	3.0E+03	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**3.0E+03**
Methylene Chloride [C]	0	--	--	na	5.9E+03	--	--	na	1.2E+04	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.2E+04**
Methoxychlor	0	--	3.0E-02	na	--	--	6.0E-02	na	--	--	--	--	--	--	--	--	--	**--**	**6.0E-02**	**na**	**--**
Mirex	0	--	0.0E+00	na	--	--	0.0E+00	na	--	--	--	--	--	--	--	--	--	**--**	**0.0E+00**	**na**	**--**
Nickel	1.29	1.4E+02	1.6E+01	na	4.6E+03	2.8E+02	3.0E+01	na	9.2E+03	--	--	--	--	--	--	--	--	**2.8E+02**	**3.0E+01**	**na**	**9.2E+03**
Nitrate (as N)	0	--	--	na	--	--	--	na	--	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**--**
Nitrobenzene	0	--	--	na	6.9E+02	--	--	na	1.4E+03	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.4E+03**
N-Nitrosodimethylamine[C]	0	--	--	na	3.0E+01	--	--	na	6.0E+01	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**6.0E+01**
N-Nitrosodiphenylamine[C]	0	--	--	na	6.0E+01	--	--	na	1.2E+02	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.2E+02**
N-Nitrosodi-n-propylamine[C]	0	--	--	na	5.1E+00	--	--	na	1.0E+01	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.0E+01**
Nonylphenol	0	2.8E+01	6.6E+00	--	--	5.6E+01	1.3E+01	na	--	--	--	--	--	--	--	--	--	**5.6E+01**	**1.3E+01**	**na**	**--**
Parathion	0	6.5E-02	1.3E-02	na	--	1.3E-01	2.6E-02	na	--	--	--	--	--	--	--	--	--	**1.3E-01**	**2.6E-02**	**na**	**--**
PCB Total[C]	0	--	1.4E-02	na	6.4E-04	--	2.8E-02	na	1.3E-03	--	--	--	--	--	--	--	--	**--**	**2.8E-02**	**na**	**1.3E-03**
Pentachlorophenol [C]	0	1.1E+01	8.2E+00	na	3.0E+01	2.1E+01	1.6E+01	na	6.0E+01	--	--	--	--	--	--	--	--	**2.1E+01**	**1.6E+01**	**na**	**6.0E+01**
Phenol	0	--	--	na	8.6E+05	--	--	na	1.7E+06	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.7E+06**
Pyrene	0	--	--	na	4.0E+03	--	--	na	8.0E+03	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**8.0E+03**
Radionuclides	0	--	--	na	--	--	--	na	--	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**--**
Gross Alpha Activity (pCi/L)	0	--	--	na	--	--	--	na	--	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**--**
Beta and Photon Activity (mrem/yr)	0	--	--	na	--	--	--	na	--	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**--**
Radium 226 + 228 (pCi/L)	0	--	--	na	--	--	--	na	--	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**--**
Uranium (ug/l)	0	--	--	na	--	--	--	na	--	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**--**

Parameter	Background	Water Quality Criteria				Wasteload Allocations				Antidegradation Baseline				Antidegradation Allocations				**Most Limiting Allocations**			
(ug/l unless noted)	Conc.	Acute	Chronic	HH (PWS)	HH	Acute	Chronic	HH (PWS)	HH	Acute	Chronic	HH (PWS)	HH	Acute	Chronic	HH (PWS)	HH	**Acute**	**Chronic**	**HH (PWS)**	**HH**
Selenium, Total Recoverable	0.26	2.0E+01	5.0E+00	na	4.2E+03	4.0E+01	9.7E+00	na	8.4E+03	--	--	--	--	--	--	--	--	**4.0E+01**	**9.7E+00**	**na**	**8.4E+03**
Silver	0.03	2.1E+00	--	na	--	4.2E+00	--	na	--	--	--	--	--	--	--	--	--	**4.2E+00**	**--**	**na**	**--**
Sulfate	0	--	--	na	--	--	--	na	--	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**--**
1,1,2,2-Tetrachloroethane[C]	0	--	--	na	4.0E+01	--	--	na	8.0E+01	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**8.0E+01**
Tetrachloroethylene[C]	0	--	--	na	3.3E+01	--	--	na	6.6E+01	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**6.6E+01**
Thallium	0.04	--	--	na	4.7E-01	--	--	na	9.0E-01	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**9.0E-01**
Toluene	0	--	--	na	6.0E+03	--	--	na	1.2E+04	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.2E+04**
Total dissolved solids	0	--	--	na	--	--	--	na	--	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**--**
Toxaphene [C]	0	7.3E-01	2.0E-04	na	2.8E-03	1.5E+00	4.0E-04	na	5.6E-03	--	--	--	--	--	--	--	--	**1.5E+00**	**4.0E-04**	**na**	**5.6E-03**
Tributyltin	0	4.6E-01	7.2E-02	na	--	9.2E-01	1.4E-01	na	--	--	--	--	--	--	--	--	--	**9.2E-01**	**1.4E-01**	**na**	**--**
1,2,4-Trichlorobenzene	0	--	--	na	7.0E+01	--	--	na	1.4E+02	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.4E+02**
1,1,2-Trichloroethane[C]	0	--	--	na	1.6E+02	--	--	na	3.2E+02	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**3.2E+02**
Trichloroethylene [C]	0	--	--	na	3.0E+02	--	--	na	6.0E+02	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**6.0E+02**
2,4,6-Trichlorophenol [C]	0	--	--	na	2.4E+01	--	--	na	4.8E+01	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**4.8E+01**
2-(2,4,5-Trichlorophenoxy) propionic acid (Silvex)	0	--	--	na	--	--	--	na	--	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**--**
Vinyl Chloride[C]	0	--	--	na	2.4E+01	--	--	na	4.8E+01	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**4.8E+01**
Zinc	6.23	9.2E+01	9.3E+01	na	2.6E+04	1.8E+02	1.8E+02	na	5.2E+04	--	--	--	--	--	--	--	--	**1.8E+02**	**1.8E+02**	**na**	**5.2E+04**

Notes:

1. All concentrations expressed as micrograms/liter (ug/l), unless noted otherwise
2. Discharge flow is highest monthly average or Form 2C maximum for Industries and design flow for Municipals
3. Metals measured as Dissolved, unless specified otherwise
4. "C" indicates a carcinogenic parameter
5. Regular WLAs are mass balances (minus background concentration) using the % of stream flow entered above under Mixing Information.
   Antidegradation WLAs are based upon a complete mix.
6. Antideg. Baseline = (0.25(WQC - background conc.) + background conc.) for acute and chronic
   = (0.1(WQC - background conc.) + background conc.) for human health
7. WLAs established at the following stream flows: 1Q10 for Acute, 30Q10 for Chronic Ammonia, 7Q10 for Other Chronic, 30Q5 for Non-carcinogens and Harmonic Mean for Carcinogens. To apply mixing ratios from a model set the stream flow equal to (mixing ratio - 1), effluent flow equal to 1 and 100% mix.

Metal	Target Value (SSTV)
Antimony	1.3E+03
Arsenic	1.8E+02
Barium	na
Cadmium	1.0E+00
Chromium III	7.0E+01
Chromium VI	1.3E+01
Copper	7.6E+00
Iron	na
Lead	1.1E+01
Manganese	na
Mercury	9.2E-01
Nickel	1.8E+01
Selenium	5.8E+00
Silver	1.7E+00
Zinc	7.1E+01

Note: do not use QL's lower than the minimum QL's provided in agency guidance

5/5/2016 1:56:31 PM

Facility = Chesterfield Power Station - 001
Chemical = Ammonia
Chronic averaging period = 30
WLAa = 16.8
WLAc = 1.13
Q.L. = 0.1
# samples/mo. = 1
# samples/wk. = 1

Summary of Statistics:

observations = 1
Expected Value = .1
Variance = .0036
C.V. = 0.6
97th percentile daily values = .243341
97th percentile 4 day average = .166379
97th percentile 30 day average= .120605
< Q.L. = 0
Model used = BPJ Assumptions, type 2 data

No Limit is required for this material

The data are:

0.1

5/26/2016 1:04:44 PM

Facility = Chesterfield Power Station - 001
Chemical = Chloride
Chronic averaging period = 4
WLAa = 1700000
WLAc = 450000
Q.L. = 100
# samples/mo. = 1
# samples/wk. = 1

Summary of Statistics:

observations = 1
Expected Value = 30440
Variance = 3335736
C.V. = 0.6
97th percentile daily values = 74073.2
97th percentile 4 day average = 50645.7
97th percentile 30 day average= 36712.2
< Q.L. = 0
Model used = BPJ Assumptions, type 2 data

No Limit is required for this material

The data are:

30440

5/5/2016 2:01:26 PM

Facility = Chesterfield Power Station - 001
Chemical = TRC
Chronic averaging period = 4
WLAa   = 38
WLAc   = 22
Q.L.   = 100
samples/mo. = 4
samples/wk. = 1

Summary of Statistics:

observations = 1
Expected Value = 20000
Variance   = 1440000
C.V.   = 0.6
97th percentile daily values = 48668.3
97th percentile 4 day average = 33275.8
97th percentile 30 day average= 24121.0
< Q.L.   = 0
Model used   = BPJ Assumptions, type 2 data

A limit is needed based on Chronic Toxicity
Maximum Daily Limit   = 32.1766452491711
Average Weekly limit = 32.1766452491711
Average Monthly LImit = 22

The data are:

20000

5/26/2016 11:43:11 AM

Facility = Chesterfield Power Station - 001
Chemical = Copper
Chronic averaging period = 4
WLAa   = 19
WLAc   = 13
Q.L.   = 1
samples/mo. = 1
samples/wk. = 1

Summary of Statistics:

observations = 2
Expected Value = 1.16619
Variance   = .4896
C.V.   = 0.6
97th percentile daily values = 2.83782
97th percentile 4 day average = 1.94029
97th percentile 30 day average= 1.40648
< Q.L.   = 1
Model used   = BPJ Assumptions, Type 1 data

No Limit is required for this material

The data are:

6
0

5/5/2016 2:00:20 PM

Facility = Chesterfield Power Station - 001
Chemical = Mercury
Chronic averaging period = 4
WLAa = 2.8
WLAc = 1.5
Q.L. = 0.0006
# samples/mo. = 1
# samples/wk. = 1

Summary of Statistics:

observations = 1
Expected Value = .00064
Variance = .000000
C.V. = 0.6
97th percentile daily values = .001557
97th percentile 4 day average = .001064
97th percentile 30 day average= .000771
< Q.L. = 0
Model used = BPJ Assumptions, type 2 data

No Limit is required for this material

The data are:

0.00064

5/26/2016 11:48:40 AM

Facility = Chesterfield Power Station - 001
Chemical = Zinc
Chronic averaging period = 4
WLAa = 180
WLAc = 180
Q.L. = 10
# samples/mo. = 1
# samples/wk. = 1

Summary of Statistics:

observations = 1
Expected Value = 13
Variance = 60.84
C.V. = 0.6
97th percentile daily values = 31.6344
97th percentile 4 day average = 21.6292
97th percentile 30 day average= 15.6786
< Q.L. = 0
Model used = BPJ Assumptions, type 2 data

No Limit is required for this material

The data are:

13

FRESHWATER
WATER QUALITY CRITERIA / WASTELOAD ALLOCATION ANALYSIS

Facility Name: Chesterfield Power Station 002 Permit No.: VA0004146

Receiving Stream: James River Version: OWP Guidance Memo 00-2011 (8/24/00)

Stream Information		
Mean Hardness (as CaCO3) =	66	mg/L
90% Temperature (Annual) =	29.3	deg C
90% Temperature (Wet season) =		deg C
90% Maximum pH =	8	SU
10% Maximum pH =	7.2	SU
Tier Designation (1 or 2) =	1	
Public Water Supply (PWS) Y/N? =	n	
Trout Present Y/N? =	n	
Early Life Stages Present Y/N? =	y	

Stream Flows		
1Q10 (Annual) =	1	MGD
7Q10 (Annual) =	1	MGD
30Q10 (Annual) =	1	MGD
1Q10 (Wet season) =		MGD
30Q10 (Wet season) =		MGD
30Q5 =	1	MGD
Harmonic Mean =	1	MGD

Mixing Information		
Annual - 1Q10 Mix =	100	%
- 7Q10 Mix =	100	%
- 30Q10 Mix =	100	%
Wet Season - 1Q10 Mix =	100	%
- 30Q10 Mix =	100	%

Effluent Information		
Mean Hardness (as CaCO3) =	89	mg/L
90% Temp (Annual) =	47.2	deg C
90% Temp (Wet season) =		deg C
90% Maximum pH =	8	SU
10% Maximum pH =	7.2	SU
Discharge Flow =	1	MGD

Parameter	Background	Water Quality Criteria				Wasteload Allocations				Antidegradation Baseline				Antidegradation Allocations				**Most Limiting Allocations**			
(ug/l unless noted)	Conc.	Acute	Chronic	HH (PWS)	HH	Acute	Chronic	HH (PWS)	HH	Acute	Chronic	HH (PWS)	HH	Acute	Chronic	HH (PWS)	HH	**Acute**	**Chronic**	**HH (PWS)**	**HH**
Acenapthene	0	--	--	na	9.9E+02	--	--	na	2.0E+03	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**2.0E+03**
Acrolein	0	--	--	na	9.3E+00	--	--	na	1.9E+01	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.9E+01**
Acrylonitrile[C]	0	--	--	na	2.5E+00	--	--	na	5.0E+00	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**5.0E+00**
Aldrin [C]	0	3.0E+00	--	na	5.0E-04	6.0E+00	--	na	1.0E-03	--	--	--	--	--	--	--	--	**6.0E+00**	**--**	**na**	**1.0E-03**
Ammonia-N (mg/l) (Yearly)	0	8.41E+00	5.27E-01	na	--	1.68E+01	1.05E+00	na	--	--	--	--	--	--	--	--	--	**1.68E+01**	**1.05E+00**	**na**	**--**
Ammonia-N (mg/l) (High Flow)	0	8.41E+00	2.43E+00	na	--	8.41E+00	2.43E+00	na	--	--	--	--	--	--	--	--	--	**8.41E+00**	**2.43E+00**	**na**	**--**
Anthracene	0	--	--	na	4.0E+04	--	--	na	8.0E+04	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**8.0E+04**
Antimony	0.13	--	--	na	6.4E+02	--	--	na	1.3E+03	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.3E+03**
Arsenic	0.62	3.4E+02	1.5E+02	na	--	6.8E+02	3.0E+02	na	--	--	--	--	--	--	--	--	--	**6.8E+02**	**3.0E+02**	**na**	**--**
Barium	38.66	--	--	na	--	--	--	na	--	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**--**
Benzene [C]	0	--	--	na	5.1E+02	--	--	na	1.0E+03	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.0E+03**
Benzidine[C]	0	--	--	na	2.0E-03	--	--	na	4.0E-03	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**4.0E-03**
Benzo (a) anthracene [C]	0	--	--	na	1.8E-01	--	--	na	3.6E-01	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**3.6E-01**
Benzo (b) fluoranthene [C]	0	--	--	na	1.8E-01	--	--	na	3.6E-01	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**3.6E-01**
Benzo (k) fluoranthene [C]	0	--	--	na	1.8E-01	--	--	na	3.6E-01	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**3.6E-01**
Benzo (a) pyrene [C]	0	--	--	na	1.8E-01	--	--	na	3.6E-01	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**3.6E-01**
Bis2-Chloroethyl Ether [C]	0	--	--	na	5.3E+00	--	--	na	1.1E+01	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.1E+01**
Bis2-Chloroisopropyl Ether	0	--	--	na	6.5E+04	--	--	na	1.3E+05	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.3E+05**
Bis 2-Ethylhexyl Phthalate [C]	0	--	--	na	2.2E+01	--	--	na	4.4E+01	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**4.4E+01**
Bromoform [C]	0	--	--	na	1.4E+03	--	--	na	2.8E+03	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**2.8E+03**
Butylbenzylphthalate	0	--	--	na	1.9E+03	--	--	na	3.8E+03	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**3.8E+03**
Cadmium	0.12	2.9E+00	9.3E-01	na	--	5.8E+00	1.7E+00	na	--	--	--	--	--	--	--	--	--	**5.8E+00**	**1.7E+00**	**na**	**--**
Carbon Tetrachloride [C]	0	--	--	na	1.6E+01	--	--	na	3.2E+01	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**3.2E+01**
Chlordane [C]	0	2.4E+00	4.3E-03	na	8.1E-03	4.8E+00	8.6E-03	na	1.6E-02	--	--	--	--	--	--	--	--	**4.8E+00**	**8.6E-03**	**na**	**1.6E-02**
Chloride	14.48	8.6E+05	2.3E+05	na	--	1.7E+06	4.6E+05	na	--	--	--	--	--	--	--	--	--	**1.7E+06**	**4.6E+05**	**na**	**--**
TRC	0	1.9E+01	1.1E+01	na	--	3.8E+01	2.2E+01	na	--	--	--	--	--	--	--	--	--	**3.8E+01**	**2.2E+01**	**na**	**--**
Chlorobenzene	0	--	--	na	1.6E+03	--	--	na	3.2E+03	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**3.2E+03**

Parameter	Background	Water Quality Criteria				Wasteload Allocations				Antidegradation Baseline				Antidegradation Allocations				**Most Limiting Allocations**			
(ug/l unless noted)	Conc.	Acute	Chronic	HH (PWS)	HH	Acute	Chronic	HH (PWS)	HH	Acute	Chronic	HH (PWS)	HH	Acute	Chronic	HH (PWS)	HH	**Acute**	**Chronic**	**HH (PWS)**	**HH**
Chlorodibromomethane[C]	0	--	--	na	1.3E+02	--	--	na	2.6E+02	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**2.6E+02**
Chloroform	0	--	--	na	1.1E+04	--	--	na	2.2E+04	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**2.2E+04**
2-Chloronaphthalene	0	--	--	na	1.6E+03	--	--	na	3.2E+03	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**3.2E+03**
2-Chlorophenol	0	--	--	na	1.5E+02	--	--	na	3.0E+02	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**3.0E+02**
Chlorpyrifos	0	8.3E-02	4.1E-02	na	--	1.7E-01	8.2E-02	na	--	--	--	--	--	--	--	--	--	**1.7E-01**	**8.2E-02**	**na**	**--**
Chromium III	0	4.6E+02	6.0E+01	na	--	9.2E+02	1.2E+02	na	--	--	--	--	--	--	--	--	--	**9.2E+02**	**1.2E+02**	**na**	**--**
Chromium VI	0	1.6E+01	1.1E+01	na	--	3.2E+01	2.2E+01	na	--	--	--	--	--	--	--	--	--	**3.2E+01**	**2.2E+01**	**na**	**--**
Chromium, Total	0	--	--	1.0E+02	--	--	--	na	--	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**--**
Chrysene [C]	0	--	--	na	1.8E-02	--	--	na	3.6E-02	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**3.6E-02**
Copper	1.31	1.1E+01	7.2E+00	na	--	2.0E+01	1.3E+01	na	--	--	--	--	--	--	--	--	--	**2.0E+01**	**1.3E+01**	**na**	**--**
Cyanide, Free	0	2.2E+01	5.2E+00	na	1.6E+04	4.4E+01	1.0E+01	na	3.2E+04	--	--	--	--	--	--	--	--	**4.4E+01**	**1.0E+01**	**na**	**3.2E+04**
DDD [C]	0	--	--	na	3.1E-03	--	--	na	6.2E-03	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**6.2E-03**
DDE [C]	0	--	--	na	2.2E-03	--	--	na	4.4E-03	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**4.4E-03**
DDT [C]	0	1.1E+00	1.0E-03	na	2.2E-03	2.2E+00	2.0E-03	na	4.4E-03	--	--	--	--	--	--	--	--	**2.2E+00**	**2.0E-03**	**na**	**4.4E-03**
Demeton	0	--	1.0E-01	na	--	--	2.0E-01	na	--	--	--	--	--	--	--	--	--	**--**	**2.0E-01**	**na**	**--**
Diazinon	0	1.7E-01	1.7E-01	na	--	3.4E-01	3.4E-01	na	--	--	--	--	--	--	--	--	--	**3.4E-01**	**3.4E-01**	**na**	**--**
Dibenz(a,h)anthracene [C]	0	--	--	na	1.8E-01	--	--	na	3.6E-01	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**3.6E-01**
1,2-Dichlorobenzene	0	--	--	na	1.3E+03	--	--	na	2.6E+03	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**2.6E+03**
1,3-Dichlorobenzene	0	--	--	na	9.6E+02	--	--	na	1.9E+03	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.9E+03**
1,4-Dichlorobenzene	0	--	--	na	1.9E+02	--	--	na	3.8E+02	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**3.8E+02**
3,3-Dichlorobenzidine[C]	0	--	--	na	2.8E-01	--	--	na	5.6E-01	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**5.6E-01**
Dichlorobromomethane [C]	0	--	--	na	1.7E+02	--	--	na	3.4E+02	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**3.4E+02**
1,2-Dichloroethane [C]	0	--	--	na	3.7E+02	--	--	na	7.4E+02	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**7.4E+02**
1,1-Dichloroethylene	0	--	--	na	7.1E+03	--	--	na	1.4E+04	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.4E+04**
1,2-trans-dichloroethylene	0	--	--	na	1.0E+04	--	--	na	2.0E+04	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**2.0E+04**
2,4-Dichlorophenol	0	--	--	na	2.9E+02	--	--	na	5.8E+02	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**5.8E+02**
2,4-Dichlorophenoxy acetic acid (2,4-D)	0	--	--	na	--	--	--	na	--	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**--**
1,2-Dichloropropane[C]	0	--	--	na	1.5E+02	--	--	na	3.0E+02	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**3.0E+02**
1,3-Dichloropropene [C]	0	--	--	na	2.1E+02	--	--	na	4.2E+02	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**4.2E+02**
Dieldrin [C]	0	2.4E-01	5.6E-02	na	5.4E-04	4.8E-01	1.1E-01	na	1.1E-03	--	--	--	--	--	--	--	--	**4.8E-01**	**1.1E-01**	**na**	**1.1E-03**
Diethyl Phthalate	0	--	--	na	4.4E+04	--	--	na	8.8E+04	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**8.8E+04**
2,4-Dimethylphenol	0	--	--	na	8.5E+02	--	--	na	1.7E+03	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.7E+03**
Dimethyl Phthalate	0	--	--	na	1.1E+06	--	--	na	2.2E+06	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**2.2E+06**
Di-n-Butyl Phthalate	0	--	--	na	4.5E+03	--	--	na	9.0E+03	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**9.0E+03**
2,4 Dinitrophenol	0	--	--	na	5.3E+03	--	--	na	1.1E+04	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.1E+04**
2-Methyl-4,6-Dinitrophenol	0	--	--	na	2.8E+02	--	--	na	5.6E+02	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**5.6E+02**
2,4-Dinitrotoluene [C]	0	--	--	na	3.4E+01	--	--	na	6.8E+01	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**6.8E+01**
Dioxin 2,3,7,8-tetrachlorodibenzo-p-dioxin	0	--	--	na	5.1E-08	--	--	na	1.0E-07	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.0E-07**
1,2-Diphenylhydrazine[C]	0	--	--	na	2.0E+00	--	--	na	4.0E+00	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**4.0E+00**
Alpha-Endosulfan	0	2.2E-01	5.6E-02	na	8.9E+01	4.4E-01	1.1E-01	na	1.8E+02	--	--	--	--	--	--	--	--	**4.4E-01**	**1.1E-01**	**na**	**1.8E+02**
Beta-Endosulfan	0	2.2E-01	5.6E-02	na	8.9E+01	4.4E-01	1.1E-01	na	1.8E+02	--	--	--	--	--	--	--	--	**4.4E-01**	**1.1E-01**	**na**	**1.8E+02**
Alpha + Beta Endosulfan	0	2.2E-01	5.6E-02	--	--	4.4E-01	1.1E-01	--	--	--	--	--	--	--	--	--	--	**4.4E-01**	**1.1E-01**	**--**	**--**
Endosulfan Sulfate	0	--	--	na	8.9E+01	--	--	na	1.8E+02	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.8E+02**
Endrin	0	8.6E-02	3.6E-02	na	6.0E-02	1.7E-01	7.2E-02	na	1.2E-01	--	--	--	--	--	--	--	--	**1.7E-01**	**7.2E-02**	**na**	**1.2E-01**
Endrin Aldehyde	0	--	--	na	3.0E-01	--	--	na	6.0E-01	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**6.0E-01**

Parameter	Background	Water Quality Criteria				Wasteload Allocations				Antidegradation Baseline				Antidegradation Allocations				**Most Limiting Allocations**			
(ug/l unless noted)	Conc.	Acute	Chronic	HH (PWS)	HH	Acute	Chronic	HH (PWS)	HH	Acute	Chronic	HH (PWS)	HH	Acute	Chronic	HH (PWS)	HH	**Acute**	**Chronic**	**HH (PWS)**	**HH**
Ethylbenzene	0	--	--	na	2.1E+03	--	--	na	4.2E+03	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**4.2E+03**
Fluoranthene	0	--	--	na	1.4E+02	--	--	na	2.8E+02	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**2.8E+02**
Fluorene	0	--	--	na	5.3E+03	--	--	na	1.1E+04	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.1E+04**
Foaming Agents	0	--	--	na	--	--	--	na	--	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**--**
Guthion	0	--	1.0E-02	na	--	--	2.0E-02	na	--	--	--	--	--	--	--	--	--	**--**	**2.0E-02**	**na**	**--**
Heptachlor [C]	0	5.2E-01	3.8E-03	na	7.9E-04	1.0E+00	7.6E-03	na	1.6E-03	--	--	--	--	--	--	--	--	**1.0E+00**	**7.6E-03**	**na**	**1.6E-03**
Heptachlor Epoxide[C]	0	5.2E-01	3.8E-03	na	3.9E-04	1.0E+00	7.6E-03	na	7.8E-04	--	--	--	--	--	--	--	--	**1.0E+00**	**7.6E-03**	**na**	**7.8E-04**
Hexachlorobenzene[C]	0	--	--	na	2.9E-03	--	--	na	5.8E-03	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**5.8E-03**
Hexachlorobutadiene[C]	0	--	--	na	1.8E+02	--	--	na	3.6E+02	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**3.6E+02**
Hexachlorocyclohexane Alpha-BHC[C]	0	--	--	na	4.9E-02	--	--	na	9.8E-02	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**9.8E-02**
Hexachlorocyclohexane Beta-BHC[C]	0	--	--	na	1.7E-01	--	--	na	3.4E-01	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**3.4E-01**
Hexachlorocyclohexane Gamma-BHC[C] (Lindane)	0	9.5E-01	na	na	1.8E+00	1.9E+00	--	na	3.6E+00	--	--	--	--	--	--	--	--	**1.9E+00**	**--**	**na**	**3.6E+00**
Hexachlorocyclopentadiene	0	--	--	na	1.1E+03	--	--	na	2.2E+03	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**2.2E+03**
Hexachloroethane[C]	0	--	--	na	3.3E+01	--	--	na	6.6E+01	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**6.6E+01**
Hydrogen Sulfide	0	--	2.0E+00	na	--	--	4.0E+00	na	--	--	--	--	--	--	--	--	--	**--**	**4.0E+00**	**na**	**--**
Indeno (1,2,3-cd) pyrene [C]	0	--	--	na	1.8E-01	--	--	na	3.6E-01	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**3.6E-01**
Iron	725	--	--	na	--	--	--	na	--	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**--**
Isophorone[C]	0	--	--	na	9.6E+03	--	--	na	1.9E+04	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.9E+04**
Kepone	0	--	0.0E+00	na	--	--	0.0E+00	na	--	--	--	--	--	--	--	--	--	**--**	**0.0E+00**	**na**	**--**
Lead	0.3	8.6E+01	9.8E+00	na	--	1.7E+02	1.9E+01	na	--	--	--	--	--	--	--	--	--	**1.7E+02**	**1.9E+01**	**na**	**--**
Malathion	0	--	1.0E-01	na	--	--	2.0E-01	na	--	--	--	--	--	--	--	--	--	**--**	**2.0E-01**	**na**	**--**
Manganese	266.58	--	--	na	--	--	--	na	--	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**--**
Mercury	0.00269	1.4E+00	7.7E-01	- -	- -	2.8E+00	1.5E+00	- -	- -	--	--	--	--	--	--	--	--	**2.8E+00**	**1.5E+00**	**- -**	**- -**
Methyl Bromide	0	--	--	na	1.5E+03	--	--	na	3.0E+03	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**3.0E+03**
Methylene Chloride [C]	0	--	--	na	5.9E+03	--	--	na	1.2E+04	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.2E+04**
Methoxychlor	0	--	3.0E-02	na	--	--	6.0E-02	na	--	--	--	--	--	--	--	--	--	**--**	**6.0E-02**	**na**	**--**
Mirex	0	--	0.0E+00	na	--	--	0.0E+00	na	--	--	--	--	--	--	--	--	--	**--**	**0.0E+00**	**na**	**--**
Nickel	1.29	1.5E+02	1.6E+01	na	4.6E+03	2.9E+02	3.1E+01	na	9.2E+03	--	--	--	--	--	--	--	--	**2.9E+02**	**3.1E+01**	**na**	**9.2E+03**
Nitrate (as N)	0	--	--	na	--	--	--	na	--	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**--**
Nitrobenzene	0	--	--	na	6.9E+02	--	--	na	1.4E+03	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.4E+03**
N-Nitrosodimethylamine[C]	0	--	--	na	3.0E+01	--	--	na	6.0E+01	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**6.0E+01**
N-Nitrosodiphenylamine[C]	0	--	--	na	6.0E+01	--	--	na	1.2E+02	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.2E+02**
N-Nitrosodi-n-propylamine[C]	0	--	--	na	5.1E+00	--	--	na	1.0E+01	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.0E+01**
Nonylphenol	0	2.8E+01	6.6E+00	--	--	5.6E+01	1.3E+01	na	--	--	--	--	--	--	--	--	--	**5.6E+01**	**1.3E+01**	**na**	**--**
Parathion	0	6.5E-02	1.3E-02	na	--	1.3E-01	2.6E-02	na	--	--	--	--	--	--	--	--	--	**1.3E-01**	**2.6E-02**	**na**	**--**
PCB Total[C]	0	--	1.4E-02	na	6.4E-04	--	2.8E-02	na	1.3E-03	--	--	--	--	--	--	--	--	**--**	**2.8E-02**	**na**	**1.3E-03**
Pentachlorophenol [C]	0	1.1E+01	8.2E+00	na	3.0E+01	2.1E+01	1.6E+01	na	6.0E+01	--	--	--	--	--	--	--	--	**2.1E+01**	**1.6E+01**	**na**	**6.0E+01**
Phenol	0	--	--	na	8.6E+05	--	--	na	1.7E+06	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.7E+06**
Pyrene	0	--	--	na	4.0E+03	--	--	na	8.0E+03	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**8.0E+03**
Radionuclides	0	--	--	na	--	--	--	na	--	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**--**
Gross Alpha Activity (pCi/L)	0	--	--	na	--	--	--	na	--	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**--**
Beta and Photon Activity (mrem/yr)	0	--	--	na	--	--	--	na	--	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**--**
Radium 226 + 228 (pCi/L)	0	--	--	na	--	--	--	na	--	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**--**
Uranium (ug/l)	0	--	--	na	--	--	--	na	--	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**--**

Parameter	Background	Water Quality Criteria				Wasteload Allocations				Antidegradation Baseline				Antidegradation Allocations				**Most Limiting Allocations**			
(ug/l unless noted)	Conc.	Acute	Chronic	HH (PWS)	HH	Acute	Chronic	HH (PWS)	HH	Acute	Chronic	HH (PWS)	HH	Acute	Chronic	HH (PWS)	HH	**Acute**	**Chronic**	**HH (PWS)**	**HH**
Selenium, Total Recoverable	0.26	2.0E+01	5.0E+00	na	4.2E+03	4.0E+01	9.7E+00	na	8.4E+03	--	--	--	--	--	--	--	--	**4.0E+01**	**9.7E+00**	**na**	**8.4E+03**
Silver	0.03	2.2E+00	--	na	--	4.4E+00	--	na	--	--	--	--	--	--	--	--	--	**4.4E+00**	**--**	**na**	**--**
Sulfate	0	--	--	na	--	--	--	na	--	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**--**
1,1,2,2-Tetrachloroethane[C]	0	--	--	na	4.0E+01	--	--	na	8.0E+01	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**8.0E+01**
Tetrachloroethylene[C]	0	--	--	na	3.3E+01	--	--	na	6.6E+01	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**6.6E+01**
Thallium	0.04	--	--	na	4.7E-01	--	--	na	9.0E-01	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**9.0E-01**
Toluene	0	--	--	na	6.0E+03	--	--	na	1.2E+04	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.2E+04**
Total dissolved solids	0	--	--	na	--	--	--	na	--	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**--**
Toxaphene [C]	0	7.3E-01	2.0E-04	na	2.8E-03	1.5E+00	4.0E-04	na	5.6E-03	--	--	--	--	--	--	--	--	**1.5E+00**	**4.0E-04**	**na**	**5.6E-03**
Tributyltin	0	4.6E-01	7.2E-02	na	--	9.2E-01	1.4E-01	na	--	--	--	--	--	--	--	--	--	**9.2E-01**	**1.4E-01**	**na**	**--**
1,2,4-Trichlorobenzene	0	--	--	na	7.0E+01	--	--	na	1.4E+02	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.4E+02**
1,1,2-Trichloroethane[C]	0	--	--	na	1.6E+02	--	--	na	3.2E+02	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**3.2E+02**
Trichloroethylene [C]	0	--	--	na	3.0E+02	--	--	na	6.0E+02	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**6.0E+02**
2,4,6-Trichlorophenol [C]	0	--	--	na	2.4E+01	--	--	na	4.8E+01	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**4.8E+01**
2-(2,4,5-Trichlorophenoxy) propionic acid (Silvex)	0	--	--	na	--	--	--	na	--	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**--**
Vinyl Chloride[C]	0	--	--	na	2.4E+01	--	--	na	4.8E+01	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**4.8E+01**
Zinc	6.23	9.4E+01	9.5E+01	na	2.6E+04	1.8E+02	1.8E+02	na	5.2E+04	--	--	--	--	--	--	--	--	**1.8E+02**	**1.8E+02**	**na**	**5.2E+04**

Notes:

1. All concentrations expressed as micrograms/liter (ug/l), unless noted otherwise
2. Discharge flow is highest monthly average or Form 2C maximum for Industries and design flow for Municipals
3. Metals measured as Dissolved, unless specified otherwise
4. "C" indicates a carcinogenic parameter
5. Regular WLAs are mass balances (minus background concentration) using the % of stream flow entered above under Mixing Information.
   Antidegradation WLAs are based upon a complete mix.
6. Antideg. Baseline = (0.25(WQC - background conc.) + background conc.) for acute and chronic
   = (0.1(WQC - background conc.) + background conc.) for human health
7. WLAs established at the following stream flows: 1Q10 for Acute, 30Q10 for Chronic Ammonia, 7Q10 for Other Chronic, 30Q5 for Non-carcinogens and Harmonic Mean for Carcinogens. To apply mixing ratios from a model set the stream flow equal to (mixing ratio - 1), effluent flow equal to 1 and 100% mix.

Metal	Target Value (SSTV)
Antimony	1.3E+03
Arsenic	1.8E+02
Barium	na
Cadmium	1.0E+00
Chromium III	7.2E+01
Chromium VI	1.3E+01
Copper	7.9E+00
Iron	na
Lead	1.2E+01
Manganese	na
Mercury	9.2E-01
Nickel	1.9E+01
Selenium	5.8E+00
Silver	1.8E+00
Zinc	7.3E+01

Note: do not use QL's lower than the minimum QL's provided in agency guidance

5/5/2016 2:04:29 PM

Facility = Chesterfield Power Station 002
Chemical = Ammonia
Chronic averaging period = 30
WLAa = 16.8
WLAc = 1.05
Q.L. = 0.05
# samples/mo. = 1
# samples/wk. = 1

Summary of Statistics:

observations = 1
Expected Value = .07
Variance = .001764
C.V. = 0.6
97th percentile daily values = .170339
97th percentile 4 day average = .116465
97th percentile 30 day average= .084423
< Q.L. = 0
Model used = BPJ Assumptions, type 2 data

No Limit is required for this material

The data are:

0.07

5/27/2016 10:40:53 AM

Facility = Chesterfield Power Station - 002
Chemical = Chloride
Chronic averaging period = 4
WLAa = 1700000
WLAc = 4600000
Q.L. = 100
# samples/mo. = 1
# samples/wk. = 1

Summary of Statistics:

observations = 1
Expected Value = 32010
Variance = 3688704
C.V. = 0.6
97th percentile daily values = 77893.6
97th percentile 4 day average = 53257.9
97th percentile 30 day average= 38605.7
< Q.L. = 0
Model used = BPJ Assumptions, type 2 data

No Limit is required for this material

The data are:

32010

5/13/2016 10:03:25 AM

Facility = Chesterfield Power Station - 002
Chemical = TRC
Chronic averaging period = 4
WLAa   = 38
WLAc   = 22
Q.L.   = 100
samples/mo. = 4
samples/wk. = 1

Summary of Statistics:

observations = 1
Expected Value = 20000
Variance   = 1440000
C.V.   = 0.6
97th percentile daily values = 48668.3
97th percentile 4 day average = 33275.8
97th percentile 30 day average= 24121.0
< Q.L.   = 0
Model used   = BPJ Assumptions, type 2 data

A limit is needed based on Chronic Toxicity
Maximum Daily Limit   = 32.1766452491711
Average Weekly limit = 32.1766452491711
Average Monthly LImit = 22

The data are:

20000

6/2/2016 9:23:33 AM

Facility = Chesterfield Power Station - 002
Chemical = Copper
Chronic averaging period = 4
WLAa = 20
WLAc = 13
Q.L. = 1
# samples/mo. = 1
# samples/wk. = 1

Summary of Statistics:

observations = 4
Expected Value = 7.5
Variance = 20.25
C.V. = 0.6
97th percentile daily values = 18.2506
97th percentile 4 day average = 12.4784
97th percentile 30 day average= 9.04539
< Q.L. = 0
Model used = BPJ Assumptions, type 2 data

No Limit is required for this material

The data are:

13
4
8
5

5/5/2016 2:07:39 PM

Facility = Chesterfield Power Station 002
Chemical = Mercury
Chronic averaging period = 4
WLAa = 2.8
WLAc = 1.5
Q.L. = 0.0001
# samples/mo. = 1
# samples/wk. = 1

Summary of Statistics:

observations = 1
Expected Value = .00094
Variance = .000000
C.V. = 0.6
97th percentile daily values = .002287
97th percentile 4 day average = .001563
97th percentile 30 day average= .001133
< Q.L. = 0
Model used = BPJ Assumptions, type 2 data

No Limit is required for this material

The data are:

0.00094

5/26/2016 11:57:14 AM

Facility = Chesterfield Power Station - 002
Chemical = Zinc
Chronic averaging period = 4
WLAa = 180
WLAc = 180
Q.L. = 10
# samples/mo. = 1
# samples/wk. = 1

Summary of Statistics:

observations = 1
Expected Value = 26
Variance = 243.36
C.V. = 0.6
97th percentile daily values = 63.2688
97th percentile 4 day average = 43.2585
97th percentile 30 day average= 31.3573
< Q.L. = 0
Model used = BPJ Assumptions, type 2 data

No Limit is required for this material

The data are:

26

b. Reasonable Potential Analysis for Outfall 003

Effluent limitations for parameters submitted with the application were evaluated in accordance with DEQ Guidance Memo 00-2011. All observed pollutants and pollutants reported less than QLs that exceeded the agency accepted values were evaluated for reasonable potential to violate in stream water quality standards. Pollutants that were reported less than a DEQ accepted QL were considered absent for the purposes of this evaluation.

MSTRANTI (version 2b), a DEQ developed spreadsheet was used to calculate Waste Load Allocations (WLAs) based on mixed conditions. Stream data, effluent data and mixing ratios were entered into MSTRANTI to determine the WLAs.

Like Outfalls 001 and 002, Outfall 003 discharges to the tidal James River. However, because Outfall 003 discharges a large volume of water at the head of Farrar Gut, it creates free flowing stream characteristics in a tidal water body. Historically, discharges to Farrar Gut have been evaluated as if to a free-flowing stream because of this discharge. This approach remains appropriate and will be carried forward in the 2016 permit reissuance. Because the Outfall 003 discharge creates the free flowing stream condition, it is evaluated as if discharging to a dry ditch with zero flow. This represents a more conservative analysis than assuming tidal defaults. Further, because of this condition, background concentrations were not used.

STATS.EXE (version 2.0.4) is then used to evaluate reasonable potential and calculate a limitation if needed. WLAs, monitoring frequencies and reported effluent pollutant concentrations are input in STATS.EXE to evaluate each pollutant individually. Because chlorine is purposefully introduced in to the effluent, TRC limitations were forced using an assumed datum. As shown in the STATS outputs included in this section, no other limitations are needed to protect ambient aquatic Water Quality Standards at Outfall 003.

For parameters with standards based on Human Health (HH), the maximum observed values were compared to the HH WLAs calculated in MSTRANTI. The receiving stream is not designated as a PWS, so the HH PWS standards do not apply to this discharge. As shown in the table below, all observed values are less than the applicable WLAs. Pollutants without an applicable standard cannot be evaluated at this time.

Pollutant	Observed Values	Human Health WLA	Reasonable Potential (Y/N)
Dissolved Copper (µg/L)	2.00	-	N(1)
Chloroform (µg/L)	1.89	11,000	N
Beta Particle & Photon Activity (pCi/L)	3.23	-	N(1)
Chlorides (µg/L)	32,060	-	N(1)
E. coli (N/100mL)	30	126	N
Dissolved Barium (µg/L)	121*	-	N(1)
Dissolved Iron (µg/L)	560*	-	N(1)
Dissolved Manganese (µg/L)	60*	-	N(1)
Sulfate (mg/L)	57.2	-	N(1)

* Observed values are expressed in terms of total rather than dissolved.
(1)Receiving stream not subject to PWS-based Human Health WQS.

MSTRANTI DATA SOURCE REPORT
(Chesterfield Power Station: Outfall 003)

Stream Information	
Mean Hardness	2-JMS099.30
90% Temperature (annual)	Refer to Outfall 003 Effluent Information
90% Temperature (wet season)	
90% Maximum pH	
10% Maximum pH	
Tier Designation	Flow Frequency Memo (02/29/2016)
Stream Flows	
All Data	Per the Flow Frequency Memo (02/29/2016), effluent flow from outfall 003 dominates the tidal receiving stream, Farrar Gut. Consequently, Farrar Gut is treated as a free flowing stream with Outfall 003 being the head of the stream. Ambient flows of zero are used as a conservative assumption.
Mixing Information	
All percentages	100% mix assumed because effluent flow from Outfall 003 dominates the tidal flow within Farrar Gut.
Effluent Information	
Mean Hardness	App Data
90% Temperature (annual)	90th percentile of the max temperature reported on the monthly DMRs over the last three years.
90% Temperature (wet season)	NA
90% Maximum pH	The ambient stream pH based on 40 years of sampling (2-JMS099.30) was used in lieu of the single effluent sample provided in the application. Because the effluent is non-contact cooling water withdrawn from the river and

10% Maximum pH	there is no chemical adjustment of pH, the stream values are considered a more conservative input. In addition, the single sample effluent value is within the ambient range.
Discharge Flow	Max Daily Flow reported in the application.

Data Location:

Flow Frequency Analysis — Attachment 2
DMR Data — Attachment 4.a
App Data — Attachment 4.b

FRESHWATER
WATER QUALITY CRITERIA / WASTELOAD ALLOCATION ANALYSIS

Facility Name: Chesterfield Power Station 003 Permit No.: VA0004146

Receiving Stream: Farrar Gut Version: OWP Guidance Memo 00-2011 (8/24/00)

Stream Information		
Mean Hardness (as CaCO3) =	66	mg/L
90% Temperature (Annual) =	51.7	deg C
90% Temperature (Wet season) =		deg C
90% Maximum pH =	8	SU
10% Maximum pH =	7.2	SU
Tier Designation (1 or 2) =	1	
Public Water Supply (PWS) Y/N? =	n	
Trout Present Y/N? =	n	
Early Life Stages Present Y/N? =	y	

Stream Flows		
1Q10 (Annual) =	0	MGD
7Q10 (Annual) =	0	MGD
30Q10 (Annual) =	0	MGD
1Q10 (Wet season) =		MGD
30Q10 (Wet season) =		MGD
30Q5 =	0	MGD
Harmonic Mean =	0	MGD

Mixing Information		
Annual - 1Q10 Mix =	100	%
- 7Q10 Mix =	100	%
- 30Q10 Mix =	100	%
Wet Season - 1Q10 Mix =		%
- 30Q10 Mix =		%

Effluent Information		
Mean Hardness (as CaCO3) =	92	mg/L
90% Temp (Annual) =	51.7	deg C
90% Temp (Wet season) =		deg C
90% Maximum pH =	8	SU
10% Maximum pH =	7.2	SU
Discharge Flow =	742	MGD

Parameter	Background	Water Quality Criteria				Wasteload Allocations				Antidegradation Baseline				Antidegradation Allocations				**Most Limiting Allocations**			
(ug/l unless noted)	Conc.	Acute	Chronic	HH (PWS)	HH	Acute	Chronic	HH (PWS)	HH	Acute	Chronic	HH (PWS)	HH	Acute	Chronic	HH (PWS)	HH	**Acute**	**Chronic**	**HH (PWS)**	**HH**
Acenapthene	0	--	--	na	9.9E+02	--	--	na	9.9E+02	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**9.9E+02**
Acrolein	0	--	--	na	9.3E+00	--	--	na	9.3E+00	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**9.3E+00**
Acrylonitrile[C]	0	--	--	na	2.5E+00	--	--	na	2.5E+00	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**2.5E+00**
Aldrin [C]	0	3.0E+00	--	na	5.0E-04	3.0E+00	--	na	5.0E-04	--	--	--	--	--	--	--	--	**3.0E+00**	**--**	**na**	**5.0E-04**
Ammonia-N (mg/l) (Yearly)	0	8.41E+00	2.21E-01	na	--	8.41E+00	2.21E-01	na	--	--	--	--	--	--	--	--	--	**8.41E+00**	**2.21E-01**	**na**	**--**
Ammonia-N (mg/l) (High Flow)	0	8.41E+00	2.43E+00	na	--	8.41E+00	2.43E+00	na	--	--	--	--	--	--	--	--	--	**8.41E+00**	**2.43E+00**	**na**	**--**
Anthracene	0	--	--	na	4.0E+04	--	--	na	4.0E+04	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**4.0E+04**
Antimony	0	--	--	na	6.4E+02	--	--	na	6.4E+02	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**6.4E+02**
Arsenic	0	3.4E+02	1.5E+02	na	--	3.4E+02	1.5E+02	na	--	--	--	--	--	--	--	--	--	**3.4E+02**	**1.5E+02**	**na**	**--**
Barium	0	--	--	na	--	--	--	na	--	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**--**
Benzene [C]	0	--	--	na	5.1E+02	--	--	na	5.1E+02	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**5.1E+02**
Benzidine[C]	0	--	--	na	2.0E-03	--	--	na	2.0E-03	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**2.0E-03**
Benzo (a) anthracene [C]	0	--	--	na	1.8E-01	--	--	na	1.8E-01	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.8E-01**
Benzo (b) fluoranthene [C]	0	--	--	na	1.8E-01	--	--	na	1.8E-01	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.8E-01**
Benzo (k) fluoranthene [C]	0	--	--	na	1.8E-01	--	--	na	1.8E-01	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.8E-01**
Benzo (a) pyrene [C]	0	--	--	na	1.8E-01	--	--	na	1.8E-01	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.8E-01**
Bis2-Chloroethyl Ether [C]	0	--	--	na	5.3E+00	--	--	na	5.3E+00	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**5.3E+00**
Bis2-Chloroisopropyl Ether	0	--	--	na	6.5E+04	--	--	na	6.5E+04	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**6.5E+04**
Bis 2-Ethylhexyl Phthalate [C]	0	--	--	na	2.2E+01	--	--	na	2.2E+01	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**2.2E+01**
Bromoform [C]	0	--	--	na	1.4E+03	--	--	na	1.4E+03	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.4E+03**
Butylbenzylphthalate	0	--	--	na	1.9E+03	--	--	na	1.9E+03	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.9E+03**
Cadmium	0	3.6E+00	1.1E+00	na	--	3.6E+00	1.1E+00	na	--	--	--	--	--	--	--	--	--	**3.6E+00**	**1.1E+00**	**na**	**--**
Carbon Tetrachloride [C]	0	--	--	na	1.6E+01	--	--	na	1.6E+01	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.6E+01**
Chlordane [C]	0	2.4E+00	4.3E-03	na	8.1E-03	2.4E+00	4.3E-03	na	8.1E-03	--	--	--	--	--	--	--	--	**2.4E+00**	**4.3E-03**	**na**	**8.1E-03**
Chloride	0	8.6E+05	2.3E+05	na	--	8.6E+05	2.3E+05	na	--	--	--	--	--	--	--	--	--	**8.6E+05**	**2.3E+05**	**na**	**--**
TRC	0	1.9E+01	1.1E+01	na	--	1.9E+01	1.1E+01	na	--	--	--	--	--	--	--	--	--	**1.9E+01**	**1.1E+01**	**na**	**--**
Chlorobenzene	0	--	--	na	1.6E+03	--	--	na	1.6E+03	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.6E+03**

Parameter	Background	Water Quality Criteria				Wasteload Allocations				Antidegradation Baseline				Antidegradation Allocations				**Most Limiting Allocations**			
(ug/l unless noted)	Conc.	Acute	Chronic	HH (PWS)	HH	Acute	Chronic	HH (PWS)	HH	Acute	Chronic	HH (PWS)	HH	Acute	Chronic	HH (PWS)	HH	**Acute**	**Chronic**	**HH (PWS)**	**HH**
Chlorodibromomethane[C]	0	--	--	na	1.3E+02	--	--	na	1.3E+02	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.3E+02**
Chloroform	0	--	--	na	1.1E+04	--	--	na	1.1E+04	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.1E+04**
2-Chloronaphthalene	0	--	--	na	1.6E+03	--	--	na	1.6E+03	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.6E+03**
2-Chlorophenol	0	--	--	na	1.5E+02	--	--	na	1.5E+02	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.5E+02**
Chlorpyrifos	0	8.3E-02	4.1E-02	na	--	8.3E-02	4.1E-02	na	--	--	--	--	--	--	--	--	--	**8.3E-02**	**4.1E-02**	**na**	**--**
Chromium III	0	5.3E+02	6.9E+01	na	--	5.3E+02	6.9E+01	na	--	--	--	--	--	--	--	--	--	**5.3E+02**	**6.9E+01**	**na**	**--**
Chromium VI	0	1.6E+01	1.1E+01	na	--	1.6E+01	1.1E+01	na	--	--	--	--	--	--	--	--	--	**1.6E+01**	**1.1E+01**	**na**	**--**
Chromium, Total	0	--	--	1.0E+02	--	--	--	na	--	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**--**
Chrysene [C]	0	--	--	na	1.8E-02	--	--	na	1.8E-02	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.8E-02**
Copper	0	1.2E+01	8.3E+00	na	--	1.2E+01	8.3E+00	na	--	--	--	--	--	--	--	--	--	**1.2E+01**	**8.3E+00**	**na**	**--**
Cyanide, Free	0	2.2E+01	5.2E+00	na	1.6E+04	2.2E+01	5.2E+00	na	1.6E+04	--	--	--	--	--	--	--	--	**2.2E+01**	**5.2E+00**	**na**	**1.6E+04**
DDD [C]	0	--	--	na	3.1E-03	--	--	na	3.1E-03	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**3.1E-03**
DDE [C]	0	--	--	na	2.2E-03	--	--	na	2.2E-03	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**2.2E-03**
DDT [C]	0	1.1E+00	1.0E-03	na	2.2E-03	1.1E+00	1.0E-03	na	2.2E-03	--	--	--	--	--	--	--	--	**1.1E+00**	**1.0E-03**	**na**	**2.2E-03**
Demeton	0	--	1.0E-01	na	--	--	1.0E-01	na	--	--	--	--	--	--	--	--	--	**--**	**1.0E-01**	**na**	**--**
Diazinon	0	1.7E-01	1.7E-01	na	--	1.7E-01	1.7E-01	na	--	--	--	--	--	--	--	--	--	**1.7E-01**	**1.7E-01**	**na**	**--**
Dibenz(a,h)anthracene [C]	0	--	--	na	1.8E-01	--	--	na	1.8E-01	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.8E-01**
1,2-Dichlorobenzene	0	--	--	na	1.3E+03	--	--	na	1.3E+03	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.3E+03**
1,3-Dichlorobenzene	0	--	--	na	9.6E+02	--	--	na	9.6E+02	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**9.6E+02**
1,4-Dichlorobenzene	0	--	--	na	1.9E+02	--	--	na	1.9E+02	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.9E+02**
3,3-Dichlorobenzidine[C]	0	--	--	na	2.8E-01	--	--	na	2.8E-01	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**2.8E-01**
Dichlorobromomethane [C]	0	--	--	na	1.7E+02	--	--	na	1.7E+02	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.7E+02**
1,2-Dichloroethane [C]	0	--	--	na	3.7E+02	--	--	na	3.7E+02	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**3.7E+02**
1,1-Dichloroethylene	0	--	--	na	7.1E+03	--	--	na	7.1E+03	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**7.1E+03**
1,2-trans-dichloroethylene	0	--	--	na	1.0E+04	--	--	na	1.0E+04	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.0E+04**
2,4-Dichlorophenol	0	--	--	na	2.9E+02	--	--	na	2.9E+02	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**2.9E+02**
2,4-Dichlorophenoxy acetic acid (2,4-D)	0	--	--	na	--	--	--	na	--	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**--**
1,2-Dichloropropane[C]	0	--	--	na	1.5E+02	--	--	na	1.5E+02	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.5E+02**
1,3-Dichloropropene [C]	0	--	--	na	2.1E+02	--	--	na	2.1E+02	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**2.1E+02**
Dieldrin [C]	0	2.4E-01	5.6E-02	na	5.4E-04	2.4E-01	5.6E-02	na	5.4E-04	--	--	--	--	--	--	--	--	**2.4E-01**	**5.6E-02**	**na**	**5.4E-04**
Diethyl Phthalate	0	--	--	na	4.4E+04	--	--	na	4.4E+04	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**4.4E+04**
2,4-Dimethylphenol	0	--	--	na	8.5E+02	--	--	na	8.5E+02	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**8.5E+02**
Dimethyl Phthalate	0	--	--	na	1.1E+06	--	--	na	1.1E+06	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.1E+06**
Di-n-Butyl Phthalate	0	--	--	na	4.5E+03	--	--	na	4.5E+03	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**4.5E+03**
2,4 Dinitrophenol	0	--	--	na	5.3E+03	--	--	na	5.3E+03	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**5.3E+03**
2-Methyl-4,6-Dinitrophenol	0	--	--	na	2.8E+02	--	--	na	2.8E+02	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**2.8E+02**
2,4-Dinitrotoluene [C]	0	--	--	na	3.4E+01	--	--	na	3.4E+01	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**3.4E+01**
Dioxin 2,3,7,8-tetrachlorodibenzo-p-dioxin	0	--	--	na	5.1E-08	--	--	na	5.1E-08	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**5.1E-08**
1,2-Diphenylhydrazine[C]	0	--	--	na	2.0E+00	--	--	na	2.0E+00	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**2.0E+00**
Alpha-Endosulfan	0	2.2E-01	5.6E-02	na	8.9E+01	2.2E-01	5.6E-02	na	8.9E+01	--	--	--	--	--	--	--	--	**2.2E-01**	**5.6E-02**	**na**	**8.9E+01**
Beta-Endosulfan	0	2.2E-01	5.6E-02	na	8.9E+01	2.2E-01	5.6E-02	na	8.9E+01	--	--	--	--	--	--	--	--	**2.2E-01**	**5.6E-02**	**na**	**8.9E+01**
Alpha + Beta Endosulfan	0	2.2E-01	5.6E-02	--	--	2.2E-01	5.6E-02	--	--	--	--	--	--	--	--	--	--	**2.2E-01**	**5.6E-02**	**--**	**--**
Endosulfan Sulfate	0	--	--	na	8.9E+01	--	--	na	8.9E+01	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**8.9E+01**
Endrin	0	8.6E-02	3.6E-02	na	6.0E-02	8.6E-02	3.6E-02	na	6.0E-02	--	--	--	--	--	--	--	--	**8.6E-02**	**3.6E-02**	**na**	**6.0E-02**
Endrin Aldehyde	0	--	--	na	3.0E-01	--	--	na	3.0E-01	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**3.0E-01**

Parameter	Background	Water Quality Criteria				Wasteload Allocations				Antidegradation Baseline				Antidegradation Allocations				**Most Limiting Allocations**			
(ug/l unless noted)	Conc.	Acute	Chronic	HH (PWS)	HH	Acute	Chronic	HH (PWS)	HH	Acute	Chronic	HH (PWS)	HH	Acute	Chronic	HH (PWS)	HH	**Acute**	**Chronic**	**HH (PWS)**	**HH**
Ethylbenzene	0	--	--	na	2.1E+03	--	--	na	2.1E+03	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**2.1E+03**
Fluoranthene	0	--	--	na	1.4E+02	--	--	na	1.4E+02	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.4E+02**
Fluorene	0	--	--	na	5.3E+03	--	--	na	5.3E+03	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**5.3E+03**
Foaming Agents	0	--	--	na	--	--	--	na	--	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**--**
Guthion	0	--	1.0E-02	na	--	--	1.0E-02	na	--	--	--	--	--	--	--	--	--	**--**	**1.0E-02**	**na**	**--**
Heptachlor [C]	0	5.2E-01	3.8E-03	na	7.9E-04	5.2E-01	3.8E-03	na	7.9E-04	--	--	--	--	--	--	--	--	**5.2E-01**	**3.8E-03**	**na**	**7.9E-04**
Heptachlor Epoxide[C]	0	5.2E-01	3.8E-03	na	3.9E-04	5.2E-01	3.8E-03	na	3.9E-04	--	--	--	--	--	--	--	--	**5.2E-01**	**3.8E-03**	**na**	**3.9E-04**
Hexachlorobenzene[C]	0	--	--	na	2.9E-03	--	--	na	2.9E-03	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**2.9E-03**
Hexachlorobutadiene[C]	0	--	--	na	1.8E+02	--	--	na	1.8E+02	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.8E+02**
Hexachlorocyclohexane Alpha-BHC[C]	0	--	--	na	4.9E-02	--	--	na	4.9E-02	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**4.9E-02**
Hexachlorocyclohexane Beta-BHC[C]	0	--	--	na	1.7E-01	--	--	na	1.7E-01	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.7E-01**
Hexachlorocyclohexane Gamma-BHC[C] (Lindane)	0	9.5E-01	na	na	1.8E+00	9.5E-01	--	na	1.8E+00	--	--	--	--	--	--	--	--	**9.5E-01**	**--**	**na**	**1.8E+00**
Hexachlorocyclopentadiene	0	--	--	na	1.1E+03	--	--	na	1.1E+03	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.1E+03**
Hexachloroethane[C]	0	--	--	na	3.3E+01	--	--	na	3.3E+01	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**3.3E+01**
Hydrogen Sulfide	0	--	2.0E+00	na	--	--	2.0E+00	na	--	--	--	--	--	--	--	--	--	**--**	**2.0E+00**	**na**	**--**
Indeno (1,2,3-cd) pyrene [C]	0	--	--	na	1.8E-01	--	--	na	1.8E-01	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.8E-01**
Iron	0	--	--	na	--	--	--	na	--	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**--**
Isophorone[C]	0	--	--	na	9.6E+03	--	--	na	9.6E+03	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**9.6E+03**
Kepone	0	--	0.0E+00	na	--	--	0.0E+00	na	--	--	--	--	--	--	--	--	--	**--**	**0.0E+00**	**na**	**--**
Lead	0	1.1E+02	1.2E+01	na	--	1.1E+02	1.2E+01	na	--	--	--	--	--	--	--	--	--	**1.1E+02**	**1.2E+01**	**na**	**--**
Malathion	0	--	1.0E-01	na	--	--	1.0E-01	na	--	--	--	--	--	--	--	--	--	**--**	**1.0E-01**	**na**	**--**
Manganese	0	--	--	na	--	--	--	na	--	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**--**
Mercury	0	1.4E+00	7.7E-01	- -	- -	1.4E+00	7.7E-01	- -	- -	--	--	--	--	--	--	--	--	**1.4E+00**	**7.7E-01**	**- -**	**- -**
Methyl Bromide	0	--	--	na	1.5E+03	--	--	na	1.5E+03	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.5E+03**
Methylene Chloride [C]	0	--	--	na	5.9E+03	--	--	na	5.9E+03	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**5.9E+03**
Methoxychlor	0	--	3.0E-02	na	--	--	3.0E-02	na	--	--	--	--	--	--	--	--	--	**--**	**3.0E-02**	**na**	**--**
Mirex	0	--	0.0E+00	na	--	--	0.0E+00	na	--	--	--	--	--	--	--	--	--	**--**	**0.0E+00**	**na**	**--**
Nickel	0	1.7E+02	1.9E+01	na	4.6E+03	1.7E+02	1.9E+01	na	4.6E+03	--	--	--	--	--	--	--	--	**1.7E+02**	**1.9E+01**	**na**	**4.6E+03**
Nitrate (as N)	0	--	--	na	--	--	--	na	--	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**--**
Nitrobenzene	0	--	--	na	6.9E+02	--	--	na	6.9E+02	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**6.9E+02**
N-Nitrosodimethylamine[C]	0	--	--	na	3.0E+01	--	--	na	3.0E+01	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**3.0E+01**
N-Nitrosodiphenylamine[C]	0	--	--	na	6.0E+01	--	--	na	6.0E+01	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**6.0E+01**
N-Nitrosodi-n-propylamine[C]	0	--	--	na	5.1E+00	--	--	na	5.1E+00	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**5.1E+00**
Nonylphenol	0	2.8E+01	6.6E+00	--	--	2.8E+01	6.6E+00	na	--	--	--	--	--	--	--	--	--	**2.8E+01**	**6.6E+00**	**na**	**--**
Parathion	0	6.5E-02	1.3E-02	na	--	6.5E-02	1.3E-02	na	--	--	--	--	--	--	--	--	--	**6.5E-02**	**1.3E-02**	**na**	**--**
PCB Total[C]	0	--	1.4E-02	na	6.4E-04	--	1.4E-02	na	6.4E-04	--	--	--	--	--	--	--	--	**--**	**1.4E-02**	**na**	**6.4E-04**
Pentachlorophenol [C]	0	1.1E+01	8.2E+00	na	3.0E+01	1.1E+01	8.2E+00	na	3.0E+01	--	--	--	--	--	--	--	--	**1.1E+01**	**8.2E+00**	**na**	**3.0E+01**
Phenol	0	--	--	na	8.6E+05	--	--	na	8.6E+05	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**8.6E+05**
Pyrene	0	--	--	na	4.0E+03	--	--	na	4.0E+03	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**4.0E+03**
Radionuclides	0	--	--	na	--	--	--	na	--	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**--**
Gross Alpha Activity (pCi/L)	0	--	--	na	--	--	--	na	--	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**--**
Beta and Photon Activity (mrem/yr)	0	--	--	na	--	--	--	na	--	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**--**
Radium 226 + 228 (pCi/L)	0	--	--	na	--	--	--	na	--	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**--**
Uranium (ug/l)	0	--	--	na	--	--	--	na	--	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**--**

Parameter	Background	Water Quality Criteria				Wasteload Allocations				Antidegradation Baseline				Antidegradation Allocations				**Most Limiting Allocations**			
(ug/l unless noted)	Conc.	Acute	Chronic	HH (PWS)	HH	Acute	Chronic	HH (PWS)	HH	Acute	Chronic	HH (PWS)	HH	Acute	Chronic	HH (PWS)	HH	**Acute**	**Chronic**	**HH (PWS)**	**HH**
Selenium, Total Recoverable	0	2.0E+01	5.0E+00	na	4.2E+03	2.0E+01	5.0E+00	na	4.2E+03	--	--	--	--	--	--	--	--	**2.0E+01**	**5.0E+00**	**na**	**4.2E+03**
Silver	0	3.0E+00	--	na	--	3.0E+00	--	na	--	--	--	--	--	--	--	--	--	**3.0E+00**	**--**	**na**	**--**
Sulfate	0	--	--	na	--	--	--	na	--	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**--**
1,1,2,2-Tetrachloroethane[C]	0	--	--	na	4.0E+01	--	--	na	4.0E+01	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**4.0E+01**
Tetrachloroethylene[C]	0	--	--	na	3.3E+01	--	--	na	3.3E+01	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**3.3E+01**
Thallium	0	--	--	na	4.7E-01	--	--	na	4.7E-01	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**4.7E-01**
Toluene	0	--	--	na	6.0E+03	--	--	na	6.0E+03	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**6.0E+03**
Total dissolved solids	0	--	--	na	--	--	--	na	--	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**--**
Toxaphene [C]	0	7.3E-01	2.0E-04	na	2.8E-03	7.3E-01	2.0E-04	na	2.8E-03	--	--	--	--	--	--	--	--	**7.3E-01**	**2.0E-04**	**na**	**2.8E-03**
Tributyltin	0	4.6E-01	7.2E-02	na	--	4.6E-01	7.2E-02	na	--	--	--	--	--	--	--	--	--	**4.6E-01**	**7.2E-02**	**na**	**--**
1,2,4-Trichlorobenzene	0	--	--	na	7.0E+01	--	--	na	7.0E+01	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**7.0E+01**
1,1,2-Trichloroethane[C]	0	--	--	na	1.6E+02	--	--	na	1.6E+02	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.6E+02**
Trichloroethylene [C]	0	--	--	na	3.0E+02	--	--	na	3.0E+02	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**3.0E+02**
2,4,6-Trichlorophenol [C]	0	--	--	na	2.4E+01	--	--	na	2.4E+01	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**2.4E+01**
2-(2,4,5-Trichlorophenoxy) propionic acid (Silvex)	0	--	--	na	--	--	--	na	--	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**--**
Vinyl Chloride[C]	0	--	--	na	2.4E+01	--	--	na	2.4E+01	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**2.4E+01**
Zinc	0	1.1E+02	1.1E+02	na	2.6E+04	1.1E+02	1.1E+02	na	2.6E+04	--	--	--	--	--	--	--	--	**1.1E+02**	**1.1E+02**	**na**	**2.6E+04**

Notes:

1. All concentrations expressed as micrograms/liter (ug/l), unless noted otherwise
2. Discharge flow is highest monthly average or Form 2C maximum for Industries and design flow for Municipals
3. Metals measured as Dissolved, unless specified otherwise
4. "C" indicates a carcinogenic parameter
5. Regular WLAs are mass balances (minus background concentration) using the % of stream flow entered above under Mixing Information.
   Antidegradation WLAs are based upon a complete mix.
6. Antideg. Baseline = (0.25(WQC - background conc.) + background conc.) for acute and chronic
   = (0.1(WQC - background conc.) + background conc.) for human health
7. WLAs established at the following stream flows: 1Q10 for Acute, 30Q10 for Chronic Ammonia, 7Q10 for Other Chronic, 30Q5 for Non-carcinogens and Harmonic Mean for Carcinogens. To apply mixing ratios from a model set the stream flow equal to (mixing ratio - 1), effluent flow equal to 1 and 100% mix.

Metal	Target Value (SSTV)
Antimony	6.4E+02
Arsenic	9.0E+01
Barium	na
Cadmium	6.4E-01
Chromium III	4.2E+01
Chromium VI	6.4E+00
Copper	5.0E+00
Iron	na
Lead	7.3E+00
Manganese	na
Mercury	4.6E-01
Nickel	1.1E+01
Selenium	3.0E+00
Silver	1.2E+00
Zinc	4.4E+01

Note: do not use QL's lower than the minimum QL's provided in agency guidance

2/16/2016 6:56:34 PM

Facility = Chesterfield Power Station 003
Chemical = Ammonia
Chronic averaging period = 30
WLAa = 8.41
WLAc = 0.221
Q.L. = 0.08
# samples/mo. = 1
# samples/wk. = 1

Summary of Statistics:

observations = 1
Expected Value = .08
Variance = .002304
C.V. = 0.6
97th percentile daily values = .194673
97th percentile 4 day average = .133103
97th percentile 30 day average= .096484
< Q.L. = 0
Model used = BPJ Assumptions, type 2 data

No Limit is required for this material

The data are:

0.08

2/16/2016 6:58:08 PM

Facility = Chesterfield Power Station 003
Chemical = Chloride
Chronic averaging period = 30
WLAa = 860000
WLAc = 230000
Q.L. = 100
# samples/mo. = 1
# samples/wk. = 1

Summary of Statistics:

observations = 1
Expected Value = 32060
Variance = 3700236
C.V. = 0.6
97th percentile daily values = 78015.3
97th percentile 4 day average = 53341.1
97th percentile 30 day average= 38666.0
< Q.L. = 0
Model used = BPJ Assumptions, type 2 data

No Limit is required for this material

The data are:

32060

2/16/2016 6:53:32 PM

Facility = Chesterfield Power Station 003
Chemical = TRC
Chronic averaging period = 4
WLAa = 19
WLAc = 11
Q.L. = 0.1
# samples/mo. = 4
# samples/wk. = 1

Summary of Statistics:

observations = 1
Expected Value = 20000
Variance = 1440000
C.V. = 0.6
97th percentile daily values = 48668.3
97th percentile 4 day average = 33275.8
97th percentile 30 day average= 24121.0
< Q.L. = 0
Model used = BPJ Assumptions, type 2 data

A limit is needed based on Chronic Toxicity
Maximum Daily Limit = 16.0883226245855
Average Weekly limit = 16.0883226245856
Average Monthly LImit = 11

The data are:

20000

5/20/2016 8:06:57 AM

Facility = Chesterfield Power Station 003
Chemical = Copper
Chronic averaging period = 4
WLAa = 12
WLAc = 8.3
Q.L. = 1
# samples/mo. = 1
# samples/wk. = 1

Summary of Statistics:

observations = 1
Expected Value = 2
Variance = 1.44
C.V. = 0.6
97th percentile daily values = 4.86683
97th percentile 4 day average = 3.32758
97th percentile 30 day average= 2.41210
< Q.L. = 0
Model used = BPJ Assumptions, type 2 data

No Limit is required for this material

The data are:

2

2/16/2016 6:55:15 PM

Facility = Chesterfield Power Station 003
Chemical = Mercury
Chronic averaging period = 4
WLAa = 1.4
WLAc = 0.77
Q.L. = 0.0001
# samples/mo. = 1
# samples/wk. = 1

Summary of Statistics:

observations = 1
Expected Value = .00116
Variance = .000000
C.V. = 0.6
97th percentile daily values = .002822
97th percentile 4 day average = .001929
97th percentile 30 day average= .001399
< Q.L. = 0
Model used = BPJ Assumptions, type 2 data

No Limit is required for this material

The data are:

0.00116

c. Reasonable Potential Analysis for Internal Outfall 301

Effluent limitations for parameters submitted with the application were evaluated in accordance with DEQ Guidance Memo (GM) 00-2011. All observed pollutants and pollutants reported less than QLs that exceeded the agency accepted values were evaluated for reasonable potential to violate in stream water quality standards. Pollutants that were reported less than a DEQ accepted QL were considered absent for the purposes of this evaluation.

MSTRANTI (version 2b), a DEQ developed spreadsheet, was used to calculate Waste Load Allocations (WLAs) based on mixed conditions. Stream data, effluent data and mixing ratios were entered into MSTRANTI to determine the WLAs.

Internal Outfall 301 discharges into the thermal discharge channel of external Outfall 003. Therefore, Internal Outfall 301 is evaluated as if discharging to a free flowing stream consisting of the Outfall 003 discharge. This method supports meeting Water Quality Standards (WQS) at the point of discharge from Outfall 003. Permit limitations are based on conservative low flow conditions, in which the effluent has the greatest potential to impact the receiving stream. Review of the daily flow data from Outfall 003 over the last 10 years shows 1Q10, 7Q10, 30Q10, 30Q5, and harmonic mean flows of 0 MGD, 11.59 MGD, 106.67 MGD, 111.07 MGD, and 111.07 MGD, respectively. However, the May 5, 2016 Application Addendum states that the facility will maintain a minimum flow of 57.28 MGD in Outfall 003 below which no discharge from Outfall 301 will occur (See **Attachment 4.a)**. This results in a 1Q10 and 7Q10 of 57.28 MGD. Based on the hydraulic dynamics and turbulence in the thermal discharge channel and the commitment to install a diffuser on the outfall, 100% mix is assumed. Observed pollutant concentrations for Outfall 003 reported in the Water Quality Criteria Monitoring form (See **Attachment 4.b**) were used as background concentrations for the receiving water. Ambient temperature inputs were back calculated to result in a flow weighted average temperature of 35°C for the mixed stream and effluent. No fish or benthic organisms are expected to be present in water temperatures greater than 35°C. The remaining MSTRANTI inputs are explained in the Data Source Report below. The resulting WLAs from MSTRANTI represent conservative concentrations for each pollutant that can be discharged at Outfall 301 while maintaining WQS at the point of discharge from Outfall 003.

STATS.EXE (version 2.0.4) was then used to evaluate reasonable potential and calculate a limitation if needed. WLAs, monitoring frequencies and reported effluent pollutant concentrations were input in STATS.EXE to evaluate each pollutant individually. The effluent pollutant concentrations for Internal Outfall 301 were determined using a flow weighted average of the worst case pollutant concentrations in the individual waste streams routed to the Low volume Wastewater Treatment System (LVWWTS). Concentrations were determined for two worst case scenarios. Scenario 1 assumed maximum operating process flows from the various waste streams with no stormwater flows. Scenario 2 assumed average operating process wastewater flows with stormwater flows based on a 25 year 24 hour storm event. Individual waste stream flows were divided by the total estimated flow going to Outfall 301 to calculate the percent contribution of the total flow. Then, the worst case concentration for each pollutant from each waste stream was multiplied by the respective flow percentage, and the flow weighted concentrations were added together to determine the worst case flow weighted concentration for each scenario. See **Attachment 4.c** for further discussion. The highest concentration between the two scenarios for each pollutant was used in the reasonable potential analyses.

The reasonable potential analyses determined the need for effluent limitations for chloride, TRC, copper, nickel, and zinc. Heptachlor data submitted with the application indicated reasonable potential and a permit limitation was included in the initial draft. The permittee subsequently provided information that suggested analytical errors occurred during the initial heptachlor analysis. Additional data was provided on June 3, 2016 indicating that the pollutant is not present in the discharge. Consequently, the limitation was removed from the permit and replaced with semiannual monitoring. See Attachment 13 for owner comments and additional heptachlor data.

The permittee provided two data sets for chloride and TRC (See **Attachment 4.c**). The first data set included elevated concentrations for chloride and TRC that were considered unrepresentative of some waste streams. It was the permittee's opinion that the elevated concentrations were anomalous and the result of analytical interference. The permittee conducted another round of sampling for chloride (from the FGD WWTP, FGD Yard Sump, and Master Sump) and TRC (from the Bottom Ash, Coal Pile Runoff, UAP Toe Drain, FGD WWTP, FGD Yard Sump, and Master Sump).

The table below shows the parameters with observed concentrations and the corresponding WLAs.

For parameters with standards based on Human Health (HH), the maximum observed values were compared to the HH WLAs calculated in MSTRANTI. The receiving stream is not designated as a public water supply (PWS), so the HH PWS standards do not apply to this discharge. All other concentrations were less than the HH WLAs; therefore, no further limitations are needed for these parameters to protect human health.

Parameter*	Worst Case Concentration	Water Quality-based WLAs		Human Health WLAs	Limit Required
		WLAa	WLAc		
4,4-DDE	0.0011	-	-	0.043	No
a-BHC	0.0032	-	-	0.96	No
Acrylonitrile	0.95	-	-	49	No
Aldrin	0.002	32	-	0.0098	No
Ammonia (mg/L)	1.8	81.6	10.2	-	No
Antimony	4.2	-	-	12,000	No
Arsenic	25	3,600	1,600	-	No
Barium	240	-	-	-	No(1)
b-BHC	0.0042	-	-	3.3	No
Benzene	0.13	-	-	10,000	No
Cadmium	1.4	27	8.9	--	No
Chlordane	0.0046	25	0.045	0.16	No
Chloride (mg/L)	1,300	8,800	2,100	-	Yes
TRC	660	200	120	-	Yes
Chlorodibromomethane	0.41	-	-	2500	No
Chloroform	9.2	-	-	210,000	No
Chromium VI	42	170	120	-	No
Total Chromium	9.5	-	-	-	No(1)
Copper	85	80	49	-	Yes
DDD	0.001	-	-	0.06	No
DDT	0.0009	12	0.011	0.043	No
Dichlorobromomethane	1.6	-	-	3,300	No

Dieldrin	0.0038	2.5	0.59	0.011	No
Alpha-Endosulfan	0.0016	2.3	0.59	1,700	No
Beta-Endosulfan	0.0076	2.3	0.59	1,700	No
Endosulfan Sulfate	0.036	-	-	1,700	No
Endrin	0.0017	0.91	0.38	1.2	No
Ethylbenzene	0.25	-	-	41,000	No
Heptachlor	0.028[(2)], <0.05	5.5	0.04	0.015	No
Heptachlor Epoxide	0.0015	5.5	0.04	0.0076	No
Iron (mg/L)	22	-	-	-	No[(1)]
Lead	4.9	770	88	-	No
Mercury	0.08	15	8.1	-	No
Methylene Chloride	1.2	-	-	120,000	No
Nickel	110	1400	160	90,000	Yes
Nitrate as N (mg/L)	16	-	-	-	No[(1)]
Nitrobenzene	0.9	-	-	13,000	No
N-Nitrosodiphenylamine	0.91	-	-	1,200	No
Pentachlorophenol	0.73	120	89	590	No
Phenol	1.6	-	-	17,000,000	No
Radium 226 (pCi/L)	0.37	-	-	-	No[(1)]
Radium 228(pCi/L)	0.60	-	-	-	No[(1)]
Selenium	19	210	53	82,000	No
Sulfate (mg/L)	1300	-	-	-	No[(1)]
Thallium	5.0	-	-	9.2	No
Toluene	0.16	-	-	120,000	No
Total Dissolved Solids	4700	-	-	-	No[(1)]
Zinc	380	900	900	510,000	Yes

**all parameters are in µg/L unless otherwise noted*

[(1)]VAWQS for these parameters applicable only to receiving streams with a special standard for public water supply (PWS).

[(2)] See Attachment 13 for a discussion of analytical errors and the uncertainty of the data.

MSTRANTI DATA SOURCE REPORT
(Chesterfield Power Station: Outfall 301 - LVWWTS)

Stream Information	
Mean Hardness	Refer to ambient stream data for 2-JMS009.30.
90% Temperature (annual)	The temperature input was back-calculated to result in a mixed temperature of 35°C at 30Q10 flows. No fish or benthic organisms are expected to be present in water temperatures greater than 35°C.
90% Temperature (wet season)	NA
90% Maximum pH	Refer to ambient stream data for 2-JMS009.30.
10% Maximum pH	Refer to ambient stream data for 2-JMS009.30.
Tier Designation	Flow Frequency Memo (02/29/2016)
Stream Flows	
All Data	Because Internal Outfall 301 discharges to Outfall 003, the daily flows over the last 10 years for Outfall 003 were used to determine the 30Q10, 30Q5, and harmonic mean flows. The 1Q10 and 7Q10 are based on minimum operational flows from Outfall 003, below which Dominion has committed not to discharge from this outfall.
Mixing Information	
All percentages	100% mix assumed because of the turbulent flows within the thermal discharge channel of Outfall 003 and the commitment to install a diffuser at Outfall 301.
Effluent Information	
Mean Hardness	Most conservative hardness data submitted in the 2009 reissuance application.
90% Temperature (annual)*	The max temperature reported for Outfalls 004 and 005 in the reissuance application.
90% Temperature (wet season)	NA
90% Maximum pH*	Because Outfall 301 will be a new outfall and no previous monitoring data is available, the max pH allowed by 40CFR 423 and VA WQS was used. This is the most conservative value.
10% Maximum pH*	The 10th percentile of the reported pH values from the DMR data for Outfalls 004 and 005.

Discharge Flow	Data reported in the application addendum (05/09/2016).

*For temperature of the effluent, values reported for Outfall 004 were used. This is due to the fact that most of the same waste streams discharging through Outfall 004 will be discharging through Internal Outfall 301.

Data Location:

Flow Frequency Analysis — Attachment 2
DMR Data — Attachment 4.a
App Data — Attachment 4.b and 4.e

FRESHWATER
WATER QUALITY CRITERIA / WASTELOAD ALLOCATION ANALYSIS

Facility Name: Chesterfield Power Station - 301 - 6.0 MGD Permit No.: VA0004146

Receiving Stream: Outfall 003 Version: OWP Guidance Memo 00-2011 (8/24/00)

Stream Information		
Mean Hardness (as CaCO3) =	66	mg/L
90% Temperature (Annual) =	35.4	deg C
90% Temperature (Wet season) =		deg C
90% Maximum pH =	8	SU
10% Maximum pH =	7.2	SU
Tier Designation (1 or 2) =	1	
Public Water Supply (PWS) Y/N? =	n	
Trout Present Y/N? =	N	
Early Life Stages Present Y/N? =	Y	

Stream Flows		
1Q10 (Annual) =	57.28	MGD
7Q10 (Annual) =	57.28	MGD
30Q10 (Annual) =	106.67	MGD
1Q10 (Wet season) =		MGD
30Q10 (Wet season) =		MGD
30Q5 =	111.07	MGD
Harmonic Mean =	111.07	MGD

Mixing Information		
Annual - 1Q10 Mix =	100	%
- 7Q10 Mix =	100	%
- 30Q10 Mix =	100	%
Wet Season - 1Q10 Mix =		%
- 30Q10 Mix =		%

Effluent Information		
Mean Hardness (as CaCO3) =	92	mg/L
90% Temp (Annual) =	32.2	deg C
90% Temp (Wet season) =		deg C
90% Maximum pH =	9	SU
10% Maximum pH =	7.8	SU
Discharge Flow =	6	MGD

Parameter	Background	Water Quality Criteria				Wasteload Allocations				Antidegradation Baseline				Antidegradation Allocations				**Most Limiting Allocations**			
(ug/l unless noted)	Conc.	Acute	Chronic	HH (PWS)	HH	Acute	Chronic	HH (PWS)	HH	Acute	Chronic	HH (PWS)	HH	Acute	Chronic	HH (PWS)	HH	**Acute**	**Chronic**	**HH (PWS)**	**HH**
Acenapthene	0	--	--	na	9.9E+02	--	--	na	1.9E+04	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.9E+04**
Acrolein	0	--	--	na	9.3E+00	--	--	na	1.8E+02	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.8E+02**
Acrylonitrile[C]	0	--	--	na	2.5E+00	--	--	na	4.9E+01	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**4.9E+01**
Aldrin [C]	0	3.0E+00	--	na	5.0E-04	3.2E+01	--	na	9.8E-03	--	--	--	--	--	--	--	--	**3.2E+01**	**--**	**na**	**9.8E-03**
Ammonia-N (mg/l) (Yearly)	0.08	7.81E+00	6.21E-01	na	--	8.16E+01	1.02E+01	na	--	--	--	--	--	--	--	--	--	**8.16E+01**	**1.02E+01**	**na**	**--**
Ammonia-N (mg/l) (High Flow)	0	1.32E+00	4.86E-01	na	--	1.32E+00	4.86E-01	na	--	--	--	--	--	--	--	--	--	**1.32E+00**	**4.86E-01**	**na**	**--**
Anthracene	0	--	--	na	4.0E+04	--	--	na	7.8E+05	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**7.8E+05**
Antimony	0	--	--	na	6.4E+02	--	--	na	1.2E+04	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.2E+04**
Arsenic	0	3.4E+02	1.5E+02	na	--	3.6E+03	1.6E+03	na	--	--	--	--	--	--	--	--	--	**3.6E+03**	**1.6E+03**	**na**	**--**
Barium	0	--	--	na	--	--	--	na	--	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**--**
Benzene [C]	0	--	--	na	5.1E+02	--	--	na	1.0E+04	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.0E+04**
Benzidine[C]	0	--	--	na	2.0E-03	--	--	na	3.9E-02	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**3.9E-02**
Benzo (a) anthracene [C]	0	--	--	na	1.8E-01	--	--	na	3.5E+00	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**3.5E+00**
Benzo (b) fluoranthene [C]	0	--	--	na	1.8E-01	--	--	na	3.5E+00	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**3.5E+00**
Benzo (k) fluoranthene [C]	0	--	--	na	1.8E-01	--	--	na	3.5E+00	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**3.5E+00**
Benzo (a) pyrene [C]	0	--	--	na	1.8E-01	--	--	na	3.5E+00	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**3.5E+00**
Bis2-Chloroethyl Ether [C]	0	--	--	na	5.3E+00	--	--	na	1.0E+02	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.0E+02**
Bis2-Chloroisopropyl Ether	0	--	--	na	6.5E+04	--	--	na	1.3E+06	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.3E+06**
Bis 2-Ethylhexyl Phthalate [C]	0	--	--	na	2.2E+01	--	--	na	4.3E+02	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**4.3E+02**
Bromoform [C]	0	--	--	na	1.4E+03	--	--	na	2.7E+04	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**2.7E+04**
Butylbenzylphthalate	0	--	--	na	1.9E+03	--	--	na	3.7E+04	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**3.7E+04**
Cadmium	0	2.6E+00	8.4E-01	na	--	2.7E+01	8.9E+00	na	--	--	--	--	--	--	--	--	--	**2.7E+01**	**8.9E+00**	**na**	**--**
Carbon Tetrachloride [C]	0	--	--	na	1.6E+01	--	--	na	3.1E+02	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**3.1E+02**
Chlordane [C]	0	2.4E+00	4.3E-03	na	8.1E-03	2.5E+01	4.5E-02	na	1.6E-01	--	--	--	--	--	--	--	--	**2.5E+01**	**4.5E-02**	**na**	**1.6E-01**
Chloride	32060	8.6E+05	2.3E+05	na	--	8.8E+06	2.1E+06	na	--	--	--	--	--	--	--	--	--	**8.8E+06**	**2.1E+06**	**na**	**--**
TRC	0	1.9E+01	1.1E+01	na	--	2.0E+02	1.2E+02	na	--	--	--	--	--	--	--	--	--	**2.0E+02**	**1.2E+02**	**na**	**--**
Chlorobenzene	0	--	--	na	1.6E+03	--	--	na	3.1E+04	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**3.1E+04**

Parameter	Background	Water Quality Criteria				Wasteload Allocations				Antidegradation Baseline				Antidegradation Allocations				**Most Limiting Allocations**			
(ug/l unless noted)	Conc.	Acute	Chronic	HH (PWS)	HH	Acute	Chronic	HH (PWS)	HH	Acute	Chronic	HH (PWS)	HH	Acute	Chronic	HH (PWS)	HH	**Acute**	**Chronic**	**HH (PWS)**	**HH**
Chlorodibromomethane[C]	0	--	--	na	1.3E+02	--	--	na	2.5E+03	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**2.5E+03**
Chloroform	1.89	--	--	na	1.1E+04	--	--	na	2.1E+05	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**2.1E+05**
2-Chloronaphthalene	0	--	--	na	1.6E+03	--	--	na	3.1E+04	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**3.1E+04**
2-Chlorophenol	0	--	--	na	1.5E+02	--	--	na	2.9E+03	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**2.9E+03**
Chlorpyrifos	0	8.3E-02	4.1E-02	na	--	8.8E-01	4.3E-01	na	--	--	--	--	--	--	--	--	--	**8.8E-01**	**4.3E-01**	**na**	**--**
Chromium III	0	4.2E+02	5.4E+01	na	--	4.4E+03	5.7E+02	na	--	--	--	--	--	--	--	--	--	**4.4E+03**	**5.7E+02**	**na**	**--**
Chromium VI	0	1.6E+01	1.1E+01	na	--	1.7E+02	1.2E+02	na	--	--	--	--	--	--	--	--	--	**1.7E+02**	**1.2E+02**	**na**	**--**
Chromium, Total	0	--	--	1.0E+02	--	--	--	na	--	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**--**
Chrysene [C]	0	--	--	na	1.8E-02	--	--	na	3.5E-01	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**3.5E-01**
Copper	2	9.4E+00	6.5E+00	na	--	8.0E+01	4.9E+01	na	--	--	--	--	--	--	--	--	--	**8.0E+01**	**4.9E+01**	**na**	**--**
Cyanide, Free	0	2.2E+01	5.2E+00	na	1.6E+04	2.3E+02	5.5E+01	na	3.1E+05	--	--	--	--	--	--	--	--	**2.3E+02**	**5.5E+01**	**na**	**3.1E+05**
DDD [C]	0	--	--	na	3.1E-03	--	--	na	6.0E-02	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**6.0E-02**
DDE [C]	0	--	--	na	2.2E-03	--	--	na	4.3E-02	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**4.3E-02**
DDT [C]	0	1.1E+00	1.0E-03	na	2.2E-03	1.2E+01	1.1E-02	na	4.3E-02	--	--	--	--	--	--	--	--	**1.2E+01**	**1.1E-02**	**na**	**4.3E-02**
Demeton	0	--	1.0E-01	na	--	--	1.1E+00	na	--	--	--	--	--	--	--	--	--	**--**	**1.1E+00**	**na**	**--**
Diazinon	0	1.7E-01	1.7E-01	na	--	1.8E+00	1.8E+00	na	--	--	--	--	--	--	--	--	--	**1.8E+00**	**1.8E+00**	**na**	**--**
Dibenz(a,h)anthracene [C]	0	--	--	na	1.8E-01	--	--	na	3.5E+00	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**3.5E+00**
1,2-Dichlorobenzene	0	--	--	na	1.3E+03	--	--	na	2.5E+04	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**2.5E+04**
1,3-Dichlorobenzene	0	--	--	na	9.6E+02	--	--	na	1.9E+04	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.9E+04**
1,4-Dichlorobenzene	0	--	--	na	1.9E+02	--	--	na	3.7E+03	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**3.7E+03**
3,3-Dichlorobenzidine[C]	0	--	--	na	2.8E-01	--	--	na	5.5E+00	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**5.5E+00**
Dichlorobromomethane [C]	0	--	--	na	1.7E+02	--	--	na	3.3E+03	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**3.3E+03**
1,2-Dichloroethane [C]	0	--	--	na	3.7E+02	--	--	na	7.2E+03	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**7.2E+03**
1,1-Dichloroethylene	0	--	--	na	7.1E+03	--	--	na	1.4E+05	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.4E+05**
1,2-trans-dichloroethylene	0	--	--	na	1.0E+04	--	--	na	2.0E+05	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**2.0E+05**
2,4-Dichlorophenol	0	--	--	na	2.9E+02	--	--	na	5.7E+03	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**5.7E+03**
2,4-Dichlorophenoxy acetic acid (2,4-D)	0	--	--	na	--	--	--	na	--	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**--**
1,2-Dichloropropane[C]	0	--	--	na	1.5E+02	--	--	na	2.9E+03	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**2.9E+03**
1,3-Dichloropropene [C]	0	--	--	na	2.1E+02	--	--	na	4.1E+03	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**4.1E+03**
Dieldrin [C]	0	2.4E-01	5.6E-02	na	5.4E-04	2.5E+00	5.9E-01	na	1.1E-02	--	--	--	--	--	--	--	--	**2.5E+00**	**5.9E-01**	**na**	**1.1E-02**
Diethyl Phthalate	0	--	--	na	4.4E+04	--	--	na	8.6E+05	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**8.6E+05**
2,4-Dimethylphenol	0	--	--	na	8.5E+02	--	--	na	1.7E+04	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.7E+04**
Dimethyl Phthalate	0	--	--	na	1.1E+06	--	--	na	2.1E+07	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**2.1E+07**
Di-n-Butyl Phthalate	0	--	--	na	4.5E+03	--	--	na	8.8E+04	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**8.8E+04**
2,4 Dinitrophenol	0	--	--	na	5.3E+03	--	--	na	1.0E+05	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.0E+05**
2-Methyl-4,6-Dinitrophenol	0	--	--	na	2.8E+02	--	--	na	5.5E+03	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**5.5E+03**
2,4-Dinitrotoluene [C]	0	--	--	na	3.4E+01	--	--	na	6.6E+02	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**6.6E+02**
Dioxin 2,3,7,8-tetrachlorodibenzo-p-dioxin	0	--	--	na	5.1E-08	--	--	na	1.0E-06	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.0E-06**
1,2-Diphenylhydrazine[C]	0	--	--	na	2.0E+00	--	--	na	3.9E+01	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**3.9E+01**
Alpha-Endosulfan	0	2.2E-01	5.6E-02	na	8.9E+01	2.3E+00	5.9E-01	na	1.7E+03	--	--	--	--	--	--	--	--	**2.3E+00**	**5.9E-01**	**na**	**1.7E+03**
Beta-Endosulfan	0	2.2E-01	5.6E-02	na	8.9E+01	2.3E+00	5.9E-01	na	1.7E+03	--	--	--	--	--	--	--	--	**2.3E+00**	**5.9E-01**	**na**	**1.7E+03**
Alpha + Beta Endosulfan	0	2.2E-01	5.6E-02	--	--	2.3E+00	5.9E-01	--	--	--	--	--	--	--	--	--	--	**2.3E+00**	**5.9E-01**	**--**	**--**
Endosulfan Sulfate	0	--	--	na	8.9E+01	--	--	na	1.7E+03	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.7E+03**
Endrin	0	8.6E-02	3.6E-02	na	6.0E-02	9.1E-01	3.8E-01	na	1.2E+00	--	--	--	--	--	--	--	--	**9.1E-01**	**3.8E-01**	**na**	**1.2E+00**
Endrin Aldehyde	0	--	--	na	3.0E-01	--	--	na	5.9E+00	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**5.9E+00**

Parameter	Background	Water Quality Criteria				Wasteload Allocations				Antidegradation Baseline				Antidegradation Allocations				**Most Limiting Allocations**			
(ug/l unless noted)	Conc.	Acute	Chronic	HH (PWS)	HH	Acute	Chronic	HH (PWS)	HH	Acute	Chronic	HH (PWS)	HH	Acute	Chronic	HH (PWS)	HH	**Acute**	**Chronic**	**HH (PWS)**	**HH**
Ethylbenzene	0	--	--	na	2.1E+03	--	--	na	4.1E+04	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**4.1E+04**
Fluoranthene	0	--	--	na	1.4E+02	--	--	na	2.7E+03	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**2.7E+03**
Fluorene	0	--	--	na	5.3E+03	--	--	na	1.0E+05	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.0E+05**
Foaming Agents	0	--	--	na	--	--	--	na	--	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**--**
Guthion	0	--	1.0E-02	na	--	--	1.1E-01	na	--	--	--	--	--	--	--	--	--	**--**	**1.1E-01**	**na**	**--**
Heptachlor [C]	0	5.2E-01	3.8E-03	na	7.9E-04	5.5E+00	4.0E-02	na	1.5E-02	--	--	--	--	--	--	--	--	**5.5E+00**	**4.0E-02**	**na**	**1.5E-02**
Heptachlor Epoxide[C]	0	5.2E-01	3.8E-03	na	3.9E-04	5.5E+00	4.0E-02	na	7.6E-03	--	--	--	--	--	--	--	--	**5.5E+00**	**4.0E-02**	**na**	**7.6E-03**
Hexachlorobenzene[C]	0	--	--	na	2.9E-03	--	--	na	5.7E-02	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**5.7E-02**
Hexachlorobutadiene[C]	0	--	--	na	1.8E+02	--	--	na	3.5E+03	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**3.5E+03**
Hexachlorocyclohexane Alpha-BHC[C]	0	--	--	na	4.9E-02	--	--	na	9.6E-01	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**9.6E-01**
Hexachlorocyclohexane Beta-BHC[C]	0	--	--	na	1.7E-01	--	--	na	3.3E+00	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**3.3E+00**
Hexachlorocyclohexane Gamma-BHC[C] (Lindane)	0	9.5E-01	na	na	1.8E+00	1.0E+01	--	na	3.5E+01	--	--	--	--	--	--	--	--	**1.0E+01**	**--**	**na**	**3.5E+01**
Hexachlorocyclopentadiene	0	--	--	na	1.1E+03	--	--	na	2.1E+04	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**2.1E+04**
Hexachloroethane[C]	0	--	--	na	3.3E+01	--	--	na	6.4E+02	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**6.4E+02**
Hydrogen Sulfide	0	--	2.0E+00	na	--	--	2.1E+01	na	--	--	--	--	--	--	--	--	--	**--**	**2.1E+01**	**na**	**--**
Indeno (1,2,3-cd) pyrene [C]	0	--	--	na	1.8E-01	--	--	na	3.5E+00	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**3.5E+00**
Iron	0	--	--	na	--	--	--	na	--	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**--**
Isophorone[C]	0	--	--	na	9.6E+03	--	--	na	1.9E+05	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.9E+05**
Kepone	0	--	0.0E+00	na	--	--	0.0E+00	na	--	--	--	--	--	--	--	--	--	**--**	**0.0E+00**	**na**	**--**
Lead	0	7.3E+01	8.3E+00	na	--	7.7E+02	8.8E+01	na	--	--	--	--	--	--	--	--	--	**7.7E+02**	**8.8E+01**	**na**	**--**
Malathion	0	--	1.0E-01	na	--	--	1.1E+00	na	--	--	--	--	--	--	--	--	--	**--**	**1.1E+00**	**na**	**--**
Manganese	0	--	--	na	--	--	--	na	--	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**--**
Mercury	0.00116	1.4E+00	7.7E-01	- -	- -	1.5E+01	8.1E+00	- -	- -	--	--	--	--	--	--	--	--	**1.5E+01**	**8.1E+00**	**- -**	**- -**
Methyl Bromide	0	--	--	na	1.5E+03	--	--	na	2.9E+04	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**2.9E+04**
Methylene Chloride [C]	0	--	--	na	5.9E+03	--	--	na	1.2E+05	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.2E+05**
Methoxychlor	0	--	3.0E-02	na	--	--	3.2E-01	na	--	--	--	--	--	--	--	--	--	**--**	**3.2E-01**	**na**	**--**
Mirex	0	--	0.0E+00	na	--	--	0.0E+00	na	--	--	--	--	--	--	--	--	--	**--**	**0.0E+00**	**na**	**--**
Nickel	0	1.3E+02	1.5E+01	na	4.6E+03	1.4E+03	1.6E+02	na	9.0E+04	--	--	--	--	--	--	--	--	**1.4E+03**	**1.6E+02**	**na**	**9.0E+04**
Nitrate (as N)	0	--	--	na	--	--	--	na	--	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**--**
Nitrobenzene	0	--	--	na	6.9E+02	--	--	na	1.3E+04	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.3E+04**
N-Nitrosodimethylamine[C]	0	--	--	na	3.0E+01	--	--	na	5.9E+02	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**5.9E+02**
N-Nitrosodiphenylamine[C]	0	--	--	na	6.0E+01	--	--	na	1.2E+03	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.2E+03**
N-Nitrosodi-n-propylamine[C]	0	--	--	na	5.1E+00	--	--	na	1.0E+02	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.0E+02**
Nonylphenol	0	2.8E+01	6.6E+00	--	--	3.0E+02	7.0E+01	na	--	--	--	--	--	--	--	--	--	**3.0E+02**	**7.0E+01**	**na**	**--**
Parathion	0	6.5E-02	1.3E-02	na	--	6.9E-01	1.4E-01	na	--	--	--	--	--	--	--	--	--	**6.9E-01**	**1.4E-01**	**na**	**--**
PCB Total[C]	0	--	1.4E-02	na	6.4E-04	--	1.5E-01	na	1.2E-02	--	--	--	--	--	--	--	--	**--**	**1.5E-01**	**na**	**1.2E-02**
Pentachlorophenol [C]	0	1.1E+01	8.4E+00	na	3.0E+01	1.2E+02	8.9E+01	na	5.9E+02	--	--	--	--	--	--	--	--	**1.2E+02**	**8.9E+01**	**na**	**5.9E+02**
Phenol	0	--	--	na	8.6E+05	--	--	na	1.7E+07	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.7E+07**
Pyrene	0	--	--	na	4.0E+03	--	--	na	7.8E+04	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**7.8E+04**
Radionuclides	0	--	--	na	--	--	--	na	--	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**--**
Gross Alpha Activity (pCi/L)	0	--	--	na	--	--	--	na	--	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**--**
Beta and Photon Activity (mrem/yr)	3.23	--	--	na	--	--	--	na	--	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**--**
Radium 226 + 228 (pCi/L)	0	--	--	na	--	--	--	na	--	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**--**
Uranium (ug/l)	0	--	--	na	--	--	--	na	--	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**--**

Parameter	Background	Water Quality Criteria				Wasteload Allocations				Antidegradation Baseline				Antidegradation Allocations				**Most Limiting Allocations**			
(ug/l unless noted)	Conc.	Acute	Chronic	HH (PWS)	HH	Acute	Chronic	HH (PWS)	HH	Acute	Chronic	HH (PWS)	HH	Acute	Chronic	HH (PWS)	HH	**Acute**	**Chronic**	**HH (PWS)**	**HH**
Selenium, Total Recoverable	0	2.0E+01	5.0E+00	na	4.2E+03	2.1E+02	5.3E+01	na	8.2E+04	--	--	--	--	--	--	--	--	**2.1E+02**	**5.3E+01**	**na**	**8.2E+04**
Silver	0	1.8E+00	--	na	--	1.9E+01	--	na	--	--	--	--	--	--	--	--	--	**1.9E+01**	**--**	**na**	**--**
Sulfate	0	--	--	na	--	--	--	na	--	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**--**
1,1,2,2-Tetrachloroethane[C]	0	--	--	na	4.0E+01	--	--	na	7.8E+02	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**7.8E+02**
Tetrachloroethylene[C]	0	--	--	na	3.3E+01	--	--	na	6.4E+02	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**6.4E+02**
Thallium	0	--	--	na	4.7E-01	--	--	na	9.2E+00	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**9.2E+00**
Toluene	0	--	--	na	6.0E+03	--	--	na	1.2E+05	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.2E+05**
Total dissolved solids	0	--	--	na	--	--	--	na	--	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**--**
Toxaphene [C]	0	7.3E-01	2.0E-04	na	2.8E-03	7.7E+00	2.1E-03	na	5.5E-02	--	--	--	--	--	--	--	--	**7.7E+00**	**2.1E-03**	**na**	**5.5E-02**
Tributyltin	0	4.6E-01	7.2E-02	na	--	4.9E+00	7.6E-01	na	--	--	--	--	--	--	--	--	--	**4.9E+00**	**7.6E-01**	**na**	**--**
1,2,4-Trichlorobenzene	0	--	--	na	7.0E+01	--	--	na	1.4E+03	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.4E+03**
1,1,2-Trichloroethane[C]	0	--	--	na	1.6E+02	--	--	na	3.1E+03	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**3.1E+03**
Trichloroethylene [C]	0	--	--	na	3.0E+02	--	--	na	5.9E+03	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**5.9E+03**
2,4,6-Trichlorophenol [C]	0	--	--	na	2.4E+01	--	--	na	4.7E+02	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**4.7E+02**
2-(2,4,5-Trichlorophenoxy) propionic acid (Silvex)	0	--	--	na	--	--	--	na	--	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**--**
Vinyl Chloride[C]	0	--	--	na	2.4E+01	--	--	na	4.7E+02	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**4.7E+02**
Zinc	0	8.5E+01	8.6E+01	na	2.6E+04	9.0E+02	9.0E+02	na	5.1E+05	--	--	--	--	--	--	--	--	**9.0E+02**	**9.0E+02**	**na**	**5.1E+05**

Notes:

1. All concentrations expressed as micrograms/liter (ug/l), unless noted otherwise
2. Discharge flow is highest monthly average or Form 2C maximum for Industries and design flow for Municipals
3. Metals measured as Dissolved, unless specified otherwise
4. "C" indicates a carcinogenic parameter
5. Regular WLAs are mass balances (minus background concentration) using the % of stream flow entered above under Mixing Information.
   Antidegradation WLAs are based upon a complete mix.
6. Antideg. Baseline = (0.25(WQC - background conc.) + background conc.) for acute and chronic
   = (0.1(WQC - background conc.) + background conc.) for human health
7. WLAs established at the following stream flows: 1Q10 for Acute, 30Q10 for Chronic Ammonia, 7Q10 for Other Chronic, 30Q5 for Non-carcinogens and Harmonic Mean for Carcinogens. To apply mixing ratios from a model set the stream flow equal to (mixing ratio - 1), effluent flow equal to 1 and 100% mix.

Metal	Target Value (SSTV)
Antimony	1.2E+04
Arsenic	9.5E+02
Barium	na
Cadmium	5.3E+00
Chromium III	3.4E+02
Chromium VI	6.7E+01
Copper	3.0E+01
Iron	na
Lead	5.3E+01
Manganese	na
Mercury	4.9E+00
Nickel	9.3E+01
Selenium	3.2E+01
Silver	7.6E+00
Zinc	3.6E+02

Note: do not use QL's lower than the minimum QL's provided in agency guidance

5/19/2016 10:24:20 AM

Facility = Chesterfield Power Station - 301
Chemical = Aldrin
Chronic averaging period = 4
WLAa   = 32
WLAc   =
Q.L.   = 0.0013
samples/mo. = 1
samples/wk. = 1

Summary of Statistics:

observations = 1
Expected Value = .002
Variance   = .000001
C.V.   = 0.6
97th percentile daily values = .004866
97th percentile 4 day average = .003327
97th percentile 30 day average= .002412
< Q.L.   = 0
Model used   = BPJ Assumptions, type 2 data

No Limit is required for this material

The data are:

0.002

5/19/2016 10:24:57 AM

Facility = Chesterfield Power Station - 301
Chemical = Ammonia
Chronic averaging period = 30
WLAa = 81.6
WLAc = 10.2
Q.L. = 0.2
# samples/mo. = 1
# samples/wk. = 1

Summary of Statistics:

observations = 1
Expected Value = 1.8
Variance = 1.1664
C.V. = 0.6
97th percentile daily values = 4.38015
97th percentile 4 day average = 2.99482
97th percentile 30 day average= 2.17089
< Q.L. = 0
Model used = BPJ Assumptions, type 2 data

No Limit is required for this material

The data are:

1.8

5/19/2016 10:25:33 AM

Facility = Chesterfield Power Station - 301
Chemical = Arsenic
Chronic averaging period = 4
WLAa   = 3600
WLAc   = 1600
Q.L.   = 1
samples/mo. = 1
samples/wk. = 1

Summary of Statistics:

observations = 1
Expected Value = 25
Variance   = 225
C.V.   = 0.6
97th percentile daily values = 60.8354
97th percentile 4 day average = 41.5947
97th percentile 30 day average= 30.1513
< Q.L.   = 0
Model used   = BPJ Assumptions, type 2 data

No Limit is required for this material

The data are:

25

5/19/2016 10:26:12 AM

Facility = Chesterfield Power Station - 301
Chemical = Cadmium
Chronic averaging period = 4
WLAa   = 27
WLAc   = 8.9
Q.L.   = 1
samples/mo. = 1
samples/wk. = 1

Summary of Statistics:

observations = 1
Expected Value = 1.4
Variance   = .7056
C.V.   = 0.6
97th percentile daily values = 3.40678
97th percentile 4 day average = 2.32930
97th percentile 30 day average= 1.68847
< Q.L.   = 0
Model used   = BPJ Assumptions, type 2 data

No Limit is required for this material

The data are:

1.4

5/19/2016 10:26:58 AM

Facility = Chesterfield Power Station - 301
Chemical = Chlordane
Chronic averaging period = 4
WLAa = 25
WLAc = 0.045
Q.L. = 0.0012
# samples/mo. = 1
# samples/wk. = 1

Summary of Statistics:

observations = 1
Expected Value = .0046
Variance = .000007
C.V. = 0.6
97th percentile daily values = .011193
97th percentile 4 day average = .007653
97th percentile 30 day average= .005547
< Q.L. = 0
Model used = BPJ Assumptions, type 2 data

No Limit is required for this material

The data are:

0.0046

5/19/2016 10:27:51 AM

Facility = Chesterfield Power Station - 301
Chemical = Chloride
Chronic averaging period = 4
WLAa   = 8800000
WLAc   = 2100000
Q.L.   = 1000
samples/mo. = 1
samples/wk. = 1

Summary of Statistics:

observations = 1
Expected Value = 1300000
Variance   = 6084000
C.V.   = 0.6
97th percentile daily values = 3163442
97th percentile 4 day average = 2162927
97th percentile 30 day average= 1567869
< Q.L.   = 0
Model used   = BPJ Assumptions, type 2 data

A limit is needed based on Chronic Toxicity
Maximum Daily Limit   = 3071407.04651178
Average Weekly limit = 3071407.04651178
Average Monthly LImit = 3071407.04651178

The data are:

1300000

5/19/2016 10:34:18 AM

Facility = Chesterfield Power Station - 301
Chemical = TRC
Chronic averaging period = 4
WLAa   = 200
WLAc   = 120
Q.L.   = 20
samples/mo. = 1
samples/wk. = 1

Summary of Statistics:

observations = 1
Expected Value = 660
Variance   = 156816
C.V.   = 0.6
97th percentile daily values = 1606.05
97th percentile 4 day average = 1098.10
97th percentile 30 day average= 795.995
< Q.L.   = 0
Model used   = BPJ Assumptions, type 2 data

A limit is needed based on Chronic Toxicity
Maximum Daily Limit   = 175.508974086388
Average Weekly limit = 175.508974086388
Average Monthly LImit = 175.508974086388

The data are:

660

5/19/2016 10:28:35 AM

Facility = Chesterfield Power Station - 301
Chemical = Chromium VI
Chronic averaging period = 4
WLAa   = 170
WLAc   = 120
Q.L.   = 3
samples/mo. = 1
samples/wk. = 1

Summary of Statistics:

observations = 1
Expected Value = 42
Variance   = 635.04
C.V.   = 0.6
97th percentile daily values = 102.203
97th percentile 4 day average = 69.8791
97th percentile 30 day average= 50.6542
< Q.L.   = 0
Model used   = BPJ Assumptions, type 2 data

No Limit is required for this material

The data are:

42

5/19/2016 10:29:35 AM

Facility = Chesterfield Power Station - 301
Chemical = Copper
Chronic averaging period = 4
WLAa   = 80
WLAc   = 49
Q.L.   = 2
samples/mo. = 1
samples/wk. = 1

Summary of Statistics:

observations = 1
Expected Value = 85
Variance   = 2601
C.V.   = 0.6
97th percentile daily values = 206.840
97th percentile 4 day average = 141.422
97th percentile 30 day average= 102.514
< Q.L.   = 0
Model used   = BPJ Assumptions, type 2 data

A limit is needed based on Chronic Toxicity
Maximum Daily Limit   = 71.6661644186083
Average Weekly limit = 71.6661644186083
Average Monthly LImit = 71.6661644186083

The data are:

85

5/25/2016 3:50:31 PM

Facility = Chesterfield Power Station - 301
Chemical = DDT
Chronic averaging period = 4
WLAa   = 12
WLAc   = 0.011
Q.L.   = 0.0007
samples/mo. = 1
samples/wk. = 1

Summary of Statistics:

observations = 1
Expected Value = .0009
Variance   = .000000
C.V.   = 0.6
97th percentile daily values = .002190
97th percentile 4 day average = .001497
97th percentile 30 day average= .001085
< Q.L.   = 0
Model used   = BPJ Assumptions, type 2 data

No Limit is required for this material

The data are:

0.0009

5/25/2016 3:52:34 PM

Facility = Chesterfield Power Station - 301
Chemical = Dieldrin
Chronic averaging period = 4
WLAa = 2.5
WLAc = 0.59
Q.L. = 0.00079
# samples/mo. = 1
# samples/wk. = 1

Summary of Statistics:

observations = 1
Expected Value = .0038
Variance = .000005
C.V. = 0.6
97th percentile daily values = .009246
97th percentile 4 day average = .006322
97th percentile 30 day average= .004583
< Q.L. = 0
Model used = BPJ Assumptions, type 2 data

No Limit is required for this material

The data are:

0.0038

5/25/2016 3:53:55 PM

Facility = Chesterfield Power Station - 301
Chemical = Alpha-Endosulfan
Chronic averaging period = 4
WLAa = 2.3
WLAc = 0.59
Q.L. = 0.0009
# samples/mo. = 1
# samples/wk. = 1

Summary of Statistics:

observations = 1
Expected Value = .0016
Variance = .000000
C.V. = 0.6
97th percentile daily values = .003893
97th percentile 4 day average = .002662
97th percentile 30 day average= .001929
< Q.L. = 0
Model used = BPJ Assumptions, type 2 data

No Limit is required for this material

The data are:

0.0016

5/25/2016 3:54:53 PM

Facility = Chesterfield Power Station - 301
Chemical = Beta-Endosulfan
Chronic averaging period = 4
WLAa = 2.3
WLAc = 0.59
Q.L. = 0.0009
# samples/mo. = 1
# samples/wk. = 1

Summary of Statistics:

observations = 1
Expected Value = .0076
Variance = .000020
C.V. = 0.6
97th percentile daily values = .018493
97th percentile 4 day average = .012644
97th percentile 30 day average= .009166
< Q.L. = 0
Model used = BPJ Assumptions, type 2 data

No Limit is required for this material

The data are:

0.0076

5/19/2016 10:30:15 AM

Facility = Chesterfield Power Station - 301
Chemical = Endrin
Chronic averaging period = 4
WLAa   = 0.91
WLAc   = 0.38
Q.L.   = 0.0013
samples/mo. = 1
samples/wk. = 1

Summary of Statistics:

observations = 1
Expected Value = .0017
Variance   = .000001
C.V.   = 0.6
97th percentile daily values = .004136
97th percentile 4 day average = .002828
97th percentile 30 day average= .002050
< Q.L.   = 0
Model used   = BPJ Assumptions, type 2 data

No Limit is required for this material

The data are:

0.0017

5/26/2016 4:51:44 PM

Facility = Chesterfield Power Station - 301
Chemical = Heptachlor
Chronic averaging period = 4
WLAa   = 5.5
WLAc   = 0.04
Q.L.   = 0.0009
samples/mo. = 1
samples/wk. = 1

Summary of Statistics:

observations = 1
Expected Value = .028
Variance   = .000282
C.V.   = 0.6
97th percentile daily values = .068135
97th percentile 4 day average = .046586
97th percentile 30 day average= .033769
< Q.L.   = 0
Model used   = BPJ Assumptions, type 2 data

A limit is needed based on Chronic Toxicity
Maximum Daily Limit   = 5.85029913621293E-02
Average Weekly limit = 5.85029913621293E-02
Average Monthly LImit = 5.85029913621293E-02

The data are:

0.028

5/26/2016 7:26:02 AM

Facility = Chesterfield Power Station - 301
Chemical = Heptachlor Epoxide
Chronic averaging period = 4
WLAa = 5.5
WLAc = 0.04
Q.L. = 0.0009
# samples/mo. = 1
# samples/wk. = 1

Summary of Statistics:

observations = 1
Expected Value = .0015
Variance = .000000
C.V. = 0.6
97th percentile daily values = .003650
97th percentile 4 day average = .002495
97th percentile 30 day average= .001809
< Q.L. = 0
Model used = BPJ Assumptions, type 2 data

No Limit is required for this material

The data are:

0.0015

5/19/2016 10:30:57 AM

Facility = Chesterfield Power Station - 301
Chemical = Lead
Chronic averaging period = 4
WLAa = 770
WLAc = 88
Q.L. = 0.5
# samples/mo. = 1
# samples/wk. = 1

Summary of Statistics:

observations = 1
Expected Value = 4.9
Variance = 8.6436
C.V. = 0.6
97th percentile daily values = 11.9237
97th percentile 4 day average = 8.15257
97th percentile 30 day average= 5.90966
< Q.L. = 0
Model used = BPJ Assumptions, type 2 data

No Limit is required for this material

The data are:

4.9

5/26/2016 7:28:23 AM

Facility = Chesterfield Power Station - 301
Chemical = Mercury
Chronic averaging period = 4
WLAa = 15
WLAc = 8.1
Q.L. = 0.0031
# samples/mo. = 1
# samples/wk. = 1

Summary of Statistics:

observations = 1
Expected Value = .08
Variance = .002304
C.V. = 0.6
97th percentile daily values = .194673
97th percentile 4 day average = .133103
97th percentile 30 day average= .096484
< Q.L. = 0
Model used = BPJ Assumptions, type 2 data

No Limit is required for this material

The data are:

0.08

5/19/2016 10:31:50 AM

Facility = Chesterfield Power Station - 301
Chemical = Nickel
Chronic averaging period = 4
WLAa   = 1400
WLAc   = 160
Q.L.   = 1
samples/mo. = 1
samples/wk. = 1

Summary of Statistics:

observations = 1
Expected Value = 110
Variance   = 4356
C.V.   = 0.6
97th percentile daily values = 267.675
97th percentile 4 day average = 183.016
97th percentile 30 day average= 132.665
< Q.L.   = 0
Model used   = BPJ Assumptions, type 2 data

A limit is needed based on Chronic Toxicity
Maximum Daily Limit   = 234.011965448517
Average Weekly limit = 234.011965448517
Average Monthly LImit = 234.011965448517

The data are:

110

5/26/2016 5:03:59 PM

Facility = Chesterfield Power Station - 301
Chemical = Pentachlorophenol
Chronic averaging period = 4
WLAa = 120
WLAc = 89
Q.L. = 0.64
# samples/mo. = 1
# samples/wk. = 1

Summary of Statistics:

observations = 1
Expected Value = .73
Variance = .191844
C.V. = 0.6
97th percentile daily values = 1.77639
97th percentile 4 day average = 1.21456
97th percentile 30 day average= .880418
< Q.L. = 0
Model used = BPJ Assumptions, type 2 data

No Limit is required for this material

The data are:

0.73

5/26/2016 7:31:33 AM

Facility = Chesterfield Power Station - 301
Chemical = Selenium
Chronic averaging period = 4
WLAa = 210
WLAc = 53
Q.L. = 5
# samples/mo. = 1
# samples/wk. = 1

Summary of Statistics:

observations = 1
Expected Value = 19
Variance = 129.96
C.V. = 0.6
97th percentile daily values = 46.2349
97th percentile 4 day average = 31.6120
97th percentile 30 day average= 22.9150
< Q.L. = 0
Model used = BPJ Assumptions, type 2 data

No Limit is required for this material

The data are:

19

5/19/2016 10:35:53 AM

Facility = Chesterfield Power Station - 301
Chemical = Zinc
Chronic averaging period = 4
WLAa   = 900
WLAc   = 900
Q.L.   = 5
samples/mo. = 1
samples/wk. = 1

Summary of Statistics:

observations = 1
Expected Value = 380
Variance   = 51984
C.V.   = 0.6
97th percentile daily values = 924.698
97th percentile 4 day average = 632.240
97th percentile 30 day average= 458.300
< Q.L.   = 0
Model used   = BPJ Assumptions, type 2 data

A limit is needed based on Acute Toxicity
Maximum Daily Limit   = 900
Average Weekly limit = 900
Average Monthly LImit = 900

The data are:

380

d. Reasonable Potential Analysis for Outfall 004 – Pre-Drawdown

Effluent limitations for parameters submitted with the application were evaluated in accordance with DEQ Guidance Memos 00-2011 and GM14-2003. All observed pollutants and pollutants reported less than QLs that exceeded the agency accepted values were evaluated for reasonable potential to violate in stream water quality standards. Pollutants that were reported less than a DEQ accepted QL were considered absent for the purposes of this evaluation.

MSTRANTI (version 2b), a DEQ developed spreadsheet was used to calculate Waste Load Allocations (WLAs) based on mixed conditions. Stream data, effluent data and mixing ratios were entered into MSTRANTI to determine the WLAs.

Outfall 004 discharges to the upper end of Farrar Gut (river mile 3.75). In previous permits, Outfall 004 has been evaluated in conjunction with Outfall 005 as discharging to a free flowing stream consisting of the Outfall 003 discharge. However, in this permit, Outfalls 004 and 005 are evaluated separately. Furthermore, Outfall 004 was evaluated as if discharging to a dry ditch with no dilution; and therefore, ambient inputs were reflective of the effluent inputs. The maximum of the 30 day max flow values from the last three years of DMR data was selected for Outfall 004 to establish the effluent flow.

Once the WLAs were determined using MSTRANTI, STATS.EXE (version 2.0.4) was then used to evaluate reasonable potential and calculate a limitation if needed. WLAs, monitoring frequencies and reported effluent pollutant concentrations were entered into STATS.EXE to evaluate each pollutant individually. As shown in the STATS outputs included in this section, Ammonia as N and Total Recoverable Selenium limitations are needed to protect ambient aquatic Water Quality Standards at Outfall 004. These limitations have been added to the permit with a compliance schedule.

Ammonia as N effluent limitations were assigned for Outfall 004 in the 2004 permit to protect WQS. The limitations were established in 2004 because Dominion anticipated installing air pollution control equipment with the potential to impact ash pond ammonia concentrations. The anticipated ammonia concentrations during the 2004 permit term could not be accurately predicted and were expected to vary. Consequently, a limitation was forced in STATS.exe and assigned in the 2004 permit. Dominion has now installed and is operating all of the technologies expected to contribute ammonia, and a considerable amount of ammonia data has been collected. The data shows that from a nutrient loading perspective the ammonia loading from Outfall 004 is insignificant and the total nitrogen loading limits in the Nutrient GP (VAN040086) are in compliance with the TMDL. However, from an ammonia toxicity perspective, ammonia limits are necessary. The ammonia limits from the 2004 permit have been retained in this permit as interim limits, and the new ammonia limits have been assigned with a compliance schedule.

For parameters with standards based on Human Health (HH), the maximum observed values were compared to the HH WLAs calculated in MSTRANTI. The receiving stream is not designated as a PWS, so the HH PWS standards do not apply to this discharge. The observed Dissolved Thallium concentration exceeded the HH WLAs. Total Recoverable Thallium limitations were included in the permit. The observed values for the other pollutants were less than the HH WLAs; therefore, no limitations are needed for these parameters to protect human health. Pollutants without an applicable standard cannot be evaluated at this time.

Pollutant	Observed Value	Human Health WLA	Reasonable Potential (Y/N)
Chloride (µg/L)	118,320	-	N[1]
Dissolved Antimony (µg/L)	8.00	640	N
Dissolved Arsenic (µg/L)	41.00	-	N[1]
Dissolved Cadmium (µg/L)	1.10	-	N[1]
Dissolved Copper (µg/L)	8.00	-	N[1]
Dissolved Nickel (µg/L)	25.00	4,600	N
Dissolved Thallium (µg/L)	0.50	0.47	Y
Dissolved Zinc (µg/L)	26.00	26,000	N
Gross Alpha Particle Activity (pCi/L)	4.44	-	N[1]
Sulfate (mg/L)	150.31	-	N[1]
Total Barium (µg/L)	343	-	N[1]
Total Chromium (µg/L)	2.00	-	N[1]
Total Iron (µg/L)	70	-	N[1]
Total Manganese (µg/L)	80	-	N[1]
Total Selenium (µg/L)	19	4,200	Y

[1] VAWQS for these parameters applicable only to receiving streams with a special standard for public water supply (PWS).

MSTRANTI DATA SOURCE REPORT
(Chesterfield Power Station: Outfall 004)

Stream Information	
Mean Hardness	The outfall is considered to discharge into a dry ditch with no dilution. Therefore, stream information inputs are reflective of effluent information inputs.
90% Temperature (annual)	
90% Temperature (wet season)	
90% Maximum pH	
10% Maximum pH	
Tier Designation	
Stream Flows	
All Data	Farrar Gut is considered to be tidal. However, the outfall was evaluated as discharging into a dry ditch with no dilution. See flow frequency memo (02/29/2016) in **Attachment 2**.
Mixing Information	
All percentages	Farrar Gut is considered to be tidal. However, the outfall was evaluated as discharging into a dry ditch with no dilution.
Effluent Information	
Mean Hardness	Average hardness value from WET test results.
90% Temperature (annual)	Max temperature reported on the application serves as a surrogate for 90th percentile temperature. Given the limited data set, the max value is the best estimate available.
90% Temperature (wet season)	NA
90% Maximum pH	90th percentile of the max pH and 10th percentile of the max pH from DMR data.
10% Maximum pH	
Discharge Flow	The maximum of 30 day maximum average flows reported on the DMRs over the last three years was used as the discharge flow.

Data Location:

Flow Frequency Analysis — Attachment 2
DMR Data — Attachment 4.a
App Data — Attachment 4.e

FRESHWATER
WATER QUALITY CRITERIA / WASTELOAD ALLOCATION ANALYSIS

Facility Name: Chesterfield Power Station 004 Pre-Drawdown Permit No.: VA0004146

Receiving Stream: Farrar Gut Version: OWP Guidance Memo 00-2011 (8/24/00)

Stream Information		
Mean Hardness (as CaCO3) =	381	mg/L
90% Temperature (Annual) =	32.2	deg C
90% Temperature (Wet season) =		deg C
90% Maximum pH =	8.5	SU
10% Maximum pH =	7.8	SU
Tier Designation (1 or 2) =	1	
Public Water Supply (PWS) Y/N? =	n	
Trout Present Y/N? =	n	
Early Life Stages Present Y/N? =	y	

Stream Flows		
1Q10 (Annual) =	0	MGD
7Q10 (Annual) =	0	MGD
30Q10 (Annual) =	0	MGD
1Q10 (Wet season) =		MGD
30Q10 (Wet season) =		MGD
30Q5 =	0	MGD
Harmonic Mean =	0	MGD

Mixing Information		
Annual - 1Q10 Mix =	0	%
- 7Q10 Mix =	0	%
- 30Q10 Mix =	0	%
Wet Season - 1Q10 Mix =		%
- 30Q10 Mix =		%

Effluent Information		
Mean Hardness (as CaCO3) =	381	mg/L
90% Temp (Annual) =	32.2	deg C
90% Temp (Wet season) =		deg C
90% Maximum pH =	8.5	SU
10% Maximum pH =	7.8	SU
Discharge Flow =	22.41	MGD

Parameter	Background	Water Quality Criteria				Wasteload Allocations				Antidegradation Baseline				Antidegradation Allocations				**Most Limiting Allocations**			
(ug/l unless noted)	Conc.	Acute	Chronic	HH (PWS)	HH	Acute	Chronic	HH (PWS)	HH	Acute	Chronic	HH (PWS)	HH	Acute	Chronic	HH (PWS)	HH	**Acute**	**Chronic**	**HH (PWS)**	**HH**
Acenapthene	0	--	--	na	9.9E+02	--	--	na	9.9E+02	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**9.9E+02**
Acrolein	0	--	--	na	9.3E+00	--	--	na	9.3E+00	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**9.3E+00**
Acrylonitrile[C]	0	--	--	na	2.5E+00	--	--	na	2.5E+00	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**2.5E+00**
Aldrin [C]	0	3.0E+00	--	na	5.0E-04	3.0E+00	--	na	5.0E-04	--	--	--	--	--	--	--	--	**3.0E+00**	**--**	**na**	**5.0E-04**
Ammonia-N (mg/l) (Yearly)	0	3.20E+00	3.48E-01	na	--	3.20E+00	3.48E-01	na	--	--	--	--	--	--	--	--	--	**3.20E+00**	**3.48E-01**	**na**	**--**
Ammonia-N (mg/l) (High Flow)	0	3.20E+00	1.09E+00	na	--	3.20E+00	1.09E+00	na	--	--	--	--	--	--	--	--	--	**3.20E+00**	**1.09E+00**	**na**	**--**
Anthracene	0	--	--	na	4.0E+04	--	--	na	4.0E+04	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**4.0E+04**
Antimony	0	--	--	na	6.4E+02	--	--	na	6.4E+02	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**6.4E+02**
Arsenic	0	3.4E+02	1.5E+02	na	--	3.4E+02	1.5E+02	na	--	--	--	--	--	--	--	--	--	**3.4E+02**	**1.5E+02**	**na**	**--**
Barium	0	--	--	na	--	--	--	na	--	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**--**
Benzene [C]	0	--	--	na	5.1E+02	--	--	na	5.1E+02	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**5.1E+02**
Benzidine[C]	0	--	--	na	2.0E-03	--	--	na	2.0E-03	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**2.0E-03**
Benzo (a) anthracene [C]	0	--	--	na	1.8E-01	--	--	na	1.8E-01	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.8E-01**
Benzo (b) fluoranthene [C]	0	--	--	na	1.8E-01	--	--	na	1.8E-01	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.8E-01**
Benzo (k) fluoranthene [C]	0	--	--	na	1.8E-01	--	--	na	1.8E-01	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.8E-01**
Benzo (a) pyrene [C]	0	--	--	na	1.8E-01	--	--	na	1.8E-01	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.8E-01**
Bis2-Chloroethyl Ether [C]	0	--	--	na	5.3E+00	--	--	na	5.3E+00	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**5.3E+00**
Bis2-Chloroisopropyl Ether	0	--	--	na	6.5E+04	--	--	na	6.5E+04	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**6.5E+04**
Bis 2-Ethylhexyl Phthalate [C]	0	--	--	na	2.2E+01	--	--	na	2.2E+01	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**2.2E+01**
Bromoform [C]	0	--	--	na	1.4E+03	--	--	na	1.4E+03	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.4E+03**
Butylbenzylphthalate	0	--	--	na	1.9E+03	--	--	na	1.9E+03	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.9E+03**
Cadmium	0	1.8E+01	3.2E+00	na	--	1.8E+01	3.2E+00	na	--	--	--	--	--	--	--	--	--	**1.8E+01**	**3.2E+00**	**na**	**--**
Carbon Tetrachloride [C]	0	--	--	na	1.6E+01	--	--	na	1.6E+01	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.6E+01**
Chlordane [C]	0	2.4E+00	4.3E-03	na	8.1E-03	2.4E+00	4.3E-03	na	8.1E-03	--	--	--	--	--	--	--	--	**2.4E+00**	**4.3E-03**	**na**	**8.1E-03**
Chloride	0	8.6E+05	2.3E+05	na	--	8.6E+05	2.3E+05	na	--	--	--	--	--	--	--	--	--	**8.6E+05**	**2.3E+05**	**na**	**--**
TRC	0	1.9E+01	1.1E+01	na	--	1.9E+01	1.1E+01	na	--	--	--	--	--	--	--	--	--	**1.9E+01**	**1.1E+01**	**na**	**--**
Chlorobenzene	0	--	--	na	1.6E+03	--	--	na	1.6E+03	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.6E+03**

Parameter	Background	Water Quality Criteria				Wasteload Allocations				Antidegradation Baseline				Antidegradation Allocations				**Most Limiting Allocations**			
(ug/l unless noted)	Conc.	Acute	Chronic	HH (PWS)	HH	Acute	Chronic	HH (PWS)	HH	Acute	Chronic	HH (PWS)	HH	Acute	Chronic	HH (PWS)	HH	**Acute**	**Chronic**	**HH (PWS)**	**HH**
Chlorodibromomethane[C]	0	--	--	na	1.3E+02	--	--	na	1.3E+02	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.3E+02**
Chloroform	0	--	--	na	1.1E+04	--	--	na	1.1E+04	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.1E+04**
2-Chloronaphthalene	0	--	--	na	1.6E+03	--	--	na	1.6E+03	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.6E+03**
2-Chlorophenol	0	--	--	na	1.5E+02	--	--	na	1.5E+02	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.5E+02**
Chlorpyrifos	0	8.3E-02	4.1E-02	na	--	8.3E-02	4.1E-02	na	--	--	--	--	--	--	--	--	--	**8.3E-02**	**4.1E-02**	**na**	**--**
Chromium III	0	1.7E+03	2.2E+02	na	--	1.7E+03	2.2E+02	na	--	--	--	--	--	--	--	--	--	**1.7E+03**	**2.2E+02**	**na**	**--**
Chromium VI	0	1.6E+01	1.1E+01	na	--	1.6E+01	1.1E+01	na	--	--	--	--	--	--	--	--	--	**1.6E+01**	**1.1E+01**	**na**	**--**
Chromium, Total	0	--	--	1.0E+02	--	--	--	na	--	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**--**
Chrysene [C]	0	--	--	na	1.8E-02	--	--	na	1.8E-02	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.8E-02**
Copper	2	4.7E+01	2.8E+01	na	--	4.7E+01	2.8E+01	na	--	--	--	--	--	--	--	--	--	**4.7E+01**	**2.8E+01**	**na**	**--**
Cyanide, Free	0	2.2E+01	5.2E+00	na	1.6E+04	2.2E+01	5.2E+00	na	1.6E+04	--	--	--	--	--	--	--	--	**2.2E+01**	**5.2E+00**	**na**	**1.6E+04**
DDD [C]	0	--	--	na	3.1E-03	--	--	na	3.1E-03	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**3.1E-03**
DDE [C]	0	--	--	na	2.2E-03	--	--	na	2.2E-03	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**2.2E-03**
DDT [C]	0	1.1E+00	1.0E-03	na	2.2E-03	1.1E+00	1.0E-03	na	2.2E-03	--	--	--	--	--	--	--	--	**1.1E+00**	**1.0E-03**	**na**	**2.2E-03**
Demeton	0	--	1.0E-01	na	--	--	1.0E-01	na	--	--	--	--	--	--	--	--	--	**--**	**1.0E-01**	**na**	**--**
Diazinon	0	1.7E-01	1.7E-01	na	--	1.7E-01	1.7E-01	na	--	--	--	--	--	--	--	--	--	**1.7E-01**	**1.7E-01**	**na**	**--**
Dibenz(a,h)anthracene [C]	0	--	--	na	1.8E-01	--	--	na	1.8E-01	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.8E-01**
1,2-Dichlorobenzene	0	--	--	na	1.3E+03	--	--	na	1.3E+03	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.3E+03**
1,3-Dichlorobenzene	0	--	--	na	9.6E+02	--	--	na	9.6E+02	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**9.6E+02**
1,4-Dichlorobenzene	0	--	--	na	1.9E+02	--	--	na	1.9E+02	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.9E+02**
3,3-Dichlorobenzidine[C]	0	--	--	na	2.8E-01	--	--	na	2.8E-01	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**2.8E-01**
Dichlorobromomethane [C]	0	--	--	na	1.7E+02	--	--	na	1.7E+02	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.7E+02**
1,2-Dichloroethane [C]	0	--	--	na	3.7E+02	--	--	na	3.7E+02	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**3.7E+02**
1,1-Dichloroethylene	0	--	--	na	7.1E+03	--	--	na	7.1E+03	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**7.1E+03**
1,2-trans-dichloroethylene	0	--	--	na	1.0E+04	--	--	na	1.0E+04	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.0E+04**
2,4-Dichlorophenol	0	--	--	na	2.9E+02	--	--	na	2.9E+02	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**2.9E+02**
2,4-Dichlorophenoxy acetic acid (2,4-D)	0	--	--	na	--	--	--	na	--	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**--**
1,2-Dichloropropane[C]	0	--	--	na	1.5E+02	--	--	na	1.5E+02	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.5E+02**
1,3-Dichloropropene [C]	0	--	--	na	2.1E+02	--	--	na	2.1E+02	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**2.1E+02**
Dieldrin [C]	0	2.4E-01	5.6E-02	na	5.4E-04	2.4E-01	5.6E-02	na	5.4E-04	--	--	--	--	--	--	--	--	**2.4E-01**	**5.6E-02**	**na**	**5.4E-04**
Diethyl Phthalate	0	--	--	na	4.4E+04	--	--	na	4.4E+04	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**4.4E+04**
2,4-Dimethylphenol	0	--	--	na	8.5E+02	--	--	na	8.5E+02	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**8.5E+02**
Dimethyl Phthalate	0	--	--	na	1.1E+06	--	--	na	1.1E+06	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.1E+06**
Di-n-Butyl Phthalate	0	--	--	na	4.5E+03	--	--	na	4.5E+03	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**4.5E+03**
2,4 Dinitrophenol	0	--	--	na	5.3E+03	--	--	na	5.3E+03	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**5.3E+03**
2-Methyl-4,6-Dinitrophenol	0	--	--	na	2.8E+02	--	--	na	2.8E+02	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**2.8E+02**
2,4-Dinitrotoluene [C]	0	--	--	na	3.4E+01	--	--	na	3.4E+01	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**3.4E+01**
Dioxin 2,3,7,8-tetrachlorodibenzo-p-dioxin	0	--	--	na	5.1E-08	--	--	na	5.1E-08	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**5.1E-08**
1,2-Diphenylhydrazine[C]	0	--	--	na	2.0E+00	--	--	na	2.0E+00	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**2.0E+00**
Alpha-Endosulfan	0	2.2E-01	5.6E-02	na	8.9E+01	2.2E-01	5.6E-02	na	8.9E+01	--	--	--	--	--	--	--	--	**2.2E-01**	**5.6E-02**	**na**	**8.9E+01**
Beta-Endosulfan	0	2.2E-01	5.6E-02	na	8.9E+01	2.2E-01	5.6E-02	na	8.9E+01	--	--	--	--	--	--	--	--	**2.2E-01**	**5.6E-02**	**na**	**8.9E+01**
Alpha + Beta Endosulfan	0	2.2E-01	5.6E-02	--	--	2.2E-01	5.6E-02	--	--	--	--	--	--	--	--	--	--	**2.2E-01**	**5.6E-02**	**--**	**--**
Endosulfan Sulfate	0	--	--	na	8.9E+01	--	--	na	8.9E+01	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**8.9E+01**
Endrin	0	8.6E-02	3.6E-02	na	6.0E-02	8.6E-02	3.6E-02	na	6.0E-02	--	--	--	--	--	--	--	--	**8.6E-02**	**3.6E-02**	**na**	**6.0E-02**
Endrin Aldehyde	0	--	--	na	3.0E-01	--	--	na	3.0E-01	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**3.0E-01**

Parameter	Background	Water Quality Criteria				Wasteload Allocations				Antidegradation Baseline				Antidegradation Allocations				**Most Limiting Allocations**			
(ug/l unless noted)	Conc.	Acute	Chronic	HH (PWS)	HH	Acute	Chronic	HH (PWS)	HH	Acute	Chronic	HH (PWS)	HH	Acute	Chronic	HH (PWS)	HH	**Acute**	**Chronic**	**HH (PWS)**	**HH**
Ethylbenzene	0	--	--	na	2.1E+03	--	--	na	2.1E+03	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**2.1E+03**
Fluoranthene	0	--	--	na	1.4E+02	--	--	na	1.4E+02	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.4E+02**
Fluorene	0	--	--	na	5.3E+03	--	--	na	5.3E+03	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**5.3E+03**
Foaming Agents	0	--	--	na	--	--	--	na	--	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**--**
Guthion	0	--	1.0E-02	na	--	--	1.0E-02	na	--	--	--	--	--	--	--	--	--	**--**	**1.0E-02**	**na**	**--**
Heptachlor [C]	0	5.2E-01	3.8E-03	na	7.9E-04	5.2E-01	3.8E-03	na	7.9E-04	--	--	--	--	--	--	--	--	**5.2E-01**	**3.8E-03**	**na**	**7.9E-04**
Heptachlor Epoxide[C]	0	5.2E-01	3.8E-03	na	3.9E-04	5.2E-01	3.8E-03	na	3.9E-04	--	--	--	--	--	--	--	--	**5.2E-01**	**3.8E-03**	**na**	**3.9E-04**
Hexachlorobenzene[C]	0	--	--	na	2.9E-03	--	--	na	2.9E-03	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**2.9E-03**
Hexachlorobutadiene[C]	0	--	--	na	1.8E+02	--	--	na	1.8E+02	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.8E+02**
Hexachlorocyclohexane Alpha-BHC[C]	0	--	--	na	4.9E-02	--	--	na	4.9E-02	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**4.9E-02**
Hexachlorocyclohexane Beta-BHC[C]	0	--	--	na	1.7E-01	--	--	na	1.7E-01	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.7E-01**
Hexachlorocyclohexane Gamma-BHC[C] (Lindane)	0	9.5E-01	na	na	1.8E+00	9.5E-01	--	na	1.8E+00	--	--	--	--	--	--	--	--	**9.5E-01**	**--**	**na**	**1.8E+00**
Hexachlorocyclopentadiene	0	--	--	na	1.1E+03	--	--	na	1.1E+03	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.1E+03**
Hexachloroethane[C]	0	--	--	na	3.3E+01	--	--	na	3.3E+01	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**3.3E+01**
Hydrogen Sulfide	0	--	2.0E+00	na	--	--	2.0E+00	na	--	--	--	--	--	--	--	--	--	**--**	**2.0E+00**	**na**	**--**
Indeno (1,2,3-cd) pyrene [C]	0	--	--	na	1.8E-01	--	--	na	1.8E-01	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.8E-01**
Iron	0	--	--	na	--	--	--	na	--	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**--**
Isophorone[C]	0	--	--	na	9.6E+03	--	--	na	9.6E+03	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**9.6E+03**
Kepone	0	--	0.0E+00	na	--	--	0.0E+00	na	--	--	--	--	--	--	--	--	--	**--**	**0.0E+00**	**na**	**--**
Lead	0	6.5E+02	7.4E+01	na	--	6.5E+02	7.4E+01	na	--	--	--	--	--	--	--	--	--	**6.5E+02**	**7.4E+01**	**na**	**--**
Malathion	0	--	1.0E-01	na	--	--	1.0E-01	na	--	--	--	--	--	--	--	--	--	**--**	**1.0E-01**	**na**	**--**
Manganese	0	--	--	na	--	--	--	na	--	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**--**
Mercury	0	1.4E+00	7.7E-01	- -	- -	1.4E+00	7.7E-01	- -	- -	--	--	--	--	--	--	--	--	**1.4E+00**	**7.7E-01**	**- -**	**- -**
Methyl Bromide	0	--	--	na	1.5E+03	--	--	na	1.5E+03	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.5E+03**
Methylene Chloride [C]	0	--	--	na	5.9E+03	--	--	na	5.9E+03	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**5.9E+03**
Methoxychlor	0	--	3.0E-02	na	--	--	3.0E-02	na	--	--	--	--	--	--	--	--	--	**--**	**3.0E-02**	**na**	**--**
Mirex	0	--	0.0E+00	na	--	--	0.0E+00	na	--	--	--	--	--	--	--	--	--	**--**	**0.0E+00**	**na**	**--**
Nickel	0	5.7E+02	6.3E+01	na	4.6E+03	5.7E+02	6.3E+01	na	4.6E+03	--	--	--	--	--	--	--	--	**5.7E+02**	**6.3E+01**	**na**	**4.6E+03**
Nitrate (as N)	0	--	--	na	--	--	--	na	--	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**--**
Nitrobenzene	0	--	--	na	6.9E+02	--	--	na	6.9E+02	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**6.9E+02**
N-Nitrosodimethylamine[C]	0	--	--	na	3.0E+01	--	--	na	3.0E+01	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**3.0E+01**
N-Nitrosodiphenylamine[C]	0	--	--	na	6.0E+01	--	--	na	6.0E+01	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**6.0E+01**
N-Nitrosodi-n-propylamine[C]	0	--	--	na	5.1E+00	--	--	na	5.1E+00	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**5.1E+00**
Nonylphenol	0	2.8E+01	6.6E+00	--	--	2.8E+01	6.6E+00	na	--	--	--	--	--	--	--	--	--	**2.8E+01**	**6.6E+00**	**na**	**--**
Parathion	0	6.5E-02	1.3E-02	na	--	6.5E-02	1.3E-02	na	--	--	--	--	--	--	--	--	--	**6.5E-02**	**1.3E-02**	**na**	**--**
PCB Total[C]	0	--	1.4E-02	na	6.4E-04	--	1.4E-02	na	6.4E-04	--	--	--	--	--	--	--	--	**--**	**1.4E-02**	**na**	**6.4E-04**
Pentachlorophenol [C]	0	1.9E+01	1.5E+01	na	3.0E+01	1.9E+01	1.5E+01	na	3.0E+01	--	--	--	--	--	--	--	--	**1.9E+01**	**1.5E+01**	**na**	**3.0E+01**
Phenol	0	--	--	na	8.6E+05	--	--	na	8.6E+05	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**8.6E+05**
Pyrene	0	--	--	na	4.0E+03	--	--	na	4.0E+03	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**4.0E+03**
Radionuclides	0	--	--	na	--	--	--	na	--	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**--**
Gross Alpha Activity (pCi/L)	0	--	--	na	--	--	--	na	--	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**--**
Beta and Photon Activity (mrem/yr)	0	--	--	na	--	--	--	na	--	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**--**
Radium 226 + 228 (pCi/L)	0	--	--	na	--	--	--	na	--	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**--**
Uranium (ug/l)	0	--	--	na	--	--	--	na	--	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**--**

Parameter	Background	Water Quality Criteria				Wasteload Allocations				Antidegradation Baseline				Antidegradation Allocations				**Most Limiting Allocations**			
(ug/l unless noted)	Conc.	Acute	Chronic	HH (PWS)	HH	Acute	Chronic	HH (PWS)	HH	Acute	Chronic	HH (PWS)	HH	Acute	Chronic	HH (PWS)	HH	**Acute**	**Chronic**	**HH (PWS)**	**HH**
Selenium, Total Recoverable	0	2.0E+01	5.0E+00	na	4.2E+03	2.0E+01	5.0E+00	na	4.2E+03	--	--	--	--	--	--	--	--	**2.0E+01**	**5.0E+00**	**na**	**4.2E+03**
Silver	0	3.4E+01	--	na	--	3.4E+01	--	na	--	--	--	--	--	--	--	--	--	**3.4E+01**	**--**	**na**	**--**
Sulfate	0	--	--	na	--	--	--	na	--	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**--**
1,1,2,2-Tetrachloroethane[C]	0	--	--	na	4.0E+01	--	--	na	4.0E+01	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**4.0E+01**
Tetrachloroethylene[C]	0	--	--	na	3.3E+01	--	--	na	3.3E+01	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**3.3E+01**
Thallium	0	--	--	na	4.7E-01	--	--	na	4.7E-01	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**4.7E-01**
Toluene	0	--	--	na	6.0E+03	--	--	na	6.0E+03	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**6.0E+03**
Total dissolved solids	0	--	--	na	--	--	--	na	--	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**--**
Toxaphene [C]	0	7.3E-01	2.0E-04	na	2.8E-03	7.3E-01	2.0E-04	na	2.8E-03	--	--	--	--	--	--	--	--	**7.3E-01**	**2.0E-04**	**na**	**2.8E-03**
Tributyltin	0	4.6E-01	7.2E-02	na	--	4.6E-01	7.2E-02	na	--	--	--	--	--	--	--	--	--	**4.6E-01**	**7.2E-02**	**na**	**--**
1,2,4-Trichlorobenzene	0	--	--	na	7.0E+01	--	--	na	7.0E+01	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**7.0E+01**
1,1,2-Trichloroethane[C]	0	--	--	na	1.6E+02	--	--	na	1.6E+02	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.6E+02**
Trichloroethylene [C]	0	--	--	na	3.0E+02	--	--	na	3.0E+02	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**3.0E+02**
2,4,6-Trichlorophenol [C]	0	--	--	na	2.4E+01	--	--	na	2.4E+01	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**2.4E+01**
2-(2,4,5-Trichlorophenoxy) propionic acid (Silvex)	0	--	--	na	--	--	--	na	--	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**--**
Vinyl Chloride[C]	0	--	--	na	2.4E+01	--	--	na	2.4E+01	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**2.4E+01**
Zinc	0	3.6E+02	3.7E+02	na	2.6E+04	3.6E+02	3.7E+02	na	2.6E+04	--	--	--	--	--	--	--	--	**3.6E+02**	**3.7E+02**	**na**	**2.6E+04**

Notes:

1. All concentrations expressed as micrograms/liter (ug/l), unless noted otherwise
2. Discharge flow is highest monthly average or Form 2C maximum for Industries and design flow for Municipals
3. Metals measured as Dissolved, unless specified otherwise
4. "C" indicates a carcinogenic parameter
5. Regular WLAs are mass balances (minus background concentration) using the % of stream flow entered above under Mixing Information.
   Antidegradation WLAs are based upon a complete mix.
6. Antideg. Baseline = (0.25(WQC - background conc.) + background conc.) for acute and chronic
   = (0.1(WQC - background conc.) + background conc.) for human health
7. WLAs established at the following stream flows: 1Q10 for Acute, 30Q10 for Chronic Ammonia, 7Q10 for Other Chronic, 30Q5 for Non-carcinogens and Harmonic Mean for Carcinogens. To apply mixing ratios from a model set the stream flow equal to (mixing ratio - 1), effluent flow equal to 1 and 100% mix.

Metal	Target Value (SSTV)
Antimony	6.4E+02
Arsenic	9.0E+01
Barium	na
Cadmium	1.9E+00
Chromium III	1.3E+02
Chromium VI	6.4E+00
Copper	1.7E+01
Iron	na
Lead	4.4E+01
Manganese	na
Mercury	4.6E-01
Nickel	3.8E+01
Selenium	3.0E+00
Silver	1.4E+01
Zinc	1.5E+02

Note: do not use QL's lower than the minimum QL's provided in agency guidance

3/8/2016 10:48:44 AM

Facility = Chesterfield Power Station 004 - Pre-Closure
Chemical = Ammonia
Chronic averaging period = 30
WLAa = 3.2
WLAc = 0.348
Q.L. = 0.2
# samples/mo. = 2
# samples/wk. = 1

Summary of Statistics:

observations = 36
Expected Value = .636384
Variance = .260725
C.V. = 0.802365
97th percentile daily values = 1.83002
97th percentile 4 day average = 1.16146
97th percentile 30 day average= .799621
< Q.L. = 7
Model used = delta lognormal

A limit is needed based on Chronic Toxicity
Maximum Daily Limit = 0.796436398048564
Average Weekly limit = 0.796436398048564
Average Monthly LImit = 0.611087548989739

The data are:

0.16
0.08
0.13
0.09
0.34
0.47
0.45
2.69
1.41
0.81
0
0.79
0.84
0.54
0.6
0.18
0.63
0.71
0.56
1.07
1.17
0.72
0.56
0.28
0.2

0.2
0.19
0.34
0.35
0.58
0.5
1.26
1.86
0.8
0.56
0.23

3/8/2016 10:50:08 AM

Facility = Chesterfield Power Station 004 - Pre-Closure
Chemical = Arsenic
Chronic averaging period = 4
WLAa = 340
WLAc = 150
Q.L. = 10
# samples/mo. = 2
# samples/wk. = 1

Summary of Statistics:

observations = 1
Expected Value = 41
Variance = 605.16
C.V. = 0.6
97th percentile daily values = 99.7701
97th percentile 4 day average = 68.2153
97th percentile 30 day average= 49.4481
< Q.L. = 0
Model used = BPJ Assumptions, type 2 data

No Limit is required for this material

The data are:

41

3/8/2016 10:51:22 AM

Facility = Chesterfield Power Station 004 - Pre-Closure
Chemical = Cadmium
Chronic averaging period = 4
WLAa = 18
WLAc = 3.2
Q.L. = 1
# samples/mo. = 2
# samples/wk. = 1

Summary of Statistics:

observations = 1
Expected Value = 1.1
Variance = .4356
C.V. = 0.6
97th percentile daily values = 2.67675
97th percentile 4 day average = 1.83016
97th percentile 30 day average= 1.32665
< Q.L. = 0
Model used = BPJ Assumptions, type 2 data

No Limit is required for this material

The data are:

1.1

3/8/2016 10:52:43 AM

Facility = Chesterfield Power Station 004 - Pre-Closure
Chemical = Chloride
Chronic averaging period = 4
WLAa = 860000
WLAc = 230000
Q.L. = 1
# samples/mo. = 2
# samples/wk. = 1

Summary of Statistics:

observations = 1
Expected Value = 118320
Variance = 5039864
C.V. = 0.6
97th percentile daily values = 287921.
97th percentile 4 day average = 196859.
97th percentile 30 day average= 142700.
< Q.L. = 0
Model used = BPJ Assumptions, type 2 data

No Limit is required for this material

The data are:

118320

3/8/2016 10:53:54 AM

Facility = Chesterfield Power Station 004 - Pre-Closure
Chemical = Chromium III
Chronic averaging period = 4
WLAa = 1700
WLAc = 220
Q.L. = 1
# samples/mo. = 2
# samples/wk. = 1

Summary of Statistics:

observations = 1
Expected Value = 2
Variance = 1.44
C.V. = 0.6
97th percentile daily values = 4.86683
97th percentile 4 day average = 3.32758
97th percentile 30 day average= 2.41210
< Q.L. = 0
Model used = BPJ Assumptions, type 2 data

No Limit is required for this material

The data are:

2

3/8/2016 10:55:12 AM

Facility = Chesterfield Power Station 004 - Pre-Closure
Chemical = Copper
Chronic averaging period = 4
WLAa = 47
WLAc = 28
Q.L. = 1
# samples/mo. = 2
# samples/wk. = 1

Summary of Statistics:

observations = 1
Expected Value = 8
Variance = 23.04
C.V. = 0.6
97th percentile daily values = 19.4673
97th percentile 4 day average = 13.3103
97th percentile 30 day average= 9.64842
< Q.L. = 0
Model used = BPJ Assumptions, type 2 data

No Limit is required for this material

The data are:

8

3/8/2016 10:56:37 AM

Facility = Chesterfield Power Station 004 - Pre-Closure
Chemical = Nickel
Chronic averaging period = 4
WLAa = 570
WLAc = 63
Q.L. = 1
# samples/mo. = 2
# samples/wk. = 1

Summary of Statistics:

observations = 1
Expected Value = 25
Variance = 225
C.V. = 0.6
97th percentile daily values = 60.8354
97th percentile 4 day average = 41.5947
97th percentile 30 day average= 30.1513
< Q.L. = 0
Model used = BPJ Assumptions, type 2 data

No Limit is required for this material

The data are:

25

3/8/2016 10:57:34 AM

Facility = Chesterfield Power Station 004 - Pre-Closure
Chemical = Selenium
Chronic averaging period = 4
WLAa = 20
WLAc = 5
Q.L. = 1
# samples/mo. = 2
# samples/wk. = 1

Summary of Statistics:

observations = 1
Expected Value = 19
Variance = 129.96
C.V. = 0.6
97th percentile daily values = 46.2349
97th percentile 4 day average = 31.6120
97th percentile 30 day average= 22.9150
< Q.L. = 0
Model used = BPJ Assumptions, type 2 data

A limit is needed based on Chronic Toxicity
Maximum Daily Limit = 7.31287392026616
Average Weekly limit = 7.31287392026616
Average Monthly LImit = 5.94671198131213

The data are:

19

3/8/2016 10:58:49 AM

Facility = Chesterfield Power Station 004 - Pre-Closure
Chemical = Tributyltin
Chronic averaging period = 4
WLAa = 0.46
WLAc = 0.072
Q.L. = 0.01
# samples/mo. = 2
# samples/wk. = 1

Summary of Statistics:

observations = 1
Expected Value = .032
Variance = .000368
C.V. = 0.6
97th percentile daily values = .077869
97th percentile 4 day average = .053241
97th percentile 30 day average= .038593
< Q.L. = 0
Model used = BPJ Assumptions, type 2 data

No Limit is required for this material

The data are:

0.032

3/8/2016 10:59:39 AM

Facility = Chesterfield Power Station 004 - Pre-Closure
Chemical = Zinc
Chronic averaging period = 4
WLAa = 360
WLAc = 370
Q.L. = 1
# samples/mo. = 2
# samples/wk. = 1

Summary of Statistics:

observations = 1
Expected Value = 26
Variance = 243.36
C.V. = 0.6
97th percentile daily values = 63.2688
97th percentile 4 day average = 43.2585
97th percentile 30 day average= 31.3573
< Q.L. = 0
Model used = BPJ Assumptions, type 2 data

No Limit is required for this material

The data are:

26

e. Reasonable Potential Analysis for Outfall 005 – Pre-Drawdown

Effluent limitations for parameters submitted with the application were evaluated in accordance with DEQ Guidance Memos 00-2011 and GM14-2003. All observed pollutants and pollutants reported less than QLs that exceeded the agency accepted values were evaluated for reasonable potential to violate in stream water quality standards. Pollutants that were reported less than a DEQ accepted QL were considered absent for the purposes of this evaluation.

MSTRANTI (version 2b), a DEQ developed spreadsheet was used to calculate Waste Load Allocations (WLAs) based on mixed conditions. Stream data, effluent data and mixing ratios were entered into MSTRANTI to determine the WLAs.

Outfall 005 discharges to Farrar Gut near its confluence with the James River (river mile 0.37). Due to the proximity of Outfall 005 to the mainstem of the James River, receiving stream flow conditions were assumed to be tidal. Due to the difficulty in modeling mixing zones in tidal receiving waters, default dilution ratios are typically used. The default dilution ratios are 2:1 for acute and 50:1 for chronic; however, for this outfall, 2:1 acute and 2:1 chronic dilution ratios were used. A 2:1 chronic dilution ratio was used because it better represents the shallow embayment conditions of Farrar Gut. Shallow embayments are assumed to have lower tidal dilution than deeper tidal rivers. Using a 2:1 chronic dilution ratio is a more conservative approach. This is different from the 2004 permit receiving stream flow assumptions. DEQ believes this approach is more representative of site-specific conditions at Outfall 005 and more conservative. Data collected at Buoy 157 on the James River was used for ambient pH and hardness values. Ambient temperature inputs were back calculated to result in a flow weighted average temperature of 35°C for the mixed stream and effluent. No fish or benthic organisms are expected to be present in water temperatures greater than 35°C. The maximum of the 30 day max values from the DMR was selected for Outfall 005 to establish the effluent flow.

Using WLAs generated by MSTRANTI, STATS.EXE (version 2.0.4) was then used to evaluate reasonable potential and calculate a limitation if needed. WLAs, monitoring frequencies and reported effluent pollutant concentrations were input in STATS.EXE to evaluate each pollutant individually. As shown in the STATS outputs included in this section, no limitations are needed to protect ambient aquatic Water Quality Standards at Outfall 005.

Ammonia monitoring was required at Outfall 005 in the 2004 permit. The monitoring was required because Dominion anticipated installing air pollution control equipment with the potential to impact ash pond ammonia concentrations. The anticipated ammonia concentrations during the 2004 permit term could not be accurately predicted and were expected to vary. An ammonia limitation was not assigned for Outfall 005 in 2004 because it was not anticipated that a significant amount of ammonia would transfer to the Upper Ash Pond with dredging activity. Dominion has now installed and is operating all of the technologies expected to contribute ammonia, and a considerable amount of ammonia data has been collected. Evaluation of the observed data does not indicate that reasonable potential to violate the WQSs exists. Neither a limitation nor continued monitoring is proposed for Outfall 005 in the permit reissuance.

For parameters with standards based on Human Health (HH), the maximum observed values were compared to the HH WLAs calculated in MSTRANTI. The receiving stream is not designated as a PWS, so the HH PWS standards do not apply to this discharge. As shown in the table below, no observed concentrations exceeded the HH WLAs at this outfall. Pollutants without an applicable standard cannot be evaluated at this time.

Pollutant	Observed Value	Human Health WLA	Reasonable Potential (Y/N)
Dissolved Arsenic (µg/L)	5.00	-	N[1]
Total Selenium (µg/L)	4	8,400	N
Dissolved Thallium (µg/L)	0.50	0.94	N
Total Barium (µg/L)	177	-	N[1]
Total Iron (µg/L)	390	-	N[1]
Total Manganese (µg/L)	80	-	N[1]
Sulfate (mg/L)	76.58	-	N[1]
Beta Particle & Photon Activity (pCi/L)	2.88	-	N[1]
Chloride (µg/L)	4,840	-	N[1]

[1] VAWQS for these parameters applicable only to receiving streams with a special standard for public water supply (PWS).

MSTRANTI DATA SOURCE REPORT
(Chesterfield Power Station: Outfall 005 – Pre-Closure)

Stream Information	
Mean Hardness	Refer to ambient stream data for 2-JMS009.30.
90% Temperature (annual)	The temperature input was back-calculated to result in a mixed temperature of 35°C. No fish or benthic organisms are expected to be present in water temperatures greater than 35°C.
90% Temperature (wet season)	NA
90% Maximum pH	Refer to ambient stream data for 2-JMS009.30.
10% Maximum pH	Refer to ambient stream data for 2-JMS009.30.
Tier Designation	Flow Frequency Memo (02/29/2016)
Stream Flows	
All Data	Farrar Gut is considered to be tidal. Therefore, tidal dilutions of 2:1 acute and 2:1 chronic are used in the analysis. See Flow Frequency memo (02/29/2016) in Attachment 2.
Mixing Information	
All percentages	Farrar Gut is considered to be tidal. Therefore, tidal dilutions of 2:1 acute and 2:1 chronic are used in the analysis.
Effluent Information	
Mean Hardness	Average hardness value from WET test results.
90% Temperature (annual)	Max temperature reported on the Application serves as a surrogate for 90th percentile temperature. Given the limited data set, the max value is the best estimate available.
90% Temperature (wet season)	NA
90% Maximum pH	90th percentile of the max pH and 10th percentile of the max pH from DMR data.
10% Maximum pH	
Discharge Flow	Because tidal dilutions are used in the analysis, the stream flow is entered as 1 MGD.

Data Location:

Flow Frequency Analysis — Attachment 2
DMR Data — Attachment 4.a
App Data — Attachment 4.e

FRESHWATER
WATER QUALITY CRITERIA / WASTELOAD ALLOCATION ANALYSIS

Facility Name: Chesterfield Power Station 005 Pre-Drawdown Permit No.: VA0004146

Receiving Stream: Farrar Gut Version: OWP Guidance Memo 00-2011 (8/24/00)

Stream Information		
Mean Hardness (as CaCO3) =	66	mg/L
90% Temperature (Annual) =	38.5	deg C
90% Temperature (Wet season) =		deg C
90% Maximum pH =	8	SU
10% Maximum pH =	7.2	SU
Tier Designation (1 or 2) =	1	
Public Water Supply (PWS) Y/N? =	n	
Trout Present Y/N? =	n	
Early Life Stages Present Y/N? =	y	

Stream Flows		
1Q10 (Annual) =	1	MGD
7Q10 (Annual) =	1	MGD
30Q10 (Annual) =	1	MGD
1Q10 (Wet season) =		MGD
30Q10 (Wet season) =		MGD
30Q5 =	1	MGD
Harmonic Mean =	1	MGD

Mixing Information		
Annual - 1Q10 Mix =	100	%
- 7Q10 Mix =	100	%
- 30Q10 Mix =	100	%
Wet Season - 1Q10 Mix =		%
- 30Q10 Mix =		%

Effluent Information		
Mean Hardness (as CaCO3) =	56	mg/L
90% Temp (Annual) =	31.5	deg C
90% Temp (Wet season) =		deg C
90% Maximum pH =	8.5	SU
10% Maximum pH =	7.9	SU
Discharge Flow =	1	MGD

Parameter	Background	Water Quality Criteria				Wasteload Allocations				Antidegradation Baseline				Antidegradation Allocations				**Most Limiting Allocations**			
(ug/l unless noted)	Conc.	Acute	Chronic	HH (PWS)	HH	Acute	Chronic	HH (PWS)	HH	Acute	Chronic	HH (PWS)	HH	Acute	Chronic	HH (PWS)	HH	**Acute**	**Chronic**	**HH (PWS)**	**HH**
Acenapthene	0	--	--	na	9.9E+02	--	--	na	2.0E+03	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**2.0E+03**
Acrolein	0	--	--	na	9.3E+00	--	--	na	1.9E+01	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.9E+01**
Acrylonitrile[C]	0	--	--	na	2.5E+00	--	--	na	5.0E+00	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**5.0E+00**
Aldrin [C]	0	3.0E+00	--	na	5.0E-04	6.0E+00	--	na	1.0E-03	--	--	--	--	--	--	--	--	**6.0E+00**	**--**	**na**	**1.0E-03**
Ammonia-N (mg/l) (Yearly)	0	5.93E+00	4.93E-01	na	--	1.19E+01	9.86E-01	na	--	--	--	--	--	--	--	--	--	**1.19E+01**	**9.86E-01**	**na**	**--**
Ammonia-N (mg/l) (High Flow)	0	3.20E+00	1.09E+00	na	--	3.20E+00	1.09E+00	na	--	--	--	--	--	--	--	--	--	**3.20E+00**	**1.09E+00**	**na**	**--**
Anthracene	0	--	--	na	4.0E+04	--	--	na	8.0E+04	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**8.0E+04**
Antimony	0.13	--	--	na	6.4E+02	--	--	na	1.3E+03	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.3E+03**
Arsenic	0.62	3.4E+02	1.5E+02	na	--	6.8E+02	3.0E+02	na	--	--	--	--	--	--	--	--	--	**6.8E+02**	**3.0E+02**	**na**	**--**
Barium	38.66	--	--	na	--	--	--	na	--	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**--**
Benzene [C]	0	--	--	na	5.1E+02	--	--	na	1.0E+03	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.0E+03**
Benzidine[C]	0	--	--	na	2.0E-03	--	--	na	4.0E-03	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**4.0E-03**
Benzo (a) anthracene [C]	0	--	--	na	1.8E-01	--	--	na	3.6E-01	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**3.6E-01**
Benzo (b) fluoranthene [C]	0	--	--	na	1.8E-01	--	--	na	3.6E-01	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**3.6E-01**
Benzo (k) fluoranthene [C]	0	--	--	na	1.8E-01	--	--	na	3.6E-01	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**3.6E-01**
Benzo (a) pyrene [C]	0	--	--	na	1.8E-01	--	--	na	3.6E-01	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**3.6E-01**
Bis2-Chloroethyl Ether [C]	0	--	--	na	5.3E+00	--	--	na	1.1E+01	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.1E+01**
Bis2-Chloroisopropyl Ether	0	--	--	na	6.5E+04	--	--	na	1.3E+05	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.3E+05**
Bis 2-Ethylhexyl Phthalate [C]	0	--	--	na	2.2E+01	--	--	na	4.4E+01	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**4.4E+01**
Bromoform [C]	0	--	--	na	1.4E+03	--	--	na	2.8E+03	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**2.8E+03**
Butylbenzylphthalate	0	--	--	na	1.9E+03	--	--	na	3.8E+03	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**3.8E+03**
Cadmium	0.12	2.2E+00	7.7E-01	na	--	4.4E+00	1.4E+00	na	--	--	--	--	--	--	--	--	--	**4.4E+00**	**1.4E+00**	**na**	**--**
Carbon Tetrachloride [C]	0	--	--	na	1.6E+01	--	--	na	3.2E+01	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**3.2E+01**
Chlordane [C]	0	2.4E+00	4.3E-03	na	8.1E-03	4.8E+00	8.6E-03	na	1.6E-02	--	--	--	--	--	--	--	--	**4.8E+00**	**8.6E-03**	**na**	**1.6E-02**
Chloride	14480	8.6E+05	2.3E+05	na	--	1.7E+06	4.5E+05	na	--	--	--	--	--	--	--	--	--	**1.7E+06**	**4.5E+05**	**na**	**--**
TRC	0	1.9E+01	1.1E+01	na	--	3.8E+01	2.2E+01	na	--	--	--	--	--	--	--	--	--	**3.8E+01**	**2.2E+01**	**na**	**--**
Chlorobenzene	0	--	--	na	1.6E+03	--	--	na	3.2E+03	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**3.2E+03**

Parameter	Background	Water Quality Criteria				Wasteload Allocations				Antidegradation Baseline				Antidegradation Allocations				**Most Limiting Allocations**			
(ug/l unless noted)	Conc.	Acute	Chronic	HH (PWS)	HH	Acute	Chronic	HH (PWS)	HH	Acute	Chronic	HH (PWS)	HH	Acute	Chronic	HH (PWS)	HH	**Acute**	**Chronic**	**HH (PWS)**	**HH**
Chlorodibromomethane[C]	0	--	--	na	1.3E+02	--	--	na	2.6E+02	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**2.6E+02**
Chloroform	0	--	--	na	1.1E+04	--	--	na	2.2E+04	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**2.2E+04**
2-Chloronaphthalene	0	--	--	na	1.6E+03	--	--	na	3.2E+03	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**3.2E+03**
2-Chlorophenol	0	--	--	na	1.5E+02	--	--	na	3.0E+02	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**3.0E+02**
Chlorpyrifos	0	8.3E-02	4.1E-02	na	--	1.7E-01	8.2E-02	na	--	--	--	--	--	--	--	--	--	**1.7E-01**	**8.2E-02**	**na**	**--**
Chromium III	0	3.8E+02	4.9E+01	na	--	7.6E+02	9.9E+01	na	--	--	--	--	--	--	--	--	--	**7.6E+02**	**9.9E+01**	**na**	**--**
Chromium VI	0	1.6E+01	1.1E+01	na	--	3.2E+01	2.2E+01	na	--	--	--	--	--	--	--	--	--	**3.2E+01**	**2.2E+01**	**na**	**--**
Chromium, Total	0	--	--	1.0E+02	--	--	--	na	--	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**--**
Chrysene [C]	0	--	--	na	1.8E-02	--	--	na	3.6E-02	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**3.6E-02**
Copper	1.31	8.4E+00	5.9E+00	na	--	1.6E+01	1.0E+01	na	--	--	--	--	--	--	--	--	--	**1.6E+01**	**1.0E+01**	**na**	**--**
Cyanide, Free	0	2.2E+01	5.2E+00	na	1.6E+04	4.4E+01	1.0E+01	na	3.2E+04	--	--	--	--	--	--	--	--	**4.4E+01**	**1.0E+01**	**na**	**3.2E+04**
DDD [C]	0	--	--	na	3.1E-03	--	--	na	6.2E-03	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**6.2E-03**
DDE [C]	0	--	--	na	2.2E-03	--	--	na	4.4E-03	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**4.4E-03**
DDT [C]	0	1.1E+00	1.0E-03	na	2.2E-03	2.2E+00	2.0E-03	na	4.4E-03	--	--	--	--	--	--	--	--	**2.2E+00**	**2.0E-03**	**na**	**4.4E-03**
Demeton	0	--	1.0E-01	na	--	--	2.0E-01	na	--	--	--	--	--	--	--	--	--	**--**	**2.0E-01**	**na**	**--**
Diazinon	0	1.7E-01	1.7E-01	na	--	3.4E-01	3.4E-01	na	--	--	--	--	--	--	--	--	--	**3.4E-01**	**3.4E-01**	**na**	**--**
Dibenz(a,h)anthracene [C]	0	--	--	na	1.8E-01	--	--	na	3.6E-01	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**3.6E-01**
1,2-Dichlorobenzene	0	--	--	na	1.3E+03	--	--	na	2.6E+03	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**2.6E+03**
1,3-Dichlorobenzene	0	--	--	na	9.6E+02	--	--	na	1.9E+03	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.9E+03**
1,4-Dichlorobenzene	0	--	--	na	1.9E+02	--	--	na	3.8E+02	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**3.8E+02**
3,3-Dichlorobenzidine[C]	0	--	--	na	2.8E-01	--	--	na	5.6E-01	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**5.6E-01**
Dichlorobromomethane [C]	0	--	--	na	1.7E+02	--	--	na	3.4E+02	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**3.4E+02**
1,2-Dichloroethane [C]	0	--	--	na	3.7E+02	--	--	na	7.4E+02	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**7.4E+02**
1,1-Dichloroethylene	0	--	--	na	7.1E+03	--	--	na	1.4E+04	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.4E+04**
1,2-trans-dichloroethylene	0	--	--	na	1.0E+04	--	--	na	2.0E+04	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**2.0E+04**
2,4-Dichlorophenol	0	--	--	na	2.9E+02	--	--	na	5.8E+02	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**5.8E+02**
2,4-Dichlorophenoxy acetic acid (2,4-D)	0	--	--	na	--	--	--	na	--	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**--**
1,2-Dichloropropane[C]	0	--	--	na	1.5E+02	--	--	na	3.0E+02	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**3.0E+02**
1,3-Dichloropropene [C]	0	--	--	na	2.1E+02	--	--	na	4.2E+02	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**4.2E+02**
Dieldrin [C]	0	2.4E-01	5.6E-02	na	5.4E-04	4.8E-01	1.1E-01	na	1.1E-03	--	--	--	--	--	--	--	--	**4.8E-01**	**1.1E-01**	**na**	**1.1E-03**
Diethyl Phthalate	0	--	--	na	4.4E+04	--	--	na	8.8E+04	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**8.8E+04**
2,4-Dimethylphenol	0	--	--	na	8.5E+02	--	--	na	1.7E+03	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.7E+03**
Dimethyl Phthalate	0	--	--	na	1.1E+06	--	--	na	2.2E+06	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**2.2E+06**
Di-n-Butyl Phthalate	0	--	--	na	4.5E+03	--	--	na	9.0E+03	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**9.0E+03**
2,4 Dinitrophenol	0	--	--	na	5.3E+03	--	--	na	1.1E+04	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.1E+04**
2-Methyl-4,6-Dinitrophenol	0	--	--	na	2.8E+02	--	--	na	5.6E+02	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**5.6E+02**
2,4-Dinitrotoluene [C]	0	--	--	na	3.4E+01	--	--	na	6.8E+01	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**6.8E+01**
Dioxin 2,3,7,8-tetrachlorodibenzo-p-dioxin	0	--	--	na	5.1E-08	--	--	na	1.0E-07	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.0E-07**
1,2-Diphenylhydrazine[C]	0	--	--	na	2.0E+00	--	--	na	4.0E+00	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**4.0E+00**
Alpha-Endosulfan	0	2.2E-01	5.6E-02	na	8.9E+01	4.4E-01	1.1E-01	na	1.8E+02	--	--	--	--	--	--	--	--	**4.4E-01**	**1.1E-01**	**na**	**1.8E+02**
Beta-Endosulfan	0	2.2E-01	5.6E-02	na	8.9E+01	4.4E-01	1.1E-01	na	1.8E+02	--	--	--	--	--	--	--	--	**4.4E-01**	**1.1E-01**	**na**	**1.8E+02**
Alpha + Beta Endosulfan	0	2.2E-01	5.6E-02	--	--	4.4E-01	1.1E-01	--	--	--	--	--	--	--	--	--	--	**4.4E-01**	**1.1E-01**	**--**	**--**
Endosulfan Sulfate	0	--	--	na	8.9E+01	--	--	na	1.8E+02	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.8E+02**
Endrin	0	8.6E-02	3.6E-02	na	6.0E-02	1.7E-01	7.2E-02	na	1.2E-01	--	--	--	--	--	--	--	--	**1.7E-01**	**7.2E-02**	**na**	**1.2E-01**
Endrin Aldehyde	0	--	--	na	3.0E-01	--	--	na	6.0E-01	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**6.0E-01**

Parameter	Background	Water Quality Criteria				Wasteload Allocations				Antidegradation Baseline				Antidegradation Allocations				**Most Limiting Allocations**			
(ug/l unless noted)	Conc.	Acute	Chronic	HH (PWS)	HH	Acute	Chronic	HH (PWS)	HH	Acute	Chronic	HH (PWS)	HH	Acute	Chronic	HH (PWS)	HH	**Acute**	**Chronic**	**HH (PWS)**	**HH**
Ethylbenzene	0	--	--	na	2.1E+03	--	--	na	4.2E+03	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**4.2E+03**
Fluoranthene	0	--	--	na	1.4E+02	--	--	na	2.8E+02	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**2.8E+02**
Fluorene	0	--	--	na	5.3E+03	--	--	na	1.1E+04	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.1E+04**
Foaming Agents	0	--	--	na	--	--	--	na	--	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**--**
Guthion	0	--	1.0E-02	na	--	--	2.0E-02	na	--	--	--	--	--	--	--	--	--	**--**	**2.0E-02**	**na**	**--**
Heptachlor [C]	0	5.2E-01	3.8E-03	na	7.9E-04	1.0E+00	7.6E-03	na	1.6E-03	--	--	--	--	--	--	--	--	**1.0E+00**	**7.6E-03**	**na**	**1.6E-03**
Heptachlor Epoxide[C]	0	5.2E-01	3.8E-03	na	3.9E-04	1.0E+00	7.6E-03	na	7.8E-04	--	--	--	--	--	--	--	--	**1.0E+00**	**7.6E-03**	**na**	**7.8E-04**
Hexachlorobenzene[C]	0	--	--	na	2.9E-03	--	--	na	5.8E-03	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**5.8E-03**
Hexachlorobutadiene[C]	0	--	--	na	1.8E+02	--	--	na	3.6E+02	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**3.6E+02**
Hexachlorocyclohexane Alpha-BHC[C]	0	--	--	na	4.9E-02	--	--	na	9.8E-02	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**9.8E-02**
Hexachlorocyclohexane Beta-BHC[C]	0	--	--	na	1.7E-01	--	--	na	3.4E-01	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**3.4E-01**
Hexachlorocyclohexane Gamma-BHC[C] (Lindane)	0	9.5E-01	na	na	1.8E+00	1.9E+00	--	na	3.6E+00	--	--	--	--	--	--	--	--	**1.9E+00**	**--**	**na**	**3.6E+00**
Hexachlorocyclopentadiene	0	--	--	na	1.1E+03	--	--	na	2.2E+03	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**2.2E+03**
Hexachloroethane[C]	0	--	--	na	3.3E+01	--	--	na	6.6E+01	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**6.6E+01**
Hydrogen Sulfide	0	--	2.0E+00	na	--	--	4.0E+00	na	--	--	--	--	--	--	--	--	--	**--**	**4.0E+00**	**na**	**--**
Indeno (1,2,3-cd) pyrene [C]	0	--	--	na	1.8E-01	--	--	na	3.6E-01	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**3.6E-01**
Iron	725	--	--	na	--	--	--	na	--	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**--**
Isophorone[C]	0	--	--	na	9.6E+03	--	--	na	1.9E+04	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.9E+04**
Kepone	0	--	0.0E+00	na	--	--	0.0E+00	na	--	--	--	--	--	--	--	--	--	**--**	**0.0E+00**	**na**	**--**
Lead	0.3	6.3E+01	7.2E+00	na	--	1.3E+02	1.4E+01	na	--	--	--	--	--	--	--	--	--	**1.3E+02**	**1.4E+01**	**na**	**--**
Malathion	0	--	1.0E-01	na	--	--	2.0E-01	na	--	--	--	--	--	--	--	--	--	**--**	**2.0E-01**	**na**	**--**
Manganese	266.58	--	--	na	--	--	--	na	--	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**--**
Mercury	0.00269	1.4E+00	7.7E-01	- -	- -	2.8E+00	1.5E+00	- -	- -	--	--	--	--	--	--	--	--	**2.8E+00**	**1.5E+00**	**- -**	**- -**
Methyl Bromide	0	--	--	na	1.5E+03	--	--	na	3.0E+03	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**3.0E+03**
Methylene Chloride [C]	0	--	--	na	5.9E+03	--	--	na	1.2E+04	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.2E+04**
Methoxychlor	0	--	3.0E-02	na	--	--	6.0E-02	na	--	--	--	--	--	--	--	--	--	**--**	**6.0E-02**	**na**	**--**
Mirex	0	--	0.0E+00	na	--	--	0.0E+00	na	--	--	--	--	--	--	--	--	--	**--**	**0.0E+00**	**na**	**--**
Nickel	1.29	1.2E+02	1.3E+01	na	4.6E+03	2.4E+02	2.5E+01	na	9.2E+03	--	--	--	--	--	--	--	--	**2.4E+02**	**2.5E+01**	**na**	**9.2E+03**
Nitrate (as N)	0	--	--	na	--	--	--	na	--	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**--**
Nitrobenzene	0	--	--	na	6.9E+02	--	--	na	1.4E+03	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.4E+03**
N-Nitrosodimethylamine[C]	0	--	--	na	3.0E+01	--	--	na	6.0E+01	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**6.0E+01**
N-Nitrosodiphenylamine[C]	0	--	--	na	6.0E+01	--	--	na	1.2E+02	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.2E+02**
N-Nitrosodi-n-propylamine[C]	0	--	--	na	5.1E+00	--	--	na	1.0E+01	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.0E+01**
Nonylphenol	0	2.8E+01	6.6E+00	--	--	5.6E+01	1.3E+01	na	--	--	--	--	--	--	--	--	--	**5.6E+01**	**1.3E+01**	**na**	**--**
Parathion	0	6.5E-02	1.3E-02	na	--	1.3E-01	2.6E-02	na	--	--	--	--	--	--	--	--	--	**1.3E-01**	**2.6E-02**	**na**	**--**
PCB Total[C]	0	--	1.4E-02	na	6.4E-04	--	2.8E-02	na	1.3E-03	--	--	--	--	--	--	--	--	**--**	**2.8E-02**	**na**	**1.3E-03**
Pentachlorophenol [C]	0	1.3E+01	1.0E+01	na	3.0E+01	2.7E+01	2.0E+01	na	6.0E+01	--	--	--	--	--	--	--	--	**2.7E+01**	**2.0E+01**	**na**	**6.0E+01**
Phenol	0	--	--	na	8.6E+05	--	--	na	1.7E+06	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.7E+06**
Pyrene	0	--	--	na	4.0E+03	--	--	na	8.0E+03	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**8.0E+03**
Radionuclides	0	--	--	na	--	--	--	na	--	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**--**
Gross Alpha Activity (pCi/L)	0	--	--	na	--	--	--	na	--	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**--**
Beta and Photon Activity (mrem/yr)	0	--	--	na	--	--	--	na	--	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**--**
Radium 226 + 228 (pCi/L)	0	--	--	na	--	--	--	na	--	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**--**
Uranium (ug/l)	0	--	--	na	--	--	--	na	--	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**--**

Parameter	Background	Water Quality Criteria				Wasteload Allocations				Antidegradation Baseline				Antidegradation Allocations				**Most Limiting Allocations**			
(ug/l unless noted)	Conc.	Acute	Chronic	HH (PWS)	HH	Acute	Chronic	HH (PWS)	HH	Acute	Chronic	HH (PWS)	HH	Acute	Chronic	HH (PWS)	HH	**Acute**	**Chronic**	**HH (PWS)**	**HH**
Selenium, Total Recoverable	0.26	2.0E+01	5.0E+00	na	4.2E+03	4.0E+01	9.7E+00	na	8.4E+03	--	--	--	--	--	--	--	--	**4.0E+01**	**9.7E+00**	**na**	**8.4E+03**
Silver	0.03	1.5E+00	--	na	--	2.9E+00	--	na	--	--	--	--	--	--	--	--	--	**2.9E+00**	**--**	**na**	**--**
Sulfate	0	--	--	na	--	--	--	na	--	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**--**
1,1,2,2-Tetrachloroethane[C]	0	--	--	na	4.0E+01	--	--	na	8.0E+01	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**8.0E+01**
Tetrachloroethylene[C]	0	--	--	na	3.3E+01	--	--	na	6.6E+01	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**6.6E+01**
Thallium	0.04	--	--	na	4.7E-01	--	--	na	9.0E-01	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**9.0E-01**
Toluene	0	--	--	na	6.0E+03	--	--	na	1.2E+04	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.2E+04**
Total dissolved solids	0	--	--	na	--	--	--	na	--	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**--**
Toxaphene [C]	0	7.3E-01	2.0E-04	na	2.8E-03	1.5E+00	4.0E-04	na	5.6E-03	--	--	--	--	--	--	--	--	**1.5E+00**	**4.0E-04**	**na**	**5.6E-03**
Tributyltin	0	4.6E-01	7.2E-02	na	--	9.2E-01	1.4E-01	na	--	--	--	--	--	--	--	--	--	**9.2E-01**	**1.4E-01**	**na**	**--**
1,2,4-Trichlorobenzene	0	--	--	na	7.0E+01	--	--	na	1.4E+02	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.4E+02**
1,1,2-Trichloroethane[C]	0	--	--	na	1.6E+02	--	--	na	3.2E+02	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**3.2E+02**
Trichloroethylene [C]	0	--	--	na	3.0E+02	--	--	na	6.0E+02	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**6.0E+02**
2,4,6-Trichlorophenol [C]	0	--	--	na	2.4E+01	--	--	na	4.8E+01	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**4.8E+01**
2-(2,4,5-Trichlorophenoxy) propionic acid (Silvex)	0	--	--	na	--	--	--	na	--	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**--**
Vinyl Chloride[C]	0	--	--	na	2.4E+01	--	--	na	4.8E+01	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**4.8E+01**
Zinc	6.23	7.7E+01	7.8E+01	na	2.6E+04	1.5E+02	1.5E+02	na	5.2E+04	--	--	--	--	--	--	--	--	**1.5E+02**	**1.5E+02**	**na**	**5.2E+04**

Notes:

1. All concentrations expressed as micrograms/liter (ug/l), unless noted otherwise
2. Discharge flow is highest monthly average or Form 2C maximum for Industries and design flow for Municipals
3. Metals measured as Dissolved, unless specified otherwise
4. "C" indicates a carcinogenic parameter
5. Regular WLAs are mass balances (minus background concentration) using the % of stream flow entered above under Mixing Information.
   Antidegradation WLAs are based upon a complete mix.
6. Antideg. Baseline = (0.25(WQC - background conc.) + background conc.) for acute and chronic
   = (0.1(WQC - background conc.) + background conc.) for human health
7. WLAs established at the following stream flows: 1Q10 for Acute, 30Q10 for Chronic Ammonia, 7Q10 for Other Chronic, 30Q5 for Non-carcinogens and Harmonic Mean for Carcinogens. To apply mixing ratios from a model set the stream flow equal to (mixing ratio - 1), effluent flow equal to 1 and 100% mix.

Metal	Target Value (SSTV)
Antimony	1.3E+03
Arsenic	1.8E+02
Barium	na
Cadmium	8.5E-01
Chromium III	5.9E+01
Chromium VI	1.3E+01
Copper	6.2E+00
Iron	na
Lead	8.5E+00
Manganese	na
Mercury	9.2E-01
Nickel	1.5E+01
Selenium	5.8E+00
Silver	1.2E+00
Zinc	5.9E+01

Note: do not use QL's lower than the minimum QL's provided in agency guidance

5/26/2016 12:24:20 PM

Facility = Chesterfield Power Station - 005
Chemical = Ammonia
Chronic averaging period = 30
WLAa = 11.9
WLAc = 0.986
Q.L. = 0.2
# samples/mo. = 4
# samples/wk. = 1

Summary of Statistics:

observations = 7
Expected Value =
Variance =
C.V. =
97th percentile daily values =
97th percentile 4 day average =
97th percentile 30 day average=
< Q.L. = 7
Model used = BPJ Assumptions, Type 1 data

No Limit is required for this material

The data are:

0.13
0
0
0
0
0
0.01

5/26/2016 12:25:53 PM

Facility = Chesterfield Power Station - 005
Chemical = Arsenic
Chronic averaging period = 4
WLAa   = 680
WLAc   = 300
Q.L.   = 1
samples/mo. = 1
samples/wk. = 1

Summary of Statistics:

observations = 1
Expected Value = 5
Variance   = 9
C.V.   = 0.6
97th percentile daily values = 12.1670
97th percentile 4 day average = 8.31895
97th percentile 30 day average= 6.03026
< Q.L.   = 0
Model used   = BPJ Assumptions, type 2 data

No Limit is required for this material

The data are:

5

5/26/2016 1:01:51 PM

Facility = Chesterfield Power Station - 005
Chemical = Chloride
Chronic averaging period = 4
WLAa = 1700000
WLAc = 450000
Q.L. = 1
# samples/mo. = 1
# samples/wk. = 1

Summary of Statistics:

observations = 1
Expected Value = 4840
Variance = 8433216
C.V. = 0.6
97th percentile daily values = 11777.7
97th percentile 4 day average = 8052.74
97th percentile 30 day average= 5837.29
< Q.L. = 0
Model used = BPJ Assumptions, type 2 data

No Limit is required for this material

The data are:

4840

5/26/2016 6:41:59 PM

```
Facility  = Chesterfield Power Station - 005
Chemical  = Total Recoverable Selenium
Chronic averaging period =  4
WLAa    =  40
WLAc    =  9.7
Q.L.      = 1
# samples/mo. = 1
# samples/wk. = 1

Summary of Statistics:

# observations = 1
Expected Value =  4
Variance       =  5.76
C.V.           = 0.6
97th percentile daily values  =  9.73367
97th percentile 4 day average =  6.65516
97th percentile 30 day average=  4.82421
# < Q.L.       =  0
Model used     = BPJ Assumptions, type 2 data


 No Limit is required for this material


The data are:


 4
```

5/26/2016 12:28:41 PM

Facility = Chesterfield Power Station - 005
Chemical = Tributyltin
Chronic averaging period = 4
WLAa = 0.92
WLAc = 0.14
Q.L. = 0.01
# samples/mo. = 1
# samples/wk. = 1

Summary of Statistics:

observations = 1
Expected Value = .03
Variance = .000324
C.V. = 0.6
97th percentile daily values = .073002
97th percentile 4 day average = .049913
97th percentile 30 day average= .036181
< Q.L. = 0
Model used = BPJ Assumptions, type 2 data

No Limit is required for this material

The data are:

0.03

f. Discharges associated with Coal Combustion Residual (CCR) impoundment closure: Effluent Screening and Limitation Development – Outfall 101 – Upper Ash Pond (UAP) and Lower Ash Pond (LAP) Effluent – Closure

Effective October 2015, the U.S. Environmental Protection Agency (EPA) adopted a final Rule that will regulate the disposal of coal combustion residuals (CCR) as solid waste under subtitle D of the Resource Conservation and Recovery Act. Coal combustion residuals (otherwise known as coal ash) may include fly ash, bottom ash, boiler slag, and other low volume waste materials and are generated from burning coal for the purposes of generating electrical power. Disposal of the CCRs at this facility has historically been accomplished in impoundments located on site. These impoundments include surface waters originating from precipitation, storm water runoff into the impoundments, comingled process wastewaters, and waters used to hydraulically dredge ash from one pond to another. Interstitial, or pore, waters, also exist within the bottom residual mass of the impoundment. Due to its direct contact and exposure to the coal ash materials, the pollutant concentrations of the coal ash interstitial waters may pose a reasonable potential to exceed established water quality criteria. In response to EPA's 2015 CCR Rule, the owner plans to remove and discharge the accumulated waters to dry the ash and residuals that have settled to the bottom of the impoundment. This process is expected to involve the disturbance, movement, or re-suspension of the bottom residuals. Drying the ash and bottom residuals will facilitate their subsequent removal or construction of a closure cap of the impoundment system.

To identify and evaluate constituents of potential concern (COPC) associated with the dewatering of coal ash ponds, DEQ relied upon work previously performed by the EPA and documented in the following: 1) 40CFR Part 423 federal effluent limitation guidelines (ELGs) for the "Steam Electric Power Generating Point Source Category;" 2) a June 7, 2010 EPA memorandum titled, "National Pollutant Discharge Elimination System (NPDES) Permitting of Wastewater Discharges from Flue Gas Desulfurization (FGD) and Coal Combustion Residual (CCR) Impoundments at Steam Electric Power Plants;" and 3) a 2015 final Rule (commonly referred to as the "CCR Rule") that amended 40 CFR §§257.50 – 257.107, "Standards for the Disposal of Coal Combustion Residuals in Landfills and Surface Impoundments."

In its June 2010 memo,[1] EPA identified 37 chemical parameters that had the potential to exist in relatively high concentrations in CCR effluent. Several years later, in the preamble to the 2015 CCR Rule, EPA identified 35 (Table 1[2]) chemical parameters that represented a hazard potential because they were characteristic of releases from coal combustion impoundments and may pose a toxicity risk potential. EPA performed further probabilistic analyses of the potential risks to human health and ecological receptors from the 35-Table 1 constituents and narrowed the list down to 23 (Table 2[3]) parameters (List of Chemical Constituents Retained for Probabilistic Analysis). These parameters include Aluminum, Antimony, Arsenic, Barium, Beryllium, Boron, Cadmium, Chloride, Chromium, Cobalt, Copper, Fluoride, Iron, Lead, Lithium, Mercury, Molybdenum, Nickel, Selenium, Silver, Thallium, Vanadium and Zinc.

Although the parameters listed in the CCR Rule Table 2 represent potential risks from CCR leachate releases, a conservative assumption was made that the probabilistic risks associated with leachate releases would be comparable to concerns associated with the release of CCR pore water. These constituents and all other constituents were classified in one of 4 categories for consideration. It is assumed that the wastewater discharged from Outfall 101 during closure activities will be similar. The categories and effluent development methodology for each category were applied to both outfalls.

---

[1] United States Environmental Protection Agency, June 7, 2010 Memorandum from James A. Hanlon, Director, Office of Wastewater Management to Water Division Directors Regions 1 – 10; "National Pollutant Discharge Elimination System (NPDES) Permitting of Wastewater Discharges from Flue Gas Desulfurization (FGD) and Coal Combustion Residual (CCR) Impoundments at Steam Electric Power Plants," Attachment B, Water Quality-Based Effluent Limits, Coal Combustion Waste Impoundments; Appendix A, Steam Electric 2007/2008 Detailed Study Report, Ash Pond Effluent Concentrations.

[2] Federal Register, Vol. 80, No. 74, Friday, April 17, 2015, "Table 1 – List of Chemical Constituents Evaluated in the CCR Risk Assessment," page 21449.

[3] Federal Register, Vol. 80, No. 74, Friday, April 17, 2015, "Table 2 – List of Chemical Constituents Retained for Probabilistic Analysis," page 21450.

- **Category 1 – CCR Rule Table 2 constituents for which water quality criteria have been adopted in the Virginia Water Quality Standards (VAWQS) regulation (9VAC25-260):** Category 1 constituents include Antimony, Arsenic, Barium, Cadmium, Chloride, Chromium (III and VI), Copper, Iron, Lead, Mercury, Nickel, Selenium, Silver, Thallium, and Zinc. These constituents were evaluated for effluent limitations and water quality-based effluent limitations were developed for applicable Category 1 constituents regardless of whether or not the existing data for the facility demonstrated a reasonable potential to exceed the water quality criteria. No water quality criteria are applicable to the aquatic life designation for Antimony, Barium, Iron, or Thallium. For Antimony and Thallium, the effluent limitation is equal to the non-public water supply (Non-PWS) allocation for human health. The only human health allocations applicable to Barium and Iron are for public water supply (PWS) waters. The receiving stream does not have a special standard for PWS waters. Therefore, no limits were developed for Barium and Iron. However, monitoring is required as described in Category 2.

  WLAs used in the effluent limitation evaluation were generated in accordance with DEQ Guidance Memos 00-2011 and GM14-2003. MSTRANTI (version 2b), a DEQ developed spreadsheet was used to calculate Waste Load Allocations (WLAs) based on mixed conditions. Stream data, effluent data and mixing ratios were entered into MSTRANTI to determine the WLAs.

  Outfall 101 discharges to Outfall 001 or 002, which in turn discharge to the tidal James River. Because of the challenge in modeling tidal discharges, dilution ratios of 2:1 acute and 2:1 chronic were assumed. The use of a 2:1 chronic dilution ratio is considerably more restrictive than the 50:1 chronic dilution ratio that has historically been used. Mixing ratios were input into MSTRANTI as follows:

  2:1 acute – A design flow of 1 MGD and 1Q10 flow of 1 MGD
  2:1 chronic – A design flow of 1 MGD and 7Q10 of 1 MGD

  Even though Outfall 101 discharges to Outfall 001 or 002, it is being permitted as if it is a direct discharge to the James River (i.e. no dilution by either cooling water outfall is provided). As such, James River background concentrations were used in establishing the WLAs for Outfall 101.

  STATS.EXE (version 2.0.4) was then used to evaluate reasonable potential and calculate limitations. WLAs, monitoring frequencies and effluent concentrations equal to the lower of the WLAs were input in STATS.EXE to evaluate each pollutant individually and force effluent limitations. See Table 1 below for applicable parameters

- **Category 2 – CCR Rule Table 2 constituents for which water quality criteria have not be adopted in the Virginia Water Quality Standards regulation (9VAC25-260):** A Whole Effluent Toxicity limitation was established in the absence of an applicable Virginia numeric water quality criterion. This approach is consistent with EPA's Technical Support Document for Water Quality-based Toxics Control and the June 7, 2010 EPA memorandum. Parameters included in this category include Aluminum, Barium, Beryllium, Boron, Cobalt, Iron, Molybdenum and Vanadium. Monitoring with no limits for these parameters is also included in this permit. The monitoring shall occur during the same composite period as the WET monitoring. If an exceedance of the WET limits occurs, the concurrent monitoring will assist the permittee in determining which parameter(s) may have caused the exceedance and in developing measures to prevent future exceedances. **Attachment 9** details the derivation of the calculated WET limitations that will be included with this permit action.

- **Category 3 – Constituents not listed in CCR Rule Table 2 for which water quality criteria have been adopted in the Virginia Water Quality Standards regulation (9VAC25-260):** A reasonable potential analysis was performed to determine the need for water-quality based effluent limitations on a case-by-case basis for Outfall 101. The reasonable potential analysis was conducted as described above under Category 1. See Table 3 below for applicable parameters.

- **Category 4 – Federal Effluent Guidelines:** Technology-based effluent limits were assigned to applicable constituents addressed by the Federal Effluent Guidelines and not otherwise controlled by

a more restrictive water quality-based effluent limitation. See Table 4 below for applicable parameters.

Table 1 - Category 1 Constituents for Outfall 101

Parameter	**Concentration*** **(µg/L)**	**Wasteload Allocation (WLA)** **(µg/L)**		**Human Health WLA (µg/L)**	**Reasonable Potential**
		WLAa	WLAc		
Antimony	1,300	--	--	1,300	Yes
Arsenic	300	680	300	--	Yes
Barium	600	--	--	--	No[(1)]
Cadmium	1.8	6.2	1.8	--	Yes
Chloride	450,000	1,700,000	450,000	--	Yes
Chromium III[(2)]	130	980	130	--	Yes
Chromium VI[(2)]	22	32	22	--	Yes
Copper	14	21	14	--	Yes
Iron	4,200	--	--	--	No[(1)]
Lead	21	190	21	--	Yes
Mercury	1.5	2.8	1.5	--	Yes
Nickel	33	310	33	9,200	Yes
Selenium	9.7	40	9.7	8,400	Yes
Silver	5.0	5.0	--	--	Yes
Thallium	0.90	--	--	0.90	Yes
Zinc	190	190	200	52,000	Yes

* Concentration used to develop numerical limitations.
[(1)]VAWQS for these parameters applicable only to receiving streams with a special standard for public water supply (PWS).
[(2)] Table 2 from the CCR Risk Assessment does not distinguish which species of Chromium is relevant. It is PJ to include limits for Chromium III and Chromium VI.

Table 2 – Category 2 Constituents for Outfall 101

Parameter	WET Limit
Aluminum	Acute: NOAEC = 100% Chronic: 2.85 TU_c
Barium	
Beryllium	
Boron	
Cobalt	
Iron	
Molybdenum	
Vanadium	

Table 3 – Category 3 Constituents for Outfall 101

Parameter	**Concentration*** **(µg/L)**	**Wasteload Allocation (WLA)** **(µg/L)**		**Human Health WLA** **(µg/L)**	**Reasonable Potential**
		WLAa	WLAc		
Acrylonitrile	<QL	--	--	5	No
Ammonia (mg/L)	0.65	11.9	0.8	--	No
TRC	20	38	22	--	Yes
Cyanide	<QL	44	10	32,000	No
Endosulfan	<QL	0.44	0.11	180	No
Manganese	320	--	--	--	No[(1)]
Mirex	<QL	--	0	--	No
Nitrate as N	13	--	--	--	No[(1)]
Radium-226	0.405	--	--	--	No[(1)]
Radium-228	0.457	--	--	--	No[(1)]
Sulfate	140,000	--	--	--	No[(1)]
Total Dissolved Solids	760,000	--	--	--	No[(1)]

[(1)]VAWQS for these parameters applicable only to receiving streams with a special standard for public water supply (PWS).

Table 4 – Category 4 Constituents for Outfall 101

Parameter	Limitation	Applicability
pH (SU)	6.0/9.0 Daily Min/Daily Max	Any existing discharge subject to 40CFR 423.12(b).
Total Suspended Solids (mg/L)	30/100 Monthly Avg/Daily Max	Any existing discharge subject to 40CFR 423.12(b).
Oil and Grease (mg/L)	15/20 Monthly Avg/Daily Max	Any existing discharge subject to 40CFR 423(b).
Total Recoverable Copper (mg/L)*	1.0/1.0 Monthly Avg/Daily Max	Discharges of metal cleaning wastes subject to 40CFR 423.13(e).
Total Recoverable Iron (mg/L)*	1.0/1.0 Monthly Avg/Daily Max	Discharges of metal cleaning wastes subject to 40CFR 423.13(e).
Total Recoverable Arsenic (µg/L)*	8/11 Monthly Avg/Daily Max	Discharges of FGD wastewater subject to 40CFR 423.13(g)(1).
Total Recoverable Mercury (ng/L)*	356/788 Monthly Avg/Daily Max	Discharges of FGD wastewater subject to 40CFR 423.13(g)(1).
Nitrate/Nitrite as N (µg/L)*	4.4/17.0 Monthly Avg/Daily Max	Discharges of FGD wastewater subject to 40CFR 423.13(g)(1).
Total Recoverable Selenium (µg/L)*	12/23 Monthly Avg/Daily Max	Discharges of FGD wastewater subject to 40CFR 423.13(g)(1).

*These constituents and their limitations are addressed via internal outfalls.

In addition to the above limitations and monitoring, all parameters associated with 004 and 005 pre-drawdown that were not already incorporated were added. This was done as a conservative measure for the following parameters: DO, TOC and TPH.

MSTRANTI DATA SOURCE REPORT
(Chesterfield Power Station: Outfall 101)

Stream Information	
Mean Hardness	2-JMS099.30
90% Temperature (annual)	2-JMS099.30
90% Temperature (wet season)	NA
90% Maximum pH	2-JMS099.30
10% Maximum pH	2-JMS099.30
Tier Designation	Flow Frequency Memo (02/29/2016)
Stream Flows & Mixing Information	
All Data	Tidal Dilution and Mixing Ratios 2:1 acute and 2:1 chronic
Effluent Information	
Mean Hardness	Hardness was set at 100 mg/L based on PJ.
90% Temperature (annual)	90th percentile of the max DMR temperatures for 002 (the higher of 001 and 002) is used as a conservative assumption.
90% Temperature (wet season)	NA
90% Maximum pH	90th percentile of the max pH and 10th percentile of the max pH from DMR data.
10% Maximum pH	
Discharge Flow	Because tidal dilutions are used in the analysis, the stream flow is entered as 1 MGD.

Data Location:

Flow Frequency Analysis — Attachment 2
DMR Data — Attachment 4.a (Outfalls 004 and 005 – Upper and Lower Ash Pond)
App Data — Attachment 4.e

FRESHWATER
WATER QUALITY CRITERIA / WASTELOAD ALLOCATION ANALYSIS

Facility Name: Chesterfield Power Station 101 (UAP/LAP Closure) Permit No.: VA0004146

Receiving Stream: James River

Version: OWP Guidance Memo 00-2011 (8/24/00)

Stream Information		
Mean Hardness (as CaCO3) =	66	mg/L
90% Temperature (Annual) =	29.3	deg C
90% Temperature (Wet season) =		deg C
90% Maximum pH =	8	SU
10% Maximum pH =	7.2	SU
Tier Designation (1 or 2) =	1	
Public Water Supply (PWS) Y/N? =	n	
Trout Present Y/N? =	n	
Early Life Stages Present Y/N? =	y	

Stream Flows		
1Q10 (Annual) =	1	MGD
7Q10 (Annual) =	1	MGD
30Q10 (Annual) =	1	MGD
1Q10 (Wet season) =		MGD
30Q10 (Wet season) =		MGD
30Q5 =	1	MGD
Harmonic Mean =	1	MGD

Mixing Information		
Annual - 1Q10 Mix =	100	%
- 7Q10 Mix =	100	%
- 30Q10 Mix =	100	%
Wet Season - 1Q10 Mix =		%
- 30Q10 Mix =		%

Effluent Information		
Mean Hardness (as CaCO3) =	100	mg/L
90% Temp (Annual) =	47.2	deg C
90% Temp (Wet season) =		deg C
90% Maximum pH =	8.5	SU
10% Maximum pH =	7.9	SU
Discharge Flow =	1	MGD

Parameter	Background	Water Quality Criteria				Wasteload Allocations				Antidegradation Baseline				Antidegradation Allocations				**Most Limiting Allocations**			
(ug/l unless noted)	Conc.	Acute	Chronic	HH (PWS)	HH	Acute	Chronic	HH (PWS)	HH	Acute	Chronic	HH (PWS)	HH	Acute	Chronic	HH (PWS)	HH	**Acute**	**Chronic**	**HH (PWS)**	**HH**
Acenapthene	0	--	--	na	9.9E+02	--	--	na	2.0E+03	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**2.0E+03**
Acrolein	0	--	--	na	9.3E+00	--	--	na	1.9E+01	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.9E+01**
Acrylonitrile[C]	0	--	--	na	2.5E+00	--	--	na	5.0E+00	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**5.0E+00**
Aldrin [C]	0	3.0E+00	--	na	5.0E-04	6.0E+00	--	na	1.0E-03	--	--	--	--	--	--	--	--	**6.0E+00**	**--**	**na**	**1.0E-03**
Ammonia-N (mg/l) (Yearly)	0	5.93E+00	4.00E-01	na	--	1.19E+01	8.00E-01	na	--	--	--	--	--	--	--	--	--	**1.19E+01**	**8.00E-01**	**na**	**--**
Ammonia-N (mg/l) (High Flow)	0	3.20E+00	1.09E+00	na	--	3.20E+00	1.09E+00	na	--	--	--	--	--	--	--	--	--	**3.20E+00**	**1.09E+00**	**na**	**--**
Anthracene	0	--	--	na	4.0E+04	--	--	na	8.0E+04	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**8.0E+04**
Antimony	0.13	--	--	na	6.4E+02	--	--	na	1.3E+03	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.3E+03**
Arsenic	0.62	3.4E+02	1.5E+02	na	--	6.8E+02	3.0E+02	na	--	--	--	--	--	--	--	--	--	**6.8E+02**	**3.0E+02**	**na**	**--**
Barium	38.66	--	--	na	--	--	--	na	--	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**--**
Benzene [C]	0	--	--	na	5.1E+02	--	--	na	1.0E+03	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.0E+03**
Benzidine[C]	0	--	--	na	2.0E-03	--	--	na	4.0E-03	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**4.0E-03**
Benzo (a) anthracene [C]	0	--	--	na	1.8E-01	--	--	na	3.6E-01	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**3.6E-01**
Benzo (b) fluoranthene [C]	0	--	--	na	1.8E-01	--	--	na	3.6E-01	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**3.6E-01**
Benzo (k) fluoranthene [C]	0	--	--	na	1.8E-01	--	--	na	3.6E-01	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**3.6E-01**
Benzo (a) pyrene [C]	0	--	--	na	1.8E-01	--	--	na	3.6E-01	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**3.6E-01**
Bis2-Chloroethyl Ether [C]	0	--	--	na	5.3E+00	--	--	na	1.1E+01	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.1E+01**
Bis2-Chloroisopropyl Ether	0	--	--	na	6.5E+04	--	--	na	1.3E+05	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.3E+05**
Bis 2-Ethylhexyl Phthalate [C]	0	--	--	na	2.2E+01	--	--	na	4.4E+01	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**4.4E+01**
Bromoform [C]	0	--	--	na	1.4E+03	--	--	na	2.8E+03	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**2.8E+03**
Butylbenzylphthalate	0	--	--	na	1.9E+03	--	--	na	3.8E+03	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**3.8E+03**
Cadmium	0.12	3.2E+00	9.8E-01	na	--	6.2E+00	1.8E+00	na	--	--	--	--	--	--	--	--	--	**6.2E+00**	**1.8E+00**	**na**	**--**
Carbon Tetrachloride [C]	0	--	--	na	1.6E+01	--	--	na	3.2E+01	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**3.2E+01**
Chlordane [C]	0	2.4E+00	4.3E-03	na	8.1E-03	4.8E+00	8.6E-03	na	1.6E-02	--	--	--	--	--	--	--	--	**4.8E+00**	**8.6E-03**	**na**	**1.6E-02**
Chloride	14480	8.6E+05	2.3E+05	na	--	1.7E+06	4.5E+05	na	--	--	--	--	--	--	--	--	--	**1.7E+06**	**4.5E+05**	**na**	**--**
TRC	0	1.9E+01	1.1E+01	na	--	3.8E+01	2.2E+01	na	--	--	--	--	--	--	--	--	--	**3.8E+01**	**2.2E+01**	**na**	**--**
Chlorobenzene	0	--	--	na	1.6E+03	--	--	na	3.2E+03	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**3.2E+03**

Parameter	Background	Water Quality Criteria				Wasteload Allocations				Antidegradation Baseline				Antidegradation Allocations				**Most Limiting Allocations**			
(ug/l unless noted)	Conc.	Acute	Chronic	HH (PWS)	HH	Acute	Chronic	HH (PWS)	HH	Acute	Chronic	HH (PWS)	HH	Acute	Chronic	HH (PWS)	HH	**Acute**	**Chronic**	**HH (PWS)**	**HH**
Chlorodibromomethane[C]	0	--	--	na	1.3E+02	--	--	na	2.6E+02	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**2.6E+02**
Chloroform	0	--	--	na	1.1E+04	--	--	na	2.2E+04	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**2.2E+04**
2-Chloronaphthalene	0	--	--	na	1.6E+03	--	--	na	3.2E+03	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**3.2E+03**
2-Chlorophenol	0	--	--	na	1.5E+02	--	--	na	3.0E+02	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**3.0E+02**
Chlorpyrifos	0	8.3E-02	4.1E-02	na	--	1.7E-01	8.2E-02	na	--	--	--	--	--	--	--	--	--	**1.7E-01**	**8.2E-02**	**na**	**--**
Chromium III	0	4.9E+02	6.4E+01	na	--	9.8E+02	1.3E+02	na	--	--	--	--	--	--	--	--	--	**9.8E+02**	**1.3E+02**	**na**	**--**
Chromium VI	0	1.6E+01	1.1E+01	na	--	3.2E+01	2.2E+01	na	--	--	--	--	--	--	--	--	--	**3.2E+01**	**2.2E+01**	**na**	**--**
Chromium, Total	0	--	--	1.0E+02	--	--	--	na	--	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**--**
Chrysene [C]	0	--	--	na	1.8E-02	--	--	na	3.6E-02	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**3.6E-02**
Copper	1.31	1.1E+01	7.6E+00	na	--	2.1E+01	1.4E+01	na	--	--	--	--	--	--	--	--	--	**2.1E+01**	**1.4E+01**	**na**	**--**
Cyanide, Free	0	2.2E+01	5.2E+00	na	1.6E+04	4.4E+01	1.0E+01	na	3.2E+04	--	--	--	--	--	--	--	--	**4.4E+01**	**1.0E+01**	**na**	**3.2E+04**
DDD [C]	0	--	--	na	3.1E-03	--	--	na	6.2E-03	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**6.2E-03**
DDE [C]	0	--	--	na	2.2E-03	--	--	na	4.4E-03	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**4.4E-03**
DDT [C]	0	1.1E+00	1.0E-03	na	2.2E-03	2.2E+00	2.0E-03	na	4.4E-03	--	--	--	--	--	--	--	--	**2.2E+00**	**2.0E-03**	**na**	**4.4E-03**
Demeton	0	--	1.0E-01	na	--	--	2.0E-01	na	--	--	--	--	--	--	--	--	--	**--**	**2.0E-01**	**na**	**--**
Diazinon	0	1.7E-01	1.7E-01	na	--	3.4E-01	3.4E-01	na	--	--	--	--	--	--	--	--	--	**3.4E-01**	**3.4E-01**	**na**	**--**
Dibenz(a,h)anthracene [C]	0	--	--	na	1.8E-01	--	--	na	3.6E-01	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**3.6E-01**
1,2-Dichlorobenzene	0	--	--	na	1.3E+03	--	--	na	2.6E+03	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**2.6E+03**
1,3-Dichlorobenzene	0	--	--	na	9.6E+02	--	--	na	1.9E+03	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.9E+03**
1,4-Dichlorobenzene	0	--	--	na	1.9E+02	--	--	na	3.8E+02	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**3.8E+02**
3,3-Dichlorobenzidine[C]	0	--	--	na	2.8E-01	--	--	na	5.6E-01	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**5.6E-01**
Dichlorobromomethane [C]	0	--	--	na	1.7E+02	--	--	na	3.4E+02	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**3.4E+02**
1,2-Dichloroethane [C]	0	--	--	na	3.7E+02	--	--	na	7.4E+02	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**7.4E+02**
1,1-Dichloroethylene	0	--	--	na	7.1E+03	--	--	na	1.4E+04	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.4E+04**
1,2-trans-dichloroethylene	0	--	--	na	1.0E+04	--	--	na	2.0E+04	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**2.0E+04**
2,4-Dichlorophenol	0	--	--	na	2.9E+02	--	--	na	5.8E+02	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**5.8E+02**
2,4-Dichlorophenoxy acetic acid (2,4-D)	0	--	--	na	--	--	--	na	--	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**--**
1,2-Dichloropropane[C]	0	--	--	na	1.5E+02	--	--	na	3.0E+02	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**3.0E+02**
1,3-Dichloropropene [C]	0	--	--	na	2.1E+02	--	--	na	4.2E+02	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**4.2E+02**
Dieldrin [C]	0	2.4E-01	5.6E-02	na	5.4E-04	4.8E-01	1.1E-01	na	1.1E-03	--	--	--	--	--	--	--	--	**4.8E-01**	**1.1E-01**	**na**	**1.1E-03**
Diethyl Phthalate	0	--	--	na	4.4E+04	--	--	na	8.8E+04	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**8.8E+04**
2,4-Dimethylphenol	0	--	--	na	8.5E+02	--	--	na	1.7E+03	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.7E+03**
Dimethyl Phthalate	0	--	--	na	1.1E+06	--	--	na	2.2E+06	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**2.2E+06**
Di-n-Butyl Phthalate	0	--	--	na	4.5E+03	--	--	na	9.0E+03	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**9.0E+03**
2,4 Dinitrophenol	0	--	--	na	5.3E+03	--	--	na	1.1E+04	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.1E+04**
2-Methyl-4,6-Dinitrophenol	0	--	--	na	2.8E+02	--	--	na	5.6E+02	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**5.6E+02**
2,4-Dinitrotoluene [C]	0	--	--	na	3.4E+01	--	--	na	6.8E+01	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**6.8E+01**
Dioxin 2,3,7,8-tetrachlorodibenzo-p-dioxin	0	--	--	na	5.1E-08	--	--	na	1.0E-07	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.0E-07**
1,2-Diphenylhydrazine[C]	0	--	--	na	2.0E+00	--	--	na	4.0E+00	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**4.0E+00**
Alpha-Endosulfan	0	2.2E-01	5.6E-02	na	8.9E+01	4.4E-01	1.1E-01	na	1.8E+02	--	--	--	--	--	--	--	--	**4.4E-01**	**1.1E-01**	**na**	**1.8E+02**
Beta-Endosulfan	0	2.2E-01	5.6E-02	na	8.9E+01	4.4E-01	1.1E-01	na	1.8E+02	--	--	--	--	--	--	--	--	**4.4E-01**	**1.1E-01**	**na**	**1.8E+02**
Alpha + Beta Endosulfan	0	2.2E-01	5.6E-02	--	--	4.4E-01	1.1E-01	--	--	--	--	--	--	--	--	--	--	**4.4E-01**	**1.1E-01**	**--**	**--**
Endosulfan Sulfate	0	--	--	na	8.9E+01	--	--	na	1.8E+02	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.8E+02**
Endrin	0	8.6E-02	3.6E-02	na	6.0E-02	1.7E-01	7.2E-02	na	1.2E-01	--	--	--	--	--	--	--	--	**1.7E-01**	**7.2E-02**	**na**	**1.2E-01**
Endrin Aldehyde	0	--	--	na	3.0E-01	--	--	na	6.0E-01	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**6.0E-01**

Parameter	Background	Water Quality Criteria				Wasteload Allocations				Antidegradation Baseline				Antidegradation Allocations				**Most Limiting Allocations**			
(ug/l unless noted)	Conc.	Acute	Chronic	HH (PWS)	HH	Acute	Chronic	HH (PWS)	HH	Acute	Chronic	HH (PWS)	HH	Acute	Chronic	HH (PWS)	HH	**Acute**	**Chronic**	**HH (PWS)**	**HH**
Ethylbenzene	0	--	--	na	2.1E+03	--	--	na	4.2E+03	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**4.2E+03**
Fluoranthene	0	--	--	na	1.4E+02	--	--	na	2.8E+02	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**2.8E+02**
Fluorene	0	--	--	na	5.3E+03	--	--	na	1.1E+04	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.1E+04**
Foaming Agents	0	--	--	na	--	--	--	na	--	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**--**
Guthion	0	--	1.0E-02	na	--	--	2.0E-02	na	--	--	--	--	--	--	--	--	--	**--**	**2.0E-02**	**na**	**--**
Heptachlor [C]	0	5.2E-01	3.8E-03	na	7.9E-04	1.0E+00	7.6E-03	na	1.6E-03	--	--	--	--	--	--	--	--	**1.0E+00**	**7.6E-03**	**na**	**1.6E-03**
Heptachlor Epoxide[C]	0	5.2E-01	3.8E-03	na	3.9E-04	1.0E+00	7.6E-03	na	7.8E-04	--	--	--	--	--	--	--	--	**1.0E+00**	**7.6E-03**	**na**	**7.8E-04**
Hexachlorobenzene[C]	0	--	--	na	2.9E-03	--	--	na	5.8E-03	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**5.8E-03**
Hexachlorobutadiene[C]	0	--	--	na	1.8E+02	--	--	na	3.6E+02	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**3.6E+02**
Hexachlorocyclohexane Alpha-BHC[C]	0	--	--	na	4.9E-02	--	--	na	9.8E-02	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**9.8E-02**
Hexachlorocyclohexane Beta-BHC[C]	0	--	--	na	1.7E-01	--	--	na	3.4E-01	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**3.4E-01**
Hexachlorocyclohexane Gamma-BHC[C] (Lindane)	0	9.5E-01	na	na	1.8E+00	1.9E+00	--	na	3.6E+00	--	--	--	--	--	--	--	--	**1.9E+00**	**--**	**na**	**3.6E+00**
Hexachlorocyclopentadiene	0	--	--	na	1.1E+03	--	--	na	2.2E+03	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**2.2E+03**
Hexachloroethane[C]	0	--	--	na	3.3E+01	--	--	na	6.6E+01	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**6.6E+01**
Hydrogen Sulfide	0	--	2.0E+00	na	--	--	4.0E+00	na	--	--	--	--	--	--	--	--	--	**--**	**4.0E+00**	**na**	**--**
Indeno (1,2,3-cd) pyrene [C]	0	--	--	na	1.8E-01	--	--	na	3.6E-01	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**3.6E-01**
Iron	725	--	--	na	--	--	--	na	--	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**--**
Isophorone[C]	0	--	--	na	9.6E+03	--	--	na	1.9E+04	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.9E+04**
Kepone	0	--	0.0E+00	na	--	--	0.0E+00	na	--	--	--	--	--	--	--	--	--	**--**	**0.0E+00**	**na**	**--**
Lead	0.3	9.4E+01	1.1E+01	na	--	1.9E+02	2.1E+01	na	--	--	--	--	--	--	--	--	--	**1.9E+02**	**2.1E+01**	**na**	**--**
Malathion	0	--	1.0E-01	na	--	--	2.0E-01	na	--	--	--	--	--	--	--	--	--	**--**	**2.0E-01**	**na**	**--**
Manganese	266.58	--	--	na	--	--	--	na	--	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**--**
Mercury	0.00269	1.4E+00	7.7E-01	- -	- -	2.8E+00	1.5E+00	- -	- -	--	--	--	--	--	--	--	--	**2.8E+00**	**1.5E+00**	**- -**	**- -**
Methyl Bromide	0	--	--	na	1.5E+03	--	--	na	3.0E+03	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**3.0E+03**
Methylene Chloride [C]	0	--	--	na	5.9E+03	--	--	na	1.2E+04	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.2E+04**
Methoxychlor	0	--	3.0E-02	na	--	--	6.0E-02	na	--	--	--	--	--	--	--	--	--	**--**	**6.0E-02**	**na**	**--**
Mirex	0	--	0.0E+00	na	--	--	0.0E+00	na	--	--	--	--	--	--	--	--	--	**--**	**0.0E+00**	**na**	**--**
Nickel	1.29	1.6E+02	1.7E+01	na	4.6E+03	3.1E+02	3.3E+01	na	9.2E+03	--	--	--	--	--	--	--	--	**3.1E+02**	**3.3E+01**	**na**	**9.2E+03**
Nitrate (as N)	0	--	--	na	--	--	--	na	--	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**--**
Nitrobenzene	0	--	--	na	6.9E+02	--	--	na	1.4E+03	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.4E+03**
N-Nitrosodimethylamine[C]	0	--	--	na	3.0E+01	--	--	na	6.0E+01	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**6.0E+01**
N-Nitrosodiphenylamine[C]	0	--	--	na	6.0E+01	--	--	na	1.2E+02	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.2E+02**
N-Nitrosodi-n-propylamine[C]	0	--	--	na	5.1E+00	--	--	na	1.0E+01	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.0E+01**
Nonylphenol	0	2.8E+01	6.6E+00	--	--	5.6E+01	1.3E+01	na	--	--	--	--	--	--	--	--	--	**5.6E+01**	**1.3E+01**	**na**	**--**
Parathion	0	6.5E-02	1.3E-02	na	--	1.3E-01	2.6E-02	na	--	--	--	--	--	--	--	--	--	**1.3E-01**	**2.6E-02**	**na**	**--**
PCB Total[C]	0	--	1.4E-02	na	6.4E-04	--	2.8E-02	na	1.3E-03	--	--	--	--	--	--	--	--	**--**	**2.8E-02**	**na**	**1.3E-03**
Pentachlorophenol [C]	0	1.3E+01	1.0E+01	na	3.0E+01	2.7E+01	2.0E+01	na	6.0E+01	--	--	--	--	--	--	--	--	**2.7E+01**	**2.0E+01**	**na**	**6.0E+01**
Phenol	0	--	--	na	8.6E+05	--	--	na	1.7E+06	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.7E+06**
Pyrene	0	--	--	na	4.0E+03	--	--	na	8.0E+03	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**8.0E+03**
Radionuclides	0	--	--	na	--	--	--	na	--	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**--**
Gross Alpha Activity (pCi/L)	0	--	--	na	--	--	--	na	--	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**--**
Beta and Photon Activity (mrem/yr)	0	--	--	na	--	--	--	na	--	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**--**
Radium 226 + 228 (pCi/L)	0	--	--	na	--	--	--	na	--	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**--**
Uranium (ug/l)	0	--	--	na	--	--	--	na	--	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**--**

Parameter	Background	Water Quality Criteria				Wasteload Allocations				Antidegradation Baseline				Antidegradation Allocations				**Most Limiting Allocations**			
(ug/l unless noted)	Conc.	Acute	Chronic	HH (PWS)	HH	Acute	Chronic	HH (PWS)	HH	Acute	Chronic	HH (PWS)	HH	Acute	Chronic	HH (PWS)	HH	**Acute**	**Chronic**	**HH (PWS)**	**HH**
Selenium, Total Recoverable	0.26	2.0E+01	5.0E+00	na	4.2E+03	4.0E+01	9.7E+00	na	8.4E+03	--	--	--	--	--	--	--	--	**4.0E+01**	**9.7E+00**	**na**	**8.4E+03**
Silver	0.03	2.5E+00	--	na	--	5.0E+00	--	na	--	--	--	--	--	--	--	--	--	**5.0E+00**	**--**	**na**	**--**
Sulfate	0	--	--	na	--	--	--	na	--	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**--**
1,1,2,2-Tetrachloroethane[C]	0	--	--	na	4.0E+01	--	--	na	8.0E+01	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**8.0E+01**
Tetrachloroethylene[C]	0	--	--	na	3.3E+01	--	--	na	6.6E+01	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**6.6E+01**
Thallium	0.04	--	--	na	4.7E-01	--	--	na	9.0E-01	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**9.0E-01**
Toluene	0	--	--	na	6.0E+03	--	--	na	1.2E+04	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.2E+04**
Total dissolved solids	0	--	--	na	--	--	--	na	--	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**--**
Toxaphene [C]	0	7.3E-01	2.0E-04	na	2.8E-03	1.5E+00	4.0E-04	na	5.6E-03	--	--	--	--	--	--	--	--	**1.5E+00**	**4.0E-04**	**na**	**5.6E-03**
Tributyltin	0	4.6E-01	7.2E-02	na	--	9.2E-01	1.4E-01	na	--	--	--	--	--	--	--	--	--	**9.2E-01**	**1.4E-01**	**na**	**--**
1,2,4-Trichlorobenzene	0	--	--	na	7.0E+01	--	--	na	1.4E+02	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**1.4E+02**
1,1,2-Trichloroethane[C]	0	--	--	na	1.6E+02	--	--	na	3.2E+02	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**3.2E+02**
Trichloroethylene [C]	0	--	--	na	3.0E+02	--	--	na	6.0E+02	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**6.0E+02**
2,4,6-Trichlorophenol [C]	0	--	--	na	2.4E+01	--	--	na	4.8E+01	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**4.8E+01**
2-(2,4,5-Trichlorophenoxy) propionic acid (Silvex)	0	--	--	na	--	--	--	na	--	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**--**
Vinyl Chloride[C]	0	--	--	na	2.4E+01	--	--	na	4.8E+01	--	--	--	--	--	--	--	--	**--**	**--**	**na**	**4.8E+01**
Zinc	6.23	1.0E+02	1.0E+02	na	2.6E+04	1.9E+02	2.0E+02	na	5.2E+04	--	--	--	--	--	--	--	--	**1.9E+02**	**2.0E+02**	**na**	**5.2E+04**

Notes:

1. All concentrations expressed as micrograms/liter (ug/l), unless noted otherwise
2. Discharge flow is highest monthly average or Form 2C maximum for Industries and design flow for Municipals
3. Metals measured as Dissolved, unless specified otherwise
4. "C" indicates a carcinogenic parameter
5. Regular WLAs are mass balances (minus background concentration) using the % of stream flow entered above under Mixing Information.
   Antidegradation WLAs are based upon a complete mix.
6. Antideg. Baseline = (0.25(WQC - background conc.) + background conc.) for acute and chronic
   = (0.1(WQC - background conc.) + background conc.) for human health
7. WLAs established at the following stream flows: 1Q10 for Acute, 30Q10 for Chronic Ammonia, 7Q10 for Other Chronic, 30Q5 for Non-carcinogens and Harmonic Mean for Carcinogens. To apply mixing ratios from a model set the stream flow equal to (mixing ratio - 1), effluent flow equal to 1 and 100% mix.

Metal	Target Value (SSTV)
Antimony	1.3E+03
Arsenic	1.8E+02
Barium	na
Cadmium	1.1E+00
Chromium III	7.6E+01
Chromium VI	1.3E+01
Copper	8.4E+00
Iron	na
Lead	1.3E+01
Manganese	na
Mercury	9.2E-01
Nickel	2.0E+01
Selenium	5.8E+00
Silver	2.0E+00
Zinc	7.8E+01

Note: do not use QL's lower than the minimum QL's provided in agency guidance

5/26/2016 1:14:30 PM

Facility = Chesterfield Power Station - 101
Chemical = Ammonia
Chronic averaging period = 30
WLAa = 11.9
WLAc = 0.8
Q.L. = 0.2
# samples/mo. = 12
# samples/wk. = 3

Summary of Statistics:

observations = 1
Expected Value = .65
Variance = .1521
C.V. = 0.6
97th percentile daily values = 1.58172
97th percentile 4 day average = 1.08146
97th percentile 30 day average= .783934
< Q.L. = 0
Model used = BPJ Assumptions, type 2 data

No Limit is required for this material

The data are:

0.65

5/27/2016 7:58:48 AM

Facility = Chesterfield Power Station - 101
Chemical = Arsenic
Chronic averaging period = 4
WLAa = 680
WLAc = 300
Q.L. = 1
# samples/mo. = 12
# samples/wk. = 3

Summary of Statistics:

observations = 1
Expected Value = 300
Variance = 32400
C.V. = 0.6
97th percentile daily values = 730.025
97th percentile 4 day average = 499.137
97th percentile 30 day average= 361.815
< Q.L. = 0
Model used = BPJ Assumptions, type 2 data

A limit is needed based on Chronic Toxicity
Maximum Daily Limit = 438.772435215969
Average Weekly limit = 320.937333438009
Average Monthly LImit = 239.056365416908

The data are:

300

5/27/2016 7:59:20 AM

Facility = Chesterfield Power Station - 101
Chemical = Cadmium
Chronic averaging period = 4
WLAa   = 6.2
WLAc   = 1.8
Q.L.   = 0.13
samples/mo. = 12
samples/wk. = 3

Summary of Statistics:

observations = 1
Expected Value = 1.8
Variance   = 1.1664
C.V.   = 0.6
97th percentile daily values = 4.38015
97th percentile 4 day average = 2.99482
97th percentile 30 day average= 2.17089
< Q.L.   = 0
Model used   = BPJ Assumptions, type 2 data

A limit is needed based on Chronic Toxicity
Maximum Daily Limit   = 2.63263461129582
Average Weekly limit = 1.92562400062806
Average Monthly LImit = 1.43433819250145

The data are:

1.8

5/27/2016 7:59:54 AM

Facility = Chesterfield Power Station - 101
Chemical = Chloride
Chronic averaging period = 4
WLAa   = 1700000
WLAc   = 450000
Q.L.   = 1000
samples/mo. = 12
samples/wk. = 3

Summary of Statistics:

observations = 1
Expected Value = 450000
Variance   = 7290000
C.V.   = 0.6
97th percentile daily values = 1095037
97th percentile 4 day average = 748705.
97th percentile 30 day average= 542723.
< Q.L.   = 0
Model used   = BPJ Assumptions, type 2 data

A limit is needed based on Chronic Toxicity
Maximum Daily Limit   = 658158.652823954
Average Weekly limit = 481406.000157014
Average Monthly LImit = 358584.548125361

The data are:

450000

5/16/2016 9:37:38 AM

Facility = Chesterfield Power Station - 101
Chemical = TRC
Chronic averaging period = 4
WLAa   = 38
WLAc   = 22
Q.L.   = 10
samples/mo. = 12
samples/wk. = 3

Summary of Statistics:

observations = 1
Expected Value = 20
Variance   = 144
C.V.   = 0.6
97th percentile daily values = 48.6683
97th percentile 4 day average = 33.2758
97th percentile 30 day average= 24.1210
< Q.L.   = 0
Model used   = BPJ Assumptions, type 2 data

A limit is needed based on Chronic Toxicity
Maximum Daily Limit   = 32.1766452491711
Average Weekly limit = 23.5354044521207
Average Monthly LImit = 17.5308001305732

The data are:

20

5/16/2016 9:38:10 AM

Facility = Chesterfield Power Station - 101
Chemical = Chromium III
Chronic averaging period = 4
WLAa   = 980
WLAc   = 130
Q.L.   = 0.77
samples/mo. = 12
samples/wk. = 3

Summary of Statistics:

observations = 1
Expected Value = 130
Variance   = 6084
C.V.   = 0.6
97th percentile daily values = 316.344
97th percentile 4 day average = 216.292
97th percentile 30 day average= 156.786
< Q.L.   = 0
Model used   = BPJ Assumptions, type 2 data

A limit is needed based on Chronic Toxicity
Maximum Daily Limit   = 190.13472192692
Average Weekly limit = 139.072844489804
Average Monthly LImit = 103.59109168066

The data are:

130

5/16/2016 9:38:41 AM

Facility = Chesterfield Power Station - 101
Chemical = Chromium VI
Chronic averaging period = 4
WLAa   = 32
WLAc   = 22
Q.L.   = 1.9
samples/mo. = 12
samples/wk. = 3

Summary of Statistics:

observations = 1
Expected Value = 22
Variance   = 174.24
C.V.   = 0.6
97th percentile daily values = 53.5351
97th percentile 4 day average = 36.6033
97th percentile 30 day average= 26.5331
< Q.L.   = 0
Model used   = BPJ Assumptions, type 2 data

A limit is needed based on Acute Toxicity
Maximum Daily Limit   = 32
Average Weekly limit = 23.4061983974934
Average Monthly LImit = 17.4345585077051

The data are:

22

5/26/2016 5:50:46 PM

Facility = Chesterfield Power Station - 101
Chemical = Copper
Chronic averaging period = 4
WLAa   = 21
WLAc   = 14
Q.L.   = 1.5
samples/mo. = 12
samples/wk. = 3

Summary of Statistics:

observations = 1
Expected Value = 14
Variance   = 70.56
C.V.   = 0.6
97th percentile daily values = 34.0678
97th percentile 4 day average = 23.2930
97th percentile 30 day average= 16.8847
< Q.L.   = 0
Model used   = BPJ Assumptions, type 2 data

A limit is needed based on Chronic Toxicity
Maximum Daily Limit   = 20.4760469767452
Average Weekly limit = 14.9770755604404
Average Monthly LImit = 11.1559637194557

The data are:

14

5/16/2016 9:39:26 AM

Facility = Chesterfield Power Station - 101
Chemical = Lead
Chronic averaging period = 4
WLAa   = 190
WLAc   = 21
Q.L.   = 1
samples/mo. = 12
samples/wk. = 3

Summary of Statistics:

observations = 1
Expected Value = 21
Variance   = 158.76
C.V.   = 0.6
97th percentile daily values = 51.1017
97th percentile 4 day average = 34.9395
97th percentile 30 day average= 25.3271
< Q.L.   = 0
Model used   = BPJ Assumptions, type 2 data

A limit is needed based on Chronic Toxicity
Maximum Daily Limit   = 30.7140704651179
Average Weekly limit = 22.4656133406607
Average Monthly LImit = 16.7339455791835

The data are:

21

5/16/2016 9:45:13 AM

Facility = Chesterfield Power Station - 101
Chemical = Mercury
Chronic averaging period = 4
WLAa   = 2.8
WLAc   = 1.5
Q.L.   = 0.031
samples/mo. = 12
samples/wk. = 3

Summary of Statistics:

observations = 1
Expected Value = 1.5
Variance   = .81
C.V.   = 0.6
97th percentile daily values = 3.65012
97th percentile 4 day average = 2.49568
97th percentile 30 day average= 1.80907
< Q.L.   = 0
Model used   = BPJ Assumptions, type 2 data

A limit is needed based on Chronic Toxicity
Maximum Daily Limit   = 2.19386217607985
Average Weekly limit = 1.60468666719005
Average Monthly LImit = 1.19528182708454

The data are:

1.5

5/26/2016 5:51:34 PM

Facility = Chesterfield Power Station - 101
Chemical = Nickel
Chronic averaging period = 4
WLAa   = 310
WLAc   = 33
Q.L.   = 1
samples/mo. = 12
samples/wk. = 3

Summary of Statistics:

observations = 1
Expected Value = 33
Variance   = 392.04
C.V.   = 0.6
97th percentile daily values = 80.3027
97th percentile 4 day average = 54.9050
97th percentile 30 day average= 39.7997
< Q.L.   = 0
Model used   = BPJ Assumptions, type 2 data

A limit is needed based on Chronic Toxicity
Maximum Daily Limit   = 48.2649678737566
Average Weekly limit = 35.3031066781811
Average Monthly LImit = 26.2962001958599

The data are:

33

5/26/2016 5:52:08 PM

Facility = Chesterfield Power Station - 101
Chemical = Selenium
Chronic averaging period = 4
WLAa   = 40
WLAc   = 9.7
Q.L.   = 3.9
samples/mo. = 12
samples/wk. = 3

Summary of Statistics:

observations = 1
Expected Value = 9.7
Variance   = 33.8724
C.V.   = 0.6
97th percentile daily values = 23.6041
97th percentile 4 day average = 16.1387
97th percentile 30 day average= 11.6987
< Q.L.   = 0
Model used   = BPJ Assumptions, type 2 data

A limit is needed based on Chronic Toxicity
Maximum Daily Limit   = 14.1869754053163
Average Weekly limit = 10.3769737811623
Average Monthly LImit = 7.72948914848002

The data are:

9.7

5/16/2016 9:41:00 AM

Facility = Chesterfield Power Station - 101
Chemical = Silver
Chronic averaging period = 4
WLAa   = 5
WLAc   =
Q.L.   = 0.047
samples/mo. = 12
samples/wk. = 3

Summary of Statistics:

observations = 1
Expected Value = 5
Variance   = 9
C.V.   = 0.6
97th percentile daily values = 12.1670
97th percentile 4 day average = 8.31895
97th percentile 30 day average= 6.03026
< Q.L.   = 0
Model used   = BPJ Assumptions, type 2 data

A limit is needed based on Acute Toxicity
Maximum Daily Limit   = 5
Average Weekly limit = 3.65721849960834
Average Monthly LImit = 2.72414976682892

The data are:

5

5/26/2016 5:52:52 PM

Facility = Chesterfield Power Station - 101
Chemical = Zinc
Chronic averaging period = 4
WLAa   = 190
WLAc   = 200
Q.L.   = 5
samples/mo. = 12
samples/wk. = 3

Summary of Statistics:

observations = 1
Expected Value = 190
Variance   = 12996
C.V.   = 0.6
97th percentile daily values = 462.349
97th percentile 4 day average = 316.120
97th percentile 30 day average= 229.150
< Q.L.   = 0
Model used   = BPJ Assumptions, type 2 data

A limit is needed based on Acute Toxicity
Maximum Daily Limit   = 190
Average Weekly limit = 138.974302985117
Average Monthly LImit = 103.517691139499

The data are:

190

g. Ammonia Limitations

In order to comply with Nitrogen Oxide (NOx) emission requirements under the Clean Air Act (CAA), Dominion has installed state-of-the-art Selective Catalytic Reduction (SCR) technology on generating units 4, 5 and 6. The SCRs became operational in 2002 (Unit 5), 2003 (Unit 4), and 2004 (Unit 6). SCR is a post combustion process where ammonia is injected into the flue gas in the presence of a catalyst and reacts with the NOx to form molecular nitrogen and water, which are emitted to the air. The catalyst (vanadium pentoxide) is used to facilitate the chemical reaction. Unreacted ammonia is carried with the flue gases through the duct system and may become deposited on fly ash as ammonium bisulfate. The ammoniated fly ash is subsequently collected by electrostatic precipitators, is mixed with water from the James River to form a sluice, and is then conveyed to the station's old ash pond. At the pH of the sluice water (typically approximately neutral) all of the ammonia associated with the fly ash is expected to dissolve into the sluice water. Following settling of the ash, the remaining water is discharged through Outfall 004 to Farrar Gut, which is a tributary to the James River.

A Letter of Agreement (LOA) between DEQ and Virginia Power became effective on June 14, 2002 authorizing use of the SCR on Unit 4. A monitoring action level of 41 kg/d daily maximum of ammonia was established on Outfall 004. The LOA has a term of one year. In October 2003 a Consent Special Order was executed with ammonia limitations for Outfall 004 of 34.1 kg/d monthly average and 68.2 kg/d daily maximum. It was anticipated that those limitations would be adequate for the operation of the SCRs on Units 4, 5 and 6.

Soon after the SCR on Unit 4 went into operation, it was observed that the Outfall 004 discharges of ammonia had reached the limitations established in the Consent Order. Virginia Power realized that a mistake had been made in estimating the amount of nitrogen that would be in the ammonia form in the ash pond. Projecting all three SCRs in operation, Virginia Power requested that an ammonia limitation be included in the 2004 permit of 520 lbs/day (236 kg/d) monthly average based on the highest one-day projection. To support that request, Dr. Wu-Seng Lung at the University of Virginia modeled the proposed discharge using the Richmond Crater 208 model. Dr. Lung concluded that the proposed discharge of ammonia would cause insignificant increases in ammonia in the main channel of the James River. He also concluded that the water quality standards for ammonia would not be exceeded in the James. A copy of Dr. Lung's report and comments by DEQ staff are provided in **Attachment 5.i**. The requested loading was applied as a daily maximum limitation in the Special Consent Order. Staff elected to establish the limitation in the Consent Order rather than the permit so that a more appropriate limitation for inclusion in the permit could be calculated after data that reflect actual operation of all three SCRs had been collected. The Consent Order was executed May 28, 2005 and terminated May 1. 2007.

As noted above the third SCR went online in 2004 and data on Outfall 004 has been collected over the 2004 permit cycle. The data are summarized in **Attachment 4**. In addition, Dominion has since installed Flue Gas Desulfurization for Sulfur Dioxide (SO2) as required for Units 5 and 6 by Dominion's Consent Decree with EPA before 2012 and 2010, respectively. The FGD wet scrubbing process will capture any unreacted ammonia not captured by the SCR that would otherwise exit through the stack. The ammonia is then concentrated by evaporation in the FGD and discharged through the FGD blowdown stream. This contribution is reflected in the data collected since installation (Unit 6 online April 2008, Unit 5 online May 2011, Units 3 and 4 online December 2011).

The VPDES Watershed Permit Regulation for Total Nitrogen and Total Phosphorus Discharges and Nutrient Trading in the Chesapeake Bay was issued in 2007. At Dominion's request, Chesterfield Power Station was recognized as a significant discharger and assigned a loading in

the WQMP. The loadings assigned (352,036 lbs/year TN & 210 lbs/year TP) represent the net loadings contributed by Outfalls 004 and 005. These loadings are regulated through the Nutrient General Permit (VAN040086), which assigns a combined loading to Outfalls 004 and 005. Ammonia is indirectly controlled through the TN allocation implemented in the General Permit. Consequently, a separate ammonia loading limitation is not needed in the individual permit. Ammonia toxicity is separately evaluated through the reasonable potential analyses at each outfall as described in the preceding attachments.

2004

Ammonia-N Waste Load Allocation

Facility		VaP - C 004
Permit No.		VA0004146
Effluent pH		8.0
Effluent temperature		55.6
Effluent Flow		13.5
Stream flow	1Q10	719.5
	30Q10	719.5
Acute Mix		100
Chronic Mix		100

Enter facility info here

MIN	0.20	2.85	0.20
MAX	0.20		

	Criteria	WLAa
Ammonia Acute Criteria		
Without Trout	8.41	456.50
With Trout	5.62	304.88
Ammonia Chronic Criteria		WLAc
Without Fish	0.17	9.35
With fish	0.17	9.35

Use this data to calculate NH3 limits

Note:

Acute without trout equation = *0.411/(1+10^(7.204-pH)) + 58.4/(1+10^(pH-7.204))*

Acute with trout equation = *0.275/(1+10^(7.204-pH)) + 39.0/(1+10^(pH-7.204))*

Chronic without fish = *[0.0577/(1+10^(7.688-pH)) + 2.487/(1+10^((pH-7.688))] x MAX*

Chronic with fish = *[0.0577/(1+10^(7.688-pH)) + 2.487/(1+10^((pH-7.688))] x MIN*

*where MIN = the lesser of 2.85 or 1.45*10^(0.028*(25-T))*

*and MAX = 1.45*10^(0.028*(25-T))*

2004

Facility = VaP -- Chesterfield Outfall 004
Chemical = Ammonia
Chronic averaging period = 30
WLAa = 456.5
WLAc = 9.35
Q.L. = .2
# samples/mo. = 4
# samples/wk. = 1

Summary of Statistics:

observations = 1
Expected Value = 4.6
Variance = 7.6176
C.V. = 0.6
97th percentile daily values = 11.1937
97th percentile 4 day average = 7.65343
97th percentile 30 day average = 5.54784
< Q.L. = 0
Model used = BPJ Assumptions, type 2 data

No Limit is required for this material

The data are:

4.6

4.6 mg/L is the calculated concentration at a flow of 13.5 MGD (daily maximum from DMRs) and a loading of 236 kg/d (loading requested by Virginia Power).

2004

Facility = VaP -- Chesterfield Outfall 004
Chemical = Ammonia
Chronic averaging period = 30
WLAa = 456.5
WLAc = 9.35
Q.L. = .2
# samples/mo. = 4
# samples/wk. = 1

Summary of Statistics:

observations = 1
Expected Value = 8
Variance = 23.04
C.V. = 0.6
97th percentile daily values = 19.4673
97th percentile 4 day average = 13.3103
97th percentile 30 day average = 9.64842
< Q.L. = 0
Model used = BPJ Assumptions, type 2 data

A limit is needed based on Chronic Toxicity

Maximum Daily Limit = 18.8652153734425
Average Weekly limit = 18.8652153734425
Average Monthly Limit = 12.8986329992381

The data are:

8

8 mg/L was used to force limitations. 8 mg/L is a totally arbitrary concentration; higher concentrations would result in the same limitations. Limitations were forced so that the permit will contain limitations protective of the water quality standards for ammonia.

h. Total Phosphorus

Outfalls 001 – 005 were assigned Total Phosphorus limitations several permit cycles ago in accordance with the Policy for Nutrient Enriched Waters (VR 680-14-02, 1990). The James River was designated as a Nutrient Enriched Water in the Water Quality Standards, but this designation has since been repealed. The regulation for Nutrient Enriched Waters and Dischargers within the Chesapeake Bay Watershed (9VAC25-40) subsequently promulgated in 2005, excludes noncontact cooling water and storm water from the definition of "point source dischargers." Outfalls 001-003 discharge non-contact cooling water, which represents zero net addition of nutrients to the receiving stream. GM07-2008 Amendment 2 outlines conditions under which it is appropriate to remove NEW based Total Phosphorus limitations from individual permits of non-significant industrial facilities. Documentation that Outfalls 001-003 meet these criteria is as follows:

1) The limit is technology-based;
2) 9VAC25-40-30-D exempts facilities located in the Chesapeake Bay watershed from this limit;
3) The facility did not install treatment in order to comply with the limit;
4) The facility has not undertaken any process or site management changes in order to comply with the limit, and
5) The discharges from Outfalls 001-003 do not contribute to this facility being a significant discharger. At Dominion's request, Chesterfield Power Station was recognized as a significant discharger and assigned a loading in the WQMP. The loadings assigned (352, 036 lbs/day TN & 210 lbs/day TP) represent the net loadings contributed by Outfalls 004 and 005. These loadings are regulated through the Nutrient General Permit (VAN040086), which assigns a combined loading to Outfalls 004 and 005. Background contributions from the non-contact cooling water outfalls 001-003 are not addressed in the GP coverage. Monitoring over the past three years indicates that the TP concentrations observed at Outfalls 001-003 are well below the limitation of 2.0 mg/L.
6) In any subsequent expansion or process modification resulting in discharged annual *net* waste loads at or above 2,300 pounds per year of TN or 300 lbs/year of TP for Outfalls 001-003, the facility will register these outfalls for WGP coverage and will have to fully offset any nutrient contribution.

Consequently, TP limitations on Outfalls 001-003 will be removed in this permit reissuance.

Total Phosphorus from Outfalls 004 and 005 is now addressed through the Nutrient Trading General Permit. Without the installation of nutrient removal technology in accordance with 9 VAC25-40-70, limitations in the individual permit are no longer necessary.

Attachment 5.i
Modeling Associated with SCR Addition

i. Report from Dr. Wu-Seng Lung titled “Modeling Water Quality Impact of Dominion’s Chesterfield Power Station” dated November 25, 2003.

ii. Email fom Jennifer Palmore dated January 14, 2004.

iii. Email from Allan Brockenbrough dated January 20, 2004.

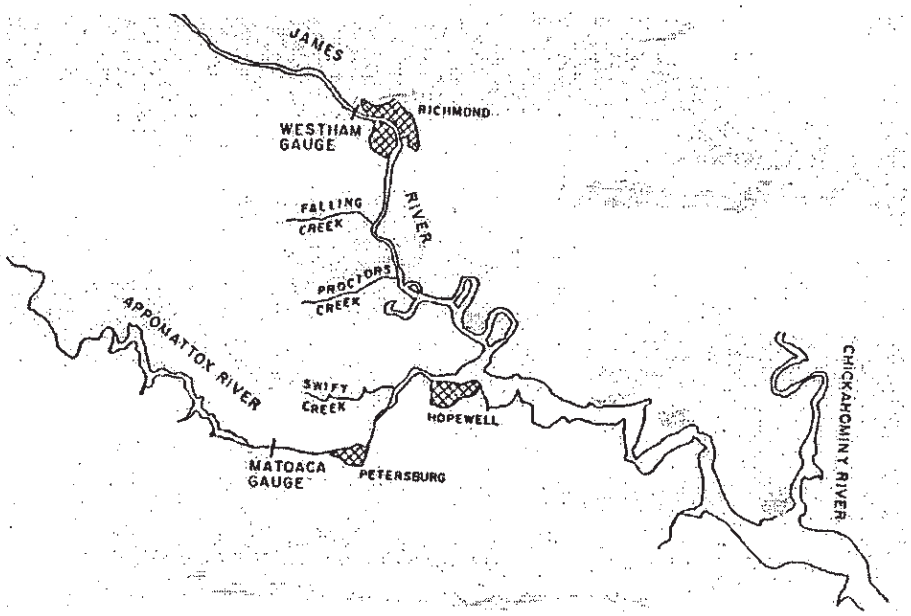
MODELING WATER QUALITY IMPACT

OF

DOMINION'S CHESTERFIELD POWER STATION

Submitted to
Dominion Generation

ATTN: Mr. Kenneth Roller



Submitted by

Wu-Seng Lung, PhD, PE

November 25, 2003

EXECUTIVE SUMMARY

Due to air pollution control requirements, Dominion's Chesterfield Power Station, located on the Upper James River Estuary near Hopewell, VA, will be installing air emission control technology (Selective Catalytic Reduction, SCR) that may incidentally contribute additional loads of ammonia and nitrate nitrogen into the river. A modeling study was conducted to assess the impact of the Dominion's Chesterfield Power Station on the receiving water quality following the implementation of SCR.

Water quality management of the Upper James River Estuary is based on the Richmond-Crater Water Quality Management Plan (RCWQMP) developed in 1989 by the Virginia State Water Control Board. Wasteload allocations for 15 major point sources along the Upper James River Estuary were developed by RCWQMP using a water quality model, JMSRV. In this study, JMSRV was used to assess the water quality impact. The model simulations were designed to address the following questions:

1. What are the ammonia and nitrate concentrations in the receiving water following the installation of air emission control technology at Dominion's Chesterfield Power Station?
2. Would the maximum allowable ammonia levels in the receiving water be maintained with the projected ammonia loads from Dominion's Chesterfield Power Station?
3. Can the dissolved oxygen standard of 5 mg/L still be met in the Upper James Estuary?
4. What would additional algal biomass (in chlorophyll *a*) be under the projected nitrogen loads (i.e., eutrophication impact)?

Model results presented in this report show very insignificant changes in ammonia and nitrate concentrations in the receiving water with projected nitrogen loads from Dominion's Chesterfield Power Station. Most importantly, the ammonia and dissolved oxygen standards will continue to be met in the Upper James River Estuary under the proposed loading scenario. Further, the impact on eutrophication is also insignificant.

Modeling Water Quality Impact of Dominion's Chesterfield Power Station[1]

Introduction and Purpose

Due to air pollution control requirements, Dominion's Chesterfield Power Station, located on the James River Estuary near Hopewell, VA, will be installing air emission control technology that may incidentally contribute additional loads of ammonia and nitrite/nitrate nitrogen into the Upper James Estuary. While the additional nitrogen loads may cause a slight increase in the inorganic nitrogen concentrations in the James River Estuary immediately below the plant outfall, the primary focus is the impact on the dissolved oxygen levels and ammonia toxicity in the receiving water.

At the present time, wasteload allocations (WLA) in the Upper James Estuary (Figure 1) are based on the Richmond-Crater Water Quality Management Plan (RCWQMP) developed in 1989. Under that Plan, carbonaceous biochemical oxygen demand (CBOD) and nutrient loads from 15 major point sources along the Upper James Estuary and the Appomattox River are allocated for years 1990, 2000, and 2010 using a water quality model, JMSRV, calibrated by HydroQual, Inc. (1986).

The purpose of this modeling study is to quantify the effect of the increased nitrogen loads from Dominion's Chesterfield Power Station on dissolved oxygen and ammonia toxicity in the Upper James Estuary using JMSRV. The model results will be submitted to the Virginia Department of the Environmental Quality (VDEQ) as technical support information for the Dominion's Chesterfield Power Station's permit renewal.

Potential Water Quality Impact

This water quality modeling study is designed to address the following questions:

1. What are the ammonia and nitrate concentrations in the receiving water following the installation of air emission control technology at Dominion's Chesterfield Power Station?
2. Would the maximum allowable ammonia levels in the receiving water be maintained with the projected ammonia loads from Dominion's Chesterfield Power Station?
3. Can the dissolved oxygen standard of 5 mg/L still be met in the Upper James Estuary?
4. What would additional algal biomass (in chlorophyll *a*) be under the projected nitrogen loads (i.e., eutrophication impact)?

Essentially, would the dissolved oxygen and ammonia standards in the ambient water be met under the proposed loading scenario for Dominion's Chesterfield Power Station? In addition, the response of the Upper James River Estuary under the proposed loading scenario is compared with that of the 1990 WLA under RCWQMP to quantify the water quality impact.

[1] Wu-Seng Lung, PhD, PE, Professor of Civil Engineering, University of Virginia

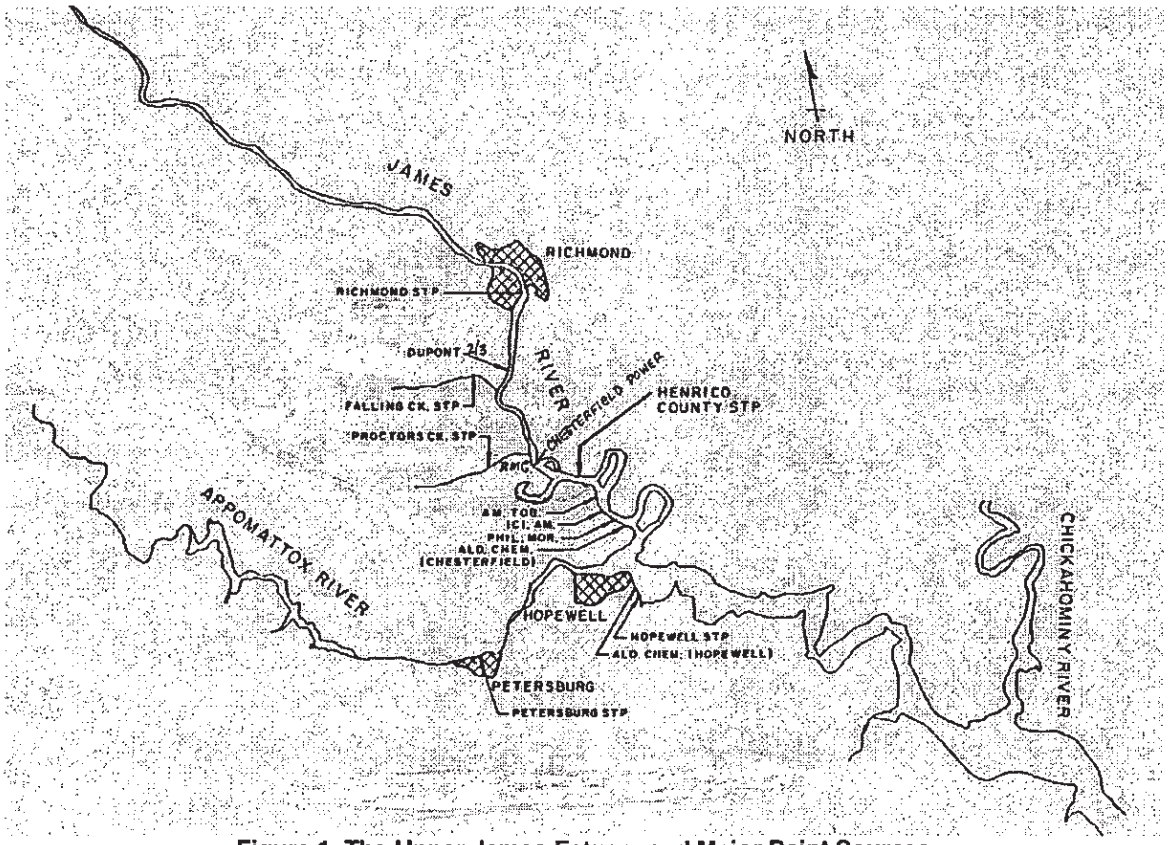


Figure 1. The Upper James Estuary and Major Point Sources

The RCWQMP and Wasteload Allocations

The legal base of the wasteload allocations for the Upper James Estuary is the Richmond-Crater Water Quality Management Plan published in 1989. The JMSRV model was used in developing these wasteloads under that Plan. A comprehensive description of the model is included in the appendix. Table 1 lists the wasteloads allocated for Dominion's Chesterfield Power Station's VP004 outfall in RCWQMP (Virginia State Water Control Board, 1989).

Table 1. Wasteload Allocations for Chesterfield Power Station's Outfall VP004

Season	Flow (mgd)	Org-N (lb/d)	NH_3-N (lb/d)	NO_3-N (lb/d)	Total N (lb/d)	Org-P (lb/d)	Inorg-P (lb/d)	Total P (lb/d)	$CBOD_u$ (lb/d)	DO (mg/L)
Summer	8.70	36	6[a]	157[b]	199	3	1	4	189	5.8
Winter	8.70	9	11[c]	19[d]	39	5	2	7	189	5.8

a. equivalent to an ammonia concentration of 0.1 mg/L
b. equivalent to a nitrate concentration of 2.2 mg/L
c. equivalent to an ammonia concentration of 0.2 mg/L
d. equivalent to a nitrate concentration of 0.3 mg/L

Note that loading rates are expressed in lb/d except dissolved oxygen where concentrations are in mg/L in the input data file to run the JMSRV model. Total phosphorus concentrations from all 15 major point sources are required to meet the 2-mg/L effluent limit.

Baseline Model Results

Model results of the 1990 WLA (from Table 1) are re-generated in this study as the baseline condition. Both summer and winter hydrologic and environmental conditions for the JMSRV model used in the 1990 WLA analysis are adopted in this regeneration run. Model kinetic coefficients calibrated by HydroQual, Inc. (1986) are also incorporated into the model input data file. The model is run time-variably for 120 days to reach a steady state, which results are summarized as follows.

Figure 2 shows model results for $CBOD_u$, organic nitrogen, ammonia, nitrate, organic phosphorus, inorganic phosphorus, chlorophyll *a*, and dissolved oxygen profiles along the river from Richmond to the junction with the Chickahominy River under the summer low flow condition. These concentration profiles match exactly those obtained with the original wasteload allocations in the RCWQMP (1989). Note that the $CBOD_u$ concentrations in Figure 2 include the oxygen needed to fully oxidize the organic carbon in the algal biomass, thereby resembling the algal biomass (chlorophyll *a*) concentration profile. Perhaps the most significant result is that the minimum dissolved oxygen (DO sag) level is meeting the ambient water quality standard of 5 mg/L.

Also shown in Figure 2 is the maximum allowable ammonia concentration to prevent ammonia toxicity in the ambient water. Ammonia toxicity is caused by unionized ammonia, which in turn is a function of pH and temperature. The maximum allowable ammonia concentration shown is based on the most recent Virginia's surface water quality criteria (VSWCB, 2003). At a pH level of 7.8 and water temperature of 29.81°C in the summer month based on the Technical Support Information (RCWQMP, 1989), the maximum allowable concentration of ammonia nitrogen is 1.18 mg/L. Figure 2 indicates that ammonia concentrations in the Upper James River Estuary are well below 1.18 mg/L under the summer low flow condition.

Figure 2 also shows that the algal biomass (in terms of chlorophyll *a*) concentration reaches a maximum level of 42 μg/L near the junction with the Appomattox River. The decline of the chlorophyll *a* levels below that point is due to the depressed inorganic phosphorus (in the form of orthophosphate) concentrations for algae (Figure 2).

Figure 3 summarizes the model results under the winter condition; again reproducing the model results in the RCWQMP of 1989. The ambient dissolved oxygen standard of 5.0 mg/L is also met and the maximum allowable ammonia concentration of 2.17 mg/L (based on RCWQMP winter pH = 7.8 and temperature = 20.23°C) is not violated. The peak of chlorophyll *a* in the winter months is significantly less than that in the summer due to cooler water temperature and reduced light levels for algae.

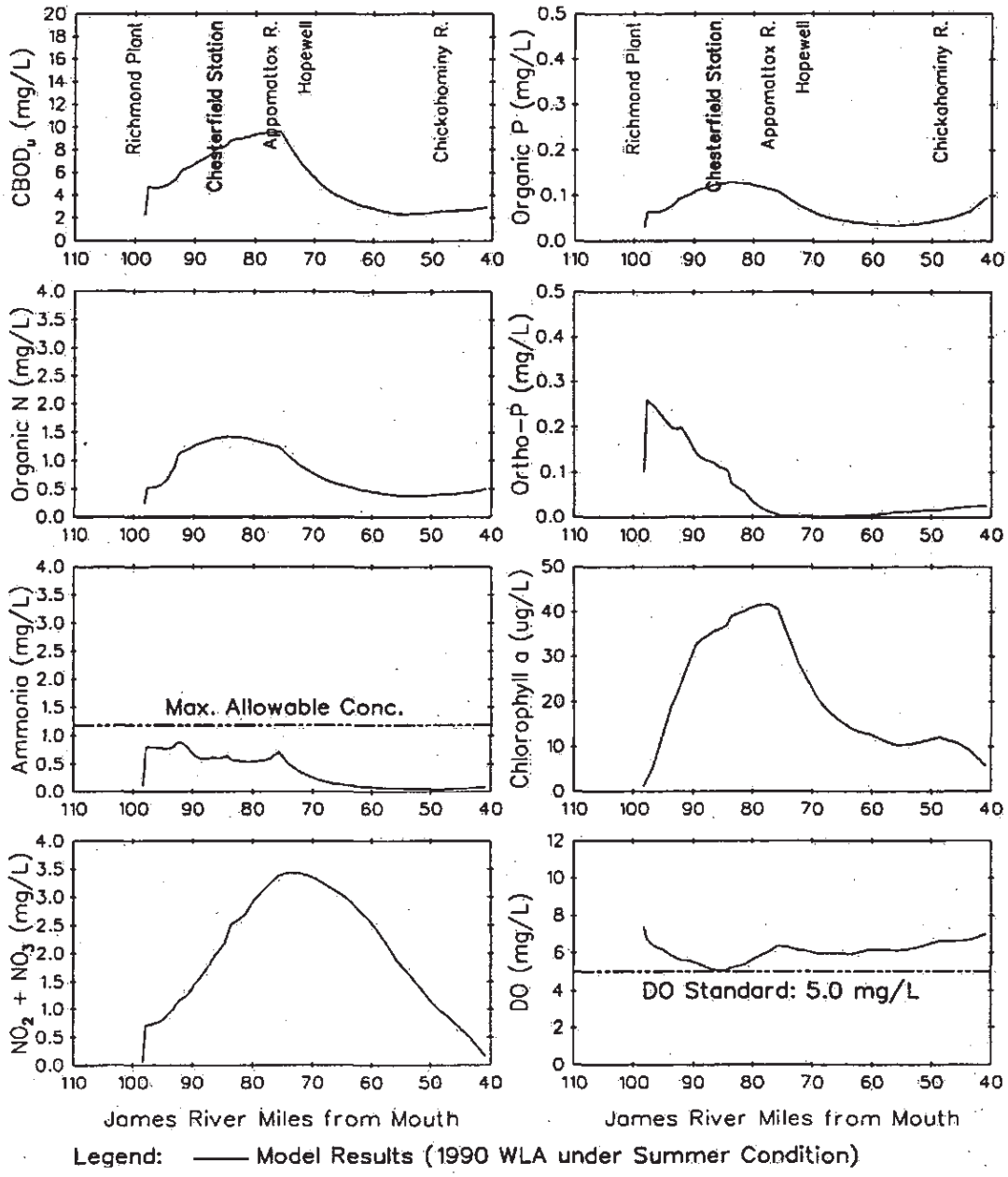


Figure 2. Baseline Model Results from Summer WLAs for the Upper James River Estuary

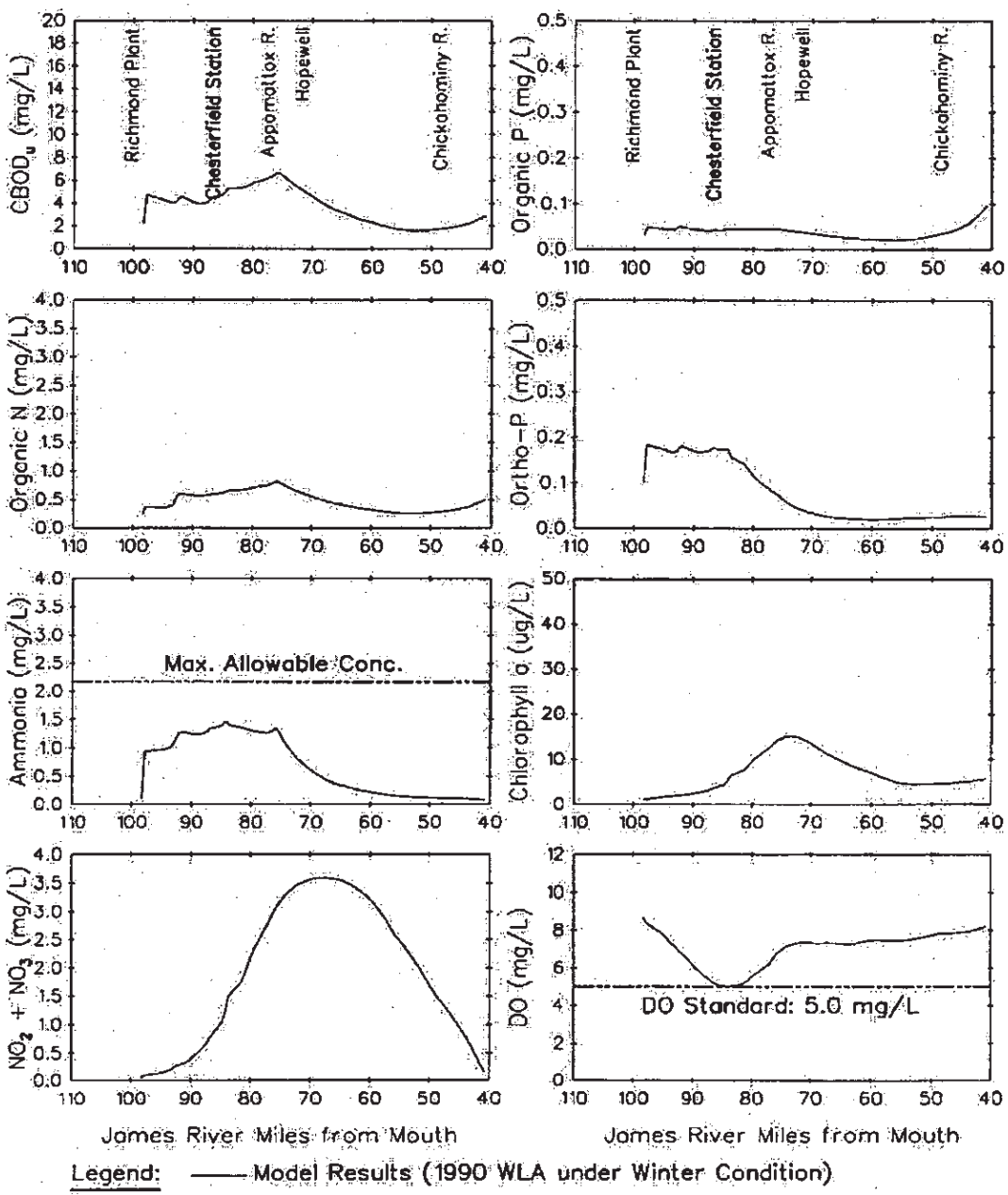


Figure 3. Baseline Model Results from Winter WLAs for the Upper James River Estuary

Impact of the Dominion's Chesterfield Power Station

The first step in quantifying the impact of Dominion's Chesterfield Power Station is to evaluate the ammonia and nitrate nitrogen loads from the Station. Additional ammonia loadings from Dominion's Chesterfield Power Station may result from the implementation of Selective Catalytic Reduction (SCR) technology to reduce NOx emissions in order to comply with existing air regulatory requirements. Ammonia is used in the SCR process and some residual ammonia may become associated with the fly ash that is generated during the combustion of coal. Consequently, the point source discharge most likely to be impacted by the SCR process is the ash pond discharge Outfall 004, which is designated as VP004 in the RCWQMP.

The proposed ammonia-loading rate for Dominion's Chesterfield Power Station is 520 lb/day for both summer and winter conditions. The proposed nitrate loading rates are 157 lb/day and 19 lb/day for summer and winter, respectively. The loading rates are converted to concentrations for comparison with the concentrations under the baseline condition 1990 WLA in Table 2.

Table 2. Loading Scenarios for Dominion's Chesterfield Power Station

Scenario	Flow (mgd)	Ammonia (mg/L) summer	Ammonia (mg/L) winter	Nitrate (mg/L) summer	Nitrate (mg/L) winter
Baseline condition:1990 WLA	8.70	0.1	0.2	2.2	0.3
Proposed loading condition	8.70	7.2	7.2	2.2	0.3

As shown in Table 2, the proposed loading condition has higher ammonia concentrations than the baseline 1990 WLA concentrations while the nitrate loads remain the same as the baseline condition.

Figure 4 compares model results of baseline 1990 WLA and proposed scenario, displaying concentration profiles of ammonia, nitrate, chlorophyll *a*, and dissolved oxygen. As illustrated, the impact of the proposed loading condition on the receiving water quality is insignificant under both summer and winter conditions. First, the dissolved oxygen standard of 5 mg/L is still met under the proposed loading condition.

There is very insignificant increase in ammonia concentrations in the receiving water as additional ammonia is taken up by algae (see the small increase in chlorophyll *a* levels in Figure 4). Because of the increase algal growth, the nitrate concentration levels are slightly lower (see the dashed line in Figure 4) than the 1990 WLA levels.

The results under the winter conditions are similar in that the ammonia and dissolved oxygen standards are met. The result for chlorophyll *a* under the winter condition is even less pronounced so the dashed lines displaying the model results of water quality impact cannot be distinguished from the results of the 1990 wasteload allocations (Figure 4). Algal growth in the wintertime is significantly minimized so the nitrate concentrations in the receiving water show a slight increase, compared with the 1990 WLA levels.

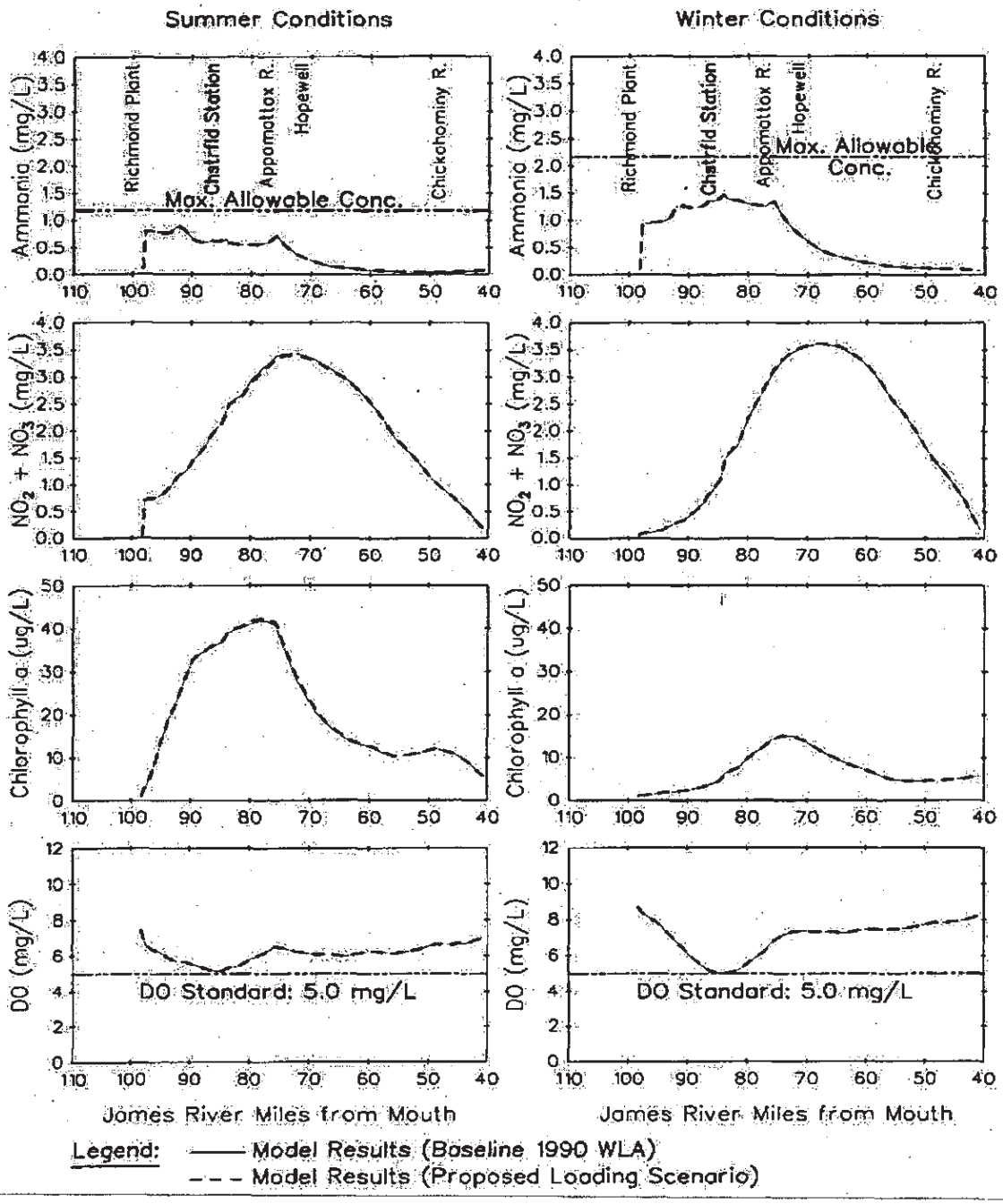


Figure 4. Model Projection Results – Baseline 1990 WLA and Proposed Scenario

Summary and Conclusions

The JMSRV model was used to assess the water quality impact of Dominion's Chesterfield Power Station under future operation conditions. Model results show that the proposed increase in nitrogen loads from the Station's outfall would yield insignificant increases in ammonia concentrations in the Upper James River Estuary under summer conditions. The ambient ammonia concentrations in the receiving water would be below the maximum allowable ammonia levels. There would be no impact on the dissolved oxygen levels in the receiving water, still meeting the DO standard of 5 mg/L. The impact on eutrophication in the receiving water is also insignificant. Water quality impact during the winter months would even be less pronounced.

It should be pointed out that the modeling analysis in this study has yielded conservative results. Point source nutrient loads to the Upper James River Estuary have decreased significantly since 1990 following the implementation of a number of nutrient control strategies such as biological nitrogen removal at municipal wastewater treatment plants. The model results in this study have shown insignificant impact of the Dominion's Chesterfield Power Station on the water quality of the Upper James River Estuary. One can therefore reasonably argue that the ambient ammonia concentration under the proposed loading condition would be comfortably below the maximum levels allowed in the Upper James River Estuary.

References Cited

Brendel, G.F., Bonetti, J.E., Rathbone, R.F., and Frey, R.N., 2000. Investigation of Ammonia Adsorption on Fly Ash Due to Installation of Selective Catalytic Reduction Systems. Technical report prepared with the support or the U.S. Department of Energy, National Energy Technology Laboratory, through its Cooperative Agreement No. DE-FC26-98FT40028 with West Virginia University Research Corporation, and with the support of Dominion Generation.

HydroQual, Inc. 1986. Water Quality Analysis of the James and Appomattox Rivers. Report prepared for Richmond Regional Planning District Commission, Richmond, VA.

Lung, W.S. 1986. Assessing Phosphorus Control in the James River Basin. *Journal of Environmental Engineering*, 112(1):44-60.

Lung, W.S. and Testerman, N. 1989. Modeling Fate and Transport of Nutrients in James Estuary. *Journal of Environmental Engineering*, 115(5): 978-991.

Virginia State Water Control Board, 1989. Richmond-Crater Water Quality Management Plan Technical Support Information. Report prepared by the Piedmont Regional Office, Water Resources Development Section.

Virginia State Water Control Board, 2003. Surface Water Quality Criteria for Ammonia. Adopted in August 2003.

APPENDIX – The JMSRV Model

The latest version of the JMSRV model was calibrated by HydroQual, Inc. for the Richmond Region Planning District Commission in 1986. The spatial domain of the model for this study is from the reach of the Upper James River downstream of the Fall Line near Richmond to Jamestown Island, below the confluence of the James River with the Chickahominy River. It also includes a 20-mile reach of the Appomattox River between Petersburg and its confluence with the James. Both the James and Appomattox Rivers in the model domain are estuaries under tidal influence. The model has since been adopted to run on PCs by Lung (1986) and has been used to track the fate and transport of point source phosphorus loads in the Upper James Estuary (Lung and Testerman, 1989).

The main stem of the Upper James Estuary is divided into 54 segments. The 20-mile reach of the Appomattox River is divided into 41 segments. There are a total of 95 segments in the model. Fifteen major dischargers (6 municipalities and 9 industries) are included as point source loads to the receiving water.

The model is able to simulate eight water quality constituents in the water column of the Upper James Estuary: $CBOD_u$, organic nitrogen, ammonia nitrogen, nitrite/nitrate nitrogen, organic phosphorus, orthophosphate, chlorophyll *a*, and dissolved oxygen. The kinetic structure of the model is shown in Figure 5.

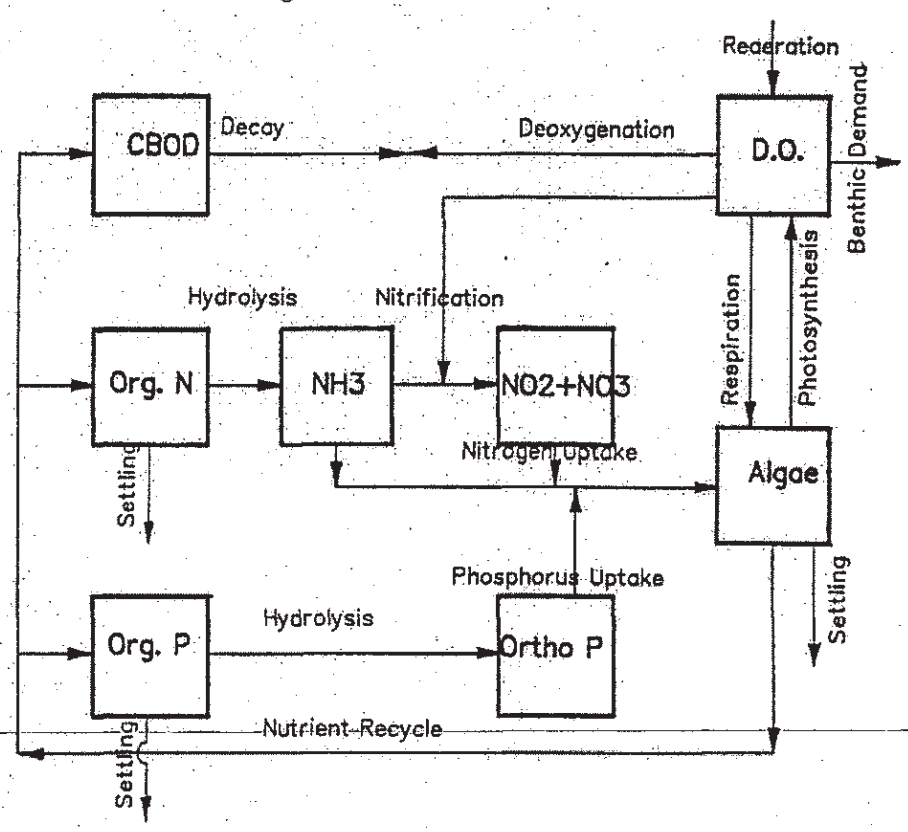


Figure 5. Water Column Kinetics in the Upper James River Model

Jenkins,Ray

From: Palmore,Jennifer
Sent: Wednesday, January 14, 2004 4:15 PM
To: Jenkins,Ray
Cc: Alling,Mark; Linderman,Curtis; Brockenbrough,Allan
Subject: Dominion VA Power

I have reviewed the submissions from Virginia Power received December 8, 2003. Included were the reports *Modeling Water Quality Impact of Dominion's Chesterfield Power Station* by Dr. Wu-Seng Lung dated November 25, 2003 and *Thermal Modeling of Chesterfield Power Station on the James River and Farrar Gut, Virginia* by Hydroqual dated November 7, 2003.

The water quality report discusses the effect that the additional ammonia load that VA Power has requested would have on ammonia toxicity and dissolved oxygen concentrations in the upper James River estuary. Permits in this reach are currently governed by the Richmond-Crater Interim Water Quality Management Plan, 1989 (RCWQMP) [9 VAC 25-720-60] which evaluated 13 major dischargers using the water quality model JMSRV. VA Power's Chesterfield Power plant was not assigned a waste load allocation. As the RCWQMP is based on the JMSRV, the JMSRV has not been recalibrated since 1986, and Dr. Lung reran the 1990 baseline load to verify that it produced identical results to the original model, I feel that this current modeling approach is an acceptable method in characterizing the effects of the increased ammonia load from VA Power.

The thermal modeling effort was initiated to predict the temperatures that would have occurred in Farrar Gut and the James River during 1998 if the plant had been operating at full permit load conditions of 5.55 BTU/hr for Units 4,5, and 6 and 1.78 BTU/hr for Units 3, 7, and 8. My previous comments regarding the Thermal Modeling report primarily focused on the method of validation. I asked for explanation as to why HydroQual used a combined calibration and validation effort, instead of using the available 1997 and 1999 synoptic survey data to perform a separate validation. HydroQual added narrative in this final report outlining their decision.

In addition, HydroQual further explained the use of the temperature data at JR1 as background temperature. I accept their explanation.

Thank you for the opportunity to review.

Jennifer V. Palmore
Senior Water Quality Planner
Dept. of Environmental Quality - Piedmont Regional Office
4949-A Cox Road
Richmond, VA 23060
(804) 527-5058

Jenkins,Ray

From: Brockenbrough,Allan
Sent: Tuesday, January 20, 2004 11:26 AM
To: Jenkins,Ray
Cc: Palmore,Jennifer; Linderman,Curtis; Alling,Mark
Subject: *Dominion Power*

I have reviewed the reviewed the report entitled *Modeling Water Quality Impact of Dominion's Chesterfield Power Station* by Wu-Seng Lung dated November 25, 2003. The report was submitted to DEQ by letter from Dominion Power dated December 8, 2003.

Dr. Lung has used his pc version on the JMSRV model to predict the impacts of increased Ammonia-N loadings from Dominion Power's outfall 004 as a result of installing Selective Catalytic Reduction (SCR) emission control technology. Use of the SCR technology will significantly reduce NOx air emissions from the facility and increase Ammonia-N in the discharge by approximately 515 lbs/day (summer). Dr. Lung first modeled the 1990 wasteload allocation from the Richmond-Crater Water Quality Management Plan (or 208 Plan) as a baseline condition. He then modeled the baseline condition plus the additional Ammonia from the SCR control devices.

The graphs provided in Figure 4 of the report demonstrate a negligible impact on mainstem James River concentrations of Ammonia, NO_2 + NO_3, Chlorophyll a and Dissolved Oxygen. Although the increase in Ammonia levels in the mainstem of the river appears negligible, the conditions under which the water quality criteria was evaluated warrant a closer look. Figure 4 includes the maximum allowable Ammonia concentration (chronic water quality criteria) based on a pH of 7.8 and a summer temperature of 29.81°C. The pH and temperature are from the Technical Support Information for the 208 Plan. The HydroQual report *Thermal Modeling of the Chesterfield Power Station on the James River and Farrar Gut, Virginia (November 7, 2003)* submitted under the same Dominion Power letter of December 8, 2003 includes mainstem synoptic survey temperature values as high as 35.8°C (instantaneous) as well as continuously modeled temperature projections which appear to approach 33°C for 30-day periods during the summer. The HydroQual model demonstrates the effect of the power station operating under full load and 1998 environmental conditions. At a temperature of 33°C and a pH of 7.8, the acute Ammonia criteria falls to 0.97 mg/l which is still well above the peak instream concentration predicted by the JMSRV model for the hottest section of the river (station JR3 in the HydroQual report roughly correspond to river mile 87 in the JMSRV, JR6 is roughly river mile 82). The Lung report therefore is suitable for demonstrating that in the mainstem of the James River there is no significant increase in Ammonia-N concentrations, no Ammonia toxicity and no significant lowering of dissolved oxygen levels due to the addition of the SCR technology. The additional Ammonia load amounts to less than 2% of the total Ammonia allocations in the 208 Plan. For consistency sake, you may consider having the Lung report revised so that maximum allowable Ammonia concentration (the chronic water quality criteria) reflects the temperature conditions predicted by the HydroQual study.

Ammonia toxicity in the vicinity of the outfall should be further evaluated in the Fact Sheet in accordance with GM 00-2011. I have no additional comments on the HydroQual report.

Allan Brockenbrough, II, P.E.
VPDES Water Quality Modeling Coordinator
DEQ - Office of Water Permit Programs
Phone (804) 698-4147
Fax (804) 698-4032
abrockenb@deq.state.va.us

Attachment 5.j

Federal Effluent Guidelines for Steam Electric Power Generating Point Sources (40CFR 423)

ELECTRONIC CODE OF FEDERAL REGULATIONS

e-CFR data is current as of May 12, 2016

Title 40 → Chapter I → Subchapter N → Part 423

Title 40: Protection of Environment

PART 423—STEAM ELECTRIC POWER GENERATING POINT SOURCE CATEGORY

Contents

§423.10 Applicability.
§423.11 Specialized definitions.
§423.12 Effluent limitations guidelines representing the degree of effluent reduction attainable by the application of the best practicable control technology currently available (BPT).
§423.13 Effluent limitations guidelines representing the degree of effluent reduction attainable by the application of the best available technology economically achievable (BAT).
§423.14 Effluent limitations guidelines representing the degree of effluent reduction attainable by the application of the best conventional pollutant control technology (BCT). [Reserved]
§423.15 New source performance standards (NSPS).
§423.16 Pretreatment standards for existing sources (PSES).
§423.17 Pretreatment standards for new sources (PSNS).
Appendix A to Part 423—126 Priority Pollutants

AUTHORITY: Secs. 101; 301; 304(b), (c), (e), and (g); 306; 307; 308 and 501, Clean Water Act (Federal Water Pollution Control Act Amendments of 1972, as amended; 33 U.S.C. 1251; 1311; 1314(b), (c), (e), and (g); 1316; 1317; 1318 and 1361).

SOURCE: 47 FR 52304, Nov. 19, 1982, unless otherwise noted.

Back to Top

§423.10 Applicability.

The provisions of this part apply to discharges resulting from the operation of a generating unit by an establishment whose generation of electricity is the predominant source of revenue or principal reason for operation, and whose generation of electricity results primarily from a process utilizing fossil-type fuel (coal, oil, or gas), fuel derived from fossil fuel (*e.g.,* petroleum coke, synthesis gas), or nuclear fuel in conjunction with a thermal cycle employing the steam water system as the thermodynamic medium. This part applies to discharges associated with both the combustion turbine and steam turbine portions of a combined cycle generating unit.

[80 FR 67893, Nov. 3, 2015]

Back to Top

§423.11 Specialized definitions.

In addition to the definitions set forth in 40 CFR part 401, the following definitions apply to this part:

(a) The term *total residual chlorine* (or total residual oxidants for intake water with bromides) means the value obtained using any of the “chlorine—total residual” methods in Table IB in 40 CFR 136.3(a), or other methods approved by the permitting authority.

(b) The term *low volume waste sources* means, taken collectively as if from one source, wastewater from all sources except those for which specific limitations or standards are otherwise established in this part. Low volume waste sources include, but are not limited to, the following: Wastewaters from ion exchange water treatment systems, water treatment evaporator blowdown, laboratory and sampling streams, boiler blowdown, floor drains, cooling tower basin cleaning wastes, recirculating house service water systems, and wet scrubber air pollution control systems whose primary purpose is particulate removal. Sanitary wastes, air conditioning wastes, and wastewater from carbon capture or sequestration systems are not included in this definition.

(c) The term *chemical metal cleaning waste* means any wastewater resulting from the cleaning of any metal process equipment with chemical compounds, including, but not limited to, boiler tube cleaning.

(d) The term *metal cleaning waste* means any wastewater resulting from cleaning [with or without chemical cleaning compounds] any metal process equipment including, but not limited to, boiler tube cleaning, boiler fireside cleaning, and air preheater cleaning.

(e) The term *fly ash* means the ash that is carried out of the furnace by a gas stream and collected by a capture device such as a mechanical precipitator, electrostatic precipitator, or fabric filter. Economizer ash is included in this definition when it is collected with fly ash. Ash is not included in this definition when it is collected in wet scrubber air pollution control systems whose primary purpose is particulate removal.

(f) The term *bottom ash* means the ash, including boiler slag, which settles in the furnace or is dislodged from furnace walls. Economizer ash is included in this definition when it is collected with bottom ash.

(g) The term *once through cooling water* means water passed through the main cooling condensers in one or two passes for the purpose of removing waste heat.

(h) The term *recirculated cooling water* means water which is passed through the main condensers for the purpose of removing waste heat, passed through a cooling device for the purpose of removing such heat from the water and then passed again, except for blowdown, through the main condenser.

(i) The term *10 year, 24/hour rainfall event* means a rainfall event with a probable recurrence interval of once in ten years as defined by the National Weather Service in Technical Paper No. 40. *Rainfall Frequency Atlas of the United States,* May 1961 or equivalent regional rainfall probability information developed therefrom.

(j) The term *blowdown* means the minimum discharge of recirculating water for the purpose of discharging materials contained in the water, the further buildup of which would cause concentration in amounts exceeding limits established by best engineering practices.

(k) The term *average concentration* as it relates to chlorine discharge means the average of analyses made over a single period of chlorine release which does not exceed two hours.

(l) The term *free available chlorine* means the value obtained using any of the “chlorine—free available” methods in Table IB in 40 CFR 136.3(a) where the method has the capability of measuring free available chlorine, or other methods approved by the permitting authority.

(m) The term *coal pile runoff* means the rainfall runoff from or through any coal storage pile.

(n) The term flue gas desulfurization (FGD) wastewater means any wastewater generated specifically from the wet flue gas desulfurization scrubber system that comes into contact with the flue gas or the FGD solids, including but not limited to, the blowdown from the FGD scrubber system, overflow or underflow from the solids separation process, FGD solids wash water, and the filtrate from the solids dewatering process. Wastewater generated from cleaning the FGD scrubber, cleaning FGD solids separation equipment, cleaning FGD solids dewatering equipment, or that is collected in floor drains in the FGD process area is not considered FGD wastewater.

(o) The term flue gas mercury control wastewater means any wastewater generated from an air pollution control system installed or operated for the purpose of removing mercury from flue gas. This includes fly ash collection systems when the particulate control system follows sorbent injection or other controls to remove mercury from flue gas. FGD wastewater generated at plants using oxidizing agents to remove mercury in the FGD system and not in a separate FGMC system is not included in this definition.

(p) The term transport water means any wastewater that is used to convey fly ash, bottom ash, or economizer ash from the ash collection or storage equipment, or boiler, and has direct contact with the ash. Transport water does not include low volume, short duration discharges of wastewater from minor leaks (*e.g.,* leaks from valve packing, pipe flanges, or piping) or minor maintenance events (*e.g.,* replacement of valves or pipe sections).

(q) The term gasification wastewater means any wastewater generated at an integrated gasification combined cycle operation from the gasifier or the syngas cleaning, combustion, and cooling processes. Gasification wastewater includes, but is not limited to the following: Sour/grey water; CO_2/steam stripper wastewater; sulfur recovery unit blowdown, and wastewater resulting from slag handling or fly ash handling, particulate removal, halogen removal, or trace organic removal. Air separation unit blowdown, noncontact cooling water, and runoff from fuel and/or byproduct piles are not considered gasification wastewater. Wastewater that is collected intermittently in floor drains in the gasification process area from leaks, spills, and cleaning occurring during normal operation of the gasification operation is not considered gasification wastewater.

(r) The term combustion residual leachate means leachate from landfills or surface impoundments containing combustion residuals. Leachate is composed of liquid, including any suspended or dissolved constituents in the liquid, that has percolated through waste or other materials emplaced in a landfill, or that passes through the surface impoundment's containment structure (*e.g.,* bottom, dikes, berms). Combustion residual leachate includes seepage and/or leakage from a combustion residual landfill or impoundment unit. Combustion residual leachate includes wastewater from landfills and surface impoundments located on non-adjoining property when under the operational control of the permitted facility.

(s) The term oil-fired unit means a generating unit that uses oil as the primary or secondary fuel source and does not use a gasification process or any coal or petroleum coke as a fuel source. This definition does not include units that use oil only for start up or flame-stabilization purposes.

(t) The phrase “as soon as possible” means November 1, 2018, unless the permitting authority establishes a later date, after receiving information from the discharger, which reflects a consideration of the following factors:

(1) Time to expeditiously plan (including to raise capital), design, procure, and install equipment to comply with the requirements of this part.

(2) Changes being made or planned at the plant in response to:

(i) New source performance standards for greenhouse gases from new fossil fuel-fired electric generating units, under sections 111, 301, 302, and 307(d)(1)(C) of the Clean Air Act, as amended, 42 U.S.C. 7411, 7601, 7602, 7607(d)(1)(C);

(ii) Emission guidelines for greenhouse gases from existing fossil fuel-fired electric generating units, under sections 111, 301, 302, and 307(d) of the Clean Air Act, as amended, 42 U.S.C. 7411, 7601, 7602, 7607(d); or

(iii) Regulations that address the disposal of coal combustion residuals as solid waste, under sections 1006(b), 1008 (a), 2002(a), 3001, 4004, and 4005(a) of the Solid Waste Disposal Act of 1970, as amended by the Resource Conservation and Recovery Act of 1976, as amended by the Hazardous and Solid Waste Amendments of 1984, 42 U.S.C. 6906(b), 6907(a), 6912(a), 6944, and 6945(a).

(3) For FGD wastewater requirements only, an initial commissioning period for the treatment system to optimize the installed equipment.

(4) Other factors as appropriate.

[47 FR 52304, Nov. 19, 1982, as amended at 77 FR 29834, May 18, 2012; 80 FR 67893, Nov. 3, 2015]

Back to Top

§423.12 Effluent limitations guidelines representing the degree of effluent reduction attainable by the application of the best practicable control technology currently available (BPT).

(a) In establishing the limitations set forth in this section, EPA took into account all information it was able to collect, develop and solicit with respect to factors (such as age and size of plant, utilization of facilities, raw materials, manufacturing processes, non-water quality environmental impacts, control and treatment technology available, energy requirements and costs) which can affect the industry subcategorization and effluent levels established. It is, however, possible that data which would affect these limitations have not been available and, as a result, these limitations should be adjusted for certain plants in this industry. An individual discharger or other interested person may submit evidence to the Regional Administrator (or to the State, if the State has the authority to issue NPDES permits) that factors relating to the equipment or facilities involved, the process applied, or other such factors related to such discharger are fundamentally different from the factors considered in the establishment of the guidelines. On the basis of such evidence or other available information, the Regional Administrator (or the State) will make a written finding that such factors are or are not fundamentally different for that facility compared to those specified in the Development Document. If such fundamentally different factors are found to exist, the Regional Administrator or the State shall establish for the discharger effluent limitations in the NPDES Permit either more or less stringent than the limitations established herein, to the extent dictated by such fundamentally different factors. Such limitations must be approved by the Administrator of the Environmental Protection Agency. The Administrator may approve or disapprove such limitations, specify other limitations, or initiate proceedings to revise these regulations. The phrase “other such factors” appearing above may include significant cost differentials. In no event may a discharger's impact on receiving water quality be considered as a factor under this paragraph.

(b) Any existing point source subject to this subpart must achieve the following effluent limitations representing the degree of effluent reduction by the application of the best practicable control technology currently available (BPT):

(1) The pH of all discharges, except once through cooling water, shall be within the range of 6.0-9.0.

(2) There shall be no discharge of polychlorinated biphenyl compounds such as those commonly used for transformer fluid.

(3) The quantity of pollutants discharged from low volume waste sources shall not exceed the quantity determined by multiplying the flow of low volume waste sources times the concentration lised in the following table:

Pollutant or pollutant property	BPT effluent limitations	
	Maximum for any 1 day (mg/l)	Average of daily values for 30 consecutive days shall not exceed (mg/l)
TSS	100.0	30.0
Oil and grease	20.0	15.0

(4) The quantity of pollutants discharged in fly ash and bottom ash transport water shall not exceed the quantity determined by multiplying the flow of fly ash and bottom ash transport water times the concentration listed in the following table:

Pollutant or pollutant property	BPT effluent limitations	
	Maximum for any 1 day (mg/l)	Average of daily values for 30 consecutive days shall not exceed (mg/l)
TSS	100.0	30.0
Oil and grease	20.0	15.0

(5) The quantity of pollutants discharged in metal cleaning wastes shall not exceed the quantity determined by multiplying the flow of metal cleaning wastes times the concentration listed in the following table:

Pollutant or pollutant property	BPT effluent limitations	
	Maximum for any 1 day (mg/l)	Average of daily values for 30 consecutive days shall not exceed (mg/l)
TSS	100.0	30.0
Oil and grease	20.0	15.0
Copper, total	1.0	1.0
Iron, total	1.0	1.0

(6) The quantity of pollutants discharged in once through cooling water shall not exceed the quantity determined by multiplying the flow of once through cooling water sources times the concentation listed in the following table:

Pollutant or pollutant property	BPT effluent limitations	
	Maximum concentration (mg/l)	Average concentration (mg/l)
Free available chlorine	0.5	0.2

(7) The quantity of pollutants discharged in cooling tower blowdown shall not exceed the quantity determined by multiplying the flow of cooling tower blowdown sources times the concentration listed in the following table:

Pollutant or pollutant property	BPT effluent limitations	
	Maximum concentration (mg/l)	Average concentration (mg/l)
Free available chlorine	0.5	0.2

(8) Neither free available chlorine nor total residual chlorine may be discharged from any unit for more than two hours in any one day and not more than one unit in any plant may discharge free available or total residual chlorine at any one time unless the utility can demonstrate to the Regional Administrator or State, if the State has NPDES permit issuing authority, that the units in a particular location cannot operate at or below this level or chlorination.

(9) Subject to the provisions of paragraph (b)(10) of this section, the following effluent limitations shall apply to the point source discharges of coal pile runoff:

Pollutant or pollutant property	BPT effluent limitations
	Maximum concentration for any time (mg/l)
TSS	50

(10) Any untreated overflow from facilities designed, constructed, and operated to treat the volume of coal pile runoff which is associated with a 10 year, 24 hour rainfall event shall not be subject to the limitations in paragraph (b)(9) of this section.

(11) The quantity of pollutants discharged in FGD wastewater, flue gas mercury control wastewater, combustion residual leachate, or gasification wastewater shall not exceed the quantity determined by multiplying the flow of the applicable wastewater times the concentration listed in the following table:

Pollutant or pollutant property	BPT Effluent limitations	
		Average of daily values for 30

	Maximum for any 1 day (mg/l)	consecutive days shall not exceed (mg/l)
TSS	100.0	30.0
Oil and grease	20.0	15.0

(12) At the permitting authority's discretion, the quantity of pollutant allowed to be discharged may be expressed as a concentration limitation instead of the mass-based limitations specified in paragraphs (b)(3) through (b)(7), and (b)(11), of this section. Concentration limitations shall be those concentrations specified in this section.

(13) In the event that wastestreams from various sources are combined for treatment or discharge, the quantity of each pollutant or pollutant property controlled in paragraphs (b)(1) through (b)(12) of this section attributable to each controlled waste source shall not exceed the specified limitations for that waste source.

(The information collection requirements contained in paragraph (a) were approved by the Office of Management and Budget under control number 2000-0194)

[47 FR 52304, Nov. 19, 1982, as amended at 48 FR 31404, July 8, 1983; 80 FR 67894, Nov. 3, 2015]

Back to Top

§423.13 Effluent limitations guidelines representing the degree of effluent reduction attainable by the application of the best available technology economically achievable (BAT).

Except as provided in 40 CFR 125.30 through 125.32, any existing point source subject to this part must achieve the following effluent limitations representing the degree of effluent reduction attainable by the application of the best available technology economically achievable (BAT).

(a) There shall be no discharge of polychlorinated biphenyl compounds such as those commonly used for transformer fluid.

(b)(1) For any plant with a total rated electric generating capacity of 25 or more megawatts, the quantity of pollutants discharged in once through cooling water from each discharge point shall not exceed the quantity determined by multiplying the flow of once through cooling water from each discharge point times the concentration listed in the following table:

Pollutant or pollutant property	BAT Effluent Limitations Maximum concentration (mg/l)
Total residual chlorine	0.20

(2) Total residual chlorine may not be discharged from any single generating unit for more than two hours per day unless the discharger demonstrates to the permitting authority that discharge for more than two hours is required for macroinvertebrate control. Simultaneous multi-unit chlorination is permitted.

(c)(1) For any plant with a total rated generating capacity of less than 25 megawatts, the quantity of pollutants discharged in once through cooling water shall not exceed the quantity determined by multiplying the flow of once through cooling water sources times the concentration listed in the following table:

Pollutant or pollutant property	BAT effluent limitations	
	Maximum concentration (mg/l)	Average concentration (mg/l)
Free available chlorine	0.5	0.2

(2) Neither free available chlorine nor total residual chlorine may be discharged from any unit for more than two hours in any one day and not more than one unit in any plant may discharge free available or total residual chlorine at any one time unless the utility can demonstrate to the Regional Administrator or State, if the State has NPDES permit issuing authority, that the units in a particular location cannot operate at or below this level of chlorination.

(d)(1) The quantity of pollutants discharged in cooling tower blowdown shall not exceed the quantity determined by multiplying the flow of cooling tower blowdown times the concentration listed below:

Pollutant or pollutant property	BAT effluent limitations	
	Maximum concentration (mg/l)	Average concentration (mg/l)
Free available chlorine	0.5	0.2

Pollutant or pollutant property	Maximum for any 1 day −(mg/l)	Average of daily values for 30 consecutive days shall not exceed = (mg/l)
The 126 priority pollutants (Appendix A) contained in chemicals added for cooling tower maintenance, except:	([1])	([1])
Chromium, total	0.2	0.2

Zinc, total	1.0	1.0

[1]No detectable amount.

(2) Neither free available chlorine nor total residual chlorine may be discharged from any unit for more than two hours in any one day and not more than one unit in any plant may discharge free available or total residual chlorine at any one time unless the utility can demonstrate to the Regional Administrator or State, if the State has NPDES permit issuing authority, that the units in a particular location cannot operate at or below this level of chlorination.

(3) At the permitting authority's discretion, instead of the monitoring specified in 40 CFR 122.11(b) compliance with the limitations for the 126 priority pollutants in paragraph (d)(1) of this section may be determined by engineering calculations which demonstrate that the regulated pollutants are not detectable in the final discharge by the analytical methods in 40 CFR part 136.

(e) The quantity of pollutants discharged in chemical metal cleaning wastes shall not exceed the quantity determined by multiplying the flow of chemical metal cleaning wastes times the concentration listed in the following table:

Pollutant or pollutant property	BAT effluent limitations	
	Maximum for any 1 day (mg/l)	Average of daily values for 30 consecutive days shall not exceed −(mg/l)
Copper, total	1.0	1.0
Iron, total	1.0	1.0

(f) [Reserved—Nonchemical Metal Cleaning Wastes].

(g)(1)(i) *FGD wastewater.* Except for those discharges to which paragraph (g)(2) or (g)(3) of this section applies, the quantity of pollutants in FGD wastewater shall not exceed the quantity determined by multiplying the flow of FGD wastewater times the concentration listed in the table following this paragraph (g)(1)(i). Dischargers must meet the effluent limitations for FGD wastewater in this paragraph by a date determined by the permitting authority that is as soon as possible beginning November 1, 2018, but no later than December 31, 2023. These effluent limitations apply to the discharge of FGD wastewater generated on and after the date determined by the permitting authority for meeting the effluent limitations, as specified in this paragraph.

Pollutant or pollutant property	BAT Effluent limitations	
	Maximum for any 1 day	Average of daily values for 30 consecutive days shall not exceed
Arsenic, total (ug/L)	11	8
Mercury, total (ng/L)	788	356
Selenium, total (ug/L)	23	12
Nitrate/nitrite as N (mg/L)	17.0	4.4

(ii) For FGD wastewater generated before the date determined by the permitting authority, as specified in paragraph (g)(1)(i), the quantity of pollutants discharged in FGD wastewater shall not exceed the quantity determined by multiplying the flow of FGD wastewater times the concentration listed for TSS in §423.12(b)(11).

(2) For any electric generating unit with a total nameplate capacity of less than or equal to 50 megawatts or that is an oil-fired unit, the quantity of pollutants discharged in FGD wastewater shall not exceed the quantity determined by multiplying the flow of FGD wastewater times the concentration listed for TSS in §423.12(b)(11).

(3)(i) For dischargers who voluntarily choose to meet the effluent limitations for FGD wastewater in this paragraph, the quantity of pollutants in FGD wastewater shall not exceed the quantity determined by multiplying the flow of FGD wastewater times the concentration listed in the table following this paragraph (g)(3)(i). Dischargers who choose to meet the effluent limitations for FGD wastewater in this paragraph must meet such limitations by December 31, 2023. These effluent limitations apply to the discharge of FGD wastewater generated on and after December 31, 2023.

Pollutant or pollutant property	BAT Effluent limitations	
	Maximum for any 1 day	Average of daily values for 30 consecutive days shall not exceed
Arsenic, total (ug/L)	4	
Mercury, total (ng/L)	39	24
Selenium, total (ug/L)	5	
TDS (mg/L)	50	24

(ii) For discharges of FGD wastewater generated before December 31, 2023, the quantity of pollutants discharged in FGD wastewater shall not exceed the quantity determined by multiplying the flow of FGD wastewater times the concentration listed for TSS in §423.12(b)(11).

(h)(1)(i) *Fly ash transport water.* Except for those discharges to which paragraph (h)(2) of this section applies, or when the fly ash transport water is used in the FGD scrubber, there shall be no discharge of pollutants in fly ash transport water. Dischargers must meet the discharge limitation in this paragraph by a date determined by the permitting authority that is as soon as possible beginning November 1, 2018, but no later than December 31, 2023. This limitation applies to the discharge of fly ash transport water generated on and after the date determined by the permitting authority for meeting the discharge limitation, as specified in this paragraph. Whenever fly ash transport water is used in any other plant process or is sent to a treatment system at the plant (except when it is used in the FGD scrubber), the resulting effluent must comply with the discharge limitation in this paragraph. When the fly ash transport water is used in the FGD scrubber, the quantity of pollutants in fly ash transport water shall not exceed the quantity determined by multiplying the flow of fly ash transport water times the concentration listed in the table in paragraph (g)(1)(i) of this section.

(ii) For discharges of fly ash transport water generated before the date determined by the permitting authority, as specified in paragraph (h)(1)(i) of this section, the quantity of pollutants discharged in fly ash transport water shall not exceed the quantity determined by multiplying the flow of fly ash transport water times the concentration listed for TSS in §423.12(b)(4).

(2) For any electric generating unit with a total nameplate generating capacity of less than or equal to 50 megawatts or that is an oil-fired unit, the quantity of pollutants discharged in fly ash transport water shall not exceed the quantity determined by multiplying the flow of fly ash transport water times the concentration listed for TSS in §423.12(b)(4).

(i)(1)(i) *Flue gas mercury control wastewater.* Except for those discharges to which paragraph (i)(2) of this section applies, there shall be no discharge of pollutants in flue gas mercury control wastewater. Dischargers must meet the discharge limitation in this paragraph by a date determined by the permitting authority that is as soon as possible beginning November 1, 2018, but no later than December 31, 2023. This limitation applies to the discharge of flue gas mercury control wastewater generated on and after the date determined by the permitting authority for meeting the discharge limitation, as specified in this paragraph. Whenever flue gas mercury control wastewater is used in any other plant process or is sent to a treatment system at the plant, the resulting effluent must comply with the discharge limitation in this paragraph.

(ii) For discharges of flue gas mercury control wastewater generated before the date determined by the permitting authority, as specified in paragraph (i)(1)(i) of this section, the quantity of pollutants discharged in flue gas mercury control wastewater shall not exceed the quantity determined by multiplying the flow of flue gas mercury control wastewater times the concentration for TSS listed in §423.12(b)(11).

(2) For any electric generating unit with a total nameplate generating capacity of less than or equal to 50 megawatts or that is an oil-fired unit, the quantity of pollutants discharged in flue gas mercury control wastewater shall not exceed the quantity determined by multiplying the flow of flue gas mercury control wastewater times the concentration for TSS listed in §423.12(b)(11).

(j)(1)(i) *Gasification wastewater.* Except for those discharges to which paragraph (j)(2) of this section applies, the quantity of pollutants in gasification wastewater shall not exceed the quantity determined by multiplying the flow of gasification wastewater times the concentration listed in the table following this paragraph (j)(1)(i). Dischargers must meet the effluent limitations in this paragraph by a date determined by the permitting authority that is as soon as possible beginning November 1, 2018, but no later than December 31, 2023. These effluent limitations apply to the discharge of gasification wastewater generated on and after the date determined by the permitting authority for meeting the effluent limitations, as specified in this paragraph.

Pollutant or pollutant property	BAT Effluent limitations	
	Maximum for any 1 day	Average of daily values for 30 consecutive days shall not exceed
Arsenic, total (ug/L)	4	
Mercury, total (ng/L)	1.8	1.3
Selenium, total (ug/L)	453	227
Total dissolved solids (mg/L)	38	22

(ii) For discharges of gasification wastewater generated before the date determined by the permitting authority, as specified in paragraph (j)(1)(i) of this section, the quantity of pollutants discharged in gasification wastewater shall not exceed the quantity determined by multiplying the flow of gasification wastewater times the concentration for TSS listed in §423.12(b)(11).

(2) For any electric generating unit with a total nameplate generating capacity of less than or equal to 50 megawatts or that is an oil-fired unit, the quantity of pollutants discharged in gasification wastewater shall not exceed the quantity determined by multiplying the flow of gasification wastewater times the concentration listed for TSS in §423.12(b)(11).

(k)(1)(i) *Bottom ash transport water.* Except for those discharges to which paragraph (k)(2) of this section applies, or when the bottom ash transport water is used in the FGD scrubber, there shall be no discharge of pollutants in bottom ash transport water. Dischargers must meet the discharge limitation in this paragraph by a date determined by the permitting authority that is as soon as possible beginning November 1, 2018, but no later than December 31, 2023. This limitation applies to the discharge of bottom ash transport water generated on and after the date determined by the permitting authority for meeting the discharge limitation, as specified in this paragraph. Whenever bottom ash transport water is used in any other plant process or is sent to a treatment system at the plant (except when it is used in the FGD scrubber), the resulting effluent must comply with the discharge limitation in this paragraph. When the bottom ash transport water is used in the FGD scrubber, the quantity of pollutants in bottom ash transport water shall not exceed the quantity determined by multiplying the flow of bottom ash transport water times the concentration listed in the table in paragraph (g)(1)(i) of this section.

(ii) For discharges of bottom ash transport water generated before the date determined by the permitting authority, as specified in paragraph (k)(1)(i) of this section, the quantity of pollutants discharged in bottom ash transport water shall not exceed the quantity determined by multiplying the flow of bottom ash transport water times the concentration for TSS listed in §423.12(b)(4).

(2) For any electric generating unit with a total nameplate generating capacity of less than or equal to 50 megawatts or that is an oil-fired unit, the quantity of pollutants discharged in bottom ash transport water shall not exceed the quantity determined by multiplying the flow of the applicable wastewater times the concentration for TSS listed in §423.12(b)(4).

(l) *Combustion residual leachate.* The quantity of pollutants discharged in combustion residual leachate shall not exceed the quantity determined by multiplying the flow of combustion residual leachate times the concentration for TSS listed in §423.12(b)(11).

(m) At the permitting authority's discretion, the quantity of pollutant allowed to be discharged may be expressed as a concentration limitation instead of any mass based limitations specified in paragraphs (b) through (l) of this section. Concentration limitations shall be those concentrations specified in this section.

(n) In the event that wastestreams from various sources are combined for treatment or discharge, the quantity of each pollutant or pollutant property controlled in paragraphs (a) through (m) of this section attributable to each controlled waste source shall not exceed the specified limitation for that waste source.

(The information collection requirements contained in paragraphs (c)(2) and (d)(2) were approved by the Office of Management and Budget under control number 2040-0040. The information collection requirements contained in paragraph (d)(3) were approved under control number 2040-0033)

[47 FR 52304, Nov. 19, 1982, as amended at 48 FR 31404, July 8, 1983; 80 FR 67894, Nov. 3, 2015]

Back to Top

§423.14 Effluent limitations guidelines representing the degree of effluent reduction attainable by the application of the best conventional pollutant control technology (BCT). [Reserved]

Back to Top

§423.15 New source performance standards (NSPS).

(a) *1982 NSPS.* Any new source as of November 19, 1982, subject to paragraph (a) of this section, must achieve the following new source performance standards, in addition to the limitations in §423.13 of this part, established on November 3, 2015. In the case of conflict, the more stringent requirements apply:

(1) *pH.* The pH of all discharges, except once through cooling water, shall be within the range of 6.0-9.0.

(2) *PCBs.* There shall be no discharge of polychlorinated biphenyl compounds such as those commonly used for transformer fluid.

(3) *Low volume waste sources, FGD wastewater, flue gas mercury control wastewater, combustion residual leachate, and gasification wastewater.* The quantity of pollutants discharged in low volume waste sources, FGD wastewater, flue gas mercury control wastewater, combustion residual leachate, and gasification wastewater shall not exceed the quantity determined by multiplying the flow of low volume waste sources times the concentration listed in the following table:

Pollutant or pollutant property	NSPS	
	Maximum for any 1 day (mg/l)	

		Average of daily values for 30 consecutive days shall not exceed (mg/l)
TSS	100.0	30.0
Oil and grease	20.0	15.0

(4) *Chemical metal cleaning wastes.* The quantity of pollutants discharged in chemical metal cleaning wastes shall not exceed the quantity determined by multiplying the flow of chemical metal cleaning wastes times the concentration listed in the following table:

Pollutant or pollutant property	NSPS	
	Maximum for any 1 day (mg/l)	Average of daily values for 30 consecutive days shall not exceed (mg/l)
TSS	100.0	30.0
Oil and grease	20.0	15.0
Copper, total	1.0	1.0
Iron, total	1.0	1.0

(5) [Reserved]

(6) *Bottom ash transport water.* The quantity of pollutants discharged in bottom ash transport water shall not exceed the quantity determined by multiplying the flow of the bottom ash transport water times the concentration listed in the following table:

Pollutant or pollutant property	NSPS	
	Maximum for any 1 day (mg/l)	Average of daily values for 30 consecutive days shall not exceed (mg/l)
TSS	100.0	30.0
Oil and grease	20.0	15.0

(7) *Fly ash transport water.* There shall be no discharge of pollutants in fly ash transport water.

(8)(i) *Once through cooling water.* For any plant with a total rated electric generating capacity of 25 or more megawatts, the quantity of pollutants discharged in once through cooling water from each discharge point shall not exceed the quantity determined by multiplying the flow of once through cooling water from each discharge point times the concentration listed in the following table:

Pollutant or pollutant property	NSPS
	Maximum concentrations (mg/l)
Total residual chlorine	0.20

(ii) Total residual chlorine may only be discharged from any single generating unit for more than two hours per day when the discharger demonstrates to the permitting authority that discharge for more than two hours is required for macroinvertebrate control. Simultaneous multi-unit chlorination is permitted.

(9)(i) *Once through cooling water.* For any plant with a total rated generating capacity of less than 25 megawatts, the quantity of pollutants discharged in once through cooling water shall not exceed the quantity determined by multiplying the flow of once through cooling water sources times the concentration listed in the following table:

Pollutant or pollutant property	NSPS	
	Maximum concentration (mg/l)	Average concentration (mg/l)
Free available chlorine	0.5	0.2

(ii) Neither free available chlorine nor total residual chlorine may be discharged from any unit for more than two hours in any one day and not more than one unit in any plant may discharge free available or total residual chlorine at any one time unless the utility can demonstrate to the Regional Administrator or state, if the state has NPDES permit issuing authority, that the units in a particular location cannot operate at or below this level of chlorination.

(10)(i) *Cooling tower blowdown.* The quantity of pollutants discharged in cooling tower blowdown shall not exceed the quantity determined by multiplying the flow of cooling tower blowdown times the concentration listed below:

Pollutant or pollutant property	NSPS	
	Maximum concentration (mg/l)	Average concentration (mg/l)
Free available chlorine	0.5	0.2

Pollutant or pollutant property	NSPS	
	Maximum for any 1 day (mg/l)	Average of daily values for 30 consecutive days shall not exceed (mg/l)
The 126 priority pollutants (appendix A) contained in chemicals added for cooling tower maintenance, except:	([1])	([1])
Chromium, total	0.2	0.2
zinc, total	1.0	1.0

[1]No detectable amount.

(ii) Neither free available chlorine nor total residual chlorine may be discharged from any unit for more than two hours in any one day and not more than one unit in any plant may discharge free available or total residual chlorine at any one time unless the utility can demonstrate to the Regional Administrator or state, if the state has NPDES permit issuing authority, that the units in a particular location cannot operate at or below this level of chlorination.

(iii) At the permitting authority's discretion, instead of the monitoring in 40 CFR 122.11(b), compliance with the standards for the 126 priority pollutants in paragraph (a)(10)(i) of this section may be determined by engineering calculations which demonstrate that the regulated pollutants are not detectable in the final discharge by the analytical methods in 40 CFR part 136.

(11) *Coal pile runoff.* Subject to the provisions of paragraph (a)(12) of this section, the quantity or quality of pollutants or pollutant parameters discharged in coal pile runoff shall not exceed the standards specified below:

Pollutant or pollutant property	NSPS for any time
TSS	not to exceed 50 mg/l.

(12) *Coal pile runoff.* Any untreated overflow from facilities designed, constructed, and operated to treat the coal pile runoff which results from a 10 year, 24 hour rainfall event shall not be subject to the standards in paragraph (a)(11) of this section.

(13) At the permitting authority's discretion, the quantity of pollutant allowed to be discharged may be expressed as a concentration limitation instead of any mass based limitations specified in paragraphs (a)(3) through (10) of this section. Concentration limits shall be based on the concentrations specified in this section.

(14) In the event that wastestreams from various sources are combined for treatment or discharge, the quantity of each pollutant or pollutant property controlled in paragraphs (a)(1) through (13) of this section attributable to each controlled waste source shall not exceed the specified limitation for that waste source.

(b) *2015 NSPS.* Any new source as of November 17, 2015, subject to paragraph (b) of this section, must achieve the following new source performance standards:

(1) *pH.* The pH of all discharges, except once through cooling water, shall be within the range of 6.0-9.0.

(2) *PCBs.* There shall be no discharge of polychlorinated biphenyl compounds such as those commonly used for transformer fluid.

(3) *Low volume waste sources.* The quantity of pollutants discharged from low volume waste sources shall not exceed the quantity determined by multiplying the flow of low volume waste sources times the concentration listed in the following table:

Pollutant or pollutant property	NSPS	
	Maximum for any 1 day (mg/l)	Average of daily values for 30 consecutive days shall not exceed (mg/l)
TSS	100.0	30.0
Oil and grease	20.0	15.0

(4) *Chemical metal cleaning wastes.* The quantity of pollutants discharged in chemical metal cleaning wastes shall not exceed the quantity determined by multiplying the flow of chemical metal cleaning wastes times the concentration listed in the following table:

Pollutant or pollutant property	NSPS	
	Maximum for any 1 day (mg/l)	Average of daily values for 30 consecutive days shall not exceed (mg/l)
TSS	100.0	30.0
Oil and grease	20.0	15.0
Copper, total	1.0	1.0
Iron, total	1.0	1.0

(5) [Reserved]

(6) *Bottom ash transport water.* There shall be no discharge of pollutants in bottom ash transport water. Whenever bottom ash transport water is used in any other plant process or is sent to a treatment system at the plant, the resulting effluent must comply with the discharge standard in this paragraph.

(7) *Fly ash transport water.* There shall be no discharge of pollutants in fly ash transport water. Whenever fly ash transport water is used in any other plant process or is sent to a treatment system at the plant, the resulting effluent must comply with the discharge standard in this paragraph.

(8)(i) *Once through cooling water.* For any plant with a total rated electric generating capacity of 25 or more megawatts, the quantity of pollutants discharged in once through cooling water from each discharge point shall not exceed the quantity determined by multiplying the flow of once through cooling water from each discharge point times the concentration listed in the following table:

Pollutant or pollutant property	NSPS
	Maximum concentration (mg/l)
Total residual chlorine	0.20

(ii) Total residual chlorine may only be discharged from any single generating unit for more than two hours per day when the discharger demonstrates to the permitting authority that discharge for more than two hours is required for macroinvertebrate control. Simultaneous multi-unit chlorination is permitted.

(9)(i) *Once through cooling water.* For any plant with a total rated generating capacity of less than 25 megawatts, the quantity of pollutants discharged in once through cooling water shall not exceed the quantity determined by multiplying the flow of once through cooling water sources times the concentration listed in the following table:

Pollutant or pollutant property	NSPS	
	Maximum concentration (mg/l)	Average concentration (mg/l)
Free available chlorine	0.5	0.2

(ii) Neither free available chlorine nor total residual chlorine may be discharged from any unit for more than two hours in any one day and not more than one unit in any plant may discharge free available or total residual chlorine at any one time unless the utility can demonstrate to the Regional Administrator or state, if the state has NPDES permit issuing authority, that the units in a particular location cannot operate at or below this level of chlorination.

(10)(i) *Cooling tower blowdown.* The quantity of pollutants discharged in cooling tower blowdown shall not exceed the quantity determined by multiplying the flow of cooling tower blowdown times the concentration listed below:

Pollutant or pollutant property	NSPS	
	Maximum concentration (mg/l)	Average concentration (mg/l)
Free available chlorine	0.5	0.2

Pollutant or pollutant property	NSPS	
	Maximum for any 1 day (mg/l)	Average of daily values for 30 consecutive days shall not exceed (mg/l)
The 126 priority pollutants (appendix A) contained in chemicals added for cooling tower maintenance, except:	([1])	([1])
Chromium, total	0.2	0.2
zinc, total	1.0	1.0

[1]No detectable amount.

(ii) Neither free available chlorine nor total residual chlorine may be discharged from any unit for more than two hours in any one day and not more than one unit in any plant may discharge free available or total residual chlorine at any one time unless the utility can demonstrate to the Regional Administrator or state, if the state has NPDES permit issuing authority, that the units in a particular location cannot operate at or below this level of chlorination.

(iii) At the permitting authority's discretion, instead of the monitoring in 40 CFR 122.11(b), compliance with the standards for the 126 priority pollutants in paragraph (b)(10)(i) of this section may be determined by engineering calculations demonstrating that the regulated pollutants are not detectable in the final discharge by the analytical methods in 40 CFR part 136.

(11) *Coal pile runoff.* Subject to the provisions of paragraph (b)(12) of this section, the quantity or quality of pollutants or pollutant parameters discharged in coal pile runoff shall not exceed the standards specified below:

Pollutant or pollutant property	NSPS for any time
TSS	not to exceed 50 mg/l.

(12) *Coal pile runoff.* Any untreated overflow from facilities designed, constructed, and operated to treat the coal pile runoff which results from a 10 year, 24 hour rainfall event shall not be subject to the standards in paragraph (b)(11) of this section.

(13) *FGD wastewater.* The quantity of pollutants discharged in FGD wastewater shall not exceed the quantity determined by multiplying the flow of FGD wastewater times the concentration listed in the following table:

Pollutant or pollutant property	NSPS	
	Maximum for any 1 day	Average of daily values for 30 consecutive days shall not exceed
Arsenic, total (ug/L)	4	
Mercury, total (ng/L)	39	24
Selenium, total (ug/L)	5	
TDS (mg/L)	50	24

(14) *Flue gas mercury control wastewater.* There shall be no discharge of pollutants in flue gas mercury control wastewater. Whenever flue gas mercury control wastewater is used in any other plant process or is sent to a treatment system at the plant, the resulting effluent must comply with the discharge standard in this paragraph.

(15) *Gasification wastewater.* The quantity of pollutants discharged in gasification wastewater shall not exceed the quantity determined by multiplying the flow of gasification wastewater times the concentration listed in the following table:

Pollutant or pollutant property	NSPS	
	Maximum for any 1 day	Average of daily values for 30 consecutive days shall not exceed
Arsenic, total (ug/L)	4	
Mercury, total (ng/L)	1.8	1.3
Selenium, total (ug/L)	453	227
Total dissolved solids (mg/L)	38	22

(16) *Combustion residual leachate.* The quantity of pollutants discharged in combustion residual leachate shall not exceed the quantity determined by multiplying the flow of combustion residual leachate times the concentration listed in the following table:

Pollutant or pollutant property	NSPS	
	Maximum for any 1 day	Average of daily values for 30 consecutive days shall not exceed
Arsenic, total (ug/L)	11	8
Mercury, total (ng/L)	788	356

(17) At the permitting authority's discretion, the quantity of pollutant allowed to be discharged may be expressed as a concentration limitation instead of any mass based limitations specified in paragraphs (b)(3) through (16) of this section. Concentration limits shall be based on the concentrations specified in this section.

(18) In the event that wastestreams from various sources are combined for treatment or discharge, the quantity of each pollutant or pollutant property controlled in paragraphs (b)(1) through (16) of this section attributable to each controlled waste source shall not exceed the specified limitation for that waste source.

(The information collection requirements contained in paragraphs (a)(8)(ii), (a)(9)(ii), and (a)(10)(ii), (b)(8)(ii), (b)(9)(ii), and (b)(10)(ii) were approved by the Office of Management and Budget under control number 2040-0040. The information collection requirements contained in paragraphs (a)(10)(iii) and (b)(10)(iii) were approved under control number 2040-0033.)

[80 FR 67896, Nov. 3, 2015]

Back to Top

§423.16 Pretreatment standards for existing sources (PSES).

Except as provided in 40 CFR 403.7 and 403.13, any existing source subject to this subpart which introduces pollutants into a publicly owned treatment works must comply with 40 CFR part 403 and achieve the following pretreatment standards for existing sources (PSES) by July 1, 1984:

(a) There shall be no discharge of polychlorinated biphenol compounds such as those used for transformer fluid.

(b) The pollutants discharged in chemical metal cleaning wastes shall not exceed the concentration listed in the following table:

Pollutant or pollutant property	PSES pretreatment standards Maximum for 1 day (mg/l)
Copper, total	1.0

(c) [Reserved—Nonchemical Metal Cleaning Wastes].

(d)(1) The pollutants discharged in cooling tower blowdown shall not exceed the concentration listed in the following table:

Pollutant or pollutant property	PSES pretreatment standards Maximum for any time (mg/l)
The 126 priority pollutants (Appendix A) contained in chemicals added for cooling tower maintenance, except:	([1])
Chromium, total	0.2
Zinc, total	1.0

[1]No detectable amount.

(2) At the permitting authority's discretion, instead of the monitoring in 40 CFR 122.11(b), compliance with the limitations for the 126 priority pollutants in paragraph (d)(1) of this section may be determined by engineering calculations which demonstrate that the regulated pollutants are not detectable in the final discharge by the analytical methods in 40 CFR part 136.

(e) *FGD wastewater.* For any electric generating unit with a total nameplate generating capacity of more than 50 megawatts and that is not an oil-fired unit, the quantity of pollutants in FGD wastewater shall not exceed the quantity determined by multiplying the flow of FGD wastewater times the concentration listed in the table following this paragraph (e). Dischargers must meet the standards in this paragraph by November 1, 2018. These standards apply to the discharge of FGD wastewater generated on and after November 1, 2018.

Pollutant or pollutant property	PSES	
	Maximum for any 1 day	Average of daily values for 30 consecutive days shall not exceed
Arsenic, total (ug/L)	11	8
Mercury, total (ng/L)	788	356
Selenium, total (ug/L)	23	12
Nitrate/nitrite as N (mg/L)	17.0	4.4

(f) *Fly ash transport water.* Except when the fly ash transport water is used in the FGD scrubber, for any electric generating unit with a total nameplate generating capacity of more than 50 megawatts and that is not an oil-fired unit, there shall be no discharge of pollutants in fly ash transport water. This standard applies to the discharge of fly ash transport water generated on and after November 1, 2018. Whenever fly ash transport water is used in any other plant process or is sent to a treatment system at the plant (except when it is used in the FGD scrubber), the resulting effluent must comply with the discharge standard in this paragraph. When the fly ash transport water is used in the FGD scrubber, the quantity of pollutants in fly ash transport water shall not exceed the quantity determined by multiplying the flow of fly ash transport water times the concentration listed in the table in paragraph (e) of this section.

(g) *Bottom ash transport water.* Except when the bottom ash transport water is used in the FGD scrubber, for any electric generating unit with a total nameplate generating capacity of more than 50 megawatts and that is not an oil-fired unit, there shall be no discharge of pollutants in bottom ash transport water. This standard applies to the discharge of bottom ash transport water generated on and after November 1, 2018. Whenever bottom ash transport water is used in any other plant process or is sent to a treatment system at the plant (except when it is used in the FGD scrubber), the resulting effluent must comply with the discharge standard in this paragraph. When the bottom ash transport water is used in the FGD scrubber, the quantity of pollutants in bottom ash transport water shall not exceed the quantity determined by multiplying the flow of bottom ash transport water times the concentration listed in the table in paragraph (e) of this section.

(h) *Flue gas mercury control wastewater.* For any electric generating unit with a total nameplate generating capacity of more than 50 megawatts and that is not an oil-fired unit, there shall be no discharge of pollutants in flue gas mercury control wastewater. This standard applies to the discharge of flue gas mercury control wastewater generated on and after November 1, 2018. Whenever flue gas mercury control wastewater is used in any other plant process or is sent to a treatment system at the plant, the resulting effluent must comply with the discharge standard in this paragraph.

(i) *Gasification wastewater.* For any electric generating unit with a total nameplate generating capacity of more than 50 megawatts and that is not an oil-fired unit, the quantity of pollutants in gasification wastewater shall not exceed the quantity determined by multiplying the flow of gasification wastewater times the concentration listed in the table following this paragraph (i). Dischargers must meet the standards in this paragraph by November 1, 2018. These standards apply to the discharge of gasification wastewater generated on and after November 1, 2018.

Pollutant or pollutant property	PSES	
	Maximum for any 1 day	Average of daily values for 30 consecutive days shall not exceed
Arsenic, total (µg/L)	4	
Mercury, total (ng/L)	1.8	1.3
Selenium, total (µg/L)	453	227
Total dissolved solids (mg/L)	38	22

[47 FR 52304, Nov. 19, 1982, as amended at 80 FR 67901, Nov. 3, 2015]

Back to Top

§423.17 Pretreatment standards for new sources (PSNS).

(a) *1982 PSNS.* Except as provided in 40 CFR 403.7, any new source as of October 14, 1980, subject to paragraph (a) of this section, which introduces pollutants into a publicly owned treatment works, must comply with 40 CFR part 403, the following pretreatment standards for new sources, and the PSES in §423.16, established on November 3, 2015. In the case of conflict, the more stringent standards apply:

(1) *PCBs.* There shall be no discharge of polychlorinated biphenyl compounds such as those used for transformer fluid.

(2) *Chemical metal cleaning wastes.* The pollutants discharged in chemical metal cleaning wastes shall not exceed the concentration listed in the following table:

Pollutant or pollutant property	PSNS
	Maximum for any 1 day (mg/L)
Copper, total	1.0

(3) [Reserved]

(4)(i) *Cooling tower blowdown.* The pollutants discharged in cooling tower blowdown shall not exceed the concentration listed in the following table:

Pollutant or pollutant property	PSNS
	Maximum for any time (mg/L)
The 126 priority pollutants (appendix A) contained in chemicals added for cooling tower maintenance, except:	([1])
Chromium, total	0.2
zinc, total	1.0

[1]No detectable amount.

(ii) At the permitting authority's discretion, instead of the monitoring in 40 CFR 122.11(b), compliance with the standards for the 126 priority pollutants in paragraph (a)(4)(i) of this section may be determined by engineering calculations which demonstrate that the regulated pollutants are not detectable in the final discharge by the analytical methods in 40 CFR part 136.

(5) *Fly ash transport water.* There shall be no discharge of wastewater pollutants from fly ash transport water.

(b) *2015 PSNS.* Except as provided in 40 CFR 403.7, any new source as of June 7, 2013, subject to this paragraph (b), which introduces pollutants into a publicly owned treatment works must comply with 40 CFR part 403 and the following pretreatment standards for new sources:

(1) *PCBs.* There shall be no discharge of polychlorinated biphenyl compounds such as those used for transformer fluid.

(2) *Chemical metal cleaning wastes.* The pollutants discharged in chemical metal cleaning wastes shall not exceed the concentration listed in the following table:

Pollutant or pollutant property	PSNS Maximum for 1 day (mg/L)
Copper, total	1.0

(3) [Reserved]

(4)(i) *Cooling tower blowdown.* The pollutants discharged in cooling tower blowdown shall not exceed the concentration listed in the following table:

Pollutant or pollutant property	PSNS Maximum for any time (mg/L)
The 126 priority pollutants (appendix A) contained in chemicals added for cooling tower maintenance, except:	([1])
Chromium, total	0.2
zinc, total	1.0

[1]No detectable amount.

(ii) At the permitting authority's discretion, instead of the monitoring in 40 CFR 122.11(b), compliance with the standards for the 126 priority pollutants in paragraph (b)(4)(i) of this section may be determined by engineering calculations which demonstrate that the regulated pollutants are not detectable in the final discharge by the analytical methods in 40 CFR part 136.

(5) *Fly ash transport* water. There shall be no discharge of pollutants in fly ash transport water. Whenever fly ash transport water is used in any other plant process or is sent to a treatment system at the plant, the resulting effluent must comply with the discharge standard in this paragraph.

(6) *FGD wastewater.* The quantity of pollutants discharged in FGD wastewater shall not exceed the quantity determined by multiplying the flow of FGD wastewater times the concentration listed in the following table:

Pollutant or pollutant property	PSNS	
	Maximum for any 1 day	Average of daily values for 30 consecutive days shall not exceed
Arsenic, total (μg/L)	4	
Mercury, total (ng/L)	39	24
Selenium, total (μg/L)	5	
TDS (mg/L)	50	24

(7) *Flue gas mercury control wastewater.* There shall be no discharge of pollutants in flue gas mercury control wastewater. Whenever flue gas mercury control wastewater is used in any other plant process or is sent to a treatment system at the plant, the resulting effluent must comply with the discharge standard in this paragraph.

(8) *Bottom ash transport water.* There shall be no discharge of pollutants in bottom ash transport water. Whenever bottom ash transport water is used in any other plant process or is sent to a treatment system at the plant, the resulting effluent must comply with the discharge standard in this paragraph.

(9) *Gasification wastewater.* The quantity of pollutants discharged in gasification wastewater shall not exceed the quantity determined by multiplying the flow of gasification wastewater times the concentration listed in the following table:

Pollutant or pollutant property	PSNS	
	Maximum for any 1 day	Average of daily values for 30 consecutive days shall not exceed
Arsenic, total (µg/L)	4	
Mercury, total (ng/L)	1.8	1.3
Selenium, total (µg/L)	453	227
Total dissolved solids (mg/L)	38	22

(10) *Combustion residual leachate.* The quantity of pollutants discharged in combustion residual leachate shall not exceed the quantity determined by multiplying the flow of combustion residual leachate times the concentration listed in the following table:

Pollutant or pollutant property	PSNS	
	Maximum for any 1 day	Average of daily values for 30 consecutive days shall not exceed
Arsenic, total (µg/L)	11	8
Mercury, total (ng/L)	788	356

[80 FR 67902, Nov. 3, 2015]

Back to Top

Appendix A to Part 423—126 Priority Pollutants

001 Acenaphthene

002 Acrolein

003 Acrylonitrile

004 Benzene

005 Benzidine

006 Carbon tetrachloride (tetrachloromethane)

007 Chlorobenzene

008 1,2,4-trichlorobenzene

009 Hexachlorobenzene

010 1,2-dichloroethane

011 1,1,1-trichloreothane

012 Hexachloroethane

013 1,1-dichloroethane

014 1,1,2-trichloroethane

015 1,1,2,2-tetrachloroethane

016 Chloroethane

018 Bis(2-chloroethyl) ether

019 2-chloroethyl vinyl ether (mixed)

020 2-chloronaphthalene

021 2,4, 6-trichlorophenol

022 Parachlorometa cresol

023 Chloroform (trichloromethane)

024 2-chlorophenol

025 1,2-dichlorobenzene

026 1,3-dichlorobenzene

027 1,4-dichlorobenzene

028 3,3-dichlorobenzidine

029 1,1-dichloroethylene

030 1,2-trans-dichloroethylene

031 2,4-dichlorophenol

032 1,2-dichloropropane

033 1,2-dichloropropylene (1,3-dichloropropene)

034 2,4-dimethylphenol

035 2,4-dinitrotoluene

036 2,6-dinitrotoluene

037 1,2-diphenylhydrazine

038 Ethylbenzene

039 Fluoranthene

040 4-chlorophenyl phenyl ether

041 4-bromophenyl phenyl ether

042 Bis(2-chloroisopropyl) ether

043 Bis(2-chloroethoxy) methane

044 Methylene chloride (dichloromethane)

045 Methyl chloride (dichloromethane)

046 Methyl bromide (bromomethane)

047 Bromoform (tribromomethane)

048 Dichlorobromomethane

051 Chlorodibromomethane

052 Hexachlorobutadiene

053 Hexachloromyclopentadiene

054 Isophorone

055 Naphthalene

056 Nitrobenzene

057 2-nitrophenol

058 4-nitrophenol

059 2,4-dinitrophenol

060 4,6-dinitro-o-cresol

061 N-nitrosodimethylamine

062 N-nitrosodiphenylamine

063 N-nitrosodi-n-propylamin

064 Pentachlorophenol

065 Phenol

066 Bis(2-ethylhexyl) phthalate

067 Butyl benzyl phthalate

068 Di-N-Butyl Phthalate

069 Di-n-octyl phthalate

070 Diethyl Phthalate

071 Dimethyl phthalate

072 1,2-benzanthracene (benzo(a) anthracene

073 Benzo(a)pyrene (3,4-benzo-pyrene)

074 3,4-Benzofluoranthene (benzo(b) fluoranthene)

075 11,12-benzofluoranthene (benzo(b) fluoranthene)

076 Chrysene

077 Acenaphthylene

078 Anthracene

079 1,12-benzoperylene (benzo(ghi) perylene)

080 Fluorene

081 Phenanthrene

082 1,2,5,6-dibenzanthracene (dibenzo(,h) anthracene)

083 Indeno (,1,2,3-cd) pyrene (2,3-o-pheynylene pyrene)

084 Pyrene

085 Tetrachloroethylene

086 Toluene

087 Trichloroethylene

088 Vinyl chloride (chloroethylene)

089 Aldrin

090 Dieldrin

091 Chlordane (technical mixture and metabolites)

092 4,4-DDT

093 4,4-DDE (p,p-DDX)

094 4,4-DDD (p,p-TDE)

095 Alpha-endosulfan

096 Beta-endosulfan

097 Endosulfan sulfate

098 Endrin

099 Endrin aldehyde

100 Heptachlor

101 Heptachlor epoxide (BHC-hexachlorocyclohexane)

102 Alpha-BHC

103 Beta-BHC

104 Gamma-BHC (lindane)

105 Delta-BHC (PCB-polychlorinated biphenyls)

106 PCB-1242 (Arochlor 1242)

107 PCB-1254 (Arochlor 1254)

108 PCB-1221 (Arochlor 1221)

109 PCB-1232 (Arochlor 1232)

110 PCB-1248 (Arochlor 1248)

111 PCB-1260 (Arochlor 1260)

112 PCB-1016 (Arochlor 1016)

113 Toxaphene

114 Antimony

115 Arsenic

116 Asbestos

117 Beryllium

118 Cadmium

119 Chromium

120 Copper

121 Cyanide, Total

122 Lead

123 Mercury

124 Nickel

125 Selenium

126 Silver

127 Thallium

126 Silver

128 Zinc

129 2,3,7,8-tetrachloro-dibenzo-p-dioxin (TCDD)

Back to Top

Need assistance?

Attachment 5.k

Outfalls 302 and 402 - FGD WWTP

Proposed Date for Applicability of ELG Limits, Proposed 24-hour Composite Sampling Approach

Attachment 4

Dominion Chesterfield Power Station
Proposed Date for Applicability of FGD Wastewater ELG Limits

In response to 40 CFR 423.13, Final Effluent Limitations Guidelines and Standards for the Steam Electric Generating Industry (ELG Rule), Dominion is providing information for consideration in establishing an applicability date by which the Chesterfield Power Station will be required to meet the limits for pollutants in the flue gas desulfurization (FGD) waste stream. The ELG Rule establishes Best Available Technology (BAT) limits for FGD wastewater with an applicability date "as soon as possible beginning November 1, 2018, but no later than December 31, 2023". The ELG Rule recognizes that a facility's ability to comply with the limits can be affected by a number of factors and, therefore, establishes criteria for a permitting authority to establish a date later than November 1, 2018 (40 CFR 423.11, definition of "as soon as possible").

Dominion has been evaluating potential compliance options since the rule's initial proposal in 2013. Attached is a preliminary schedule (Major Category Schedule) prepared by Arcadis, the engineering company that has been assisting Dominion with the preliminary technology evaluation, to develop, procure, install, and commission a treatment technology to meet the new ELG wastewater limits for the FGD discharge. We request an applicability date for the new FGD ELG wastewater limits of March 29, 2022 be included in the reissued VPDES permit for the Chesterfield Power Station. This proposed schedule was developed so that the FGD discharge can comply with the new ELG limits as soon as possible, while providing sufficient time for Dominion to fully evaluate, select, procure, install, and commission a new treatment technology that will consistently meet the ELG limits. Dominion is providing information on each of the following factors identified in the ELG Rule to support the proposed schedule:

1) Time to expeditiously plan (including to raise capital), design, procure, and install equipment to comply with the requirements of this part.

Dominion has been evaluating compliance options for the new FGD wastewater limitations since the initial Rule was proposed in 2013, including a two-phased evaluation of compliance options. The FGD wastewater limits in the Final ELG Rule are based on chemical precipitation followed by biological treatment. Compliance with these limits will require optimization of the Station's existing treatment technology along with the implementation of additional treatment technologies. Plants with the preferred technology used by EPA to set the new FGD wastewater limits have indicated to EPA they cannot meet new limits under all conditions and other technologies are currently under development by vendors and industry. These two factors significantly affect our design process and timing. Additionally, the EPA-preferred technology is supplied by one vendor for the entire country which affects procurement and start-up resources if Dominion moves forward with that approach. Our schedule includes reasonable milestones that reflect these contingencies.

The attached Major Category Schedule divides the completion of a compliance technology into five categories: Treatment Technology Selection, Engineering Design, Bidding and Contractor Procurement, Construction, and Treatment Technology Commissioning. The Treatment Technology Selection process will require pilot studies to work out design issues associated with current technology limitations. Engineering Design and Construction will need to be completed after the new Low Volume Wastewater Treatment System and landfill are operational.

2) Changes being made or planned at the plant in response to

   i. regulations that address the disposal of coal combustion residuals as solid waste, under sections 1006(b), 1008(a), 2002(a), 3001, 4004, and 4005(a) of the Solid Waste Disposal Act of 1970, as amended by the Resource Conservation and Recovery Act of 1976, as amended by the Hazardous and Solid Waste Amendments of 1984, 42 U.S.C. 6906(b), 6907(a), 6912(a), 6944, and 6945(a).

3) Dominion is in the process of significant changes at the Station to comply with the CCR Rule and the ELG Rule, including conversion of the current wet fly ash management system to a dry system, conversion to a closed cycle system for handling bottom ash, closure of the Lower and Upper Ash Ponds, construction of a new captive industrial landfill, and the installation of a new Low Volume Wastewater Treatment System to replace the Lower Ash Pond. Ash pond closure and new ash landfill construction work will continue for approximately 2 years with a high level of site activity. The new Low Volume Wastewater Treatment System and ash disposal systems will need to be constructed and commissioned, affecting Station resources, prior to installation of the new FGD treatment technology. Additionally, the existing FGD wastewater treatment system will have to be coordinated with new Station processes and the exact response of the system to the new processes will not be known until these new processes are operational. For FGD wastewater requirements only, an initial commissioning period for the treatment system to optimize the installed equipment is required.

The Final ELG Rule and supporting documents discuss in detail the need for time to properly commission a biological wastewater treatment technology to meet the FGD ELG limits. A full year of commissioning will be needed at Chesterfield to address seasonal performance (changing temperature conditions), the impact of intermittent unit shutdowns during certain times of year (typically Spring and Fall), and any potential influence of changing coal supplies on constituent concentrations in the FGD purge water.

Based on discussions with DEQ, we understand the agency has concerns establishing a date to achieve the FGD limits that is later than the expiration date of the permit. It is important to point out that the ELG Rule directs the permitting authority to identify the date when the new limitations will “apply” to a permittee given that the limitations are based on technologies that EPA has determined are not currently available. The date is not a “compliance schedule”, because the technology is not readily available and achievable. EPA discusses the issue of timing for applicability in the ELG Response to Comments, pp. 8-128 to 8-129 (language attached). As these responses make clear, EPA contemplates applicability dates that extend beyond the permit term, and in the preamble (pg. 67883) explains that setting the date in the permit will ensure that the date will be met even if the permit is administratively continued. Additionally, since setting a limit applicability date is not establishing a “compliance schedule” for a water-quality based effluent limitation, State Water Control Board Regulations that limit ”compliance schedules” to the five year permit term do not apply in this case.

In summary, as allowed under the ELG Rule, Dominion proposes a date of March 29, 2022 to achieve the new ELG FGD wastewater limits. We are providing the attached Major Category Schedule to support this date. Additionally, we propose that the permit include semi-annual reporting on progress towards the milestones included in the attached schedule.

ELG Response to Comments (EPA-HQ-OW-2009-0819-6469), pp. 8-128 to 8-129.

While the commenter understandably wants these limitations to be achieved right away, the changes at facilities that have not yet employed the technologies that serve as the bases for the final limitations (or other technologies that achieves the limitations) will take time. The time provided for in the rule allows the permitting authority to account for time the facility needs to coordinate all the requirements of this rule, along with other regulatory requirements, to make the correct planning and financing decisions, and to implement the new requirements in an orderly and feasible way. While the time period of no later than 2023 seems protracted in 2015, given the extent of the capital expenditure and the complexity of these facilities, it is reasonable.

EPA disagrees that the implementation period in the final rule is inconsistent in any way with the Clean Water Act. As explained in the preamble, the final rule establishes effluent limitations applicable to the discharge of pollutants from the steam electric power generating industry based on Best Available Technology Economically Achievable. In some cases, the rule establishes limitations that are based on technologies that are available as of the date of this final rule and thus must be met by a given plant immediately once incorporated into its NPDES permit. In other cases, the rule establishes limitations based on technologies that EPA determined are not available until at least November 1, 2018 (for reasons explained in preamble section VIII.C.7). For these limitations, EPA also determined that the technologies are available for every plant by December 31, 2023. In other words, the implementation period in the final rule ("as soon as possible beginning November 1, 2018, but no later than December 31, 2023") tracks when, in EPA's judgment, certain technologies represent Best Available Technology Economically Achievable, it is not [a] "compliance schedule" for meeting limitations based on a technology that is already available and achievable. EPA further determined that the permitting authority is in the best position to decide exactly when within that implementation period particular technologies are available for plants, in light of a consideration of certain factors that EPA has judged are relevant to the inquiry. See 40 CFR 423.11(t).

Dominion Resources

Chesterfield FGD (ELG) Wastewater Treatment

Major Category Schedule 12.08.15

Category Name and Tasks	Start	Finish
Treament Technology Selection	**Mon 7/29/13**	**Thu 9/21/17**
Technology Screening and shortlist		
Pilot Program Plan Development		
Operate Pilot Unit(s)		
Treatment Technology Selection		
Treatment Technology CER and Submit to DEQ		
Engineering Design	**Fri 2/2/18**	**Thu 6/27/19**
30% design package		
60% design package		
90% design package		
Issue For Bid and Local Permitting Packages		
Bidding and Contractor Procurement	**Mon 3/18/19**	**Wed 10/30/19**
Prebid meeting(s) and bids submittal		
Contractor selection		
Contract documents and negotiation		
Notice to Proceed		
Construction	**Thu 9/12/19**	**Tue 3/23/21**
Issue For Construction Package		
Site Mobilization/Layout		
Site work (E&S, Clearing, Excavation)		
Building Construction		
Treatment Technology manufacture, deliver, and install		
Substantial Completion Activities		
Treatment Technology Commissioning	**Wed 3/24/21**	**Tue 3/29/22**

SECTION C

FGD WWTP Discharge Proposed 24-hour Composite Sampling Approach During Period Prior to ELG Applicability Date

There are two Flue Gas Desulfurization (FGD) units that operate at the Chesterfield Power Station. One FGD treats flue gases generated by Units 3, 4, and 5 and the second FGD treats flue gases produced by Unit 6. The amount of wastewater generated by the two FGD units is directly related to the number of units operating during any given period and to the sulfur content of the coal being burned by the operating units. Wastewaters produced by both FGD units are directed to a single equalization (EQ) tank where they are stored until sufficient wastewater has collected to warrant treatment. Once sufficient wastewater has accumulated in the EQ tank, pumps are engaged and the wastewater is transferred to the FGD wastewater treatment plant (WWTP) for treatment and discharge to the Lower Ash Pond. The current sampling point for the WWTP discharge, prior to comingling with any other wastewaters, is a sample tap located in the piping just upstream from the discharge pumps of the effluent tank.

Examination of the 2015 hourly flow data for the FGD WWTP shows that not all discharges from the WWTP last for a period of 24-hours. For example, during January 2015, there were 14 periods during which the discharge from the FGD WWTP was initiated and subsequently stopped. The length of these discharges ranged from 8 to 110 hours, with four of the discharges lasting less than 24 hours. Similarly, during May 2015, there were 13 days during which discharge from the FGD WWTP was initiated and subsequently stopped. The length of these discharges ranged from 8 to 89 hours, with eight of the discharges lasting less than 24 hours.

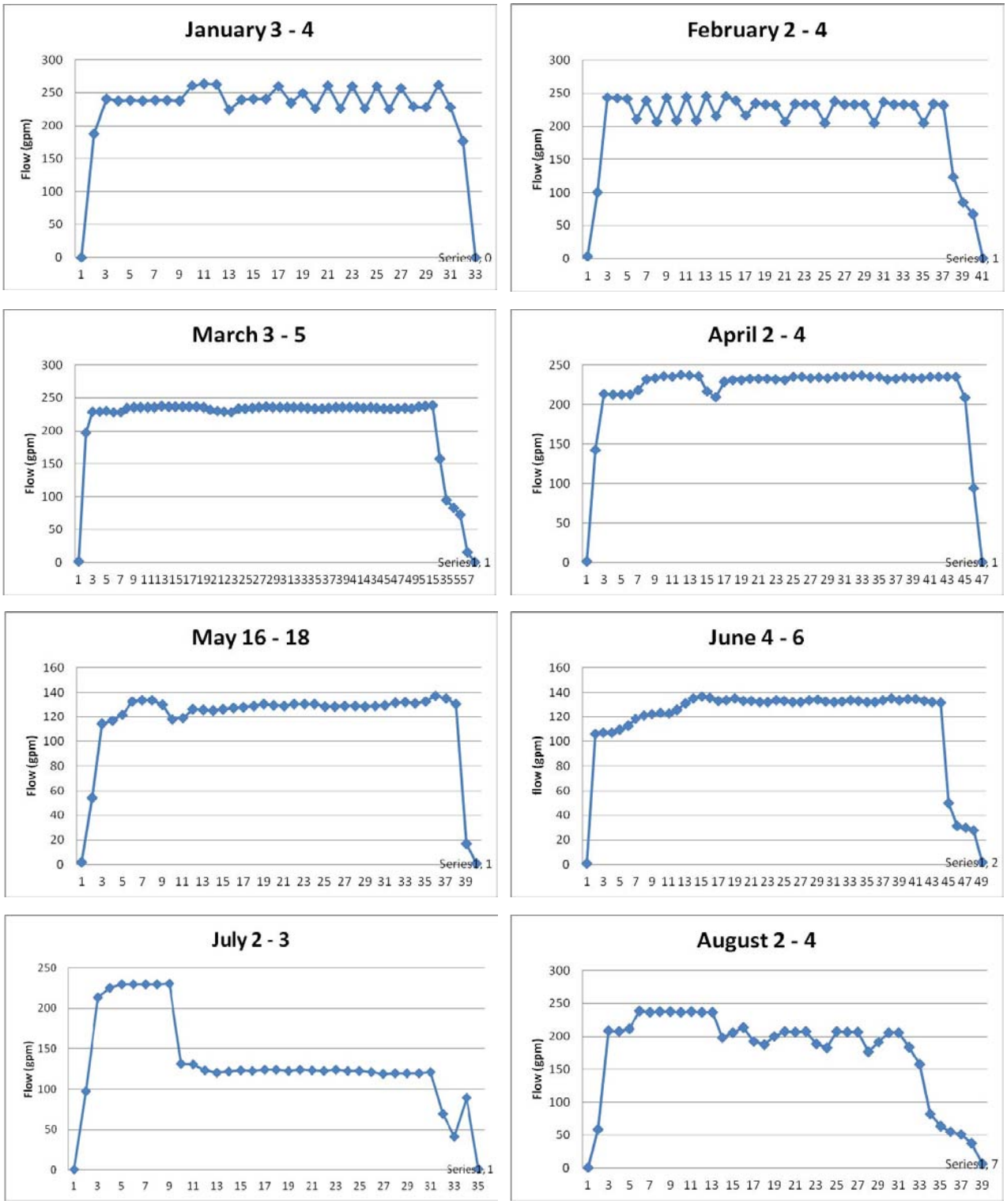
The hourly flow data for the FGD WWTP also show that effluent flows level off approximately one hour following the initiation of discharge, and typically remains stable for the remainder of the discharge period. Figure 1 shows representative periods of discharge for each month during 2015.

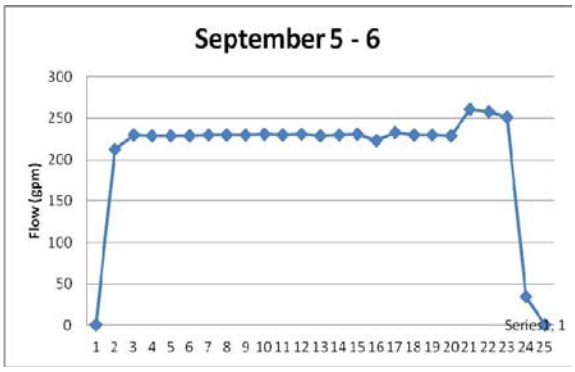
Given the above, Dominion proposes the following protocol for collection of 24-hour composite samples from the FGD WWTP.

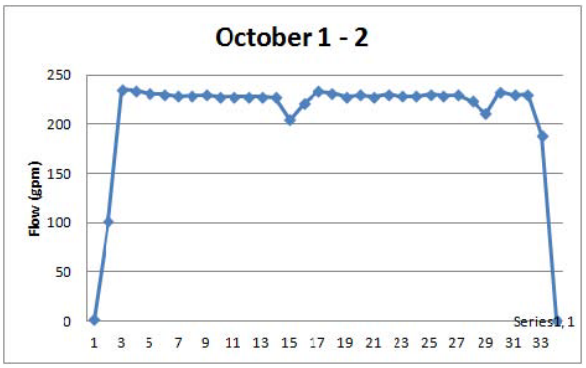
1. Sampling will be performed during a period when the FGD WWTP is expected to discharge for greater than 24 hours.
2. Two grab samples will be collected over a 24-hour period following the initiation of the discharge from the FGD WWTP.
3. The first sample will be collected no earlier than one hour and no later than 13 hours following the start of discharge.
4. The second sample will be collected no earlier than 13 hours and no later than 25 hours following the start of discharge.
5. There will be a minimum of eight (8) hours between the two samples.
6. WWTP discharge flow will be recorded during the collection of each sample and the individual grab samples will be flow-proportioned based on the two flow measurements.
7. Flow proportioning of the grab samples may be performed at the Station or in an analytical laboratory following shipment of the individual grab samples.

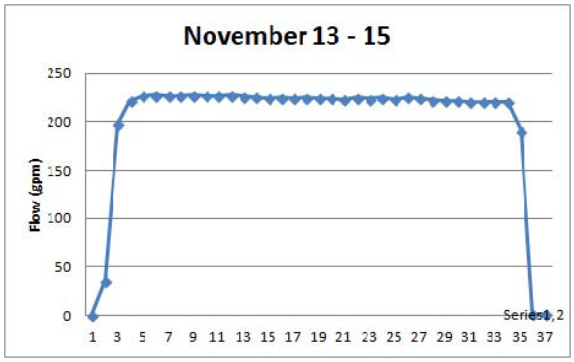
FIGURE 1

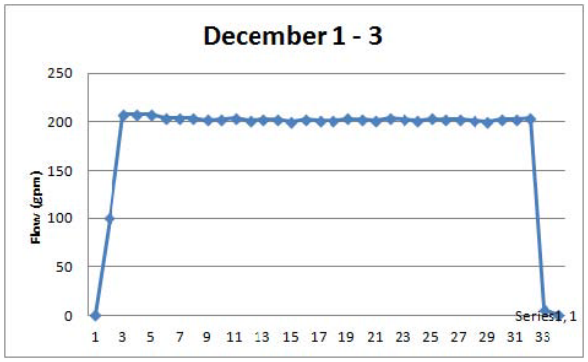
Representative Periods of FGD WWTP Discharge for Each Month During 2015




September 5 - 6
Flow (gpm)
300
250
200
150
100
50
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
Series1, 1


October 1 - 2
Flow (gpm)
250
200
150
100
50
0
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29 31 33
Series1, 1


November 13 - 15
Flow (gpm)
250
200
150
100
50
0
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29 31 33 35 37
Series1, 2


December 1 - 3
Flow (gpm)
250
200
150
100
50
0
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29 31 33
Series1, 1

Attachment 6

Removal of Outfalls 006-011

Removal of Outfalls 006-011
May 16, 2012

Background:

Outfalls 006-011 are the screen backwashes for the cooling water intakes. Monitoring performed on these outfalls during the 1997 permit cycle revealed the need to establish effluent limitations. TRC limitations were assigned to Outfalls 006-011 in the 2004 permit reissuance with a four year compliance schedule. In response to the limitations, Dominion developed a plan of compliance to re-plumb the chlorine feed system such that chlorine is introduced after the backwash water is withdrawn from the intake lines. The plumbing project was completed in November 2008. Because the facility did not reopen the permit to remove the limitations, the TRC effluent limits became effective December 10, 2008. The facility has been in compliance with the TRC limitations on each outfall since they became effective.

Dominion's compliance plan was designed to eliminate the pollutant source such that the effluent from Outfalls 006-011 is strictly river water with no additives. Since the compliance plan has been executed, the facility requested removal of Outfalls 006-011 on the basis that the effluent no longer represents the discharge of *pollutants* to state waters and, consequently, does not require permitting. In response to the facility's request, DEQ staff asked for a demonstration that all chlorine feeds were correctly relocated. The enclosed report documents Dominion's effort to make that demonstration.

The current minimum accepted agency Quantification Level (QL) for chlorine is 0.1 mg/L. However, there are methods that can analyze more precisely, and in this case Dominion was requested to demonstrate that chlorine concentrations were <38 µg/L, the limitation in the 2004 permit. As suggested by DEQ, Dominion analyzed for TRC using the HACH Ultra Low Range (ULR) Method 10014, which has a theoretical QL of at least 38 µg/L. As noted in the enclosed report, there were extensive challenges in achieving reliable results at the QL requested. After high variability was observed in the first round of analyses, the facility evaluated the performance of the analytical method by analyzing samples of tap water and ambient James River conditions at a pre-established sampling location.

Based on the evaluation, Dominion concluded the following:
1) Background TRC may be present in the James River upstream of the Power Station intakes (midway through a period of ebb tide).

2) The measured TRC concentrations in the James River varied considerably between the sampling locations and times. Considerable variability was also observed between the effluent TRC concentrations. Sources of variability may include: differences in the concentrations of interfering substances, the loss of chlorine from the sample over time, or the normal variability associated with the analytical method.

3) The average concentration of TRC measured in the intake screen backwash discharges was not significantly different at the 90% confidence level from the average James River background TRC concentration.

DEQ staff reviewed the report and evaluated the analytical results using Cochran's Approximation to the Behrens' Fisher Student's t-Test at a 5% confidence level. The spreadsheet is enclosed and indicates that there is no significant difference between the ambient data and the effluent data.

Outfalls 006-011 are therefore removed in this reissuance.

Enclosures: Dominion's chlorine sampling report (10/6/09)
Cochran's Approximation to the Behrens-Fisher Student's t-Test
Completion of Project Notification (11/6/08).

Dominion Resources Services, Inc.
5000 Dominion Boulevard, Glen Allen, VA 23060
Web Address: www.dom.com

Dominion®

RECEIVED
OCT 08 2009
PRO

CERTIFIED MAIL
RETURN RECEIPT REQUESTED

October 6, 2009

Ms. Emilee Carpenter
Water Permit Writer
Department of Environmental Quality
Piedmont Regional Office
4949-A Cox Road
Glen Allen, VA 23060

RE: **Chesterfield Power Station VPDES Permit No. VA0004146:**
Total Residual Chlorine Sampling of Screen Backwash Discharges

Dear Ms. Carpenter:

Enclosed is a report describing the results of analyses for Total Residual Chlorine (TRC) performed using samples collected from the six intake screen backwash discharges (Outfalls 006 – 011) at Dominion's Chesterfield Power Station. This information is being provided to you in support of our July 6, 2009 permit application, which requested removal of the intake screen backwash outfalls from the station's VPDES permit.

Please feel free to contact Ken Roller of my staff at (804) 273-3494 should you have any questions concerning this information.

Sincerely,

Cathy C. Taylor

Cathy C. Taylor
Director, Environmental Support

Enclosures

Chesterfield Power Station
Screen Backwash Discharge TRC Sampling

BACKGROUND

During the fall of 2008, Dominion completed a project to relocate the points for chlorine injection into the station's circulating water system. The project was undertaken to comply with effluent limits for Total Residual Chlorine (TRC) that were placed on the station's intake screen backwash discharges (Outfalls 006 – 011) when the existing VPDES permit was reissued effective December 10, 2004. Through the compliance project, the chlorine injection points were relocated downstream of the points where water is withdrawn for use in the station's Intake Screen Backwash System. As a result, all intake screen backwash discharges now consist of James River water that has not been contaminated by use in any Chesterfield Power Station plant processes. Consequently, Dominion has requested that Outfalls 006 – 011 be removed from the permit during the upcoming permit reissuance. To support this request DEQ staff suggested that the result of at least one TRC analysis at each outfall be included in the permit renewal application, and that if possible the Quantification Level (QL) for the analyses should be no greater than 38 µg/L, which is the monthly average and maximum TRC permit limit. This document provides the TRC data generated by Dominion in support of DEQ's suggestion.

METHODS and MATERIALS

TRC Analytical Procedure

TRC measurements were performed using a HACH DR 2800 Portable Spectrophotometer and the HACH Ultra Low Range (ULR) Method 10014 (see attached). The ULR method has a theoretical TRC range of 2 to 500 ug/L, and was selected for use in this project following conversations with contract laboratories, DEQ staff, and other permittees and consultants familiar with TRC analytical methods.

TRC Sampling and Analyses (June 24, 2009)

Grab samples were collected on June 24, 2009 from each of the six (6) screen backwash discharges and from two (2) locations within the James River upstream from the backwash outfalls. Locations of the backwash outfalls and two James River sampling stations are shown in Figure 1. All samples were collected during a period of chlorine addition to the station's circulating water system. The James River is the source of make-up water to the screen intake backwash discharges, and is tidal in the area of the Chesterfield Power Station. Consequently, to account for any background river TRC concentrations all samples were collected approximately midway through a period of ebb tide. The following TRC analyses were performed.

- A single TRC analysis was performed on the sample collected from the James River at sampling location A (just off the barge slip).
- Replicate TRC measurements were made on each of two samples collected from the James River sampling location B (near the Unit 6 intake) at 10:12 AM and 10:30 AM. An aliquot of the initial sample (collected at 10:12 AM) from this location was also tested for TRC following the addition of Potassium Iodide and Sodium Arsenite to correct for manganese interference. A portion of the second sample (collected at 10:30) from this location was retained for approximately three hours prior to TRC analysis.
- A single grab sample was collected from each of the screen backwash discharges. The following three TRC measurements were made on each sample:
    - An initial TRC concentration was determined
    - TRC was measured following addition of Potassium Iodide and Sodium Arsenite to correct for manganese interference
    - TRC was measured after allowing the sample to sit for approximately three hours.

TRC Sampling and Analyses (August 5, 2009)

Because of the variability observed in TRC concentrations determined for the samples collected on the June 24, 2009 (see results below), additional TRC analyses were performed on August 5, 2009 using samples of tap water and James River water. Samples of tap water were collected from the Chesterfield Power Station's laboratory spigot and were analyzed for TRC following the addition of increasing concentrations of dechlorination agent (blanking reagent). Tap water was also analyzed for TRC following the addition of blanking reagent and Potassium Iodide and Sodium Arsenite to correct for manganese interference.

Following testing of the tap water, four samples were collected from the James River sampling location A. The samples were collected approximately midway during a period of ebb tide, and were collected over a period of about one hour. The following TRC analyses were performed using HACH Method 10014:

- Sample 1 (9:37 AM) - An initial TRC measurement was followed immediately by a second TRC measurement. Aliquots of the sample were then treated with increasing concentrations of the method blanking reagent (0.5 – 1.5 ml) until a relatively stable TRC concentration was determined. An unaltered aliquot of the sample was then retested for TRC to examine persistence relative to the initial sample.

- Sample 2 (10:00 AM) - This sample was analyzed for TRC

- Sample 3 (10:10 AM) - An initial TRC concentration was determined. TRC measurements were then made on aliquots of the sample following addition of 1.5 ml of the method blanking reagent alone and following addition of the blanking agent plus Potassium Iodide and Sodium Arsenite to correct for manganese interference. An unaltered aliquot of the sample was then tested for TRC to examine persistence relative to the initial sample.

- Sample 4 (10:31 AM) – An initial TRC concentration was determined. TRC measurements were then made on aliquots of the sample following addition of 1.5 ml of the method blanking reagent alone and following addition of the blanking agent plus Potassium Iodide and Sodium Arsenite to correct for manganese interference.

RESULTS & DISCUSSION

TRC Sampling and Analyses (June 24, 2009)

Results of the TRC analyses performed on samples collected June 24, 2009 are presented in Table 1, and are discussed below.

James River TRC Concentrations

Chlorine concentrations measured in the James River samples varied considerably with initial TRC concentrations ranging from 27 ug/L at sampling Station A to 41 ug/L at Station B. Chlorine concentrations also varied considerably between the two samples collected from sampling location B, and between the three concentrations determined for the sample collected at 10:12 AM. Treatment of the 10:12 sample for manganese interference yielded a TRC concentration of 28 ug/L. This suggests that manganese may have been responsible for some of the TRC measured; however, relatively similar chlorine concentrations of 27 ug/L and 31 ug/L were determined for aliquots of the second sample collected from the same location at 10:30 AM. A chlorine concentration of 24 ug/L was determined for the 10:30 sample three hours.

Screen Backwash TRC Concentrations

TRC concentrations measured in the screen backwash discharges ranged from 38 ug/L (Outfall 011) to 56 ug/L (Outfall 008). With the exception of Outfall 011 the initial TRC concentrations determined for all of the screen backwash discharges were slightly

higher than TRC concentrations measured in the James River samples collected from Location B. Following treatment for manganese interference, TRC concentrations in the screen backwash discharges decreased in many outfalls (by 13 ug/L for Outfall 007) and ranged from 38 – 46 ug/L. In addition, chlorine concentrations were lower than initial readings three hours following sample collection in the samples from Outfalls 006, 007, 008, and 009.

The data generated for the James River samples indicate that chlorine was present in the river, and that TRC concentrations varied considerably between sampling locations in the James River as well as between samples collected from the same river location. It is not possible from the data, however, to determine whether the observed variability was due to spatial and/or temporal differences in TRC concentrations or resulted from one or more of the following factors: 1) differences in the concentrations of interfering substances, 2) the loss of chlorine from the sample over time, and/or 3) the normal variability associated with the analytical method. Similarly, elevated TRC concentrations were measured in the individual screen backwash discharges, but it is not possible to determine from the data the reason for this variability.

The mean concentration of chlorine for the two samples collected from the James River location B is 32.83 ug/L, and the average TRC concentration for the six screen backwash discharges is 46.17. A t-test shows no statistically significant difference between the two means at the 90% level (see attached test results).

TRC Sampling and Analyses (August 5, 2009)

Because of the variability in TRC concentrations observed following analysis of the James River and screen backwash samples, additional tests with tap water and James River water were undertaken on August 5, 2009 to gain a better understanding of the capabilities of the

analytical method. Results of the August 5, 2009 testing are presented in Table 2 and are discussed below.

Tap Water

An initial chlorine concentration of 844 ug/L was determined for the CPS laboratory tap water, which is within the range of TRC concentrations expected for this water (see attached 2008 Colonial Heights Water Quality Report). Addition of 0.5 ml, 1.0 ml, 1.5 ml and 2.0 ml of the HACH Method 10016 blanking reagent (Dechlorinating Agent) reduced the measured TRC concentrations to 243 ug/L, 88 ug/L, 69 ug/L, and 57 ug/L, respectively. Addition of 1.5 ml of the blanking reagent plus sample adjustment for manganese interference resulted in a TRC reading of 66 ug/L. These results indicate that TRC can be reduced by the addition of the blanking reagent; however, the results also suggest that the analytical system may continue to produce positive TRC measurements as high as 57 ug/L even after the addition of 2.0 mg/L of the blanking reagent.

James River Water (Sampling Location A)

Sample 1 - A TRC concentration of 86 ug/L was determined for this sample. An immediate retest of the sample yielded a similar TRC concentration of 81 ug/L. Addition of 0.5, 1.0 and 1.5 ml of the HACH Method 10016 blanking solution resulted in TRC readings of 39 ug/L, 21 ug/L and 25 ug/L, respectively. Sample 1 was retested at 10:08 AM and a TRC concentration of 55 ug/L was measured.

Sample 2 - A TRC concentration of 61 ug/L was determined for this sample.

Sample 3 (10:10 AM) - An initial TRC concentration of 76 ug/L was measured in this sample. Addition of 1.5 ml of dechlorination reagent resulted in a TRC concentration of 19 ug/L. Measurement of the sample following addition of 1.5 ml of dechlorination agent and treatment for manganese interference resulted in a measurement of <1 ug/L TRC, indicating that approximately 19 ug/L of the previous TRC concentrations were due

to the presence of manganese in the sample. A retest of the sample at 10:25 yielded a TRC concentration of 73 ug/L.

Sample 4 (10:31 AM) - An initial TRC concentration of 74 ug/L was measured in this sample. Addition of 1.5 ml of dechlorination reagent yielded a TRC concentration of 17 ug/L, and manganese correction plus 1.5 ml of dechlorination reagent resulted in a TRC concentration of 11 ug/L.

Results of the August 5, 2009 TRC sampling support the results obtained during the June 24, 2009 sampling. Chlorine concentrations at the James River sampling location A were extremely variable differing by 25 ug/l in the first two samples, which were collected 23 minutes apart. In addition, a retest of Sample 1, performed approximately 30 minutes following sample collection, yielded a TRC concentration that was 31 ug/L less than that measured in the initial reading of this sample.

In addition, treatment of Samples 1, 3 and 4 with the HACH dechlorinating agent substantially reduced the TRC concentrations measured in each of these samples indicating that TRC was present in the James River above the intakes for the Chesterfield Power Station circulating water system. Treatment with the dechloriniating agent, however, did not totally eliminate a positive TRC reading from any of the three samples. Additional treatment of Samples 3 and 4 for manganese interference totally (Sample 3) or partially (Sample 4) removed any residual positive TRC measurement from these samples.

CONCLUSIONS

As suggested by DEQ, Dominion analyzed the Chesterfield Power Station's intake screen backwash outfalls for TRC using the HACH Ultra Low Range (ULR) Method 10014, which has a theoretical QL of at least 38 ug/L. In addition, Dominion also measured TRC concentrations in samples collected from the James River shortly before sampling of the intake backwash discharges, and performed additional tap water and James River sampling to further evaluate

the performance of the analytical method. Based on these evaluations the following conclusions can be reached:

- Background TRC may be present in the James River upstream of the Chesterfield Power Station.

- TRC concentrations measured in the James River varied considerably between sampling locations in the James River as well between samples collected from the same river location on the same day and on different days. Considerable variability was also observed between the TRC concentrations determined for the individual screen backwash discharges. It is not possible from the data, however, to determine whether the observed variability was due to spatial and/or temporal differences in TRC concentrations or resulted from one or more of the following factors: 1) differences in the concentrations of interfering substances, 2) the loss of chlorine from the sample over time, and/or 3) the normal variability associated with the analytical method.

- The average concentration of TRC measured in the intake screen backwash discharges was not significantly different at the 90% confidence level from the average James River background TRC concentration.

Figure 1. Locations of Intake Screen Backwash Outfalls and James River TRC Sampling Stations

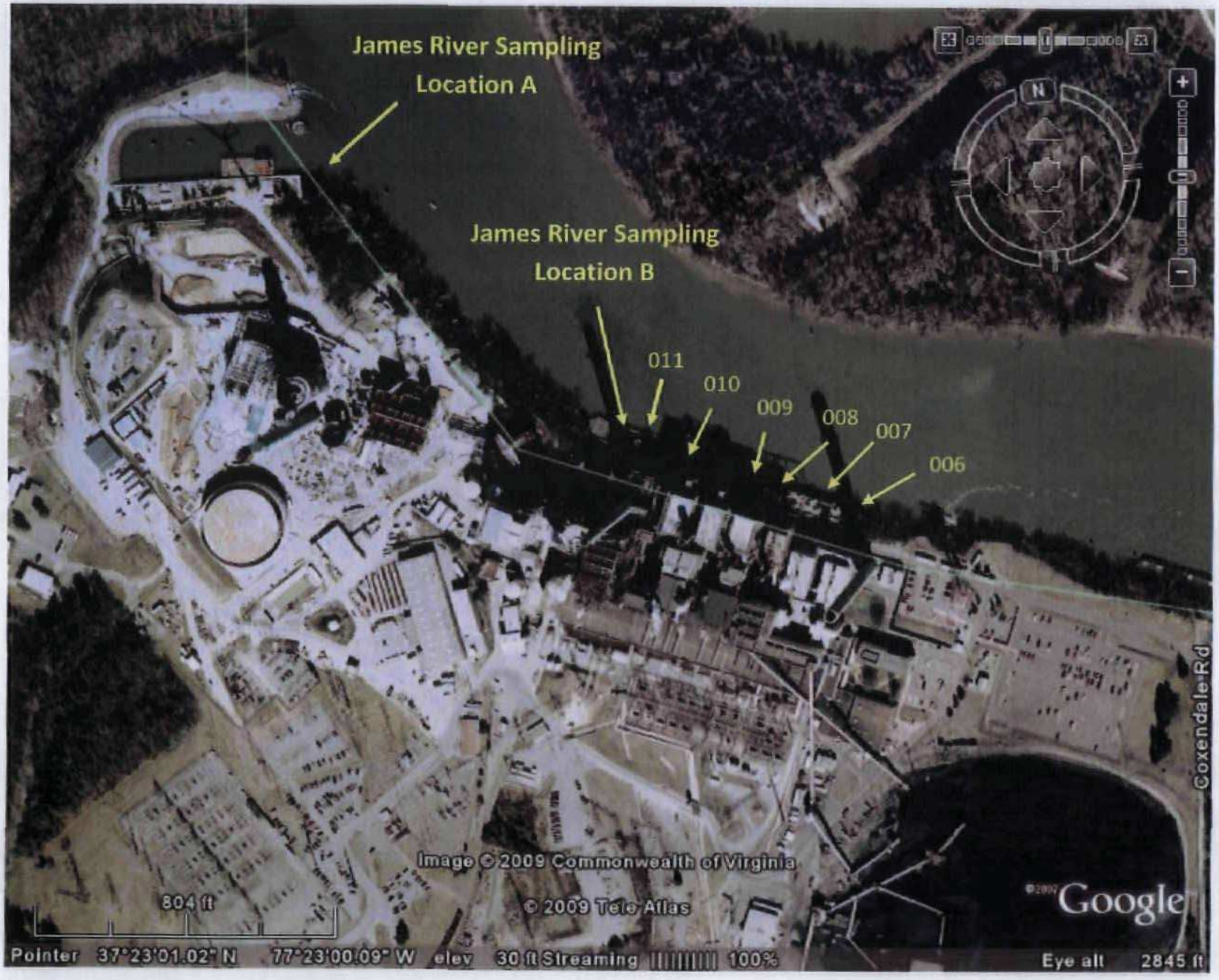


Table 1. Total Residual Chlorine (TRC) Measured in Samples from the Intake Screen Backwash Discharges and the James River (06/24/2009)

SAMPLE LOCATION	DR2800	Sample 1			Sample 2		Mn Interference	*Persistence Test
River Sampling Location A	Sample Time	9:50						
	Chlorine Reading	27						
River Sampling Locatoin B	Sample Time	10:12	10:12	10:12	10:30	10:30	10:12	Collected 10:30 / Ran 13:30
	Chlorine Reading	41	31	38	27	31	28	24
Outfall 011 (U6)	Sample Time	10:41					10:41	Collected 10:41 / Ran 13:35
	Chlorine Reading	38					38	38
Outfall 010 (U5)	Sample Time	11:30					11:30	Collected 11:30 / Ran 13:49
	Chlorine Reading	42					40	42
Outfall 009 (U4)	Sample Time	11:43					11:43	Collected 11:43 / Ran 13:50
	Chlorine Reading	49					46	42
Outfall 008 (U3)	Sample Time	11:53					11:53	Collected 11:53 / Ran 13:55
	Chlorine Reading	45					41	38
Outfall 007 (U8)	Sample Time	11:18					11:18	Collected 11:18 / Ran 13:45
	Chlorine Reading	56					43	29
Outfall 006 (U7)	Sample Time	11:05					11:05	Collected 11:05 / Ran 13:40
	Chlorine Reading	47					39	29

*Persistence Test: samples were poured into open bottles in the field and TRC analyses performed several hours later in the lab to test if the chlorine had dissipatec

Chesterfield's chlorine system was in service during sampling

James River tide was going out, at lowest at 13:20

Reagent blank = 2 ug/l (TRC data in the table account for this analytical background concentration).

All concentrations (ug/L)

Table 2. Total Residual Chlorine (TRC) measured in samples of Tap Water and James River Water (08/05/2009)					
Time	Sample	1 ml buffer + 1 ml TRC indicator	Dechlorinating Agent (ml)	Manganese Adjustment	TRC (ug/L)
Tap Water					
8:00	Method Blank (DI)	Yes	0.5	No	2
	Initial Reading	Yes	0	No	844
	Dechlorination	Yes	0.5	No	243
	Dechlorination	Yes	1	No	88
	Dechlorination	Yes	1.5	No	69
	Dechlor. + Mn	Yes	1.5	Yes	66
	Dechlorination	Yes	2	No	57
9:15	Dechlor. Agent Adsorbance Check	No	1.5	No	-1
James River Sample 1					
9:37	Initial Reading	Yes	0	No	86
	Retest	Yes	0	No	81
	Dechlorination	Yes	0.5	No	39
9:58	Dechlorination	Yes	1	No	21
	Dechlorination	Yes	1.5	No	25
10:08	Retest Sample	Yes	0	No	55
James River Sample 2					
10:00	Only Test with Sample	Yes	0	No	61
James River Sample 3					
10:10	Initial Reading	Yes	0	No	76
	Dechlorination	Yes	1.5	No	19
	Dechlor. + Mn	Yes	1.5	Yes	-1
10:25	Restest Sample	Yes	0	No	73
James River Sample 4					
10:31	Initial Reading	Yes	0	No	74
	Dechlorination	Yes	1.5	No	17
	Dechlor. + Mn	Yes	1.5	Yes	11

Statistical comparison of the mean TRC concentrations determined for the James River (group 1) and the intake screen backwash discharges (group 2).

The SAS System

The TTEST Procedure

Statistics											
Variable	group	N	Lower CL Mean	Mean	Upper CL Mean	Lower CL Std Dev	Std Dev	Upper CL Std Dev	Std Err	Minimum	Maximum
value	1	2	-16.07	32.85	81.769	2.4292	5.4447	173.74	3.85	29	36.7
value	2	6	39.683	46.167	52.65	3.8563	6.1779	15.152	2.5221	38	56
value	Diff (1-2)		-25.43	-13.32	-1.206	3.9062	6.0619	13.349	4.9495		

T-Tests					
Variable	Method	Variances	DF	t Value	Pr > |t|
value	Pooled	Equal	6	-2.69	0.0360
value	Satterthwaite	Unequal	1.97	-2.89	0.1034

Equality of Variances					
Variable	Method	Num DF	Den DF	F Value	Pr > F
value	Folded F	5	1	1.29	1.0000

Cochran's Approximation to the Behrens-Fisher Student's t-Test (at a 5% Level of Significance)

To use this spreadsheet, please fill in only the shaded boxes.

Permit Number	VA0004146
Facility Name	Chesterfield Power Station
Parameter	Total Residual Chlorine
What is the number of observations in the set of background data (n_b)?	2
What is the number of observations in the set of monitoring data (n_m)?	6

	Background	Monitored Site	$[X_b-X_b(ave)]^2$	$[X_m-X_m(ave)]^2$
1	27	38	49.000	66.694
2	41	42	49.000	17.361
3		49	0.000	8.028
4		45	0.000	1.361
5		56	0.000	96.694
6		47	0.000	0.694
7			0.000	0.000
8			0.000	0.000
9			0.000	0.000
10			0.000	0.000
11			0.000	0.000
12			0.000	0.000
13			0.000	0.000
14			0.000	0.000
15			0.000	0.000
16			0.000	0.000
17			0.000	0.000
18			0.000	0.000
19			0.000	0.000
20			0.000	0.000

$X_b(ave)$ = 34.000 $X_m(ave)$ = 46.167

T_b = 6.314 (from lookup table)

T_m = 2.015

s_b^2 = 98.000 $= [(X_{b1}-X_b(ave))^2+(X_{b2}-X_b(ave))^2...(X_{bn}-X_b(ave))^2]/(n_b-1)$

s_m^2 = 38.167 $= [(X_{m1}-X_m(ave))^2+(X_{m2}-X_m(ave))^2..(X_{mn}-X_m(ave))^2]/(n_m-1)$

T_{star} = 1.635 $= [X_m(ave)-X_b(ave)]/sqrt(s_m^2/n_m + s_b^2/n_b)$

W_b = 49.000 $= s_b^2/n_b$

W_m = 6.361 $= s_m^2/n_m$

T_{comp} = 5.820035625 $= (W_b*T_b + W_m*T_m)/(W_b + W_m)$

There is no significant difference between the monitoring data and the background data

Dominion Generation
Chesterfield Power Station
500 Coxendale Road, Chester, VA 23836

Dominion®

RECEIVED
NOV 10 2008
PRO

November 07, 2008

CERTIFIED MAIL
RETURN RECEIPT REQUESTED

Virginia Department of Environmental Quality
Piedmont Regional Office
4949-A Cox Road
Glen Allen, Va. 23060

Re: CHESTERFIELD POWER STATION - VPDES DISCHARGE MONITORING REPORT FOR OCTOBER, 2008

Gentlemen:

Attached are the original and one copy of the October, 2008 VPDES Discharge Monitoring Reports for Chesterfield Power Station. Also attached are ground water remediation results for October, 2008, the Nutrient DMR's, and the final TRC Effluent Limit Compliance Project Progress Report.

As you know, this report is required by and prepared specifically for the Virginia Department of Environmental Quality. It represents truly, accurately, and completely the observed results of the measurements and analyses required by the state to be performed or submitted, but only such results. It is not intended as an assertion of the accuracy on any instrument, readings, or analytical result, nor is it an endorsement of the suitability of any analytical or measurement procedure.

If you have any questions or desire additional information, please do not hesitate to contact us.

Sincerely,

Richard T. Elder
Station Director

Attachments

cc: CPS Laboratory

Chesterfield Power Station
Total Residual Chlorine Effluent Limit Compliance Project
Final Progress Report
(November 6, 2008)

The VPDES permit for the Chesterfield Power Station (Permit No. VA0004146) was reissued on December 10, 2004 and contains Monthly Average and Daily Maximum Total Residual Chlorine (TRC) limits of 38 ug/L on the screen backwash discharges (Outfalls 006 – 011). The station is to achieve compliance with the Total Residual Chlorine limitations no later than 48 months following the effective date of the permit (December 10, 2008).

By letter dated June 8, 2006, Dominion submitted to DEQ our Plan of Action and Conceptual Engineering Report for achieving compliance with the TRC limits. The method selected to achieve compliance is to relocate the points for sodium hypochlorite injection, which will provide an unchlorinated freshwater supply to each of the screen wash systems. The compliance plan was approved by DEQ on June 23, 2006 and Dominion began implementation of the plan in August 2006. Our progress on this project to date is described below:

Project Progress

- All installation activities have been completed.
- Commissioning has been completed.
- The project has been completed. Chlorine has been removed as a potentially discharged pollutant and, as our DMR indicates, we are in compliance with the Total Residual Chlorine limitations.

Please contact Dawn Garber at (804) 796-6350 should you have any questions concerning this project.

Attachment 7

Discussion of 316(a) and 316(b)

2016 Discussion:
According to Dominion's reissuance applicaton, station operations have not materially changed since the approval of the 316(a) variance in 2004. There is also no evidence that the stream characteristics have materially changed since that time. Consequently, it appears that the 316(a) study approved in 2004 remains representative for the James River and station operations. The variance, therefore, is carried forward in this reissuance.

Clean Water Act Sections 316(a) and 316(b)

Request to Continue CWA Section 316(a) Variance

Chesterfield Power Station currently operates under a Clean Water Act (CWA) Section 316(a) thermal variance, which was granted by DEQ with reissuance of the VPDES Permit. The process leading to DEQ's decision to grant the 316(a) variance spanned about seven years. During this seven-year period, Dominion worked closely with the DEQ and other stakeholders to develop and implement a comprehensive 316(a) demonstration study plan. The study plan approved by DEQ, and carried out by Dominion, was multifaceted and consisted of resource intensive field investigations involving the collection of extensive environmental data. These data were coupled with state-of-the-art hydrodynamic modeling to examine the thermal impacts to the James River associated with operation of the power station at full station thermal load conditions. Results of the 316(a) study were reviewed by fisheries biologists who are considered expert in their field. Their review found, and DEQ concurred, that the thermal discharge from the Chesterfield Power Station does not cause appreciable harm to the overall aquatic biological community and that a balanced, indigenous community of shellfish, fish, and wildlife does exist in the James River in the vicinity of the power station.

The current VPDES permit for the Chesterfield Power Station contains heat rejection limits (expressed as BTUs/hr) on the three non-contact cooling water discharges (Outfalls 001, 002, and 003). Through the above 316(a) studies Dominion successfully demonstrated that the existing heat rejection limits are protective of the balanced, indigenous aquatic community in the James River. Since completion of these studies and issuance of the variance, station operations have not materially changed with respect to the cooling water discharges and there are no current plans to increase the thermal loading from the Chesterfield Power Station beyond the existing thermal limitations. Dominion believes that the data generated during our 316(a) studies remains representative for the James River and for our station operations, and therefore, we request continuance of Chesterfield's 316(a) variance.

Clean Water Act Section 316(b)

The Chesterfield Power Station withdraws water from the James River for use in plant processes. The majority of the water withdrawn is used in a once-through cooling water system to dissipate waste heat from the station's generating units. The intake structures associated with this withdrawal are regulated under Clean Water Act Section 316(b). The following is a brief summary of 316(b) related activities that Dominion has been involved with, relative to the Chesterfield Power Station, during the effective term of the existing VPDES permit.

On July 9, 2004, EPA promulgated new 316(b) regulations governing cooling water intake structures for existing power plants (Phase II rule), such as the Chesterfield Power Station. Under the Phase II rule, Dominion was required to prepare and submit a Comprehensive Demonstration Study (CDS) for the Chesterfield Power Station providing Dominion's mechanism for documenting compliance with the Phase II regulatory requirements. A special condition was included in Chesterfield's VPDES permit requiring submittal of the CDS by January 7, 2008 as part of an application for permit renewal to incorporate 316(b) compliance alternatives.

As an initial step in the CDS process, Dominion prepared a Proposal for Information Collection (PIC) that described our approach to achieving compliance with the rule and the processes that would be used to generate the information required for CDS development. The PIC for the Chesterfield Power Station was submitted to DEQ on February 16, 2005 and was subsequently approved by DEQ by letter dated July 29 2005. Another step in the CDS development process involved studies to investigate the degree that the existing aquatic population of the James River is being impinged and/or entrained by Chesterfield Power Station's current water withdrawal system. Dominion carried out these studies between July 2005 and June 2006.

On July 9, 2007 EPA suspended the requirements of the Phase II rule. As a result of this action, the DEQ modified Chesterfield's VPDES Permit on January 1, 2007 to remove the requirement for submittal of the 316(b) related permit application. This condition was replaced with the current Special Condition I.B.21 which requires submittal of the biological data generated as part of the approved PIC by December 31, 2008. In compliance with this requirement, Dominion submitted a report containing the impingement mortality and entrainment characterization results to DEQ on December 29, 2008.

2004 Discussion

Attachment 7 – 316(a) Demonstration

Special Condition 6 in the existing VPDES permit addresses the operation of a sparger system in the Outfall 003 discharge canal to remove heat from the 003 wastestream. Heat removal attributable to the full system (32 pump platforms with 4 nozzles each) was theoretically 684.3 x 10^6 BTU/Hour. (Addition of that value to the thermal limitation in the existing permit of 4.87 x 10^9 BTU/Hour results in the proposed limitation of 5.55 x 10^9 BTU/Hour.)

In 1995, Virginia Power began discussions with DEQ staff regarding the retirement of the sparger system. As retirement of the system represented a theoretical increase in the thermal discharge at Outfall 003, the staff responded that a 316(a) study provided the best mechanism for evaluating the issues associated with an increased thermal loading. Section 316(a) of the Clean Water Act allows for a demonstration that thermal limitations do not have to be more stringent than what is necessary to assure the protection and propagation of a balanced, indigenous population of shellfish, fish, and wildlife in and on the body of water into which the discharge is made. Included in this attachment are letters dated December 21, 1995 from Virginia Power, June 27, 1996 from Virginia Power, September 27, 1996 from DEQ, and January 15, 1997 from Virginia Power. These letters provide a brief summary of the development of the 316(a) study plan. Except for Dr. John Ney's report submitted with Virginia Power's June 27, 1996 letter and the study plan submitted with the January 15, 1997 letter, attachments mentioned in the letters are not included in this fact sheet.

The goal of the study was to demonstrate that the requested increase in thermal loading from Outfall 003 would be in accordance with the protection and propagation of a balanced, indigenous population of shellfish, fish, and wildlife in and on the body of water into which the discharge is made. The study consisted of two parts: Collection of data to document the current condition and a thermal modeling effort to predict the increase in stream temperatures at the higher thermal loading. Virginia Power was allowed to turn off the sparger system so that the thermal loading at Outfall 003 would be as close as possible to the requested loading during the 316(a) study. An initial, cursory modeling effort gave some indication of what could be expected when the spargers were turned off and provided the basis for staff approval to turn them off.

The following items are included in this attachment to provide a summary of the results of the 316(a) study:

1. The "Executive Summary" and "Conclusions" from Virginia Power's 316(a) Demonstration Report.

   Also included from the 316(a) report are sections discussing fish kills that have occurred in Farrar Gut – pages 7-29 through 7-31 and 7-41 through 7-45. Also see Dr. John Ney's report dated June 1996.

2. Letter dated July 20, 2001 from DEQ staff concurring with the conclusions of the 316(a) study report. The need for additional thermal modeling was also noted.

3. The "Executive Summary" and "Conclusion" from HydroQual's thermal modeling report dated November 7, 2003.

4. Papers from Dr. John Ney and Dr. Cynthia Jones commenting on the impact of the predicted rise in temperatures at the proposed thermal loading on the conclusions reached in the 316(a) study report.

The existing permit defines the thermal mixing zone ($\Delta T > 3^{\circ}$ C) as follows: The old channel of the James River around Farrar Island to its confluence with the main channel of the James River at Dutch Gap, the coves and inlets of Farrar Island, and the main channel of the James River, its bays, coves, inlets, and meanderings form the upstream boundary at navigational aid QK F1 "155" (37° 23' 1" N and 77° 23' 1" W) to the downstream boundary at navigational aid F1 sec "147" (37° 22' 7" N and 77° 19' 4" W). The projected mixing zone based on the HydroQual modeling at the proposed thermal loading does not appear to reach as far downstream as the existing, defined zone, and certainly does not extend the existing zone.

The 316(a) study and related thermal modeling focus on shellfish, fish, and wildlife as discussed above. Over the past several years in particular, questions have also been raised about the human health effects of the elevated temperatures in Farrar Gut; i.e, effects associated with swimming, boating, etc. (See the table in Attachment 5.c. for Outfall 003 temperature data.) The staff has discussed these issues with the State Department of Health, Virginia Power, and Central Office staff. At this time our water quality standards do not support the imposition of an effluent limitation in the permit based on human health concerns. Virginia Power has historically demonstrated compliance with the designated thermal mixing zone, and a successful 316(a) demonstration represents compliance with the State's temperature standards. The issue of human health effects must be more specifically addressed in our standards before we can consider recommending a permit condition, which could also have implications for other heated discharges. The Health Department is working with Virginia Power to insure that appropriate signage is in place to inform the public of possible risks.

Assessment of the Thermal Impacts of Full-Load Operation of the Chesterfield Power Plant on Biological Organisms and Fish Assemblages of the James River and Farrar Gut, Virginia

Comments on Revised Assessment HydroQual Report

By:

Cynthia M. Jones, Ph.D.
Director, Center for Quantitative Fisheries Ecology
Old Dominion University
4608 Hampton Blvd.
Norfolk, VA 23529

August 2003

Summary Conclusions

I have read the revised report from HydroQual dated April 25, 2003 (DRS10020) based on corrected flows (Unit 6 now modeled with 403 MGD) and various letters (April 9, 2003) attesting to mis-assumptions in the modeling effort that had previously assumed that the Chesterfield Power Generating Station (CPS) could operate at 100% without the water pumps all operating at 100%. In the revised evaluation, average temperature maxima are now 1.1°C in Farrar Gut and 0.6°C in the James River.

My evaluation is based on the original final draft (DRS 10010) of HydroQual dated February 19, 2002, revised report dated July 8, 2002, and the revised report (DRS 10020) dated April 25, 2003, and summary letters. HydroQual, Inc. performed full-load modeling with the ECOM three-dimensional hydrothermal model developed by Blumberg and Mellor (1980 and 1987). This model has been used successfully to model hydrodynamic systems throughout the U.S. To simulate full-load operation, the model was validated for on-site conditions at the CPS with data obtained from the environmental studies conducted from January through December 1998 from the Dominion Power monitoring survey (May 1997 through February 1999). These data were supplemented by HydroQual with other input data, such as wind speed and direction, and air temperature. The model was validated by simulating conditions during the survey period and noting that model output mirrored the on-site conditions then. Hence, the model could be used for subsequent simulations of full-load conditions. The model used a variable grid structure horizontally with a smaller grid size in critical areas such as Farrar Gut for finer detailed analysis of temperature conditions there. In Figures 14 and 15, the model simulation slightly overestimated summer temperatures at station FG4 and it could be argued that if the simulations for full load did the same, then the temperatures predicted by the model in the summer were a worst-case scenario. Even so, temperatures in Farrar Gut under full-load conditions increased, on average, only 1.1°C at FG4 and by 0.6 °C in the James River. These temperatures are slightly elevated over those observed in the field during the monitoring survey and are minor compared to the natural-

environmental variability seen at the CPS sites observed under normal operating conditions.

The specific effects of increased temperature on fish assemblages were addressed previously by Dr. John Ney in his evaluation letter dated March 2002. The temperature in Farrar Gut has remained the same in this new set of model simulations and the ramifications of temperature increase to fish populations remain the same as in the last report. The only change in the model output is in the James River. Temperatures have increased by 0.2 °C in the new simulations. The fish assemblages in this area are mobile and the slight increase should not restrict their ability to survive or reproduce.

These new model results do not change my opinion that full-load operation of the CPS, as simulated by the HydroQual model, will have no additional impact on the biota of Farrar Gut and the lower James River.

Reference

Blumberg, A.F. and G.L. Mellor. 1980. A Coastal Ocean Numerical Model. *In* Mathematical Modeling for Estuarine Physics. Proceedings of an International Symposium, [Eds] J. Sundermann and K.P. Holz, Springer-Verlag, p 202-219.

Blumberg, A.F. and G.L. Mellor. 1987. A Description of a Three-Dimensional Coastal Ocean Circulation Model. Three-dimensional coastal ocean models, N.S. Heaps, ed., American Geophysical Union, Washington, D.C., 1-16.

Assessment of the Thermal Impact of Full Load Operation of Chesterfield Power Plant on the Fish Assemblage of the Lower James River Based on Hydroqual's Revised Report

by John J. Ney, Ph.D.

June 2003

I have read the revised Hydroqual report (dated April 25, 2003) *Thermal Modeling of Chesterfield Power Station on the James River and Farrar Gut, Virginia* by Blumberg, Ahsan and Li to evaluate how changes in the thermal regime due to continuous full load operation of CPS could affect the fish assemblage of the James River in the vicinity of CPS as well as of the Farrar Gut oxbow, to which three of the CPS units discharge. The updated Hydroqual report is based on revised inputs concerning the discharge point for heated effluent to Farrar Gut and maximum achievable pump flows which would be necessary to operate CPS at full load.

It is my understanding that the revised full-load ΔT projections would result in an average increase of 0.6 C in the James River and 1.1 C in Farrar Gut over temperatures actually measured at James River and Farrar Gut stations throughout 1998 as part of the CPS 316(a) demonstration.

I commented at length (March 2002) on the impacts to the fish assemblage that would be associated with the full-load thermal regime projections developed by Hydroqual in an earlier draft report. In that report, the average James River ΔT for full-load operation was projected at 0.4 C over 1998 survey temperatures, and the average ΔT for Farrar Gut was 1.1 C. On the basis of these values, as well as monthly full-load projections, I concluded that:

1. Full-load temperature increases in the mainstem James River would not restrict the ability of any James River resident or anadromous fish species to find suitable habitats to meet its life cycle needs for reproduction, migration, growth, or survival.

2. Temperature increases in Farrar Gut could affect the duration of the annual attraction (winter)/avoidance (summer) schedule. However, such changes would be so slight as to be beyond detection.

3. Frequency of fish kills in Farrar Gut would not increase due to full-load operation.

Given that the new Hydroqual full-load ΔT projections are virtually identical to those in its earlier draft, I find no grounds for revising the conclusions summarized above.

John J. Ney, Ph.D.
Professor- Fisheries Ecology
Dept. of Fisheries & Wildlife Sciences
VPI & SU
Blacksburg, VA 24061

Assessment of the Thermal Impacts of Full Load Operation of Chesterfield Power Plant on the Fish Assemblage of the Lower James River

by John J. Ney, Ph.D.
March 2002

Introduction

I have read the final draft of the Hydroqual report, "Thermal Modeling of the Chesterfield Power Station on the James River and Farrar Gut, Virginia" (Blumberg and Ahsan 2002) which predicts the temperature increases (ΔTs) that would occur in the receiving waters if Chesterfield Power Station (CPS) was operated at 100% loading (heat rejection of 5.5×10^9 BTU heat rejection) throughout the year. The following is my assessment of the response of the James River fish assemblage to those temperature increases. This analysis is based on my experience with the fish assemblage in the vicinity of CPS and its response to cooling water discharge. I was the primary author of the "Juvenile and Adult Fishes" section of the CPS 316(a) demonstration (Virginia Power 2000) and authored a 1996 report, "Analysis of the Incidence of Fish Mortalities in the Vicinity of the Chesterfield Power Station".

Hydroqual used the ECOM 3-dimensional, multi-grad model to predict temperature increases for 8 dates (3 winter, 1 spring, 4 summer) during 1998 at four stations in Farrar Gut (FG 1-4) and four stations in the James River. These dates were chosen to correspond to thermal surveys conducted for the 316(a) demonstration so that the model could be calibrated, and the predicted temperatures at 100% load could be compared to observed temperatures. The eight dates selected were times when CPS was operating at >75% load, so that worst-case conditions (i.e., high temperatures) could be examined.

The modeling effort appears to have been quite thorough, incorporating all relevant meteorological and hydrological variables, and its grid system provides fine-scale detail. Model validation was impressive, predictions agreeing with observations within ~1 C. Therefore, I have confidence in the model output and base my assessment on the temperature increases it predicts.

Response of the Fish Assemblage

The average predicted increase in ΔT for full loading in the James River is ~0.4 C over the surveyed temperatures on the 1998 dates. Temperature increases of this magnitude will not restrict the ability of any resident or anadromous James River fish species to find suitable habitat to meet its life cycle needs – reproduction, migration, growth, and survival. Temperatures in the mainstem James River increase so little that they do not merit further consideration

For Farrar Gut stations, the average predicted increase in ΔT based on the 1998 data is 1.1 C. While such increases are small, they have the potential to affect the annual attraction/avoidance cycle and the incidence of fish kills. I address both types of thermal response below.

Attraction/Avoidance

Most James River fishes prefer water temperatures of 25-32 C and have upper thermal tolerance limits of 36-40 C (Brown 1974; Houston 1982; Stefan et al. 1992). Fishes in this warmwater species complex (e.g., catfishes, largemouth bass, bluegill sunfish, gizzard shad) generally avoid waters >35 C, as was the case during 1997-99 summer surveys in Farrar Gut. The 316(a) demonstration also showed that the upper half of Farrar Gut provided a winter thermal refuge for several species, notably gizzard and threadfin shad and bluegill sunfish. Conversely, fish of all species avoided upper Farrar Gut (stations FG1 and FG2, sometimes extending to FG3) during the heat of summer (July surveys).

At full load, the Hydroqual model predicts winter water temperature increases of ~ 1 c at Farrar Gut stations. Temperatures will still remain within the attraction range (15-25 c) at stations FG1-FG3. The full-load predictions for summer (July-August) show slightly greater ΔTs, probably because of reduced rate of atmospheric dissipation, averaging 2.1, 2.2, 1.2, and 0.9 C at stations FG1, FG2, FG3, and FG4, respectively. Summer water temperatures at FG1 and FG2 commonly exceed 40 C under present operating conditions, and fish avoid the area. They will continue to do so under full load. Summer temperatures at FG3 are frequently in the avoidance range (36+ C) under current operating conditions. The frequency of summer avoidance temperatures at FG3 may increase slightly if CPS is operated continuously at full load. However, summer avoidance temperatures should not occur at FG4 under 100% loading.

In summary, full load operation of CPS during winter should not attract more fish to upper Farrar Gut. Continuous 100% loading could, however, prolong the period of attraction a few days, depending on the temperature differential between the ambient James River and Farrar Gut. Similarly, fish will continue to avoid upper Farrar Gut during the peak summer months, with the duration of avoidance possibly prolonged a few days and extending to FG3 a bit more often than presently occurs. These potential temporal and spatial increases in the attraction/avoidance cycle are very slight; it would probably require several years of intense monitoring to quantify them, given inherent meteorological variability. They should have no discernable effects on the well-being of the James River fish assemblage.

Potential for Fish Kills

Fish kills have occasionally occurred in Farrar Gut. Three documented kills occurred during the late 1980s, most likely the result of malfunctions in the CPS

chlorination system. (Ney 1996). In response, the chlorination system was replaced; no subsequent fish mortalities attributable to chlorine exposure have been observed.

However, a prolonged die-off, involving mostly gizzard shad, occurred during the winter of 1996, and a kill of threadfin shad happened in February 1999. Threadfin shad died when ambient James River temperature dropped below 7 C. The 1996 gizzard shad die-off was most probably due to repeated exposure to rapidly alternating water temperatures. In this extremely cold and snowy winter, the James River ambient water temperature dropped to as low as 3 C, which can be lethal to gizzard shad (Williamson and Nelson 1985). However, upper Farrar Gut temperatures were in the range of 16-21C. At high water slack tide, the very cold James River water pushed up the Gut, resulting in temperature drops of as much as 10 C within 1-2 hours. Gizzard shad can tolerate instant temperature drops of as much as 13 C (Cox and Coutant 1976), but the stress of repeated exposures (twice daily) to these shifts probably induced mortality.

Threadfin shad will continue to experience die-offs in the James River during cold winters. This species, native to the far southern U.S. and Mexico, has migrated northward as the climate has warmed, but it simply cannot tolerate cold winters. Of more concern is the potential for increased cold shock kills to gizzard shad such as occurred in 1996 if CPS is operated at full load. To the degree that discharge temperature increases, the temperature differential between it and incoming high-tide James River water will be greater. The Hydroqual model predicts an increase of ~ 1 C in the upper Gut, which, for the three 1998 winter dates examined, translated to a maximim of 21 C, which also occurred in upper Farrar Gut during the 1996 die-off period. During that extreme winter, high water slack temperature in Farrar Gut (measured by DEQ) dropped to as low as 11 C, resulting in a 10 C differential within 1-2 hours. The maximum differential would continue or be slightly increased (to perhaps 11 C) at full loading. As noted above, gizzard shad can tolerate this amount of cold shock, although probably not repeated exposure to it. The incidence of such multiple-exposure, cold-shock kills is the direct result of abnormally severe winters and can be expected to occur infrequently. Operation of CPS at full load should not increase the frequency of such kills.

With the exception of the 1999 threadfin shad event, all documented fish kills in Farrar Gut consisted predominantly of gizzard shad. As I noted in the 316(a) demonstration, the gizzard shad is one of the most abundant fishes in the lower James River and its population is refractory to localized die-offs.

Conclusion

Because the water temperature increases projected to result from full load operation of CPS are so slight, any effects on the attraction/avoidance cycle and frequency of fish kills in Farrar Gut would likely be so small as to be beyond detection, given the variable influences of hydrology and meteorology. In my opinion, full load operation of CPS, as projected by the Hydroqual model, will have no additional impact on the abundance and composition of the James River Fish assemblage.

References

Blumberg, A.F., and Q. Ahsan. 2002. Thermal modeling of Chesterfield Power Station on the James River and Farrar Gut, Virginia. Hydroqual, Inc. report to Dominion Generation, Richmond.

Brown, H. 1974. Handbook of the effects of temperature on some North American fishes. American Electric Power Service Corporation, Canton, Ohio.

Cox, D.K., and C.C. Coutant. 1976. Acute cold-shock resistance of gizzard shad. Pages 159-161 *in* G.W. Esch and R.W. McFarlane, editors. Thermal Ecology II. U.S. Deparatment of Energy, Washington, D.C.

Houston, A.H. 1982. Thermal effects upon fishes. National research Council of Canada, Ottawa.

Ney, J.J. 1996. Analysis if the incidence of fish mortalities in the vicinity of the Chesterfield Power Station. Report to Virginia Power Company, Richmond.

Stefan, H.G., and 3 others. 1992. A methodology to estimate global climate change impacts on lake and stream environmental conditions and fishery resources with application to Minnesota. U.S. Environmental Protection Agency, Washington, D.C.

Virginia Power Company. 2000. Section 316(a) demonstration. VPDES Permit Number 0004146. Chesterfield Power Station.

Williamson, K.L., and P.C. Nelson. 1985. Habitat index suitability models and instream flow suitability curves: gizzard shad. U.S. Fish and wildlife service Biological Report 82 (10.112).

Prepared and Submitted by:

John J. Ney
Professor of Fisheries Ecology
Department of Fisheries and Wildlife Sciences
Virginia Polytechnic Institute and State University
Blacksburg, VA 24061-0321

COMMONWEALTH of VIRGINIA

DEPARTMENT OF ENVIRONMENTAL QUALITY

James S. Gilmore, III
Governor

John Paul Woodley, Jr.
Secretary of Natural Resources

PIEDMONT REGIONAL OFFICE
4949-A Cox Road
Glen Allen, Virginia 23060
(804) 527-5020
Fax (804) 527-5106
http://www.deq.state.va.us

Dennis H. Treacy
Director

Gerard Seeley, Jr.
Piedmont Regional Director

July 20, 2001

Ms. Pamela F. Faggert
Vice President and Chief Environmental Officer
Dominion Energy & Dominion Generation
Innsbrook Technical Center
5000 Dominion Boulevard
Glen Allen, Virginia 23060

RE: VPDES Permit No. VA0004146 – Chesterfield Power Station
316(a) Demonstration

Dear Ms. Faggert:

The staff of the Department of Environmental Quality has reviewed the 316(a) Demonstration Report submitted by your letter dated February 29, 2000, and **CH2M**Hill's "Thermal Impact Modeling Study for the Virginia Power Chesterfield Station" submitted by Bill Bolin on February 22, 2001.

The staff concurs with the conclusion stated in the 316(a) Demonstration Report that at the conditions observed during the study, the thermal discharge from Outfall 003 should not cause appreciable harm to the overall, aquatic biological community, and that a balanced, indigenous community of fish, shellfish, and wildlife exists in the James River in the vicinity of the power station. The thermal modeling report however, does not adequately predict the temperatures that will be experienced at full load (i.e., at the thermal limitation requested by Dominion) and consequently, additional thermal modeling is needed to accurately predict those temperatures. After those temperatures are predicted, an assessment must be made to determine if the conclusions of the Demonstration Report are still valid at the predicted temperatures.

As the staff has questions about some of the specific assumptions and inputs used by **CH2M**Hill in their modeling, we suggest a meeting with Dominion staff and the modeling consultant. It may be advantageous to also develop the model to evaluate pollutants such as ammonia as Dominion is pursuing authorization to discharge ammonia at Outfall 004.

Please contact Ray Jenkins at 527-5037 if you have questions.

Sincerely,

Gerard Seeley, Jr.
Regional Director

cc: DEQ – Office of Water Permit Support
DEQ – Office of Water Quality Standards
EPA – Region III (3WP12)
Mr. Martin L. Bowling, Jr. – Vice President Operations, Dominion Energy & Dominion Generation

EXECUTIVE SUMMARY

The Chesterfield Power Station (CPS) is a fossil-fuel electric generating station on the James River east of Richmond and is owned and operated by Dominion (the Company). An extensive 316a Demonstration on the cooling water discharges for Units 4, 5 and 6 was conducted by the Company in 1997-1999 under various typical operating conditions.

Following submittal of the 316(a) Final Report the Virginia Department of Environmental Quality (VADEQ) responded with the following in a letter to the Company:

> "The staff concurs with the conclusion stated in the 316(a) Demonstration Report that at the conditions observed during the study, the thermal discharge from Outfall 003 should not cause appreciable harm to the overall, aquatic biological community, and that a balanced, indigenous community of fish, shellfish, and wildlife exists in the James River in the vicinity of the power station. The thermal modeling report however, does not adequately predict the temperatures that will be experienced at full load (i.e., at the thermal limitation requested by Dominion) and consequently, additional thermal modeling is needed to accurately predict those temperatures. After those temperatures are predicted, an assessment must be made to determine if the conclusions of the Demonstration Report are still valid at the predicted temperatures."

HydroQual, Inc. was contracted by the Company to perform the subsequent modeling study utilizing data from the 316a and comparing them to predicted values of the Chesterfield P.S. operating under the full permit load conditions of 5.55×10^9 BTU/hr for Units 4, 5 and 6 and 1.78×10^9 BTU/hr for Units 3, 7 and 8. The three-dimensional hydrothermal model, ECOM, used in this study has the capability of predicting time variable intake, outlet and river temperatures. The present modeling analysis provides an objective and scientific assessment of the thermal discharges under full permit load conditions.

A practical, numerically efficient, accurate approach has been taken in order to discretize the entire water body including Farrar Gut and the James River within a single modeling grid framework. An orthogonal, curvilinear grid system consisting of a 46x24-segment grid in the horizontal plane was used. A transformed σ-coordinate system in the vertical plane with 11 layers allows the model to have an equal number of high-resolution vertical segments in all the computational grid boxes.

Dominion conducted a series of 24 synoptic temperature monitoring surveys from May 1997 through February 1999. Each survey measured vertical profiles at fourteen stations throughout the James River and Farrar Gut. An assessment of the available data revealed that the year 1998 has a complete set of temperature profile data covering both the winter and summer months. Therefore, the model simulation period was selected as January through December 1998. This provides an

opportunity to model both the critical winter and summer months and determine the temperature rise in Farrar Gut and the James River when the plant is operating in accordance with its full permit capacity.

Different types of data were used as input to the model. Water level boundary conditions were applied at the open boundary at Eppes Island near Hopewell, VA (NOS Station 8638481), using tidal harmonics (amplitude and phase) of the S2, M2, N2, K1, P1 and O1 components. In addition to the water level boundary conditions, the model also requires temperatures at the downstream boundary at Eppes Island. Observed temperature at Turkey Island station (TI1) was used for the downstream boundary conditions. The model was also driven by daily averaged freshwater flows and associated temperature as measured at the USGS flow gage at Richmond, VA. These flows were applied at the grid cell at Richmond. Unfortunately there was no continuous record of temperature available for the Richmond gage. Therefore the temperature recorded at station JR1 during 1998 by Dominion Generation was used for the boundary temperature condition at Richmond. This implicitly assumes that the temperature at JR1 is unimpacted by Chesterfield operations for 1998. The validity of this assumption is justified by how well the model reproduces the temperature at JR1. Finally, the hydrodynamic model requires the input of wind speed and direction, air temperature, relative humidity and short-wave solar radiation. These data were obtained from the Richmond Airport meteorological station.

Chesterfield P.S. operational data were brought into the modeling framework by configuring the plant's intake and discharge flows and associated temperature in the model input module. Discharge temperatures at the condenser for Units 3, 7, and 8 were directly used in the model. However, for Units 4, 5 and 6, the discharge temperatures recorded at the condenser could not be used directly, because these units do not immediately discharge to the Farrar Gut. Plant discharges from these units are routed via underground piping to the head end of a discharge canal where a continuous temperature monitoring station, 003, was located. The heated discharges then flow to Farrar Gut through the canal. Temperature measured at the nearest monitoring station in the Gut was considered to be the true reflection of the plant's thermal discharge. It should be noted that the model requires a continuous specification of temperature at the head end of Farrar Gut. Temperature measured at FG1 was intermittent and therefore, regressions between the temperature at FG1 and Station 003, and Station 003 and the plant outlet temperatures (available hourly throughout the year), were used to fill in the missing data.

The model simulations were performed for January through December of 1998, a period that encompassed the majority of field measurements conducted by Dominion. Calibration and validation of the model have been accomplished by comparing model results against observed tidal levels and temperature in Farrar Gut and the James River. To maximize the strength of the model's

skill assessment, the calibration and validation process is performed concurrently using data from twelve synoptic surveys representing the conditions in the James River and Farrar Gut during the spring, summer and the winter months of 1998. A concurrent approach of calibration and validation was adopted because the temperature data used for this study are statistically independent and they represent a wide range of meteorological and hydrological conditions including hot summer and cold winter months and high (spring) and low flow (summer) periods. The model calibration parameters do not change in time. Therefore, the degree of reliability and robustness of the model for reproducing conditions in both the James River and Farrar Gut during this wide range of seasonal atmospheric and hydrologic conditions can be most reliably assessed. Calibrating and validating the model for the entire year-1998 also encompasses a wide range of tidal (spring-neap cycle) conditions. A successful model skill assessment using data over a complete annual cycle is arguably the strictest test of model performance (Blumberg and Pritchard, 1997). Overall the model prediction of temperature during 1998 is quite good and the overall RMS error is 1.1C (2.0F). Model calibration against tidal level data was also quite good. The error is less than 1%.

The present analysis was directed at computing the temperature rise (ΔT) in Farrar Gut and the James River for conditions when the plant was operating at full permit load capacity (5.55×10^9 BTU/hr for Units 4, 5, and 6 and 1.78×10^9 BTU/hr for Units 3, 7 and 8). The model is used to perform a continuous simulation for the entire 1998 period. For analysis purposes, we isolate the periods when the synoptic surveys were conducted throughout the James River system. This is because the survey data give a very accurate depiction of conditions in the entire river as they capture both the vertical and horizontal thermal structure and seasonal temperature variations. We examine the temperature rise for the times when synoptic survey data were available during 1998 (including summer and winter months). The average temperature rise (ΔT) is found to be 1.6C (2.9F) at Station FG4 during permit load conditions. Accurate temperature prediction at FG4, near the confluence of Farrar Gut and the James River is considered an important part of the model because this is the point at which the thermal loading from Outfall 003 is ultimately discharged to the James River. The average temperature rise for the entire Farrar Gut is 1.1C (2.0F) and for the James River it is 0.6C (1.2F). These temperature rises are not high enough to produce significant changes to the hydrodynamic characteristics of the James River system.

than the lower discharges of 1998 do. Figures 16a through 16c illustrate longitudinal profiles of temperatures along the James River. The highest temperature rise occurs near stations JR4 and JR5, downstream of Outfalls 001 and 002. It should be noted that waters from Farrar Gut enters the James between stations JR4 and JR5.

The average increase in temperatures due to full permit load conditions, during the synoptic survey periods, were 1.1C (2.0F) in Farrar Gut and 0.6C (1.2F) in the James River. This does not include the synoptic survey on October 22, 1998 when the Chesterfield plant was not operating. The average temperature rise due to permit load conditions at FG4 is 1.6C (2.9F). Station FG4 is a key location at which the thermal loading from Outfall 003 is ultimately discharged to the James River. These temperature rises are not high enough to produce significant changes to the hydrodynamic characteristics of the James River system.

9. CONCLUSION

Chesterfield Power Station is in the process of renewing its NPDES permit. Dominion has previously performed a Section 316(a) demonstration on the cooling water discharge for Units 4, 5 and 6 under various operating conditions. However, the demonstration did not focus on the combined simultaneous operating conditions of these units at full permit load. The Virginia Department of Environmental Quality (DEQ) identified the need for a modeling effort to accurately predict the temperature in Farrar Gut under full permit load conditions of 5.55×10^9 BTU/hr for Units 4, 5 and 6, and 1.78×10^9 BTU/hr for Units 3, 7 and 8.

The current study addressed the need to predict temperatures in Farrar Gut and the James River, specifically at stations where synoptic surveys were conducted under full permit load conditions. The three-dimensional hydrothermal model, ECOM, was used in this study. The model simulations were performed during January through December of 1998, a period that was sufficiently long enough to encompass the field measurements conducted by Dominion. Calibration and validation of the model have been performed by comparing model results against observed tidal levels and temperature data in Farrar Gut and the James River. The model skill assessment was demonstrated by comparing the model predicted temperature against the observations at all the stations surveyed by Dominion Generation during 1998, including the cold winter and hot summer months. Overall the model prediction of temperature for the entire period of 1998 is quite good and the overall RMS error is 1.1C (2.0F). Model calibration against tidal level data was also quite good.

An analysis of the plant data and model results indicates that the Chesterfield P.S. operating loads are quite variable in time. These synoptic data give a very accurate depiction of conditions in the entire river as they capture both the vertical and horizontal thermal structure as well as seasonal variability in temperature. The model calibration performed against these temperature profile data provides a high level of confidence in the model. The present analysis was directed at computing the temperature rise (ΔT) in Farrar Gut and the James River for predicted condition of when the station was operating at full permit load capacity (5.55×10^9 BTU/hr for Units 4, 5 and 6, and 1.78×10^9 BTU/hr for Units 3, 7 and 8). For the times when synoptic survey data were available during the entire simulation period of 1998, including the summer and winter months, the average temperature rise (ΔT) is 1.6C (2.9F) at Station FG4, a key location for this study located at the confluence of Farrar Gut and the James River. Accurate temperature prediction at FG4 is considered an important part of the model because this is the point at which the thermal loading from Outfall 003 is ultimately discharged to the James River. The average temperature rise for the entire Farrar Gut is 1.1C (2.0F) and for the James River it is 0.6C (1.2F).

10. REFERENCES

Ahsan, Q., and A. F. Blumberg, 1999. A Three-Dimensional Hydrothermal Model of Onondaga Lake, New York. *Journal of Hydraulics*, Vol 125, No 9, September 1999, ASCE.

Blumberg, A. F. and D. M. Goodrich, 1990. Modeling of Wind-Induced Destratification in Chesapeake Bay, Estuaries, 13(3), 236-249.

Blumberg, A. F. and N. Kim, 2001. Flow Balances in St. Andrew Bay Revealed Through Hydrodynamic Simulations, Estuaries, Vol 23, No. 1, p. 21-23, February 2001.

Blumberg, A. F. and G. L. Mellor. 1980. A Coastal Ocean Numerical Model, In Mathematical Modeling of Estuarine Physics. Proceedings of an International Symposium, J. Sundermann and K.P. Holz (Eds.), Springer-Verlag, Berlin, 202-19.

Blumberg, A. F., and G. Mellor, 1985. A Simulation of the Circulation in the Gulf of Mexico. Israel Journal of Earth Sciences, Vol. 34, 1985, pp 122-144.

Blumberg, A.F., and G. L. Mellor. 1987. A Description of a Three-Dimensional Coastal Ocean Circulation Model. Three-dimensional coastal ocean models, N.S. Heaps, ed., American Geophysical Union, Washington, D.C., 1-16.

Innsbrook Technical Center
5000 Dominion Boulevard
Glen Allen, Virginia 23060

JAN 1997
PRO

January 15, 1997

VIRGINIA POWER

Ray R. Jenkins
Department of Environmental Quality
Piedmont Regional Office
4949-A Cox Road
Glen Allen, VA 23060-6295

PRO - Paylor, Bell, alling, Daub, Pfeifle
WER&S - Daub
EPA
OWPS

RE: 316(a) Study Plan

Dear Mr. Jenkins:

Attached is Virginia Power's proposed study plan to conduct a 316(a) demonstration for Chesterfield Power Station to determine if current thermal limitations and requirements are more stringent than necessary to assure the protection and propagation of a balanced, indigenous community of shellfish, fish and wildlife in the James River/Farrar Gut area. We appreciate your suggestions for study categories in your September 27, 1996 letter to me and we believe we have sufficiently addressed all of the categories in our study plan.

Please note that we have hired the following two consultants to assist us during the study:

1) Dr. John Ney - Professor and Fisheries Section Coordinator, Virginia Polytechnic Institute and State University

2) Dr. Cynthia Jones - Associate Director, Applied Marine Research Laboratory, Old Dominion University

The consultants made recommendations concerning the development of the study plan and will be advising us during the study. In addition, John Kauffman of the Virginia Department of Game and Inland Fisheries, has agreed to participate in the study and provide input into the process as appropriate.

The study plan includes a temperature monitoring program that willl fulfill the requirements of Special Conditions 5 of the draft VPDES permit. Quarterly reports will be submitted according to the schedule in the draft permit. A revised monitoring protocol will be submitted within 60 days after the end of data collection for the 316(a) study.

Initiation of field data collection will commence upon DEQ approval of the study plan. We wish to start the study during the first quarter of 1997.

Thank you for your timely review of the proposed study plan. Please call me at 273-2948 if you have any questions.

Sincerely,

J. W. White
Director
Environmental Compliance-Water/Waste

Attachment

STUDY PLAN FOR A 316(a) DEMONSTRATION AT CHESTERFIELD POWER STATION

JANUARY 1997

INTRODUCTION

In accordance with Section 316(a) of the Clean Water Act, Virginia Power has decided to undertake a study to demonstrate whether the current thermal limitations in VPDES Permit VA0004146 for Chesterfield Power Station (CPS) are more stringent than necessary to assure the protection and propagation of a balanced, indigenous community of shellfish, fish and wildlife in the upper tidal James River adjacent to the power station. A detailed study plan is described in this document and includes all appropriate environmental components, including items recommended by the Department of Environmental Quality (DEQ) in a letter dated September 27, 1996 from R.R. Jenkins, necessary to determine what thermal limitations and requirements are adequate to permit efficient operation of the power station while assuring the protection of the aquatic community.

EPA has not issued final guidance that establishes the required elements of a 316(a) demonstration; however, several draft documents have been published (DEQ references a 1977 draft EPA document in the above mentioned letter). The draft documents describe various demonstration types (e.g., 1,2, or 3) and also provide for alternative study plans based upon the uniqueness of the receiving water and the approval by the authorized state agency. It is not Virginia

Power's intent to propose a specific demonstration "Type", but to submit a study plan for DEQ approval that will allow for the determination of whether the thermal discharges from CPS cause appreciable harm to the biological communities to the extent of interfering with the protection and propagation of a balanced, indigenous community of shellfish, fish, and wildlife.

The study will essentially examine the thermal impacts associated with the operation of the entire power station (Units 3-8)on the James River/ Farrar Gut area. Virginia Power is specifically interested in determining if the demonstration can justify the retirement of a floating power spray module system, called a sparger system, used to reduce heat discharged from Units 4, 5, and 6. This system was voluntarily installed in the early 1970s to provide supplemental cooling as well as to increase dissolved oxygen levels in the river. Virginia Power believes that the continued operation of the sparger system is not cost effective because there are no perceived environmental benefits associated with its current operation.

A single variable is difficult to isolate in a complex ecological system such as the upper tidal James River; therefore, impact assessment should be related to the total effect on the ecosystem. This holistic approach allows scientists to consider the resiliency of biological systems to imposed perturbations in assessing community health. For example, it may be possible that biological changes or localized impacts within the Farrar Gut area could be identified while still maintaining a balanced, indigenous community . Therefore, it is important to sample the biota seasonally and in areas within and outside the influence of the thermal discharge. In addition, information on station operation, local hydrology, and thermal isotherms is necessary to relate to the results of biological sampling..

METHODS

Study Sites and Frequency

Sampling locations will be selected to make physical and biotic comparisons among similar habitats that are in Farrar Gut, the mainstem of the river, and areas out of the influence of the thermal effects (e.g., James Island and Turkey Island oxbows). Seasonal collections will be made to reflect anticipated differences in the physical, chemical, and biological environment.

Water Temperature and Dissolved Oxygen

Temperature and dissolved oxygen levels are interrelated and are important physicochemical parameters in any thermal study of an aquatic ecosystem. Water temperature and dissolved oxygen surveys will be conducted six times per year (Table 1) at Stations JR1, JR2, JR3, JR4, JR5, JR6, JR7, JR8, JN1 and TI1 in the James River, at Stations FG1, FG2, FG3, and FG4 in Farrar Gut, and at Stations Q1 and Q2 to represent quarries adjacent to both the gut and river (Figure 1). Water temperature will be measured to the nearest 0.1°C and dissolved oxygen to the nearest 0.1 mg/l using Hydrolab Surveyor 3 water quality meters. Measurements will be made in one meter increments surface to bottom at mid-channel and near both shores for a total of three sampling locations on a transect at each station with the exception of the two quarry stations, and at Station FG2, where channel width is minimal. At these stations, surface to bottom profiles will be made near the center of the quarries and at mid-channel at FG2. Transect surveys will commence at slack before ebb tide and/or slack before flood tide. The surveys performed during low water slack (LWS) tides will start at the downstream stations and work upstream. The surveys conducted at high water slack (HWS) will begin upstream and work downstream. If an initial survey is performed on LWS, then one week later a complementary survey will be performed at HWS. If the initial survey is performed on HWS,

then one week later a complementary survey will be performed on LWS.

In addition, continuous temperature recorders will be installed on the first survey of each pair of surveys at Stations JR1, JR5, JN1, and TI1 in the James River and at Stations FG1, FG3, and FG4 in Farrar Gut.. The instruments will be programmed to record temperatures at one hour intervals, and will subsequently be retrieved on the second survey of each paired survey, one week later per quarter.

Nutrients

Nutrient input from both point sources and non-point sources can affect the relative abundance and species composition of both phytoplankton and zooplankton populations in the James River and Farrar Gut. Water samples will be collected quarterly (Table 1) and analyzed for total phosphorus, nitrate + nitrite, and ammonia at Stations JR1, JR5, JR7, JN1 and TI1 in the James River and at Stations FG2, FG3 and FG4 in Farrar Gut (Figure 1) using a 3 meter PVC pipe with a diameter of 4 cm. This collection method allows for an integrated surface and subsurface water grab. Tidal conditions will be documented for each survey. Total phosphorus will be measured using EPA Method 365.2, nitrate + nitrite will be measured using EPA Method 353.2, and ammonia will be measured using EPA Method 350.3.

Phytoplankton and Chlorophyll (a)

Phytoplankton generally represent a significant portion of the basic energy requirements in most surface waters through their ability to convert solar energy and inorganic carbon to usable food materials for zooplankton and some fish species (Odum 1971; U.S. EPA 1977). While most rivers and streams are considered "low potential impact areas" for phytoplankton according to U.S. EPA's 316(a) Technical Guidance Manual (1977), there are concerns of thermal discharges resulting in

phytoplankton population shifts toward nuisance species. Water samples for both qualitative and quantitative analyses of phytoplankton community structure will be collected quarterly (Table 1) at Stations JR1, JR5, JR7, JN1 and TI1 in the James River, Stations FG2, FG3 and FG4 in Farrar Gut, and at both quarry stations, Q1 and Q2 (Figure 1). In tidal freshwater environments such as the James River in the vicinity of Chesterfield Power Station, tidal fluctuations would be expected to show minimal influence on the planktonic community structure (Dr. Harold G. Marshall, Old Dominion University - personal communication), therefore sampling will not be correlated with a particular tide cycle. Tidal conditions will, however, be documented for each survey. Water samples will be collected using the same 3 meter PVC pipe used to collect nutrient samples, thus representing an integrated sample including the euphotic zone. Two (2) replicate 500 ml subsamples will then be preserved with Lugol's solution. In addition, Secchi depth and pH will be measured at each station. The replicate subsamples will then be examined microscopically for determination of taxonomic composition, algal concentrations (cells/liter) and cell volume (cubic microns/microliter).

Although phytoplankton biomass estimates based on chlorophyll (a) measurement are relatively imprecise, they sometimes provide additional insight into the relative amount of standing crop (U. S. EPA 1973). Therefore, in addition to characterization of the phytoplankton community by microscopic examination, the chlorophyll (a) content, adjusted for pheophytin (Standard Methods 10200H), will also be measured through collection of samples quarterly.

Zooplankton

Zooplankton represent the first consumer level of the aquatic food chain and are especially important in the diets of young-of-year fishes and some species of adult fishes (Jensen 1974).

Seasonal cycles of zooplankton abundance are dependent on food supply (algae, protozoa, bacteria and detritus) and temperature (Edmondson 1965; Pennak 1978). Zooplankton samples will be collected quarterly (Table 1) at Stations JR1, JR5, JR7, JN1 and TI1 in the James River and at Stations FG2, FG3 and FG4 in Farrar Gut (Figure 1) concurrent with the nutrient and phytoplankton sampling schedule. Three replicate vertical tows from bottom to surface will be made at each midchannel station using an 80 micron mesh Wisconsin plankton net with the depth recorded for determination of sample volume based on net dimensions. Samples will be preserved with formalin/rose bengal dye and returned to the laboratory for microscopic examination and determination of taxonomic composition and relative densities (number/cubic meter).

Benthic Macroinvertebrates

Benthic macroinvertebrates will be monitored to represent a sessile component of the riverine biota. Aquatic macroinvertebrates are considered to be excellent indicators of environmental stress due to their lack of mobility, sensitivity to various environmental perturbations, and extended life cycles (Hynes 1965; Lehmkuhl 1970; Cairns and Dickson 1971). Benthic macroinvertebrate populations will be surveyed quarterly (Table 1) using an Ekman dredge at Stations JR1, JR5, JR7, JN1 and TI1 in the James River, and at Stations FG2, FG3 and FG4 in Farrar Gut (Figure 1). Substrate in this area of the river generally consists of a mixture of silt, sand, clay and organic detritus (Jensen 1974), and the Ekman dredge represents the most efficient gear for sampling substrates of this type (Flannagan 1970; Howmiller 1971; U.S.EPA 1973). Samples will be collected near shore to avoid areas dredged for ship passage, and from similar substrate types. Substrate type will be characterized and this information included in the station to station comparisons. A total of three grabs will be collected per station. Each grab will be washed through

a #30 mesh sieve, placed in a jar and labeled. The sample will be preserved with 80% ethyl alcohol and stained with rose bengal dye. In the laboratory, samples will be hand-sorted, identified to major taxa and enumerated for calculations of abundance at each station (average number of organisms/square meter). Since benthic macroinvertebrates are sessile, sampling will not be correlated with any particular tide cycle.

Juvenile and Adult Fishes

Fish populations represent the upper component of the food chain. Fish have the capability to adapt to changes in their thermal regime via their mobility. Jensen (1974) found that the relative abundance of fishes in the study area varied seasonally and in response to thermal effluent. Boat electrofishing will be utilized to monitor the littoral component of the fish population, while bottom-set experimental gill nets will be used to monitor the offshore component. Electrofishing has been utilized in stream sampling to characterize species composition, relative abundance, size distribution and population structure and is considered more efficient and less biased than other sampling methods (Woolcott et al. 1974; Catchings et al. 1984). Gill nets are often used to sample fishes at depths not effectively sampled by boat electrofishing. Gill net data are not as quantitative as electrofishing data, but can be used to identify the presence or absence of species not vulnerable to electrofishing and as an indicator of relative abundance (Little et al. 1984). Fish sampling will be conducted seasonally (Table 1) to accurately represent the presence of fish within Farrar Gut and the James River. Boat electrofishing surveys will be conducted at Stations JR1, JR5, JR7, JN1 and TI1 in the James River, at Stations FG1, FG2, FG3 and FG4 in Farrar Gut, and at quarry Stations Q1 and Q2 (Figure 1). At each station one hundred meters of shoreline will be electrofished. Selected gamefish and larger rough fish will be measured (total length in mm) and weighed (weight in grams),

and released in the field. The remainder of the catch will be preserved and returned for laboratory processing and determination of the species composition and relative abundance of fish per station. As recommended in the U. S. EPA's 316 (a) Technical Guidance Manual (1977), three species will be considered as "Representative Important Species" (RIS) warranting more detailed study. These species include largemouth bass (Micropterus salmoides) and channel catfish (Ictalurus punctatus) as important game and commercial fish species representing the top of the aquatic food chain and with varying life history requirements according to age, and gizzard shad (Dorosoma cepedianum) which, while not commercially important, does represent a forage fish species when young and is susceptible to thermal shock. Particular attention will be focused on the relative abundance of these species in Farrar Gut, the mainstem James River and its oxbows and in the two quarry locations,. An experimental anchor tagging study of bass and catfish will be conducted to determine residency and seasonal distributions (gizzard shad are too fragile to tag). In addition, length frequency, annual growth in length, and body condition (relative weight - Wr) will be examined for each RIS species to identify any thermal effects on growth history. Reproductive success will be assessed based on length frequency results, body condition and observation of any spawning behavior (i.e. nesting activity or spawning congregations).

In addition to electrofishing, experimental gill nets will be deployed at Stations JR1, JR5, JR7, JN1 and TI1 in the James River and Stations FG1, FG3 and FG4 in Farrar Gut (Figure 1) for a period of up to six hours. The length of the net sets may require adjustment dependent upon fish and debris catch rates determined at the beginning of the study. The experimental gill nets will be approximately 100 feet long and 6 feet deep with panels of 1-1/2", 2", 2-1/2", 3" and 4" stretch monofilament mesh. Any large fish exhibiting minimal net damage will be measured, weighed and

released in the field, while the remainder of the sample will be processed at the laboratory. Gill net results will be reported as catch per unit effort (hours) and used to supplement taxonomic characterizations among stations.

As part of the fishery assessment, a literature search and communication with regional ichthyologists will also be conducted to identify any endangered, threatened or species of special concern that could possibly occur in the study area. It is recognized that at least one species of special concern, the Atlantic sturgeon (*Acipenser oxyrhynchus)* uses the tidal James River as a nursery ground (Jenkins and Burkhead 1994). However, abundance appears to be very low: only 35 juvenile sturgeon were captured in extensive trawl surveys conducted by the Virginia Institute of Marine Science between 1964 and 1982. Juvenile sturgeon might inhabit hard-bottomed areas of the lower James River for up to three years, although the distribution and life history of Atlantic sturgeon in the Chesapeake Bay region is poorly understood (Gilbert 1989). In the unlikely event that a juvenile sturgeon is captured in the course of this study, it will measured and released and the Virginia Department of Game and Inland Fisheries will be notified.

Habitat Formers

Aquatic vegetation can serve as important nursery areas for fish and other aquatic organisms. The type of vegetation present can also reduce forage availability for piscivores, result in oxygen depletion and create a nuisance for boating and recreational opportunities. The abundance and distribution of aquatic plants can be influenced by a variety of factors including nutrient levels, temperature, turbidity, siltation and current velocity. Annual summer visual surveys by boat of the study area will be conducted to identify aquatic plant communities. The data will be used to document the size, distribution and composition of the aquatic plant communities. The vegetative

communities in Farrar Gut, the mainstem James River, and the Jones Neck and Turkey Island oxbows will then be compared.

Vertebrate Wildlife

The presence and estimated abundance of vertebrate wildlife usage of the study area will be documented by visual observation. In addition, concentrations of waterfowl and other vertebrate wildlife observed during the biological monitoring surveys will be documented.

Other

Station operating data will be provided to include station load, circulating water pump operation, and an assessment of chemical usage and discharges (e.g., chlorine). Also, hydrologic information associated with the study area will be presented including a description of the upstream and downstream tidal excursion.

SCHEDULE AND FINAL REPORT

Data collection will be initiated the first quarter of 1997, assuming there are no major concerns with the study plan by DEQ. It is anticipated that, at a minimum, a progress review meeting with DEQ will be requested after the first year of data collection to evaluate the status of the demonstration and determine if changes are recommended for the second year. The Virginia Department of Game and Inland Fisheries (John Kauffman) has agreed to participate in the 316(a) study in an advisory capacity and should be invited to any progress review meetings.

The final report resulting from this study will present two years of data on all biotic components, thermal and nutrient dynamics, and plant operating conditions. Appropriate

comparisons will be made between similar habitats (main river, oxbows, and quarries) within versus outside the thermal mixing zone. The narrative of this demonstration will synthesize this information with the relevant literature base to comprehensively assess the effects of CPS thermal discharges on the aquatic community of the James River.

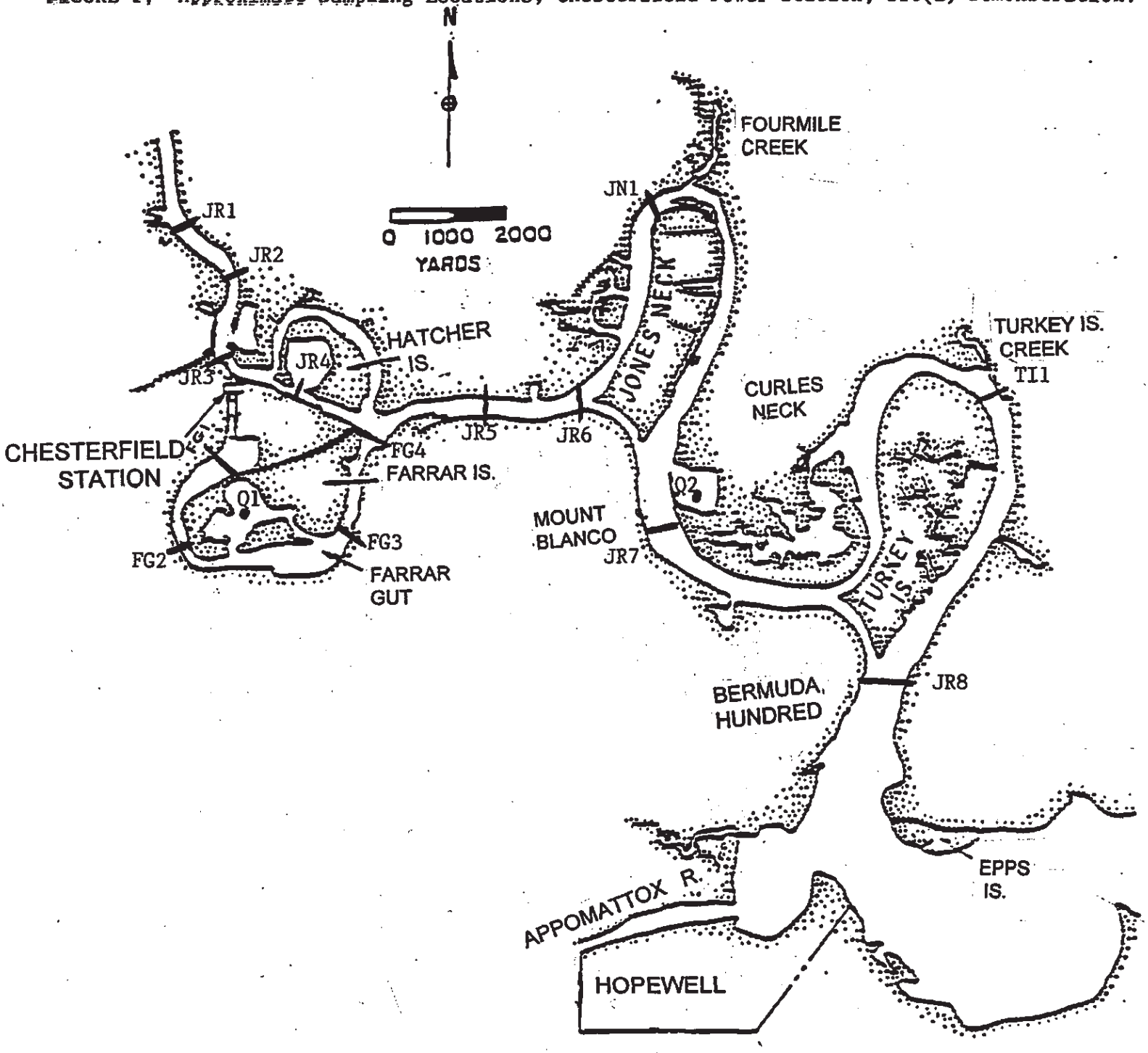
The 316(a) study will provide the scientific information to determine whether the existing thermal limitations and requirements are more stringent than necessary to protect the aquatic community. It is understood that any new heat rejection limitations proposed after the study will be based upon the results of the demonstration including necessary predictions to account for any differences between the limitations requested and actual operational levels.

TABLE 1: **Sampling Dates by Discipline in the James River, Chesterfield Power Station**

	Months											
	J	F	M	A	M	J	J	A	S	O	N	D
Temperature/DO		X		X	X			X		X	X	
Nutrients		X			X			X			X	
Phytoplankton/Chlorophyll(a)		X			X			X			X	
Zooplankton		X			X			X			X	
Benthics		X			X			X			X	
Fish		X		X	X			X		X	X	
Habitat Formers								X				
Vertebrate Wildlife		*		*	*			*		*	*	

* incidental wildlife observations to be recorded in field notes during regular sampling.

FIGURE 1: Approximate Sampling Locations, Chesterfield Power Station, 316(a) Demonstration.



	JR1	JR2	JR3	JR4	JR5	JR6	JR7	JR8	JN1	TI1	FG1	FG2	FG3	FG4	Q1	Q2
Temperature/Dissolved Oxygen	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Continuous Temperature Recorders	X				X				X	X	X		X	X		
Nutrients	X				X		X		X	X		X	X	X		
Phytoplankton/Chlorophyll (a)	X				X		X		X	X		X	X	X	X	X
Zooplankton	X				X		X		X	X		X	X	X		
Benthic Macroinvertebrates	X				X		X		X	X		X	X	X		
Electrofishing	X				X		X		X	X	X	X	X	X	X	X
Gill Netting	X				X		X		X	X	X		X	X		

Literature Cited

Cairns, J., and K. L. Dickson. 1971. A simple method for the biological assessment of the effects of waste discharges on aquatic bottom-dwelling organisms. Journal of the Water Pollution Control Federation 43(5):755-772.

Catchings, E,. D., L. E, Kornman, J. L. Boaze, and J. Kauffman. 1984. Electrofishing. Pages 3-1 through 3-18 in Warmwater Streams Techniques Manual: Fishes. Warmwater Streams Committee, Southern Division, American Fisheries Society, Bethesda, MD.

Edmondson, W. T. 1965. Reproductive rate of planktonic rotifers as related to food and temperature in nature. Ecological Monographs 35(1):61-111.

Flannagan, J. F. 1970. Efficiencies of various grabs and corers in sampling freshwater benthos. Journal of the Fisheries Research Board of Canada 27:1691-1700.

Gilbert, C.R. 1989. Species profiles: Atlantic and shortnose sturgeons . U.S. Fish and Wildlife Services Biological Report 82 (11.122).

Howmiller, R. P. 1971. A comparison of the Effectiveness of Ekman and Ponar Grabs. Transactions of the American Fisheries Society 100:560-564

Hynes, H. B. N. 1965. The significance of macroinvertebrates in the study of mild river pollution. Pages 235-240 in Biological Problems in Water Pollution. United States Public Health Service Publication, Cincinnati, OH.

Jenkins, R.E., and N. M. Burkhead. 1994. Freshwater fishes of Virginia. American Fisheries Society, Bethesda, MD.

Jensen, L. D. 1974. Environmental responses to thermal discharges from the Chesterfield Station, James River, Virginia. Cooling Water Discharge Research Project (RP 49). Electric Power Research Institute, Palo Alto, CA.

Lehmkuhl, D. M. 1979. Environmental disturbance and life histories: principles and examples. Journal of the Fisheries Research Board of Canada 36:329-334.

Little, J. D., C. J. Killebrew, and W. H. Tarplee, Jr. 1984. Nets. Pages 6-1 through 6-17 in Warmwater Streams Techniques Manual: Fishes. Warmwater Streams Committee, Southern Division, American Fisheries Society, Bethesda, MD.

Odum, E. P. 1971. Fundamentals of Ecology. Third edition. W. B. Saunders, Philadelphia, PA.

United States Environmental Protection Agency. 1973. Biological Field and Laboratory Methods for Measuring the Quality of Surface Waters and Effluents. Office of Research and Development, Cincinnati, OH.

United States Environmental Protection Agency. 1977. Draft Interagency 316(a) Technical Guidance Manual and Guide for Thermal Effects Sections of Nuclear Facilities Environmental Impact Statements. Office of Water Enforcement Permits Division, Washington, D.C.

Woolcott, W. S. 1974. The Effects of Thermal Loading by the Bremo Power Station on a Piedmont Section of the James River. Volume II. Virginia Institute for Scientific Research, Richmond, VA.

COMMONWEALTH of VIRGINIA

DEPARTMENT OF ENVIRONMENTAL QUALITY

George Allen
Governor

Becky Norton Dunlop
Secretary of Natural Resources

PIEDMONT REGIONAL OFFICE
4949-A Cox Road
Glen Allen, Virginia 23060
(804) 527-5020
Fax (804) 527-5106
http://www.deq.state.va.us

Thomas L. Hopkins
Director

Gerard Seeley, Jr.
Piedmont Regional Director

cc: EPA

September 27, 1996

Mr. J. W. White
Director
Environmental Compliance -- Water/Waste
Virginia Power
Innsbrook Technical Center
5000 Dominion Boulevard
Glen Allen, Virginia 23060

RE: VPDES Permit VA0004146 -- Chesterfield Power Station

Dear Mr. White:

As discussed at our meeting on September 11, 1996 the staff of the Department of Environmental Quality has reviewed the requirements of a 316(a) study and attempted to identify those areas that are of greatest concern for the James River/Farrar Gut area. Our reference for the following discussion is a draft document developed by the EPA titled "Interagency 316(a) Technical Guidance Manual and Guide for Thermal Effects Sections of Nuclear Facilities Environmental Impact Statements" dated May 1, 1977. A copy of that document is enclosed.

The EPA document identifies categories of study and establishes for six biotic categories criteria for determining if a thermal discharge represents a "low potential impact" to that category. If classified as "low potential impact", the amount of additional work needed to address that category should be minimal and a Type III Low Potential Impact Determination will be needed (see page 63 of document).

Our evaluation of the requirements of a 316(a) demonstration is as follows:

1. Phytoplankton

   This biotic category may possibly be classified as "low potential impact". There are important questions about the phytoplankton community however, that should be answered by an "Other Type III Demonstration" (see page 64 of document). The demonstration

Phytoplankton (continued)

should include algal identification and chlorophyll analyses at stations in Farrar Gut, the "Lone Star" quarry, the Jones Neck and Presquile Isle oxbows, the quarry located just below Jones Neck Cutoff (public access available), and upstream above any thermal influence (above Buoy 157).

2. Zooplankton and Meroplankton

This biotic category can probably be classified as "low potential impact". A Type III Low Potential Impact Determination will be needed.

3. Habitat Formers

This biotic category can probably be classified as "low potential impact". A Type III Low Potential Impact Determination will be needed.

4. Shellfish/Macroinvertebrates

This biotic category may possibly be classified as "low potential impact". There are important questions about the shellfish/macroinvertebrate community however, that should be answered by an "Other Type III Demonstration". The demonstration should include a comparison of the benthic community in Farrar Gut to that in the Presquile Isle oxbow.

5. Fish

A Type II Demonstration (see page 34 of document) is required for this category. An endangered species that may be in the study area is the sturgeon.

6. Other Vertebrate Wildlife

This biotic category can probably be classified as "low potential impact". A Type III Low Potential Impact Determination will be needed.

7. The outline for conducting a Type II study identifies a number of areas that must be addressed. Of particular importance are the following sections:

   a. Plant Operating Data (3.5.3.1.), especially the section that requires an assessment of chlorine in the discharge.

   b. Hydrologic Information (3.5.3.2.), especially the determination of tidal range; i.e., the upstream and downstream tidal excursion.

   c. Plume Data Requirements (3.5.3.5.) with isotherms plotted at 1°C intervals.

As the VPDES permit for the Chesterfield Power Station has expired, your comments on the feasibility of conducting a 316(a) demonstration would be appreciated as soon as possible and by no later than October 15, 1996.

We are continuing to research other questions you have raised and will respond as soon as possible.

Please contact me at 804/527-5037 if you have any questions. If you feel that a meeting would be helpful please let me know.

Sincerely,

Ray R. Jenkins, Jr.

Ray R. Jenkins, Jr.
Environmental Engineer Senior
Water Permits

/rrj

cc: DEQ – Water Environmental Research and Standards
DEQ – Office of Water Permit Support

ANALYSIS OF THE INCIDENCE OF FISH MORTALITIES IN THE VICINITY OF THE CHESTERFIELD POWER STATION

A Report to Virginia Power

by

John J. Ney, Ph.D.
Professor of Fisheries Science
Virginia Polytechnic Institute and State University
Blacksburg, VA 24061-0321

June 1996

INTRODUCTION

Virginia Power operates a six unit (1,750 MW total rating capacity) coal-fired generating station on the James River near Chesterfield, Virginia. Cooling water is withdrawn from the James River, and the heated effluent is discharged to the river (three units) and to Farrar Gut (three units), a 3.5 mile backwater loop connecting to the James River downstream of the station. Heated water enters the upstream end of Farrar Gut through a 1,750-feet discharge canal. Since 1971, the discharge canal has contained 128 floating spray units (termed "spargers") intended to dissipate waste heat into the atmosphere, reducing the ΔT of the discharge entering the Gut. The James River at Chesterfield is fresh water under tidal influence (average of 2.9 ft. differential between high and low tides).

Sightings of dead fish in Farrar Gut have been reported on several occasions over the 35-year operating history of CPS. The most recent die-off occurred during the winter of 1996, prompting questions about the impact of CPS operation on the fish community of Farrar Gut. At this time, Virginia Power is questioning the cost effectiveness of continued operation of its sparger complex in the CPS discharge canal. The Company is concerned whether termination of sparger operations would adversely affect the fish community of Farrar Gut.

This paper addresses the concerns regarding past fish mortalities in Farrar Gut and the potential incidence of such mortalities in the future. Specific objectives of this paper are to:

1) Identify the probable sources of past reported fish mortalities in Farrar Gut.
2) Evaluate the impact of these losses to the balanced, indigenous community; and
3) Assess the potential influence of discontinuance of sparger operations on the frequency and magnitude of future fish mortalities.

The paper represents my objective professional assessment of the impact of the operation of Chesterfield Power Station on the fish community of Farrar Gut. This assessment is primarily derived from the sources of information listed below.

SOURCES OF INFORMATION

Inputs to this paper include data and reports on the James River/CPS/Farrar Gut physical and biological characteristics provided by Virginia Power, the Department of Environmental Quality (DEQ), the Virginia Department of Game and Inland Fisheries (VDGIF), and the Virginia Marine Resources Commission (VMRC). This information was supplemented by personal communication with DEQ and VDGIF personnel as well as with Dr. Gregory Garman, Professor of Biological Science at Virginia Commonwealth University.

A third major source of information for this paper is the published scientific literature, most particularly on the thermal tolerances of fish and the ecology of resident species. Finally, I draw on my own experience as a professional fisheries scientist. Since 1976, I have been a faculty member at Virginia Tech, conducting research on anthropogenic impacts to fish and other aquatic biota which include consequences of hydro and steam electric power generation. Prior to employment at Virginia Tech, I was the Senior Biologist for Wisconsin Electric Power Company, investigating potential impacts on aquatic communities resulting from chlorination, fish entrapment, and thermal discharges. I also made a site visit to CPS and Farrar Gut on May 23, 1996.

In preparing this report, I have been most impressed with the spirit of ready cooperation displayed by all parties from whom I asked assistance. I am particularly grateful for the inputs provided by Mark Alling, Ray Jenkins and Bill Pfeifle of the DEQ staff, Dean Fowler of VDGIF, and Greg Garman of VCU.

SOURCES OF PAST MORTALITIES

To my knowledge, five fish kills have been documented in Farrar Gut, the first in 1980, another in 1987, two in 1989, and the most recent in the winter of 1996. It is, of course, possible that other incidents of fish mortalities have occurred in Farrar Gut because no one is assigned to survey for dead fish on a continual basis. However, any such kills, if they occurred, were probably too transient and/or involved too few fish to bring attention to the event.

For each of the five reported kills, I briefly summarize the reports, including any assessments of cause. I then offer my own interpretation of probable cause, based on the information available.

July 1980

Virginia Power and State Water Control Board personnel investigated a fish kill in Farrar Gut that occurred about July 16 (internal report from A.C. Cooke to J. M. White, Jr.). At least 14 species were included in this kill, predominantly catfish, gizzard shad and shiners, probably totalling in excess of a thousand individuals. The kill appeared to have occurred primarily in the vicinity of the discharge canal. Water temperatures measured on July 18 were in excess of 40° in the discharge canal and upper end of Farrar Gut and dissolved oxygen was 5.3 ppm. Mr. Cooke speculated that the kill may have occurred in response to high temperatures coupled with low overnight dissolved oxygen from nocturnal respiration by "great quantities of algae." Hypoxic conditions created by algae blooms frequently cause extensive, overnight fish mortalities in eutrophic lakes and ponds, an event termed "summerkill." It is entirely possible that a summerkill phenomenon was responsible for this Farrar Gut die-off, particularly if the late night period coincided with slack tide. Alternatively, an abrupt change in water quality (temperature or potential toxicant) of the discharge could have precipitated the kill. Whether the July 1980 fish kill was primarily due to extreme but natural conditions or anthropogenic causes cannot be determined at this time.

August 1987

Virginia Power personnel discovered approximately 1,000 dead gizzard shad in the discharge canal and made a report to DEQ (letter from B. M. Marshall to R. R. Jenkins, Jr.). Water temperature at this time was 42°C in the discharge canal, decreasing progressively to 33°C at the mouth of Farrar Gut. Water chemistry measurements noted no toxic concentrations and adequate dissolved oxygen. A Virginia Power (VP) biologist speculated that the gizzard shad (only species reported) probably died of thermal shock. This conclusion is reasonable, as the ultimate upper incipient lethal temperature for gizzard shad is 39°C (Stefan et al. 1992). However, gizzard shad avoid temperatures in excess of 37°C (Williamson and Nelson 1985) and should not have been present in the discharge canal at this time. A sudden rise from $\leq$ 37°C to 42°C in effluent temperature could have produced heat shock, but discharge temperatures immediately prior to the kill were not recorded. Consequently, the cause of this kill is probably heat shock, but the events that produced its occurrence cannot be determined.

March 1989

An internal VP report (later reported to DEQ) found an estimated 2,000 dead fish in the discharge canal on March 27, 1989. The majority of these were gizzard shad with some channel catfish. Temperature in the discharge canal was 24°C. The reporting biologist speculated that a chlorine overdose may have caused this kill, as the temperature was near the preferred level of both species and no evidence of toxicants was found. In the absence of data on discharge water quality when the kill actually occurred (March 24 or 25), this explanation is reasonable.

May 1989

On May 2, 1989, approximately 3,500-5,000 dead fish were discovered in the discharge canal (report from B. M. Marshal to R. R. Jenkins, Jr.). Again, the vast majority were gizzard shad with some channel catfish. Temperature (29°C) dissolved oxygen, conductivity, and pH were measured when the fish kill was discovered and found to be well within tolerance levels. This kill was similar in all respects to the March kill, except that

excess chlorine discharge was not implicated. After the March die-off, daily inspections of the chlorine feed system were implemented and chlorine discharge was maintained at target concentrations. Speculation was offered that the gizzard shad may have died from stress associated with spawning (in combination with migration into the discharge canal). This explanation is not completely satisfying. Gizzard shad do not normally experience post-spawning mortality, although cold-induced winter die-offs are common throughout the species range (Becker 1983; Adams et al. 1985). However, spring die-offs of gizzard shad may occur prior to spawning if the adult fish have experienced starvation (Adams et al. 1985). The condition and spawning status of the shad killed in this incident were not described. Additionally, the pre-stress explanation does not account for the mortality of channel catfish. It appears more probable that some rapid change in water quality within the discharge canal precipitated this kill. Without constant monitoring of water chemistry parameters, it is impossible to confidently attribute this kill to any particular agent or cause.

Winter 1996

Unlike the fish kills in the 1980s, this die-off in Farrar Gut occurred several times between January and early March. I do not have documentation of the total magnitude of these kills, but at least 99% of the observed dead fish were gizzard shad, with some channel and blue catfish as well as yellow perch (Mark Alling, DEQ, personal communication).

Water chemistry monitoring in February revealed no lethal levels of toxic substances (Bill Pfeifle, DEQ, personal communication). Rather, the almost certain immediate cause of death was cold shock, a result of the unusual winter weather of 1996 and tidal action in Farrar Gut. Any person who has lived in Virginia for several years appreciates that the winter of 1996 was abnormal for its heavy snowfalls and prolonged cold temperatures. A snowfall of 30 inches blanketed much of the James River watershed in early January, followed by a rapid melt-off and flooding near the end of the month. The same sequence of events (high snowfall, rapid melting, flooding) was repeated in February. The infusion of huge amounts of cold meltwater depressed water temperatures in the lower James River for much of the winter. Thermal monitoring data from the James River in the vicinity of CPS

substantiate the extreme temperature depression that occurred during the winter of 1996. January water temperatures measured by VP personnel at a station about one mile upstream of the CPS mixing zone boundary ranged between 2.7 and 6.4°C over the 1992-95 period, but dropped to 0.5°C in January 1996. Monthly temperature measurements made by DEQ personnel near this site (Buoy 157) between 1986 and 1995 were never lower than 2.5°C.

At high tide, James River water invades Farrar Gut, pushing up towards the discharge canal. The middle and lower sections of Farrar Gut consist alternately of warm water from the discharge canal at low tides and, in winter, colder James River water at high tides. The rapid change in temperature at specific locations provides the potential for cold shock for fishes that are resident in those locations.

A DEQ study of water temperature distributions in Farrar Gut conducted in February 1996 provides an excellent illustration of the cold winter/high tide effects. On February 26-28, temperature transects showed that water temperature decreased only 3°C (from 19°C to 16°C) from the discharge canal to the confluence with the James River at low tide, but 9°C (from 19°C to 10°C) at high tide. The ΔT between low and high tides progressively increased down the Gut, averaging only 1°C for the first mile below the discharge canal but reaching 7-8°C at a station 0.5 miles above the confluence. At this latter station, readings made twice per hour over the two-day period showed temperature shifts of as much as 10°C (between 21° and 11°C) occurring within 1-2 hour time frame, in response to tidal flows. Thus four precipitous temperature shifts (two up, two down) occurred daily during this period.

Each of these temperature differentials was probably not sufficient in itself to induce cold shock mortality in gizzard shad and other fishes, but the repeated exposures likely caused death in some fish. Thermal bioassays indicate that the zone of tolerance for fish acclimated to one temperature then exposed to a second is rather large (Figure 1). The temperature criteria promulgated to protect all fish against cold shock in thermal plumes (USEPA 1986) indicates that fish can tolerate temperature differentials of 15°C when the

discharge is 25°C and ambient water is 10°C, and 13°C when the discharge is 20°C and ambient water is 7°C (see Figure 2). My review of the thermal tolerance literature (Coutant 1973; Becker et al. 1977; Houston 1982) supports this interpretation. For example, Otto and Rice (1974) found that yellow perch abruptly transferred from 20°C to 10°C water responded only by slowing swimming speed. Perhaps even more relevant to this paper, Cox and Coutant (1976) reported that adult gizzard shad suffered only 10% mortality when transferred from 20°C to 7°C ($\Delta T = 13°C$).

The DEQ temperature/tide study of February 26-28, 1996 in Farrar Gut showed temperature shifts that did not exceed single-dose tolerance limits or low lethal thresholds. The fish kills that occurred in Farrar Gut during the winter of 1996 resulted either because: 1) at some times, the temperature shift was even more pronounced; 2) low lethal thresholds were sometimes encountered (about 3°C for gizzard shad; Williamson and Nelson 1985); or 3) multiple exposures to temperature differentials induced death. Temperatures below the incipient lower lethal limit probably did not occur in Farrar Gut because of the mixing of heated discharged water with ambient river water. Lower high-tide temperatures than recorded in the DEQ study may have occurred when James River temperatures plunged to near 0°C, but the heated discharge temperatures should have dropped concurrently, keeping the ΔT similar. It is most probable that multiple exposures to rapid temperature differentials were responsible for the fish kills in the winter of 1996. However, to my knowledge, the response of fish to repeated, abrupt temperature change has not been described.

Synopsis

The four fish kills reported in the 1980s in Farrar Gut were short-term events that occurred in the discharge canal, most probably as the result of some rapid but undocumented natural or anthropogenic change in water quality. Occurrence of the 1987 and 1989 kills within a 20-month time frame 7-9 years ago suggests that they may be due to an operational malfunction which has since been corrected.

The winter of 1996 fish kill differed from the earlier die-offs in that it was: a) a prolonged, multi-episodic event; b) did not happen in the discharge canal; and c) was almost certainly due to cold shock. This fish kill was a response to the extreme climatological conditions of the period. Although tidally-induced temperature shifts must occur within Farrar Gut every winter, their magnitude is inadequate to induce large-scale mortality. Thus, the winter 1996 fish kill should also be viewed as an anomalous event.

However, there is no guarantee that another fish kill will not occur again at some date in Farrar Gut, as a function of weather, plant operation, or the condition and behavior of the fishes themselves. The question that attends documentation and attribution of recorded and potential kills is their impact, both to the balanced indigenous community and to the human users of the James River fishery resource.

SIGNIFICANCE OF FISH KILLS

In all but the first documented cases of fish kills in Farrar Gut, the dominant species affected (usually at least 99% by number) was gizzard shad. Other species identified included channel and blue catfish, and yellow perch, but these occurred in lower numbers and the impacts of their loss on the community and fishery should be correspondingly slight.

This aspect of my analysis consequently focuses on gizzard shad. There is anecdotal evidence that some of the dead shad may actually have been threadfin shad, a close relative. The threadfin shad in the James River is an introduced species and a marginal member of the fish community because of its poor tolerance of low ($< 9°C$) water temperatures (Jenkins et al. 1993; Strawn 1965); it will not be considered further.

The gizzard shad is the leading candidate to be a victim of fish kills in the James River due to its high abundance and thermal fragility. The gizzard shad ranges throughout the Mississippi and Atlantic Coast drainages from the southern Great Lakes to the Gulf of Mexico (Williamson and Nelson 1985). It is subject to massive winter die-offs (exclusive of

those that might be associated with heated discharges) throughout its range (Adams et al. 1985). In Virginia reservoirs, die-offs of gizzard shad are a predictable consequence of relatively severe winters (Ney et al. 1988). In northern waters, the abundance of gizzard shad populations fluctuates dramatically with the severity of the winter (Becker 1983).

Gizzard shad thrive in warm, shallow, turbid, and mud-bottomed water, such as the James River, where their number can become exceedingly high (Miller 1957). In many freshwater lakes and reservoirs, gizzard shad can overpopulate, accounting for more than half the total biomass of fish (Noble 1981). This shad is often regarded as a pest species, and some states have active shad control programs (Becker 1983).

The relative contribution of gizzard shad to the James River fish community has not been quantified. The species is "one of the most abundant, if not the most abundant fish" in the tidal James River (Dean Fowler, VDGIF, personal communication). Electrofishing surveys in the Richmond area found gizzard shad to be the most abundant species, comprising 22% by number of the total catch (Garman and Smock 1988). This relative abundance is much higher than that reported by Jensen et al. (1974) for the James River. However, this Johns Hopkins study sampled fish by seining and trapping, ineffective techniques for gizzard shad.

The economic value of gizzard shad to humans is limited to industrial (animal feed, fertilizer) commercial uses; its flesh is tasteless and bony (Becker 1983). Preliminary commercial harvest statistics compiled by the VMRC show average annual landings for 1990-95 of James River gizzard shad at 520,000 lbs (about 1,000,000 fish) worth 10¢/lb. (total of $52,000/year).

The ecological value of the gizzard shad is as a forage fish for piscivorous sport and commercial fishes. As a forage species, the gizzard shad is low on the food chain (periphyton, detritus, phytoplankton, and zooplankton) and very prolific. However, it rapidly outgrows the ingestibility limits of most of its predators (often within a few months

after hatching) and can thus block much of the energy flow to the top of the trophic pyramid (Ney 1981; Ney and Orth 1986). Gizzard shad have also been indicted in the suppression of recruitment of bluegill and largemouth bass, through trophic competition with young-of-year (Dettmers and Stein 1992; Noble 1981). Indeed, there is some evidence that highly abundant adult gizzard shad can suppress production of their own progeny (Swingle 1950). Conversely, low number of adults can beget large year classes of offspring (Miller 1957).

In summary, gizzard shad are highly abundant in the James River, sustain a low-value commercial fishery, and serve the community function of energy transfer when young. However, the gizzard shad soon outgrows most of its predators and can suppress recruitment of sportfish species. Despite characteristic large-scale winter die-offs, the gizzard shad is extremely resilient.

In appreciation of this combination of traits, the die-off of even several thousand gizzard shad, as has occasionally occurred in Farrar Gut, can only be interpreted to have negligible costs, both economic and ecological, and may actually be beneficial to the balanced indigenous community.

POTENTIAL FOR FUTURE FISH MORTALITIES

Elimination of sparger operation will raise the discharge temperature into Farrar Gut to some extent, which in turn raises concerns about thermal shock impacts on the fishes that use that area. The potential for such impacts is largely a function of the extent to which discharge temperature will be further elevated.

Continuous temperature measurements were made by VP personnel at the entrance and exit of the discharge canal between February 14 and August 7, 1989, and between July 24 and October 2, 1995. The difference between entrance and exit temperatures is primarily due to heat dissipation by the spargers. In 1989, the average temperature differential was 0.33°C while in 1995, the average differential was 0.91°C.

Fishes will seek their preferred water temperature, and attempt to avoid both high and low temperatures (Coutant 1977). A slight increase of discharge temperature during warmer months may cause some fish to avoid the discharge canal to a greater extent than at present, but avoidance will not result in mortality. Rather, the principal concern is for occurrence of cold shock mortality due to a higher discharge temperature and potentially greater ΔT when heated discharge and tidal inflow meet in Farrar Gut, the situation that apparently triggered the winter 1996 fish fill.

The *in situ* temperature measurements in the discharge canal during the February 14-March 16, 1989 period produced an average temperature reduction of 0.15°C, and a maximum of 0.6°C. However, only about half of the spargers were operating at this time. From this data, a worst-case winter scenario would produce a temperature difference of about 1.0°C in discharge temperature between 100% and 0% sparger operation.

An increase of 1.0°C in discharge temperature will expand the ΔT between low and high tide periods in Farrar Gut by a lesser differential because the incoming high tide will be mixing with the heated discharge to some extent. However, an addition of even 1.0°C cannot be predicted with any confidence to perceptibly increase the <u>frequency</u> of cold shock winter fish kills. Instead, the occurrence of such events is a function of extreme climatological conditions, weather patterns that produce an unusual amount of snow and/or cold, and much reduced ambient water temperatures for extended periods. The <u>magnitude</u> of any future cold-shock kill could be greater without the spargers to the extent that a $\leq$ 1.0°C increase in the ΔT exceeds the tolerance zone of resident fishes. Undoubtedly, many James River fishes use Farrar Gut as a thermal refuge in the winter, but only the gizzard shad has suffered large kills. An increase in ΔT of $\leq$ 1.0°C in extreme winter might then increase the shad die-off to a slight degree, particularly if cold weather is prolonged. However, the loss to date of gizzard shad has had a negligible impact, and discontinuance of sparger operation cannot be expected to discernibly affect the shad population nor its function in the community.

SUMMARY AND CONCLUSIONS

Of the five documented fish kills in Farrar Gut, four were short-term events in the vicinity of the discharge canal and were probably due to some rapid but transient change in water quality. The most recent kill, during the winter of 1996, differed in that mortality occurred over an extended period and throughout Farrar Gut. The cause of this kill was most certainly cold shock, although the exact mechanism of lethality (multiple exposures or one-time exceedance of the zone of tolerance) cannot be determined. The magnitude and extent of the 1996 die-off can be attributed to the unusual severity of the winter, which reduced ambient water temperature in the James River for extended periods.

Four of the five fish kills were dominated by gizzard shad. This species is a very abundant and resilient fish with a history of thermal fragility over its wide geographic distribution. The commercial fishery for gizzard shad in the James River is attributable to its abundance rather than its economic value. Ecologically, the gizzard shad has an important community function as forage for piscivorous sport and food fishes, but it rapidly outgrows its predators and can suppress recruitment of young sportfish through trophic competition. The documented loss of gizzard shad in the Farrar Gut fish kills is economically slight and ecologically insignificant to the balanced indigenous community.

Projections of the effects of sparger removal on the frequency or magnitude of future fish kills is based on a further, worst-case elevation of temperature in the discharge canal of 1-2°C in summer and 1.0°C in winter. This slight increase in summer temperatures might cause some fish to avoid Farrar Gut locations for longer periods but should not result in fish kills. The frequency of winter cold shock kills will continue to be a function of extreme climatological conditions, which will far override the effect of a minute rise in discharge temperature. The magnitude of cold shock kills, if any occur, could increase for gizzard shad, the most thermally sensitive species. The additional losses should not be sufficient to discernibly affect the shad populations or the fish community.

LITERATURE CITED

Adams, S. M., J. E. Breck, and R. B. McLean. 1985. Cumulative stress-induced mortality of gizzard shad in a southeastern U.S. reservoir. Environmental Biology of Fishes 13:103-112.

Becker, C. D., R. G. Genoway, and M. J. Schneider. 1977. Comparative cold resistance of three Columbia River organisms. Transactions of the American Fisheries Society 106:178-183.

Becker, G. C. 1983. Fishes of Wisconsin. University of Wisconsin Press, Madison.

Coutant, C. C. 1973. Heat and temperature. Pages 151-172 and 410-419 in Water Quality Criteria 1972. National Academy of Sciences, Washington, D.C.

Coutant, C. C. 1977. Compilation of temperature preference data. Journal of the Fishery Research Board of Canada 34:739-745.

Cox, D. K. and C. C. Coutant. 1976. Acute cold-schok resistance of gizzard shad. Pages 159-161 in G. W. Esch and R. W. McFarlane, editors. Thermal Ecology II. U.S. Department of Energy, Washington, D.C.

Dettmers, J. M. and R. A. Stein. 1992. Food consumption by larval gizzard shad: zooplankton effects and implications for reservoir communities. Transactions of the American Fisheries Society 121:494-507.

Garman, G. C. and L. Smock. 1988. Annual report of the James River mainstem investigation. F-74-R1, Virginia Department of Game and Inland Fisheries, Richmond.

Houston, A. H. 1982. Thermal effects upon fishes. National Research Council of Canada, Ottawa.

Jenkins, R. E., and N. M. Burkhead. 1993. Freshwater fishes of Virginia . American Fisheries Society, Bethesda, Maryland.

Jensen, L. D. 1974, editor. Environmental effects of the Chesterfield Power Station on the aquatic life of the James River. Johns Hopkins University, Baltimore.

Miller, R. R. 1957. Systematics and biology of the gizzard shad (*Dorosoma cepedianum*) and related fishes. U.S. Fish and Wildlife Service Fishery Bulletin 73:371-392.

Ney, J. J. 1981. Evolution of forage-fish management in the United States. Transactions of the American Fisheries Society 110:725-728.

Ney, J. J. and D. J. Orth. 1986. Coping with future shock: matching predator stocking programs to prey abundance. Pages 81-91 in R. H. Stroud, editor. Fish Culture in Fisheries Management. American Fisheries Society, Bethesda, Maryland.

Ney, J. J. and four others. 1988. The Smith Mountain Lake fishery: factors affecting major sport and forage fish populations. Department of Fisheries and Wildlife Sciences, Virginia Tech, Blacksburg.

Noble, R. L. 1981. Management of forage fishes in impoundments of the southern United States. Transactions of the American Fisheries Society.

Otto, R. G and J. O. Rice. 1974. Swimming speeds of yellow perch (Percu flavescens) following an abrupt change in environmental temperature. Journal of the Fishery Rsearch Board of Canada 31:1731-1734.

Stefan, H. G., M. Hondzo, B. Sinokrot, and X. Fang. 1992. A methodology to estimate global climate change impacts on lake and stream environmental conditions and fishery resources with application to Minnesota. U.S. Environmental Protection Agency, Washington, D.C.

Strawn, K. 1965. Resistance of threadfin shad to low temperatures. Proceedings of the Annual Conference of the Southeastern Association of Game and Fish Commissioners 17:290-293.

Swingle, H. S. 1950. Relationships and dynamics of balanced and unbalanced fish populations. Alabama Agricultural Experiment Station Bulletin 274.

USEPA. 1986. Quality Criteria for Water. EPA 440/5-86-001.

Williamson, K. L. and P. C. Nelson. 1985. Habitat suitability index models and instream flow suitability curves: gizzard shad. U.S. Fish and Wildlife Service Biological Report 82(10.112).

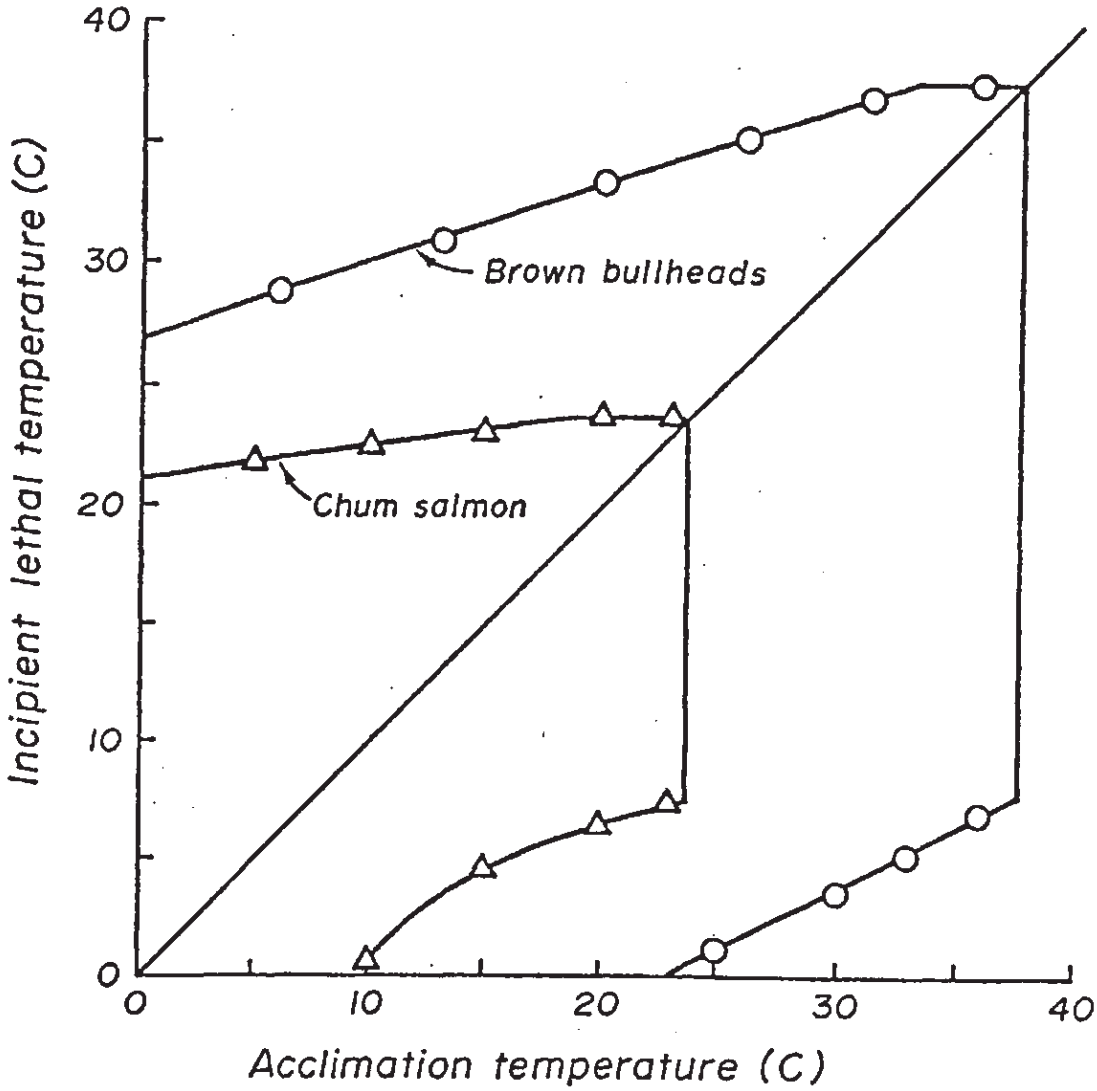


Figure 1. Thermal tolerance zones as a function of acclimation temperature. Depicted here for brown bullhead and chum salmon (from Warren 1971. Biology and Water Pollution Control. W.B. SAunders, Philadelphia).

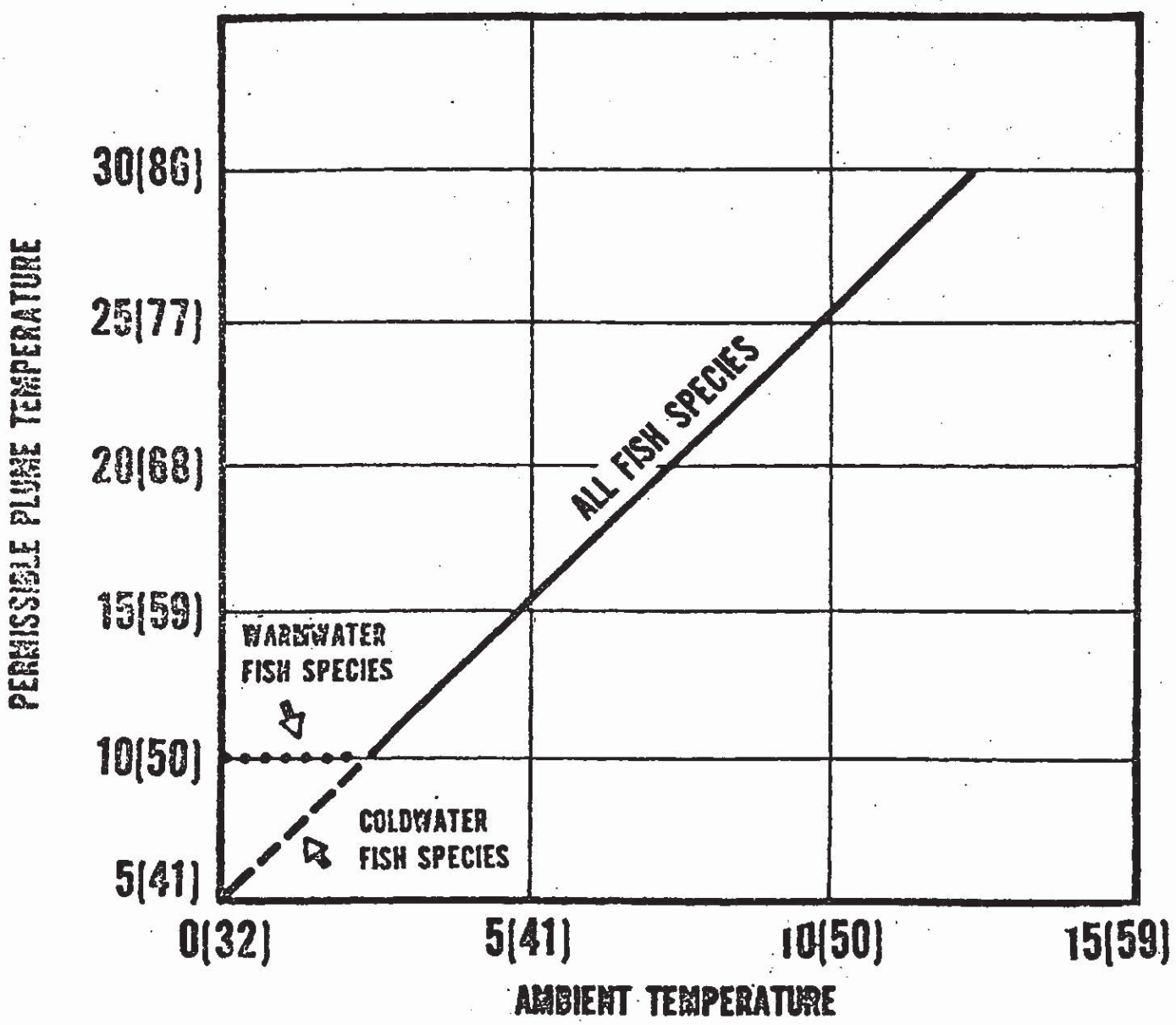


FIGURE 2. GRAPH TO ESTIMATE THE MAXIMUM WEEKLY AVERAGE TEMPERATURE OF PLUMES FOR VARIOUS AMBIENT TEMPERATURES, °C (°F). (USEPA 1986).

Executive Summary

In October 1996, Virginia Power communicated to the Virginia Department of Environmental Quality (DEQ) its intent to undertake an environmental study at the Chesterfield Power Station in Chester, Virginia in accordance with Section 316(a) of the Clean Water Act (October 9, 1996 letter to Mr. Ray R. Jenkins of DEQ). Section 316(a) provides for facilities that have a thermal discharge into the waters of the United States to demonstrate whether current thermal effluent limitations are more stringent than necessary to assure the protection and propagation of a balanced, indigenous community of shellfish, fish and wildlife in and on the body of water into which the discharge is made.

The Demonstration was designed to characterize the interaction of thermal effluent from the station's Outfall 003 with spatial and temporal variation in nutrient concentrations, phytoplankton, zooplankton, benthic macroinvertebrates, juvenile and adult fishes, aquatic macrophytes, and vertebrate wildlife found in the vicinity of the Chesterfield Power Station. Field sampling, which commenced in April 1997 and concluded in February 1999, was conducted seasonally at sites located above and below the power station's discharge on the mainstem James River as well as in Farrar Gut (a former oxbow of the river that receives the Outfall 003 discharge) and in oxbows downriver of Farrar Gut. In addition, two flooded quarries connected to Farrar Gut and the Jones Neck Oxbow, respectively, were sampled. The study makes extensive use of comparisons among sampling locations as well as to results obtained by Jensen (1974) from similar measurements taken during 1968-1971.

Physical Components

Seasonal variation in water temperature followed ambient air temperatures. Thermal influence of the discharge of Outfall 003 was most prominent in the upper reaches of Farrar Gut with the downstream extent of the thermal plume influenced by the direction of tidal flux. The mixing of thermal effluent with tidal waters that occurs in Farrar Gut greatly reduces thermal influence on the mainstem James River.

Dissolved oxygen measurements showed no evidence of summer oxygen sags which were reported by Jensen (1974) thirty years ago. The measurements further demonstrate that oxygen levels were adequate for fish even in the hottest parts of the summer. Results of this study and other recent work (Alden 1997) show that water quality initiatives in the early seventies including improvements in controlling point source pollution have resulted in improved dissolved oxygen levels in this section of the James River.

Nutrients

Nutrient concentration values from this study also showed that water quality has increased markedly since the Jensen (1974) study with reduced concentrations of total phosphorus and ammonia. In general, the results of this study show that nutrient concentrations increased from upstream to downstream and were stable in Farrar Gut. Further, samples collected near the station's intake and 003 Outfall were similar suggesting that the power station did not alter concentrations of nutrients.

Chlorophyll *a* - Phytoplankton

Concentrations of phytoplankton and chlorophyll *a* in rivers reflect a combination of nutrient availability, turbulence, light availability, turbidity, washout, and consumption by grazers and therefore are quite variable. Nevertheless, chlorophyll concentrations in Farrar Gut were very similar to those from the James River. The overall trend among stations was an increase downstream. Values from the oxbow stations and quarry stations, however, were considerably higher than the river stations, perhaps reflecting differences in all the factors listed above. Algal abundance and biovolume values were highly correlated with, but more variable than, the chlorophyll concentrations.

Taxonomic analyses of algal abundance and biovolume by Dr. Harold Marshall (Old Dominion University) revealed an extremely diverse assemblage (100 taxa) of algae dominated by green algae and diatoms. Seasonally, a spring bloom of diatoms was replaced by summer dominance by green algae, followed by bluegreen algae into October, followed by a resurgence of diatoms and green algae. Higher algal abundances in Farrar Gut were correlated with the increased temperatures there, but there was no corresponding taxonomic composition shift. Algal abundance in this study frequently exceeded values reported by Jensen (1974) for 1970 and 1971, despite lower nutrient concentrations, suggesting improvements in water quality since the Jensen study and that the power station has no adverse effects on the phytoplankton community.

Zooplankton

Zooplankters represent the first consumer level of the aquatic food chain and are especially important in the diets of young-of-year fishes and some species of adult fish. Therefore, variation in their seasonal and spatial distribution and abundance are important to the functioning of the system. A total of 25 zooplankton taxa was collected with the rotifer group being the most diverse taxonomically. Rotifers were also the most abundant zooplankters collected, with the copepod and cladoceran groups (crustacean zooplankton) ranked second and third in abundance, respectively. Crustacean zooplankton abundance was much higher (+427%) than that from 1968-1971 reported by Jensen (1974). Rotifer abundance was not reported by Jensen (1974), therefore comparisons to rotifer abundance in this study could not be made.

During summer, zooplankton community structure was less diverse in upper Farrar Gut (station FG2) than at other locations while diversity indices in lower Farrar Gut better approximated those from mainstem river and oxbow stations. In fact, diversity at both lower Farrar Gut stations exceeded or equaled that of the Jones Neck Oxbow in August 1997 and July 1998. For the remainder of the year, improvement in the zooplankton community structure was evident at FG2 with diversity exceeding that of downstream stations in Farrar Gut, mainstem river and oxbow stations on some occasions.

Zooplankton density typically increased from upstream to downstream and was highest during summer months. Zooplankton density was consistently and significantly lower at James River station JR1, located on the upstream boundary

of the study area, than at all other stations. Zooplankton abundance at FG2 was consistently greater than at JR1, yet also significantly less than most of the remaining sites; however, zooplankton densities were highest at FG2 during summer months. Zooplankton densities increased downstream in Farrar Gut to the point that zooplankton abundance in the lower gut (FG4) was not significantly different from that of the mainstem river or oxbows.

Taken together, these results suggest that the zooplankton community is significantly healthier than it was in the early seventies (Jensen 1974), and the power station does not negatively impact this ecosystem component.

Benthic Macroinvertebrates

Because of their sessile nature, high reproductive rates, and relatively long life spans, benthic macroinvertebrates can serve as indicators of environmental health/stress. As in Jensen's (1974) previous study, the benthic community in the tidal region of the James River in the vicinity of Chesterfield Power Station was dominated numerically (98%) by Oligochaeta (worms) and Chironomidae (midges). However the nymphs of the oxygen-sensitive mayfly *Hexagenia* were collected during all months sampled in the current study, suggesting that water quality has significantly improved since Jensen (1974) did his surveys. Seven of eight sampling locations had similar abundances of benthic macroinvertebrates, and overall benthic abundance increased from upstream to downstream, similar to algae and zooplankton (see above). Benthic density at station FG2 was significantly ($P<0.05$) lower than all others, possibly due to its proximity to the 003 thermal discharge. Samples from Farrar Gut stations FG3 and FG4 had

approximately 10 times as many macroinvertebrates as did FG2, and did not differ from mainstem James River or oxbow stations.

Juvenile and Adult Fishes

Fish are considered the most critical component of aquatic biota in assessment of impacts from cooling water discharges because fish represent the upper levels of the food web and so reflect the health of the lower levels. Their tremendous popular appeal for recreational, commercial, and aesthetic reasons causes the public to view the status of the fish community as indicative of the health of the aquatic ecosystem. Therefore, extensive electrofishing and gillnet surveys of fish abundance were conducted, with special analysis of largemouth bass, channel catfish, blue catfish and gizzard shad as "representative, important species". Within the electrofishing samples, gizzard shad, threadfin shad, bluegill sunfish, largemouth bass, carp, spottail shiners, and white perch were the most frequently taken taxa. The gillnet samples reflected a different fish capture selectivity, with gizzard shad, threadfin shad, white perch, blue catfish, and channel catfish the most commonly collected taxa. A total of 35 native and introduced, riverine, and estuarine species was collected. Species compositions in the current study were similar to those found by Jensen (1974) except for the increased importance of threadfin shad and the replacement of two catfish by the channel catfish and blue catfish abundant in the James River now.

Comparison of fish taken at stations within the power station's thermal mixing zone (FG1, FG2, FG3, FG4, JR5, Q1) with those collected at reference sites (JR1, JR7, JN1, TI1, Q2), showed that the thermal stations attracted fish in

winter resulting in the greatest seasonally averaged abundances, with the upper reaches of Farrar Gut serving as a thermal refuge in winter. Non-thermal stations, however, had more species (7.3 vs 6.0 for electrofishing and 5.4 vs 4.1 for gillnet samples, respectively). Fish avoided waters above 35°C so fish were less abundant at the northernmost Farrar Gut stations in summer, although some were collected in gillnet samples in July 1998. Fish abundance in the lower portion of Farrar Gut (FG3 and FG4) was more similar on average to oxbow reference stations than to upper gut stations. Oxbow stations tended to have a somewhat more diverse species composition than lower Farrar Gut stations, which may be a function of accessibility and habitat. The two quarry stations had the least seasonal variability in fish abundance, a reflection of the dominance of these lake-like habitats by resident fish species such as bluegill sunfish, largemouth bass and carp. The flooded quarry off Farrar Gut averaged 4°C warmer than its counterpart off the Jones Neck Oxbow, but electrofishing surveys consistently caught twice as many fish there. Comparisons among mainstem James River stations upstream and downstream of Chesterfield Power Station demonstrated that the power station's cooling water discharge had no discernable effect on the abundance and composition of the fish assemblage in the mixing zone.

The selected Representative Important Species (gizzard shad, largemouth bass, channel catfish and blue catfish) were well distributed among the habitats sampled in fisheries surveys and showed no negative influence of cooling water discharge on growth, size distributions, or condition. Tag returns indicated that

channel catfish and blue catfish were quite mobile, while largemouth bass were more likely to remain within a home range.

Infrequent fish kills in Farrar Gut have been due to a combination of causes – plant operation or malfunction, extreme weather, and the behavior and physiology of the fishes themselves. The January 1999 threadfin shad kill reflected a die-off of a species whose tolerance for cold (minimum = 9°C) is marginal for the James River. Previous kills were dominated by gizzard shad, the most abundant and sometimes ecologically problematic species in the fish assemblage. The number of shad killed is negligible relative to their abundance and these events cannot be construed to have impacted the James River fish assemblage.

Basically, the only identifiable effect on the fish component of the community found in either this study, or by Jensen (1974), was the seasonal attraction/avoidance response to the heated water.

Habitat Formers

The presence of aquatic macrophytes and the diversity of plant communities was found to be driven more by hydrodynamics than water temperature. For example, current scouring at some sites serves to reduce plants to patches of waterwillow and smartweed whereas the more-protected oxbows and Farrar Gut had the richest and most diverse plant communities, consisting of pickerelweed, wildrice, smartweed, arrow-arum, and broadleaf cattail. The thermal effluent discharged from the power station did not appear to limit

establishment of aquatic vegetation in Farrar Gut or elsewhere within the thermal mixing zone.

Vertebrate Wildlife

Due to the importance of the James River to migratory and indigenous waterfowl and other birds, an informal survey of birds was performed by Virginia Power personnel as they conducted fieldwork associated with other aspects of the study. Forty species of birds within 16 families were recorded during the study. In any given month, only 15-19 of these species were observed due to the migratory behavior of most of the species present. Six species were observed throughout the study (double-crested cormorant, great blue heron, Canada goose, turkey vulture, black vulture, and bald eagle) and belted kingfishers and American crows were observed in 11 of 12 months. Birds of prey (other than the bald eagle) were among the less frequently observed with the red-tailed hawk occurring in 7 of 12 months, northern harrier (2/12 months), red-shouldered hawk (1/12 months), and broad-winged hawk (1/12 months). Overall, birds were frequently observed on the study sites around Chesterfield Power Station, with the number of birds observed at stations at Farrar Gut often exceeding those further away, even though the latter stations represented 2.5 times as many river miles as are within Farrar Gut.

Conclusions

The results found in this report provide an objective and scientific assessment of the effects of the existing thermal discharge from the Chesterfield Power Station on the aquatic community in the James River. The results from

this study demonstrate that the thermal discharge from Outfall 003 does not cause appreciable harm to the overall aquatic biological community and a balanced indigenous community of shellfish, fish and wildlife does exist in the James River in the vicinity of the power station.

10.0 Conclusions

The objectives of this study were to firstly characterize the components of the aquatic ecosystem in the James River in the vicinity of Chesterfield Power Station, and then secondly, to assess the impacts of the station operations specifically from Outfall 003, and with the sparger system inactive, on these components. The study was conducted over a two-year period in accordance with protocol that was developed by representatives from DEQ, VDGIF, academia, and the power company. The overall intent of the study design was to provide requisite information for valid evaluations leading to informed decisions.

We are confident that all of these objectives were accomplished thanks to the oversight and input from all representatives of the team. The study results clearly demonstrate that the discharge from 003, even with the spargers deactivated, has not caused appreciable harm to the overall aquatic biological community in the James River in the vicinity of the power station to the extent of limiting or restricting the balanced, indigenous populations of shellfish, fish and wildlife. There are seasonal and very local results. For example, the fish move in and out of the immediate discharge area seasonally yet downstream of the discharge area the fish populations are comparable to other parts of the study area. Similarly the benthos are suppressed proximal to the discharge but they too recover further down Farrar Gut.

In the final analysis, the results of this 316(a) Demonstration show that the current thermal effluent limitations in the VPDES Permit VA0004146 for

Chesterfield Power Station are more stringent than necessary to assure the protection and propagation of a balanced, indigenous aquatic community in the James River in the vicinity of the station.

recaptured in the quarries in which they were tagged, two showed regional movement within the study area (JR1 to JR4, FG4 to JR4) and one, tagged at FG1, was recaptured at Hopewell six months later. Two channel catfish were recaptured near the same station at which they were tagged. Two were recaptured in Richmond, one four days after tagging. One blue catfish tagged at FG1 in January 1998 was recaptured in July at Hopewell near a paper mill; however, the temperature regime there is unknown. Based on these results, the catfish species showed a greater propensity for movement than did largemouth bass and information was limited regarding movement of RIS in response to water temperature.

Incidence of Fish Kills

Two fish kills (i.e., observation of a number of dead fish) occurred in Farrar Gut since this study was initiated in 1997. These are described here.

February 18, 1998 - Approximately 170 dead gizzard shad in the 4-6" range were counted in the 003 discharge canal. Cause of death is uncertain. The James River was high and turbid from rainfall the previous day. Station personnel evaluated the operation of the station to determine if there had been any upsets, spills or other unusual occurrences. None were found. Unit 6 was operating at reduced load and the station's chlorination system was not operating. Water temperature in the discharge canal at 3 p.m. was 18-19°C. At this time fish were observed breaking water and moving about the canal in apparent good health. Several anglers were fishing in the discharge canal; anglers had previously been observed collecting shad for bait in the canal with cast nets. Whether the shad

were discarded bait or died from some cause associated with the recent rainfall event could not be determined. Densities of both gizzard and threadfin shad were high throughout Farrar Gut in the January 1998 electrofishing survey. Relative to their total abundance, the number of dead gizzard shad represented an insignificant and very localized mortality event.

February 26, 1999 - About 10,000 dead threadfin shad (3-5") were found in the discharge canal. Death was most likely due to cold shock after Unit 6 went off-line the previous day, reducing water temperature in the immediate vicinity of its discharge to 7°C. Units 4 and 5 remained in operation, and downstream mixing caused the temperature midway down the canal to be 17.5°C. Threadfin shad abundance was extremely high in Farrar Gut in the January 1999 electrofishing survey. Although Unit 6 had experienced 26 outages in the previous 14 months, only this particular outage was followed by a fish kill. The combination of high shad density and extreme low river temperatures appeared to interact to produce the fish kill during this outage.

An additional 5,000 dead threadfin shad were observed in the mainstem James River at the embayment next to the CPS intake screens backwash sluice; they had apparently been impinged on the vertical travelling screens, then washed off. A recent cold snap had reduced ambient river temperature to ~ 5°C. Threadfin shad are notoriously cold-intolerant, becoming stressed and ultimately dying when water temperature falls below 9°C (Strawn 1963). The low river temperature most probably killed the shad prior to impingement. It is also

probable that a major die-off of threadfin shad occurred throughout the lower James River at this time.

7.3 Discussion

James River Fish Assemblage

A total of 10,433 specimens was captured in the fisheries surveys, 23% by gillnet and 77% by electrofishing. The disparity in total catch reflects differences in the two gears and the nature of their deployment. Electrofishing is an instantaneous and active capture technique, while gillnets are passive, relying on movement and inability of fish to avoid the nets (Murphy and Willis 1996). In this study, gillnets were set for ~4 hours during daylight. Sets of longer duration or at night would have produced more fish (Hubert 1996). However, neither was possible in this study because of the high number of stations involved, and the safety hazard posed by night sampling on the James River.

Gillnets and electrofishing are effective and complementary capture gears. Gillnets target mobile, fusiform fish that wedge or gill in the mesh (e.g., white perch) as well as spiny fishes that entangle (e.g., catfishes). Electrofishing is most effective in surface waters (to ~ 6') and targets both sedentary (e.g., sunfish) and schooling species (e.g., gizzard shad). Electrofishing is also more effective for small fishes (e.g., shiners, young-of-year) that can pass through even small-mesh gillnet panels.

Catches by the two gears showed some strong similarities as well as expected differences. For each gear, almost half the total catch was the two *Dorosoma* species, gizzard and threadfin shad, which is indicative of their high

catfish species. There was little evidence of movement of these RIS in response to water temperature.

Incidence of Fish Kills

Two fish kill events have occurred in Farrar Gut since 1997, and four previous fish kills have been documented since 1987. Ney (1996) investigated the nature and causes of these mortalities. His findings, as well as relevant information on the February 1998 and February 1999 die-offs, is reviewed here to identify causes and assess ecological significance.

The February 1998 kill occurred in the Farrar Gut discharge canal and involved <200 gizzard shad. No CPS unit shutdown or excess chlorine discharge preceded the finding of dead fish. It is possible that the dead shad were bait discarded by anglers.

The February 1999 fish kill involved approximately 10,000 threadfin shad in the discharge canal and about another 5,000 washed off the travelling screens at the CPS James River intake. Mortality in the discharge canal was probably due to shutdown of Unit 6, which plunged the discharge temperature to 7°C. Threadfin shad in the immediate vicinity of that effluent thus suffered lethal cold shock. However, the impingement losses should be considered a natural event. Threadfin shad cannot tolerate temperature <9°C, and the ambient James River temperature was ~5°C due to a cold snap.

One brief fish kill occurred in 1987 with two more in 1989, as well as a more prolonged die-off during the winter of 1996. These appear to have had various causes. The first event, in August 1987, involved ~1,000 gizzard shad in

the discharge canal which Ney (1996) considered most plausibly due to a sudden rise in temperature and resultant heat shock. In March 1989, ~2,000 fish, mostly gizzard shad with a few channel catfish, were found dead in the discharge canal. Water temperature was in the preferred range (~25°C), and no generating unit shutdowns occurred. It is probable, however, that a sudden change in discharge water quality did happen, perhaps involving excess chlorine. A similar kill occurred in May 1989 involving ~ 5,000 fish, again predominantly gizzard shad with some channel catfish. Again, some sudden change in water quality was probably responsible, although the source could not be identified.

Fish die-offs in Farrar Gut occurred several times between January and early March 1996. Total counts of dead fish were not made, but involved at least 99% gizzard shad. Unlike previous mortality events, this one was prolonged and not confined to the discharge canal. Fish almost certainly died of cold shock, the result of an extremely cold winter and rapidly alternating water temperatures due to normal plant operation and tidal flow. At high tide, extremely cold waters pushed up the Gut, displacing the warm outflow. Temperatures in the middle and lower Gut dropped as much as 10°C within an hour, twice per day. While the bioassay literature indicates that fish can withstand one such event, death would likely occur from the cumulative stress of repeated exposures.

Review of these six fish kill events (in the past 12 years) implicates a variety of causes - plant operation (or malfunction), extreme climatic conditions, and the thermal behavior and tolerance of the fishes themselves. These have been uncommon events that primarily involved (usually >99%) gizzard shad and

threadfin shad, both small, highly abundant fishes that are thermally fragile. The threadfin shad in the James River is an introduced species (native to the far southern U.S. and Mexico) that simply cannot tolerate cold winters. Wherever it exists in Virginia, the threadfin shad undergoes huge die-offs in cold winters. Because it is very prolific and can produce two generations per year, populations can rebound quickly following a mild winter. "Boom and bust" fluctuations characterize Virginia threadfin shad populations. In the "balanced indigenous community" of the James River, the threadfin shad must be considered a marginal member whose continued existence depends on the availability of winter thermal refuges, such as provided by Farrar Gut.

The native gizzard shad is also subject to massive winter die-offs throughout its broad range from the Great Lakes to the Gulf of Mexico (Adams et al. 1985). More cold tolerant than threadfin shad, gizzard shad have a lower lethal threshold of 3°C, although prolonged exposure to slightly higher temperatures can be fatal. (Williamson and Nelson 1985).

Gizzard shad are both extremely prolific and low on the food chain; they account for half the fish biomass in some lakes and reservoirs (Noble 1981). Electrofishing surveys in the James River near Richmond by Garman and Smock (1988) found gizzard shad to be the most abundant species, accounting for 22% of the total catch. In the present study, gizzard shad were 16% of the electrofishing catch and 39% of the gillnet catch (threadfin shad were 27% and 11%, respectively).

During the 1990-95 period, the Virginia Marine Resources Commission recorded annual commercial landings of James River gizzard shad averaging 520,000 lbs. per year worth $0.10 per lb. as animal feed or fertilizer. Ecologically, gizzard shad is most important as a forage fish for valued game and commercial species. However, it rapidly outgrows the ingestibility limits of most predators and can then block energy flow to the top of the food web (Ney and Orth 1986). Gizzard shad have been indicted in the suppression of sportfish populations through trophic competition with their young, and high populations of gizzard shad can suppress production of their own progeny (Swingle 1957). Conversely, low numbers of adults can produce large year classes of offspring (Miller 1957). Some states consider gizzard shad a nuisance species and have active control programs (Becker 1983).

In summary, the six reported fish kills at CPS since 1987 have been comprised predominantly of gizzard and (recently) threadfin shad numbering a few hundred to several thousand. Both were highly abundant species during the course of this study, although threadfin shad abundance is controlled by the severity of the winter and the species is, at best, a "wild card" in community dynamics. Gizzard shad sustain a low-value commercial fishery, and their forage value, while substantial, is largely limited to young-of-year. On the negative side, gizzard shad can depress early growth and survival of other fishes. Despite occasional large-scale winter die-offs, gizzard shad populations are extremely resilient.

In appreciation of these features of the two shad species, the magnitude of their losses in the Farrar Gut fish kills can only be interpreted to have had negligible costs, both economic and ecological. Otherwise, the fish kills only involved a few channel catfish, which remain abundant, along with expanding populations of the introduced blue and flathead catfishes. The infrequent fish kills that have occurred in Farrar Gut must be judged to have had no discernible impact on the balanced indigenous community of the lower James River in the Chesterfield area.

7.4 Conclusions

This intensive two-year field study characterized the fish assemblage of the James River in the vicinity of Chesterfield Power Station. Fish abundance and species composition were highly dynamic, among stations, seasons, and years. However, spatial and temporal comparisons described patterns of fish distribution and permitted a detailed assessment of the impacts of the CPS cooling water discharge into Farrar Gut on the fishes of the James River. The study resulted in the following conclusions:

1. The lower James River fish assemblage is a diverse mixture of native and introduced, riverine, and estuarine species, many of which are highly mobile. Of the 35 species captured in electrofishing and gillnet surveys, eight (gizzard shad, threadfin shad, bluegill sunfish, spottail shiner, channel and blue catfish, carp, white perch) constituted over 90% of the total catch. The James River fish assemblage in the Chesterfield area was previously described in a Johns Hopkins University study from 1968 to 1971. In the course of 30 years, the fish

Innsbrook Technical Center
5000 Dominion Boulevard
Glen Allen, Virginia 23060

June 27, 1996

JUN 1996
PRO

VIRGINIA POWER

cc: EPA

Mr. Ray R. Jenkins, Jr.
Environmental Engineer Senior
DEQ-Piedmont Regional Office
4949-A Cox Road
Glen Allen, Va 23060-6296

Dear Mr. Jenkins:

As you are aware, since December of 1995, Virginia Power has been discussing with the Department of Environmental Quality (DEQ) a request to retire the spray module or sparger system in the cooling water discharge canal, Outfall 003, at Chesterfield Power Station (see letter from A. W. Hadder dated December 21, 1995). DEQ has expressed some concern over existing conditions in Farrar Gut including reported fish kills. After several meetings and phone conversations, Virginia Power agreed to address the issues and concerns identified by DEQ. A draft study plan was submitted to DEQ and comments were received and responded to on April 23, and May 6, 1996, respectively.

Three primary task items were identified in the study plan. Each task item and the consultant hired to perform the requested work are listed below:

1) Legal analysis of state and federal antibacksliding requirements-performed by James Christman, Esq. of Hunton & Williams.

2) Modeling study to predict thermal mixing zone compliance and water temperature conditions, without sparger operation-performed by CH2M Hill (The modeling protocol was approved June 10,1996 by Dale Phillips of DEQ).

3) Ecological assessment of reported fish kills in Farrar Gut-performed by Dr. John Ney of Virginia Polytechnic Institute and State University.

Enclosed are the final reports of each of the three areas of interest. Five additional copies are also included for distribution within the Piedmont and Central DEQ offices.

Overall, the reports provide several conclusions related to the regulatory and environmental issues associated with retiring the spargers:

1) The legal analysis concluded that increasing the heat rejection limit does not violate state or federal antibacksliding rules.

2) The model predicted that without sparger operation the temperature at the mouth of Farrar Gut would increase only 0.4° C and 0.5°C in the winter and summer, respectively, with a linear maximum increase of 1°C to 2°C at the upper end of the Gut. Upon retirement of the spargers, the thermal discharges at Chesterfield Power Station are expected to continue to comply with the Virginia Water Quality Standards Regulation (VR680-21-00).

3) The ecological assessment concluded that most of the reported fish kills were dominated primarily by one species, gizzard shad, and were probably caused by some rapid but transient change in water quality. The cause of the most recent kill, during the winter of 1996, is attributed to an unusually severe winter which reduced ambient water temperatures. Winter cold shock kills will continue to be a function of extreme climatological conditions, which will far override the effect of a small rise in discharge temperature. The loss of gizzard shad in Farrar Gut is considered economically slight and ecologically insignificant to the balance indigenous community in the James River. (Please note that a copy of Dr. Ney's report has also been forwarded to the Virginia Department of Game and Inland Fisheries.)

Virginia Power believes that the attached reports properly address the concerns of DEQ and that the findings strongly support our original request to retire the spargers. Accordingly, we ask that Special Condition No. 3 be removed from VPDES No. VA 0004146 and that the heat rejection limit for Outfall 003 be increased to 5.83×10^9 Btu/hour (existing limit plus credit allowed, with an additional 5% to allow for improvements in station efficiency). We also request that the new heat rejection limitation be incorporated into the new permit, expected to be issued this fall.

If our request for permit modification is granted, Virginia Power proposes to leave the spargers in the discharge canal for one year as a precautionary measure. In the event compliance or environmental concerns arise during this period, the system could be placed back in operation. In addition, we will be contacting you soon to schedule a meeting to review our request and to discuss any interests in future monitoring.

Please let me know if you have any questions (273-2948).

Sincerely,

J. W. White
Director
Environmental Compliance-Water/Waste

Attachments

JWW/jmh

cc:
Jim Christman - H&W
Lisa Sullivan - CH2M Hill
Dr. John Ney - VPI
Gary Martel - VDGIF(w/Dr. Ney's report)

Innsbrook Technical Center
5000 Dominion Boulevard
Glen Allen, Virginia 23060

DEC 1995
PRO

VIRGINIA POWER

cc: EPA

December 21, 1995

Mr. Ray R. Jenkins
Environmental Engineer Senior
Piedmont Regional Office
Department of Environmental Quality
P. O. Box 6030
Glen Allen, Virginia 23058

RE: CHESTERFIELD POWER STATION-VPDES PERMIT NO. VA0004146-REQUEST TO AMEND HEAT REJECTION RATE REQUIREMENTS FOR OUTFALL 003

Dear Mr. Jenkins:

This letter requests deletion of Special Condition No. 3 from VPDES Permit No. VA0004146 and recalculation of the allowable heat rejection rate for Outfall 003. This request is made as part of the permit renewal process. We will file our complete application for renewal of the permit early next year but we request that review and consideration of our request to delete the Special Condition and recalculate the Outfall 003 heat rejection rate begin as soon as possible.

Outfall 003 is the discharge of condenser cooling water from Units 4, 5, and 6 at Chesterfield Power Station into Farrar Gut, an oxbow segment of the James River. Special Condition No. 3 involves the operation of the spray module or sparger system in the Outfall 003 discharge canal and the accounting of the heat rejection rate attributable to the operation of the sparger system. The system was installed in 1971 at a cost of $1.5 million and a design maximum energy consumption of 2.5 megawatts of electricity. Current annual operating and maintenance costs are approximately $0.5 million.

Virginia Power believes that the sparger system is not justified or cost effective from an environmental and regulatory perspective and that the system should be removed from service. Concomitant with removal of the system, the heat rejection rate requirements for Outfall 003 should be recalculated to reflect the design conditions of the electric generating units and the condenser cooling water discharge.

We are not proposing any change to the thermal mixing zone requirements in the renewed permit. Compliance with the state water quality thermal standards at the end of the mixing zone will not be compromised by removal of the sparger system. Importantly, in our best professional judgement, we do not expect any adverse ecological impact associated with removing the system.

We have reviewed the legal and regulatory basis for removing the system and increasing the allowable heat rejection rate. Our conclusion is that the antibacksliding policy of the state does not apply. Moreover, we believe that if the policy did apply, our requested action is not prohibited by the policy. We have attached a legal analysis addressing these issues that was prepared by our counsel.

Your timely review of this attachment and our request would be appreciated. Once you have reviewed the legal analysis, we would like to meet with you to answer any questions that may arise and to further discuss the regulatory and environmental issues. I have asked Bob Williams to contact you during the week of January 1, 1996 to set up a meeting. Meanwhile, if you have any immediate questions regarding this letter or attachment, please contact him at 273-2994.

Sincerely,

A. W. Hadder

A. W. Hadder
Manager
Environmental Policy and Compliance

Attachment

RJW/jmh

Dominion Generation
5000 Dominion Boulevard, Glen Allen, VA 23060

Dominion

BY U.S. MAIL
RETURN RECEIPT REQUESTED

April 29, 2015

Mr. Brian Wrenn
Department of Environmental Quality
Piedmont Regional Office
4949-A Cox Road
Glen Allen, VA 23060

RE: Dominion Chesterfield Power Station VPDES Permit No. VA0004146
Alternate Schedule Request for 316(b) Regulation Implementation

Dear Mr. Wrenn:

Virginia Electric and Power Company d/b/a Dominion Virginia Power (Dominion) owns and operates the Chesterfield Power Station (Station) in Chesterfield County, Virginia. Discharges from the Station are regulated through the Virginia National Pollutant Discharge Elimination System (NPDES) permit No. VA0004146. The Station withdraws cooling water from shoreline intakes (see attachment) in the James River.

On October 14, 2014, the Environmental Protection Agency finalized regulations for cooling water intake structures at existing facilities pursuant to Section 316(b) of the Clean Water Act. Section 40 CFR 122.21(r) of the rule establishes the application information required to support entrainment and impingement technology decisions. Section 40 CFR 125.95(a)(2) of the rule allows permittees to request an alternative schedule for information submittal for permits that expire before July 14, 2018. Additionally, Section 40 CFR 125.98(b)(6) allows the permitting authority to include in a permit that was applied for before the rule effective date but issued after the rule effective date permit conditions to ensure that all of the applicable information is included in the subsequent permit application.

In the case of the Chesterfield Power Station, we plan to provide the information required in Section 40 CFR 122.21(r)(2) through (13). The information required will include a two year Entrainment Characterization Study which we plan to initiate this summer. Additionally, three studies, the Comprehensive Technology and Cost Evaluation Study, Benefits Valuation Study

and Non-water Quality and Other Impacts Study, must be informed by, and therefore be completed after the Entrainment Characterization Study. The later three studies also must undergo an external peer review process. Based on the requirements of these studies articulated in the rule and our experience conducting similar studies in other states, we anticipate this effort will require on the order of four years.

Accordingly, we request an alternative schedule in our reissued permit to specify that all applicable information in Section 40 CFR 122.21(r) be submitted with the subsequent permit reissuance application. Additionally, we are agreeable to providing annual progress reports to DEQ detailing the work completed relative to Section 40 CFR 122.21(r).

As requested in your March 4, 2015 letter, attached is information on the Cooling Water Intake Structures and System at the Chesterfield Power Station. Thank you for your review and consideration of our request. Please contact Oula Shehab-Dandan at (804) 273-2697 or by email at oula.k.shehab-dandan@dom.com should you have any questions or concerns with this request and the submitted information.

Sincerely,

Cathy C. Taylor

Cathy C. Taylor
Director, Electric Environmental Services

Attachment

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Edward H. Baine

Edward H.Baine
VP, Power Generation System Operations

(804) 273-3592
Phone Number

4/28/15
Date

ATTACHEMENT 1

Response to March 4, 2015 DEQ letter re: Chesterfield Intakes

Chesterfield Power Station (CPS) contains six power-generating units: Units 3, 4, 5, and 6 are coal-fired units while Units 7 and 8 are combined-cycle units. The station is a base-load facility which means the facility serves as one of Dominion's primary means of generating the minimum amount of power necessary to meet customer demands. Accordingly, the facility generally operates on a twenty-four hour per day, seven days per week basis, although there is seasonal variation in its operations and maintenance (O&M). In the summer months, all pumps are in operation to meet thermal transfer requirements. There are times in the winter months when all of the pumps are in operation, usually in January and February, which is the winter peaking season. Major outages on the generating units are scheduled for the spring and fall months after the end of the winter peaking season. The duration of the maintenance outages depends on the scheduled work that needs to be done on the units.

Summary of Cooling Water Intake Structures

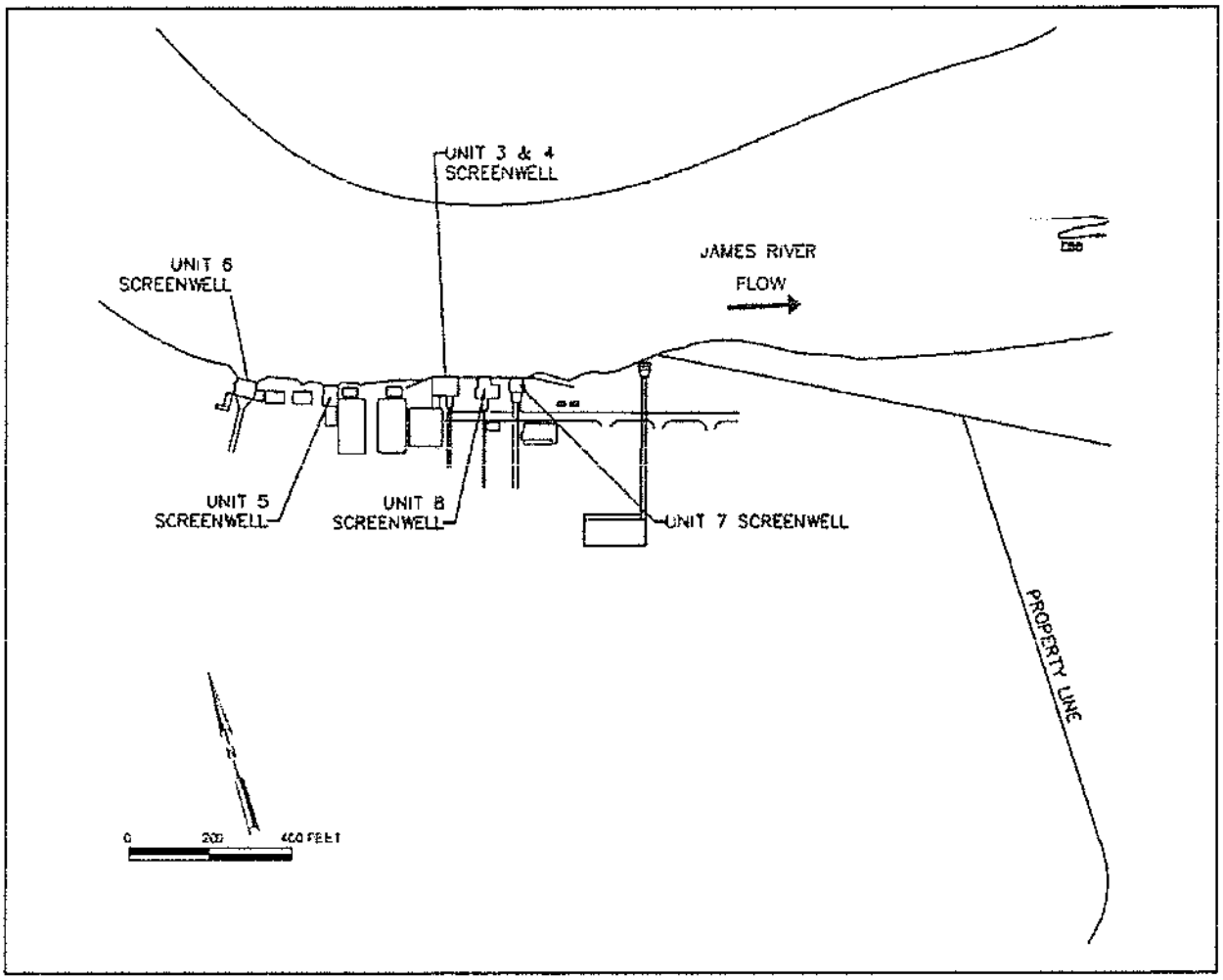
As addressed in the accompanying letter, we are requesting an alternative schedule to complete the information required by 122.21(r)(2) through (13). Below is information regarding the current configuration and specifications of the Cooling Water Intake Structures (CWIS). As we develop the detailed information required by 122.21(r)(2) through (13), we may need to update some of the descriptions and specifications provided here.

The six power-generating units at CPS utilize a once-through cooling water system that withdraws cooling water from the tidal portion of the James River through five CWISs. When the facility is generating power, the circulating cooling water system is in operation. All the CWISs are submerged and flush with and parallel to the south shoreline. See Figure 1 for the unit configuration layout. The total design flow at CPS with all pumps working to capacity is approximately 1,058 million gallons per day (MGD). Over 98 percent of the water withdrawn from the James River is used for cooling water purposes.

The James River in the vicinity of CPS CWISs is approximately 410 ft wide and 31 ft deep and flows in a generally southeasterly direction. The intake structures are designed to operate at river levels ranging from 3.5 ft below mean sea level (MSL) to 19.0 ft above MSL. The mean high and low water differ by approximately 5.2 ft with the mean high water at 3.5 ft above MSL while the mean low water is 1.7 ft below MSL. All elevations in this report refer to MSL.

Upon approach, the river water encounters a curtain wall at each CWIS that extends beyond the low water level. The curtain walls for Units 3, 4, 7, and 8 extend to 4.5 ft below MSL while the

curtain wall for Units 5 and 6 drops down to approximately 4.0 ft below MSL. Each CWIS has trash racks which are installed across the intake structures upstream of the screen bays. Trash racks extend across the entire length of each intake structure (i.e. from the intake structure invert to the intake deck) and prevent debris from entering the screen houses. The trash racks for Units 3 and 4 are approximately 14.5 ft tall by 9.9 ft wide with 0.375-in. bars on 4.0-in. centers. The Unit 5 trash rack is approximately 16.5 ft tall by 12.5 ft wide with 0.375-in. bars on 4.5-in. centers. The Unit 6 trash rack is approximately 19.0 ft high by 15.0 ft wide with 0.375-in. bars on 4.0-in. centers. Units 7 and 8 have trash racks that are approximately 14.5 ft high by 11.0 ft wide with 0.375-in. bars on 3.0-in. centers.



Source: CH2M HILL (2007)

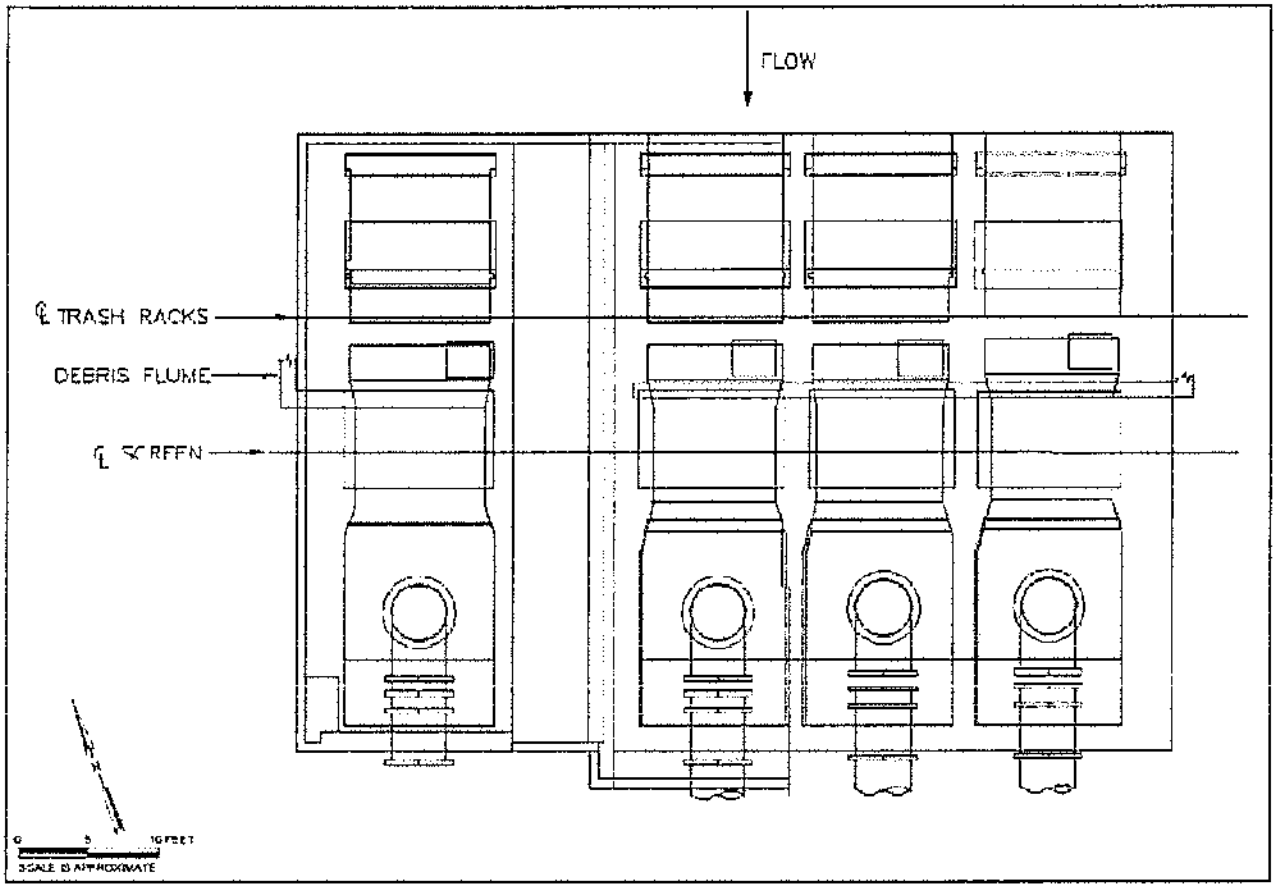
Figure 1 Chesterfield Power Station CWIS Configuration

The traveling water screens are located between 10 and 20 ft downstream of the trash racks. Each of the power-generating units contains two traveling water screens except Unit 6, which has three traveling water screens, for a total of 13 traveling water screens. Units 3, 4, 7, and 8

have 8-foot wide screens, and Units 5 and 6 have 10-foot-wide screens, all with standard 3/8-in. mesh. Units 4, 5, and 6 rotate at a single speed of approximately 10 ft per minute (ft/min), while Unit 3 can rotate at 3 ft/min or 10 ft/min in automatic mode. Units 7 and 8 can rotate at either approximately 5 ft/min or 10 ft/min depending on loading. During normal operation, the screens are generally manually controlled for all units.

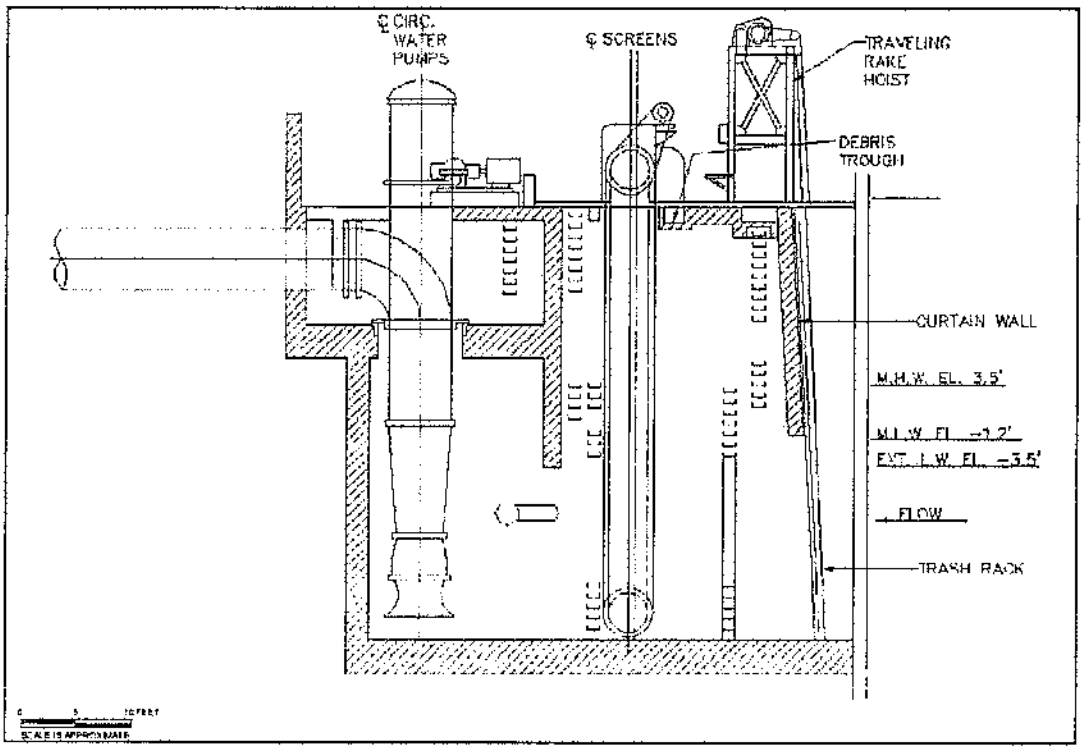
The screens have front spray wash systems and the debris collection trough located on the upstream side of the screens. Screen wash pumps for Units 7 and 8 draw water from the pump house. Units 3 through 6 do not have operating screen wash pumps, and the wash water for these screens is fed from the ash sluice water system from each unit. As the intake screens rotate, debris impinged on the screens is drawn upward and washed off by a wash water spray into a water-filled wash water trough. This water-filled trough conveys organisms and debris back into the James River. These discharges are permitted in the Virginia Discharge Elimination System (VPDES) Permit (VA0004146).

Screened cooling water is conveyed to the circulating water pumps, located at 12 to 18 ft downstream of the traveling water screens, through individual bays. Each unit has a separate circulating water system comprised of two or three vertical shaft, wet-pit, circulating cooling water pumps, two each for Units 3, 4, 5, 7, and 8 and three for Unit 6. The circulating pumps are located in the respective Unit's pump house. Upon exiting the circulating cooling water system, the water is returned to the James River via one of three cooling water discharge points: one for Unit 3, one for Units 7 and 8, and one for Units 4, 5, and 6. The discharge for Units 3, 7, and 8 discharge directly into the James River, approximately 100 ft downstream from the CWIS (via outfalls 001 and 002). Units 4, 5, and 6 discharge into a discharge canal and then into Farrar Gut, an oxbow that flows into the James River approximately 1.2 miles downstream from the intake structures (via outfall 003). Plan and section drawings of typical portions of the CPS CWIS are provided in Figures 2 and 3, respectively.



Source: CH2M HILL (2007)

Figure 2 Typical Plan View of Chesterfield Power



Source: CH2M HILL (2007)

Figure 3 Typical Section View of Chesterfield Power Station CWIS

Specific Responses to Questions in March 4, 2015 Letter

1. Design Specifications for CWISs:
   a. Date of construction of CWISs:

      Date of construction of CWISs:

Unit	Construction Date
3	1952
4	1960
5	1964
6	1969
7	Utilizes original Unit 1 and 2 intake; exact construction date not available
8	Utilizes original Unit 1 and 2 intake; exact construction date not available

b. Dimensions and location of CWISs:

Unit	Approximate Length of Intake Structure (ft)	# of Intake Bays	Approximate Bay Width (ft)	Latitude	Longitude
3	45	2	11	37°23'00.7"	77°22'54.5"
4	45	2	11	37°23'00.7"	77°22'54.5"
5	35	2	13	37°23'01.8"	77°22'57.7"
6	48	3	11	37°23'02.4"	77°22'59.5"
7	30	2	10	37°22'59.9"	77°22'52.5"
8	31	2	10	37°23'00.4"	77°22'53.5"

c. Information regarding intake ports: As described in summary of CWISs above, each CWIS has a curtain wall that extends to 4.0 to 4.5 ft below MSL. Water enters the CWIS below the curtain wall, passes through the screens and is brought into the station using vertical shaft, wet-pit circulating water pumps.

d. Design intake capacity: The total design intake flow at CPS with all pumps working to capacity is approximately 1,058 million gallons per day (MGD).

e. Approximate velocities:

CWIS	Approach (fps)	Through-screen (fps)
Unit 3/4	0.6	1.2
Unit 5	0.8	1.7
Unit 6	1.0	1.7
Unit 7	0.7	1.2
Unit 8	0.7	1.2

2. Information on travelling screens: All requested information provided above.
3. Information circulating water pumps: Units 3, 4, 5, 7 and 8 each have 2 circulating water pumps, while Unit 6 has three circulating water pumps. There are no dedicated back-up pumps. None of the pumps have variable speed capabilities. Below are the capacities of the pumps:

Unit	# of Pumps	Approximate capacity per pump (MGD)
3	2	44.67
4	2	57.24
5	2	105.19
6	3	144.07
7	2	52.99
8	2	52.99

4. Data on any structural or behavioral system to deter fish from entering the CWIS: As discussed above, each CWIS has a curtain wall that extends to 4.0 to 4.5 ft below MSL. The curtain walls can deter some fish and eggs from entering the CWIS.
5. Operation and maintenance procedures for CWIS including intake flow variation: We currently do not have procedures or capabilities to vary intake flows when units are in operation as discussed in item #6 below.
   Regarding operation and maintenance of the CWISs, the CWISs are inspected and observed at least once per shift to identify if operation of the backwash and/or travelling capability of the screens is warranted and to identify any operational or maintenance issues that need to be addressed. Typically, the operation (backwash and/or travelling capability) of the screens is based on differential level across the screens and is initiated manually if operational and river conditions warrant. The inspections are also used to identify if any maintenance issues with the screens or other components of the CWIS exist.
6. Information on temperature ranges, pressures, and durations of the cooling process: As discussed above CPS is a base-load facility which means the facility serves as one of Dominion's primary means of generating the minimum amount of power necessary to meet customer demands and generally operates on a twenty-four hour per day, seven days per week basis. The existing pumps do not have variable speed capabilities, meaning that they are either in operation or are out of operation. In the summer months and the winter peaking season, all pumps are typically in operation to meet thermal transfer requirements. There are times in the spring and fall when some of the pumps are not in operation either because a unit is offline or in a maintenance outage. However, the times when pumps are out of service varies depending on temperatures, energy demand and maintenance schedules. As part of the *Technical Feasibility and Cost Evaluation Study* that will be conducted, we will evaluate a range of measures to reduce flow and associated entrainment including operational measures and variable speed pumps. That evaluation will be informed by the data collected through the *Entrainment Characterization Study*. Operational changes and additional technology requirements are premature until the feasibility, cost and benefits are evaluated in accordance with the 316(b) Rule.

DRAFT Entrainment Characterization Study Plan

Prepared for:
Dominion Resources Services, Inc.

Prepared by:
HDR Engineering, Inc.

April 10, 2015

Chesterfield Power Station

Chester, VA 23836

Contents

1 Introduction ... 1
1.1 Regulatory Background ... 1
1.2 Study Plan Objectives and Document Organization ... 3
2 Generating Station Description ... 3
2.1 Site and Environmental Description ... 3
2.2 Station Description ... 10
2.2.1 Station Operational History ... 10
2.2.2 Intake Structure ... 10
3 Historical Studies ... 14
3.1 Entrainment Study, 2005-2006 ... 14
3.2 Ambient Ichthyoplankton Bongo Net Sampling, 2005-2006 ... 17
4 Threatened and Endangered Species ... 21
5 Basis for Sampling Design ... 26
6 Entrainment Characterization Study Plan ... 28
6.1 Introduction ... 28
6.2 Safety Policy ... 30
6.3 Field Collection Procedures ... 30
6.3.1 Location ... 30
6.3.2 Equipment ... 30
6.3.3 Sampling Schedule ... 36
6.3.4 Entrainment Sample Collection Procedures ... 36
6.3.5 Pump Flow Rate Check Procedures ... 38
6.3.6 Water Quality Measurements ... 39
6.4 Laboratory Procedures ... 39
6.4.1 Equipment ... 39
6.4.2 Laboratory Analysis ... 40
Sample Sorting ... 40
Sort Sub-sampling Procedure ... 40
Sample Identification ... 41
Morphometrics ... 41
Taxonomic Resolution Monitoring ... 41
Methods for Identifying Atlantic Sturgeon ... 41
6.4.3 Laboratory Quality Control (QC) Procedures ... 42
7 References ... 43

Appendices

Appendix A. Atlantic Sturgeon Life History Information

Appendix B. Field Instrumentation: Calibrations and Standardizations

Appendix C. Lists of Data to be Collected and Recorded for Field Collection and Laboratory Analysis

Tables

Table 1-1. §316(b) Rule for Existing Facilities Submittal Requirements Summary 2

Table 3-1. Chesterfield Power Station June 2005 – May 2006 Entrainment Sampling Methods Summary 14

Table 3-2. Average Density and Percent Composition of Ichthyoplankton and Macroinvertebrates Entrained at Chesterfield Power Station, June 2005 – May 2006 15

Table 3-3. Monthly Densities (No./100 m^3) of Common Ichthyoplankton Entrained at Chesterfield Power Station, June 2005 – May 2006..... 17

Table 3-4. Average Density of Selected Species Entrained at Chesterfield Power Station During Different Diel Periods 17

Table 3-5. Density (No./100 m^3) of Ichthyoplankton in James River Ambient Ichthyoplankton Samples at Chesterfield Power Station, June 2005 – May 2006 19

Table 3-6. Density (No./100 m^3) of Ichthyoplankton in Entrainment Samples at Chesterfield Power Station, June 2005 – May 2006..... 20

Table 4-1. Federal and State Threatened, Endangered, and Proposed Species with the Potential to Occur within 2 miles of the Cooling Water Intake of CPS..... 22

Table 5-1. Summary of Approach for Development of §122.21(r)(9) Required Entrainment Characterizations 28

Table 6-1. Entrainment Sampling Details 29

Figures

Figure 2-1. Chesterfield Power Station Regional Location Map 4

Figure 2-2. Chesterfield Power Station Area Map 5

Figure 2-3. The James River Watershed 6

Figure 2-4. Aerial View of Chesterfield Power Station with Cooling Water Intake Location 7

Figure 2-5. General Water Depths in James River near Chesterfield Power Station (Soundings in Feet at Mean Lower Low Water) 8

Figure 2-6. Survey of James River Depths in Vicinity of Chesterfield Power Station CWISs 9

Figure 2-7. Chesterfield Power Station CWIS Configuration 11

Figure 2-8. Typical Plan View of Chesterfield Power Station CWIS 12

Figure 2-9. Typical Section View of Chesterfield Power Station CWIS 13

Figure 3-1. Ambient Ichthyoplankton Sampling Locations Near Chesterfield Power Station, June 2005 - May 2006 18

Figure 6-1. Proposed Location of Chesterfield Power Station Entrainment Sampling, 2015 – 2017 32

Figure 6-2. Conceptual Design of Intake Piping for Entrainment Sampling 33

Figure 6-3. Entrainment Pump Sampling System Configuration 35

1 Introduction

1.1 Regulatory Background

Clean Water Act §316(b) was enacted under the 1972 Clean Water Act, which also introduced the National Pollutant Discharge Elimination System (NPDES) permit program. Facilities with NPDES permits are subject to §316(b), which requires that the location, design, construction and capacity of cooling water intake structures (CWIS) reflect best technology available (BTA) for minimizing adverse environmental impacts. Cooling water intakes can cause adverse environmental impacts by drawing early life-stage fish and shellfish into and through cooling water systems (entrainment), or trapping juvenile or adult fish against the screens at the opening of an intake structure (impingement).

On August 15, 2014, the final §316(b) rule for existing facilities was published in the Federal Register. The rule applies to existing facilities that withdraw more than 2 million gallons per day (MGD) from Waters of the United States, use at least 25 percent of that water exclusively for cooling purposes, and have or require an NPDES permit. The rule supersedes the Phase II rule, which regulated large electrical generating facilities until it was remanded in 2007, and the remanded existing-facility portion of the previously promulgated Phase III rule.

Facilities subject to the new rule are required to develop and submit technical material, identified at §122.21(r)(2)-(13), that will be used by the NPDES Director (Director) to make a BTA determination for the facility (Table 1-1). The specific material required to be submitted and compliance schedule are dependent on actual intake flow rates at the facility and NPDES permit renewal date, respectively. Facilities are to submit their §316(b) application material to their Director along with their next permit renewal, unless that permit renewal takes place prior to July 14, 2018, in which case an alternate schedule may be negotiated.

Dominion's Chesterfield Power Station (CPS) is subject to the existing facility rule and based on its current configuration and operation is anticipated to be required to develop and submit each of the §122.21(r)(2)-(13) submittal requirements with its next permit renewal in accordance with the rule's technical and schedule requirements. Within the §122.21(r)(2)-(13) requirements, (r)(4), (7), (9) and (11) have specific requirements related to entrainment evaluations (refer to Table 1-1 for additional detail). This document provides an Entrainment Characterization Study Plan to support §316(b) compliance at the facility with consideration of these specific requirements. Notably, this Entrainment Characterization Study Plan is not explicitly required by the rule.

Table 1-1. §316(b) Rule for Existing Facilities Submittal Requirements Summary

Submittal Requirements at §122.21(r)		Submittal Descriptions
(2)	Source Water Physical Data	Characterization of the source water body including intake area of influence
(3)	Cooling Water Intake Structure Data	Characterization of cooling water system; includes drawings and narrative; description of operation; water balance
(4)	Source Water Baseline Biological Characterization data	Characterization of biological community in the vicinity of the intake; life history summaries; susceptibility to impingement and entrainment; must include existing data; identification of missing data; threatened and endangered species and designated critical habitat summary for action area; identifies fragile fish and shellfish species list (<30 percent impingement survival)
(5)	Cooling Water System Data	Narrative description of cooling water system and intake structure; proportion of design flow used; water reuse summary; proportion of source water body withdrawn (monthly); seasonal operation summary; existing impingement mortality and entrainment reduction measures; flow/MW efficiency
(6)	Chosen Method of Compliance with Impingement Mortality Standard	Provides facility's proposed approach to meet the impingement mortality requirement (chosen from seven available options); provides detailed study plan for monitoring compliance, if required by selected compliance option; addresses entrapment where required
(7)	Entrainment Performance studies	Provides summary of relevant entrainment studies (latent mortality, technology efficacy); can be from the facility or elsewhere with justification; studies should not be more than 10 years old without justification; new studies are not required.
(8)	Operational Status	Provides operational status for each unit; age and capacity utilizations for the past five years; upgrades within last 15 years; uprates and Nuclear Regulatory Committee relicensing status for nuclear facilities; decommissioning and replacement plans; current and future operation as it relates to actual and design intake flow
(9)	Entrainment Characterization Study	Requires at least two years of data to sufficiently characterize annual, seasonal, and diel variations in entrainment, including variations related to climate, weather, spawning, feeding, and water column migration; facilities may use historical data that are representative of current operation of the facility and conditions at the site with documentation regarding the continued relevance of the data to document total entrainment and entrainment mortality; includes identifications to the lowest taxon possible; data must be representative of each intake; must document how the location of the intake in the water body and water column are accounted for; must document intake flows associated with the data collection; documentation in the study must include the method in which latent mortality would be identified (including QAQC); sampling and data must be appropriate for a quantitative survey
(10)	Comprehensive Technical Feasibility & Cost Evaluation Study	Provides an evaluation of technical feasibility and incremental costs of entrainment technologies; Net Present Value of facility compliance costs and social costs to be provided; requires peer review
(11)	Benefits Valuation Study	Provides a discussion of monetized and non-monetized water quality benefits of candidate entrainment technologies from (r)(10) using data in (r)(9); benefits to be quantified physical or biological units and monetized using appropriate economic valuation methods; includes changes in fish stock and harvest levels and description of monetization; must evaluate thermal discharges, facility capacity, operations, and reliability; discussion of previous mitigation efforts and affects; benefits to environment and community; social benefits analysis based on principle of willingness-to-pay; requires peer review
(12)	Non-Water Quality Environmental and Other Impacts Assessment	Provides a discussion of non-water quality factors (air emissions and their health and environmental impacts, energy penalty, thermal discharge, noise, safety, grid reliability, consumptive water use, etc.) attributable to the entrainment technologies; requires peer review
(13)	Peer Review	Documentation of external peer review, by qualified experts, of submittals (r) (10), (11), and (12). Peer Reviews must be approved by the NPDES Director and present their credentials. The applicant must explain why it disregarded any significant peer reviewer recommendations.

1.2 Study Plan Objectives and Document Organization

The Entrainment Characterization Study Plan provided in this report was developed to support CPS §316(b) compliance through development of a site-specific entrainment study plan with the following key objectives in mind:

1. Collect data to support development of §122.21(r)(4) which requires a listing of species and life stages most susceptible to entrainment at the facility;
2. Collect data to support development of §122.21(r)(7) which allows for summaries of relevant technology efficacy studies conducted at the facility[1];
3. Collect data to support development of §122.21(r)(9) which requires at least two years of entrainment studies be conducted at the facility;
4. Collect data to support Dominion's objective of having data sufficient to evaluate biological efficacy of potential alternative intake technologies that may require site specific evaluation at the facility as a part of the §122.21(r)(10)-(13) compliance evaluations.

To meet these objectives, this document provides summaries of the station's configuration and operations (Section 2), historical biological sampling efforts conducted at the facility that are relevant to cooling water intake evaluations (Section 3), a summary of Threatened and Endangered Species identified in the vicinity of the facility (Section 4), a sampling program design justification based on this information (Section 5), and the recommended study methods including key parameters of gear, schedule, frequency, and quality control procedures (Section 6).

2 Generating Station Description

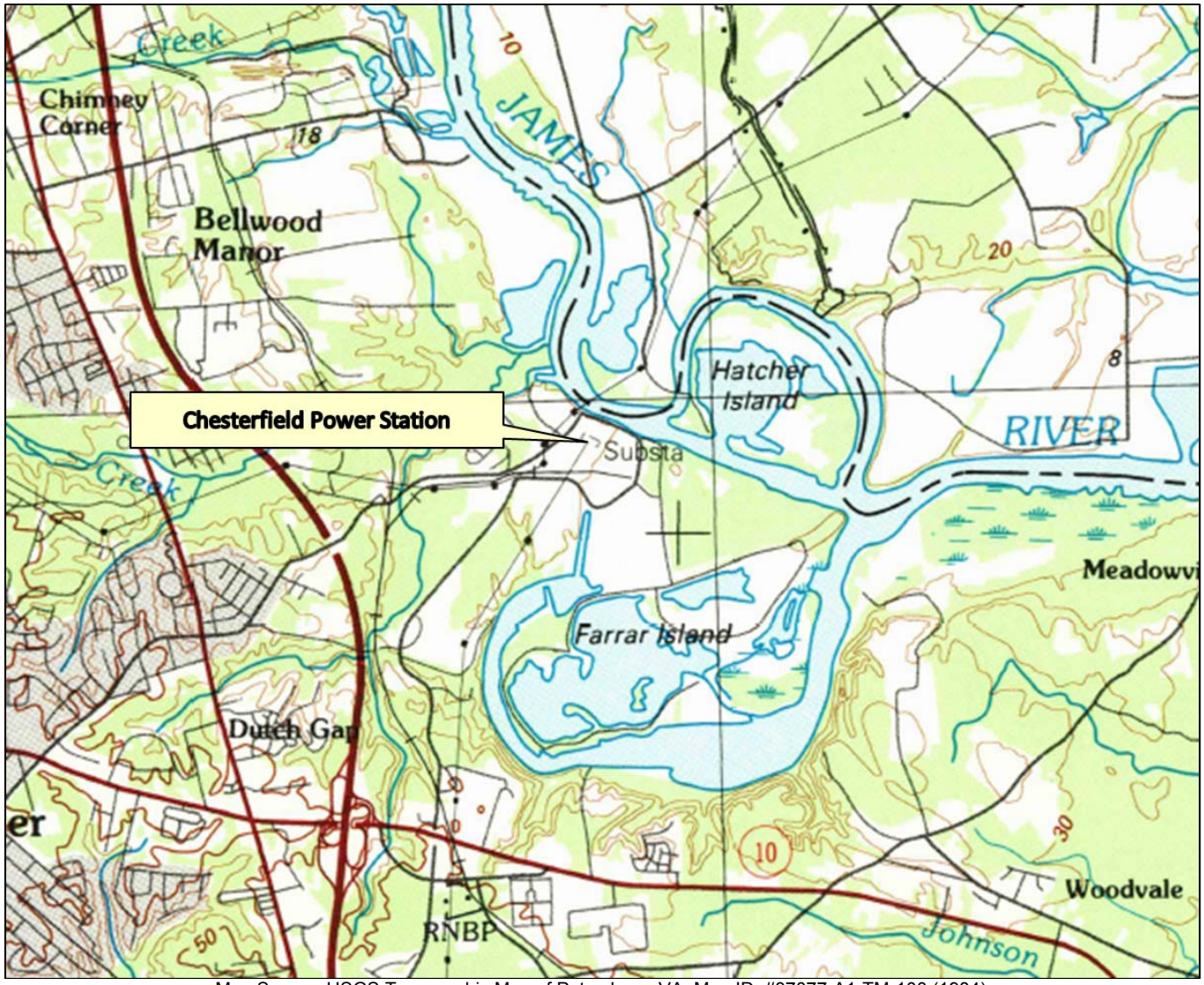
2.1 Site and Environmental Description

Chesterfield Power Station (CPS) is located in the upper tidal portion of the James River, approximately 13 miles downstream of the fall line in the City of Richmond (Figure 2-1). The CPS is located in the Lower James River section in the Coastal Uplands Physiographic Province. In the area of the Station, the James River begins the transition from a higher gradient straight channel with generally steep banks to a meandering channel with oxbow features. The CPS is located near Hatcher Island and Farrar Gut which are two of the first oxbows in the river (Figure 2-2). The river is channelized and dredged to maintain passage for barge and vessel travel to the Port of Richmond.

[1] CPS is expected to reduce entrainment at the facility due to flow reduction relative to design flow and potentially other factors. This study plan will collect data to support calculation of this and potentially other entrainment reduction attributes at the facility.

Map Source: USGS Topographic Map of Petersburg, VA; Map ID #37077-A1-TM-100 (1984)

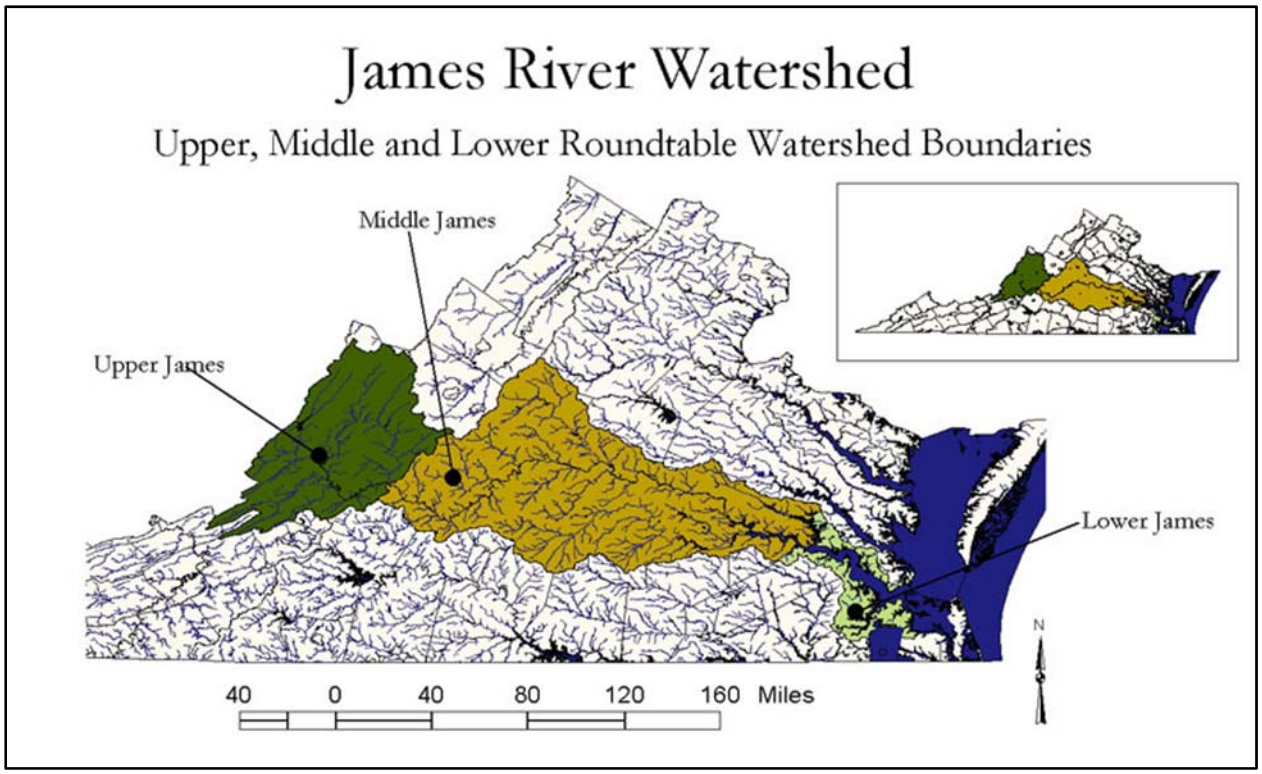
Figure 2-1. Chesterfield Power Station Regional Location Map



Map Source: USGS Topographic Map of Petersburg, VA; Map ID #37077-A1-TM-100 (1984)

Figure 2-2. Chesterfield Power Station Area Map

The James River watershed encompasses approximately 10,000 square miles, which makes up almost 25 percent of the state. The James River watershed covers about one-third of the Chesapeake Bay drainage area in Virginia. The river flows approximately 340 miles from the Alleghany Mountains of western Virginia to the Chesapeake Bay. The watershed is comprised of three sections: the Upper James watershed begins in Allegheny County and travels through the Allegheny and Blue Ridge Mountains until Lynchburg, the Middle James watershed runs from Lynchburg to Richmond, while the Lower James watershed stretches from Richmond to the Chesapeake Bay (Figure 2-3).



Source: Middle James Roundtable

Figure 2-3. The James River Watershed

The six power-generating units at CPS use a once-through cooling water system. Cooling water is withdrawn from the James River through five submerged Cooling Water Intake Structures (CWISs) oriented parallel to, and flush with, the south shoreline of the river (Figure 2-4).

The CWISs for the six units are located on the south side of the river on a bluff. The intakes are located immediately downstream from the Chesterfield County's Proctors Creek Wastewater Treatment Plant. In the vicinity of the CWIS, the river has an abbreviated littoral or shoreline zone as a result of steep bank elevations and the channelized river bottom. At the station, the river is approximately 410 feet (ft) wide and flows in a generally southeasterly direction. Water depths in front of the intakes range from 29 ft to 33 ft with a normal depth of approximately 31 ft.

Image Source: Google Earth, 10/21/2012, Retrieved 9/25/2012

Figure 2-4. Aerial View of Chesterfield Power Station with Cooling Water Intake Location

General river depths in the region of the Station are provided in the navigational chart provided in Figure 2-5. Surveyed river bottom depths are provided in the topographical survey provided in Figure 2-6.

The James River at the station experiences a mean tidal amplitude of approximately 2.0 ft. The water level in this portion of the James River fluctuates greatly with an extreme high of elevation 19.0 ft and an extreme low of elevation -3.5 ft. The mean high and low water differ by 5.2 ft; the mean high water is at grade elevation (El.) 3.5 ft and the mean low water is at El. -1.7 ft. Maximum tidal current is approximately 2.8 ft/s with average maximum ebb and flood tidal currents of 1.34 ft/s and 1.5 ft/s, respectively. The James River in the vicinity of the station is a temperate zone river with average temperatures generally ranging from 0.0 ^{o}C in February to 34 ^{o}C in August.

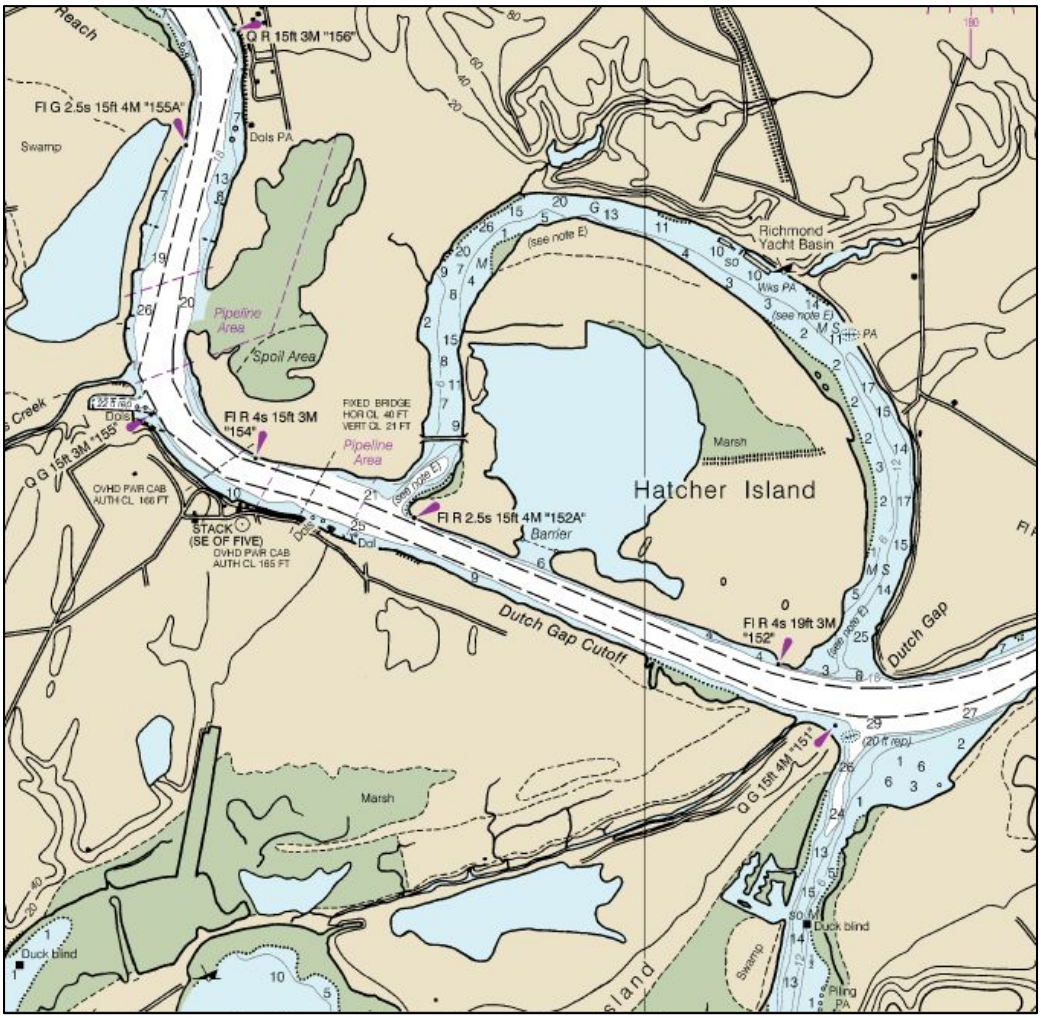


Image Source: NOAA Office of Coast Survey Chart 12252, January 2013, Retrieved 9/25/2014

Figure 2-5. General Water Depths in James River near Chesterfield Power Station (Soundings in Feet at Mean Lower Low Water)

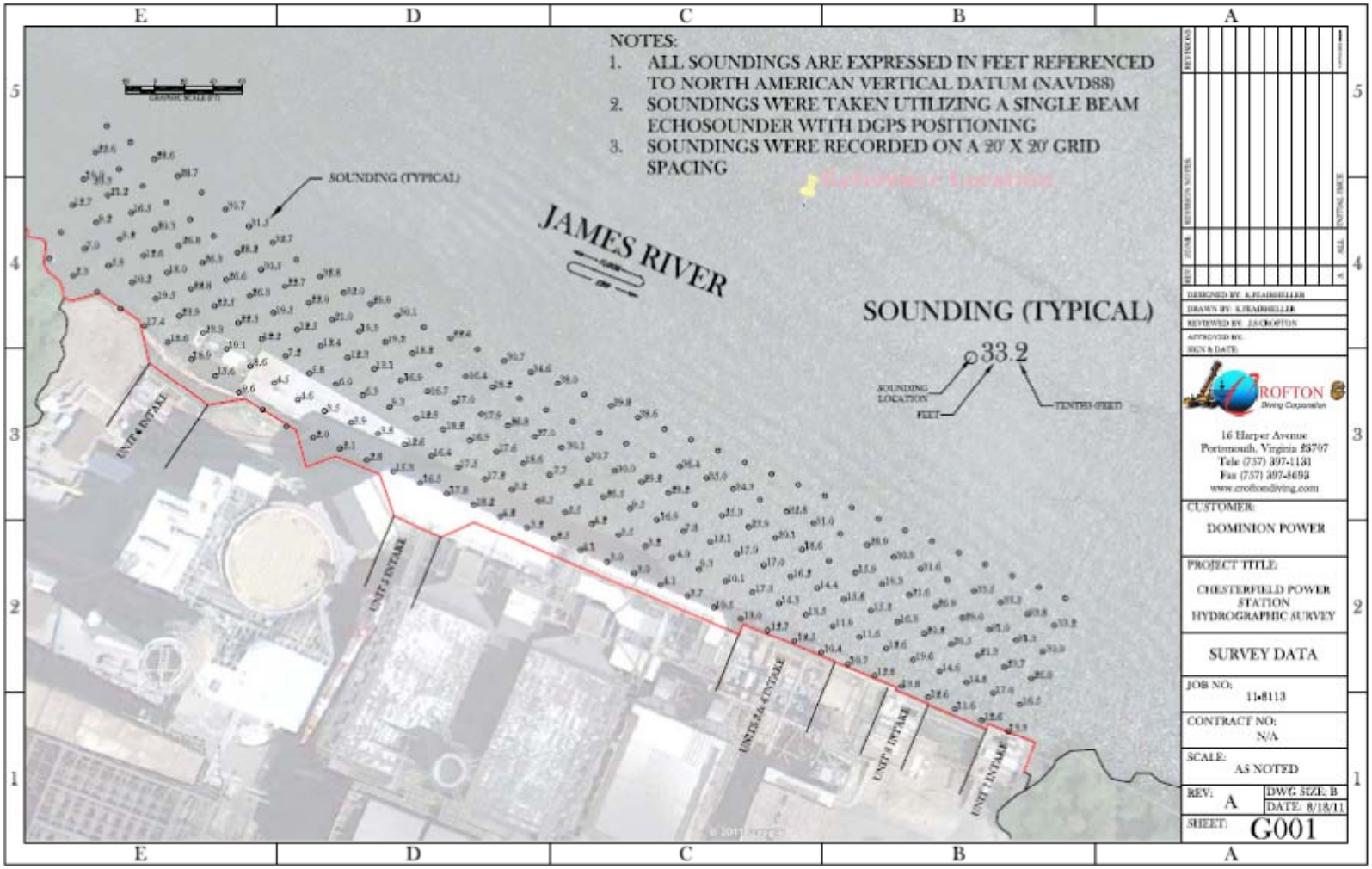


Figure 2-6. Survey of James River Depths in Vicinity of Chesterfield Power Station CWISs

2.2 Station Description

2.2.1 Station Operational History

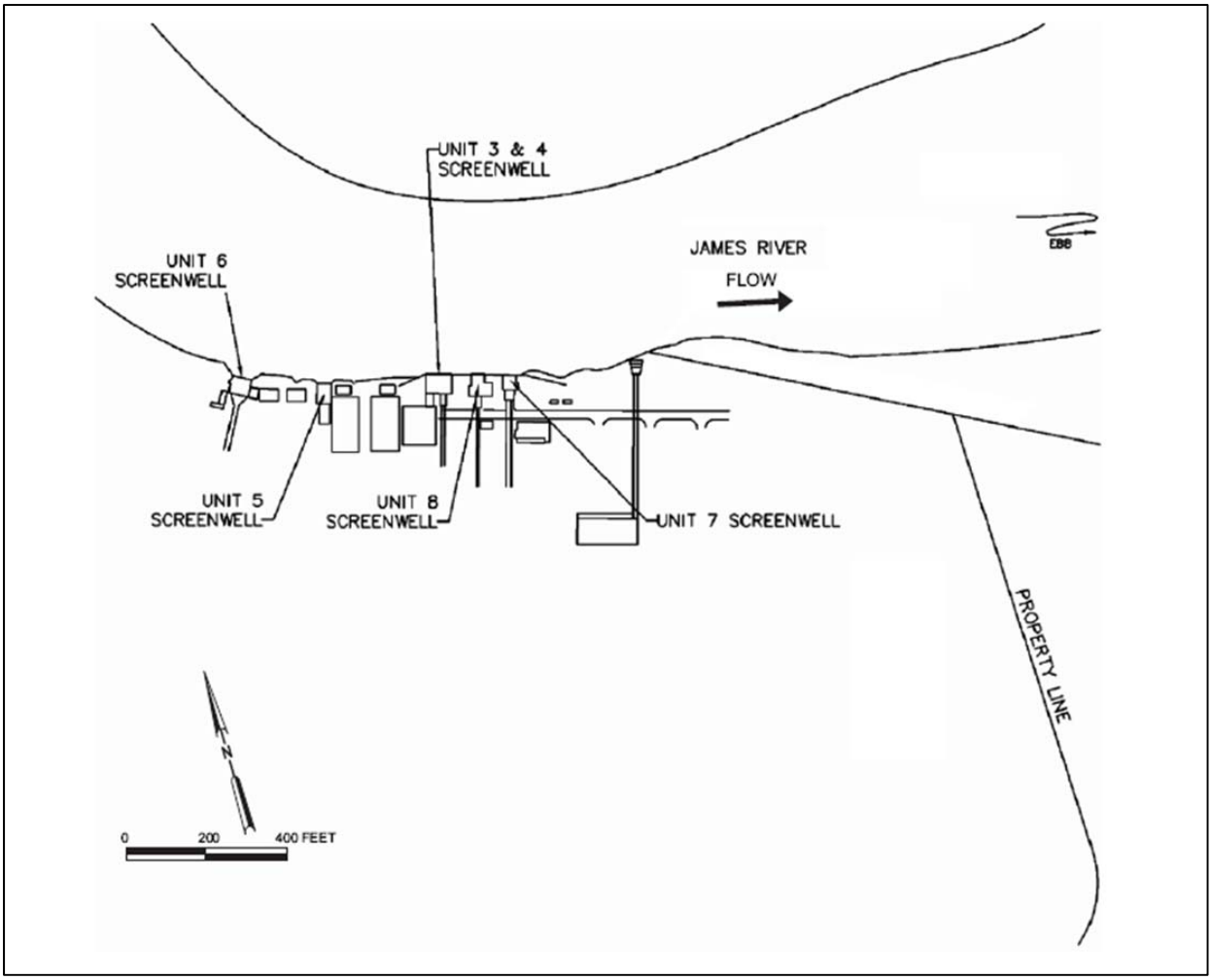
CPS contains six power-generating units: Units 3, 4, 5, and 6 are coal-fired units while Units 7 and 8 are combined-cycle units. The station is a base-load facility which means the facility serves as one of Dominion's primary means of generating the minimum amount of power necessary to meet customer demands. Accordingly, the facility generally operates on a twenty-four hour per day, seven days per week basis, although there is seasonal variation in its operations and maintenance (O&M). In the summer months, all pumps are in operation to meet thermal transfer requirements. There are times in the winter months when all of the pumps are in operation, usually in January and February, which is the winter peaking season. Major outages on the generating units are scheduled for the spring and fall months after the end of the winter peaking season. The duration of the maintenance outages depends on the scheduled work that needs to be done on the units.

2.2.2 Intake Structure

The six power-generating units at CPS utilize a once-through cooling water system that withdraws cooling water from the tidal portion of the James River through five CWISs. When the facility is generating power, the circulating cooling water system is in operation. All the CWISs are submerged and flush with and parallel to the south shoreline. See Figure 2-7 for the unit configuration layout. The total design flow at CPS with all pumps working to capacity is approximately 1,058 million gallons per day (MGD). Over 98 percent of the water withdrawn from the James River is used for cooling water purposes.

The James River in the vicinity of CPS CWISs is approximately 410 ft wide and 31 ft deep and flows in a generally southeasterly direction. The intake structures are designed to operate at river levels ranging from 3.5 ft below mean sea level (MSL) to 19.0 ft above MSL. The mean high and low water differ by approximately 5.2 ft with the mean high water at 3.5 ft above MSL while the mean low water is 1.7 ft below MSL. All elevations in this report refer to MSL.

Upon approach, the river water encounters a curtain wall that extends beyond the low water level. The curtain walls for Units 3, 4, 7, and 8 extend to 4.5 ft below MSL while the curtain wall for Units 5 and 6 drops down to approximately 4.0 ft below MSL. Each CWIS has trash racks which are installed across the intake structures upstream of the screen bays. Trash racks extend across the entire length of each intake structure (i.e. from the intake structure invert to the intake deck) and prevent debris from entering the screen houses. The trash racks for Units 3 and 4 are approximately 14.5 ft tall by 9.9 ft wide with 0.375-in. bars on 4.0-in. centers. The Unit 5 trash rack is approximately 16.5 ft tall by 12.5 ft wide with 0.375-in. bars on 4.5-in. centers. The Unit 6 trash rack is approximately 19.0 ft high by 15.0 ft wide with 0.375-in. bars on 4.0-in. centers. Units 7 and 8 have trash racks that are approximately 14.5 ft high by 11.0 ft wide with 0.375-in. bars on 3.0-in. centers.



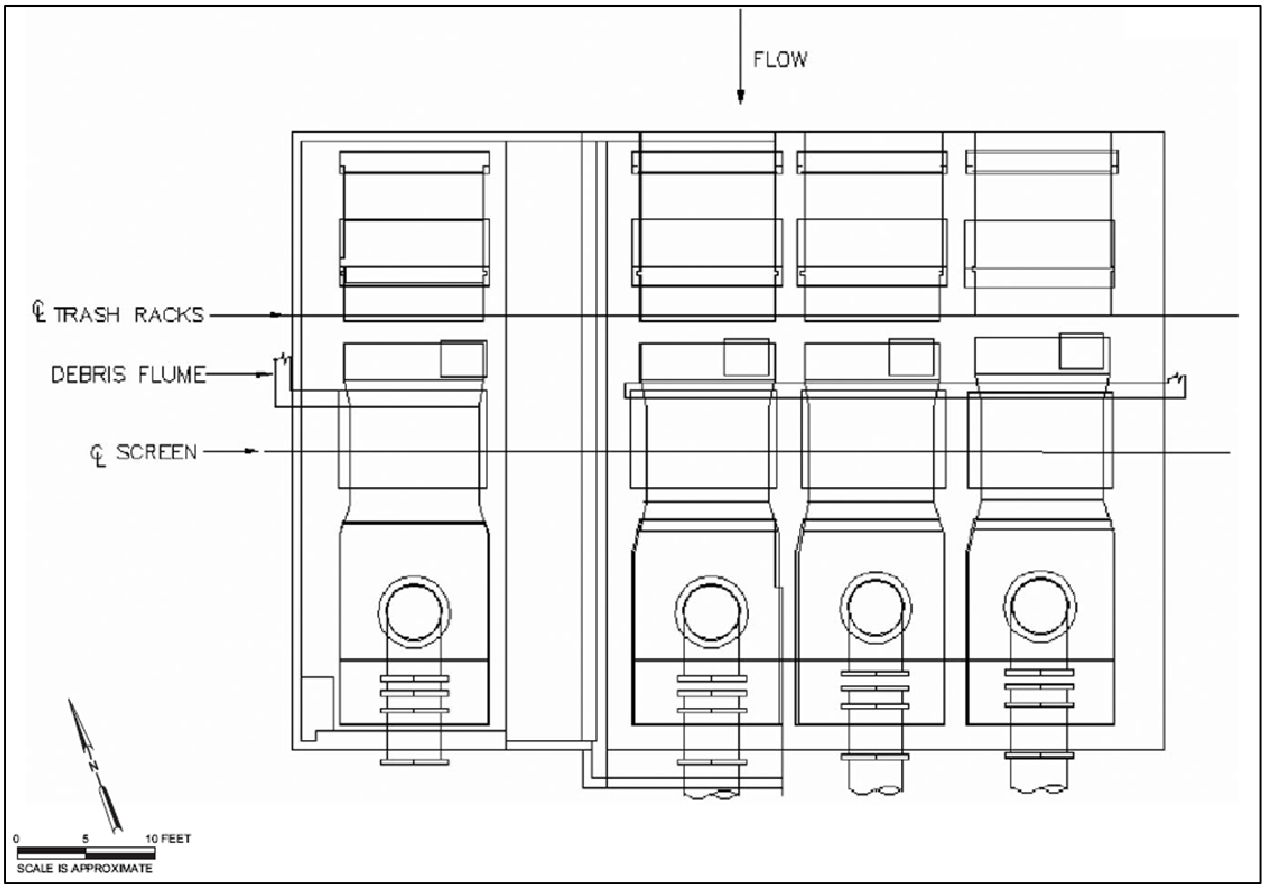
Source: CH2M HILL (2007)

Figure 2-7. Chesterfield Power Station CWIS Configuration

The traveling water screens are located between 10 and 20 ft downstream of the trash racks. Each of the power-generating units contains two traveling water screens except Unit 6, which has three traveling water screens, for a total of 13 traveling water screens. Units 3, 4, 7, and 8 have 8-foot wide screens, and Units 5 and 6 have 10-foot-wide screens, all with standard 3/8-in. mesh. Each of the vertical traveling screens is designed for continuous operation. Units 4, 5, and 6 rotate at a single speed of approximately 10 ft per minute (ft/min), while Unit 3 can rotate at 3 ft/min or 10 ft/min in automatic mode. Units 7 and 8 can rotate at either approximately 5 ft/min or 10 ft/min depending on loading. During normal operation, the screens are generally manually controlled for all units.

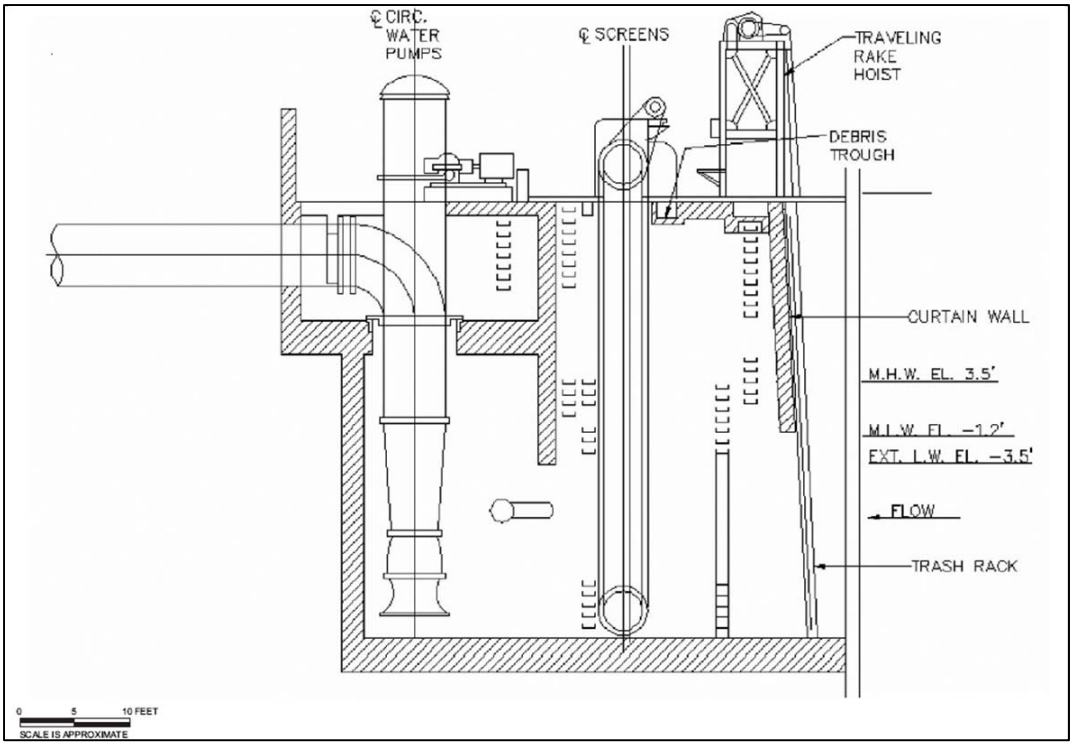
The screens have front spray wash systems and the debris collection trough located on the upstream side of the screens. Screen wash pumps for Units 7 and 8 draw water from the pump house. Units 3 through 6 do not have operating screen wash pumps, and the wash water for these screens is fed from the ash sluice water system from each unit. As the intake screens rotate, debris impinged on the screens is drawn upward and washed off by a wash water spray into a water-filled wash water trough. This water-filled trough conveys organisms and debris back into the James River. These discharges are permitted in the Virginia Discharge Elimination System (VPDES) Permit (VA0004146).

Screened cooling water is conveyed to the circulating water pumps, located at 12 to 18 ft downstream of the traveling water screens, through individual bays. Each unit has a separate circulating water system comprised of two or three vertical shaft, wet-pit, circulating cooling water pumps, two each for Units 3, 4, 5, 7, and 8 and three for Unit 6. The circulating pumps are located in the respective Unit's pump house. Upon exiting the circulating cooling water system, the water is returned to the James River via one of three cooling water discharge points: one for Unit 3, one for Units 7 and 8, and one for Units 4, 5, and 6. The discharge for Units 3, 7, and 8 discharge directly into the James River, approximately 100 ft downstream from the CWIS (via outfalls 001 and 002). Units 4, 5, and 6 discharge into a discharge canal and then into Farrar Gut, an oxbow that flows into the James River approximately 1.2 miles downstream from the intake structures (via outfall 003). A satellite image of the outfall configuration is provided previously in Figure 2-4. Plan and section drawings of typical portions of the CPS CWIS are provided in Figures 2-8 and 2-9, respectively.



Source: CH2M HILL (2007)

Figure 2-8. Typical Plan View of Chesterfield Power Station CWIS



Source: CH2M HILL (2007)

Figure 2-9. Typical Section View of Chesterfield Power Station CWIS

3 Historical Studies

Past fisheries studies conducted at CPS which are pertinent to §316(b) include the following:

- June 2005 – May 2006 Impingement and Entrainment Studies (EA 2007)
- June 2005 – May 2006 Ambient Adult and Juvenile Finfish Sampled by Electrofishing and Gillnets; Ambient Ichthyoplankton Sampling by Towed Plankton Net (EA 2007)
- April 1997 – February 1999 Adult and Juvenile Finfish Sampled by Electrofishing and Gillnets (VEPCO 2000)
- January – December 1977 Impingement and Entrainment Studies (VEPCO 1977)

For the purposes of development of this Study Plan, the June 2005 – May 2006 entrainment and ambient ichthyoplankton studies (EA 2007) are summarized below.

3.1 Entrainment Study, 2005-2006

Results of this study, conducted June 2005 to May 2006, were used to identify the species and life stages that would be most susceptible to entrainment. This generally includes only the youngest life stages (eggs. larvae and early juveniles). This study addressed species comprising the forage base, as well as those most important in terms of significance to commercial and recreational fisheries. Details of June 2005 – May 2006 entrainment sampling program are presented in Table 3-1.

Table 3-1. Chesterfield Power Station June 2005 – May 2006 Entrainment Sampling Methods Summary

Entrainment	Details
Units Sampled	Unit 6
Sampling Location	In front of CPS Unit 6
Surveys from June 2005 to May 2006	2 surveys per month for 12 months
Daily Collection Schedule	Every 6 hours in a 24-hr period (4 collections / 24-hr period) centered around 1000, 1600, 2200 and 0400 hours
Depths Sampled	Near surface, mid-depth and near bottom
Number of Samples Collected per Depth	2 samples per depth using paired bongo nets (duplicate samples at each depth)
Sample Duration	10 minutes
Sampling Gear	0.5-m diameter mouth plankton nets constructed of 505-µm mesh netting, each affixed in a double-net bongo frame; General Oceanics 2030R or 2030R6 (low flow) mechanical flowmeter suspended in the mouth of each net
Water Quality Measurements	Temperature, dissolved oxygen, pH, and conductivity measured with YSI Model 556 water quality analyzer at mid-depth during each entrainment sampling event

A total of 40 taxa and life stages were collected in entrainment samples collected at CPS (Table 3-2). Most entrained organisms were young life stages of fish. Larvae of River Herring (a collective term for Alewife and Blueback Herring), *Dorosoma* sp. eggs and larvae, Gizzard Shad larvae, and Bay Anchovy eggs were most abundant. Young bivalves and, to a lesser extent, shrimp were fairly common.

Identification and evaluation of the primary seasonal periods of reproduction, larval recruitment, and peak abundance for relevant taxa were based on results of this entrainment sampling. As mentioned above, the most commonly entrained organisms were the young life stages of fish - eggs and larvae (Table 3-2). With the exception of Bay Anchovy eggs (peak in August 2005) and *Dorosoma* sp. eggs (common in June and July 2005), other common egg and larval forms were most often entrained during April and May 2006 (Table 3-3). All of the common species shown are typical spring spawners, except that Bay Anchovy spawn over an extended period, as evidenced by their peak egg density in August 2005.

Densities of common species/life stages entrained at CPS also varied with time of day (Table 3-4). Both River Herring larvae and *Dorosoma* sp. eggs were more abundant in early morning (0400 hrs) samples. Gizzard Shad larvae were more abundant in late morning samples, whereas White Perch larvae exhibited no particular trend or pattern. Based on this evaluation, entrainment rates are higher at night, and particularly in the early morning, for the most abundant species entrained.

Table 3-2. Average Density and Percent Composition of Ichthyoplankton and Macroinvertebrates Entrained at Chesterfield Power Station, June 2005 – May 2006

Species/Taxon	Life Stage	No./100 m^3	Percent	Cumulative Percent
River Herring	larvae	31.61	23.27	23.27
Bivalve	young	26.78	19.72	42.99
Dorsoma sp.	egg	18.07	13.30	56.29
Gizzard Shad	larvae	10.55	7.77	64.06
Bay Anchovy	egg	8.43	6.21	70.26
Shrimp		6.93	5.10	75.37
Dorsoma sp.	larvae	6.00	4.42	79.78
Fish eggs	undetermined/damaged	4.21	3.10	82.88
River Herring	egg	3.42	2.52	85.40
White Perch	larvae	3.20	2.36	87.76
White Perch	egg	2.36	1.74	89.49
Alewife	larvae	2.28	1.68	91.17
Hickory Shad	larvae	2.19	1.61	92.79
Other crab	zoea	2.07	1.52	94.31
Clupeidae, sp.	larvae	2.07	1.52	95.83

Species/Taxon	Life Stage	No./100 m^3	Percent	Cumulative Percent
Tessellated Darter	larvae	0.95	0.70	96.53
Fish larvae	undetermined/damaged	0.57	0.42	96.95
Inland Silverside	larvae	0.55	0.40	97.36
Hickory Shad	egg	0.41	0.30	97.66
Blueback Herring	larvae	0.40	0.29	97.95
American Shad	egg	0.36	0.27	98.22
Lepomis sp.	larvae	0.29	0.21	98.43
Hogchoker	egg	0.27	0.20	98.63
Spottail Shiner	larvae	0.24	0.18	98.81
Inland Silverside	egg	0.23	0.17	98.98
Dorsoma sp.	undetermined/damaged	0.22	0.16	99.14
Blueback Herring	egg	0.21	0.15	99.29
Pomoxis sp.	larvae	0.18	0.13	99.43
Centrarchidae sp.	egg	0.15	0.11	99.54
Bluegill	larvae	0.15	0.11	99.65
Centrarchidae sp.	larvae	0.10	0.07	99.72
Bay Anchovy	larvae	0.08	0.06	99.78
Centrarchidae	juvenile	0.07	0.05	99.83
Atherinopsidae sp.	egg	0.04	0.03	99.86
Common Carp	larvae	0.04	0.03	99.89
Threadfin Shad	larvae	0.04	0.03	99.92
Naked Goby	larvae	0.02	0.01	99.93
Channel Catfish	larvae	0.02	0.01	99.95
Atlantic Silverside	larvae	0.01	0.01	99.96
Blue Crab	megalopae	0.01	0.01	99.96
American Shad	larvae	0.01	0.01	99.97
Blue Catfish	larvae	0.01	0.01	99.98
Atherinopsidae sp.	larvae	0.01	0.01	99.99
Bay Anchovy	juvenile	0.01	0.01	99.99
Black Crappie	larvae	0.01	0.01	100.00

Source: Table 10 of EA 2007

Table 3-3. Monthly Densities (No./100 m^3) of Common Ichthyoplankton Entrained at Chesterfield Power Station, June 2005 – May 2006

Species/Taxon	Life Stage	2005							2006				
		Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
Bay Anchovy	egg	0.0	9.1	90.1	0.2	0.1	0.0	1.7	0.0	0.0	0.0	0.0	0.0
Bay Anchovy	larvae	0.0	0.0	0.0	0.9	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
River Herring	egg	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.3	51.5
River Herring	larvae	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.4	17.2	393.4
Gizzard Shad	larvae	1.2	0.3	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	21.7	103.3
Hickory Shad	larvae	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	14.0	12.2
Dorsoma sp.	egg	24.5	39.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	29.8	122.8
White Perch	egg	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10.8	16.6	11.7
White Perch	larvae	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.6	8.4	29.6
Tessellated Darter	larvae	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.9	8.1	3.3

Source: Table 12 of EA 2007

Table 3-4. Average Density of Selected Species Entrained at Chesterfield Power Station During Different Diel Periods

Time of Day	Average Density Collected per 100 m^{-3}				
	River Herring Larvae	Dorosma sp. Egg	Gizzard Shad Larvae	Bay Anchovy Egg	White Perch Larvae
Late AM	334	31	311	221	23
Early PM	597	28	135	197	59
Late PM	413	86	66	528	19
Early AM	1079	318	95	25	53

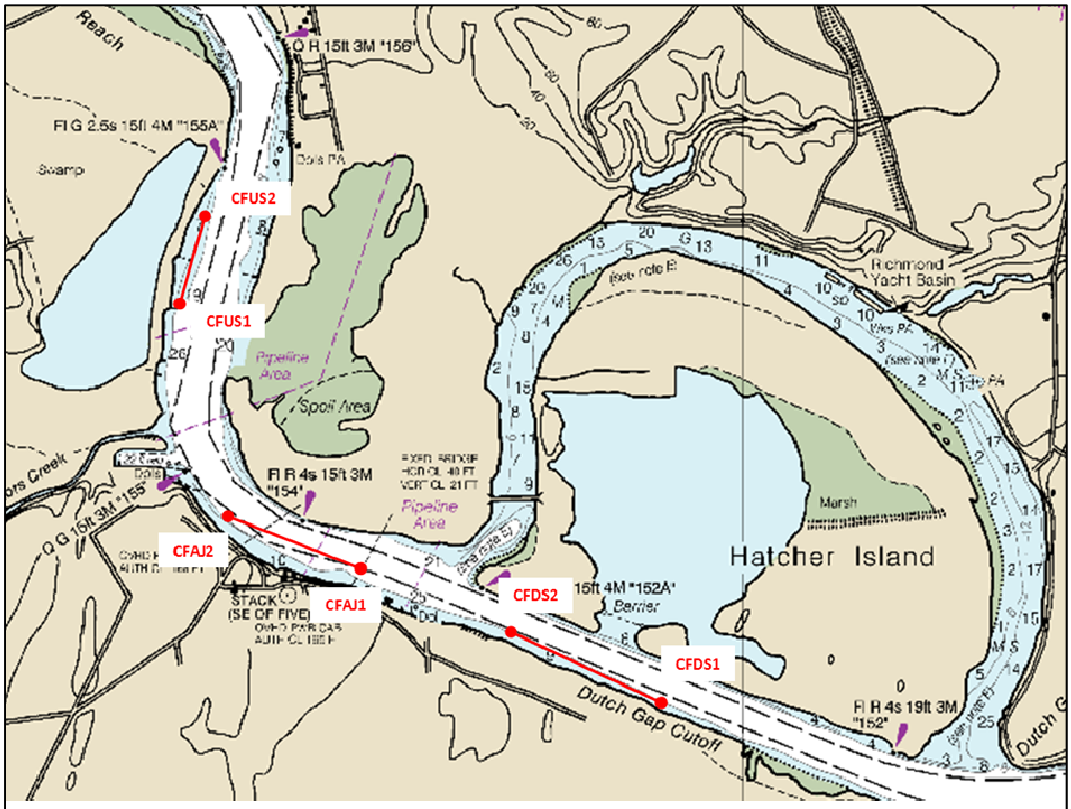
Source: EA 2007

3.2 Ambient Ichthyoplankton Bongo Net Sampling, 2005-2006

Ambient ichthyoplankton sampling conducted on a biweekly basis June 2005 - May 2006 provided information on larval fish and pelagic invertebrates in the vicinity of the CPS CWIS. The James River upstream, downstream, and adjacent to the intake was sampled at 1000, 1600, 2200 and 0400 hours on a biweekly basis (Figure 3-1). These samples were collected with a single 0.5-meter diameter plankton net consisting of .505-mm netting, and with a GO 2030R flowmeter affixed in the net mouth. Stepped-oblique tows were made from a boat for 4.5

minutes against the prevailing tide, i.e., 1.5 minutes near bottom, 1.5 minutes at mid-depth, and 1.5 minutes near the surface.

Five taxa were collected in ambient ichthyoplankton samples collected June 2005 - May 2006. These were, in order of abundance, River Herring larvae, Gizzard Shad larvae, *Dorosoma* sp. eggs, White Perch larvae and Bay Anchovy eggs (Table 3-5). The River Herring category included Alewife and Blueback Herring, and indeterminate larvae of either species. All ichthyoplankton, except for a single collection of Bay Anchovy eggs in December 2005, were collected between the months of May and August. Table 3-6 presents the density of ichthyoplankton entrained on the same days of ambient ichthyoplankton samples collected during June 2005 – May 2006 for the side-by-side comparison.



Map Source: NOAA Coast Survey Chart of James River, Jordan Pt. to Richmond (Jan. 2013); Chart #12252, Retrieved September 25, 2014

Note: Tow tracks shown as red lines with red dots marking either end.
Endpoints designated as: CFUS1 (Upstream), CFUS2 (Upstream);
CFAJ1 (Adjacent), CFAJ2 (Adjacent);
CFDS1 (Downstream), CFDS2 (Downstream)

Source: CH2M HILL (2007)

Figure 3-1. Ambient Ichthyoplankton Sampling Locations Near Chesterfield Power Station, June 2005 - May 2006

Table 3-5. Density (No./100 m^3) of Ichthyoplankton in James River Ambient Ichthyoplankton Samples at Chesterfield Power Station, June 2005 – May 2006

Sample Date	Bay Anchovy	Dorsoma sp.	River Herring	Gizzard Shad	White Perch
	egg	egg	larvae	larvae	larvae
06/21/05	0.0	467.8	0.0	5.1	0.0
06/27/05	0.0	91.3	0.3	13.3	0.0
07/11/05	0.0	0.2	0.0	0.0	0.0
07/25/05	0.1	0.0	0.0	0.0	0.0
08/08/05	0.3	0.0	0.0	0.0	0.0
08/22/05	0.0	0.0	0.0	0.0	0.0
09/12/05	0.0	0.0	0.0	0.0	0.0
09/26/05	0.0	0.0	0.0	0.0	0.0
10/10/05	0.0	0.0	0.0	0.0	0.0
10/24/05	0.0	0.0	0.0	0.0	0.0
11/07/05	0.6	0.0	0.0	0.0	0.0
11/20/05	0.0	0.0	0.0	0.0	0.0
12/07/05	0.0	0.0	0.0	0.0	0.0
12/21/05	0.0	0.0	0.0	0.0	0.0
01/09/06	0.0	0.0	0.0	0.0	0.0
01/23/06	0.0	0.0	0.0	0.0	0.0
02/08/06	0.0	0.0	0.0	0.0	0.0
02/22/06	0.0	0.0	0.0	0.0	0.0
03/06/06	0.0	0.0	0.0	0.0	0.0
03/20/06	0.0	0.0	1.6	0.0	1.6
04/03/06	0.0	0.7	4.7	0.0	12.0
04/17/06	0.0	101.1	12.5	58.9	12.9
05/01/06	0.0	29.6	26.0	144.2	9.1
05/15/06	0.0	98.1	2292.6	737.4	114.2

Note: "River Herring" is a combination of three taxa: River Herring, Alewife and Blueback Herring

Source: Table 17 of EA 2007

Table 3-6. Density (No./100 m^3) of Ichthyoplankton in Entrainment Samples at Chesterfield Power Station, June 2005 – May 2006

Sample Date	Bay Anchovy	Dorsoma sp.	River Herring	Gizzard Shad	White Perch
	egg	egg	larvae	larvae	larvae
06/21/05	0.0	44.3	0.0	2.4	0.0
06/27/05	0.0	4.8	0.0	0.0	0.0
07/11/05	2.9	74.8	0.0	0.0	0.0
07/25/05	15.3	4.3	0.0	0.6	0.0
08/08/05	34.5	0.0	0.0	0.0	0.0
08/22/05	145.7	0.0	0.0	0.0	0.0
09/12/05	0.0	0.0	0.0	0.5	0.0
09/26/05	0.3	0.0	0.0	0.0	0.0
10/10/05	0.2	0.0	0.0	0.0	0.0
10/24/05	0.0	0.0	0.0	0.0	0.0
11/07/05	0.0	0.0	0.0	0.0	0.0
11/20/05	0.0	0.0	0.0	0.0	0.0
12/07/05	3.4	0.0	0.0	0.0	0.0
12/21/05	0.0	0.0	0.0	0.0	0.0
01/09/06	0.0	0.0	0.0	0.0	0.0
01/23/06	0.0	0.0	0.0	0.0	0.0
02/08/06	0.0	0.0	0.0	0.0	0.0
02/22/06	0.0	0.0	0.0	0.0	0.0
03/06/06	0.0	0.0	0.0	0.0	0.0
03/20/06	0.0	0.0	1.6	0.0	0.6
04/03/06	0.0	0.6	9.1	0.0	6.6
04/17/06	0.0	59.1	25.2	43.3	10.2
05/01/06	0.0	170.4	33.2	56.5	7.8
05/15/06	0.0	75.2	753.6	150.0	51.5

Note: "River Herring" is a combination of three taxa: River Herring, Alewife and Blueback Herring

Source: Table 16 of EA 2007

4 Threatened and Endangered Species

The EPA consulted with the US Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS) (or collectively, Services) under the Endangered Species Act during development of the existing facilities §316(b) rule. While the Services concluded that the rule is not likely to jeopardize the continued existence of listed species or result in the destruction or adverse modification of designated critical habitat, the rule requires that facilities identify all Federally-listed threatened and endangered species and/or designated critical habitat that are or may be present "in the vicinity of impingement and entrainment at the cooling water intake structure" in §122.21(r)(4). The text below provides a review of listed species associated with CPS to support development of this Entrainment Characterization Study Plan.

The Virginia Fish and Wildlife Information Service (VAFWIS) database, managed by the Virginia Department of Game and Inland Fisheries (VDGIF) and the USFWS Information, Planning, and Conservation System were consulted on August 18, 2014 to develop a list of Federal and state of Virginia endangered and threatened species known or likely to occur within a 2-mile radius of CPS (See Table 4-1). Additionally, the complete list of threatened and endangered species that occur in the state of Virginia (USFWS 2014) was reviewed and compared against the list of threatened and endangered species under NMFS jurisdiction (NMFS 2014) to confirm that NMFS species were not omitted from the list. A review of scientific literature and other documents was also conducted, including a NMFS Biological Opinion and Letter of Concurrence for projects proposed to occur near the vicinity of the CWIS; those documents were used to confirm that marine species under the jurisdiction of NMFS were appropriately considered. Additionally, for each species with the potential to occur in the vicinity of the CWIS, the USFWS or NMFS species profile was reviewed to confirm that no critical habitat was designated. A review of the following resources was used to develop the species list in Table 4-1.

- VAFWIS (http://vafwis.org/fwis/)
- IPAC (http://ecos.fws.gov/ipac/)
- USFWS Listings and Occurrence for Virginia (http://ecos.fws.gov/tess_public/pub/stateListingAndOccurrenceIndividual.jsp?state=VA&s8fid=112761032792&s8fid=112762573902)
- Endangered and Threatened Species Under NMFS' Jurisdiction (http://www.nmfs.noaa.gov/pr/species/esa/listed.htm)
- Biological Opinion of James River Federal Navigation Project: Tribell Shoal Channel to Richmond Harbor in Surry, James City, Prince George, Charles City, Henrico, and Chesterfield Counties and the Cities of Richmond and Hopewell, Virginia (FINER/2012/01183).
- Letter of concurrence, from Mr. D.M. Morris, NMFS, to Ms. Amy Hull, Nuclear Regulatory Commission that continued operation Surry Nuclear Power Station, Units 1 and 2 is not likely to adversely affect species listed by NMFS.
- USFWS or NMFS Species Profile (http://www.fws.gov/endangered/, or http://www.nmfs.noaa.gov/pr/species/esa/listed.htm)

Table 4-1. Federal and State Threatened, Endangered, and Proposed Species with the Potential to Occur within 2 miles of the Cooling Water Intake of CPS

Common Name	Scientific Name	Status*	Tier**	Potential to Occur in the Vicinity of the Intake	Potential for Entrainment of Early Life Stages	Potential for Impingement of Adults and Juveniles
FISH						
Atlantic Sturgeon[a]	*Acipenser oxyrinchus*	FE, SE	II	Early life stages – Unlikely, spawning occurs in the James River downstream of the area of influence Adults and Juveniles - Likely	Unlikely and Unexpected	Unlikely and Unexpected
MOLLUSKS						
Atlantic Pigtoe[a]	*Fusconaia masoni*	FS, ST	II	Adults, juveniles, and glochidia – Unlikely, preferred habitat is upstream of the fall line Host fish – likely to occur in the vicinity of the CWIS	Unlikely and Unexpected	No
AMPHIBIANS						
Barking Treefrog[a]	*Hyla gratiosa*	ST	II	No - breeds in cypress ponds and bays, and in pine barren ponds; open canopied ponds; all Virginia breeding sites were found in graminoid dominated temporary ponds.[c]	No	No
BIRDS						
Upland Sandpiper[a]	*Bartramia longicauda*	ST	I	No – terrestrial	No	No
Loggerhead Shrike[a]	*Lanius ludovicianus*	ST	I	No – terrestrial	No	No

Common Name	Scientific Name	Status*	Tier**	Potential to Occur in the Vicinity of the Intake	Potential for Entrainment of Early Life Stages	Potential for Impingement of Adults and Juveniles
Migrant Loggerhead Shrike[a]	*Lanius ludovicianus migrans*	ST		No – terrestrial	No	No
MAMMALS						
Northern Long-Eared bat[a,b]	*Myotis septentrionalis*	FP		No – terrestrial	No	No
PLANTS						
Sensitive Joint-Vetch[b]	*Aeschynomene virginica*	FT		No - typically grows in the intertidal zone of coastal marshes[d]	No	No

Status*	**Tier****
FE= Federally Endangered	I=VA Wildlife Action Plan - Tier I – Critical Conservation Need;
FT= Federally Threatened	II=VA Wildlife Action Plan - Tier II - Very High Conservation Need;
SE= State Endangered	III=VA Wildlife Action Plan - Tier III - High Conservation Need;
ST= State Threatened	IV=VA Wildlife Action Plan - Tier IV - Moderate Conservation Need
FS= Federal Species of Concern	

Source

[a]Virginia Department of Game and Inland Fisheries; Fish and Wildlife Information Service

[b]US Fish and Wildlife Service; Information, Planning, and Conservation System

[c]VGDIF 2014

[d]USFWS 2012

Note that only Federal and State threatened and endangered species were included in Table 4-1. Federal species of concern and candidate species were omitted from the list (unless they were also State Threatened or Endangered), because there are no requirements to address those species under Section 7 of the Endangered Species Act.

The majority of the species in Table 4-1 is terrestrial species or occurs in habitats that are not in the vicinity of the CPS cooling water intake structure (CWIS) and thus would not be subject to entrainment or impingement at the facility. Additional literature was reviewed to identify aquatic species that do not occur near the CWIS and thus should be eliminated from further consideration; these documents are cited in Table 4-1.

The freshwater bivalve Atlantic Pigtoe (*Fusconaia masoni*) is a state threatened species and a Federal species of concern, currently under review for listing under the ESA, that may inhabit the James River near CPS. However, this species typically inhabits the upper parts of rivers, above the fall line, in clean, swift-moving waters and is often found in gravel or gravel-sand substrata (VAFWIS 2014, Terwilliger 1991). The species has been documented in the James River, near Richmond in Henrico County, however, Terwilliger (1990) indicates that the species might no longer be present in the James. In 2011 and 2012, Virginia Department of Game and Inland Fisheries (VGDIF) conducted extensive mussel surveys on the James River upstream of the Richmond (and the project site). No Atlantic Pigtoe were encountered in this survey. In the vicinity of CPS, sediments are described as gravel/cobble/pebble, rock, and sand with complex bottom (Bilkovic et al. 2009). The navigation channel near the CPS is maintained via dredging (NMFS 2012a, Bushnoe et al. 2005).

This species is thought to be a tachytictic (i.e., short-term) brooder, with gravid females collected from the James River from May to June and glochidia most likely released before September (VAFWIS 2014, Terwilliger 1991, Johnson 1970). Once attached to a suitable host fish, the time it takes for glochidia to metamorphose into juveniles and drop off the fish has been documented at 19 – 24 days (Rash 2005), depending on water temperature, fish species and other factors. Once juveniles excyst from the host fish they must settle into suitable substrate to survive.

Knowledge is incomplete as to which fish species provides the most suitable host for the Atlantic Pigtoe (Wolf 2010). Results of laboratory research indicate that host fish for Atlantic Pigtoe include Bluegill Sunfish (*Lepomis macrochirus*), Shield Darter (*Percina peltata*), White Shiner (*Luxilus albeolus*) and Satinfin Shiner (*Cyprinella analostana*), Longnose Dace (*Rhinichthys cataractae*) and Creek Chub (*Semotilus atromaculatus*) (Dee and Watters 1998; Rash 2005, Wolf and Emrick 2011). Of these, the White Shiner is not expected to occur in the James River. Longnose Dace and Creek Chub were the primary hosts of the fish tested by Wolf and Emrick (2012), but habitat in the main stem of the tidal James River in the vicinity of CPS is not suitable for these species.

Based on the habitat preferred by Atlantic Pigtoe adults, juveniles, and larvae, the probability for entrainment of infected host fish is unexpected and unlikely. As a result, this study plan includes no specific studies of Atlantic Pigtoe entrainment.

Atlantic Sturgeon (listed as both endangered and threatened)[2] spawn in the James River. Benthic substrates that provide suitable sturgeon spawning habitat (i.e., rock and cobble gravel) occur in the vicinity of CPS; however, these areas might not have viable spawning conditions (e.g., hydrodynamic characteristics) (Bilkovic et al. 1999). Bushnoe et al. (2005) indicate that the Turkey Island and Jones Neck oxbows, which are approximately 3 - 7 miles downstream from CPS, are considered potential spawning habitat due to their hydrodynamic characteristics and benthic substrate (i.e., rock and gravel/cobble/pebble) (Bilkovic et al. 2009, NMFS 2012a). A second area of seemingly suitable habitat is located approximately 30 miles downstream of CPS (NMFS 2012b).

In a telemetry study, Hager (2011) observed two seasonal migrations by adult Atlantic Sturgeon in the James River; in the spring from April through May and in the late summer and early fall from August through October. No fish passed above river mile 67 in the spring (downstream of CPS). During the late summer to early fall residency (August-October), fish ascended the river rapidly and congregated in upriver sites between river mile 48 and the fall line near Richmond, VA. During late summer, Atlantic Sturgeon exhibited a preference for the river section where the upper James and Appomattox rivers meet, approximately 9 miles downriver from CPS (Hager 2011). Appendix A provides additional detail on Atlantic Sturgeon spawning migrations in the James River.

Eggs are adhesive and demersal and are expected to attach to the substrate within 20 minutes; therefore, sturgeon eggs occur only on the spawning grounds (Hildebrand and Schroeder 1928, Jones et al. 1978). Spawning is expected to occur during April through June (temperatures for spawning can range from 13-26°C); evidence suggests that spawning might occur in the fall as well, with high adult usage in the river from August through November (Balazik et al. 2012, Secor et al. 2012). Eggs typically hatch in 4-7 days depending on temperature (Gilbert 1989; Hildebrand and Schroeder 1928). At hatching, Atlantic Sturgeon larvae are large bodied and are assumed to undertake a demersal existence in the same areas where they were spawned (ASMFC 2012, Bath et al. 1981). Yolk-sac larvae are expected to inhabit the same areas where they were spawned (Bain et al. 2000; ASMFC 2012). Bath et al. (1981) only collected sturgeon larvae in bottom samples. Larvae are also active swimmers and leave the bottom when 8 to 10 days old to swim in the water column (Kynard and Horgan 2002). The yolk-sac larval stage is completed in about 8 to12 days (Jones et al. [1978] reports 6 days), at which time the larvae move downstream to the rearing grounds (Kynard and Horgan 2002). During the first half of this migration, larvae move only at night and use benthic structure (e.g., gravel matrix) as refuge during the day (Kynard and Horgan 2002). During the latter half of migration to the rearing

[2] Atlantic Sturgeon originating from the New York Bight, Chesapeake Bay, South Atlantic and Carolina Distinct Population Segments (DPSs) are listed as endangered. Those originating from the Gulf of Maine DPS are listed as threatened. Atlantic Sturgeon from these five DPSs have the potential to occur in the James River and the vicinity of the Chesterfield cooling water intake; however, the majority of the spawning adults are likely to originate from the James River and thus, the Chesapeake Bay DPS (NMFS 2012a).

grounds, when larvae are more fully developed, movement occurs during both day and night. Larvae transition into the juvenile phase at approximately 30 mm total length (TL) and move further downstream into brackish waters, developing a tolerance to salinity. Eventually they become residents in estuarine waters for months to years before emigrating to open ocean (ASSRT 2007, ASMFC 2012). ASMFC (2012) notes that some Atlantic Sturgeon occupy freshwater habitats for two or more years, while others move downstream to brackish waters when the water temperature drops. Bain et al. (2000) report that early juveniles were collected from salinities ranging from 0-5 ppt from April through October in the Hudson River and from 3-18 ppt from October through March. However, temperature and dissolved oxygen are likely key habitat parameters (ASMFC 2012). Bain et al. (1997) report that from July through September juvenile sturgeon use deep channels in the Hudson River. Juvenile Atlantic Sturgeon in North Carolina use deep and cool areas as thermal refuges, particularly in the summertime (Moser and Ross 1995 as cited in ASMFC 2012). Based on the demersal nature of sturgeon eggs and larvae, entrainment of Atlantic Sturgeon is unlikely and unexpected at the CPS CWIS.

Nonetheless, because of its protected status this study plan includes explicit methods that are focused on maximizing the potential of identifying early life stage Atlantic Sturgeon should they be collected in entrainment samples (refer to Methods for Identifying Atlantic Sturgeon section for additional details).

5 Basis for Sampling Design

HDR performed a site visit at CPS on August 19, 2014 to evaluate potential entrainment sampling options for the CWISs, the point of §316(b) compliance at the facility, and determined that collection locations are greatly limited for the following reasons:

- As shown in Figure 2-7 (in Section 2 of this Study Plan), there are 5 separate intake structures at this power station. Units 7 and 8 are adjacent to each other at the east end of the intake area. Units 3 and 4 have a common intake in the center section of the intake area. Units 5 and 6 are adjacent to each other at the west end of the intake structure area. There is no common access between the intake structures. All of the Units have conventional traveling screens.

- Unit 6 withdraws almost 40% of the total water volume for the CPS. Unit 5 withdraws 18% of the total water volume and each of the remaining Units withdraws less than 13% of the water volume for the station. It is not feasible to collect entrainment samples at more than one intake structure concurrently since there is no common access between the intake structures.

- There is limited access to the water between the screens and the circulating water pumps for the collection of pumped or streamed net entrainment samples.

- There is limited access to the water between the bar racks and screens from most of the intake deck level such that collection of pumped or streamed net entrainment samples is not feasible.

- Streamed net sampling from the intake channel in front of the bar racks requires the use of a boat anchored in front of the intake structures, which introduces weather related safety concerns and potential for missed sampling events and limited control over volume sampled (subject to intake velocity rather than pump capacity).

Based on these findings, it was determined that pumped samples taken from the river side of the bar racks were the preferred method for entrainment sample collections. Based on the water volume at the five intake structures at the CPS, Unit 6 was selected as the primary sampling location, and Unit 5 as the secondary location in the event Unit 6 is not operating. Specifically, entrainment samples are to be collected by using a gas-powered 4-inch trash pump to pump water through a 335-µm mesh plankton net suspended in a water buffering tank. Entrainment samples will be collected concurrently from three depth intervals (near surface, mid-depth, and near bottom).

Entrainment sampling surveys will be conducted twice per month over a 24-month interval from July 1, 2015 – June 30, 2017. Each sample collection event will be conducted over a 24-hour period with sample sets collected every 6 hours. The sample frequency selected for this entrainment study will provide finfish and invertebrate (shellfish) taxa, density distribution and seasonal/diel variation data over a two year period. Shellfish, for the purposes of this study, will be inclusive of shrimp, crabs (including horseshoe), lobsters, crayfish, and motile stages of bivalves and gastropods.

This methodology includes the following significant changes relative to the June 2005 - May 2006 entrainment study (refer to Section 3.1 for details):

1) Use of a pump to collect samples directly in front of the bar racks at Unit 6 rather than a streamed net approximately 50 feet in front of the bar racks at Unit 6;

2) Use of 335-µm mesh targeted for the current study rather than 505-µm mesh;

3) Collection of detailed morphometric data is included to support alternative technology evaluations;

4) Inclusion of methods and evaluations to maximize resolution of the taxonomic identifications with regard to Atlantic Sturgeon and other species; and

5) Collection of 24 months of entrainment data rather than 12 months.

The approach for development of the specific entrainment characterizations required in §122.21(r)(9) is summarized in Table 5-1.

Table 5-1. Summary of Approach for Development of §122.21(r)(9) Required Entrainment Characterizations

122.21(r)(9) Requirement	Basis for Meeting the Requirement
Two years of data and annual variation	Evaluation of species and life stage composition and densities based on July 2015 – June 2016 (Year 1) and July 2016 – June 2017 (Year 2) entrainment studies
Seasonal variation	Evaluation of monthly species and life stage compositions based on the Year 1 and Year 2 studies
Diel variation	Evaluation of densities in 6-hour sample collections in the Year 1 and Year 2 studies
Variation related to climate and weather	Evaluation of Year 1 and Year 2 data relative to water temperature and weather events (e.g., rain events)
Variation related to spawning, feeding and water column migrations	Evaluation of Year 1 and Year 2 data to determine species and life stage period of occurrence for spawning and feeding variation; Evaluation of differences among near surface, mid-depth and near bottom collections for water column migrations
Identification of lowest taxon possible	The resolution of taxonomic and life stage designations will be monitored through regular evaluations of catch data with the goal of reducing percent of unidentified organisms and increasing resolution of genera and higher taxonomic designations
Data must be representative of each intake	Sampling in front of Unit 6 would be representative of “average” intake water because this Unit withdraws almost 40% of the total volume of the cooling water withdrawn at the CPS
How the location of the intake in the water body are accounted for	Sampling of near surface, mid-depth and near bottom at the bar racks assumed to be the best method to account for intake location
Document flow associated with the data collections	Facility will monitor flows for period of sampling for use in the final report produced after sampling
Methods in which latent mortality will be identified	Assume 100% mortality
Data must be appropriate for a quantitative survey	Data will be expressed as taxon and life stage specific densities which can be multiplied by flow to support quantification of entrainment

6 Entrainment Characterization Study Plan

6.1 Introduction

This section of the Study Plan provides methods, materials, and procedures for entrainment sample collection and processing. Any failures at the sampling or laboratory analysis stage are often uncorrectable because design-specified sampling times cannot be repeated once they

have passed. Therefore, Standard Operating Procedures (SOPs) and a Quality Assurance (QA) Plan will be developed by the contractor performing the field studies for the entrainment sample collection and processing based on this Study Plan and the contractors preferred methods, datasheets and equipment to eliminate, reduce, and/or quantify those errors.

Adherence to sample collection and lab analysis SOPs will be observed and documented through regular technical assessments/audits. These technical assessments/audits will be conducted by a QA officer, who is independent of those individuals collecting and generating the data during the study and has experience in performing QA/QC programs for aquatic monitoring surveys, and will be scheduled to occur at least quarterly throughout the course of the study. The specific requirements are to be developed by the contractor performing the work, will incorporate a checklist of items to be inspected based on the SOPs, and will include observations relevant to performance of sampling that may not be covered by the SOP. Careful attention will be paid to the initiation of the study when staff may be less familiar with the SOPs.

Entrainment sampling will be carried out at CPS twice per month from July 1, 2015 – June 30, 2017. The sampling will start in July 2015. This month was selected to expedite the start date for sampling to the extent possible as required within the larger §316(b) compliance timeframe and with a goal of minimizing the potential for disjoining year classes of anadromous fishes where the period of occurrence for entrainment of these species is generally over by July. Entrainment samples will be collected directly from in front of the bar racks at the Unit 6 CWIS. During each 24-hr sampling event, concurrent samples will be collected from near surface, mid-water and near bottom depths four times, centered around 0400, 1000, 1600, and 2200 hours. Samples will be collected by pumping water through a 0.5-m diameter mouth plankton net constructed of 335-µm netting suspended in a buffering tank. A total of four, 6-hour samples will be collected from each depth over a 24-hr period sampling event. Table 6-1 provides the details of entrainment sampling.

Table 6-1. Entrainment Sampling Details

Entrainment	Details
Units to be Sampled	Unit 6 (Primary Location) and Unit 5 (Secondary Location)
July 1, 2015 – June 30, 2017 Sampling Events	Twice per month sampling events (within the first and third week of each month) for 24 months (2/month x 24 months = 48 sampling events)
Daily Collection Schedule	Samples collected every 6 hours in a 24-hr period (4 collections / 24-hr period)
Targeted Organisms	Fish eggs, larvae, and juveniles; shellfish life stages
Depths	Near surface, mid-depth, near bottom for a total of 3 depths
Number of Samples Collected per Depth	1 sample per depth by pumping water through a 335-µm net suspended in a buffering tank (Three sub-samples for each depth will be combined)
Sample Duration	~100 minutes per depth per 6-hour sample (or time required to get 100 m^3 per depth per 6-hour sample)

Entrainment	Details
Number of Samples per Sampling Event	4 collections/survey x 3 depths/collection x 1 sample/depth = 12 samples/survey
Total Number of Samples	12 samples/survey x 2 surveys/month x 24 months = 576 samples

6.2 Safety Policy

All work performed under the direction of Dominion Environmental Services (DES) and/or Dominion Business Units (BU) on Dominion properties and/or on properties owned or operated by third parties (i.e., not owned or operated by the contractor or Dominion) is to be performed using safe work practices that are at least equivalent to those required for Dominion personnel and of any third party owner or operator. At a minimum, all contractors are expected to be aware of, and adhere to, Dominion's Corporate Safety Policy, DES Safety Work Practices and any BU or other location-specific safety policies and procedures.

6.3 Field Collection Procedures

6.3.1 Location

Entrainment samples will be collected in front of bar racks at the Unit 6 CWIS from near surface, mid-water and near bottom depths. The primary sample location will be at Unit 6 in front of the bar rack (See Figure 6-1). The deck space is limited at this Unit. It may be necessary to stage the pumps on the deck and the buffering tanks on the concrete apron adjacent to the east side of the intake structure. If Unit 6 is not operating, it is unsafe or infeasible to sample at Unit 6 for other reasons, the secondary location will be at Unit 5 in front of the bar rack (Figure 6-1). At this location the pumps and buffering tanks will need to be staged on the deck in front of the bar racks. Changes or variations in the sampling location over the duration of the 24-month study will require Dominion notification and approval.

Near surface, mid-water and near bottom pumped samples will be collected from intake piping installed along the front of the bar racks with the face of bar racks used to stabilize the temporary intake piping. The near bottom sample will be collected approximately 3 feet above the bottom, the mid depth sample will be collected at the mid-depth of the water column at Mean Sea Level (MSL), and the surface sample intake will be positioned 3 feet below the surface at Mean Low Water (MLW) in order to make sure that the intake piping of the surface sample is low enough to stay below the water surface and the system keeps its prime. Figure 6-2 presents the conceptual design of intake piping for the entrainment sampling at three depths.

6.3.2 Equipment

Sampling equipment will be acquired and/or constructed according to specifications in this Study Plan. Adequate backup equipment will be provided to ensure the study design can be followed in the event of equipment failure or loss. Prior to initiation of sampling, equipment will be tested or otherwise confirmed to meet specifications. A calibration program will be instituted

for equipment requiring calibration that must be consistent with Dominion's instrumentation calibration and maintenance practice document (See Appendix B).

Cooling water at the CWIS will be pumped using temporary gas-powered four-inch centrifugal pumps (trash pump) and four-inch diameter intake piping installed at the face of bar racks.

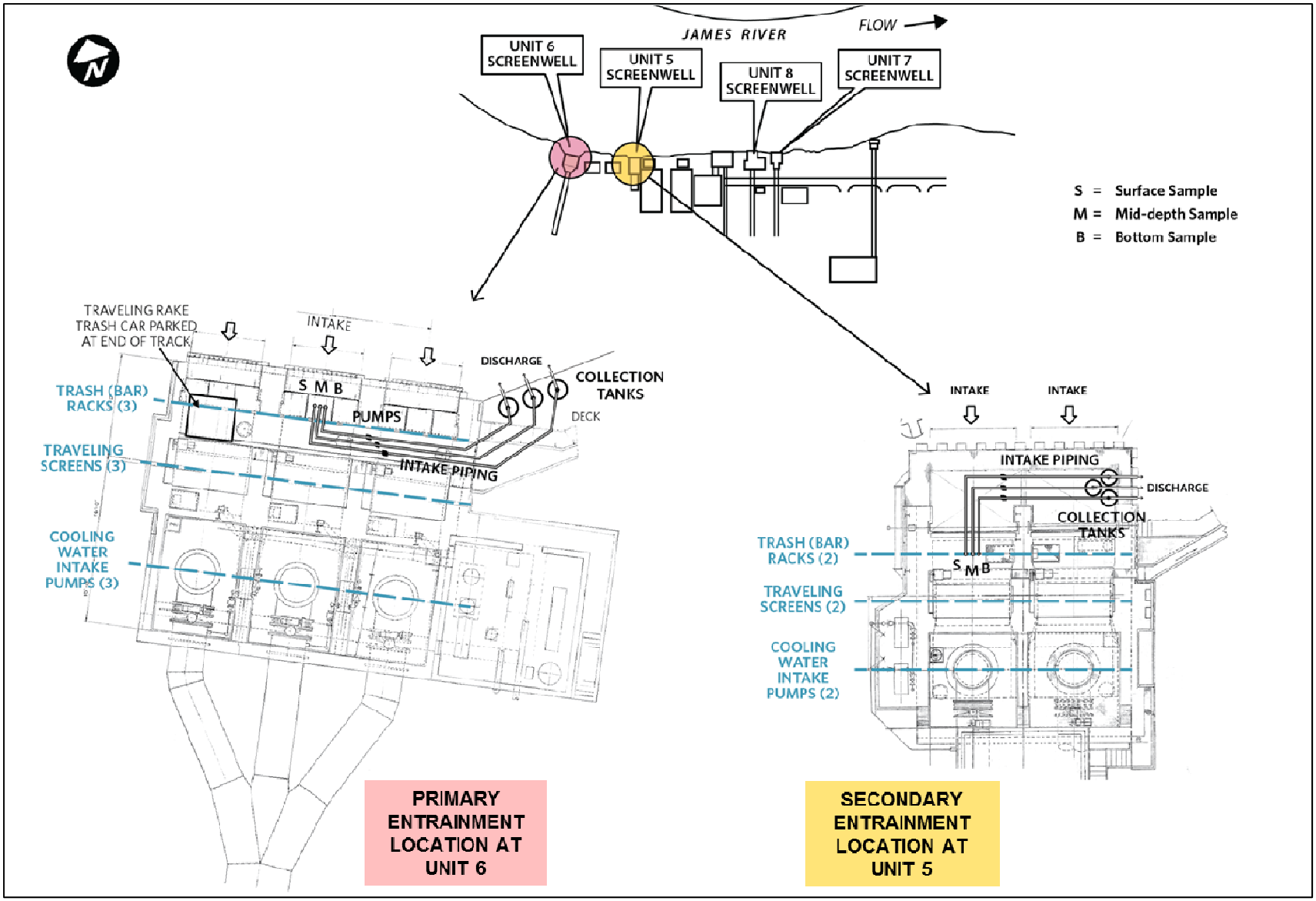


Figure 6-1. Proposed Location of Chesterfield Power Station Entrainment Sampling, 2015 – 2017

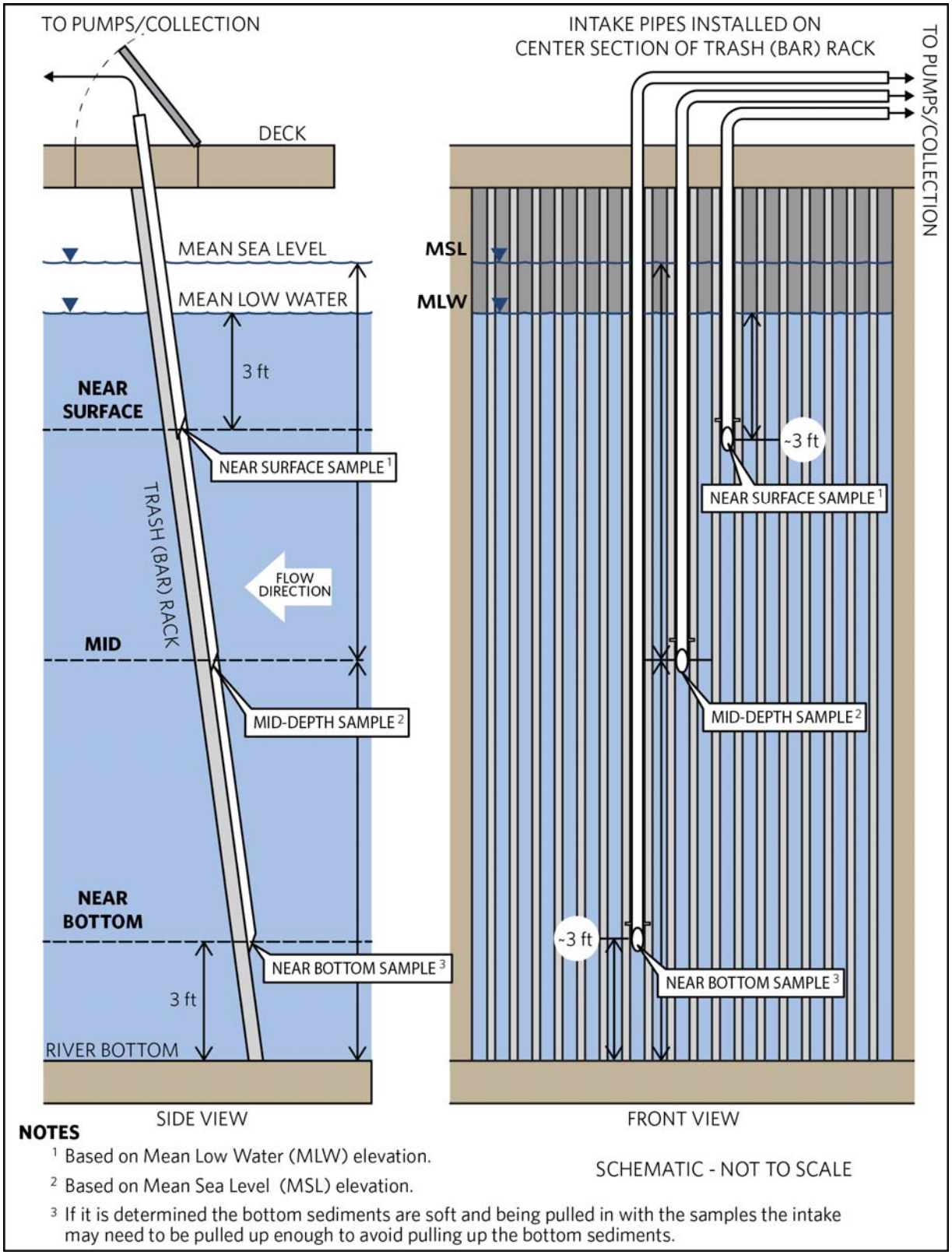


Figure 6-2. Conceptual Design of Intake Piping for Entrainment Sampling

The pumped intake water will be filtered through a 335-micron mesh conical plankton net suspended in a 200-gallon polyethylene sample buffering tank (See Figure 6-3).

The following list includes the minimum items expected to be required for entrainment sample collection:

- 94 x 102-cm, 335-µm mesh hoop plankton nets (9) with 335-µm mesh PVC cod-end buckets (9)
- 94 x 102-cm, 505-µm mesh hoop plankton nets (9) with 505-µm mesh PVC cod-end buckets (9)[3]
- 4-Inch trash pumps with open head design/gas cans (4 pumps)
- 200-gallon buffering tanks (3)
- Intake hoses (surface, mid, and bottom)
- 4-inch Schedule 40 PVC pipe of various lengths and configurations
- 4-inch PVC flex hose of various lengths and configurations
- In-line flowmeter (3)
- 120 VAC submersible wash down pump and 25 ft of ¾-inch diameter hose
- 1-L wide-mouth sample jars with labels
- 10% Formalin/Rose Bengal stain solution
- PPE: hard hats, safety glasses, steel toe boots, ear muffs/plugs, PFD's
- First-aid kit
- Flashlights
- Disposable Nitrile gloves
- Plastic buckets (assorted capacities)
- 335-µm sieves (3), squirt bottles, spoons
- Field Binder w/pens, pencils, SOP, data sheets, calibration sheets, QC sheets, etc.
- Clipboard
- Stopwatch
- Niskin water sampler
- Extra 5-gal buckets or similar for sample transportation
- Portable water quality meters as described below[4]
    - Handheld Salinity, Conductivity & Temperature meter with autoranging scales (e.g., YSI Model 30 or equivalent) with the following minimum specifications:
        - Conductivity ranges of 0 to 500 µS/cm and 0-200 mS/cm with an accuracy of +/- 0.5 % full scale
        - Salinity range of 0 to 80 ppt with an accuracy of +/- 2 % or +/- 0.1 ppt
        - Temperature range of -5 to 45 ^{o}C with an accuracy of +/- 0.2 ^{o}C

[3] It is anticipated that during certain periods, 335-µm mesh may result in clogging of the net with a potential to compromise sample collections; 505-µm mesh may be used during these periods. Dominion is to be notified prior to, or immediately after, a net mesh large than 335-um is required to be used.

[4] A multiple parameter water quality meter may be used provided it meets the minimum specifications outlined for the individual meters.

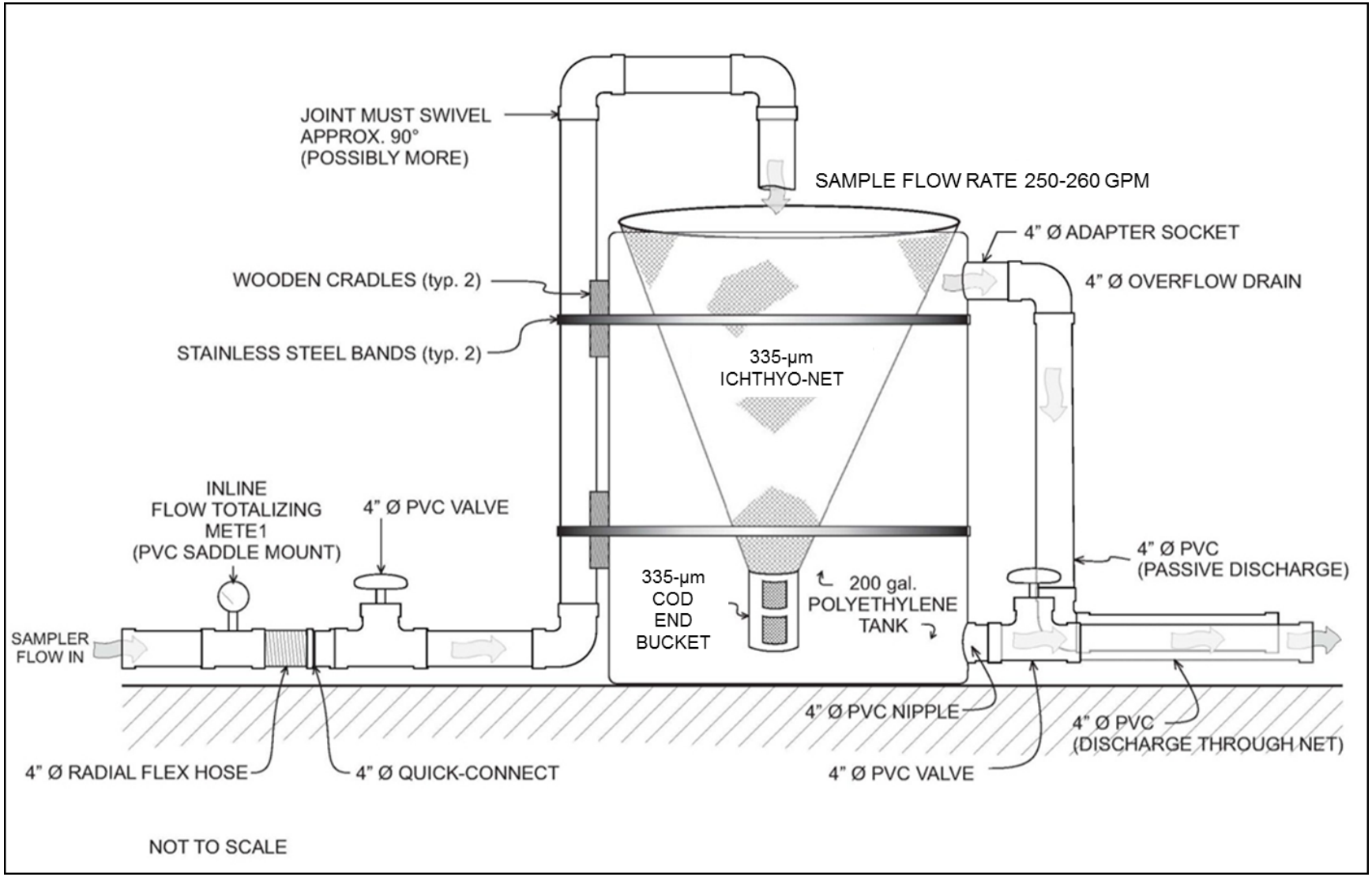


Figure 6-3. Entrainment Pump Sampling System Configuration

- Handheld Dissolved Oxygen & Temperature meter with autoranging scales (e.g. YSI Model 55 or equivalent) with the following minimum specifications:
  - Dissolved Oxygen % Saturation ranging from 0 to 200 % with an accuracy of +/- 2 %
  - Dissolved Oxygen mg/L ranging from 0 to 2 mg/L with an accuracy of +/- 0.3 mg/L
  - Temperature range of -5 to 45 ^{o}C with an accuracy of +/- 0.2 ^{o}C
- Portable pH meters with the following minimum specifications:
  - pH range of 0 to 14 units with an accuracy of +/- 0.2 units

- DO bottles & HACH chemicals for backup
- Calibration solutions as required for the water quality instrumentation

6.3.3 Sampling Schedule

The sampling program will be continued for 24 consecutive months with 48 sample events (two sampling events per month) conducted over the July 1, 2015 – June 30, 2017 period. Sampling events will be distributed within the second and fourth week of each month for the 24-month period. Each sampling event will encompass a 24-hour period divided into four, 6-hour subsampling periods centered around 0400, 1000, 1600, and 2200 hours. If a sampling event is missed due to weather or other unforeseen events, the scheduled sampling event will be conducted within 96-hours of resolution of the complicating event.

6.3.4 Entrainment Sample Collection Procedures

The first shift crew will check in with the facility operations engineer or designee and security personnel to notify them of the initiation of the survey and the crew's arrival on site. Prior to initiating entrainment sampling, the crew will install the intake piping at the three depths along the bar rack (refer to Section 6.3.1 for details). Stabilizers will be used to keep the pipes in place and orient them to the intake flow. Once the intake pipes are secured in place, the intake piping will be connected to trash pumps with 4-inch flexible hoses and then the hoses will be connected to the buffering tanks. All connections will be checked. All sampling pumps will be placed in secondary containments with oil/fuel sorbent pads in the event there is a fuel or oil spill[5]. The discharge hoses from the tanks will be directed over the bulkhead, with a discharge point below river water level.

The gas-powered pump head will be primed (filled with water) before starting the pump. Once the pump has begun to discharge water and a stable flow has been established the engine throttle will be adjusted and/or the throttling valve located at the terminal end of the flow metering pipe will be adjusted slowly to achieve a flow rate of approximately 250-260 gallons per minute (gpm). A pump flow rate check is to be conducted for each pump prior to commencing the 24-hour sampling event (refer to Section 6.3.5 for details). To commence

[5] All pumps will be shut down and allowed to cool prior to refueling. Gasoline storage cans will be Type I UL-approved containers outfitted with flame arrestors; the gas cans will be stored in secondary containments. A dry chemical (ABC) fire extinguisher will be available in the area of the pumps.

sampling, the buffering tank discharge valve should be closed to fill to the level of the tank to the upper overflow drain. The discharge valve is then partially opened to balance the level in the buffering tank to the point where water is just spilling into the upper overflow drain (and not overflowing the top).

Once the flow in the system is balanced, the sample net is inserted into the buffering tank and the start time, pump flow and flow totalizer readings are recorded on the appropriate data sheet. The crew should observe the sampler to ensure that the water level is maintained at the correct level throughout the collection period.

Flow rates will be monitored and adjusted as necessary; a maximum flow rate of 250-260 gpm has been selected to minimize potential damage to the organisms in the net during the sample collection interval. An inline flowmeter will be used to monitor and maintain the flow rate for each sample. The target water volume for each entrainment sample is 100 m^3 (26,417 gallons). Contractor's SOP must include methods for tracking sample volumes in the field with potential to adjust sample times as may be required to achieve 100 m^3 sample volume per depth. Systematic deviation from this target sample volume will require Dominion's prior approval.

In addition, three sub-samples of approximately 35 m^3 each (~35 minutes) will be collected from each depth interval to minimize the time collected organisms will be in the net and reduce the potential for damage to the organisms from abrasion in the net. After approximately 35 minutes (or a volume of ~35 m^3), the net will be removed from the buffer tank and switched with a second net (this is to be performed without shutting down the pump). The removed net containing the sub-sample will then be washed down from the outside of the net into the cod-end bucket and the sample will be transferred into a labeled sample jar. The three sub-samples from each sample depth interval will be combined into one sample for each 6-hour sampling event. The near surface, mid-depth, and near bottom samples will be collected concurrently using three pairs of pumps and buffering tanks. At the end of the sample interval (or sub-sample interval), the net will be removed from the buffering tank, washed down from the outside into the cod-end bucket and transferred to a 1-liter wide-mouth polyethylene sample jar labeled with the pertinent sample information.

The sample jar(s) will be preserved to a 5% Formalin solution with a "vital stain", such as rose bengal and labeled appropriately. Each sample jar will be filled no more than halfway (50%) with the sample so that at least 500 ml of a 10% Formalin solution can be mixed with the sample to properly preserve it. All preserved samples will be packaged and transported to the laboratory for processing.

All pertinent information for each sample will be recorded on the appropriate data sheet to document the samples collected and ensure they are correctly identified and labeled for sampling processing. This information shall include but is not limited to: sample number/ID, year, date, time (start and end), sample location, sample depth, pumping duration (min), total volume filtered (m^3), water quality measurements, cooling water pump status, crew member initials.

At the completion of the 24-hr sampling period and final pump flow calibrations, the entrainment sampling apparatus will be broken down. The intake piping will be removed from the bar racks and all equipment (pumps. hoses, and buffering tanks) will be removed from the intake structure and stored in the designated location. The second shift crew will check in with the facility operations engineer or designee and security personnel to notify them of the surveys completion and the crew's departure from the site. The number and rated capacity of circulating and service water pumps in operation during the sampling interval will be verified and recorded.

Measures must be made to ensure the sampling event does not interfere with plant operation nor result in risk to health and safety of field personnel. The contractor must contact the facility to provide them a weeks' notice prior to each sampling event. The contractor should coordinate with the facility personnel to ensure sampling activities will not interfere with any scheduled maintenance activities at the intake structure of the station. If there are required activities that could conflict with plant maintenance operations the sampling event will be postponed as necessary so it does not interfere with plant operations. Prior to the sampling events, the contractor shall request that the facility personnel observe the bar racks and clean them of debris prior to the installation of the sampling equipment to minimize the possibility that the bar racks will need to be cleaned during the sampling event. In the event the station is required to access the bar racks during the sampling event due to unscheduled maintenance activities the sampling equipment can be removed if necessary. All open grates will be protected with barricades during the sampling events.

6.3.5 Pump Flow Rate Check Procedures

Prior to commencing with the first sampling period and again at the end of the last sampling period (before pump shut down) a pump flow rate check will be conducted for each pump according to the flow rate check procedure outlined as follows:

- With the sample net removed from the tank the crew will lower the water level of the buffering tank to the 50-gal mark on the side of the tank by opening the discharge regulating valve on the lower discharge line from the tank.
- When the water level is at the 50-gal line on the tank, the valve will be quickly closed.
- The crew will begin timing the rising water level in the tank until it reaches the 150-gal level line (100 gal pumped).
- During the flow rate check procedure, the fill time will be recorded and the start and end flows will be read from the flowmeter and noted on the flow rate check field form.

The flow rate check will be calculated by the following equation:

$$100\ gal/t = X\ gal/60\ sec \quad or \quad X = 6000/t$$

Where t is the time in seconds to fill 100 gal, and X is the calculated gpm.

This procedure will be run three times, and the average compared to the observed flow rate from the flowmeter. If there is discrepancy of more than 20% the pipe connections will be checked and the flow rate check procedure will be conducted again until the results are within 20% of the flowmeter results. All flow rate check data will be recorded on the appropriate data sheet.

6.3.6 Water Quality Measurements

Water quality parameters (water temperature, dissolved oxygen, pH, salinity and conductivity) will be recorded with a calibrated water quality analyzer (see instrument specifications above) concurrent with the time and depth of each entrainment subsample.

Quality control for water quality data collection will be performed twice per sampling event (once per 12-hour shift) using either a second calibrated water quality meter or by collecting water samples for wet chemistry analysis. Calibration of water quality equipment will be consistent with the *Field Instrumentation: Calibration and Standardizations* requirements in Appendix B.

6.4 Laboratory Procedures

The entrainment samples collected during this study will be transported to the laboratory for sorting and analysis using the equipment and procedures identified below.

6.4.1 Equipment

The following list includes the expected minimum items required for laboratory analysis:

- Light boxes
- Pyrex trays
- 335µm sieves
- Plastic buckets (2 qt)
- Folsom Plankton Splitter (or equivalent)
- Binocular dissecting microscope with ocular micrometer
- Computer with ImageTool™ Software (or equivalent)
- Measuring board (accurate to the nearest millimeter)
- Featherweight forceps, dissecting forceps, eyedroppers, probes, spoons
- Petri dishes and covers
- Pencils, data sheets
- Vials (assorted capacities: 8 to 120 ml), vial holders
- Multiple and single mechanical hand counters
- Labels, Scotch tape
- 5% Formalin solution
- Safety glasses
- Squirt bottles (assorted sizes), plastic beakers (2 L)
- Nitrile gloves, paper towels
- SOP
- Taxonomic keys.

6.4.2 Laboratory Analysis

After collected samples are transported to the laboratory for processing, following major activities will be accomplished:

1) For very abundant samples, the total sample may be carefully mixed and split as needed to obtain a reliable and representative estimate of the total sample collection (refer to Sort Sub-sampling Procedure section for more information).
2) Identify each fish and shellfish to the lowest practicable taxon including life stage designation.
3) Determine the number and size of fish and shellfish collected (refer to Morphometrics section for more information).
4) Enter field sheet information and laboratory analysis data into Dominion approved database format.

Chronological sample processing will be performed for the duration of the study. Samples will be stored for a minimum of five years after the completion of the data collection effort. Protocols for managing and storing samples from multiple facilities, should a contractor be working at multiple facilities, will be required.

Sample Sorting

The following sample sorting protocol is to be followed:

- After a sample number has been assigned, the sample will be gently rinsed through a mesh of 335 μm or smaller to remove excess formalin.
- The rinsed sample will be placed in a sorting tray with adequate water to cover the sample. If the sample is thick with detritus, it may be split into several trays using a Folsom plankton splitter to improve visibility and sorting effectiveness.
- Fish, shellfish larvae, and/or eggs will be removed with forceps or eyedroppers and placed in glass vials with 5% buffered formalin and labeled externally with the sample number to await identification. Tops of vials will be taped to reduce loss of fluid.
- All samples (sorted organisms and not detritus) will be stored as appropriate to protect from freezing, breakage, or other sample damage.

Sort Sub-sampling Procedure

The preservative-free washed sample will be transferred to the Henson Plankton Splitter (or similar). A sufficient quantity of water will be added to the box to ensure thorough mixing and dispersal of the sample. The box will be tilted until the sample has moved into the two separate chambers. Then, half of the sample will be carefully drained from the box. Samples will be split in half, and then the halves will be split in quarters, and so on, until the approximate number of organisms that were the target of the split is ≥200 in the final split portion.

The final split portion will be analyzed for whichever group was the target of the subsampling procedure. If a minimum of 200 eggs or larvae is reached, sorting for that group ends with that split portion. The whole sample, including the final split, will be analyzed for the other group of

ichthyoplankton. The split fraction will be recorded on the data sheet for each taxon and life stage to which the split applies.

Sample Identification

After sorting, the fish and shellfish will be identified to the lowest practical taxon and enumerated. All fish will be assigned a life stage: viable egg, non-viable egg, yolk sac larvae, post yolk sac larvae, juvenile, or unidentified larval stage. Only whole larvae, parts of larvae with a head and a majority portion of the body present (more than half), or pieces of larvae with an extensive portion of the body present (more than three quarters) will be counted. All fish and shellfish will be preserved in 5% formalin and stored in properly labeled vials. All shellfish will be identified to the lowest practical taxon, enumerated and assigned to a life stage.

Morphometrics

For each 6-hr sample, the following morphometric data will be collected:

- Up to 10 individuals from each fish taxon and life stage will be measured for total length and notochord length, greatest soft tissue body depth and width, and head capsule depth and width, all to the nearest 0.1 mm;
- Up to 10 eggs of each taxon will be measured for minimum and maximum diameter;
- Up to 5 Blue Crab (*Callinectes sapidus*) individuals from each life stage will be measured for greatest body length, width, and depth to the nearest 0.1 mm; megalopa and later life stage measurement maximum widths and depths will be based on carapace.

Only whole organisms will be subject to morphometric evaluations. Organisms subject to the morphometric evaluation should be selected at random from within each taxonomic category (i.e., each taxon and life stage). Length measurements will be performed with a calibrated ocular micrometer or other calibrated tool (e.g., ImageTool™ Software).

Taxonomic Resolution Monitoring

The resolution of taxonomic and life stage designations will be monitored through regular evaluations of catch data with the goal of reducing percent of unidentified organisms and increasing resolution of genera and higher taxonomic designations. These evaluations will occur on a quarterly basis. Density data will be reported to Dominion within one month of the close of each three month period, as number of organisms per 100 m^3 by month, for each taxon and life stage.

Methods for Identifying Atlantic Sturgeon

Atlantic Sturgeon are not expected to be susceptible to impingement at CPS. However, in the event of observation or collection of Atlantic Sturgeon, the Virginia Department of Game and Inland Fisheries will be contacted per the requirements of the Scientific Collection Permit that will be obtained prior to any sampling. The following method will be used to maximize the potential identification of this species in entrainment samples should they be collected:

1. Because of their large size and distinctive morphology, it is unlikely that sturgeon eggs and larvae would remain unidentified. Regardless, unidentified eggs and larvae and split fraction samples collected from March through November will be subject to an additional visual scan for eggs ranging in size from 2-3 mm and for larvae 6 mm or greater. This range of months is meant to be inclusive because of the uncertainty associated with spawning period of the James River Atlantic Sturgeon. The range of sizes is also meant to be inclusive to allow for slight variation from the descriptions.

2. This subset of eggs will be scanned for an apparent germinal disc and pigmentation. All pigmented eggs will be examined for consistency with the description of eggs provided in Appendix A.

3. The subset of yolk-sac larvae will be viewed for consistency with the description of yolk-sac larvae provided in Appendix A, distinguishing characteristics will include size, color and a continuous finfold extending from behind the head dorsally around the notochord and ventrally to the posterior end of the yolk sac.

4. Larvae will be examined for consistency with size and developmental stage (see Snyder 1988). Bath et al. (1988) provides an extensive description of Atlantic and Shortnose Sturgeon (*Acipenser brevirostrum*), that can be used as an aid in identifying Atlantic Sturgeon.

For Quality Control purposes, any eggs and larvae identified as potential sturgeon specimens will be preserved separately and provided to an appropriate third party for taxonomic identification. The third party will provide a “blind” taxonomic identification wherein they will not be provided the results from the original taxonomic designation.

See Appendix C for a list of data to be collected and recorded during field collection and processing.

6.4.3 Laboratory Quality Control (QC) Procedures

Quality control methods for split, sort and identification of ichthyoplankton will be checked using a continuous sampling plan (CSP) to assure an Average Outgoing Quality Limit (AOQL) of 0.1 (≥90% accuracy). Specific methods for quality control will be provided in the SOP developed by the contractor performing the work. Quality control checks will be recorded on appropriate datasheets and these records will be maintained for review.

7 References

Atlantic States Marine Fisheries Commission (ASMFC). 2012. Habitat Addendum IV to Amendment 1 to the Interstate Fishery Management Plan for Atlantic Sturgeon.

Bain, M.B. 1997. Atlantic and shortnose sturgeons of the Hudson River: Common and divergent life history attributes. *Environmental Biology of Fishes* 48: 347-358.

Bain, M.B., N. Haley, D. Peterson, J.R. Waldman, and K. Arend. 2000. Harvest and habitats of Atlantic Sturgeon, *Acipenser oxyrinchus* Mitchill, 1815, in the Hudson River estuary: Lessons for sturgeon conservation. *Boletin-Instituto Español de Oceanografía* 16: 43-53.

Balazik, G. C. Garman, J.P. Van Eenennaam. 2012. Empirical Evidence of Fall Spawning by Atlantic Sturgeon in the James River, Virginia. Transactions of the American Fisheries Society 141: 1465-1471.

Bath, D.W., J.M. O'Conner, J.B. Alber & L.G. Arvidson. 1981. Development and identification of larval Atlantic Sturgeon (*Acipenser oxyrhynchus*) and Shortnose Sturgeon (*A. brevirostrum*) from the Hudson River estuary, New York. Copeia 1981: 711–717.

Bilkovic, DM, K Angstadt, and D Stanhope. 2009. Atlantic Sturgeon Spawning Habitat on the James River, Virginia. Final report to NOAA Chesapeake Bay Office, Award Number NA06NMF4570303. Virginia Institute of Marine Science, Center for Coastal Resources Management, Gloucester Point, Virginia.

Bushnoe, T.M., J.A. Musick, and D.S. Ha. 2005. Essential Spawning and Nursery Habitat of Atlantic Sturgeon (*Acipenser oxyrinchus*) in Virginia. Appendix 1 of Essential Fish Habitat of Atlantic Sturgeon *Acipenser Oxyrinchus* in the Southern Chesapeake Bay. Principal Investigator: Jasck Musick. VIMS Scientific Report #145.

CH2MHILL. 2007. Draft Comprehensive Demonstration Study for Chesterfield Power Station. 2006.

Chesapeake Bay Journal. May 2011. Blue catfish boom threatens region's river ecosystems. The Bay Journal 22(3).

Dee, S.O. and T. Watters. New or confirmed host identifications for ten freshwater mussels. Proceedings of the Conservation, Captive Care, and Propagation of Freshwater Mussels Symposium. Pages 77-82. Ohio Biological Society.

EA. 2007. Impingement Mortality and Entrainment Characterization Report, Chesterfield Power Station, June 2005 – 2006. EA Engineering, Science, and Technology, Inc., Sparks, Maryland.

Gilbert, C.R. 1989. Species profiles: life histories and environmental requirements of coastal fishes and invertebrates (Mid-Atlantic Bight)--Atlantic and Shortnose Sturgeons. U.S. Fish Wildl. Serv. Biol. Rep. 82(11.122). U.S. Army Corps of Engineers TR EL82-4. 28 pp.

Hager, C. 2011. Atlantic Sturgeon review: Gather data on reproducing subpopulation of Atlantic Sturgeon in the James River. Contract EA133FIOCN0317.

Hildebrand, S.F. and W.C. Schroeder. 1928. Fishes of Chesapeake Bay. Department of Commerce, Bulletin of the United States Bureau of Fisheries, Volume XLIII.

Johnson, R.I. 1970. The systematics and zoogeography of the Unionidae (Mollusca: Bivalvia) of the southern Atlantic slope region. *Bulletin of the Museum of Comparative Zoology* 140(6):263-449.

Jones, P. W., Martin, F. D. and Hardy, J. D. Jr. 1978: Development of fishes of the Mid-Atlantic Bight. An atlas of egg, larval and juvenile stages. Volume I Acipenseridae through Ictaluridae. U. S. Dep. Interior, Fish Wildl. Serv., Biol. Serv. Prog. FWS/OBS-78/12. 366 pp.

Kynard, B. and M. Horgan. 2002. Ontogenetic behavior and migration of Atlantic Sturgeon, *Acipenser oxyrinchus oxyrinchus*, and Shortnose Sturgeon, *A. brevirostrum*, with notes on social behavior. Environmental Behavior of Fishes 63: 137-150.

Lung, W.S. 1991. Trends in BOD/DO modeling for wasteload allocations of the James River estuary. Technical memorandum prepared under subcontract for Tetra Tech, Inc., Fairfax, VA.

Moser, M. L., and S. W. Ross. 1995. Habitat use and movements of shortnose and Atlantic sturgeons in the lower Cape Fear River, North Carolina. Transactions of the American Fisheries Society 124: 225-234.

National Marine Fisheries Service (NMFS). 2012a. Biological Opinion of James River Federal Navigation Project: Tribell Shoal Channel to Richmond Harbor in Surry, James City, Prince George, Charles City, Henrico, and Chesterfield Counties and the Cities of Richmond and Hopewell, Virginia (FINER/2012/01183).

NMFS. 2012b. Letter of concurrence, from Mr. D.M. Morris, NMFS, to Ms. Amy Hull, Nuclear Regulatory Commission, that continued operation Surry Nuclear Power Station, Units 1 and 2 is not likely to adversely affect species listed by NMFS.

Rash, J.M. 2005. Life history characteristics of the Atlantic Pigtoe (*Fusconaia mason*i). Abstract of Papers 83rd Annual Meeting of the Virginia Academy of Science, May 17-20, 2005. James Madison University, Harrisonburg, VA.

Secor, D. H., E. J. Niklitschek, J. T. Stevenson, T. E. Gunderson, S. P. Minkkinen, B. Richardson, B. Florence, M. Mangold, J. Skjeveland, and A. Henderson-Arzapalo. 2000. Dispersal and growth of yearling Atlantic Sturgeon, *Acipenser oxyrinchus*, released into Chesapeake Bay. Fishery Bulletin 98: 800-810.

Terwiliger, K. 1991. Virginia's Endangered Species: Proceedings of a Symposium. Virginia Department of Game and Inland Fisheries, McDonald and Woodward Publishing Company, Blacksburg, VA.

U.S. Fish and Wildlife Service (FWS), Raleigh Ecological Serices Field Office. 2012. Sensitive Joint-vetch (Aeschynomene virginica). Retrieved September 7, 2014. http://www.fws.gov/raleigh/species/es_sensitive_joint-vetch.html

VEPCO. 2000. Section 316(a) Demonstration. VPDES Permit Number VA0004146 - Chesterfield Power Station. Virginia Electric and Power Company, Environmental Policy and Compliance, Glen Allen, Virginia.

VEPCO. 1977. Chesterfield Power Station Impingement and Entrainment Study. Final report. Prepared by Virginia Electric and Power, Environmental Services Department, Richmond, VA.

Virginia Fish and Wildlife Information System (VAFWIS). 2014. Virginia Wildlife and Information Service. Atlantic Pigtoe Chapters. Available online. Retrieved October 7, 2014. *http://vafwis.org/fwis/booklet.html?Menu=_.All+Chapters&bova=060173&version=16350*

Virginia Department of Game and Inland Fisheries (VDGIF). 2014. Barking treefrog (Hyla gratiosa). Available online. Retrieved September 7, 2014. *http://www.dgif.virginia.gov/wildlife/information/?s=020002*

Watson, J. 2012. James River Mainstem Freshwater Mussel Surveys. Virginia Department of Game & Inland Fisheries, Bureau of Wildlife Resources. Accessed on November 13, 2013. Available online: http://www.google.com/url?sa=t&rct=j&q=&esrc=s&frm=1&source=web&cd=4&ved=0CC8QFjAD&url=http%3A%2F%2Fncmollusks.wikispaces.com%2Ffile%2Fview%2FJamesRiverSurveys.pdf&ei=1QVmVIfDH_TesASBvICgBg&usg=AFQjCNHoLbYHINRMh89V_2H6BPNyEZT8cA&sig2=NR_T2jFldgg2ucIZqnJn_w&bvm=bv.79142246,d.cWc.

Wolf, E.D. 2010. Propagation and Culture of Species at Risk Atlantic Pigtoe. Department of Defense Legacy Program. Project #09-450.

Wolf, E.D. and V. Emrick. 2011. Propagation and Culture of Species at Risk Atlantic Pigtoe. Department of Defense Legacy Program. Project #10-450.

Appendix A

Atlantic Sturgeon Life History Information

Atlantic Sturgeon Life History Information

Atlantic Sturgeon (*Acipenser oxyrinchus*) originating from the New York Bight, Chesapeake Bay, South Atlantic and Carolina Distinct Population Segments (DPSs) are listed as endangered. Those originating from the Gulf of Maine DPS are listed as threatened. Atlantic Sturgeon from these five DPSs have the potential to occur in the James River and the vicinity of the cooling water CWIS of the CPS. The marine range of all five DPSs extends along the Atlantic coast from Canada to Cape Canaveral, Florida (NMFS 2012a).

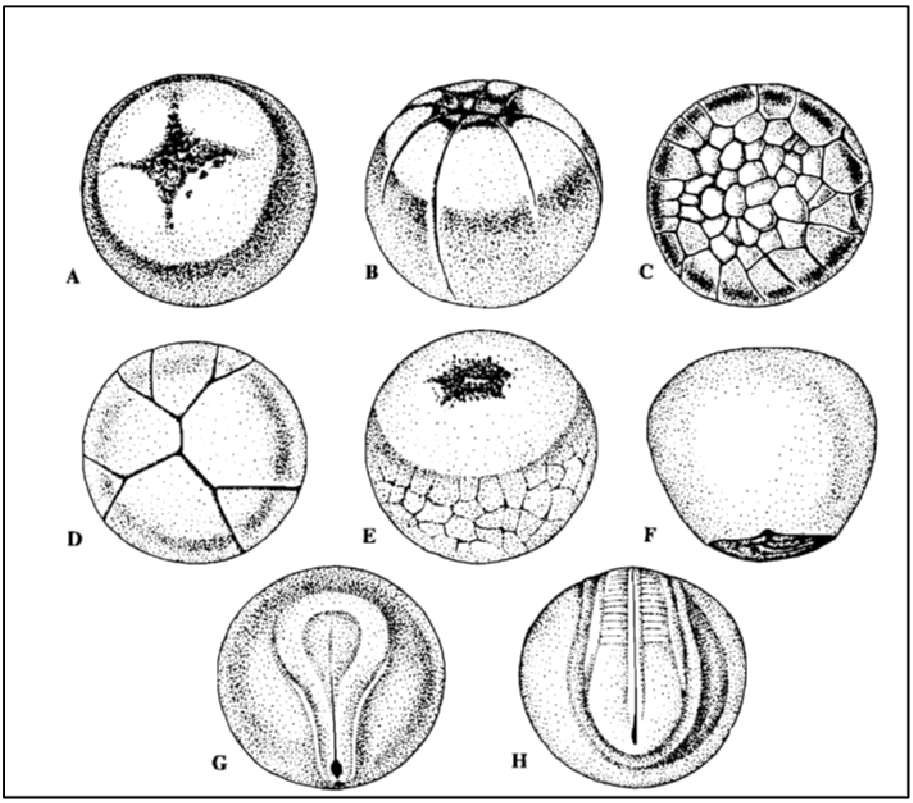
The James River historically provided the largest stock of Atlantic Sturgeon in the Chesapeake and the majority of the adults in the river are likely to originate from the James River and thus, the Chesapeake Bay DPS (Hildebrand and Shroeder 1928; ASSRT 2007; Hager 2011; NMFS 2012a). Because early life stages (eggs and larvae), yearlings, and juveniles do not leave their natal river or estuary, any Atlantic Sturgeon from these life stages in the James River would have originated from the Chesapeake Bay DPS. Subadult Atlantic Sturgeon (greater than 50 cm but not yet sexually mature), move outside their natal rivers. Therefore, subadult Atlantic Sturgeon present in the James River and in the vicinity of the CWIS could be from any of the five DPSs.

Atlantic Sturgeon spawn in the James River. Benthic substrates that provide suitable sturgeon spawning habitat (i.e., rock and cobble gravel) occur in the vicinity of CPS; however, some of these areas might not have viable spawning conditions (e.g., hydrodynamic characteristics) (Bilkovic et al. 1999). Bushnoe et al. (2005) indicate that the Turkey Island and Jones Neck oxbows, which are approximately 3 -7 miles downstream CPS are considered potential spawning habitat due to their hydrodynamic characteristics and also benthic substrate, including rock and gravel/cobble/pebble (Bilkovic et al. 2009, NMFS 2012a). Spawning is expected to occur from the April through June; evidence exists that spawning might occur in the fall as well, with high adult usage in the river from August through November (Balazik et al. 2012, Secor et al. 2000). Virginia Marine Resources Commission restricts dredging in the James River from March 15 through June 30 to accommodate spring-spawning anadromous fish (Balazik et al. 2012) and NMFS (2012b) recently restricted dredging in the lower James River from February 15 to June 15th and in the rest of the river from February 15 to June 30 to protect anadromous fish during migration and spawning periods.

Eggs can hatch in 4 - 7 days depending on temperature (Gilbert 1989; Hildebrand and Schroeder 1928). Eggs are strongly adhesive and demersal, and occur only on the spawning grounds attaching to the substrate in 20 minutes (Jones et al. 1978). Atlantic Sturgeon eggs are approximately 2.6 mm in diameter (Hildebrand and Schroeder 1928) and hatch approximately 94, 140, and 168 hours after egg deposition at temperatures of 20°C, 18°C, and 17.8 °C, respectively (Gilbert 1989; Hildebrand and Schroeder 1928).

Ripe (unfertilized) Atlantic Sturgeon eggs are reported to be 2.5 - 2.6 mm in diameter, globular in shape, and of a light to dark brown color. Fertilized eggs are up to 2.9 mm in diameter, slate gray or light to dark brown, and become oval as development proceeds (Jones et al. 1978) (see Figure A-1). The germinal disc is evident in the unfertilized egg. A cross- or star-shaped pigment

patch is apparent in the animal pole of the fertilized egg. The eggs are distinctly two-layered with the outer layer being a viscous substance.



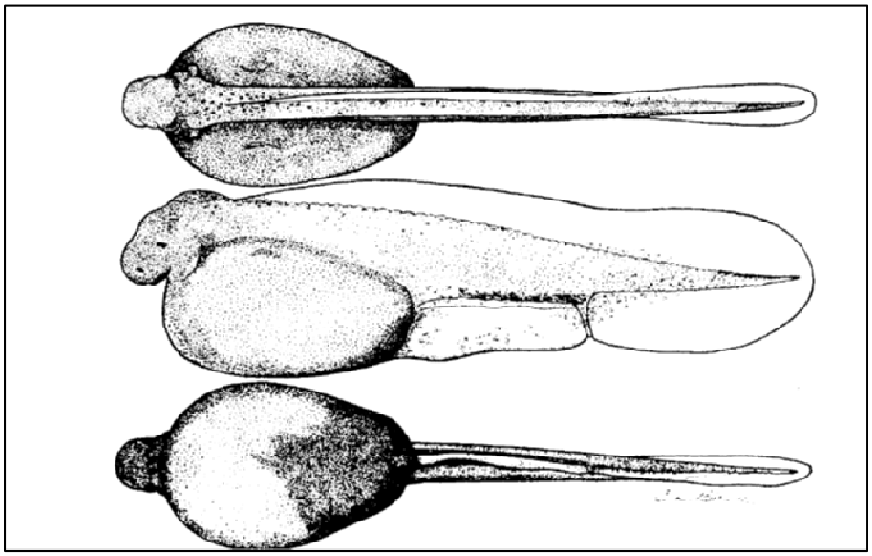
Source: Jones et al. 1978 as presented in Gilbert 1989

Figure A-1. Atlantic Sturgeon Egg Development from Unfertilized Egg to 48-hour Stage

Yolk-sac larvae are expected to inhabit the same areas where they were spawned (Bain et al. 2000; ASMFC 2012). Smith et al. (1980 in Gilbert 1989) also reported that the yolk-sac larvae were darkly pigmented and active swimmers. Hard substrate is important to larval Atlantic Sturgeon as it provides refuge from predators (Kieffer and Kynard 1996 and Fox et al. 2000 as cited in ASMFC 2012). Bath et al. (1981) only collected sturgeon larvae in bottom samples. Larvae are also active swimmers and leave the bottom when 8 to 10 days old to swim in the water column (Kynard and Horgan 2002).

The yolk-sac larval stage is completed in about 8 to12 days (Jones et al. [1978] reports 6 days), at which time the larvae move downstream to the rearing grounds (Kynard and Horgan 2002). During the first half of this migration, larvae move only at night and use benthic structure (e.g., gravel matrix) as refuge during the day (Kynard and Horgan 2002). During the latter half of migration to the rearing grounds, when larvae are more fully developed, movement occurs during both day and night. Larvae transition into the juvenile phase at approximately 30 mm total length (TL) and move further downstream into brackish waters, developing a tolerance to salinity. Eventually they become residents in estuarine waters for months to years before emigrating to open ocean (ASSRT 2007, ASMFC 2012).

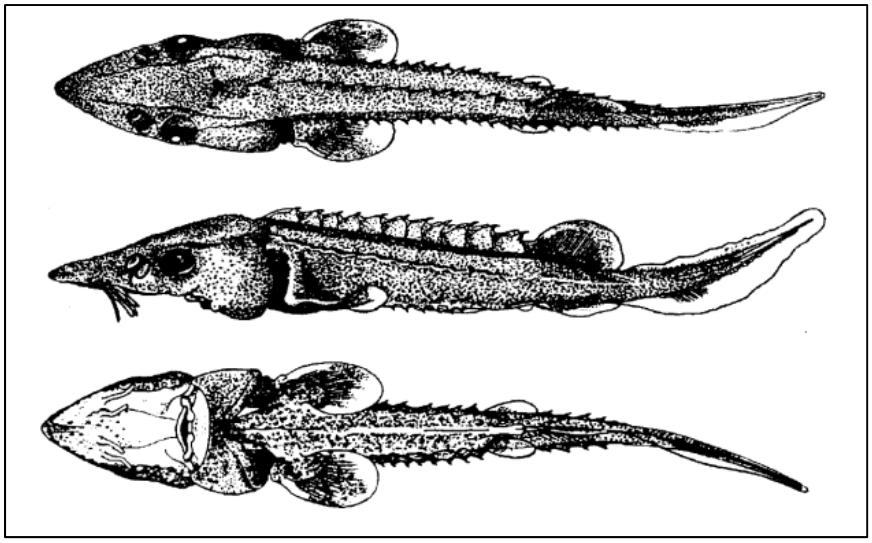
Atlantic Sturgeon larvae are expected to be approximately 7 - 9 mm TL at hatching (Bath et al. 1981, Smith 1980 as cited in Bain et al. 2000, Gilbert 1989, Snyder 1988), although Jones et al. (1978) describe a newly hatched Atlantic Sturgeon larvae at 11.5 mm TL. The head width is 8% of standard length (SL) with a depth of 11 % of SL (behind the posterior margin of the eye). The yolk-sac maxima is 23 % of SL and the yolk-sac depth is 20% of SL (Snyder 1988). Jones et al. (1978) describes the newly hatched Atlantic Sturgeon larvae with a head and the tail that is darkly pigmented and a yolk that is a large "dirty yellow," vascular oval. The head is not deflected over the yolk (bent around the yolk). The mouth is formed. The eye is relatively small and is about the same size as the round auditory vesicles. The branchial arches are concealed by the opercular folds, the barbels are lacking, pectoral buds are present, and the origin of the dorsal finfold is in the occipital region. Bath et al. (1981) reports that a continuous finfold extends from behind the head dorsally around the notochord and ventrally to the posterior end of the yolk sac, a dorsal wedge-shaped cavity at the fourth ventricle in the posterior of the blunt head, and a vent extended through the finfold at 0.6 to 0.7 of the TL from the snout. The spiral valve was distinguishable, even in small specimens.



Source: Snyder 1988

Figure A-2. Atlantic Sturgeon Yolk Sac Larvae Just Hatched

Snyder (1988) reports that Atlantic Sturgeon complete yolk absorption by 13 - 14 mm SL in 6 - 7 days, acquire their first scutes between 17 and 20 mm SL at 13 - 29 days, acquire their first fin rays at 21 mm SL (13 - 29 days), and acquire a full complement of fin rays, except the caudal fin, between 47 and 58 mm SL at 29 - 100 days. A 29-day hatchery-reared larva is presented in Figure A-3.



Source: Snyder 1988

Figure A-3. Atlantic Sturgeon, 28.9 mm SL, 29.3 MM TL, 29 Days After Hatching

Mean myomere counts for Shortnose and Atlantic Sturgeon are 38 preanal and 22 or 23 postanal. Snyder (1988) presents a detailed comparison of shortnose and Atlantic Sturgeon and provides details on the age and length of the onset of certain developmental events.

Juvenile Atlantic Sturgeon demonstrate a lot of variation with regard to salinity tolerance (ASMFC 2012). Atlantic Sturgeon spawn in their natal river and remain in the river until approximately age two and at lengths of approximately 76 - 92 cm (30 - 36 inches; ASSRT 2007). Yearlings are known to occupy freshwater portions of their natal river (Secor et al. 2000) and their distribution in the James River is expected to follow this pattern. Juveniles in the river are also restricted to low salinity areas, with overwintering known to occur in deep water areas near river mile 25 (NMFS 2012a).

Hager (2011) used telemetry to establish movement patterns of adult and subadult Atlantic Sturgeon in the James River. Thirty-two adults and thirty-three subadults were outfitted with telemetry tags and telemetry receivers were placed throughout the river to record the presence of tagged fish when they are within approximately one kilometer of the receivers.

Results of Hager (2011) indicate that adult Atlantic Sturgeon enter the James River in spring when water temperatures are around 17°C, and occur from river mile 29 to river mile 67 before departing from the river in June when water temperatures are around 24° C. Data collected in 2010 demonstrated a congregation of sturgeon in freshwater areas near river mile 48, suggesting the possibility of spawning in this area (Hager 2011). Adult Sturgeon appear to be absent from the James River for most of the summer until late August when tagged fish are once again detected in the river (Hager 2011). During the late summer-early fall residency (August-October), fish ascend the river rapidly and congregate in upriver sites between river mile 48 and the fall line near Richmond, VA; possibly in response to physiologically stressful conditions (e.g., low dissolved oxygen and elevated water temperature) in the lower James River and Chesapeake Bay (Hager 2011). During late summer, Atlantic Sturgeon exhibited a

preference for the river section where the upper James and Appomattox rivers meet, approximately 9 miles downstream from CPS (Hager 2011). As temperature declines in late September or early October, adults disperse through downriver sites and begin to move out of the river (Hager 2011). By November, adults occupy only lower river sites (Hager 2011). By December, adults are undetected on the tracking array and, thus, are presumed to be out of the river (Hager 2011).

The highest number of subadults are present in the river in the spring and fall with the lowest numbers present in August when ambient water temperatures in the river are the highest. At this time of year, most subadults leave the river and any Atlantic Sturgeon remaining in the river are holding in cool water refugia (Hager 2011). The number of subadults in the river peaks in October. Many subadults leave the river for overwintering with some known to overwinter off the coast of North Carolina. Subadults overwintering within the river are located downstream of Hog Island.

Literature Cited

Atlantic States Marine Fisheries Commission (ASMFC). 2012. Habitat Addendum IV to Amendment 1 to the Interstate Fishery Management Plan for Atlantic Sturgeon.

Atlantic Sturgeon Status Review Team (ASSRT). 2007. Status Review of Atlantic Sturgeon (*Acipenser oxyrinchus oxyrinchus*). Report to National Marine Fisheries Service, Northeast Regional Office. February 23, 2007. 174 pp.

Balazik, G. C. Garman, J.P. Van Eenennaam. 2012. Empirical Evidence of Fall Spawning by Atlantic Sturgeon in the James River, Virginia. Transactions of the American Fisheries Society 141: 1465-1471.

Bain, M.B., N. Haley, D. Peterson, J.R. Waldman, and K. Arend. 2000. Harvest and habitats of Atlantic Sturgeon, *Acipenser oxyrinchus* Mitchill, 1815, in the Hudson River estuary: Lessons for sturgeon conservation. Boletin-Instituto Español de Oceanografía 16: 43-53.

Bath, D.W., J.M. O'Conner, J.B. Alber & L.G. Arvidson. 1981. Development and identification of larval Atlantic Sturgeon (*Acipenser oxyrhynchus*) and Shortnose Sturgeon (*A. brevirostrum*) from the Hudson River estuary, New York. Copeia 1981: 711–717.

Bilkovic, DM, K Angstadt, and D Stanhope. 2009. Atlantic Sturgeon Spawning Habitat on the James River, Virginia. Final report to NOAA Chesapeake Bay Office, Award Number NA06NMF4570303. Virginia Institute of Marine Science, Center for Coastal Resources Management, Gloucester Point, Virginia.

Bushnoe, T.M., J.A. Musick, and D.S. Ha. 2005. Essential Spawning and Nursery Habitat of Atlantic Sturgeon (*Acipenser oxyrinchus*) in Virginia. Appendix 1 of Essential Fish Habitat of Atlantic Sturgeon *Acipenser Oxyrinchus* in the Southern Chesapeake Bay. Principal Investigator: Jasck Musick. VIMS Scientific Report #145.

Fox, D. 2006. History of Atlantic Sturgeon Fishery. Power Point presentation presented to Delaware Department of Natural Resources, courtesy of Greg Murphy (DEDNR) April 13, 2006.

Gilbert, C.R. 1989. Species profiles: life histories and environmental requirements of coastal fishes and invertebrates (Mid-Atlantic Bight)--Atlantic and Shortnose Sturgeons. U.S. Fish Wildl. Serv. Biol. Rep. 82(11.122). U.S. Army Corps of Engineers TR EL82-4. 28 pp.

Hager, C. 2011. Atlantic Sturgeon review: Gather data on reproducing subpopulation of Atlantic Sturgeon in the James River. Contract EA133FIOCN0317.

Hildebrand, S.F. and W.C. Schroeder. 1928. Fishes of Chesapeake Bay. Department of Commerce, Bulletin of the United States Bureau of Fisheries, Volume XLIII.

Jones, P. W., Martin, F. D. and Hardy, J. D. Jr. 1978: Development of fishes of the Mid-Atlantic Bight. An atlas of egg, larval and juvenile stages. Volume I Acipenseridae through

Ictaluridae. U. S. Dep. Interior, Fish Wildl. Serv., Biol. Serv. Prog. FWS/OBS-78/12. 366 pp.

Kieffer, M. C. and B. Kynard. 1993. Annual movements of Shortnose and Atlantic Sturgeons in the Merrimack River, Massachusetts. Transactions of the American Fisheries Society 122: 1088-1103.

Kynard, B. and M. Horgan. 2002. Ontogenetic behavior and migration of Atlantic Sturgeon, *Acipenser oxyrinchus oxyrinchus*, and Shortnose Sturgeon, *A. brevirostrum*, with notes on social behavior. Environmental Behavior of Fishes 63: 137-150.

National Marine Fisheries Service (NMFS). 2012a. Letter of concurrence, from Mr. D.M. Morris, NMFS, to Ms. Amy Hull, Nuclear Regulatory Commission, that continued operation Surry Nuclear Power Station, Units 1 and 2 is not likely to adversely affect species listed by NMFS.

NMFS. 2012b. Biological Opinion of James River Federal Navigation Project: Tribell Shoal Channel to Richmond Harbor in Surry, James City, Prince George, Charles City, Henrico, and Chesterfield Counties and the Cities of Richmond and Hopewell, Virginia (FINER/2012/01183).

Smith, T. I. J., E. K. Dingley and D. E. Marchette. 1980. Induced spawning and culture of the Atlantic Sturgeon, *Acipenser oxyrinchus* (Mitchill). Progressive Fish-Culturist 42: 147-151.

Secor, D. H., E. J. Niklitschek, J. T. Stevenson, T. E. Gunderson, S. P. Minkkinen, B. Richardson, B. Florence, M. Mangold, J. Skjeveland, and A. Henderson-Arzapalo. 2000. Dispersal and growth of yearling Atlantic Sturgeon, *Acipenser oxyrinchus*, released into Chesapeake Bay. Fishery Bulletin 98: 800-810.

Snyder, D.E. 1988. Description and Identification of Shortnose and Atlantic Sturgeon Larvae. American Fisheries Society Symposium 5: 7-30.

Appendix B

Field Instrumentation: Calibrations and Standardizations

WORK PRACTICE DOCUMENT

Field Instrumentation:

Calibrations and Standardizations

Dominion Environmental Services

Table of Contents

1.0 Introduction 2
2.0 Scope 2
3.0 Dominion Employees Covered 2
4.0 Work Practice Description 3
5.0 Safety 3
6.0 Work Practice Requirements 3
7.0 Electric Environmental Biology Calibration and Standardization Protocols 5
7.1 Chlorine 5
7.2 Conductivity/Salinity 5
7.3 Dissolved Oxygen (D.O) 7
7.4 pH Meters 8
7.5 Flowmeters 10
7.6 Temperature 10
7.7 Turbidity 10
7.8 Weight 11
7.9 Oxidation/Reduction Potential ORP 12
8.0 Contacts 13
9.0 Tables 14
11.0 Distribution List 21

WORK PRACTICE DOCUMENT

Calibrations and Standardizations

Electric Environmental Biology

Written Date: 8/16/2011

Revision Date:

Document Owner: Casey Seelig

1.0 Introduction

Dominion is required to monitor a variety of physicochemical parameters in the environment. These parameters are monitored with various types and models of scientific instrumentation. Instruments must be either calibrated or standardized and properly maintained to ensure the accuracy and precision of the data being collected. **Calibration** is a process of physically adjusting an instrument to accurately read a known standard or series of standards. **Standardization** is a process of checking an instrument against a known standard or series of standards to document its accuracy. Standardization, without a physical adjustment to the instrument, checks that the instrument is functioning to its design specifications and, if not the instrument can either be calibrated, serviced by the operator, or sent back to the manufacturer for repair. The manufacturer's recommended calibration and maintenance procedures for a particular instrument are designed to keep the equipment performing to the manufacturer's specifications. Every instrument's accuracy should be verified and documented to ensure it meets the acceptability criteria established for the work.

2.0 Scope

The purpose of this work practice document is to provide the protocols necessary to ensure all field instrumentation and test methods, which are used to measure environmental parameters, are providing data of acceptable accuracy. This work practice document defines the proper methods, frequencies, and acceptance criteria for documenting field instrument and test kit accuracy using calibrations and standardizations. The procedures in this document are general in nature. Due to the number and variety of field instrumentation used, specific calibration procedures for each instrument are beyond the scope of this document. The user's manual should be consulted for specific calibration and standardization procedures.

3.0 Dominion Employees Covered

This work practice applies to all Dominion Environmental Services (DES) employees using field instrumentation to monitor environmental parameters as well as any contractors employed by DES that conduct environmental analyses for monitoring studies. The guidelines and procedures

listed in this work practice document apply to instruments used in the field. This does not cover the calibration or standardization of laboratory equipment.

4.0 Work Practice Description

The field instrumentation calibrations and standardizations work practice provides guidance on how to prepare for and safely conduct calibrations and equipment accuracy checks on field instrumentation. This work practice is intended for experienced field technicians or for those under the direct supervision of employees trained in proper calibration and standardization methods used for equipment and reagents required in the collection of environmental data.

5.0 Safety

Safety is a core Dominion principle and all calibration and standardization work must incorporate safe work practices. It is the responsibility of every employee and contractor to work safely. Safety of each employee, contractor, their co-workers and the general public are the first priority of every job. The conduct of all work should conform to the expectations described in the Dominion Safety Policy, the Safety Work Practice for Dominion Environmental Services, the Safety Work Practice for Biology, and the policies of the business unit where the work is being done. The types of Personal Protective Equipment (PPE) necessary for calibrating and standardizing field instruments must be reviewed prior to starting calibrations or standardizations to identify and mitigate any hazards.

1. Specific hazards associated with the type of instruments to be calibrated or standardized must be known prior to the start of the calibration or standardization. Examples of such hazards might include: health and safety concerns associated with the use of pH standards as identified by the Material Safety Data Sheet (MSDS).
2. Where the mitigation of hazards is not possible, Personal Protective Equipment (PPE) must be worn to safely complete the calibration/standardization. A hazard assessment must be performed to evaluate each calibration or standardization task and the proper PPE needs to be worn as outlined in the MSDS and any governing Laboratory Chemical Hygiene Plan. The need for safety glasses, gloves, and appropriate clothing should be considered in every hazard assessment.
3. All employees are required, at a minimum, to be familiar with the Hazard Communication Program for their business unit. The Hazard Communication Program outlines safety expectations when handling and using chemical products, including employee training, chemical labeling, and access to MSDS.

6.0 Work Practice Requirements

1. Personnel that will be calibrating or standardizing instruments or test kits for readings will, at a minimum:

a) Be cognizant of the safe handling and waste disposal of calibration or standardization chemicals.
b) Have training in the use of instrumentation;
c) Have training for the proper use of required PPE;
d) Have a thorough understanding of the proper methods outlined by the manufacturer to maintain, calibrate or standardize the instrument or test kit.

2. Verify state and federal protocols for accuracy and precision of measurements:
   a) Review acceptance criteria required by the state and agencies (current acceptance criteria are listed in calibration procedures below and in Table1);
   b) Document all calibrations and standardizations of monitoring instruments and test kits.
3. Pre-Calibration/Standardization Preparation
   a) Review the manufacturer's recommendations and procedures;
   b) Locate and fill out the appropriate calibration/standardization log sheet;
   c) Verify the expiration/certification date of all standards to be used in the calibration/standardization process;
   d) Verify the instrument's or test kit's make, model, and serial number or unique identifier and record it on the log sheet;
4. Instrument or Test kit Calibration/Standardization
   a) Document the date, time, and the person(s) conducting the calibration/standardization;
   b) Select a range of standards to be used for calibration or to be checked for the instrument/test kit's accuracy, which will bracket expected field/laboratory survey results;
   c) Document the results (standard verses reading) and verify that they meet the acceptance criteria;
   e) If the equipment fails calibration/standardization, service and clean the equipment and re-calibrate/standardize;
   f) If the equipment continues to fail, label "Inactive Status" and remove the equipment from service (send the equipment back to the manufacturer for servicing) and document this on the log sheet;

Note: If an instrument or test kit does not comply with the established acceptance criteria, it must not be used for collecting data and must be removed from service.

   g) Properly label and dispose of all waste chemicals and materials. Dispose of any hazardous wastes according to the Hazard Waste Management Guidance Document.
5. Verification
   a) DES personnel must record the instrument/test kit identifier (e.g., serial number) on field and boat log sheets to provide a traceable accuracy for every measurement collected;
   b) Annual reviews of calibration/standardization logs should be performed to verify compliance. Calibration/standardization logs should be checked to verify that records are complete, legible, and up to date.

7.0 Calibration and Standardization Protocols

Many instruments and test kits are not able to be calibrated in the field or by the user. These instruments and test kits need to be checked routinely using known standards to establish and document their accuracy. For example it is not possible to adjust a capillary thermometer; therefore accuracy needs to be compared to a reference thermometer of certified accuracy. In many cases checking standards and documenting the instrument's accuracy in the range of conditions it will be used can be more efficient than calibration procedures. In all cases, follow the manufacturer's recommended maintenance and calibration directives.

The following frequencies (Table 1) established for documenting calibrations and standardizations are for instruments and test kits routinely being used for weekly or monthly monitoring studies. If equipment is being used daily for recording large amounts of data, calibration/standardization frequencies must be increased (see Table 1) or standards must be run with samples. For infrequently used equipment (once a quarter or year), calibrations and standardizations should occur prior to use. Data loggers which are being deployed for extended periods of time (>1 month) must be calibrated/standardized immediately prior to and following deployment in the field.

Prior to calibration, all instrument probes must be cleaned according to the manufacturers instructions. Failure to perform this step (proper maintenance) can lead to erratic measurements. When calibrating instruments care must be taken to insure that the volume of the calibration solutions is sufficient to cover both the probe and temperature sensor and be free of air bubbles (see manufacturer's instructions for additional information).

A record of each calibration must be made in the calibration log. The record needs to include at a minimum:

- serial number of the instrument
- parameters which were calibrated
- standards used in calibration
- date and time of calibration
- initials of technician

7.1 Chlorine

Chlorine testing in the field is usually done using a colorimeter. There are two methods of standardization: 1) gel standards (once a week or prior to use) and 2) ampule standards (recommended every 13 weeks). Prior to reading the standards, zero the colorimeter with a blank (deionized water) and record measurements to 0.01 mg/L. Acceptance criterion for the gel standards (0.20, 0.83, and 1.53 mg/L) is ±15% and for the ampule standards (0.12, 0.60, 1.20 mg/L) is ±20%. If expected chlorine levels are higher than the range of these standards, select standards that bracket the expected field results.

7.2 Conductivity and Salinity

Conductivity is used to measure the ability of an aqueous solution to carry an electrical current. Specific conductance is the conductivity value corrected to 25°C. There are a

variety of instruments available to measure conductivity, specific conductance, salinity, and temperature. Most instruments are calibrated against a single standard which is near, but below the specific conductance of the environmental samples. A second standard which is above the environmental sample specific conductance is used to check the linearity of the instrument in the range of measurements.

If cleaning electrical connections, changing batteries (recharging), or changing sensors does not correct standardization failures, then the unit should be sent back to the manufacturer for servicing. Freshwater standards (0.05-1.00 mS/cm) or Seawater standards (40-60 mS/cm) are recommended for standardizations checks every 13 weeks. These standardizations should be conducted at a temperature of 25°C±1°C. The acceptance criterion is ±5%. The temperature probes of these meters should be checked for accuracy (acceptance criterion ±0.5°C) at the same time because temperature is factored into the meters program for calculating conductivity, specific conductance and salinity. Standardizations can be done with a specifically designated and labeled "Reference Meter", which must be standardized with standard water samples every 4 weeks. Refractometers (salinity/density) must be standardized (acceptance criterion ±1.0 ppt) every 13 weeks or prior to use with a "Reference Meter." Before using a refractometer for recording salinity data, verify that it meets or exceeds the precision requirements for the data being collected.

Calibration Procedure

1. Allow the calibration standard to equilibrate to the ambient temperature.

2. Remove probe from its storage container, rinse the probe with a small amount of the conductivity/specific conductance standard (discard the rinsate), and place the probe into the conductivity/specific conductance standard.

3. Select monitoring/run mode. Wait until the probe temperature has stabilized.

4. Look up the conductivity value at this temperature from the conductivity versus temperature correction table usually found on the standard bottle or on the standard instruction sheet. You may need to interpolate the conductivity value between temperatures. Select calibration mode, then conductivity. Enter the temperature corrected conductivity value into the instrument.

5. Select monitoring/run mode. The reading should remain within manufacturer's specifications. If it does not, re-calibrate. If readings continue to change after recalibration, consult manufacturer.

6. Read the specific conductance on the instrument and compare the value to the specific conductance value on the standard. The instrument value should agree with the standard within the manufacturer's specifications. If not, re-calibrate. If the re-calibration does not correct the problem, the probe may need to be cleaned or serviced by the instrument manufacturer.

7. Remove probe from the standard, rinse the probe with a small amount of the second conductivity/specific conductance standard (discard the rinsate), and place the probe into the second conductivity/specific conductance standard. The second standard will serve to verify the linearity of the instrument. Read the specific conductance value from the instrument and compare the value to the specific conductance on the standard. The two values should agree within the specifications of the instrument. If they do not agree, recalibrate. If readings do not compare, then the second standard may be outside the linear range of the instrument. Use a standard that is closer, but above the first standard and repeat the verification. If values still do not compare, try cleaning the probe or consult the manufacturer.

8. When monitoring groundwater or surface water, use the specific conductance readings.

7.3 Dissolved Oxygen (D.O.)

Dissolved oxygen (DO) content in water is measured using a membrane electrode. The DO probe's membrane and electrolyte solution should be replaced prior to the sampling period. Failure to perform this step may lead to erratic measurements. There are a variety of instruments available to measure dissolved oxygen (% saturation & mg/L) and temperature.

If cleaning electrical connections, changing batteries (recharging), or changing the permeable membrane on the sensor does not correct standardization failures, then the unit should be sent back to the manufacturer for servicing. If the unit has an air calibration function, air calibrate (100% saturation) the meter prior to use or follow manufacture's directives. Newer instruments utilize a luminescent dissolved oxygen probe (LDO). LDO sensor caps need to be replaced based on the manufacturer's maintenance schedule. LDO sensors are calibrated using air saturated water.

Calibration Procedure

1. Gently dry the temperature sensor according to manufacturer's instructions.

2. Place a wet sponge or a wet paper towel on the bottom of the DO calibration container.

3. Place the DO probe into the container without the probe coming in contact with the wet sponge or paper towel. The probe must fit tightly into the container to prevent the escape of moisture evaporating from the sponge or towel.

4. Allow the confined air to become saturated with water vapor (saturation occurs in approximately 10 to 15 minutes). During this time, turn-on the instrument to allow the DO probe to warm-up. Select monitoring/run mode. Check temperature readings. Temperature readings must stabilize before continuing to the next step.

5. Select calibration mode; then select "DO %".

6. Enter the local barometric pressure (usually in mm of mercury) for the sampling location into the instrument. This measurement must be determined from an on-site barometer. Do not use barometric pressure obtained from the local weather services unless the pressure is corrected for the elevation of the sampling location. [Note: inches of mercury times 25.4 mm/inch equals mm of mercury or consult Oxygen Solubility at Indicated Pressure, Table 2].

7. The instrument should indicate that the calibration is in progress. The instrument will take approximately one minute to calibrate. After calibration, the instrument should display percent saturated DO.

8. Select monitoring/run mode. Compare the DO mg/l reading to the Oxygen Solubility at Indicated Pressure chart (Table 2). The numbers should agree. If they do not agree to the accuracy of the instrument (usually ± 0.2 mg/L), repeat calibration. If this does not work, change the membrane and electrolyte solution. Insure that there are no air bubbles trapped below the membrane.

9. Remove the probe from the container and place it into a 0.0 mg/L DO standard. The standard must be filled to the top of its container and the DO probe must fit tightly into the standard's container (no head space). Check temperature readings. They must stabilize before continuing.

10. Wait until the "mg/l DO" readings have stabilized. The instrument should read 0.0 mg/L or to the accuracy of the instrument (usually ± 0.2 mg/L). If the instrument cannot reach these values, it will be necessary to clean the probe, and change the membrane and electrolyte solution. If this does not work, prepare a new 0.0 mg/L DO standard. If these measures do not work, contact manufacturer.

Note: To prepare a zero mg/L DO standard follow the procedure stated in Standard Methods (4500-O G; 18th edition). The method states to add excess sodium sulfite (until no more dissolves) and a trace amount of cobalt chloride to water. The standard container must be completely filled (no head space). This solution is prepared prior to the sampling event. If some of the solution is lost during instrument calibration, add more water to the container so that the standard is stored with no head space.

7.4 pH Meters

The pH of a sample is determined electrometrically using a glass electrode. There are a variety of instruments available to measure pH and temperature. There are pH test strips, indicator solutions, data loggers (e.g., Hydrolab minisonde) with pH sensors and hand-held DC powered pH meters. A pH meter must be calibrated/standardized daily prior to use (Standard Methods 4500-H^+ B; 18th Edition). If standardizing, select standard buffer solutions that bracket the pH range of the samples to be measured. The

acceptance criterion is ±0.1 su. If pH standards 2 and 10 are used, pH 7 should be used as a check. When calibrating (two point calibration), use fresh (unused) buffer standards. The temperature probes of pH meters (if there is a readout displayed) should be checked for accuracy (acceptance criterion (±0.5°C) at the same time as pH calibration/standardization because temperature adjustments are made by the meters program in calculating the pH value. Properly label and dispose of all waste chemicals and materials. Dispose of hazardous wastes according with the Hazard Waste Management Guidance Document.

Calibration Procedure

1. Allow the fresh buffered standards to equilibrate to the ambient temperature.

2. Fill calibration containers with the fresh buffered standards so each standard will cover the pH probe and temperature sensor.

3. Remove probe from its storage container, rinse with distilled water, and blot dry with soft tissue.

4. Select monitoring/run mode. Immerse probe into the initial standard (e.g., pH 7).

5. Stir the standard until the readings stabilize. If the reading does not change within 30 seconds, select calibration mode and then select "pH". Enter the buffered standard value into instrument. Select monitoring/run mode. The readings should remain within manufacturer's specifications; if they change, re-calibrate. If readings continue to change after re-calibration, consult manufacturer.

6. Remove probe from the initial standard, rinse with distilled water, and blot dry.

7. Immerse probe into the second standard (e.g., pH 4). Repeat step 5.

8. Remove probe from the second standard, rinse with distilled water, and blot dry. If instrument only accepts two standards, the calibration is complete. Go to step 11. Otherwise continue.

9. Immerse probe in third buffered standard (e.g., pH 10) and repeat step 5.

10. Remove probe from the third standard, rinse with distilled water, and blot dry.

11. Select monitoring/run mode, if not already selected. To ensure that the initial calibration standard (e.g., pH 7) has not changed; immerse the probe into the initial standard. Wait for the readings to stabilize. The reading should read the initial standard value within the manufacturer's specifications. If not, re-calibrate the instrument. If recalibration does not help, the calibration range may be too great. Reduce calibration range by using standards that are closer together.

12. The calibration is complete. Place pH probe in its storage container.

7.5 Flowmeters

Flowmeters (e.g., General Oceanics, Inc.) are used in the openings of plankton nets to estimate the volume of water passing through the net during sampling. These mechanical meters record the revolutions of the impellers; the revolutions per unit time are used to calculate flow through the net. Flowmeters must be standardized once every 52 weeks. The accuracy of these meters is based on how freely the impeller spins, which is verified using a General Oceanics, Inc. Calibration Frame. The frame imparts a torsionally precise spin to the rotor and a count difference is noted in the flowmeter window. A minimum count is necessary for the flowmeter to be within calibration. The acceptance criterion for a General Oceanics, Inc. flowmeter is 80 revolutions per standard spin.

7.6 Temperature

Temperature data are collected with data loggers, thermometers, and thermistors in a variety of multiparameter meters (e.g., pH, D.O., and Conductivity/Salinity). Each instrument must have the accuracy of its temperature component verified because many of the other parameters change with temperature. "Reference Thermometers" are glass, capillary thermometers that have a read out accuracy 0.1°C and they have their accuracy verified with a certified thermometer once every 52 weeks. The acceptance criterion for Reference Thermometers is ±0.2°C. All other capillary thermometers used in the collection of data are standardized to the Reference Thermometers every 52 weeks (the acceptance criterion is ±0.5°C). Data loggers are standardized every 26 weeks (the acceptance criterion is ±0.5°C). Thermistors in multimeters are standardized every 13 weeks (the acceptance criterion is ±0.5°C).

Verification Procedure

1. Allow a container filled with water to come to room temperature.

2. Place a thermometer that is traceable to the National Institute of Standards and Technology (NIST) and the instrument's temperature sensor into the water and wait for both temperature readings to stabilize.

3. Compare the two measurements. The instrument's temperature sensor must agree with the reference thermometer measurement within the accuracy of the sensor (usually ±0.15°C). If the measurements do not agree, the instrument may not be working properly and the manufacturer needs to be consulted.

7.7 Turbidity

Turbidity meters are standardized with primary standards once every 13 weeks and with secondary standards prior to use. The meters are zeroed with de-ionized water prior to standardization and use. Primary standards are made up from mixing a powder in de-ionized water (4 standards are measured: <1, 20, 100, & 800 NTU) and the acceptance criterion is ±5%. Secondary standards are gels in the range of 5, 50, 500

NTU and the acceptance criterion is ±10%. De-ionized water is measured three times prior to measuring the gel standards.

The turbidity is based upon a comparison of intensity of light scattered by a sample under defined conditions with the intensity of light scattered by a standard reference suspension. A turbidimeter is a nephelometer with a visible light source for illuminating the sample and one or more photo-electric detectors placed ninety degrees to the path of the light source. Some instruments will only accept one standard. For these instruments, the standards will serve as check points.

Calibration Procedures

1. Allow the calibration standards to equilibrate at the ambient temperature. The use of commercially available polymer primary standards (AMCO-AEPA-1) is preferred, however, the standards can be prepared using Formazin according to the EPA analytical Method 180.1.

2. If the standard cuvette is not sealed, rinse a cuvette with deionized water. Shake the cuvette to remove as much water as possible. Do not wipe dry the inside of the cuvette because lint from the wipe may remain in the cuvette. Add the standard to the cuvette.

3. Before performing the calibration procedure, make sure the cuvettes are not scratched and the outside surfaces are dry, free from fingerprints and dust. If the cuvette is scratched or dirty, discard or clean the cuvette respectively.

4. Zero the instrument by using either a zero or 0.02 NTU standard. A zero standard (approximately 0 NTU) can be prepared by passing distilled water through a 0.45 micron pore size membrane filter.

5. Using a standard in the range of 5 - 20 NTUs, calibrate according to manufacturer's instructions or verify calibration if instrument will not accept a second standard. If verifying, the instrument should read standard value to within the specifications of the instrument. If the instrument has range of scales, check each range that will be used during the sampling event with a standard that falls within that range.

7. Using a standard between 20 and 100 NTUs, calibrate according to manufacturer's instructions or verify calibration if instrument does not accept a third standard. If verifying, the instrument should read standard value to within the specifications of the instrument. If the instrument has range of scales, check each range that will be used with the proper standard for that scale.

7.8 Weight

Precision balances with an accuracy of 0.001 to 0.00001 grams are calibrated once every 52 weeks by a vendor. All scales and balances used for collecting environmental data are standardized with a minimum of three standard weights (Class 4 or better) every 4 weeks. Personnel using balances to collect weight data need to check the calibration sticker for the standardization expiration date and the range of the

standardization. If weight measurements are being made outside the documented standardization range, a new weight range bracketing the expected measurements needs to be used in standardizing the balance.

7.9 Oxidation/Reduction Potential (ORP)

The oxidation/reduction potential is the electrometric difference measured in a solution between an inert indicator electrode and a suitable reference electrode. The electrometric difference is measured in millivolts (mV) and is temperature dependent. ORP is calibrated using one-point calibration with a Zobell solution. The acceptance criteria for ORP standard potential should be within ±10 mV at a defined temperature.

Calibration Procedure

1. Allow the calibration standard (a Zobell solution) to equilibrate to ambient temperature.

2. Remove the probe from its storage container, and place it into the standard.

3. Select monitoring/run mode.

4. While stirring the standard, wait for the probe temperature to stabilize, and then read the temperature.

5. Look up the millivolt (mv) value at this temperature from the millivolt versus Temperature (Table 3) correction table usually found on the standard bottle or on the standard instruction sheet. You may need to interpolate millivolt value between temperatures. Select "calibration mode", then "ORP". Enter the temperature-corrected ORP value into the instrument.

6. Select monitoring/run mode. The readings should remain unchanged within manufacturer's specifications. If they change, re-calibrate. If readings continue to change after re-calibration, consult manufacturer.

7. If the instrument instruction manual states that the instrument is factory calibrated, then verify the factory calibration against the standard. If they do not agree within the specifications of the instrument, the instrument will need to be re-calibrated by the manufacturer.

8.0 Contacts

Name	Office	Cell
Karen Canody (Manager Biology)	804-273-3893 804-271-5304	804-627-3262
Casey Seelig (EB)	804-271-5312	804-385-6655
Raymond Heller (EB Millstone)	860-447-1791 ext. 5054	860-333-3832
Keith German (GES)	304-627-3947 ext. 4836	412-736-2983
Jim Levin (Cove Point)	410-286-5136	443-532-0912

9.0 Tables

Table 1. Calibration and Standardization Protocols

Parameter	Method	Interval	Standard	Acceptance Criterion	Calib./Stand. Method	Comments
Chlorine	Test Kit (gel standard)	Weekly	0.20 mg/L, 0.83 mg/L, 1.53 mg/L	±15%	Standardization	Zero meter to blank prior to measuring gel standards.
	Test Kit (ampule standard)	13 wks	Total Chlorine 0.12 (0.02 to 0.22) mg/L 0.60 (0.40 to 0.80) mg/L 1.20 (0.90 to 1.50) mg/L	±20%	Standardization	Record concentrations to 0.01 mg/L. Zero meter to blank prior to measuring standards.
Conductivity (specific conductance)	Instrument/Meter	13 wks	Freshwater 0.05-1.00 mS/cm	±5%	Standardization	If standard temperature is 25°C±1, standardize to specific conductance or conductivity.
			Seawater 40-60 mS/cm	±5%	Standardization	
	Reference Meter	4 wks	Freshwater 0.05-1.00 mS/cm	±5%	Standardization	
			Seawater 40-60 mS/cm	±5%	Standardization	

Parameter	Method	Interval	Standard	Acceptance Criterion	Calib./Stand. Method	Comments
Dissolved Oxygen	Reference/Instrument/Meter	4 wks	Azide – Winkler method using potassium iodide – iodate solution with an equivalent DO concentration of about 10 mg/L	±0.05 mg/L	Standardization	For dissolved oxygen, air calibrate prior to comparing to standard and record the temperature of standard.
	Optical DO Meter	4 wks	Azide – Winkler method using potassium iodide – iodate solution with an equivalent DO concentration of about 10 mg/L or Reference Meter	±0.05 mg/L	Standardization	
	Test Kit	52 wks	Azide – Winkler method using potassium iodide – iodate solution with an equivalent DO concentration of about 10 mg/L or Reference Meter	±0.05 mg/L	Standardization	
	Test Kit Instrument/Meter	Air calibrate prior to use	Azide – Winkler method using potassium iodide – iodate solution with an equivalent DO concentration of about 10 mg/L or Reference Meter	±0.05 mg/L	Standardization	
ORP	Instrument/Meter	Prior to use	Zobell's Solution	±10mV	Calibration	

Parameter	Method	Interval	Standard	Acceptance Criterion	Calib./Stand. Method	Comments
pH	AC Counter Top Units	Daily/Weekly	4.0, 7.0, and 10.0 Buffers	±0.1 su	Two Point Calibration or Standardization	Daily when meter is first turned on or weekly if meter remains on
	Battery Powered Portable Units	Day-of-Use	4.0, 7.0, and 10.0 Buffers	±0.1 su	Two Point Calibration or Standardization	Day-of-Use = 24 hour period following the last meter calibration or standardization
Flowmeter	Calibration Fame	52 wks	Standard spin	at least 80 revolutions	Standardization	General Oceanics Inc. Method
Salinity (specific conductance)	Visual Inspection	13 wks	Manufacturer's recommendations	Good condition	Equipment Check	Batteries are replaced every 13 weeks
	Reference Meter	4 wks	Freshwater 0.05-1.00 mS/cm	±5%	Standardization	If standard temperature is 25°C±1, standardize to specific conductance or conductivity.
	Instrument/Meter	13 wks	Seawater 40-60 mS/cm	±5%	Standardization	
	Instrument/Meter	13 wks	Freshwater 0.05-1.00 mS/cm	±5%	Standardization	
	Instrument/Meter	13 wks	Seawater 40-60 mS/cm	±5%	Standardization	

Parameter	Method	Interval	Standard	Acceptance Criterion	Calib./Stand. Method	Comments
Temperature	Reference Thermometer	52 wks	Certified Thermometer	±0.2°C	Three Temperatures to 0.1 °C accuracy	If deviation is greater than 0.1 °C, attach a tag with the correction factor to 0.1 °C or replace the thermometer
	Thermistor	13 wks	Reference Thermometer	±0.5°C	One temperature to 0.1 °C accuracy	
	Thermometer	52 wks	Reference Thermometer	±0.5°C	One temperature to 0.1 °C accuracy	For thermometers with 1 °C increments, record temperature to 0.2 °C and for thermometers with 0.1 °C increments to 0.1 °C
	Data Logger	26 wks	Reference Thermometer	±0.5°C	One temperature to 0.1 °C accuracy	
Turbidity	Primary Standard	13 wks	4 Standards (<1, 20, 100, & 800 NTU)	±5%	Standardization	Zero meter to de-ionized water.
	Secondary Standard	Prior to Use	Gel Standards (0-10, 10-100, 100-1000 NTU)	±10%	Standardization	Measure de-ionized water three times prior to measuring gel standards.
Weight	Balance	4 wks	Minimum of three reference weights	±5% Reference Weight	Standardization	Two weights should bracket the expected range for which the balance will be used and the third weight should be at an approximate mid-range.

Table 2. Oxygen Solubility (mg/L) at Indicated Pressure

	Atmospheric Pressure (mm Hg)						
Temp. °C	760	755	750	745	740	735	730
0	14.57	14.47	14.38	14.28	14.18	14.09	13.99
1	14.17	14.08	13.98	13.89	13.79	13.70	13.61
2	13.79	13.70	13.61	13.52	13.42	13.33	13.24
3	13.43	13.34	13.25	13.16	13.07	12.98	12.90
4	13.08	12.99	12.91	12.82	12.73	12.65	12.56
5	12.74	12.66	12.57	12.49	12.40	12.32	12.23
6	12.42	12.34	12.26	12.17	12.09	12.01	11.93
7	12.11	12.03	11.95	11.87	11.79	11.71	11.63
8	11.81	11.73	11.65	11.57	11.50	11.42	11.34
9	11.53	11.45	11.38	11.30	11.22	11.15	11.07
10	11.28	11.19	11.11	11.04	10.96	10.89	10.81
11	10.99	10.92	10.84	10.77	10.70	10.62	10.55
12	10.74	10.67	10.60	10.53	10.45	10.38	10.31
13	10.50	10.43	10.36	10.29	10.22	10.15	10.08
14	10.27	10.20	10.13	10.06	10.00	9.93	9.86
15	10.05	9.98	9.92	9.85	9.78	9.71	9.65
16	9.83	9.76	9.70	9.63	9.57	9.50	9.43
17	9.63	9.57	9.50	9.44	9.37	9.31	9.24
18	9.43	9.37	9.30	9.24	9.18	9.11	9.05
19	9.24	9.18	9.12	9.05	8.99	8.93	8.87
20	9.06	9.00	8.94	8.88	8.82	8.75	8.69
21	8.88	8.82	8.76	8.70	8.64	8.58	8.52
22	8.71	8.65	8.59	8.53	8.47	8.42	8.36
23	8.55	8.49	8.43	8.38	8.32	8.26	8.20
24	8.39	8.33	8.28	8.22	8.16	8.11	8.05
25	8.24	8.18	8.13	8.07	8.02	7.96	7.90
26	8.09	8.03	7.98	7.92	7.87	7.81	7.76
27	7.95	7.90	7.84	7.79	7.73	7.68	7.62
28	7.81	7.76	7.70	7.65	7.60	7.54	7.49
29	7.68	7.63	7.57	7.52	7.47	7.42	7.36
30	7.55	7.50	7.45	7.39	7.34	7.29	7.24
31	7.42	7.37	7.32	7.27	7.22	7.16	7.11
32	7.30	7.25	7.20	7.15	7.10	7.05	7.00
33	7.08	7.13	7.08	7.03	6.98	6.93	6.88

34	7.07	7.02	6.97	6.92	6.87	6.82	6.78
35	6.95	6.90	6.85	6.80	6.76	6.71	6.66
36	6.84	6.79	6.76	6.70	6.65	6.60	6.55
37	6.73	6.68	6.64	6.59	6.54	6.49	6.45
38	6.63	6.58	6.54	6.49	6.44	6.40	6.35
39	6.52	6.47	6.43	6.38	6.35	6.29	6.24
40	6.42	6.37	6.33	6.28	6.24	6.19	6.15
41	6.32	6.27	6.23	6.18	6.14	6.09	6.05
42	6.22	6.18	6.13	6.09	6.04	6.00	5.95
43	6.13	6.09	6.04	6.00	5.95	5.91	5.87
44	6.03	5.99	5.94	5.90	5.86	5.81	5.77
45	5.94	5.90	5.85	5.81	5.77	5.72	5.68

Table 2 (cont'd). Oxygen Solubility (mg/L) at Indicated Pressure

	Atmospheric Pressure (mm Hg)							
Temp. °C	725	720	715	710	705	700	695	690
0	13.89	13.80	13.70	13.61	13.51	13.41	13.32	13.22
1	13.51	13.42	13.33	13.23	13.14	13.04	12.95	12.86
2	13.15	13.06	12.07	12.88	12.79	12.69	12.60	12.51
3	12.81	12.72	12.63	12.54	12.45	12.36	12.27	12.18
4	12.47	12.39	12.30	12.21	12.13	12.04	11.95	11.87
5	12.15	12.06	11.98	11.89	11.81	11.73	11.64	11.56
6	11.84	11.73	11.68	11.60	11.51	11.43	11.35	11.27
7	11.55	11.47	11.39	11.31	11.22	11.14	11.06	10.98
8	11.26	11.18	11.10	11.02	10.95	10.87	10.79	10.71
9	10.99	10.92	10.84	10.76	10.69	10.61	10.53	10.46
10	10.74	10.66	10.59	10.51	10.44	10.36	10.29	10.21
11	10.48	10.40	10.33	10.28	10.18	10.11	10.04	9.96
12	10.24	10.17	10.10	10.02	9.95	9.88	9.81	9.46
13	10.01	9.94	9.87	9.80	9.73	9.66	9.59	9.52
14	9.79	9.72	9.65	9.68	9.51	9.45	9.38	9.31
15	9.58	9.51	9.44	9.58	9.31	9.24	9.18	9.11
16	9.37	9.30	9.24	9.17	9.11	9.04	8.97	8.91
17	9.18	9.11	9.05	8.98	8.92	8.85	8.79	8.73
18	8.99	8.92	8.86	8.80	8.73	8.67	8.61	8.54
19	8.81	8.74	8.68	8.62	8.56	8.49	8.43	8.37

20	8.63	8.57	8.51	8.45	8.39	8.33	8.27	8.21
21	8.46	8.40	8.34	8.28	8.22	8.16	8.10	8.04
22	8.30	8.24	8.18	8.12	8.06	8.00	7.95	7.89
23	8.15	8.09	8.03	7.97	7.91	7.86	7.80	7.74
24	7.99	7.94	7.88	7.82	7.76	7.71	7.65	7.59
25	7.85	7.79	7.74	7.68	7.60	7.57	7.51	7.46
26	7.70	7.65	7.59	7.54	7.48	7.43	7.37	7.32
27	7.57	7.52	7.46	7.41	7.35	7.30	7.25	7.19
28	7.44	7.38	7.33	7.28	7.22	7.17	7.12	7.06
29	7.31	7.26	7.21	7.15	7.10	7.05	7.00	6.94
30	7.19	7.14	7.08	7.03	6.98	6.93	6.88	6.82
31	7.06	7.01	6.96	6.91	6.86	6.81	6.76	6.70
32	6.95	6.90	6.85	6.80	6.70	6.70	6.64	6.59
33	6.83	6.78	6.73	6.68	6.83	6.58	6.53	6.48
34	6.73	6.68	6.63	6.58	6.53	6.48	6.43	6.38
35	6.61	6.56	6.51	6.47	6.42	6.37	6.36	6.27
36	6.51	6.46	6.41	6.36	6.31	6.27	6.22	6.17
37	6.40	6.35	6.31	6.26	6.21	6.16	6.12	6.07
38	6.30	6.26	6.21	6.16	6.12	6.07	6.02	5.98
39	6.26	6.15	6.11	6.06	6.01	5.97	5.92	5.87
40	6.10	6.06	6.01	5.96	5.92	5.86	5.83	5.78
41	6.00	5.96	5.91	5.87	5.82	5.78	5.73	5.69
42	5.91	5.86	5.82	5.77	5.73	5.69	5.64	5.60
43	5.82	5.78	5.73	5.69	5.65	5.60	5.56	5.51
44	5.72	5.68	5.64	5.59	5.55	5.51	5.46	5.42
45	5.64	5.59	5.55	5.51	5.47	5.42	5.38	5.34

Table 3. Temperature Dependency of Zobell's ORP Standard

Temp. °C	mV
10	243.5
15	236.0
20	228.5
25	221.1

11.0

Environmental Services
Pam Faggert

Electric Environmental Services
Cathy Taylor
Karen Canody
Don Hintz
Meredith Simas
Scott Lawton
Nicole Wilkinson
Ken Roller
Bill Scarpinato
Oula Shehab-Dandan
Liz Willoughby
Glenn Johnson
Rick Woolard
Manna Chan

Environmental Biology
Karen Canody
Don Landers
Sheila Hoffman
Paul Vidonic
Robert Andrews
Taylor Allen
Chris Taylor
Casey Seelig
Peter Sturke
Robert Graham
Glenn Bishop
Matt Overton
Greg Decker
James Foertch
John Swenarton
Joseph Vozarik
Raymond Heller
Stephen Dwyer
Susan Gonzalez

Environmental Laboratory
Herb Chriscoe

Gas Environmental Services
Mark Reaser
Sam Mathew
Sheri Franz
Tim Carter
Richard Gangle
Scott Kingston
Brad Will
Olive Dimon
Keith German
Troy Hawkins
Randy Rogers
Christopher Todd
Jim Levin
Roland Pratt
Jason Harshbarger
Judy Box
Mike Leger

Appendix C

Lists of Data to be Collected and Recorded for Field Collection and Laboratory Analysis

Minimum Entrainment Sample Collection Data

Category	Parameter	Value			
General Information	Crew Names				
	Date				
	Time (military)				
	Tidal Phase				
Weather Condition	Air Temp. (^{o}C)				
	Wind Direction				
	Wind Speed (MPH)				
	Sky				
	Precipitation (in)				
	Wave Height (ft)				
Facility Operation	Circulating Pump Status				
	Service Pump Status				
	Screen Status				
	Screen Wash Status				
Sampling Location	Unit/Bar Rack	Unit #	Bar Rack ID		
	Time (military)	Start	End		
	Duration (min.)	Calculated			
Flow meter Readings	Time (military)	Meter	Start	End	
	Flow (m^3)	Meter	Start	End	
	Total Volume (m^3)	Calculated			
Water Quality	Time (military)				
	Depth (ft)	Reading	Surface	Mid	Bottom
	Temp. (^{o}C)	Meter	Surface	Mid	Bottom
	DO (mg/L)	Meter	Surface	Mid	Bottom
	Specific Cond. (µs)	Meter	Surface	Mid	Bottom
	Specific Cond. @ 25 ^{o}C (µs)	Calculated			
	Salinity (ppt)	Calculated	Surface	Mid	Bottom
	pH	Meter	Surface	Mid	Bottom
Water Quality QC	Temp. (^{o}C)	Bottle			
	DO (mg/L)	Bottle			
	Specific Cond. (µs)	Bottle			
	pH	Bottle			
Gear Used	Mesh size (µm)				
	Dimension				
	Configuration				
Sample Collection	IP Sample Bottle #	Label	Surface	Mid	Bottom
Observations	Vegetation	Note	Light	Moderate	Heavy
	Invertebrates	Note	Light	Moderate	Heavy
	Vertebrates	Note	Light	Moderate	Heavy
Comments					
Crew Signature					

Minimum Entrainment Sample Laboratory Data Sheet

Category	Parameter	Value					
Enumeration	Date/Time						
	Sample ID						
	Species Taxon Name						
	Egg	Split Fraction	Count	Egg			
	Larvae	Split Fraction	Count	UID	YS	PYS	JUV
	Total Larvae		Count				
	Total Shellfish		Count				
	Comments						
Morphometrics	Date/Time						
	Sample Number						
	Species Taxon Name						
	Lifestage						
	Total Length / Notochord Length (mm)						
	Body Depth / Width (mm)						
	Head Capsule Depth / Width (mm)						
	Greatest Soft Tissue Body Depth / Width (mm)						
	Diameter, Max and Min (eggs only; mm)						
	Greatest Body Length, Width & Depth (Blue Crab only for each life stage; mm)						
	Maximum Widths and Depths based on carapace (Megalopa and later life stage only; mm)						
	Comments						

Note: UID = Unidentified; YS = Yolk Sac; PYS = Post Yolk Sac; JUV = Juvenile

DRAFT Impingement Characterization Study Plan

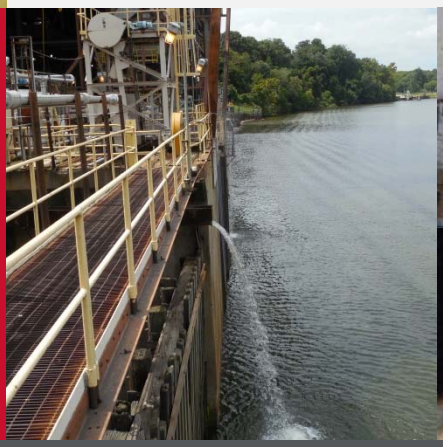
Prepared for:
Dominion Resources Services, Inc.

Prepared by:
HDR Engineering, Inc.

April 10, 2015

Chesterfield Power Station

Chester, VA 23836



Contents

1 Introduction 1
1.1 Regulatory Background 1
1.2 Study Plan Objectives and Document Organization 3
2 Generating Station Description 3
2.1 Site and Environmental Description 3
2.2 Station Description 10
2.2.1 Station Operational History 10
2.2.2 Intake Structure 10
3 Historical Studies 14
3.1 Impingement Studies 14
3.1.1 Impingement Study, 2005 – 2006 14
3.1.2 Impingement Study, 1977 18
3.2 James River Studies 18
3.2.1 Electrofishing and Gill Net Sampling, 2005 – 2006 18
3.2.2 Electrofishing and Gillnet Sampling, 1997 – 1999 21
4 Threatened and Endangered Species 24
5 Basis for Sampling Design 31
6 Impingement Characterization Study Plan 33
6.1 Introduction 33
6.2 Safety Policy 33
6.3 Field Collection Procedures 33
6.3.1 Location 35
6.3.2 Equipment 35
6.3.3 Sampling Schedule 38
6.3.4 Water Quality Measurements 38
6.4 Collection Processing 38
6.4.1 Initial Impingement Survival 39
6.4.2 Morphometrics 39
6.4.3 Debris Load Characterization 39
6.4.4 Handling Procedures for Atlantic Sturgeon 40
7 References 43

Appendices

Appendix A. Atlantic Sturgeon Life History Information
Appendix B. Field Instrumentation: Calibrations and Standardizations
Appendix C. Lists of Data to be Collected and Recorded for Field Collection and Processing

Tables

Table 1-1. §316(b) Rule for Existing Facilities Submittal Requirements Summary 2

Table 3-1. Impingement Sampling Details, 2005 – 2006 14

Table 3-2. Ranked Abundance and Percent Composition of Fish and Shellfish Impinged at CPS, 2005 – 2006 15

Table 3-3. Monthly Impingement Catch at CPS, 2005 – 2006 16

Table 3-4. Number of Impinged Fish and Shellfish Collected During Daylight and Nighttime Hours at CPS, 2005 – 2006 17

Table 3-5. Summary Results of Quarterly Ambient Juvenile and Adult Fish Sampling in the Vicinity of Chesterfield Power Station, 2005 – 2006 20

Table 3-6. Electrofishing and Gill Net Stations in the James River in the Vicinity of CPS Shown on Figure 3-2 below 21

Table 3-7. Frequency of Occurrence and Total Number of Fish and Shellfish Collected by Electrofishing During the Chesterfield 316(a) Demonstration 23

Table 3-8. Frequency of Occurrence and Total Number of Fish and Shellfish Collected by Gillnetting During the Chesterfield 316(a) Demonstration 24

Table 4-1. Federal and State Threatened, Endangered, and Proposed Species with the Potential to Occur within 2 miles of the Cooling Water Intake of CPS 26

Table 5-1. Summary of Approach for Development of §122.21(r) Required Impingement Characterizations 32

Figures

Figure 2-1. Chesterfield Power Station Regional Location Map 4

Figure 2-2. Chesterfield Power Station Area Map 5

Figure 2-3. The James River Watershed 6

Figure 2-4. Aerial View of Chesterfield Power Station with Cooling Water Intake Location 7

Figure 2-5. General Water Depths in James River near Chesterfield Power Station (Soundings in Feet at Mean Lower Low Water) 8

Figure 2-6. Survey of James River Depths in Vicinity of Chesterfield Power Station CWISs 9

Figure 2-7. Chesterfield Power Station CWIS Configuration 11

Figure 2-8. Typical Plan View of Chesterfield Power Station CWIS 12

Figure 2-9. Typical Section View of Chesterfield Power Station CWIS 13

Figure 3-1. Map Depicting the Study Area and Sampling Stations for 316(b) Studies Conducted June 2005 – May 2006 19

Figure 3-2. Map Depicting the Study Area and Sampling Stations for 316(a) Studies Conducted April 1997 – February 1999 22

Figure 6-1. Impingement Sampling Locations 36

1 Introduction

1.1 Regulatory Background

Clean Water Act §316(b) was enacted under the 1972 Clean Water Act, which also introduced the National Pollutant Discharge Elimination System (NPDES) permit program. Facilities with NPDES permits are subject to §316(b), which requires that the location, design, construction and capacity of cooling water intake structures (CWIS) reflect best technology available (BTA) for minimizing adverse environmental impacts. Cooling water intakes can cause adverse environmental impacts by drawing early life-stage fish and shellfish into and through cooling water systems (entrainment), or trapping juvenile or adult fish against the screens at the opening of an intake structure (impingement).

On August 15, 2014, the final §316(b) rule for existing facilities was published in the Federal Register. The rule applies to existing facilities that withdraw more than 2 million gallons per day (MGD) from Waters of the United States, use at least 25 percent of that water exclusively for cooling purposes, and have or require an NPDES permit. The rule supersedes the Phase II rule, which regulated large electrical generating facilities until it was remanded in 2007, and the remanded existing-facility portion of the previously promulgated Phase III rule.

Facilities subject to the new rule are required to develop and submit technical material, identified at §122.21(r)(2)-(13), that will be used by the NPDES Director (Director) to make a BTA determination for the facility (Table 1-1). The specific material required to be submitted and compliance schedule are dependent on actual intake flow rates at the facility and NPDES permit renewal date, respectively. Facilities are to submit their §316(b) application material to their Director along with their next permit renewal, unless that permit renewal takes place prior to July 14, 2018, in which case an alternate schedule may be negotiated.

Dominion's Chesterfield Power Station (CPS) is subject to the existing facility rule and based on its current configuration and operation is anticipated to be required to develop and submit each of the §122.21(r)(2)-(13) submittal requirements with its next permit renewal in accordance with the rule's technical and schedule requirements. Within the §122.21(r)(2)-(13) requirements, (r)(4) and (6) have specific requirements related to impingement evaluations (refer to Table 1-1 for details). While these requirements do not specify that an Impingement Characterization Study must be conducted, Dominion has determined that one is warranted based on the following anticipated benefits:

- Ability to document current impingement at CPS where recent impingement data is not available to support development of 122.21(r)(4) and potentially (r)(6) submittal requirements; and
- Understanding the nature of current impingement at CPS to evaluate potential effectiveness of alternative technologies and determination of fragile species composition.

Table 1-1. §316(b) Rule for Existing Facilities Submittal Requirements Summary

Submittal Requirements at §122.21(r)		Submittal Descriptions
(2)	Source Water Physical Data	Characterization of the source water body including intake area of influence
(3)	Cooling Water Intake Structure Data	Characterization of cooling water system; includes drawings and narrative; description of operation; water balance
(4)	Source Water Baseline Biological Characterization data	Characterization of biological community in the vicinity of the intake; life history summaries; susceptibility to impingement and entrainment; must include existing data; identification of missing data; threatened and endangered species and designated critical habitat summary for action area; identifies fragile fish and shellfish species list (<30 percent impingement survival)
(5)	Cooling Water System Data	Narrative description of cooling water system and intake structure; proportion of design flow used; water reuse summary; proportion of source water body withdrawn (monthly); seasonal operation summary; existing impingement mortality and entrainment reduction measures; flow/MW efficiency
(6)	Chosen Method of Compliance with Impingement Mortality Standard	Provides facility's proposed approach to meet the impingement mortality requirement (chosen from seven available options); provides detailed study plan for monitoring compliance, if required by selected compliance option; addresses entrapment where required
(7)	Entrainment Performance studies	Provides summary of relevant entrainment studies (latent mortality, technology efficacy); can be from the facility or elsewhere with justification; studies should not be more than 10 years old without justification; new studies are not required.
(8)	Operational Status	Provides operational status for each unit; age and capacity utilizations for the past five years; upgrades within last 15 years; uprates and Nuclear Regulatory Committee relicensing status for nuclear facilities; decommissioning and replacement plans; current and future operation as it relates to actual and design intake flow
(9)	Entrainment Characterization Study	Requires at least two years of data to sufficiently characterize annual, seasonal, and diel variations in entrainment, including variations related to climate, weather, spawning, feeding, and water column migration; facilities may use historical data that are representative of current operation of the facility and conditions at the site with documentation regarding the continued relevance of the data to document total entrainment and entrainment mortality; includes identifications to the lowest taxon possible; data must be representative of each intake; must document how the location of the intake in the water body and water column are accounted for; must document intake flows associated with the data collection; documentation in the study must include the method in which latent mortality would be identified (including QAQC); sampling and data must be appropriate for a quantitative survey
(10)	Comprehensive Technical Feasibility & Cost Evaluation Study	Provides an evaluation of technical feasibility and incremental costs of entrainment technologies; Net Present Value of facility compliance costs and social costs to be provided; requires peer review
(11)	Benefits Valuation Study	Provides a discussion of monetized and non-monetized water quality benefits of candidate entrainment technologies from (r)(10) using data in (r)(9); benefits to be quantified physical or biological units and monetized using appropriate economic valuation methods; includes changes in fish stock and harvest levels and description of monetization; must evaluate thermal discharges, facility capacity, operations, and reliability; discussion of previous mitigation efforts and affects; benefits to environment and community; social benefits analysis based on principle of willingness-to-pay; requires peer review
(12)	Non-Water Quality Environmental and Other Impacts Assessment	Provides a discussion of non-water quality factors (air emissions and their health and environmental impacts, energy penalty, thermal discharge, noise, safety, grid reliability, consumptive water use, etc.) attributable to the entrainment technologies; requires peer review
(13)	Peer Review	Documentation of external peer review, by qualified experts, of submittals (r) (10), (11), and (12). Peer Reviews must be approved by the NPDES Director and present their credentials. The applicant must explain why it disregarded any significant peer reviewer recommendations.

1.2 Study Plan Objectives and Document Organization

The Impingement Characterization Study Plan provided in this report was developed to support the CPS §316(b) compliance project through development of a site-specific impingement study plan with the following key objectives in mind:

1. Collect data to support development of §122.21(r)(4) which requires a listing of species and life stages most susceptible to impingement at the facility including documentation of fragile fish and shellfish species (those with < 30% impingement survival);

2. Collect data to support Dominion's objective of having data sufficient to evaluate biological efficacy of potential alternative intake technologies.

To meet these objectives, this document provides summaries of the station's configuration and operations (Section 2), historical biological sampling efforts conducted at the facility that are relevant to cooling water intake evaluations (Section 3), a summary of Threatened and Endangered Species identified in the vicinity of the facility (Section 4), a sampling program design justification based on this information (Section 5), and the recommended study methods including key parameters of gear, schedule, frequency, and quality control procedures (Section 6).

2 Generating Station Description

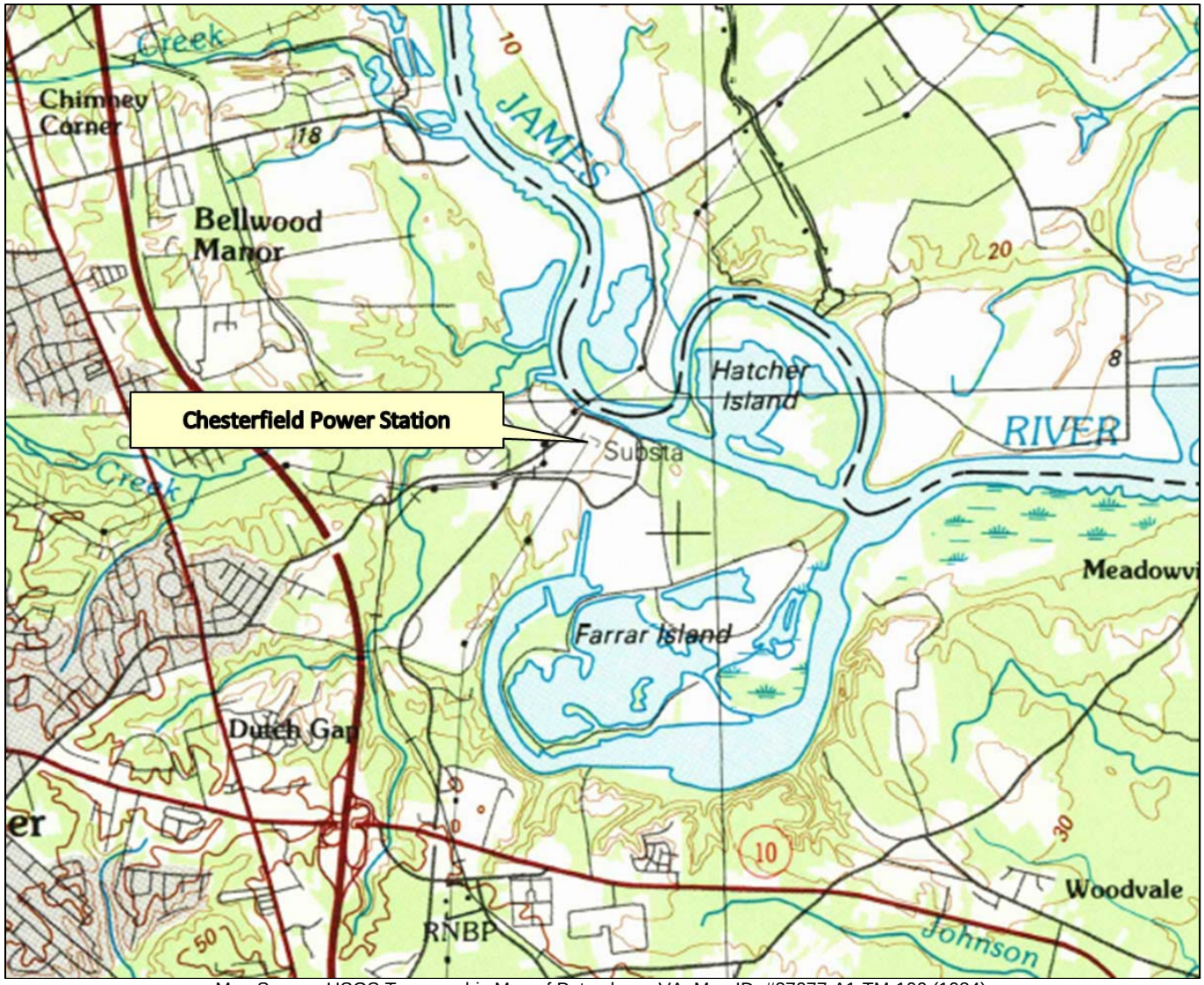
2.1 Site and Environmental Description

Chesterfield Power Station (CPS) is located in the upper tidal portion of the James River, approximately 13 miles downstream of the fall line in the City of Richmond (Figure 2-1). The CPS is located in the Lower James River section in the Coastal Uplands Physiographic Province. In the area of the Station, the James River begins the transition from a higher gradient straight channel with generally steep banks to a meandering channel with oxbow features. The CPS is located near Hatcher Island and Farrar Gut which are two of the first oxbows in the river (Figure 2-2). The river is channelized and is dredged to maintain passage for barge and vessel travel to the Port of Richmond.

The James River watershed encompasses approximately 10,000 square miles, which makes up almost 25 percent of the state. The James River watershed covers about one-third of the Chesapeake Bay drainage area in Virginia. The river flows approximately 340 miles from the Alleghany Mountains of western Virginia to the Chesapeake Bay. The watershed is comprised of three sections: the Upper James watershed begins in Allegheny County and travels through the Allegheny and Blue Ridge Mountains until Lynchburg, the Middle James watershed runs from Lynchburg to Richmond, while the Lower James watershed stretches from Richmond to the Chesapeake Bay (Figure 2-3).

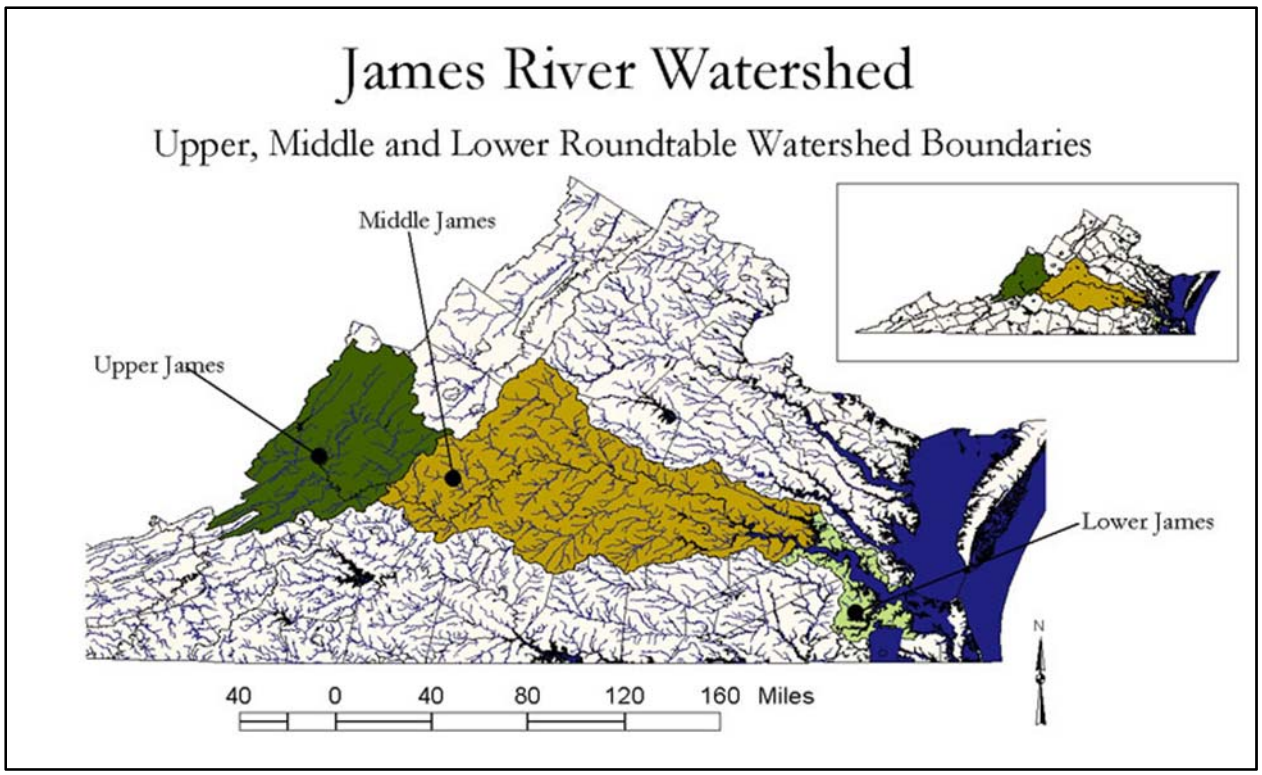
Map Source: USGS Topographic Map of Petersburg, VA; Map ID #37077-A1-TM-100 (1984)

Figure 2-1. Chesterfield Power Station Regional Location Map



Map Source: USGS Topographic Map of Petersburg, VA; Map ID #37077-A1-TM-100 (1984)

Figure 2-2. Chesterfield Power Station Area Map



Source: Middle James Roundtable

Figure 2-3. The James River Watershed

The six power-generating units at CPS use a once-through cooling water system. Cooling water is withdrawn from the James River through five submerged Cooling Water Intake Structures (CWISs) oriented parallel to, and flush with, the south shoreline of the river (Figure 2-4).

The CWISs for the six units are located on the south side of the river on a bluff. The intakes are located immediately downstream from the Chesterfield County's Proctors Creek Wastewater Treatment Plant. In the vicinity of the CWIS, the river has an abbreviated littoral or shoreline zone as a result of steep bank elevations and the channelized river bottom. At the station, the river is approximately 410 feet (ft) wide and flows in a generally southeasterly direction. Water depths in front of the intakes range from 29 ft to 33 ft with a normal depth of approximately 31 ft.

General river depths in the region of the Station are provided in the navigational chart provided in Figure 2-5. Surveyed river bottom depths are provided in the topographical survey provided in Figure 2-6.

The James River at the station experiences a mean tidal amplitude of approximately 2.0 ft. The water level in this portion of the James River fluctuates greatly with an extreme high of elevation 19.0 ft and an extreme low of elevation -3.5 ft. The mean high and low water differ by 5.2 ft; the mean high water is at grade elevation (El.) 3.5 ft and the mean low water is at El. -1.7 ft. Maximum tidal current is approximately 2.8 ft/s with average maximum ebb and flood tidal currents of 1.34 ft/s and 1.5 ft/s, respectively. The James River in the vicinity of the station is a temperate zone river with average temperatures generally ranging from 0.0 ^{o}C in February to 34 ^{o}C in August.

Image Source: Google Earth, 10/21/2012, Retrieved 9/25/2012

Figure 2-4. Aerial View of Chesterfield Power Station with Cooling Water Intake Location

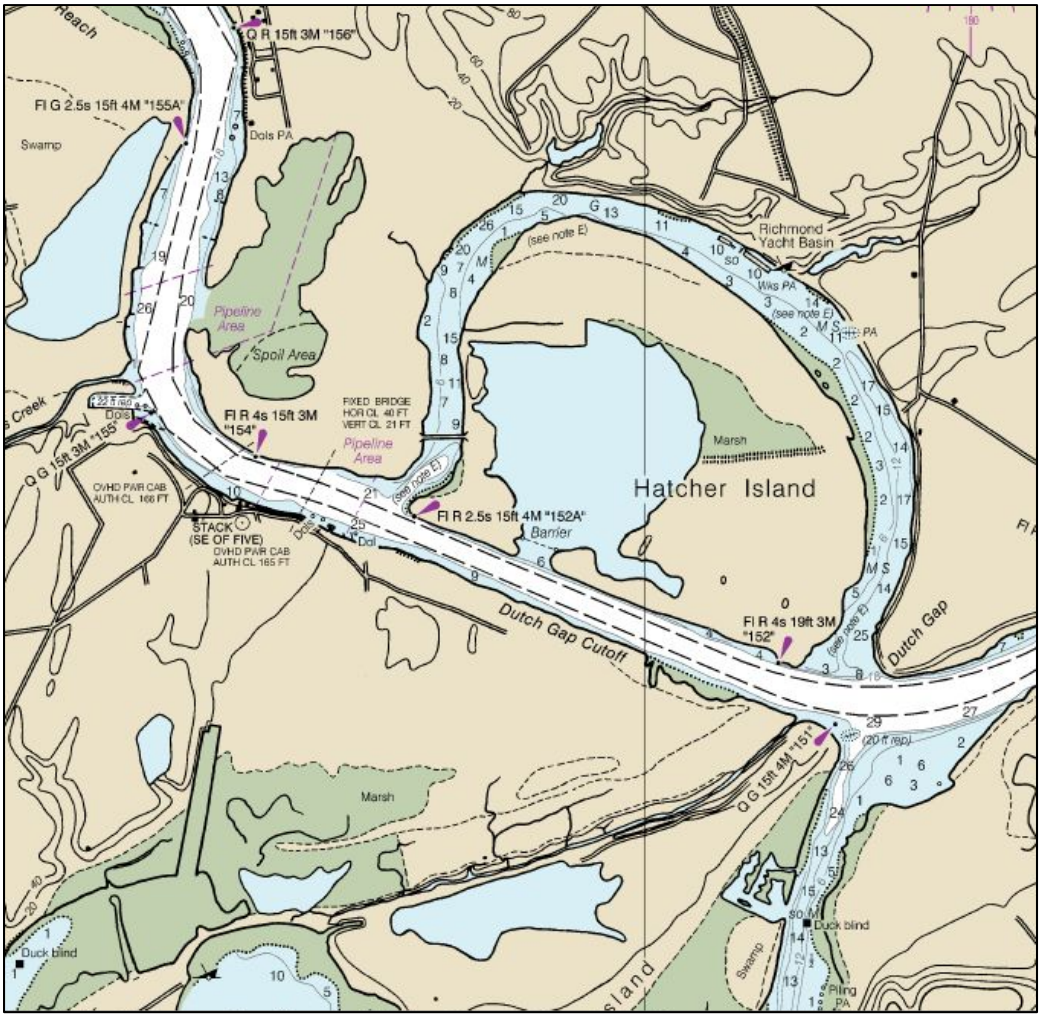


Image Source: NOAA Office of Coast Survey Chart 12252, January 2013, Retrieved 9/25/2014

Figure 2-5. General Water Depths in James River near Chesterfield Power Station (Soundings in Feet at Mean Lower Low Water)

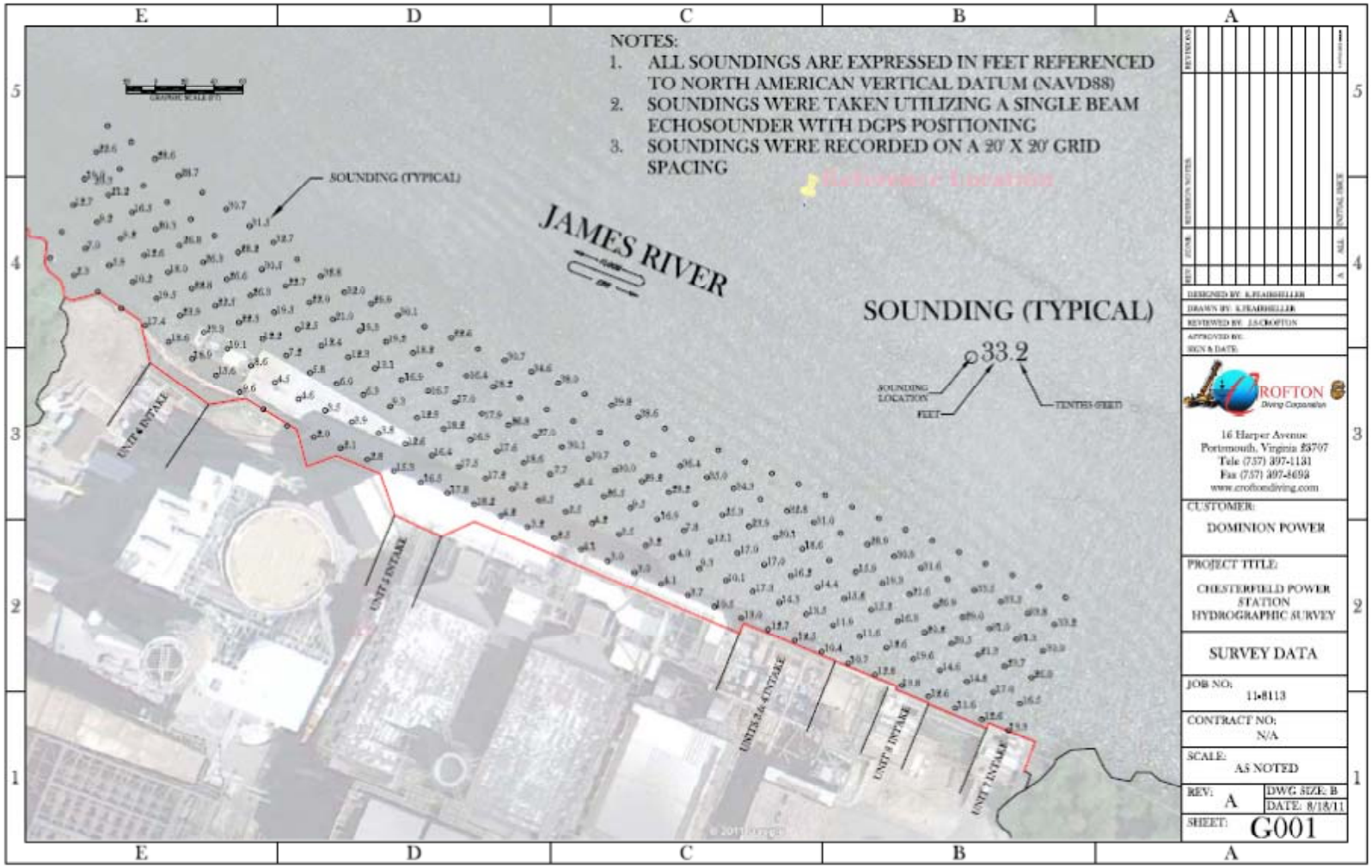


Figure 2-6. Survey of James River Depths in Vicinity of Chesterfield Power Station CWISs

2.2 Station Description

2.2.1 Station Operational History

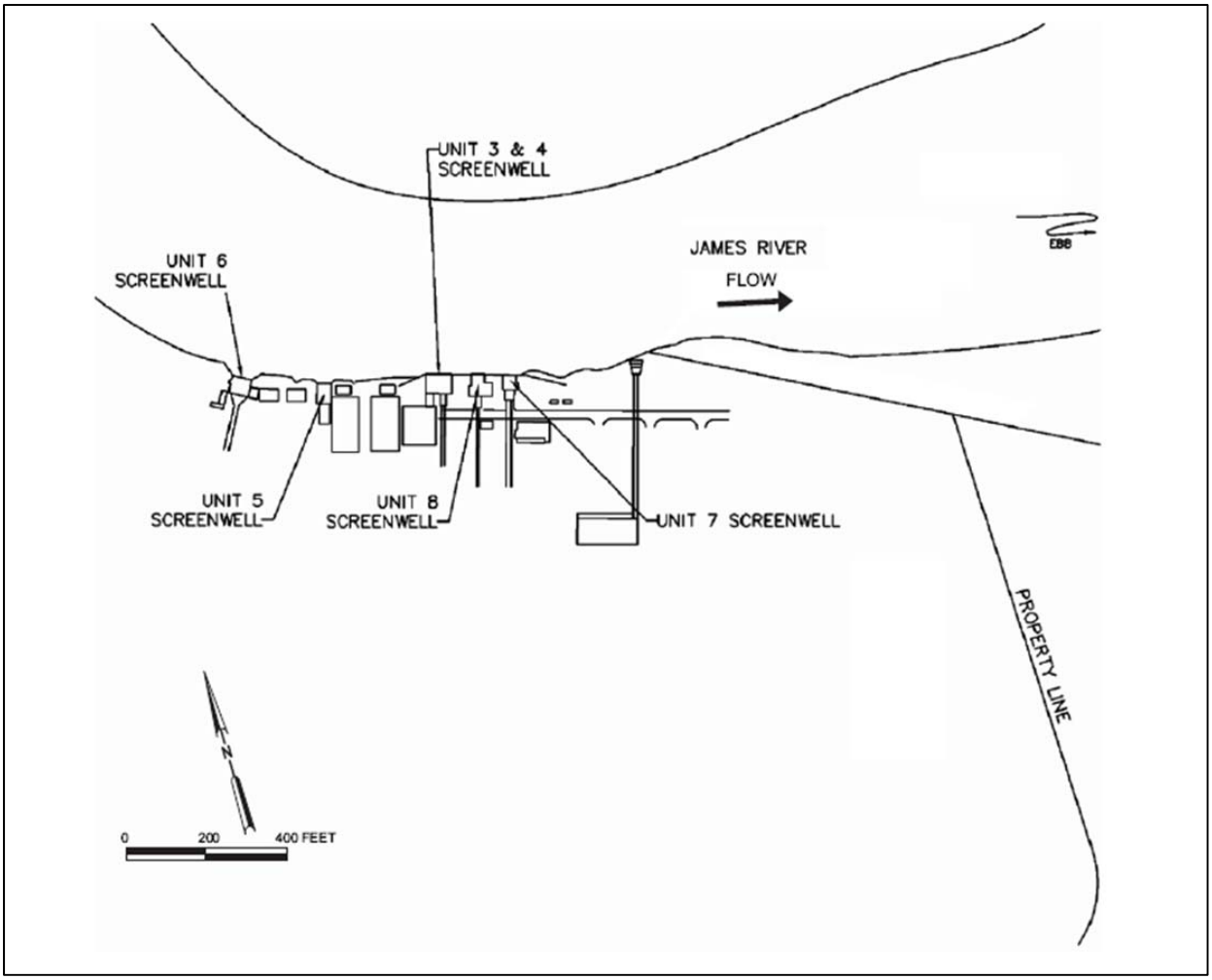
CPS contains six power-generating units: Units 3, 4, 5, and 6 are coal-fired units while Units 7 and 8 are combined-cycle units. The station is a base-load facility which means the facility serves as one of Dominion's primary means of generating the minimum amount of power necessary to meet customer demands. Accordingly, the facility generally operates on a twenty-four hour per day, seven days per week basis, although there is seasonal variation in its operations and maintenance (O&M). In the summer months, all pumps are in operation to meet thermal transfer requirements. There are times in the winter months when all of the pumps are in operation, usually in January and February, which is the winter peaking season. Major outages on the generating units are scheduled for the spring and fall months after the end of the winter peaking season. The duration of the maintenance outages depends on the scheduled work that needs to be done on the units.

2.2.2 Intake Structure

The six power-generating units at CPS utilize a once-through cooling water system that withdraws cooling water from the tidal portion of the James River through five CWISs. When the facility is generating power, the circulating cooling water system is in operation. All the CWISs are submerged and flush with and parallel to the south shoreline. See Figure 2-7 for the unit configuration layout. The total design flow at CPS with all pumps working to capacity is approximately 1,058 million gallons per day (MGD). Over 98 percent of the water withdrawn from the James River is used for cooling water purposes.

The James River in the vicinity of CPS CWISs is approximately 410 ft wide and 31 ft deep and flows in a generally southeasterly direction. The intake structures are designed to operate at river levels ranging from 3.5 ft below mean sea level (MSL) to 19.0 ft above MSL. The mean high and low water differ by approximately 5.2 ft with the mean high water at 3.5 ft above MSL while the mean low water is 1.7 ft below MSL. All elevations in this report refer to MSL.

Upon approach, the river water encounters a curtain wall that extends beyond the low water level. The curtain walls for Units 3, 4, 7, and 8 extend to 4.5 ft below MSL while the curtain wall for Units 5 and 6 drops down to approximately 4.0 ft below MSL. Each CWIS has trash racks which are installed across the intake structures upstream of the screen bays. Trash racks extend across the entire length of each intake structure (i.e. from the intake structure invert to the intake deck) and prevent debris from entering the screen houses. The trash racks for Units 3 and 4 are approximately 14.5 ft tall by 9.9 ft wide with 0.375-inch (in.) bars on 4.0-in. centers. The Unit 5 trash rack is approximately 16.5 ft tall by 12.5 ft wide with 0.375-in. bars on 4.5-in. centers. The Unit 6 trash rack is approximately 19.0 ft high by 15.0 ft wide with 0.375-in. bars on 4.0-in. centers. Units 7 and 8 have trash racks that are approximately 14.5 ft high by 11.0 ft wide with 0.375-in. bars on 3.0-in. centers.



Source: CH2M HILL (2007)

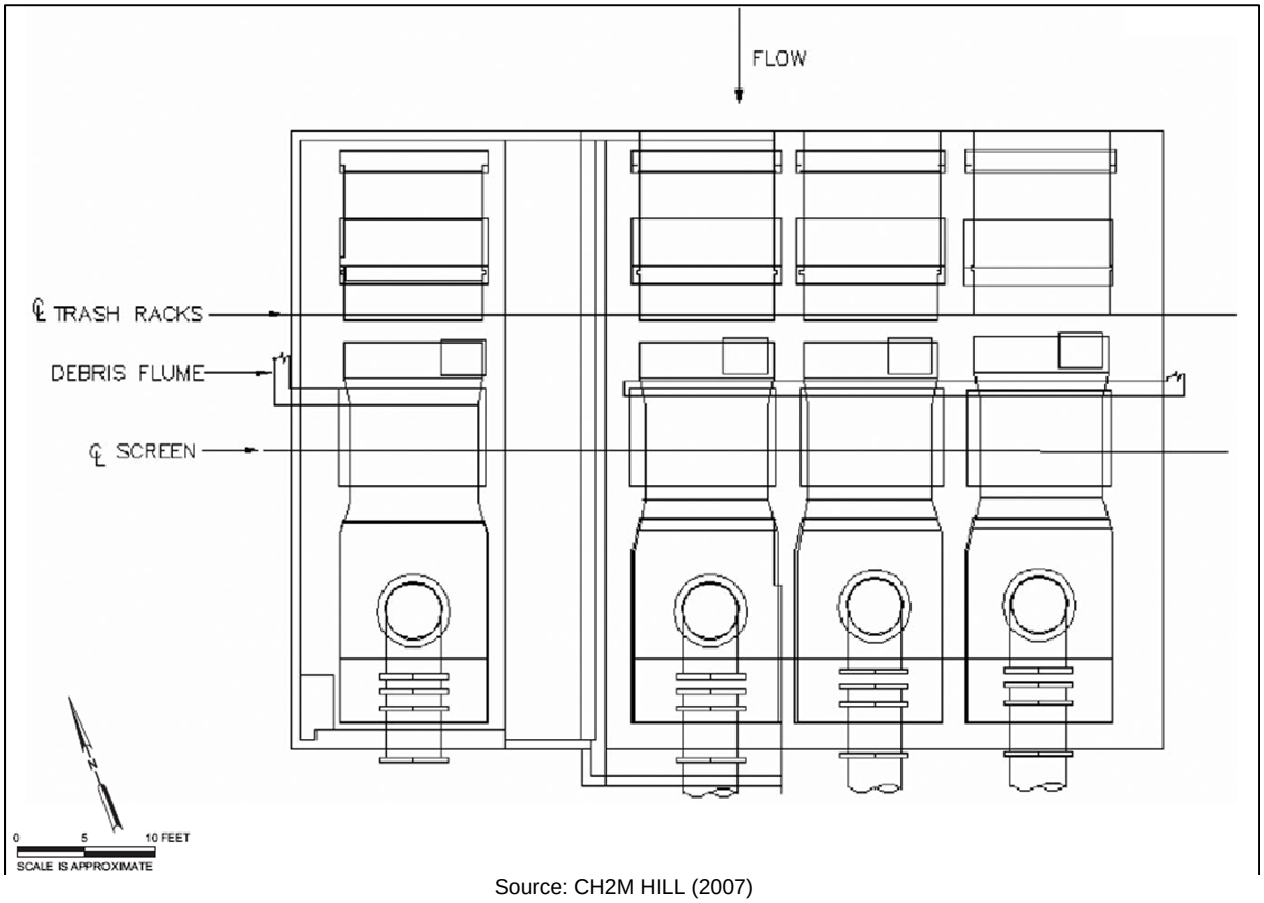
Figure 2-7. Chesterfield Power Station CWIS Configuration

The traveling water screens are located between 10 and 20 ft downstream of the trash racks. Each of the power-generating units contains two traveling water screens except Unit 6, which has three traveling water screens, for a total of 13 traveling water screens. Units 3, 4, 7, and 8 have 8-foot-wide screens, and Units 5 and 6 have 10-foot-wide screens, all with standard 3/8-in. mesh. Each of the vertical traveling screens is designed for continuous operation. Units 4, 5, and 6 rotate at a single speed of approximately 10 ft per minute (ft/min), while Unit 3 can rotate at 3 ft/min or 10 ft/min in automatic mode. Units 7 and 8 can rotate at either approximately 5 ft/min or 10 ft/min depending on loading. During normal operation, the screens are generally manually controlled for all units.

The screens have front spray wash systems and the debris collection trough located on the upstream side of the screens. Screen wash pumps for Units 7 and 8 draw water from the pump house. Units 3 through 6 do not have operating screen wash pumps, and the wash water for these screens is fed from the ash sluice water system from each unit. As the intake screens rotate, debris impinged on the screens is drawn upward and washed off by a wash water spray into a water-filled wash water trough. This water-filled trough conveys organisms and debris

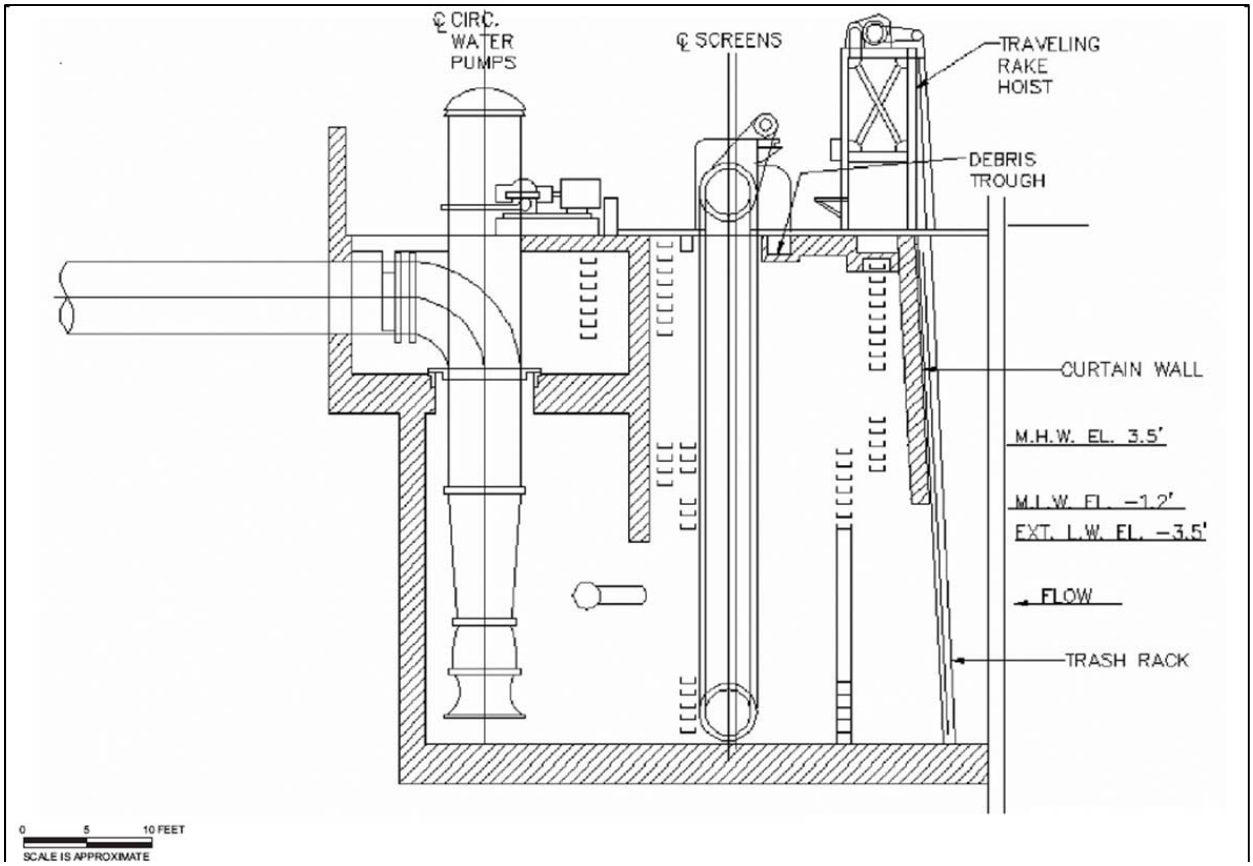
back into the James River. These discharges are permitted in the Virginia Discharge Elimination System (VPDES) Permit (VA0004146).

Screened cooling water is conveyed to the circulating water pumps, located at 12 to 18 ft downstream of the traveling water screens, through individual bays. Each unit has a separate circulating water system comprised of two or three vertical shaft, wet-pit, circulating cooling water pumps, two each for Units 3, 4, 5, 7, and 8 and three for Unit 6. The circulating pumps are located in the respective Unit's pump house. Upon exiting the circulating cooling water system, the water is returned to the James River via one of three cooling water discharge points: one for Unit 3, one for Units 7 and 8, and one for Units 4, 5, and 6. The discharge for Units 3, 7, and 8 discharge directly into the James River, approximately 100 ft downstream from the CWIS (via outfalls 001 and 002). Units 4, 5, and 6 discharge into a discharge canal and then into Farrar Gut, an oxbow that flows into the James River approximately 1.2 miles downstream from the intake structures (via outfall 003). A satellite image of the outfall configuration is provided previously in Figure 2-4. Plan and section drawings of typical portions of the CPS CWIS are provided in Figures 2-8 and 2-9, respectively.



Source: CH2M HILL (2007)

Figure 2-8. Typical Plan View of Chesterfield Power Station CWIS



Source: CH2M HILL (2007)

Figure 2-9. Typical Section View of Chesterfield Power Station CWIS

3 Historical Studies

Past fisheries studies conducted at CPS which are pertinent to §316(b) include the following:

- June 2005 – May 2006 Impingement and Entrainment Study (EA 2006)
- June 2005 – May 2006 Ambient Adult and Juvenile Finfish Sampled by Electrofishing and Gillnets; Ambient Ichthyoplankton Sampling by Towed Plankton Net (EA 2006)
- April 1997 – February 1999 Adult and Juvenile Finfish Sampled by Electrofishing and Gillnets (VEPCO 2000)
- January – December 1977 Impingement and Entrainment Studies (VEPCO 1977)

For the purposes of development of this study plan, the June 2005 – May 2006 and 1977 impingement studies (EA 2006 and VEPCO 1977, respectively), and June 2005 – May 2006 and April 1997 – February 1999 adult and juvenile fish sampling (EA 2006 and VEPCO 2000, respectively) are summarized below.

3.1 Impingement Studies

3.1.1 Impingement Study, 2005 – 2006

Results of this study, conducted June 2005 to May 2006, were used to identify the species and life stages that would be most susceptible to impingement. This generally includes adult and older juvenile life stages of fish and shellfish. This study addressed species comprising the forage base, as well as those most important in terms of significance to commercial and recreational fisheries. Details of the 2005 – 2006 impingement sampling program (EA 2006) are presented in Table 3-1.

Table 3-1. Impingement Sampling Details, 2005 – 2006

Impingement	Details
Units Sampled	Units 3, 4, 5, 6, 7 and 8
Sampling Location	Downstream of each unit (Unit 3, 4, 5, 6, 7 and 8)
Surveys from June 2005 to May 2006	Twice a month
Sampling Frequency	16, 10-minute screen-wash samples collected at 0800,0900, 1200, 1300, 1400, 1500, 1800, 1900, 2000, 2100, 2400, 0100, 0200, 0300, 0600 and 0700 hours
Sampling Method and Gear	Samples collected in five baskets consisting of 3/8-in. mesh and one dip net
Sample Duration	A single unit of effort was obtained by diverting the screen wash water from the trough into the basket for a 10-minute period.
Water Quality Measurements	Water temperature was measured with YSI Model 556 water quality analyzer in the screen-wash troughs for each of 16 hourly impingement samples

A total of 22 species of finfish and two species of shellfish were collected in impingement samples collected at CPS (Table 3-2). Blue Crab was the most abundant organism (62 individuals) and Blue Catfish (20 individuals) was the most abundant finfish collected. Most of the fish impinged were juvenile fish. Seven taxa individually accounted for 5 percent or more of the annual catch, and collectively nearly 70 percent of the total catch. The estimated annual impingement at maximum flow was calculated to be 11,383 fish and shellfish. Blue Crab were most abundant overall (6,312 individuals); most abundant finfish were Blue Catfish (2,977 individuals).

Table 3-2. Ranked Abundance and Percent Composition of Fish and Shellfish Impinged at CPS, 2005 – 2006

Species	Number	Percent	Weight (gm)	Percent
Blue Crab	62	28.6	4158.4	65.3
Blue Catfish	29	13.4	1176.0	18.5
Blueback Herring	22	10.1	54.1	0.8
Channel Catfish	18	8.3	229.0	3.6
Black Crappie	17	7.8	76.5	1.2
White Perch	16	7.4	170.3	2.7
Bluegill	11	5.1	275.6	4.3
Largemouth Bass	8	3.7	38.1	0.6
Gizzard Shad	5	2.3	45.5	0.7
Spottail Shiner	5	2.3	17.6	0.3
American Shad	4	1.8	24.3	0.4
Alewife	3	1.4	13.3	0.2
Banded Killifish	2	0.9	6.7	0.1
Flathead Catfish	2	0.9	11.0	0.2
Inland Silverside	2	0.9	6.1	0.1
Tessellated Darter	2	0.9	2.5	<0.1
Bay Anchovy	1	0.5	1.4	<0.1
Common Carp	1	0.5	21.2	0.3
Green Sunfish	1	0.5	2.0	<0.1
Hogchoker	1	0.5	29.5	0.5
Ictaluridae sp.	1	0.5	2.8	<0.1
Spot	1	0.5	0.9	<0.1
Striped Bass	1	0.5	1.9	<0.1
Unidentified Fish	1	0.5	2.2	<0.1
Common Grass Shrimp	1	0.5	1.9	<0.1
Total	217	100	6368.8	100
Source: Table 3 of EA 2006				

Information on the seasonal and daily activities of biological organisms in the vicinity of the cooling water intake structures was obtained from results of impingement studies conducted June 2005 to May 2006. Impingement was higher during June through December 2005 than during January through May 2006 (Table 3-3).

Table 3-3. Monthly Impingement Catch at CPS, 2005 – 2006

Species/Taxon	2005							2006					Annual Total
	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	
Bay Anchovy	0	0	0	1	0	0	0	0	0	0	0	0	1
Blueback Herring	0	4	7	9	1	0	0	0	0	1	0	0	22
Alewife	1	1	1	0	0	0	0	0	0	0	0	0	3
American Shad	0	1	0	1	2	0	0	0	0	0	0	0	4
Gizzard Shad	1	0	0	0	0	1	1	0	0	1	0	1	5
Common Carp	0	0	0	0	0	0	0	1	0	0	0	0	1
Spottail Shiner	1	1	1	0	0	0	0	1	0	0	1	0	5
Ictaluridae sp.	0	0	0	1	0	0	0	0	0	0	0	0	1
Blue Catfish	3	6	4	4	2	3	1	2	1	1	1	1	29
Channel Catfish	0	1	0	3	3	2	6	0	0	0	1	2	18
Flathead Catfish	0	0	0	0	2	0	0	0	0	0	0	0	2
Inland Silverside	1	0	0	0	0	0	1	0	0	0	0	0	2
Banded Killifish	0	0	0	0	0	0	2	0	0	0	0	0	2
White Perch	0	10	1	0	3	1	1	0	0	0	0	0	16
Striped Bass	0	0	0	1	0	0	0	0	0	0	0	0	1
Green Sunfish	0	0	0	0	1	0	0	0	0	0	0	0	1
Bluegill	0	1	0	0	0	1	5	2	0	0	2	0	11
Largemouth Bass	1	5	0	2	0	0	0	0	0	0	0	0	8
Black Crappie	1	14	0	0	0	0	2	0	0	0	0	0	17
Tessellated Darter	1	0	0	0	0	0	0	1	0	0	0	0	2
Spot	1	0	0	0	0	0	0	0	0	0	0	0	1
Hogchoker	0	0	0	0	1	0	0	0	0	0	0	0	1
Damaged Fish	1	0	0	0	0	0	0	0	0	0	0	0	1
Asiatic Clam	1	0	0	0	0	0	0	0	0	3	0	0	4
Common Grass	0	0	0	0	1	0	0	0	0	0	0	0	1
Blue Crab	0	3	1	10	29	18	1	0	0	0	0	0	62
Total	13	47	15	32	45	26	20	7	1	6	5	4	221

Source: Table 4 of EA 2006

The highest numbers of fish were impinged in July and October. Comparison of the numbers of individuals impinged at day versus night revealed modest differences (Table 3-4), with 62 percent of the organisms impinged during nighttime. Blueback Herring, Channel Catfish and Blue Crab were more abundant at night.

Table 3-4. Number of Impinged Fish and Shellfish Collected During Daylight and Nighttime Hours at CPS, 2005 – 2006

Species/Taxon	Day	Night
Bay Anchovy		1
Blueback Herring	6	16
Alewife	3	
American Shad	2	2
Gizzard Shad	2	3
Common Carp		1
Spottail Shiner	1	4
Ictaluridae sp.	1	
Blue Catfish	12	17
Channel Catfish	5	13
Flathead Catfish		2
Inland Silverside	1	1
Banded Killifish		2
White Perch	6	10
Striped Bass	1	
Green Sunfish		1
Bluegill	5	6
Largemouth Bass	3	5
Black Crappie	5	12
Tessellated Darter	2	
Spot		1
Hogchoker	1	
Damaged Fish	1	
Asiatic Clam	4	
Common Grass Shrimp		1
Blue Crab	22	40
Total	83	138
Source: Table 5 of EA 2006		

3.1.2 Impingement Study, 1977

Dominion conducted an impingement study at CPS from January 1977 through December 1977 (VEPCO 1977). This study consisted of twenty-seven, 24-hour periods of sampling. Each 24-hour sample period included twenty-four 10-minute sample collection periods.

A total of 441 fish representing 11 families and 23 species was collected during the study. Shellfish were not enumerated. The five most abundant species caught that comprised 65.5 percent of all impinged fish were Hogchoker (*Trinectes maculates*) (83 fish impinged), Spottail Shiner (63 fish impinged), Atlantic Menhaden (*Brevoortia tyrannus*) (55 fish impinged), Alewife (*Alosa pseudoharangus*) (54 fish impinged), and White Perch (34 fish impinged). The estimated annual impingement for each of the five abundant species was Hogchoker (11,294 impinged fish), Spottail Shiner (7,903 impinged fish), Alewife (7,0284 impinged fish), Atlantic Menhaden (6,955 impinged fish), and White Perch (4,219 impinged fish). The greatest number of impingement, and the peak occurrence of the most abundant species, Hogchoker, was in October 1977. The fewest number of fish impinged occurred in January 1977. Spottail Shiner, not present in January 1977, was the most frequently impinged species throughout the year, peaking in August 1977. The estimated annual impingement at maximum flow was calculated to be 55,557 fish and shellfish.

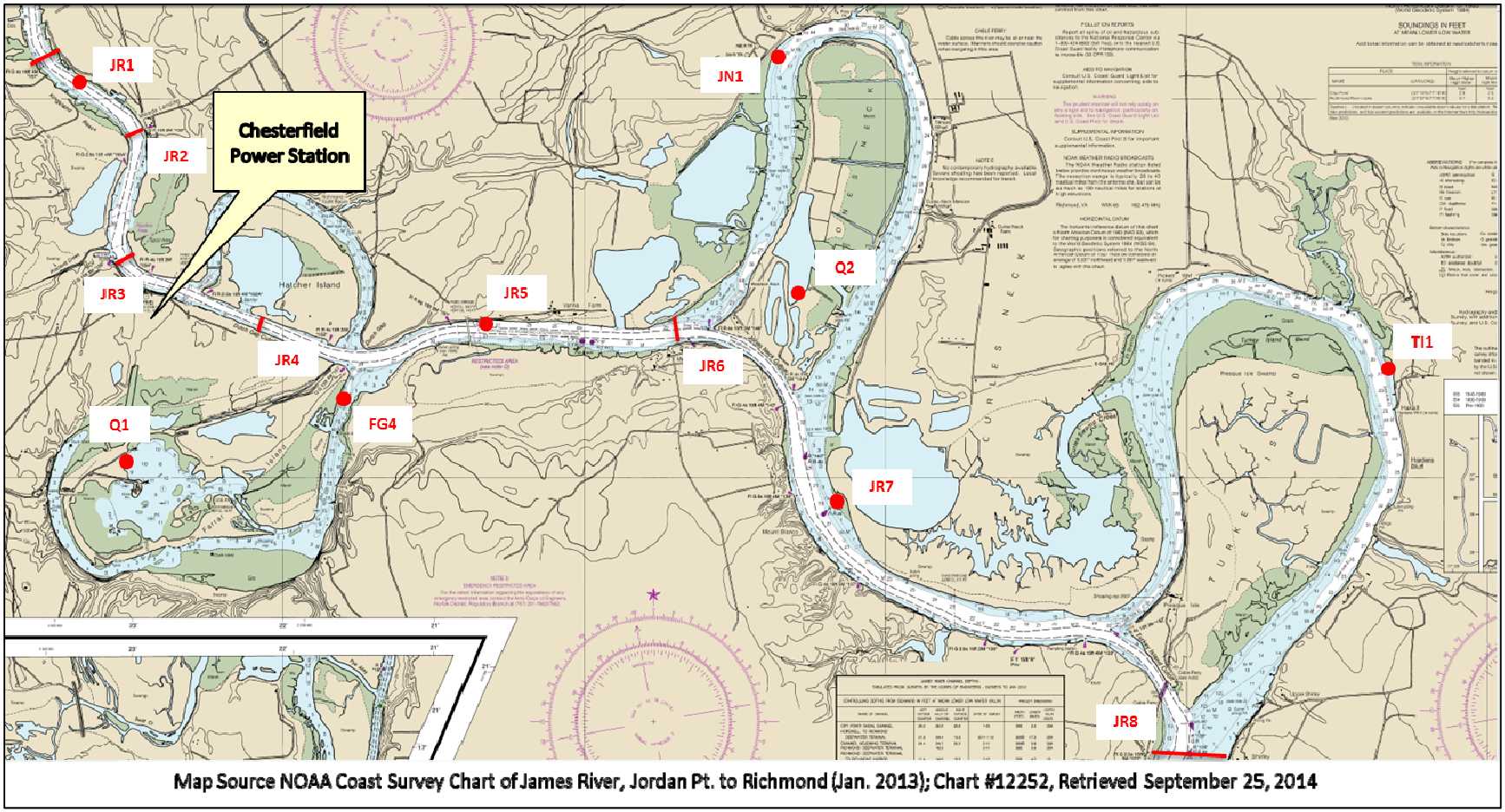
Although this study was comprehensive, it is unlikely to be representative of current conditions in terms of species composition and abundance as it was conducted more than 30 years ago. Improvement in water quality, reductions in barge traffic, and the introduction of non-native species such as Blue Catfish have all had dramatic but difficult to quantify effects on the James River's ecosystem (Lung 1991; Chesapeake Bay Journal 2011).

3.2 James River Studies

3.2.1 Electrofishing and Gill Net Sampling, 2005 – 2006

Ambient juvenile and adult fish collections conducted as part of impingement studies June 2005 - May 2006 sampled three stations by boat electrofishing and gill nets - one upstream, one downstream, and one near the station (Figure 3-1). At each station, 100 meters of shoreline were electrofished. Gill nets were 100 ft long by 6 ft deep with panels ranging from 1.5-in to 3-in stretched mesh, and were fished for 4 to 6 hours. Larger fish were identified, measured, and weighed in the field, and smaller fish were preserved and subsequently processed in the laboratory.

The fish and shellfish collected in 2005-2006 were considered representative for that year. Twenty-seven species of finfish and one shellfish (Blue Crab) were collected. White Perch, Spottail Shiners, Gizzard Shad, Blue Catfish and Bluegill were the most abundant species collected, and accounted for 80 percent of the total catch (Table 3-5). Most (88 percent) of the fish were collected during the summer (June) or fall (October) sampling periods.



Source: Modified from Dominion 2004

Figure 3-1. Map Depicting the Study Area and Sampling Stations for 316(b) Studies Conducted June 2005 – May 2006

Table 3-5. Summary Results of Quarterly Ambient Juvenile and Adult Fish Sampling in the Vicinity of Chesterfield Power Station, 2005 – 2006

Species	June	October	February	April	Total
Atlantic Sturgeon	1				**1**
Longnose Gar				1	**1**
American Eel		2			**2**
Bay Abchovy		10			**10**
American Shad	1				**1**
Blueback Herring		10		4	**14**
Gizzard Shad	40	59	1	8	**108**
Common Carp	3	17		11	**31**
Satingin Shiner	10	2	1	8	**21**
Spotfin Shiner	8				**8**
Telescope Shiner				1	**1**
Spottail Shiner	188	73	2		**263**
Flathead Catfish	1	4	1		**6**
Channel Catfish	7	30			**37**
Blue Catfish	32	52		9	**93**
Inland Silverside	19				**19**
Banded Killifish	1		8	1	**10**
Striped Bass	8	19			**27**
White Perch	26	300		19	**345**
Bluegill	8	32	18	22	**80**
Redbreast Sunfish				1	**1**
Redear Sunfish	1			1	**2**
Black Crappie		1			**1**
Largemouth Bass	5	11	5	9	**30**
Smallmouth Bass		2			**2**
Johnny Darter	2				**2**
Tessellated Darter	1				**1**
Blue Crab			1		**1**
Total	**362**	**624**	**37**	**95**	**1118**

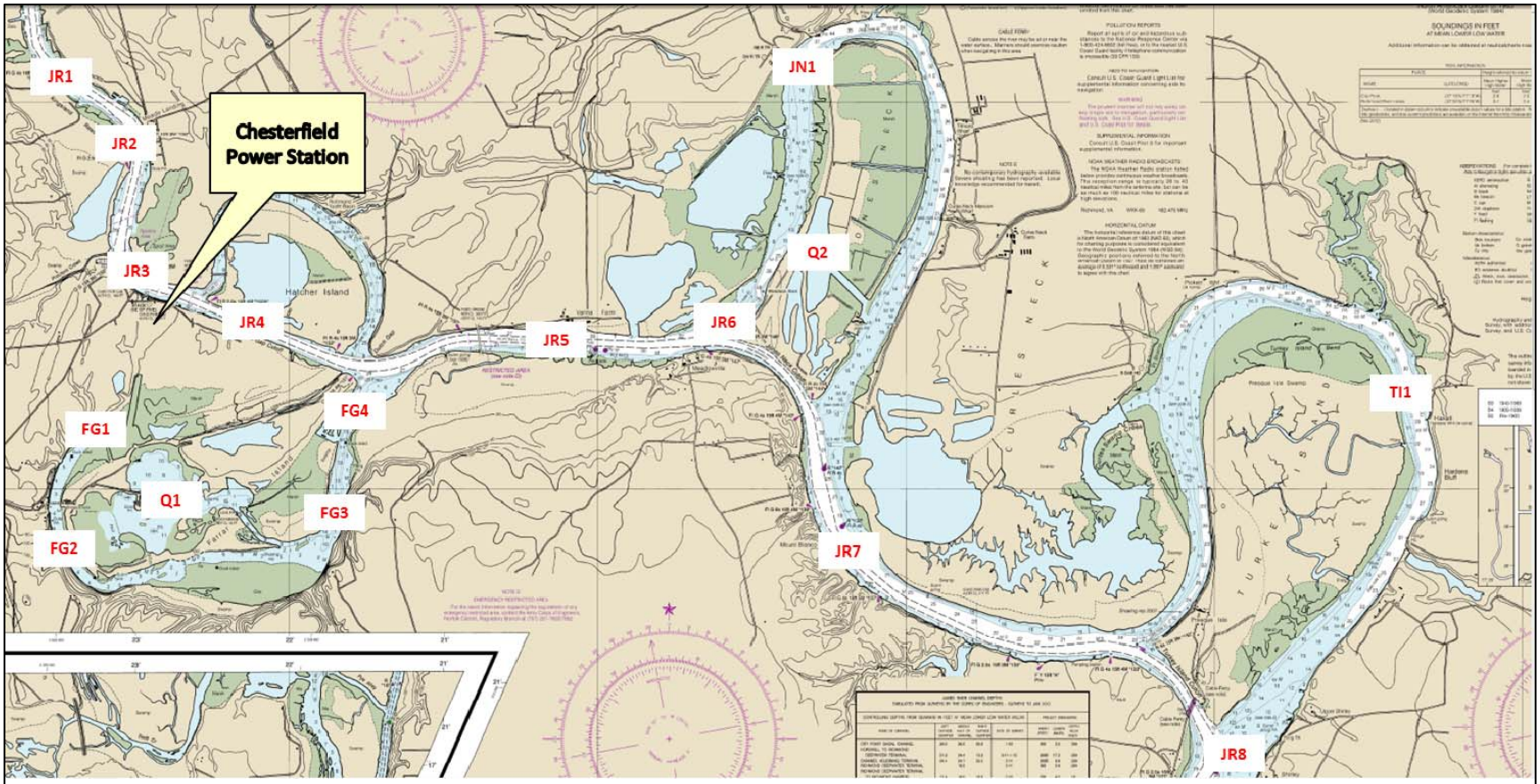
Source: Table 18 of EA 2006

3.2.2 Electrofishing and Gillnet Sampling, 1997 – 1999

In addition to the ambient sampling conducted 2005 – 2006 in association with impingement and entrainment studies, VEPCO (2000) conducted extensive electrofishing and gillnet surveys of fish relative abundance in the vicinity of CPS as part of a 316(a) demonstration study from April 1997 to February 1999 (Table 3-6; Figure 3-2). A total of 35 native and introduced species was collected, none of which had protected status. Within the electrofishing samples, Gizzard Shad, Threadfin Shad, Bluegill Sunfish, Largemouth Bass, Carp, Spottail Shiners, and White Perch were the most frequently collected taxa (Table 3-7). The gillnet samples reflected a different fish capture selectivity, with Gizzard Shad, Threadfin Shad, White Perch, Blue Catfish, and Channel Catfish the most commonly collected taxa (Table 3-8). It was noted as part of this study that results, while not directly comparable, were similar to a previous study conducted 1968-1971 (Jensen 1974), with the principal difference displayed in the relative abundances within the Catfish family Ictaluridae. In Jensen's (1974) study, White Catfish were "moderately" common, Channel Catfish common and Brown Bullheads "very" abundant. In the VEPCO (2000) study, the introduced Flathead Catfish was common, and the introduced Blue Catfish abundant. Channel Catfish remained common, but no White Catfish and only one Brown Bullhead were collected. VEPCO (2000) provides discussion related to the documented effects of introduced Flathead and Blue Catfish on other native catfishes.

Table 3-6. Electrofishing and Gill Net Stations in the James River in the Vicinity of CPS Shown on Figure 3-2 below

Electrofishing Stations	Gill Net Stations
JR1	JR1
JR5	JR5
JR7	JR7
FG1	FG1
FG2	
FG3	FG3
FG4	FG4
JN1	JN1
TI1	TI1
Q1	
Q2	



Source: Modified from Dominion 2013

Figure 3-2. Map Depicting the Study Area and Sampling Stations for 316(a) Studies Conducted April 1997 – February 1999

Table 3-7. Frequency of Occurrence and Total Number of Fish and Shellfish Collected by Electrofishing During the Chesterfield 316(a) Demonstration

Fish	% of Samples	# of Stations	# of Surveys	Total Number
Longnose Gar	1.8	1/11	2/10	3
Bowfin	0.9	1/11	1/10	1
American Eel	9.1	4/11	7/10	15
Blueback Herring	2.7	3/11	2/10	69
Alewife	5.5	5/11	4/10	33
Gizzard Shad	86.4	11/11	10/10	1,291
Threadfin Shad	40.9	11/11	8/10	2,179
Bay Anchovy	8.2	6/11	3/10	62
Satinfin Shiner	36.4	9/11	10/10	147
Common Carp	68.2	11/11	10/10	324
Eastern Silvery Minnow	0.9	1/11	1/10	2
Golden Shiner	2.7	2/11	3/10	4
Spottail Shiner	45.5	11/11	10/10	878
Quillback	1.8	1/11	2/10	3
Shorthead Redhorse	9.1	6/11	6/10	11
Blue Catfish	20.0	8/11	8/10	41
Channel Catfish	35.5	11/11	10/10	70
Flathead Catfish	2.7	2/11	3/10	3
Chain Pickerel	0.9	1/11	1/10	1
Banded Killifish	8.2	8/11	5/10	15
Mummichog	1.8	1/11	2/10	4
Inland Silverside	28.2	9/11	8/10	84
White Perch	51.8	11/11	10/10	545
Striped Bass	11.8	7/11	7/10	25
Redbreast Sunfish	3.6	4/11	3/10	4
Green Sunfish	0.9	1/11	1/10	1
Pumpkinseed	7.3	4/11	6/10	11
Bluegill	90.0	11/11	10/10	1,942
Redear Sunfish	8.2	6/11	6/10	9
Smallmouth Bass	4.5	4/11	5/10	8
Largemouth Bass	71.8	11/11	10/10	233
Black Crappie	25.5	10/11	10/10	61
Tessellated Darter	5.5	5/11	5/10	12
Yellow Perch	5.5	4/11	5/10	10
Hogchoker	0.9	1/11	1/10	1
Blue Crab	0.9	1/11	1/10	1

Source: VEPCO 2000

Table 3-8. Frequency of Occurrence and Total Number of Fish and Shellfish Collected by Gillnetting During the Chesterfield 316(a) Demonstration

Fish	% of Samples	# of Stations	# of Surveys	Total Number
Longnose Gar	5	1/8	4/10	9
Blueback Herring	12.5	6/8	3/10	35
American Shad	1.3	1/8	1/10	1
Atlantic Menhaden	7.5	5/8	3/10	12
Gizzard Shad	85	8/8	10/10	907
Threadfin Shad	21.3	7/8	6/10	264
Common Carp	20	7/8	7/10	26
Quillback	1.3	1/8	1/10	1
White Sucker	1.3	1/8	1/10	1
Shorthead Redhorse	7.5	5/8	3/10	6
Brown Bullhead	1.3	1/8	1/10	1
Blue Catfish	85	8/8	10/10	339
Channel Catfish	58.8	8/8	10/10	170
Flathead Catfish	16.3	6/8	8/10	14
White Perch	71.3	8/8	9/10	447
Striped Bass	33.8	8/8	10/10	67
Bluegill	6.3	4/8	4/10	10
Redear Sunfish	1.3	1/8	1/10	1
Largemouth Bass	10	4/8	5/10	11
Black Crappie	7.5	4/8	4/10	7
Spot	1.3	1/8	1/10	1
Hogchoker	1.3	1/8	1/10	1
Blue Crab	16.3	6/8	8/10	35

Source: VEPCO 2000

4 Threatened and Endangered Species

The EPA consulted with the US Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS) (or collectively, Services) under the Endangered Species Act during development of the existing facilities §316(b) rule. While the Services concluded that the rule is not likely to jeopardize the continued existence of listed species or result in the destruction or adverse modification of designated critical habitat, the rule requires that facilities identify all Federally-listed threatened and endangered species and/or designated critical habitat that are or may be present “in the vicinity of impingement and entrainment at the cooling water intake structure” in §122.21(r)(4). The text below provides a review of listed species associated with CPS to support development of this Entrainment Characterization Study Plan.

The Virginia Fish and Wildlife Information Service (VAFWIS) database, managed by the Virginia Department of Game and Inland Fisheries (VDGIF) and the USFWS Information, Planning, and Conservation System were consulted on August 18, 2014 to develop a list of Federal and state of Virginia endangered and threatened species known or likely to occur within a 2-mile radius of CPS (See Table 4-1). Additionally, the complete list of threatened and endangered species that occur in the state of Virginia (USFWS 2014) was reviewed and compared against the list of threatened and endangered species under NMFS jurisdiction (NMFS 2014) to confirm that NMFS species were not omitted from the list. A review of scientific literature and other documents was also conducted, including a NMFS Biological Opinion and Letter of Concurrence for projects proposed to occur near the vicinity of the CWIS; those documents were used to confirm that marine species under the jurisdiction of NMFS were appropriately considered. Additionally, for each species with the potential to occur in the vicinity of the CWIS, the USFWS or NMFS species profile was reviewed to confirm that no critical habitat was designated. A review of the following resources was used to develop the species list in Table 4-1.

- VAFWIS (http://vafwis.org/fwis/)
- IPAC (http://ecos.fws.gov/ipac/)
- USFWS Listings and Occurrence for Virginia (http://ecos.fws.gov/tess_public/pub/stateListingAndOccurrenceIndividual.jsp?state=VA&s8fid=112761032792&s8fid=112762573902)
- Endangered and Threatened Species Under NMFS' Jurisdiction (http://www.nmfs.noaa.gov/pr/species/esa/listed.htm)
- Biological Opinion of James River Federal Navigation Project: Tribell Shoal Channel to Richmond Harbor in Surry, James City, Prince George, Charles City, Henrico, and Chesterfield Counties and the Cities of Richmond and Hopewell, Virginia (FINER/2012/01183).
- Letter of concurrence, from Mr. D.M. Morris, NMFS, to Ms. Amy Hull, Nuclear Regulatory Commission that continued operation Surry Nuclear Power Station, Units 1 and 2 is not likely to adversely affect species listed by NMFS.
- USFWS or NMFS Species Profile (http://www.fws.gov/endangered/, http://www.nmfs.noaa.gov/pr/species/esa/listed.htm)

Note that only Federal and State threatened and endangered species were included in Table 4-1. Federal species of concern and candidate species were omitted from the list (unless they were also State Threatened or Endangered), because there are no requirements to address those species under Section 7 of the Endangered Species Act.

The majority of the species in Table 4-1 are terrestrial species or occur in habitats that are not in the vicinity of the CPS cooling water intake structure (CWIS) and thus would not be subject to entrainment or impingement at the facility. Additional literature was reviewed to identify aquatic species that do not occur near the CWIS and thus should be eliminated from further consideration; these documents are cited in Table 4-1.

The freshwater bivalve Atlantic Pigtoe (*Fusconaia masoni*) is a state threatened species and a Federal species of concern, currently under review for listing under the ESA, that may inhabit the James River near CPS.

Table 4-1. Federal and State Threatened, Endangered, and Proposed Species with the Potential to Occur within 2 miles of the Cooling Water Intake of CPS

Common Name	Scientific Name	Status*	Tier**	Potential to Occur in the Vicinity of the Intake	Potential for Entrainment of Early Life Stages	Potential for Impingement of Adults and Juveniles
FISH						
Atlantic Sturgeon[a]	*Acipenser oxyrinchus*	FE, SE	II	Early life stages – Unlikely, spawning occurs in the James River downstream of the area of influence Adults and Juveniles - Likely	Unlikely and Unexpected	Unlikely and Unexpected
MOLLUSKS						
Atlantic Pigtoe[a]	*Fusconaia masoni*	FS, ST	II	Adults, juveniles, and glochidia – Unlikely, preferred habitat is upstream of the fall line Host fish – likely to occur in the vicinity of the CWIS	Unlikely and Unexpected	No
AMPHIBIANS						
Barking Treefrog[a]	*Hyla gratiosa*	ST	II	No - breeds in cypress ponds and bays, and in pine barren ponds; open canopied ponds; all Virginia breeding sites were found in graminoid dominated temporary ponds.[c]	No	No
BIRDS						
Upland Sandpiper[a]	*Bartramia longicauda*	ST	I	No – terrestrial	No	No
Loggerhead Shrike[a]	*Lanius ludovicianus*	ST	I	No – terrestrial	No	No

Common Name	Scientific Name	Status*	Tier**	Potential to Occur in the Vicinity of the Intake	Potential for Entrainment of Early Life Stages	Potential for Impingement of Adults and Juveniles
Migrant Loggerhead Shrike[a]	*Lanius ludovicianus migrans*	ST		No – terrestrial	No	No
MAMMALS						
Northern Long-Eared bat[a,b]	*Myotis septentrionalis*	FP		No – terrestrial	No	No
PLANTS						
Sensitive Joint-Vetch[b]	*Aeschynomene virginica*	FT		No - typically grows in the intertidal zone of coastal marshes[d]	No	No

Status*	**Tier****
FE= Federally Endangered	I=VA Wildlife Action Plan - Tier I – Critical Conservation Need;
FT= Federally Threatened	II=VA Wildlife Action Plan - Tier II - Very High Conservation Need;
SE= State Endangered	III=VA Wildlife Action Plan - Tier III - High Conservation Need;
ST= State Threatened	IV=VA Wildlife Action Plan - Tier IV - Moderate Conservation Need
FS= Federal Species of Concern	

Source

[a]Virginia Department of Game and Inland Fisheries; Fish and Wildlife Information Service

[b]US Fish and Wildlife Service; Information, Planning, and Conservation System

[c]VGDIF 2014

[d]USFWS 2012

However, this species typically inhabits the upper parts of rivers, above the fall line, in clean, swift-moving waters and is often found in gravel or gravel-sand substrate (VAFWIS 2014, Terwilliger 1991). The species has been documented in the James River, near Richmond in Henrico County; however, Terwilliger (1990) indicates that the species might no longer be present in the James. In 2011 and 2012, Virginia Department of Game and Inland Fisheries (VGDIF) conducted extensive mussel surveys on the James River upstream of the Richmond (and the project site). No Atlantic pigtoe were encountered in this survey. In the vicinity of CPS, sediments are described as gravel/cobble/pebble, rock, and sand with complex bottom (Bilkovic et al. 2009). The navigation channel near the CPS is maintained via dredging (NMFS 2012a, Bushnoe et al. 2005). Furthermore, all stations in the main stem of the James River were characterized as degraded, based on a benthic index of biotic integrity. The one non-degraded station was located in the oxbow around Hatcher Island (Roberts et al. 2002).

This species is thought to be tachytictic (i.e., short-term brooder), with gravid females collected from the James River from May to June, and glochidia most likely released before September (VAFWIS 2014, Terwilliger 1991, Johnson 1970). Once attached to a suitable host fish, the time it takes for glochidia to metamorphose into juveniles and drop off the fish has been documented at 19 – 24 days (Rash 2005), depending on water temperature, host fish species and other factors. Once juveniles excyst from the host fish they must settle into suitable substrate to survive.

Knowledge is incomplete as to which fish species provides the most suitable host for the Atlantic Pigtoe (Wolf 2010). Results of laboratory research indicate that host fish for Atlantic Pigtoe include Bluegill Sunfish (*Lepomis macrochirus*), Shield Darter (*Percina peltata*), White Shiner (*Luxilus albeolus*) and Satinfin Shiner (*Cyprinella analostana*), Longnose Dace (*Rhinichthys cataractae*) and Creek Chub (*Semotilus atromaculatus*) (Dee and Watters 1998; Rash 2005, Wolf and Emrick 2011). Of these, the White Shiner is not expected to occur in the James River. Longnose Dace and Creek Chub were the primary hosts of the fish tested by Wolf and Emrick (2012), but habitat in the main stem of the tidal James River in the vicinity of CPS is not suitable for these species.

There is a small risk of impingement for infected host fish; however because the preferred habitat for the Atlantic Pigtoe, and any fish they might infest, is above the fall line, which is upstream of the CPS CWIS such an event is unlikely and unexpected. Additionally, Bluegill Sunfish are the only potential host fish known to be impinged at the CPS CWS (Dominion 2007).

Atlantic Sturgeon (listed as both endangered and threatened)[1] spawn in the James River. Benthic substrates that provide suitable sturgeon spawning habitat (i.e., rock and cobble gravel)

[1] Atlantic Sturgeon originating from the New York Bight, Chesapeake Bay, South Atlantic and Carolina Distinct Population Segments (DPSs) are listed as endangered. Those originating from the Gulf of Maine DPS are listed as threatened. Atlantic Sturgeon from these five DPSs have the potential to occur in the James River and the vicinity of the Chesterfield cooling water intake; however, the majority of the spawning adults are likely to originate from the James River and thus, the Chesapeake Bay DPS (NMFS 2012a).

occur in the vicinity of CPS; however, these areas might not have viable spawning conditions (e.g., hydrodynamic characteristics) (Bilkovic et al. 1999). Bushnoe et al. (2005) indicate that the Turkey Island and Jones Neck oxbows, which are approximately 3 – 7 miles downstream from CPS, are considered potential spawning habitat due to their hydrodynamic characteristics and benthic substrate (i.e., rock and gravel/cobble/pebble) (Bilkovic et al. 2009, NMFS 2012a). A second area of seemingly suitable habitat is located approximately 30 miles downstream of CPS (NMFS 2012b).

In a telemetry study, Hager (2011) observed two seasonal migrations by adult Atlantic Sturgeon in the James River; in the spring from April through May and in the late summer and early fall from August through October. No fish passed above river mile 67 in the spring (downstream of CPS). During the late summer to early fall residency (August-October), fish ascended the river rapidly and congregated in upriver sites between river mile 48 and the fall line near Richmond, VA. During late summer, Atlantic Sturgeon exhibited a preference for the river section where the upper James and Appomattox rivers meet, approximately 9 miles downriver from CPS (Hager 2011). Appendix A provides additional detail on Atlantic Sturgeon spawning migrations in the James River.

Eggs are adhesive and demersal and are expected to attach to the substrate within 20 minutes following fertilization; therefore, sturgeon eggs occur only on the spawning grounds (Hildebrand and Schroeder 1928, Jones et al. 1978). Spawning is expected to occur during April through June (temperatures for spawning can range from 13 – 26°C); evidence suggests that spawning might occur in the fall as well, with high adult usage in the river from August through November (Balazik et al. 2012, Secor et al. 2012). Eggs typically hatch in 4 – 7 days depending on temperature (Gilbert 1989; Hildebrand and Schroeder 1928). At hatching, Atlantic Sturgeon larvae are large bodied and are assumed to undertake a demersal existence in the same areas where they were spawned (ASMFC 2012, Bath et al. 1981). Bath et al. (1981) only collected sturgeon larvae in bottom samples. Larvae are also active swimmers and leave the bottom when 8 to 10 days old to swim in the water column (Kynard and Horgan 2002). The yolk-sac larval stage is completed in about 8 to12 days (Jones et al. [1978] reports 6 days), at which time the larvae move downstream to the rearing grounds (Kynard and Horgan 2002). During the first half of this migration, larvae move only at night and use benthic structure (e.g., gravel matrix) as refuge during the day (Kynard and Horgan 2002). During the latter half of migration to the rearing grounds, when larvae are more fully developed, movement occurs during both day and night. Larvae transition into the juvenile phase at approximately 30 mm total length (TL) and move further downstream into brackish waters, developing a tolerance to salinity. Eventually they become residents in estuarine waters for months to years before emigrating to open ocean (ASSRT 2007, ASMFC 2012). ASMFC (2012) notes that some Atlantic Sturgeon occupy freshwater habitats for two or more years, while others move downstream to brackish waters when the water temperature drops. Bain et al. (2000) report that early juveniles were collected from salinities ranging from 0 – 5 ppt from April through October in the Hudson River and from 3 – 18 ppt from October through March. However, temperature and dissolved oxygen are likely key habitat parameters (ASMFC 2012). Bain et al. (1997) report that from July through September juvenile sturgeon use deep channels in the Hudson River. Juvenile Atlantic Sturgeon in North Carolina use deep and cool areas as thermal refuges, particularly in the

summertime (Moser and Ross 1995 as cited in ASMFC 2012). A more detailed account of Atlantic Sturgeon life history, including distribution and size at age and other characteristics is presented in Appendix A.

Impingement occurs when a fish cannot swim fast enough to escape the intake flow vortices (e.g., the fish's swimming ability is overtaken by the velocity of water being drawn into the intake). The approach velocity at the CPS's trash racks is 0.51 to 0.72 feet per second, with a through-rack velocity of 0.55 to 0.79 feet per second. In order for impingement to happen, a fish must be overcome by the intake or approach velocity. Atlantic Sturgeon are known to occur in the vicinity of CPS. Although Atlantic Sturgeon were not collected in impingement or entrainment studies conducted at CPS, one Atlantic Sturgeon was collected as part of ambient field studies, and released alive (EA 2006, Dominion 2013). Shortnose Sturgeon, while not expected to occur in the vicinity of the CPS CWIS, are well studied and have swimming capabilities expected to be representative of Atlantic Sturgeon. Juvenile and adult Shortnose Sturgeon (body lengths greater than 58.1 cm) can avoid impingement at intakes with velocities as high as 3.0 feet per second (Kynard et al. 2005 as cited in NMFS 2012b). Shortnose Sturgeon with body lengths greater than 28 cm have been demonstrated to avoid impingement at intakes with velocities of 1.0 fps (Kynard et al. 2005 as cited in NMFS 2012b). Verhille et al. (2014) tested the swimming capacity of larval Green Sturgeon (*Acipenser mediocr*is) and White Sturgeon (*Acipenser transmontanus*) until completion of metamorphosis to juveniles. Green Sturgeon swimming capacity, based on critical swimming velocity (the speed at which a fish can no longer propel itself forward), was not significantly different, but slightly greater than White Sturgeon swimming capacity, throughout larval development. Results indicated that 4.3-cm and 6.5-cm Green Sturgeon could sustain 1.17 fps and 1.49 fps for 5 minutes, while 4.7-cm and 8.0-cm White Sturgeon could sustain 0.83 fps and 1.16 fps for 5 and 10 minutes, respectively. Critical swimming velocity for 15.4-cm, 22.1 cm, and 22.2-cm Green Sturgeon reported in other studies was 1.42 fps (20 minutes), 1.58 (20 minutes), and 1.73 fps (5 minutes). Critical swimming velocity ranged from 0.2 fps to 2.6 fps for 20 to 30 minutes for larger Green Sturgeon (34.7 cm to 68.3 cm). All Green Sturgeon were tested at 18-19ºC. Critical swimming velocity for larger White Sturgeon (24.8 cm to 38.3 cm) ranged from 1.9 fps to 2.27 fps (for 20-30 minutes. White Sturgeon were tested at 11-12.5 ºC and 18-19ºC. Absolute swimming capacity increased with size. Poletto et al. (2013) reported that Green Sturgeon (29.6 cm fork length [FL] and 150-198 days after hatching) contacted fish exclusion screens more frequently than White Sturgeon (27.4 cm FL and 170-192 days after hatching) as simulated intake flow velocity increased. However, the majority of the fish never became impinged with impingement events per fish ranging from 0 to 15 for Green Sturgeon and 0 to 1 for White Sturgeon. Fish were tested at flows of 0.67 and 1.2 fps. There were 0.68 impingements per fish for Green Sturgeon and 0.02 impingements for fish for White Sturgeon. Atlantic Sturgeon share similar life history strategies with Green and White Sturgeon; that is, besides morphological similarities and taxonomic relationships, all three species are estuarine dependent during substantial portions of their juvenile and sub-adult stages, make forays or long distance migrations through marine waters, and require similar habitat attributes for reproduction. Similar life history features and requirements support an assumption of similar swimming capabilities and behavioral responses to altered flows.

For the purposes of this study plan, it is assumed that the only listed species with potential to be impinged at CPS is Atlantic Sturgeon, but because of swimming capabilities, the probability of impingement is deemed unlikely and unexpected. Although no Atlantic Sturgeon are expected to be encountered as part of this study, this study plan includes handling methods focused on reducing stress and quickly releasing Atlantic Sturgeon, in the unlikely event that they are collected in impingement samples.

5 Basis for Sampling Design

HDR preformed a site visit at CPS on August 19, 2014 to evaluate potential impingement sampling options for the CWISs, the point of §316(b) compliance at the facility. As shown in Figure 2-9 (See Section 2.2.2), there are five separate intake structures at this power station. Units 7 and 8 are adjacent to each other at the east end of the intake area. Units 3 and 4 have a common intake structure in the center section of the intake area for CPS. Units 5 and 6 are adjacent to each other at the west end of the intake area. There is no common access between the intake structures. All of the Units have conventional traveling screens. Units 7 and 8 have separate fish/debris return troughs. The troughs exit the intake structures on the east side of the structures. At the Unit 3 and 4 intake structure, the eastern three screens empty into a common fish/debris return trough that exits from the east side of intake structure and the western-most screen empties into a trough that exits from the west side of the structure. These two fish/debris troughs wrap around the intake structure and both discharge at a common point off the northeast corner of the intake structure. Units 5 and 6 have separate fish/debris return troughs. The troughs for these two units also exit the intake structures on the east side of the structures. All of the fish/debris return troughs empty back into the James River adjacent to the intake structures.

Sampling of screenwash from individual screens was determined to be impracticable due to the limited space available to install an impingement sampling net or basket in the trough sections prior to their joining the common fish discharge trough and because the force of the water entering such a sampling device would result in increased mortality to the organisms collected in the device and thus compromise the planned initial impingement survival assessments that are an important component of the sampling objectives. In addition, there are a total of 13 individual screens at CPS that would not be able to be concurrently monitored effectively. During the site visit, the CPS representatives indicated a drop-in type basket was used at the end of the last screen house for each intake structure during the previous impingement study in 2005-2006. They indicated these baskets were available if needed for the current impingement study.

Based on these findings, it was determined that the preferred impingement sampling location would be collection of impingement samples from the fish/debris troughs at the end of the last screen house at each intake structure. Specifically, impingement sample collections will be conducted by using drop-in baskets/nets installed in the fish/debris troughs at the end of the last screen at each intake structure. Impingement sample collection events will be conducted twice per month over a 12-month study period of July 1, 2015 – June 30, 2016. Each sample collection event will be conducted over a 24-hour period with 10-minute samples collected every

hour at each of the six locations. If the debris loads and/or fish collections are light and there is available time, an additional 10-minute sample will be collected within the same hour at each location and composited with the samples for that hour. This hourly sample frequency will require the CPS to operate the screens in a continuous wash mode for the duration of a 24-hour sampling event at all five intake structures. This schedule and frequency are selected to allow for initial impingement survival assessments and to mesh with the Entrainment Characterization Study to capture efficiencies available from having field staff already on site for that study. The sample duration and frequency selected for the current impingement study will provide finfish and invertebrate (shellfish) taxonomic identifications, seasonal impingement density distributions, diel variation, and initial impingement survival. One year of study is anticipated to be sufficient to achieve the project objects.

The approach for development of the specific impingement characterizations required in §122.21(r) is summarized in Table 5-1.

Table 5-1. Summary of Approach for Development of §122.21(r) Required Impingement Characterizations

Data Needs	Basis for Developing the Data
122.21(r)(4) requirement to determine species most susceptible to impingement	Evaluation of species and life stage composition and densities based on 2015-2016 Impingement Study
122.21(r)(4) requirement for identification of fragile fish and shellfish species (<30% impingement survival)	Evaluation of literature values and initial impingement survival values from 2015-2016 Impingement Study
Diel variation	Evaluation of densities in 1-hour sample collections in the 2015-2016 Impingement Study
Variation related to climate and weather	Evaluation of the 2015-2016 Impingement Study data relative to water temperature and weather events (e.g., rain events)
Period of occurrence	Evaluation of the 2015-2016 Impingement Study monthly densities
Impingement data to support alternative technology evaluations	Evaluation of the 2015-2016 Impingement Study densities, length and weight data, and initial impingement survival

6 Impingement Characterization Study Plan

6.1 Introduction

This section of the Study Plan provides methods, materials, and procedures for impingement sample collection and processing. Any failures at the sampling or laboratory analysis stage are often uncorrectable because design-specified sampling times cannot be repeated once they have passed. Therefore, Standard Operating Procedures (SOPs) and a Quality Assurance (QA) Plan will be developed by the contractor performing the field studies for the impingement sample collection and processing based on this Study Plan and the contractors preferred methods, datasheets and equipment to eliminate, reduce, and/or quantify those errors.

Adherence to sample collection SOPs will be observed and documented through regular technical assessments. These technical assessments will be conducted by a QA officer, who is independent of those individuals collecting and generating the data during the study and has experience in performing QA/QC programs for aquatic monitoring surveys, and will be scheduled to occur at least quarterly throughout the course of the study. The specific requirements are to be developed by the contractor performing the work, will incorporate a checklist of items to be inspected based on the SOPs, and will include observations relevant to performance of sampling that may not be covered by the SOP. Careful attention will be paid to the initiation of the study when staff may be less familiar with the SOPs.

6.2 Safety Policy

All work performed under the direction of Dominion Environmental Services (DES) and/or Dominion Business Units (BU) on Dominion properties and/or on properties owned or operated by third parties (i.e., not owned or operated by the contractor or Dominion) is to be performed using safe work practices that are at least equivalent to those required for Dominion personnel and of any third party owner or operator. At a minimum, all contractors are expected to be aware of, and adhere to, Dominion's Corporate Safety Policy, DES Safety Work Practices and any BU or other location-specific safety policies and procedures.

6.3 Field Collection Procedures

An overview of the Impingement Characterization Study Plan methods is provided in Table 6-1. Upon arrival at the plant, the crew will check in with facility security and operations personnel prior to commencing any on-site activities. Prior to the start of each 24-hour impingement sampling event, the crew with the assistance of an operations engineer or designee will document the screens will be operating in a continuous wash mode for the duration of a 24-hour sampling event. The number of operating cooling water pumps will be documented.

Table 6-1. Impingement Sampling Details

Impingement	Details
Units to be Sampled	Units 3 & 4, 5, 6, 7, and 8
July 1, 2015 – June 30, 2016 Sampling Events	Twice per month sampling events (within the second and fourth week of each month) for 12 months [2/month x 12 months = 24 sampling events]
Daily Collection Schedule	Samples collected every hour in a 24-hr period (24 collections / 24-hr period)
Targeted Organisms	Adult and juvenile fish and shellfish
Sampling Location	Sample common fish return trough screenwash at the end of the last screen at each intake structure
Sampling Gear	3⁄8-inch square mesh drop-in basket/net after the last screen at each intake structure
Sample Duration	10 minutes as the target interval (every hour); if possible an additional 10-minute sample within the hour if light debris loads and/or fish collections and time allows
Number of Samples per Survey	24 sample collections/survey
Total Number of Samples	24 samples/survey x 2 surveys/month x 12 months x 6 sampling locations = 3,456 samples

Consideration must be made to ensure the sampling event does not interfere with plant operation nor result in risk to health and safety of field personnel. Specific sampling details associated with each 1-hour sample period are as follows:

- Circulating water and service water pump status, traveling screen and rake status will be documented for each Unit, pump and intake bay.
- If a Unit is not in operation impingement samples will not be collected at this location.
- If no circulating water pumps are operating at all Units, sampling will be rescheduled; periods of downtime for operation of one or more units are anticipated and should not affect the schedule, and screens should not be rotated for the unit that is not operating during impingement sampling.
- At the start of impingement sampling all screens at the operating units will be washed prior to sample collection and all screens for the operating units will be placed in a continuous mode for the duration of a 24-hour sampling event.
- After the screens have been washed and completed a minimum of one full rotation, the drop-in basket/net will be inserted in the trough to start the initial 10-minute sample collection in the first hour.
- The installation of the drop-in basket/net at each location will be staggered within each hour to allow the sampling crew to monitor all the baskets/nets and remove them after the 10-minute sample interval.
- At the end of the 10-minute sample collection period, the basket/net will be removed from the trough at each location.

- If fish and/or debris loading is light and time allows, a second 10-minute sample will be collected within the hour at the sample locations and composited with the samples for that hour.
- Following completion of each sampling time, the crew will promptly retrieve the catch from the basket/net at each location and analyze the catch. The catches from each sample location will be analyzed separately to document the catches from the individual units (the catches from Units 3 and 4 will be analyzed together).
- If the analysis cannot be done immediately the contents of the collection event will be put in a plastic bag, placed on ice and analyzed as soon as possible; this will preclude handling procedures of Sturgeon (see Section 6.4.4) and evaluations of initial impingement survival.
- After collection of the impingement sample, the fish will be separated from the debris and prepared for analysis.
- Collected finfish and shellfish will be processed and analyzed for identification, enumeration and length/weight measurements.
- Initial impingement survival data will be collected for the first 10 minutes of sample processing only during each hourly sampling (See Section 6.4.1).
- Water quality sampling will be conducted at the near-surface, mid-depth, and near-bottom at the intake of Unit 6 every six hours at 1000, 1600, 2200, and 0400 hours. Temperature, dissolved oxygen, specific conductivity, salinity, and pH will be measured using calibrated water quality meters.
- Other climatic data such as rain, cloud cover, wind speed and direction, etc. shall also be recorded on the datasheet.
- At the end of each 24-hour sampling event the crew will notify the facility engineer or designee that impingement sampling has concluded.

6.3.1 Location

Impingement samples will be collected from the fish/debris return troughs at the east end of the intake structures after the last screen. Individual samples will be collected from Unit 7, Unit 8, Unit 3, Unit 4, Unit 5, and Unit 6 (a total of 6 sample locations; however the samples from the two sample locations at the Unit 3 and 4 intake will be analyzed together). Drop-in baskets/nets will be used to collect the samples. At the Unit 3 and 4 intake structure, three screens drain to the east side of the structure and one screen drains to the west side of the structure. See Figure 6-1 for the impingement sampling locations where the nets will be inserted into the troughs.

6.3.2 Equipment

Sampling equipment will be acquired and/or constructed according to specifications in this Study Plan. Adequate backup equipment will be provided to ensure the study design can be followed in the event of equipment failure or loss. Prior to initiation of sampling, equipment will be tested or confirmed to meet specifications.

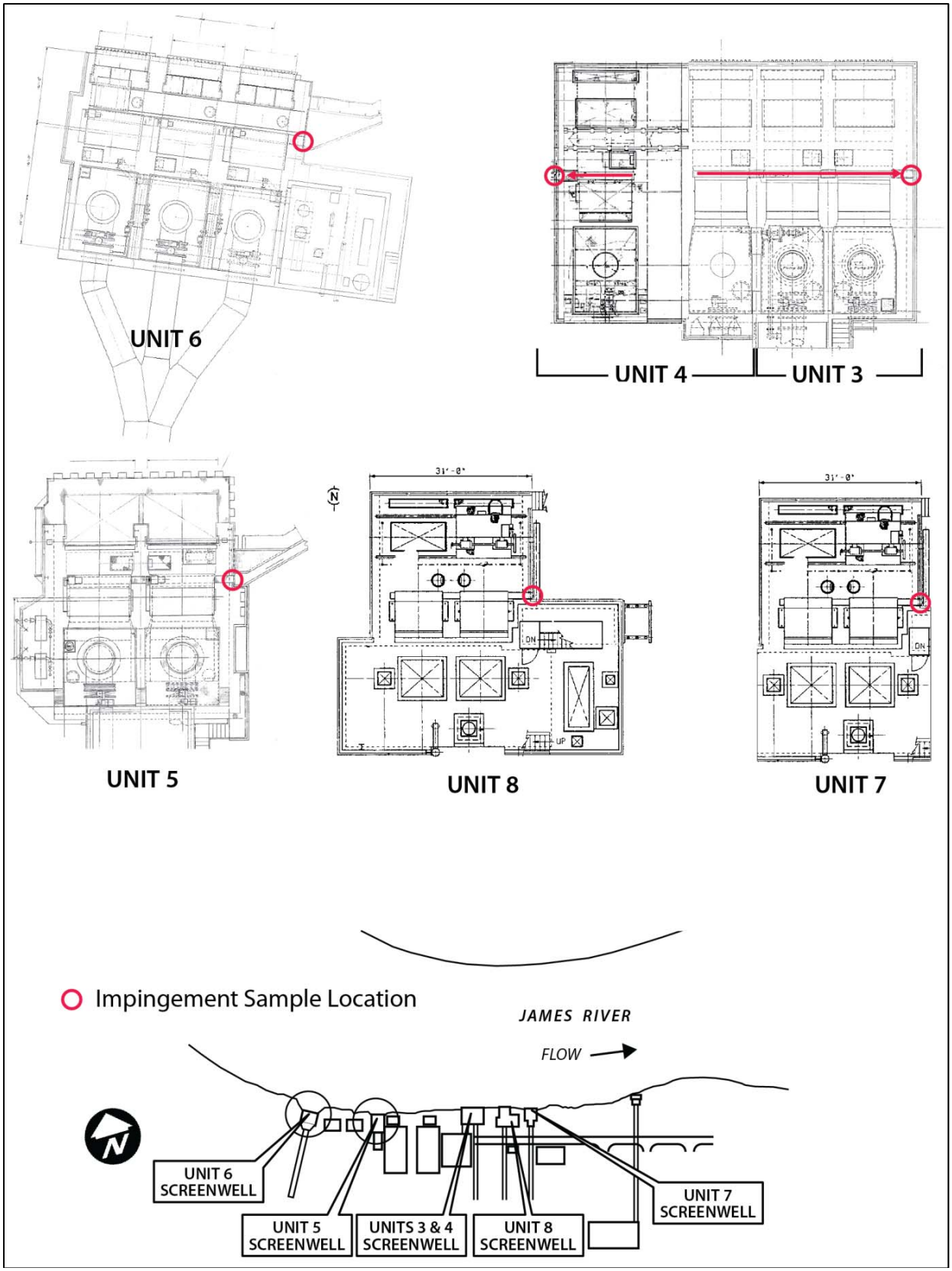


Figure 6-1. Impingement Sampling Locations

A calibration program will be instituted for equipment requiring calibration that must be consistent with Dominion's instrumentation calibration and maintenance practice document (See Appendix B). The following list includes the minimum items expected to be required for impingement sample collection:

- Balance/Electronic Scale/Spring scale (accurate to the nearest gram)
- Calibrated weights
- Sorting bin
- Table to weigh and measure on
- Measuring boards (accurate to the nearest millimeter)
- Scissors, forceps
- Disposable Nitrile gloves
- Paper towels
- Field Binder w/ pens, pencils, SOP, data sheets, QC sheets, etc.
- Calculator
- Plastic buckets (both 2 quart & 5 gallon)
- Plastic bags (large, small, & Ziploc), labels, & twist ties
- Taxonomic keys
- Cooler(s) with ice
- Calibrated 5-gallon bucket for debris volume estimates
- Certified thermometers (2)
- pH pens (3) & standards
- Watch
- 500-ml plastic bottles for water quality QC
- DO bottles & HACH chemicals for QC
- Portable water quality meters as described below[2]
    - Handheld Salinity, Conductivity & Temperature meter with autoranging scales (e.g., YSI Model 30 or equivalent) with the following minimum specifications:
        - Conductivity ranges of 0 to 500 µS/cm and 0-200 mS/cm with an accuracy of +/- 0.5 % full scale
        - Salinity range of 0 to 80 ppt with an accuracy of +/- 2 % or +/- 0.1 ppt
        - Temperature range of -5 to 45 ^{o}C with an accuracy of +/- 0.2 ^{o}C
    - Handheld Dissolved Oxygen & Temperature meter with autoranging scales (e.g., YSI Model 55 or equivalent) with the following minimum specifications:
        - Dissolved Oxygen % Saturation ranging from 0 to 200 % with an accuracy of +/- 2 %
        - Dissolved Oxygen mg/L ranging from 0 to 2 mg/L with an accuracy of +/- 0.3 mg/L
        - Temperature range of -5 to 45 ^{o}C with an accuracy of +/- 0.2 ^{o}C
    - Portable pH meters with the following minimum specifications:
        - pH range of 0 to 14 units with an accuracy of +/- 0.2 units
- DO bottles & HACH chemicals for backup
- Calibration solutions as required for the water quality instrumentation
- Buckets/Containers with calibrated 0.5 gal. graduations; 1-, 3-, and 5-gallon sizes, or as dictated by debris load.

[2] A multiple parameter water quality meter may be used provided it meets the minimum specifications outlined for the individual meters.

- Shovels/scoops as necessary
- Digital camera
- Nitrile or latex gloves
- Hand sanitizer
- Identification keys for aquatic vegetation

6.3.3 Sampling Schedule

The program will be continued for 12 consecutive months with the 24 sample events conducted over the July 1, 2015 – June 30, 2016 period. Each sampling event will encompass a 24-hour period with 24, one-hour subsampling periods. Sampling events will be distributed within the second and fourth week of each month for the 12 month period. If a sampling event is missed due to weather or other events, the scheduled sampling event will be conducted within 96-hours of resolution of the complicating event.

6.3.4 Water Quality Measurements

Water quality parameters (water temperature, dissolved oxygen, pH, salinity and conductivity) will be recorded with a water quality analyzer (see instrument specifications above). Water quality sampling will be conducted at the near-surface, mid-depth, and near-bottom at the Unit 6 intake every six hours at 1000, 1600, 2200, and 0400 hours.

Quality control for water quality data collection will be performed twice per sampling event (once per 12-hour shift) using either a second calibrated water quality meter or by collecting water samples for wet chemistry analysis. Calibration of water quality equipment will be consistent with the *Field Instrumentation: Calibration and Standardizations* requirements in Appendix B.

6.4 Collection Processing

The following collection processing will be accomplished on-site:

- All fish and macroinvertebrates will be identified to the lowest practical taxonomic level and enumerated.
- Up to 10 randomly selected live and fresh dead fish from each species collected will be measured for total length, maximum body width, and maximum body depth to the nearest millimeter and weighed to the nearest gram and no more than 100 measurements of each species are required within a 24-hour impingement sampling event.
- All balances will be checked against standard weights on each day that they are used and the results will be recorded.
- Threatened or endangered species will be processed immediately. Refer to Section 6.4.4 *Handling Procedures for Atlantic Sturgeon* for more details.
- Debris collected during a sampling event will be categorized and an estimate of volume for each category will be recorded in the datasheet.

- Following analysis of the catch and categorization of the debris, all organisms will be returned to the fish return trough and all debris will be placed in an appropriate trash receptacle.

Refer to Appendix C for a summary of key data to be collected during the study.

6.4.1 Initial Impingement Survival

Initial impingement survival data will be collected for the first 10 minutes of sample processing only during each hourly sampling. Each fish and macroinvertebrate will be classified according to the following condition criteria and enumerated by category:

- Live, Undamaged – live with no apparent damage
- Live, Damaged – live with evidence or indication of abrasion or laceration
- Fresh Dead - no vital signs, no body or opercular movement, clear eyes, red gills and no obvious signs of decay
- Dead Decaying - no vital signs, cloudy eyes, soft flesh, pale gills, other obvious signs of decay.

6.4.2 Morphometrics

For each 1-hour sample period, up to 10 randomly selected live and fresh dead fish from each taxon collected will be measured for total length, maximum body width, and maximum body depth to the nearest millimeter and weighed to the nearest gram. No more than 100 measurements of each species are required within a 24-hour impingement sampling event.

All balances will be checked against standard weights on each day that they are used and the results will be recorded on the appropriate form.

6.4.3 Debris Load Characterization

Upon completion of fish and shellfish catch processing, a debris load characterization will be completed for the impingement collection. Debris volume will be measured to the nearest 0.5 gallon by means of marked and calibrated buckets or other containers of varying sizes. At a minimum, one-, three- and five-gallon containers will be available; exact size and number of containers may be modified as is appropriate for the debris load at the facility. For all debris loads in excess of five gallons, a photograph of the entire debris load will be taken. If feasible, debris types (outlined below) will be separated, and the volume of each measured. If this is not feasible, total debris volume will be measured, and the best possible estimation of volume of each debris type will be made. Data will be recorded on the impingement sampling data forms.

Debris types/categories will include at a minimum:

- Aquatic vegetation and algae, with taxonomic description as practicable

- Terrestrial vegetation – leafy/herbaceous
- Terrestrial vegetation – woody[3]
- Aquatic or terrestrial fauna (e.g. Ctenophora; Cnidaria; Insecta) not quantified in impingement sample, with taxonomic description as practical
- Sediments or other natural inorganic debris, with general description of size composition (e.g. gravel, sand, silt etc.)
- Man-made debris/refuse with general description of types (plastic, metal etc.)

If debris collected at a facility does not fall into one of the above categories, a new one may be created. Whenever pertinent, additional descriptions and photos of debris should be recorded. Following measurement and description, debris will be disposed of according to facility procedures.

6.4.4 Handling Procedures for Atlantic Sturgeon

Atlantic Sturgeon are not expected to be susceptible to impingement at CPS. However, in the event of observation or collection of Atlantic Sturgeon, the Virginia Department of Game and Inland Fisheries will be contacted per the requirements of the Scientific Collection Permit that will be obtained prior to any sampling. In addition, the following handling methods are provided in order to reduce stress, avoid injury and mortality, and quickly release Atlantic Sturgeon, in the unlikely event that they are collected. Atlantic Sturgeon is the only sturgeon species expected in the area of the CPS intake and as such, there is no need to distinguish Atlantic Sturgeon from other species of sturgeon (NMFS 2012b).

1) Sturgeon will be removed from the collection gear as quickly and carefully as possible.
2) Live sturgeon will be placed into tubs filled and overflowing with ambient river water, which will be continuously supplied to the tubs while they contain fish.
3) In the absence of a continuous water source (pump and hose) or for sturgeon that don't fit in tubs, buckets will be used to add ambient water or every few minutes or to keep sturgeon wet while they are being processed.
4) Each sturgeon will be placed on the measuring board where live sturgeon will be kept wet throughout the data collection procedure. Large specimens will be measured using a tape measure. The following measurements will be quickly recorded in mm:
    - Total Length: straight line along the body axis from the tip of the snout to the tip of the tail (not following the curvature of the body)

[3] Branches and other woody debris that cannot conveniently be put into a bucket should be photographed.

- Fork Length: straight line along the body axis from the tip of the snout to the posterior edge of the fork of the tail (not following the curvature of the body)
- Interorbital Width: distance between the lateral margins of the bony skull at the midpoint of the orbit
- Mouth Width: distance between the left and right inside corners of the mouth (i.e., excluding the lips); this should be measured with the mouth closed

5) Each individual will be examined for a Passive Integrated Transponder (PIT) tag and external injuries.

6) After making sure that the fish is wet enough, three photographs will be quickly taken to aid in species identification and document the condition of the fish. One will be taken of the top of the fish, one will be taken of the bottom of the fish (a good view of the mouth is important), and one will be taken of the side of the fish. A ruler will be included in the photograph for scale of the dorsal and ventral surface of the head. Injuries and physical abnormalities will also be photographed. After the requisite data has been collected, live fish will be returned to the river away from the vicinity of the SPS intake, as quickly and as gently as possible to prevent mortality.

7) If Atlantic Sturgeon appear nonresponsive, an attempt will be made to resuscitate them by flushing water over the gills until recovery is obvious by the fish's desire to escape. The best method is to use a pump and hose directed into or placed in the mouth (with a piece of sponge to protect the mouth). In the absence of a pump and hose, the sturgeon can be gently dragged back and pushed forward underwater. The drag back should be gentle and slower to protect the gills (Damon-Randall et al. 2010).

8) Sturgeon handling would comply with all conditions of the VDGIF collection permit.

9) All sturgeon and sturgeon data will be reported to NMFS by Dominion by phone at 978-281-9328 or by email to incidental.take@noaa.gov.

10) If sturgeon are dead when collected or inadvertently die during processing, dead sturgeon will be handled as directed by NMFS.

Refer to the following references for additional information on sturgeon handling practices:

- Moser, M.L., M. Bain, M.R. Collins, N. Haley, B. Kynard, J.C. O'Herron II, G. Rogers, and T.S. Squiers. 2000. A Protocol for Use of Shortnose and Atlantic Sturgeons. National Marine Fisheries Service, NOAAT Technical Memorandum NMFS-OPR-18.
- Damon-Randall, K., R. Bohl, S. Bolden, D. Fox, C. Hager, B. Hickson, E. Hilton, J. Mohler, E. Robbins, T. Savoy, and A. Spells. 2010. Atlantic Sturgeon research techniques. NOAA Technical Memorandum NMFS-NE-215.

The following includes the minimum items expected to be needed to handle sturgeon, should they be collected in impingement samples:

- Large tank or tub (~5 ft x 2.5 ft x 2 ft)
- 12-volt pump for flow-through on holding tank with hoses & fittings as required
- Battery to operate pump
- 12 volt pig-tail adapter
- Fish sling (to hold & lift large fish safely for handling, transport & aid in release)
- Large net
- PIT Tag Reader
- 5-Gallon Buckets
- Scale to weigh larger fish
- Measuring board (for smaller fish)
- Tape (for large fish)
- Calipers for interorbital and mouth measurements
- Camera
- Contact numbers

7 References

Atlantic States Marine Fisheries Commission (ASMFC). 2012. Habitat Addendum IV to Amendment 1 to the Interstate Fishery Management Plan for Atlantic Sturgeon.

Balazik, G. C. Garman, J.P. Van Eenennaam. 2012. Empirical Evidence of Fall Spawning by Atlantic Sturgeon in the James River, Virginia. Transactions of the American Fisheries Society 141: 1465-1471.

Bain, M.B. 1997. Atlantic and shortnose sturgeons of the Hudson River: Common and divergent life history attributes. *Environmental Biology of Fishes* 48: 347-358.

Bain, M.B., N. Haley, D. Peterson, J.R. Waldman, and K. Arend. 2000. Harvest and habitats of Atlantic Sturgeon Acipenser oxyrinchus Mitchill, 1815, in the Hudson River estuary: Lessons for sturgeon conservation. Boletin-Instituto Español de Oceanografía 16: 43-53.

Bilkovic, DM, K Angstadt, and D Stanhope. 2009. Atlantic Sturgeon Spawning Habitat on the James River, Virginia. Final report to NOAA Chesapeake Bay Office, Award Number NA06NMF4570303. Virginia Institute of Marine Science, Center for Coastal Resources Management, Gloucester Point, Virginia.

Bushnoe, T.M., J.A. Musick, and D.S. Ha. 2005. Essential Spawning and Nursery Habitat of Atlantic Sturgeon (Acipenser oxyrinchus) in Virginia. Appendix 1 of Essential Fish Habitat of Atlantic Sturgeon Acipenser oxyrinchus in the Southern Chesapeake Bay. Principal Investigator: Jasck Musick. VIMS Scientific Report #145.

Chesapeake Bay Journal. May 2011. Blue catfish boom threatens region's river ecosystems. The Bay Journal 22(3).

Dee, S.O. and T. Watters. New or confirmed host identifications for ten freshwater mussels. Proceedings of the Conservation, Captive Care, and Propagation of Freshwater Mussels Symposium. Pages 77-82. Ohio Biological Society.

Dominion Electric Environmental Services (Dominion). 2013. Draft 316(b) Six Month Requirements Submittal for the Chesterfield Power Station.

Dominion. 2004. Proposed Biological Studies – Chesterfield Power Station

EA, Engineering Science and Technology (EA). 2006. Draft Impingement and Entrainment Mortality Characterization Report, June 2005 – May 2006, Chesterfield Power Station.

Gilbert, C.R. 1989. Species profiles: life histories and environmental requirements of coastal fishes and invertebrates (Mid-Atlantic Bight)--Atlantic and Shortnose Sturgeons. U.S. Fish Wildl. Serv. Biol. Rep. 82(11.122). U.S. Army Corps of Engineers TR EL82-4. 28 pp.

Hager, C. 2011. Atlantic Sturgeon review: Gather data on reproducing subpopulation of Atlantic Sturgeon in the James River. Contract EA133FlOCN0317.

Hildebrand, S.F. and W.C. Schroeder. 1928. Fishes of Chesapeake Bay. Department of Commerce, Bulletin of the United States Bureau of Fisheries, Volume XLIII.

Johnson, R.I. 1970. The systematics and zoogeography of the Unionidae (Mollusca: Bivalvia) of the southern Atlantic slope region. Bulletin of the Museum of Comparative Zoology 140(6):263-449.

Johnson, R.S. The Systematics and Zoogeography of the Unionidae (Mollusca: Bivalvia) of the Southern Atlantic Slope Region. Bulletin of Museum of Comparative Zoology 140(6):263-449.

Jones, P. W., Martin, F. D. and Hardy, J. D. Jr. 1978: Development of fishes of the Mid-Atlantic Bight. An atlas of egg, larval and juvenile stages. Volume I Acipenseridae through Ictaluridae. U. S. Dep. Interior, Fish Wildl. Serv., Biol. Serv. Prog. FWS/OBS-78/12. 366 pp.

Kynard, B., D. Pugh and T. Parker. 2005. Experimental studies to develop a bypass for Shortnose Sturgeon at Holyoke Dam. Final report to Holyoke Gas and Electric, Holyoke, MA.

Kynard, B. and M. Horgan. 2002. Ontogenetic behavior and migration of Atlantic Sturgeon, *Acipenser oxyrinchus oxyrinchus*, and Shortnose Sturgeon, *A. brevirostrum*, with notes on social behavior. Environmental Behavior of Fishes 63: 137-150.

Lung, W.S. 1991. Trends in BOD/DO modeling for wasteload allocations of the James River estuary. Technical memorandum prepared under subcontract for Tetra Tech, Inc., Fairfax, VA, by Envirotech, Inc., Charlottesville, VA.

Moser, M. L., and S. W. Ross. 1995. Habitat use and movements of shortnose and Atlantic sturgeons in the lower Cape Fear River, North Carolina. Transactions of the American Fisheries Society 124: 225-234.

National Marine Fisheries Service (NMFS). 2012a. Biological Opinion of James River Federal Navigation Project: Tribell Shoal Channel to Richmond Harbor in Surry, James City, Prince George, Charles City, Henrico, and Chesterfield Counties and the Cities of Richmond and Hopewell, Virginia (FINER/2012/01183).

NMFS. 2012b. Letter of concurrence, from Mr. D.M. Morris, NMFS, to Ms. Amy Hull, Nuclear Regulatory Commission, that continued operation Surry Nuclear Power Station, Units 1 and 2 is not likely to adversely affect species listed by NMFS.

Poletto, J.B., Cocherell, D.E., Ho, N., Cech, J.J. Jr., Klimley, A.P., and Fangue, N.A. Juvenile green sturgeon (*Acipenser medirostris*) and white sturgeon (*Acipenser transmontanus*) behavior near water-diversion fish screens: experiments in a laboratory swimming flume. (2014). *Canadian Journal of Fisheries and Aquatic Sciences* 71:1030-1038.

Rash, J.M. 2005. Life history characteristics of the Atlantic pigtoe (Fusconaia masoni). Abstract of Papers 83rd Annual Meeting of the Virginia Academy of Science, May 17-20, 2005. James Madison University, Harrisonburg, VA.

Secor, D. H., E. J. Niklitschek, J. T. Stevenson, T. E. Gunderson, S. P. Minkkinen, B. Richardson, B. Florence, M. Mangold, J. Skjeveland, and A. Henderson-Arzapalo. 2000. Dispersal and growth of yearling Atlantic Sturgeon, Acipenser oxyrinchus, released into Chesapeake Bay. Fishery Bulletin 98: 800-810.

Terwiliger, K. 1991. Virginia's Endangered Species: Proceedings of a Symposium. Virginia Department of Game and Inland Fisheries, McDonald and Woodward Publishing Company, Blacksburg, VA.

U.S. Fish and Wildlife Service (FWS), Raleigh Ecological Serices Field Office. 2012. Sensitive Joint-vetch (Aeschynomene virginica). Retrieved September 7, 2014. http://www.fws.gov/raleigh/species/es_sensitive_joint-vetch.html

VEPCO. 2000. Section 316(a) Demonstration. VPDES Permit Number VA0004146 - Chesterfield Power Station. Virginia Electric and Power Company, Environmental Policy and Compliance, Glen Allen, Virginia.

VEPCO. 1977. Chesterfield Power Station Impingement and Entrainment Study. Final report. Prepared by Virginia Electric and Power, Environmental Services Department, Richmond, VA.

Verhille, C.E., Poletto,J.B., Cocherell, D.E., DeCourten, B., Baird, S., Cech, J.J. Jr., and Fangue, N.A. Larval green and white sturgeon swimming performance in relation to water diversion flows. Conservation Physiology 2: doi:10.1093/conphys/cou031.

Virginia Fish and Wildlife Information System (VAFWIS). 2014. Virginia Wildlife and Information Service. Atlantic Pigtoe Chapters. Available online. Retrieved October 7, 2014. http://vafwis.org/fwis/booklet.html?Menu=_.All+Chapters&bova=060173&version=16350

Virginia Department of Game and Inland Fisheries (VDGIF). 2014. Barking treefrog (Hyla gratiosa). Available online. Retrieved September 7, 2014. http://www.dgif.virginia.gov/wildlife/information/?s=020002

Watson, J. 2012. James River Mainstem Freshwater Mussel Surveys. Virginia Department of Game & Inland Fisheries, Bureau of Wildlife Resources. Accessed on November 13, 2013 Available online: http://www.google.com/url?sa=t&rct=j&q=&esrc=s&frm=1&source=web&cd=4&ved=0CC8QFjAD&url=http%3A%2F%2Fncmollusks.wikispaces.com%2Ffile%2Fview%2FJamesRiverSurveys.pdf&ei=1QVmVIfDH_TesASBvICgBg&usg=AFQjCNHoLbYHINRMh89V_2H6BPNyEZT8cA&sig2=NR_T2jFldgg2ucIZqnJn_w&bvm=bv.79142246,d.cWc.

Wolf, E.D. 2010. Propagation and Culture of Species at Risk Atlantic Pigtoe. Department of Defense Legacy Program. Project #09-450.

Wolf, E.D. and V. Emrick. 2011. Propagation and Culture of Species at Risk Atlantic Pigtoe. Department of Defense Legacy Program. Project #10-450.

Appendix A

Atlantic Sturgeon Life History Information

Atlantic Sturgeon Life History Information

Atlantic Sturgeon (*Acipenser oxyrinchus*) originating from the New York Bight, Chesapeake Bay, South Atlantic and Carolina Distinct Population Segments (DPSs) are listed as endangered. Those originating from the Gulf of Maine DPS are listed as threatened. Atlantic Sturgeon from these five DPSs have the potential to occur in the James River and the vicinity of the cooling water CWIS of the CPS. The marine range of all five DPSs extends along the Atlantic coast from Canada to Cape Canaveral, Florida (NMFS 2012a).

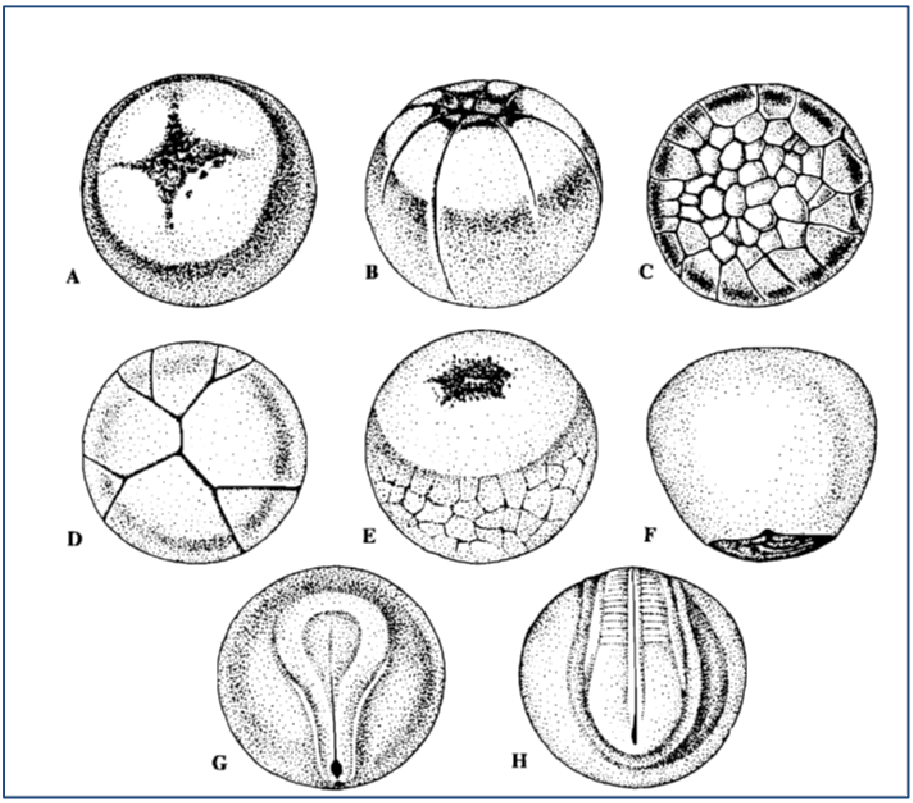
The James River historically provided the largest stock of Atlantic Sturgeon in the Chesapeake and the majority of the adults in the river are likely to originate from the James River and thus, the Chesapeake Bay DPS (Hildebrand and Shroeder 1928; ASSRT 2007; Hager 2011; NMFS 2012a). Because early life stages (eggs and larvae), yearlings, and juveniles do not leave their natal river or estuary, any Atlantic Sturgeon from these life stages in the James River would have originated from the Chesapeake Bay DPS. Subadult Atlantic Sturgeon (greater than 50 cm but not yet sexually mature), move outside their natal rivers. Therefore, subadult Atlantic Sturgeon present in the James River and in the vicinity of the CWIS could be from any of the five DPSs.

Atlantic Sturgeon spawn in the James River. Benthic substrates that provide suitable sturgeon spawning habitat (i.e., rock and cobble gravel) occur in the vicinity of CPS; however, some of these areas might not have viable spawning conditions (e.g., hydrodynamic characteristics) (Bilkovic et al. 1999). Bushnoe et al. (2005) indicate that the Turkey Island and Jones Neck oxbows, which are approximately 3 -7 miles downstream CPS are considered potential spawning habitat due to their hydrodynamic characteristics and also benthic substrate, including rock and gravel/cobble/pebble (Bilkovic et al. 2009, NMFS 2012a). Spawning is expected to occur from the April through June; evidence exists that spawning might occur in the fall as well, with high adult usage in the river from August through November (Balazik et al. 2012, Secor et al. 2000). Virginia Marine Resources Commission restricts dredging in the James River from March 15 through June 30 to accommodate spring-spawning anadromous fish (Balazik et al. 2012) and NMFS (2012b) recently restricted dredging in the lower James River from February 15 to June 15th and in the rest of the river from February 15 to June 30 to protect anadromous fish during migration and spawning periods.

Eggs can hatch in 4 - 7 days depending on temperature (Gilbert 1989; Hildebrand and Schroeder 1928). Eggs are strongly adhesive and demersal, and occur only on the spawning grounds attaching to the substrate in 20 minutes (Jones et al. 1978). Atlantic Sturgeon eggs are approximately 2.6 mm in diameter (Hildebrand and Schroeder 1928) and hatch approximately 94, 140, and 168 hours after egg deposition at temperatures of 20°C, 18°C, and 17.8 °C, respectively (Gilbert 1989; Hildebrand and Schroeder 1928).

Ripe (unfertilized) Atlantic Sturgeon eggs are reported to be 2.5 - 2.6 mm in diameter, globular in shape, and of a light to dark brown color. Fertilized eggs are up to 2.9 mm in diameter, slate gray or light to dark brown, and become oval as development proceeds (Jones et al. 1978) (see Figure A-1). The germinal disc is evident in the unfertilized egg. A cross- or star-shaped pigment

patch is apparent in the animal pole of the fertilized egg. The eggs are distinctly two-layered with the outer layer being a viscous substance.



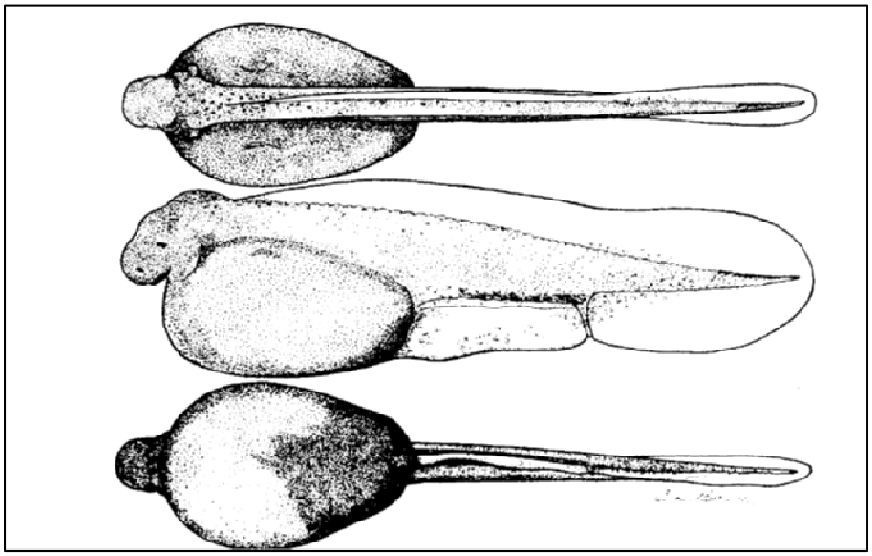
Source: Jones et al. 1978 as presented in Gilbert 1989

Figure A-1. Atlantic Sturgeon Egg Development from Unfertilized Egg to 48-hour Stage

Yolk-sac larvae are expected to inhabit the same areas where they were spawned (Bain et al. 2000; ASMFC 2012). Smith et al. (1980 in Gilbert 1989) also reported that the yolk-sac larvae were darkly pigmented and active swimmers. Hard substrate is important to larval Atlantic Sturgeon as it provides refuge from predators (Kieffer and Kynard 1996 and Fox et al. 2000 as cited in ASMFC 2012). Bath et al. (1981) only collected sturgeon larvae in bottom samples. Larvae are also active swimmers and leave the bottom when 8 to 10 days old to swim in the water column (Kynard and Horgan 2002).

The yolk-sac larval stage is completed in about 8 to12 days (Jones et al. [1978] reports 6 days), at which time the larvae move downstream to the rearing grounds (Kynard and Horgan 2002). During the first half of this migration, larvae move only at night and use benthic structure (e.g., gravel matrix) as refuge during the day (Kynard and Horgan 2002). During the latter half of migration to the rearing grounds, when larvae are more fully developed, movement occurs during both day and night. Larvae transition into the juvenile phase at approximately 30 mm total length (TL) and move further downstream into brackish waters, developing a tolerance to salinity. Eventually they become residents in estuarine waters for months to years before emigrating to open ocean (ASSRT 2007, ASMFC 2012).

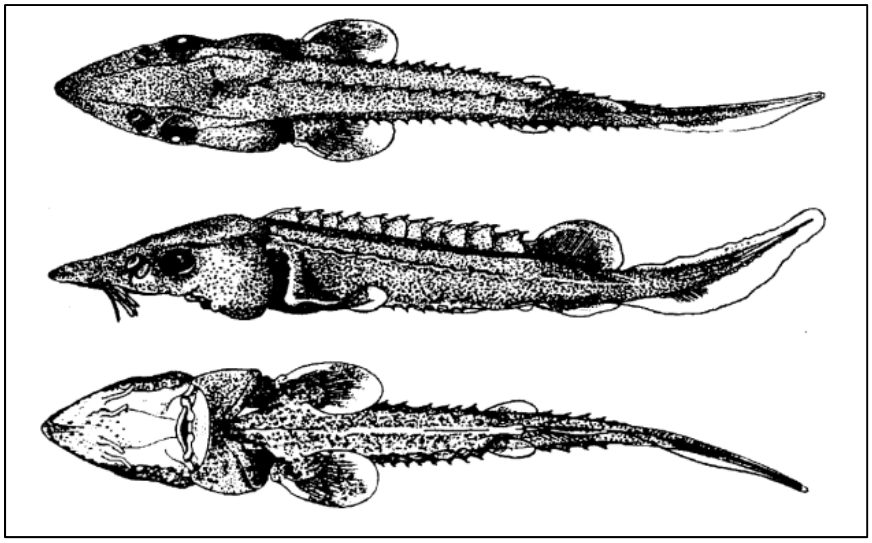
Atlantic Sturgeon larvae are expected to be approximately 7 - 9 mm TL at hatching (Bath et al. 1981, Smith 1980 as cited in Bain et al. 2000, Gilbert 1989, Snyder 1988), although Jones et al. (1978) describe a newly hatched Atlantic Sturgeon larvae at 11.5 mm TL. The head width is 8% of standard length (SL) with a depth of 11 % of SL (behind the posterior margin of the eye). The yolk-sac maxima is 23 % of SL and the yolk-sac depth is 20% of SL (Snyder 1988). Jones et al. (1978) describes the newly hatched Atlantic Sturgeon larvae with a head and the tail that is darkly pigmented and a yolk that is a large “dirty yellow,” vascular oval. The head is not deflected over the yolk (bent around the yolk). The mouth is formed. The eye is relatively small and is about the same size as the round auditory vesicles. The branchial arches are concealed by the opercular folds, the barbels are lacking, pectoral buds are present, and the origin of the dorsal finfold is in the occipital region. Bath et al. (1981) reports that a continuous finfold extends from behind the head dorsally around the notochord and ventrally to the posterior end of the yolk sac, a dorsal wedge-shaped cavity at the fourth ventricle in the posterior of the blunt head, and a vent extended through the finfold at 0.6 to 0.7 of the TL from the snout. The spiral valve was distinguishable, even in small specimens.



Source: Snyder 1988

Figure A-2. Atlantic Sturgeon Yolk Sac Larvae Just Hatched

Snyder (1988) reports that Atlantic Sturgeon complete yolk absorption by 13 - 14 mm SL in 6 - 7 days, acquire their first scutes between 17 and 20 mm SL at 13 - 29 days, acquire their first fin rays at 21 mm SL (13 - 29 days), and acquire a full complement of fin rays, except the caudal fin, between 47 and 58 mm SL at 29 - 100 days. A 29-day hatchery-reared larva is presented in Figure A-3.



Source: Snyder 1988

Figure A-3. Atlantic Sturgeon, 28.9 mm SL, 29.3 MM TL, 29 Days After Hatching

Mean myomere counts for Shortnose and Atlantic Sturgeon are 38 preanal and 22 or 23 postanal. Snyder (1988) presents a detailed comparison of shortnose and Atlantic Sturgeon and provides details on the age and length of the onset of certain developmental events.

Juvenile Atlantic Sturgeon demonstrate a lot of variation with regard to salinity tolerance (ASMFC 2012). Atlantic Sturgeon spawn in their natal river and remain in the river until approximately age two and at lengths of approximately 76 - 92 cm (30 - 36 inches; ASSRT 2007). Yearlings are known to occupy freshwater portions of their natal river (Secor et al. 2000) and their distribution in the James River is expected to follow this pattern. Juveniles in the river are also restricted to low salinity areas, with overwintering known to occur in deep water areas near river mile 25 (NMFS 2012a).

Hager (2011) used telemetry to establish movement patterns of adult and subadult Atlantic Sturgeon in the James River. Thirty-two adults and thirty-three subadults were outfitted with telemetry tags and telemetry receivers were placed throughout the river to record the presence of tagged fish when they are within approximately one kilometer of the receivers.

Results of Hager (2011) indicate that adult Atlantic Sturgeon enter the James River in spring when water temperatures are around 17°C, and occur from river mile 29 to river mile 67 before departing from the river in June when water temperatures are around 24° C. Data collected in 2010 demonstrated a congregation of sturgeon in freshwater areas near river mile 48, suggesting the possibility of spawning in this area (Hager 2011). Adult Sturgeon appear to be absent from the James River for most of the summer until late August when tagged fish are once again detected in the river (Hager 2011). During the late summer-early fall residency (August-October), fish ascend the river rapidly and congregate in upriver sites between river mile 48 and the fall line near Richmond, VA; possibly in response to physiologically stressful conditions (e.g., low dissolved oxygen and elevated water temperature) in the lower James River and Chesapeake Bay (Hager 2011). During late summer, Atlantic Sturgeon exhibited a

preference for the river section where the upper James and Appomattox rivers meet, approximately 9 miles downstream from CPS (Hager 2011). As temperature declines in late September or early October, adults disperse through downriver sites and begin to move out of the river (Hager 2011). By November, adults occupy only lower river sites (Hager 2011). By December, adults are undetected on the tracking array and, thus, are presumed to be out of the river (Hager 2011).

The highest number of subadults are present in the river in the spring and fall with the lowest numbers present in August when ambient water temperatures in the river are the highest. At this time of year, most subadults leave the river and any Atlantic Sturgeon remaining in the river are holding in cool water refugia (Hager 2011). The number of subadults in the river peaks in October. Many subadults leave the river for overwintering with some known to overwinter off the coast of North Carolina. Subadults overwintering within the river are located downstream of Hog Island.

Literature Cited

Atlantic States Marine Fisheries Commission (ASMFC). 2012. Habitat Addendum IV to Amendment 1 to the Interstate Fishery Management Plan for Atlantic Sturgeon.

Atlantic Sturgeon Status Review Team (ASSRT). 2007. Status Review of Atlantic Sturgeon (*Acipenser oxyrinchus oxyrinchus*). Report to National Marine Fisheries Service, Northeast Regional Office. February 23, 2007. 174 pp.

Balazik, G. C. Garman, J.P. Van Eenennaam. 2012. Empirical Evidence of Fall Spawning by Atlantic Sturgeon in the James River, Virginia. Transactions of the American Fisheries Society 141: 1465-1471.

Bain, M.B., N. Haley, D. Peterson, J.R. Waldman, and K. Arend. 2000. Harvest and habitats of Atlantic Sturgeon, *Acipenser oxyrinchus* Mitchill, 1815, in the Hudson River estuary: Lessons for sturgeon conservation. Boletin-Instituto Español de Oceanografía 16: 43-53.

Bath, D.W., J.M. O'Conner, J.B. Alber & L.G. Arvidson. 1981. Development and identification of larval Atlantic Sturgeon (*Acipenser oxyrhynchus*) and Shortnose Sturgeon (*A. brevirostrum*) from the Hudson River estuary, New York. Copeia 1981: 711–717.

Bilkovic, DM, K Angstadt, and D Stanhope. 2009. Atlantic Sturgeon Spawning Habitat on the James River, Virginia. Final report to NOAA Chesapeake Bay Office, Award Number NA06NMF4570303. Virginia Institute of Marine Science, Center for Coastal Resources Management, Gloucester Point, Virginia.

Bushnoe, T.M., J.A. Musick, and D.S. Ha. 2005. Essential Spawning and Nursery Habitat of Atlantic Sturgeon (*Acipenser oxyrinchus*) in Virginia. Appendix 1 of Essential Fish Habitat of Atlantic Sturgeon *Acipenser Oxyrinchus* in the Southern Chesapeake Bay. Principal Investigator: Jasck Musick. VIMS Scientific Report #145.

Fox, D. 2006. History of Atlantic Sturgeon Fishery. Power Point presentation presented to Delaware Department of Natural Resources, courtesy of Greg Murphy (DEDNR) April 13, 2006.

Gilbert, C.R. 1989. Species profiles: life histories and environmental requirements of coastal fishes and invertebrates (Mid-Atlantic Bight)--Atlantic and Shortnose Sturgeons. U.S. Fish Wildl. Serv. Biol. Rep. 82(11.122). U.S. Army Corps of Engineers TR EL82-4. 28 pp.

Hager, C. 2011. Atlantic Sturgeon review: Gather data on reproducing subpopulation of Atlantic Sturgeon in the James River. Contract EA133FlOCN0317.

Hildebrand, S.F. and W.C. Schroeder. 1928. Fishes of Chesapeake Bay. Department of Commerce, Bulletin of the United States Bureau of Fisheries, Volume XLIII.

Jones, P. W., Martin, F. D. and Hardy, J. D. Jr. 1978: Development of fishes of the Mid-Atlantic Bight. An atlas of egg, larval and juvenile stages. Volume I Acipenseridae through

Ictaluridae. U. S. Dep. Interior, Fish Wildl. Serv., Biol. Serv. Prog. FWS/OBS-78/12. 366 pp.

Kieffer, M. C. and B. Kynard. 1993. Annual movements of Shortnose and Atlantic Sturgeons in the Merrimack River, Massachusetts. Transactions of the American Fisheries Society 122: 1088-1103.

Kynard, B. and M. Horgan. 2002. Ontogenetic behavior and migration of Atlantic Sturgeon, *Acipenser oxyrinchus oxyrinchus*, and Shortnose Sturgeon, *A. brevirostrum*, with notes on social behavior. Environmental Behavior of Fishes 63: 137-150.

National Marine Fisheries Service (NMFS). 2012a. Letter of concurrence, from Mr. D.M. Morris, NMFS, to Ms. Amy Hull, Nuclear Regulatory Commission, that continued operation Surry Nuclear Power Station, Units 1 and 2 is not likely to adversely affect species listed by NMFS.

NMFS. 2012b. Biological Opinion of James River Federal Navigation Project: Tribell Shoal Channel to Richmond Harbor in Surry, James City, Prince George, Charles City, Henrico, and Chesterfield Counties and the Cities of Richmond and Hopewell, Virginia (FINER/2012/01183).

Smith, T. I. J., E. K. Dingley and D. E. Marchette. 1980. Induced spawning and culture of the Atlantic Sturgeon, *Acipenser oxyrinchus* (Mitchill). Progressive Fish-Culturist 42: 147-151.

Secor, D. H., E. J. Niklitschek, J. T. Stevenson, T. E. Gunderson, S. P. Minkkinen, B. Richardson, B. Florence, M. Mangold, J. Skjeveland, and A. Henderson-Arzapalo. 2000. Dispersal and growth of yearling Atlantic Sturgeon, *Acipenser oxyrinchus*, released into Chesapeake Bay. Fishery Bulletin 98: 800-810.

Snyder, D.E. 1988. Description and Identification of Shortnose and Atlantic Sturgeon Larvae. American Fisheries Society Symposium 5: 7-30.

Appendix B

Field Instrumentation: Calibrations and Standardizations

WORK PRACTICE DOCUMENT

Field Instrumentation:

Calibrations and Standardizations

Dominion Environmental Services

Table of Contents

1.0 Introduction 2
2.0 Scope 2
3.0 Dominion Employees Covered 2
4.0 Work Practice Description 3
5.0 Safety 3
6.0 Work Practice Requirements 3
7.0 Electric Environmental Biology Calibration and Standardization Protocols 5
- **7.1 Chlorine** 5
- **7.2 Conductivity/Salinity** 5
- **7.3 Dissolved Oxygen (D.O)** 7
- **7.4 pH Meters** 8
- **7.5 Flowmeters** 10
- **7.6 Temperature** 10
- **7.7 Turbidity** 10
- **7.8 Weight** 11
- **7.9 Oxidation/Reduction Potential ORP** 12

8.0 Contacts 13
9.0 Tables 14
11.0 Distribution List 21

WORK PRACTICE DOCUMENT

Calibrations and Standardizations

Electric Environmental Biology

Written Date: 8/16/2011

Revision Date:

Document Owner: Casey Seelig

1.0 Introduction

Dominion is required to monitor a variety of physicochemical parameters in the environment. These parameters are monitored with various types and models of scientific instrumentation. Instruments must be either calibrated or standardized and properly maintained to ensure the accuracy and precision of the data being collected. **Calibration** is a process of physically adjusting an instrument to accurately read a known standard or series of standards. **Standardization** is a process of checking an instrument against a known standard or series of standards to document its accuracy. Standardization, without a physical adjustment to the instrument, checks that the instrument is functioning to its design specifications and, if not the instrument can either be calibrated, serviced by the operator, or sent back to the manufacturer for repair. The manufacturer's recommended calibration and maintenance procedures for a particular instrument are designed to keep the equipment performing to the manufacturer's specifications. Every instrument's accuracy should be verified and documented to ensure it meets the acceptability criteria established for the work.

2.0 Scope

The purpose of this work practice document is to provide the protocols necessary to ensure all field instrumentation and test methods, which are used to measure environmental parameters, are providing data of acceptable accuracy. This work practice document defines the proper methods, frequencies, and acceptance criteria for documenting field instrument and test kit accuracy using calibrations and standardizations. The procedures in this document are general in nature. Due to the number and variety of field instrumentation used, specific calibration procedures for each instrument are beyond the scope of this document. The user's manual should be consulted for specific calibration and standardization procedures.

3.0 Dominion Employees Covered

This work practice applies to all Dominion Environmental Services (DES) employees using field instrumentation to monitor environmental parameters as well as any contractors employed by DES that conduct environmental analyses for monitoring studies. The guidelines and procedures

listed in this work practice document apply to instruments used in the field. This does not cover the calibration or standardization of laboratory equipment.

4.0 Work Practice Description

The field instrumentation calibrations and standardizations work practice provides guidance on how to prepare for and safely conduct calibrations and equipment accuracy checks on field instrumentation. This work practice is intended for experienced field technicians or for those under the direct supervision of employees trained in proper calibration and standardization methods used for equipment and reagents required in the collection of environmental data.

5.0 Safety

Safety is a core Dominion principle and all calibration and standardization work must incorporate safe work practices. It is the responsibility of every employee and contractor to work safely. Safety of each employee, contractor, their co-workers and the general public are the first priority of every job. The conduct of all work should conform to the expectations described in the Dominion Safety Policy, the Safety Work Practice for Dominion Environmental Services, the Safety Work Practice for Biology, and the policies of the business unit where the work is being done. The types of Personal Protective Equipment (PPE) necessary for calibrating and standardizing field instruments must be reviewed prior to starting calibrations or standardizations to identify and mitigate any hazards.

1. Specific hazards associated with the type of instruments to be calibrated or standardized must be known prior to the start of the calibration or standardization. Examples of such hazards might include: health and safety concerns associated with the use of pH standards as identified by the Material Safety Data Sheet (MSDS).
2. Where the mitigation of hazards is not possible, Personal Protective Equipment (PPE) must be worn to safely complete the calibration/standardization. A hazard assessment must be performed to evaluate each calibration or standardization task and the proper PPE needs to be worn as outlined in the MSDS and any governing Laboratory Chemical Hygiene Plan. The need for safety glasses, gloves, and appropriate clothing should be considered in every hazard assessment.
3. All employees are required, at a minimum, to be familiar with the Hazard Communication Program for their business unit. The Hazard Communication Program outlines safety expectations when handling and using chemical products, including employee training, chemical labeling, and access to MSDS.

6.0 Work Practice Requirements

1. Personnel that will be calibrating or standardizing instruments or test kits for readings will, at a minimum:

a) Be cognizant of the safe handling and waste disposal of calibration or standardization chemicals.
b) Have training in the use of instrumentation;
c) Have training for the proper use of required PPE;
d) Have a thorough understanding of the proper methods outlined by the manufacturer to maintain, calibrate or standardize the instrument or test kit.

2. Verify state and federal protocols for accuracy and precision of measurements:
   a) Review acceptance criteria required by the state and agencies (current acceptance criteria are listed in calibration procedures below and in Table1);
   b) Document all calibrations and standardizations of monitoring instruments and test kits.
3. Pre-Calibration/Standardization Preparation
   a) Review the manufacturer's recommendations and procedures;
   b) Locate and fill out the appropriate calibration/standardization log sheet;
   c) Verify the expiration/certification date of all standards to be used in the calibration/standardization process;
   d) Verify the instrument's or test kit's make, model, and serial number or unique identifier and record it on the log sheet;
4. Instrument or Test kit Calibration/Standardization
   a) Document the date, time, and the person(s) conducting the calibration/standardization;
   b) Select a range of standards to be used for calibration or to be checked for the instrument/test kit's accuracy, which will bracket expected field/laboratory survey results;
   c) Document the results (standard verses reading) and verify that they meet the acceptance criteria;
   e) If the equipment fails calibration/standardization, service and clean the equipment and re-calibrate/standardize;
   f) If the equipment continues to fail, label "Inactive Status" and remove the equipment from service (send the equipment back to the manufacturer for servicing) and document this on the log sheet;

Note: If an instrument or test kit does not comply with the established acceptance criteria, it must not be used for collecting data and must be removed from service.

   g) Properly label and dispose of all waste chemicals and materials. Dispose of any hazardous wastes according to the Hazard Waste Management Guidance Document.
5. Verification
   a) DES personnel must record the instrument/test kit identifier (e.g., serial number) on field and boat log sheets to provide a traceable accuracy for every measurement collected;
   b) Annual reviews of calibration/standardization logs should be performed to verify compliance. Calibration/standardization logs should be checked to verify that records are complete, legible, and up to date.

7.0 Calibration and Standardization Protocols

Many instruments and test kits are not able to be calibrated in the field or by the user. These instruments and test kits need to be checked routinely using known standards to establish and document their accuracy. For example it is not possible to adjust a capillary thermometer; therefore accuracy needs to be compared to a reference thermometer of certified accuracy. In many cases checking standards and documenting the instrument's accuracy in the range of conditions it will be used can be more efficient than calibration procedures. In all cases, follow the manufacturer's recommended maintenance and calibration directives.

The following frequencies (Table 1) established for documenting calibrations and standardizations are for instruments and test kits routinely being used for weekly or monthly monitoring studies. If equipment is being used daily for recording large amounts of data, calibration/standardization frequencies must be increased (see Table 1) or standards must be run with samples. For infrequently used equipment (once a quarter or year), calibrations and standardizations should occur prior to use. Data loggers which are being deployed for extended periods of time (>1 month) must be calibrated/standardized immediately prior to and following deployment in the field.

Prior to calibration, all instrument probes must be cleaned according to the manufacturers instructions. Failure to perform this step (proper maintenance) can lead to erratic measurements. When calibrating instruments care must be taken to insure that the volume of the calibration solutions is sufficient to cover both the probe and temperature sensor and be free of air bubbles (see manufacturer's instructions for additional information).

A record of each calibration must be made in the calibration log. The record needs to include at a minimum:

- serial number of the instrument
- parameters which were calibrated
- standards used in calibration
- date and time of calibration
- initials of technician

7.1 Chlorine

Chlorine testing in the field is usually done using a colorimeter. There are two methods of standardization: 1) gel standards (once a week or prior to use) and 2) ampule standards (recommended every 13 weeks). Prior to reading the standards, zero the colorimeter with a blank (deionized water) and record measurements to 0.01 mg/L. Acceptance criterion for the gel standards (0.20, 0.83, and 1.53 mg/L) is ±15% and for the ampule standards (0.12, 0.60, 1.20 mg/L) is ±20%. If expected chlorine levels are higher than the range of these standards, select standards that bracket the expected field results.

7.2 Conductivity and Salinity

Conductivity is used to measure the ability of an aqueous solution to carry an electrical current. Specific conductance is the conductivity value corrected to 25°C. There are a

variety of instruments available to measure conductivity, specific conductance, salinity, and temperature. Most instruments are calibrated against a single standard which is near, but below the specific conductance of the environmental samples. A second standard which is above the environmental sample specific conductance is used to check the linearity of the instrument in the range of measurements.

If cleaning electrical connections, changing batteries (recharging), or changing sensors does not correct standardization failures, then the unit should be sent back to the manufacturer for servicing. Freshwater standards (0.05-1.00 mS/cm) or Seawater standards (40-60 mS/cm) are recommended for standardizations checks every 13 weeks. These standardizations should be conducted at a temperature of 25°C±1°C. The acceptance criterion is ±5%. The temperature probes of these meters should be checked for accuracy (acceptance criterion ±0.5°C) at the same time because temperature is factored into the meters program for calculating conductivity, specific conductance and salinity. Standardizations can be done with a specifically designated and labeled "Reference Meter", which must be standardized with standard water samples every 4 weeks. Refractometers (salinity/density) must be standardized (acceptance criterion ±1.0 ppt) every 13 weeks or prior to use with a "Reference Meter." Before using a refractometer for recording salinity data, verify that it meets or exceeds the precision requirements for the data being collected.

Calibration Procedure

1. Allow the calibration standard to equilibrate to the ambient temperature.

2. Remove probe from its storage container, rinse the probe with a small amount of the conductivity/specific conductance standard (discard the rinsate), and place the probe into the conductivity/specific conductance standard.

3. Select monitoring/run mode. Wait until the probe temperature has stabilized.

4. Look up the conductivity value at this temperature from the conductivity versus temperature correction table usually found on the standard bottle or on the standard instruction sheet. You may need to interpolate the conductivity value between temperatures. Select calibration mode, then conductivity. Enter the temperature corrected conductivity value into the instrument.

5. Select monitoring/run mode. The reading should remain within manufacturer's specifications. If it does not, re-calibrate. If readings continue to change after recalibration, consult manufacturer.

6. Read the specific conductance on the instrument and compare the value to the specific conductance value on the standard. The instrument value should agree with the standard within the manufacturer's specifications. If not, re-calibrate. If the re-calibration does not correct the problem, the probe may need to be cleaned or serviced by the instrument manufacturer.

7. Remove probe from the standard, rinse the probe with a small amount of the second conductivity/specific conductance standard (discard the rinsate), and place the probe into the second conductivity/specific conductance standard. The second standard will serve to verify the linearity of the instrument. Read the specific conductance value from the instrument and compare the value to the specific conductance on the standard. The two values should agree within the specifications of the instrument. If they do not agree, recalibrate. If readings do not compare, then the second standard may be outside the linear range of the instrument. Use a standard that is closer, but above the first standard and repeat the verification. If values still do not compare, try cleaning the probe or consult the manufacturer.

8. When monitoring groundwater or surface water, use the specific conductance readings.

7.3 Dissolved Oxygen (D.O.)

Dissolved oxygen (DO) content in water is measured using a membrane electrode. The DO probe's membrane and electrolyte solution should be replaced prior to the sampling period. Failure to perform this step may lead to erratic measurements. There are a variety of instruments available to measure dissolved oxygen (% saturation & mg/L) and temperature.

If cleaning electrical connections, changing batteries (recharging), or changing the permeable membrane on the sensor does not correct standardization failures, then the unit should be sent back to the manufacturer for servicing. If the unit has an air calibration function, air calibrate (100% saturation) the meter prior to use or follow manufacture's directives. Newer instruments utilize a luminescent dissolved oxygen probe (LDO). LDO sensor caps need to be replaced based on the manufacturer's maintenance schedule. LDO sensors are calibrated using air saturated water.

Calibration Procedure

1. Gently dry the temperature sensor according to manufacturer's instructions.

2. Place a wet sponge or a wet paper towel on the bottom of the DO calibration container.

3. Place the DO probe into the container without the probe coming in contact with the wet sponge or paper towel. The probe must fit tightly into the container to prevent the escape of moisture evaporating from the sponge or towel.

4. Allow the confined air to become saturated with water vapor (saturation occurs in approximately 10 to 15 minutes). During this time, turn-on the instrument to allow the DO probe to warm-up. Select monitoring/run mode. Check temperature readings. Temperature readings must stabilize before continuing to the next step.

5. Select calibration mode; then select "DO %".

6. Enter the local barometric pressure (usually in mm of mercury) for the sampling location into the instrument. This measurement must be determined from an on-site barometer. Do not use barometric pressure obtained from the local weather services unless the pressure is corrected for the elevation of the sampling location. [Note: inches of mercury times 25.4 mm/inch equals mm of mercury or consult Oxygen Solubility at Indicated Pressure, Table 2].

7. The instrument should indicate that the calibration is in progress. The instrument will take approximately one minute to calibrate. After calibration, the instrument should display percent saturated DO.

8. Select monitoring/run mode. Compare the DO mg/l reading to the Oxygen Solubility at Indicated Pressure chart (Table 2). The numbers should agree. If they do not agree to the accuracy of the instrument (usually ± 0.2 mg/L), repeat calibration. If this does not work, change the membrane and electrolyte solution. Insure that there are no air bubbles trapped below the membrane.

9. Remove the probe from the container and place it into a 0.0 mg/L DO standard. The standard must be filled to the top of its container and the DO probe must fit tightly into the standard's container (no head space). Check temperature readings. They must stabilize before continuing.

10. Wait until the "mg/l DO" readings have stabilized. The instrument should read 0.0 mg/L or to the accuracy of the instrument (usually ± 0.2 mg/L). If the instrument cannot reach these values, it will be necessary to clean the probe, and change the membrane and electrolyte solution. If this does not work, prepare a new 0.0 mg/L DO standard. If these measures do not work, contact manufacturer.

Note: To prepare a zero mg/L DO standard follow the procedure stated in Standard Methods (4500-O G; 18th edition). The method states to add excess sodium sulfite (until no more dissolves) and a trace amount of cobalt chloride to water. The standard container must be completely filled (no head space). This solution is prepared prior to the sampling event. If some of the solution is lost during instrument calibration, add more water to the container so that the standard is stored with no head space.

7.4 pH Meters

The pH of a sample is determined electrometrically using a glass electrode. There are a variety of instruments available to measure pH and temperature. There are pH test strips, indicator solutions, data loggers (e.g., Hydrolab minisonde) with pH sensors and hand-held DC powered pH meters. A pH meter must be calibrated/standardized daily prior to use (Standard Methods 4500-H^+ B; 18th Edition). If standardizing, select standard buffer solutions that bracket the pH range of the samples to be measured. The

acceptance criterion is ±0.1 su. If pH standards 2 and 10 are used, pH 7 should be used as a check. When calibrating (two point calibration), use fresh (unused) buffer standards. The temperature probes of pH meters (if there is a readout displayed) should be checked for accuracy (acceptance criterion (±0.5°C) at the same time as pH calibration/standardization because temperature adjustments are made by the meters program in calculating the pH value. Properly label and dispose of all waste chemicals and materials. Dispose of hazardous wastes according with the Hazard Waste Management Guidance Document.

Calibration Procedure

1. Allow the fresh buffered standards to equilibrate to the ambient temperature.

2. Fill calibration containers with the fresh buffered standards so each standard will cover the pH probe and temperature sensor.

3. Remove probe from its storage container, rinse with distilled water, and blot dry with soft tissue.

4. Select monitoring/run mode. Immerse probe into the initial standard (e.g., pH 7).

5. Stir the standard until the readings stabilize. If the reading does not change within 30 seconds, select calibration mode and then select "pH". Enter the buffered standard value into instrument. Select monitoring/run mode. The readings should remain within manufacturer's specifications; if they change, re-calibrate. If readings continue to change after re-calibration, consult manufacturer.

6. Remove probe from the initial standard, rinse with distilled water, and blot dry.

7. Immerse probe into the second standard (e.g., pH 4). Repeat step 5.

8. Remove probe from the second standard, rinse with distilled water, and blot dry. If instrument only accepts two standards, the calibration is complete. Go to step 11. Otherwise continue.

9. Immerse probe in third buffered standard (e.g., pH 10) and repeat step 5.

10. Remove probe from the third standard, rinse with distilled water, and blot dry.

11. Select monitoring/run mode, if not already selected. To ensure that the initial calibration standard (e.g., pH 7) has not changed; immerse the probe into the initial standard. Wait for the readings to stabilize. The reading should read the initial standard value within the manufacturer's specifications. If not, re-calibrate the instrument. If recalibration does not help, the calibration range may be too great. Reduce calibration range by using standards that are closer together.

12. The calibration is complete. Place pH probe in its storage container.

7.5 Flowmeters

Flowmeters (e.g., General Oceanics, Inc.) are used in the openings of plankton nets to estimate the volume of water passing through the net during sampling. These mechanical meters record the revolutions of the impellers; the revolutions per unit time are used to calculate flow through the net. Flowmeters must be standardized once every 52 weeks. The accuracy of these meters is based on how freely the impeller spins, which is verified using a General Oceanics, Inc. Calibration Frame. The frame imparts a torsionally precise spin to the rotor and a count difference is noted in the flowmeter window. A minimum count is necessary for the flowmeter to be within calibration. The acceptance criterion for a General Oceanics, Inc. flowmeter is 80 revolutions per standard spin.

7.6 Temperature

Temperature data are collected with data loggers, thermometers, and thermistors in a variety of multiparameter meters (e.g., pH, D.O., and Conductivity/Salinity). Each instrument must have the accuracy of its temperature component verified because many of the other parameters change with temperature. "Reference Thermometers" are glass, capillary thermometers that have a read out accuracy 0.1°C and they have their accuracy verified with a certified thermometer once every 52 weeks. The acceptance criterion for Reference Thermometers is ±0.2°C. All other capillary thermometers used in the collection of data are standardized to the Reference Thermometers every 52 weeks (the acceptance criterion is ±0.5°C). Data loggers are standardized every 26 weeks (the acceptance criterion is ±0.5°C). Thermistors in multimeters are standardized every 13 weeks (the acceptance criterion is ±0.5°C).

Verification Procedure

1. Allow a container filled with water to come to room temperature.

2. Place a thermometer that is traceable to the National Institute of Standards and Technology (NIST) and the instrument's temperature sensor into the water and wait for both temperature readings to stabilize.

3. Compare the two measurements. The instrument's temperature sensor must agree with the reference thermometer measurement within the accuracy of the sensor (usually ±0.15°C). If the measurements do not agree, the instrument may not be working properly and the manufacturer needs to be consulted.

7.7 Turbidity

Turbidity meters are standardized with primary standards once every 13 weeks and with secondary standards prior to use. The meters are zeroed with de-ionized water prior to standardization and use. Primary standards are made up from mixing a powder in de-ionized water (4 standards are measured: <1, 20, 100, & 800 NTU) and the acceptance criterion is ±5%. Secondary standards are gels in the range of 5, 50, 500

NTU and the acceptance criterion is ±10%. De-ionized water is measured three times prior to measuring the gel standards.

The turbidity is based upon a comparison of intensity of light scattered by a sample under defined conditions with the intensity of light scattered by a standard reference suspension. A turbidimeter is a nephelometer with a visible light source for illuminating the sample and one or more photo-electric detectors placed ninety degrees to the path of the light source. Some instruments will only accept one standard. For these instruments, the standards will serve as check points.

Calibration Procedures

1. Allow the calibration standards to equilibrate at the ambient temperature. The use of commercially available polymer primary standards (AMCO-AEPA-1) is preferred, however, the standards can be prepared using Formazin according to the EPA analytical Method 180.1.

2. If the standard cuvette is not sealed, rinse a cuvette with deionized water. Shake the cuvette to remove as much water as possible. Do not wipe dry the inside of the cuvette because lint from the wipe may remain in the cuvette. Add the standard to the cuvette.

3. Before performing the calibration procedure, make sure the cuvettes are not scratched and the outside surfaces are dry, free from fingerprints and dust. If the cuvette is scratched or dirty, discard or clean the cuvette respectively.

4. Zero the instrument by using either a zero or 0.02 NTU standard. A zero standard (approximately 0 NTU) can be prepared by passing distilled water through a 0.45 micron pore size membrane filter.

5. Using a standard in the range of 5 - 20 NTUs, calibrate according to manufacturer's instructions or verify calibration if instrument will not accept a second standard. If verifying, the instrument should read standard value to within the specifications of the instrument. If the instrument has range of scales, check each range that will be used during the sampling event with a standard that falls within that range.

7. Using a standard between 20 and 100 NTUs, calibrate according to manufacturer's instructions or verify calibration if instrument does not accept a third standard. If verifying, the instrument should read standard value to within the specifications of the instrument. If the instrument has range of scales, check each range that will be used with the proper standard for that scale.

7.8 Weight

Precision balances with an accuracy of 0.001 to 0.00001 grams are calibrated once every 52 weeks by a vendor. All scales and balances used for collecting environmental data are standardized with a minimum of three standard weights (Class 4 or better) every 4 weeks. Personnel using balances to collect weight data need to check the calibration sticker for the standardization expiration date and the range of the

standardization. If weight measurements are being made outside the documented standardization range, a new weight range bracketing the expected measurements needs to be used in standardizing the balance.

7.9 Oxidation/Reduction Potential (ORP)

The oxidation/reduction potential is the electrometric difference measured in a solution between an inert indicator electrode and a suitable reference electrode. The electrometric difference is measured in millivolts (mV) and is temperature dependent. ORP is calibrated using one-point calibration with a Zobell solution. The acceptance criteria for ORP standard potential should be within ±10 mV at a defined temperature.

Calibration Procedure

1. Allow the calibration standard (a Zobell solution) to equilibrate to ambient temperature.

2. Remove the probe from its storage container, and place it into the standard.

3. Select monitoring/run mode.

4. While stirring the standard, wait for the probe temperature to stabilize, and then read the temperature.

5. Look up the millivolt (mv) value at this temperature from the millivolt versus Temperature (Table 3) correction table usually found on the standard bottle or on the standard instruction sheet. You may need to interpolate millivolt value between temperatures. Select "calibration mode", then "ORP". Enter the temperature-corrected ORP value into the instrument.

6. Select monitoring/run mode. The readings should remain unchanged within manufacturer's specifications. If they change, re-calibrate. If readings continue to change after re-calibration, consult manufacturer.

7. If the instrument instruction manual states that the instrument is factory calibrated, then verify the factory calibration against the standard. If they do not agree within the specifications of the instrument, the instrument will need to be re-calibrated by the manufacturer.

8.0 Contacts

Name	Office	Cell
Karen Canody (Manager Biology)	804-273-3893 804-271-5304	804-627-3262
Casey Seelig (EB)	804-271-5312	804-385-6655
Raymond Heller (EB Millstone)	860-447-1791 ext. 5054	860-333-3832
Keith German (GES)	304-627-3947 ext. 4836	412-736-2983
Jim Levin (Cove Point)	410-286-5136	443-532-0912

9.0 Tables

Table 1. Calibration and Standardization Protocols

Parameter	Method	Interval	Standard	Acceptance Criterion	Calib./Stand. Method	Comments
Chlorine	Test Kit (gel standard)	Weekly	0.20 mg/L, 0.83 mg/L, 1.53 mg/L	±15%	Standardization	Zero meter to blank prior to measuring gel standards.
	Test Kit (ampule standard)	13 wks	Total Chlorine 0.12 (0.02 to 0.22) mg/L 0.60 (0.40 to 0.80) mg/L 1.20 (0.90 to 1.50) mg/L	±20%	Standardization	Record concentrations to 0.01 mg/L. Zero meter to blank prior to measuring standards.
Conductivity (specific conductance)	Instrument/Meter	13 wks	Freshwater 0.05-1.00 mS/cm	±5%	Standardization	If standard temperature is 25°C±1, standardize to specific conductance or conductivity.
			Seawater 40-60 mS/cm	±5%	Standardization	
	Reference Meter	4 wks	Freshwater 0.05-1.00 mS/cm	±5%	Standardization	
			Seawater 40-60 mS/cm	±5%	Standardization	

Parameter	Method	Interval	Standard	Acceptance Criterion	Calib./Stand. Method	Comments
Dissolved Oxygen	Reference/Instrument/Meter	4 wks	Azide – Winkler method using potassium iodide – iodate solution with an equivalent DO concentration of about 10 mg/L	±0.05 mg/L	Standardization	For dissolved oxygen, air calibrate prior to comparing to standard and record the temperature of standard.
	Optical DO Meter	4 wks	Azide – Winkler method using potassium iodide – iodate solution with an equivalent DO concentration of about 10 mg/L or Reference Meter	±0.05 mg/L	Standardization	
	Test Kit	52 wks	Azide – Winkler method using potassium iodide – iodate solution with an equivalent DO concentration of about 10 mg/L or Reference Meter	±0.05 mg/L	Standardization	
	Test Kit Instrument/Meter	Air calibrate prior to use	Azide – Winkler method using potassium iodide – iodate solution with an equivalent DO concentration of about 10 mg/L or Reference Meter	±0.05 mg/L	Standardization	
ORP	Instrument/Meter	Prior to use	Zobell's Solution	±10mV	Calibration	

Parameter	Method	Interval	Standard	Acceptance Criterion	Calib./Stand. Method	Comments
pH	AC Counter Top Units	Daily/Weekly	4.0, 7.0, and 10.0 Buffers	±0.1 su	Two Point Calibration or Standardization	Daily when meter is first turned on or weekly if meter remains on
	Battery Powered Portable Units	Day-of-Use	4.0, 7.0, and 10.0 Buffers	±0.1 su	Two Point Calibration or Standardization	Day-of-Use = 24 hour period following the last meter calibration or standardization
Flowmeter	Calibration Fame	52 wks	Standard spin	at least 80 revolutions	Standardization	General Oceanics Inc. Method
Salinity (specific conductance)	Visual Inspection	13 wks	Manufacturer's recommendations	Good condition	Equipment Check	Batteries are replaced every 13 weeks
	Reference Meter	4 wks	Freshwater 0.05-1.00 mS/cm	±5%	Standardization	If standard temperature is 25°C±1, standardize to specific conductance or conductivity.
	Instrument/Meter	13 wks	Seawater 40-60 mS/cm	±5%	Standardization	
	Instrument/Meter	13 wks	Freshwater 0.05-1.00 mS/cm	±5%	Standardization	
	Instrument/Meter	13 wks	Seawater 40-60 mS/cm	±5%	Standardization	

Parameter	Method	Interval	Standard	Acceptance Criterion	Calib./Stand. Method	Comments
Temperature	Reference Thermometer	52 wks	Certified Thermometer	±0.2°C	Three Temperatures to 0.1 °C accuracy	If deviation is greater than 0.1 °C, attach a tag with the correction factor to 0.1 °C or replace the thermometer
	Thermistor	13 wks	Reference Thermometer	±0.5°C	One temperature to 0.1 °C accuracy	
	Thermometer	52 wks	Reference Thermometer	±0.5°C	One temperature to 0.1 °C accuracy	For thermometers with 1 °C increments, record temperature to 0.2 °C and for thermometers with 0.1 °C increments to 0.1 °C
	Data Logger	26 wks	Reference Thermometer	±0.5°C	One temperature to 0.1 °C accuracy	
Turbidity	Primary Standard	13 wks	4 Standards (<1, 20, 100, & 800 NTU)	±5%	Standardization	Zero meter to de-ionized water.
	Secondary Standard	Prior to Use	Gel Standards (0-10, 10-100, 100-1000 NTU)	±10%	Standardization	Measure de-ionized water three times prior to measuring gel standards.
Weight	Balance	4 wks	Minimum of three reference weights	±5% Reference Weight	Standardization	Two weights should bracket the expected range for which the balance will be used and the third weight should be at an approximate mid-range.

Table 2. Oxygen Solubility (mg/L) at Indicated Pressure

	Atmospheric Pressure (mm Hg)						
Temp. °C	760	755	750	745	740	735	730
0	14.57	14.47	14.38	14.28	14.18	14.09	13.99
1	14.17	14.08	13.98	13.89	13.79	13.70	13.61
2	13.79	13.70	13.61	13.52	13.42	13.33	13.24
3	13.43	13.34	13.25	13.16	13.07	12.98	12.90
4	13.08	12.99	12.91	12.82	12.73	12.65	12.56
5	12.74	12.66	12.57	12.49	12.40	12.32	12.23
6	12.42	12.34	12.26	12.17	12.09	12.01	11.93
7	12.11	12.03	11.95	11.87	11.79	11.71	11.63
8	11.81	11.73	11.65	11.57	11.50	11.42	11.34
9	11.53	11.45	11.38	11.30	11.22	11.15	11.07
10	11.28	11.19	11.11	11.04	10.96	10.89	10.81
11	10.99	10.92	10.84	10.77	10.70	10.62	10.55
12	10.74	10.67	10.60	10.53	10.45	10.38	10.31
13	10.50	10.43	10.36	10.29	10.22	10.15	10.08
14	10.27	10.20	10.13	10.06	10.00	9.93	9.86
15	10.05	9.98	9.92	9.85	9.78	9.71	9.65
16	9.83	9.76	9.70	9.63	9.57	9.50	9.43
17	9.63	9.57	9.50	9.44	9.37	9.31	9.24
18	9.43	9.37	9.30	9.24	9.18	9.11	9.05
19	9.24	9.18	9.12	9.05	8.99	8.93	8.87
20	9.06	9.00	8.94	8.88	8.82	8.75	8.69
21	8.88	8.82	8.76	8.70	8.64	8.58	8.52
22	8.71	8.65	8.59	8.53	8.47	8.42	8.36
23	8.55	8.49	8.43	8.38	8.32	8.26	8.20
24	8.39	8.33	8.28	8.22	8.16	8.11	8.05
25	8.24	8.18	8.13	8.07	8.02	7.96	7.90
26	8.09	8.03	7.98	7.92	7.87	7.81	7.76
27	7.95	7.90	7.84	7.79	7.73	7.68	7.62
28	7.81	7.76	7.70	7.65	7.60	7.54	7.49
29	7.68	7.63	7.57	7.52	7.47	7.42	7.36
30	7.55	7.50	7.45	7.39	7.34	7.29	7.24
31	7.42	7.37	7.32	7.27	7.22	7.16	7.11
32	7.30	7.25	7.20	7.15	7.10	7.05	7.00
33	7.08	7.13	7.08	7.03	6.98	6.93	6.88

34	7.07	7.02	6.97	6.92	6.87	6.82	6.78
35	6.95	6.90	6.85	6.80	6.76	6.71	6.66
36	6.84	6.79	6.76	6.70	6.65	6.60	6.55
37	6.73	6.68	6.64	6.59	6.54	6.49	6.45
38	6.63	6.58	6.54	6.49	6.44	6.40	6.35
39	6.52	6.47	6.43	6.38	6.35	6.29	6.24
40	6.42	6.37	6.33	6.28	6.24	6.19	6.15
41	6.32	6.27	6.23	6.18	6.14	6.09	6.05
42	6.22	6.18	6.13	6.09	6.04	6.00	5.95
43	6.13	6.09	6.04	6.00	5.95	5.91	5.87
44	6.03	5.99	5.94	5.90	5.86	5.81	5.77
45	5.94	5.90	5.85	5.81	5.77	5.72	5.68

Table 2 (cont'd). Oxygen Solubility (mg/L) at Indicated Pressure

	Atmospheric Pressure (mm Hg)							
Temp. °C	725	720	715	710	705	700	695	690
0	13.89	13.80	13.70	13.61	13.51	13.41	13.32	13.22
1	13.51	13.42	13.33	13.23	13.14	13.04	12.95	12.86
2	13.15	13.06	12.07	12.88	12.79	12.69	12.60	12.51
3	12.81	12.72	12.63	12.54	12.45	12.36	12.27	12.18
4	12.47	12.39	12.30	12.21	12.13	12.04	11.95	11.87
5	12.15	12.06	11.98	11.89	11.81	11.73	11.64	11.56
6	11.84	11.73	11.68	11.60	11.51	11.43	11.35	11.27
7	11.55	11.47	11.39	11.31	11.22	11.14	11.06	10.98
8	11.26	11.18	11.10	11.02	10.95	10.87	10.79	10.71
9	10.99	10.92	10.84	10.76	10.69	10.61	10.53	10.46
10	10.74	10.66	10.59	10.51	10.44	10.36	10.29	10.21
11	10.48	10.40	10.33	10.28	10.18	10.11	10.04	9.96
12	10.24	10.17	10.10	10.02	9.95	9.88	9.81	9.46
13	10.01	9.94	9.87	9.80	9.73	9.66	9.59	9.52
14	9.79	9.72	9.65	9.68	9.51	9.45	9.38	9.31
15	9.58	9.51	9.44	9.58	9.31	9.24	9.18	9.11
16	9.37	9.30	9.24	9.17	9.11	9.04	8.97	8.91
17	9.18	9.11	9.05	8.98	8.92	8.85	8.79	8.73
18	8.99	8.92	8.86	8.80	8.73	8.67	8.61	8.54
19	8.81	8.74	8.68	8.62	8.56	8.49	8.43	8.37

20	8.63	8.57	8.51	8.45	8.39	8.33	8.27	8.21
21	8.46	8.40	8.34	8.28	8.22	8.16	8.10	8.04
22	8.30	8.24	8.18	8.12	8.06	8.00	7.95	7.89
23	8.15	8.09	8.03	7.97	7.91	7.86	7.80	7.74
24	7.99	7.94	7.88	7.82	7.76	7.71	7.65	7.59
25	7.85	7.79	7.74	7.68	7.60	7.57	7.51	7.46
26	7.70	7.65	7.59	7.54	7.48	7.43	7.37	7.32
27	7.57	7.52	7.46	7.41	7.35	7.30	7.25	7.19
28	7.44	7.38	7.33	7.28	7.22	7.17	7.12	7.06
29	7.31	7.26	7.21	7.15	7.10	7.05	7.00	6.94
30	7.19	7.14	7.08	7.03	6.98	6.93	6.88	6.82
31	7.06	7.01	6.96	6.91	6.86	6.81	6.76	6.70
32	6.95	6.90	6.85	6.80	6.70	6.70	6.64	6.59
33	6.83	6.78	6.73	6.68	6.83	6.58	6.53	6.48
34	6.73	6.68	6.63	6.58	6.53	6.48	6.43	6.38
35	6.61	6.56	6.51	6.47	6.42	6.37	6.36	6.27
36	6.51	6.46	6.41	6.36	6.31	6.27	6.22	6.17
37	6.40	6.35	6.31	6.26	6.21	6.16	6.12	6.07
38	6.30	6.26	6.21	6.16	6.12	6.07	6.02	5.98
39	6.26	6.15	6.11	6.06	6.01	5.97	5.92	5.87
40	6.10	6.06	6.01	5.96	5.92	5.86	5.83	5.78
41	6.00	5.96	5.91	5.87	5.82	5.78	5.73	5.69
42	5.91	5.86	5.82	5.77	5.73	5.69	5.64	5.60
43	5.82	5.78	5.73	5.69	5.65	5.60	5.56	5.51
44	5.72	5.68	5.64	5.59	5.55	5.51	5.46	5.42
45	5.64	5.59	5.55	5.51	5.47	5.42	5.38	5.34

Table 3. Temperature Dependency of Zobell's ORP Standard

Temp. °C	mV
10	243.5
15	236.0
20	228.5
25	221.1

11.0

Environmental Services
Pam Faggert

Electric Environmental Services
Cathy Taylor
Karen Canody
Don Hintz
Meredith Simas
Scott Lawton
Nicole Wilkinson
Ken Roller
Bill Scarpinato
Oula Shehab-Dandan
Liz Willoughby
Glenn Johnson
Rick Woolard
Manna Chan

Environmental Biology
Karen Canody
Don Landers
Sheila Hoffman
Paul Vidonic
Robert Andrews
Taylor Allen
Chris Taylor
Casey Seelig
Peter Sturke
Robert Graham
Glenn Bishop
Matt Overton
Greg Decker
James Foertch
John Swenarton
Joseph Vozarik
Raymond Heller
Stephen Dwyer
Susan Gonzalez

Environmental Laboratory
Herb Chriscoe

Gas Environmental Services
Mark Reaser
Sam Mathew
Sheri Franz
Tim Carter
Richard Gangle
Scott Kingston
Brad Will
Olive Dimon
Keith German
Troy Hawkins
Randy Rogers
Christopher Todd
Jim Levin
Roland Pratt
Jason Harshbarger
Judy Box
Mike Leger

Appendix C

Lists of Data to be Collected and Recorded for Field Collection and Processing

Impingement Sample Collection Data Sheet

Category	Parameter	Value				
General Information	Crew Names Date Time (military) Tidal Phase					
Weather condition	Air Temp. (^{o}C) Wind Direction Wind Speed (MPH) Sky Precipitation (in.) Wave Height (ft)					
Facility Operation	Circulation Pump Service Pump Status Screen Status Screen Wash Method					
Water Quality	Time (military) Depth (ft) Temp. (^{o}C) DO (mg/L) Specific Cond. (µs) Specific Cond. @ 25 Salinity (ppt) pH	Reading Meter Meter Meter Calculated Calculated Meter				
Water Quality QC	Temp. (^{o}C) DO (mg/L) Specific Cond. (µs) pH	Bottle Bottle Bottle Bottle				
Gear Used	Mesh size (µm) Dimension Configuration					
Sample Collection	Time (military) Volume	Start Reading	End			
Collection Processing	Species Name	Live, Undamaged Count	Live, Damaged Count	Fresh Dead Count	Dead/decaying Count	Batch Species Weight
	Comments					
Length/Weight	Species Name	Length (mm)	Max Depth (mm)	Max Width (mm)	Weight (g)	
Atlantic Sturgeon	See *Handling Procedures for Atlantic Sturgeon* (Section 6.4.4)	Total Length (mm)	Fork Length (mm)	Interorbital Width (mm)	Mouth Width (mm)	Weight (g)
Debris Load	Total Debris Volume	gallons				
	Debris Volume by Type	Percentage	Aquatic vegetation and algae	Terrestrial vegetation – leafy/herbaceous		Terrestrial vegetation – woody
			Aquatic or terrestrial fauna not quantified in impingement sample, with description (exact taxonomic identification if feasible but not necessary, e.g. aquatic insect larvae)			
			Sediments or other natural inorganic debris, with general description of size composition (e.g. gravel, sand, silt etc.)			
			Man-made debris/refuse with general description of types (plastic, metal etc.)			
			"Other" with description			
Crew Signature						

Example Impingement Identification and Enumeration Quality Control Results Data Sheet

Category	Value	
Date		
Project Location		
QC Analyzer		
Original Analyzer		
QC Program:		
Model 1		
Model 2		
QC#		
Sample Number		
Date		
Species		
Original Count		
QC Count		
% Efficiency	I.D.	Count
Comments		

COMMONWEALTH of VIRGINIA

DEPARTMENT OF ENVIRONMENTAL QUALITY
PIEDMONT REGIONAL OFFICE
4949A Cox Road, Glen Allen, Virginia 23060
(804) 527-5020 Fax (804) 527-5106
www.deq.virginia.gov

Molly Joseph Ward
Secretary of Natural Resources

David K. Paylor
Director

Michael P. Murphy
Regional Director

March 4, 2015

Cathy C. Taylor
Dominion Resources Services, Inc.
5000 Dominion Boulevard
Glen Allen, Virginia 23060

Subject: Additional Information Request for §316(b) Requirements, Chesterfield Power Station, VA0004146

Dear Ms. Taylor:

On August 15, 2014, the US Environmental Protection Agency published the final rule for §316(b) of the Clean Water Act (40CFR Parts 122 and 125). §316(b) details the Best Technology Available (BTA) requirements for reducing impingement and entrainment of aquatic organisms associated with cooling water intake structures (CWISs). In accordance with the final rule, existing facilities subject to a NPDES permit with a cooling water intake designed to withdraw greater than 2 million gallons per day of cooling water from waters of the US are subject to the §316(b) rule. Chesterfield Power Station (CPS) meets all of these applicability criteria.

A significant volume of permit application data and supporting information requirements [40CFR122.21(r)] are necessary to show compliance with the BTA options in the final rule. However, 40CFR 125.95(a)(2) allows for the owner or operator of a subject facility whose current permit expires prior to or on July 14, 2018 to request an alternate schedule for the submission of this information. If the owner or operator demonstrates that it cannot develop the required information before the applicable submission date, DEQ must establish an alternate schedule for submission of the data. If you would like an alternate schedule for submission of the required data and supporting information, please submit a request in writing for the alternate schedule along with a demonstration of need.

As required by §316(b), DEQ must establish an interim BTA for VPDES permits issued after October 14, 2014 and before or on July 14, 2018 to facilities subject to the final rule where an alternate schedule has been developed. CPS currently has an application under review by DEQ for reissuance of the VPDES permit. It is anticipated that the permit will be reissued before July 14, 2018. Therefore, DEQ must establish interim BTA for impingement and entrainment technologies at CPS.

DEQ has reviewed the CPS file for details on the CWISs, impingement and entrainment prevention technologies and best management practices (BMPs) used by CPS to reduce the impacts of impingement and entrainment. Additional information is needed from CPS to make an interim BTA determination. Please provide the following items:

1. A summary of the design specifications for the current CWISs including date constructed/upgraded, dimensions of the CWISs, number and dimension of the intake ports per CWIS, vertical distance of the intake ports from the riverbed, design intake and velocity capacities, and latitude/longitude of each CWIS.

2. Updated information on the traveling screens including number, size, mesh opening, and pass through velocities if this information has changed since the August 2007 Impingement Mortality and Entrainment Characterization Report was submitted.
3. Data on any primary and back-up pumps for the CWISs including the number, design capacity, and variable speed capabilities of the pumps for each CWIS.
4. Data on any structural and behavioral systems to deter fish from entering the CWIS area.
5. Any operation and maintenance procedures for the CWISs including intake flow variation or BMPs used during periods of high potential impingement and entrainment (e.g., spawning, anadromous fish migration, etc.) and CWIS maintenance.
6. Information on the temperature ranges, pressures, and durations of the cooling process.

Please provide a written response within twenty-one (21) days of receipt of this letter. If you have any questions regarding this letter or the §316(b) final rule in general, please do not hesitate to contact Brian Wrenn at 804-527-5015 or brian.wrenn@deq.virginia.gov.

Sincerely,

Emilee C. Adamson

Emilee C. Adamson
Planning & VPDES Permit Manager

Pamela F. Faggert
Vice President and Chief Environmental Officer

Dominion Resources Services, Inc.
5000 Dominion Boulevard, Glen Allen, VA 23060
Phone: 804-273-3467

Dominion®

Certified Mail
Return Receipt Requested

December 29, 2008

RECEIVED
JAN 05 2009
PRO

Mr. Ray Jenkins
Virginia Department of Environmental Quality
Piedmont Regional Office
4949-A Cox Road
Glen Allen, VA 23060

RE: Chesterfield Power Station VPDES Permit VA0004146
Section 316(b) Phase II Requirement
Impingement Mortality and Entrainment Characterization Study Results

Dear Mr. Jenkins:

Please find enclosed the Impingement Mortality Characterization Study Results submittal for the Chesterfield Power Station as required by the VPDES permit VA0004146, Part I.B.21.

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine, and imprisonment for knowing violations.

If you have any questions, please contact Ms. Oula Shehab-Dandan at (804) 273-2697.

Sincerely,

Pamela F. Faggert

Pamela F. Faggert

Enclosure

Impingement Mortality And Entrainment Characterization Report Chesterfield Power Station June 2005 – May 2006

Prepared for

Dominion Resources Services, Inc.
5000 Dominion Boulevard
Glen Allen, Virginia 23060

Prepared by

EA Engineering, Science, and Technology, Inc.
15 Loveton Circle
Sparks, Maryland 21152

Final Report
August 2007

CONTENTS

Page

LIST OF FIGURES iii

LIST OF TABLES iii

1. INTRODUCTION 1

2. GENERATING STATION DESCRIPTION 2

2.1 Site Description 2
2.2 Station Description 2
2.3 Habitat and Biological Community 2

3. IMPINGEMENT STUDY AT CHESTERFIELD POWER STATION 4

3.1 Methods 4

3.1.1 Impingement Sampling 4
3.1.2 Water Quality 4
3.1.3 Ambient Juvenile and Adult Fish Sampling 4
3.1.4 Data Analysis 5

3.2 Results 5

3.2.1 Composition, Abundance, and Factors Influencing Impingement 5
3.2.2 Size of Impinged Fish and Shellfish 6
3.2.3 Monthly and Annual Estimates of Total Impingement 6
3.2.4 Water Quality 7
3.2.5 Comparison of 2005-2006 Impingement Data to Quarterly Ambient Juvenile/Adult Data 7
3.2.6 Historical Studies 8
3.2.7 Impingement Summary 9

4. ENTRAINMENT STUDY AT CHESTERFIELD POWER STATION 11

4.1 Methods 11

4.1.1 Entrainment Sampling and Laboratory Processing 11
4.1.2 Ambient Ichthyoplankton Sampling 11
4.1.3 Water Quality 12
4.1.4 Data Analysis 12

4.2 Results 13

4.2.1 Abundance, Distribution, and Composition 13
4.2.2 Length Frequency 13
4.2.3 Monthly and Annual Estimates of Total Entrainment 14
4.2.4 Comparison of Entrainment and Ambient River Ichthyoplankton Densities 14
4.2.5 Comparison of Entrainment Data and Ambient Juvenile and Adult Data 15
4.2.6 Historical Studies 15
4.2.7 Entrainment Summary 16

5. REFERENCES 18

APPENDIX A Impingement, Entrainment, and Ambient Ichthyoplankton Calculation Procedures
APPENDIX B Impingement Daily Sample Counts
APPENDIX C Entrainment Densities by Sampling Date, All Organisms
APPENDIX D Length Statistics for Entrained Fish Larvae and Juveniles
APPENDIX E Density of Ichthyoplankton and Invertebrates in Ambient River Samples at Chesterfield Power Station

LIST OF FIGURES

1. Diagram of the Chesterfield Power Station Cooling-Water Intake Structure Complex on the James River near Richmond, Virginia.

2. Impingement Calculation Schematic: Extrapolation of Blue Crab Numbers from a Single Sampling Event to the Annual Total, Chesterfield Power Station.

3. Total Number of Fish Impinged per Hourly Sample, Chesterfield Power Station, June 2005 – May 2006.

4. Relationship of Dissolved Oxygen and Water Temperature at Chesterfield Power Station.

5. Location of Ambient Ichthyoplankton Tow Tracks at Chesterfield Power Station.

6. Entrainment Calculation Schematic: Extrapolation of White Perch Egg Numbers from a Single Sampling Event to the Annual Total, Chesterfield Power Station.

7. Annual Average Density of Selected Species Entrained at Chesterfield Power Station During Different Diel Periods.

8. Comparison of Entrainment and Ambient Ichthyoplankton Densities of White Perch Larvae, Chesterfield Power Station.

9. Comparison of Entrainment and Ambient Ichthyoplankton Densities of *Dorosoma* sp. eggs, Chesterfield Power Station.

10. Comparison of Entrainment and Ambient Ichthyoplankton Densities of River Herring Larvae, Chesterfield Power Station.

11. Comparison of Entrainment and Ambient Ichthyoplankton Densities of Gizzard Shad Larvae, Chesterfield Power Station.

12. Comparison of Entrainment and Ambient Ichthyoplankton Densities of Bay Anchovy Eggs, Chesterfield Power Station.

LIST OF TABLES

1. List of Common and Scientific Names of Fish and Shellfish Mentioned in this Report.

LIST OF TABLES (Continued)

2. Ranked Abundance and Percent Composition of Fish and Shellfish Impinged at Chesterfield Power Station, June 2005 – May 2006.

3. Monthly Impingement Catch at Chesterfield Power Station, 2005 – 2006.

4. Number of Impinged Fish and Shellfish Collected During Daytime and Nighttime Hours at Chesterfield Power Station, 2005 – 2006.

5. Length Statistics for Impinged Organisms at Chesterfield Power Station, June 2005 – May 2006.

6. Monthly and Annual Impingement Estimates at Chesterfield Power Station Based on Maximum Cooling-Water Flow.

7. Mean Water Quality Values Associated with Impingement Sampling, Chesterfield Power Station, June 2005 – May 2006.

8. Summary Results of Quarterly Ambient Juvenile and Adult Fish Sampling in the Vicinity of Chesterfield Power Station, 2005 – 2006.

9. Ranked Abundance and Percent Composition of Impinged Fish Collected at Chesterfield Power Station, January – December 1977.

10. Comparison of Current and Historical Impingement Sample Data, Chesterfield Power Station.

11. Average Density and Percent Composition of Ichthyoplankton and Macroinvertebrates Entrained at Chesterfield Power Station, June 2005 – May 2006.

12. Average Density and Percent Composition of Ichthyoplankton Entrained at Chesterfield Power Station, June 2005 – May 2006.

13. Monthly Densities of Common Ichthyoplankton Entrained at Chesterfield Power Station, June 2005 – May 2006.

14. Length-Frequency Distribution of Entrained Gizzard Shad at Chesterfield Power Station.

15. Length-Frequency Distribution of Entrained White Perch at Chesterfield Power Station.

LIST OF TABLES (Continued)

16. Monthly and Annual Entrainment Estimates for Chesterfield Power Station, June 2005 – May 2006.

17. Density of Ichthyoplankton Entrained at Chesterfield Power Station, June 2005 – May 2006.

18. Density of Ichthyoplankton in James River Ambient Ichthyoplankton Samples at Chesterfield Power Station, June 2005 – May 2006.

19. Mean Water Quality Values Associated with Ambient Ichthyoplankton Sampling, Chesterfield Power Station, 2005 – 2006.

1.0 INTRODUCTION

Chesterfield Power Station is located on the south bank of the James River, approximately 15 miles south of Richmond, Virginia.

The Proposal for Information Collection (PIC) for Chesterfield Power Station (Dominion 2005) was submitted to the Virginia Department of Environmental Quality (VDEQ) in February 2005 and subsequently approved by VDEQ. A field impingement and entrainment study was initiated in June 2005 in accord with the approved PIC and completed in May 2006 and is the subject of this report.

This report represents the results of the Impingement and Entrainment Mortality Characterization Study for Chesterfield Power Station based on field collections made between June 2005 and May 2006.

2.0 GENERATING STATION DESCRIPTION

2.1 SITE DESCRIPTION

Chesterfield Power Station is located on the south bank of the tidal portion of the James River, approximately 15 miles south of Richmond, Virginia. The area is essentially urban in nature, and lies on the western edge of the Coastal Uplands physiographic province. At the station, the James River is approximately 410 ft wide and 31 ft deep and flows in a generally southeasterly direction.

2.2 STATION DESCRIPTION

Chesterfield Power Station utilizes a once-through cooling water system with shoreline intake structures. The plant has two discharges, one for Units 3, 7, and 8 and one for Units 4, 5, and 6. Units 3, 4, 5, and 6 are coal burning units and Units 7 and 8 are natural gas and oil combined cycle units. Together, all six units produce a total plant output of 1,726 MW (Dominion 2005).

Cooling water for all the units is withdrawn from the river through five separate cooling water intake structures, one each for Units 5, 6, 7, and 8, and one intake for Units 3 and 4 (Figure 1). Trash racks are installed across the intake structures upstream of thirteen traveling water screen bays to prevent large debris from entering the cooling water intake. Units 3, 4, 7, and 8 are equipped with 8-ft wide screens, while the screens at Units 5 and 6 are 10-ft wide.

Screened cooling water is conveyed to the circulating water pumps through individual bays. Thirteen circulating water pumps, two each for Units 3, 4, 5, 7, and 8 and three for Unit 6, are located in their respective pump houses. Units 3, 7, and 8 discharge directly into the James River, approximately 100-ft downstream of the CWISs, while Units 4, 5, and 6 discharge into a discharge canal and then to Farrar Gut, an oxbow that flows into the main river 1.2 miles downstream from the intakes.

2.3 HABITAT AND BIOLOGICAL COMMUNITY

The James River flows from the mountains of Virginia to the Chesapeake Bay. Chesterfield Power Station is situated on the upper tidal portion of the James, or the connecting link between the fall line at Richmond and the estuarine portion downstream.

The upper tidal James is typical of other tidal fresh portions of coastal plain estuaries, with a wide variety of fishes inhabiting the area depending mainly on natural variables such as water temperature, flow rate, dissolved oxygen and season.

A diverse assemblage of fish has been recorded in this area. Common estuarine species include bay anchovy, Atlantic silverside, white perch, blueback herring, and American and hickory shad. Common freshwater species occurring in this area include largemouth bass, bluegill, blue catfish, gizzard shad and spottail shiner. Scientific and common names of all species mentioned in this report are provided Table 1.

3.0 IMPINGEMENT STUDY AT CHESTERFIELD POWER STATION

3.1 METHODS

3.1.1 Impingement Sampling

Impingement sampling was carried out at Chesterfield Power Station twice a month from June 2005 through May 2006. During each sampling event, 16, 10-minute screen-wash samples were collected at 0800, 0900, 1200, 1300, 1400, 1500, 1800, 1900, 2000, 2100, 2400, 0100, 0200, 0300, 0600, and 0700 hours. Samples were collected in five baskets, consisting of 3/8-inch mesh, and one dip net in the screen-wash troughs for each unit.

All fish collected during a sample were identified and counted, and up to 15 individuals per species were individually measured (nearest mm) and weighed (nearest 0.1 gm). If more than 15 individuals per species were encountered, the excess over 15 was batch weighed. Taxonomic resources included Jenkins and Burkhead (1994), Kazyak et al. (2003), and Murdy et al. (1997).

3.1.2 Water Quality

Water quality measurements were made with a YSI Model 556 water quality analyzer that was calibrated prior to each sampling event. Water temperature was measured in the screen-wash troughs in association with each of the 16 hourly impingement samples. All biological and water quality data were recorded on standard data sheets.

3.1.3 Ambient Juvenile and Adult Fish Sampling

Dominion personnel conducted quarterly sampling of juvenile and adult fish in the vicinity of Chesterfield Power Station. Three stations were sampled by boat electrofishing and gill nets, one upstream, one downstream, and one near the station. At each station, 100 meters of shoreline were electrofished. Gill nets were 100 ft long by 6 ft deep with panels ranging from 1.5-in to 3-in stretched mesh, and were fished for 4 to 6 hours. Larger fish were identified, measured, and weighed in the field, and smaller fish were preserved and subsequently processed in the laboratory.

3.1.4 Data Analysis

All data were entered into an SQL Server database using an Access-based, "front-end" data-entry template. Reports were then printed out and proofed against the original data sheets, and electronic corrections made as necessary. All data manipulations, calculations, and summaries included in this report were performed within the database.

An example of the impingement calculation sequence is provided in Figure 2 using actual data from one of the sampling events at Chesterfield Power Station. The density of blue crab in each individual 10-minute sample is shown and extrapolated to the full hour. The hourly extrapolations were summed to estimate the number impinged during the 24-hour period. Note in Figure 2 that there were four, 2-hour periods where no impingement samples were collected, corresponding to the entrainment sampling periods. Impingement numbers for these missing hours were estimated by averaging the actual sample before, and the one after, the 2-hour missing sample period. Hourly cooling-water flow was also recorded, and if it summed to less than maximum plant capacity for 24 hours, was used to develop an adjustment factor to increase the initial 24-hour estimate to a number that would have been expected under maximum cooling-water flow for the 24-hour period. This adjusted 24-hour impingement catch was then multiplied by the number of calendar days represented by the sampling event. This value was then added to analogous values calculated for the other 23 extrapolation periods to estimate the total impingement, under maximum cooling-water flow conditions, for the entire study year. Additional calculation details are provided in Appendix A.

3.2 RESULTS

3.2.1 Composition, Abundance, and Factors Influencing Impingement

Numbers of impinged fish and shellfish collected during the study are presented in Table 2. Among the total collected were 21 species of finfish and three shellfish. Blue crab was the most abundant organism collected (62 individuals) and blue catfish was the most abundant finfish collected (only 29 individuals). Impingement was notably higher during June through December 2005 than during January through May 2006 (Table 3 and Appendix B). July and October 2005 produced the most fish (47 and 45, respectively). For individual species, blue crab and channel catfish impingement was primarily a fall phenomenon. Blueback herring were primarily impinged during summer. Impingement

of blue catfish, the most abundant finfish collected, occurred throughout the sampling year.

Comparison of impingement rates between day and night revealed only modest differences. Although not readily apparent in Figure 3, Table 4 illustrates somewhat higher catches during nighttime. Higher nighttime impingement rates have been reported by other investigators (e.g., Rulifson and Copeland 1982).

There were moderate differences in impingement rates between ebb and flood tides, as shown below.

Species	Ebb Tide	Flood Tide
Black crappie	14	3
Blue catfish	19	10
Blue crab	37	23
Total	135	82

3.2.2 Size of Impinged Fish and Shellfish

Too few individuals were collected during impingement sampling for any meaningful assessment of length-frequency distributions. Simple statistics for the length data are provided in Table 5. When the data are compared to common compendia of length-at-age data (e.g. Carlander 1969; 1977), it is clear that most impinged individuals were young-of-the-year or older juveniles. Impingement typically is a phenomenon of younger, smaller fish.

3.2.3 Monthly and Annual Estimates of Total Impingement

The impingement sampling data were used in conjunction with station cooling-water flow capacity to estimate the total number of fish and shellfish projected impinged on a monthly and annual basis (Table 6). The relative abundance and monthly distribution mirror the sample data in Table 3, but the Table 6 numbers are larger because they have been extrapolated from 10 minute samples to the hour, and from the 24-hr sample event to the approximate 15-day sample stratum that each sample event represents, and then to the entire month. Nearly 33,000 fish and shellfish were projected to have been impinged under the maximum cooling-water flow scenario. The higher estimates included blue

crab (9,403 individuals), blue catfish (4,540), blueback herring (2,990), and channel catfish (2,737).

3.2.4 Water Quality

Water quality measurements followed typical seasonal patterns (Table 7). Conductivity varied little, but was generally lower during the winter. The pH indicated slightly alkaline conditions throughout the study. All dissolved oxygen (DO) readings were higher than any level considered detrimental to aquatic organisms. DO was highest during winter corresponding to lower water temperatures. This inverse relationship is illustrated in Figure 4.

3.2.5 Comparison of 2005-2006 Impingement Data to Quarterly Ambient Juvenile/Adult Data

Most of the common species collected in impingement samples in 2005-2006 were also collected by electrofishing and/or gill nets during quarterly sampling by Dominion Resources' personnel (Table 2 and Table 8). However, there were some notable differences in the proportions of the total catches of some species between the two programs, as illustrated below.

Species	Percent (Impingement)	Percent (Ambient Samples)
Blueback herring	10.0	1.3
Gizzard shad	2.3	9.7
Spottail shiner	2.3	23.6
White perch	7.2	30.9
Black crappie	7.7	0.1
Blue crab	28.1	0.1

These differences reflect the different biases of the sampling gear including the Chesterfield Power Station intake. Clearly, spottail shiner and white perch are much more susceptible to gill netting and/or electrofishing than to impingement. The converse is true for the blue crab, which is not very susceptible to either gill netting or electrofishing. The high proportion of blue crabs in the impingement catch may reflect their tendency to scavenge fish from the traveling screens, and thus be more vulnerable to impingement themselves, a phenomenon that has been hypothesized by other investigators (e.g., Rulifson and Copeland 1982).

3.2.6 Historical Studies

Dominion conducted an impingement study between 11 January and 15 December 1977 (Vepco1977). Twenty-seven, 24-hour periods were sampled, each of which included 24, 10-minute sample collection periods.

A total of 441 fish representing 23 species and 11 families was collected during the length of the study (Table 9). Five species, hogchoker (83 individuals), spottail shiner (63 individuals), Atlantic menhaden (55 individuals), alewife (54 individuals), and white perch (34 individuals) collectively composed approximately 65.5 percent of the impinged fish collected in 1977. Five species, gizzard shad (5,060 g), blueback herring (2,066 g), alewife (1,719 g), channel catfish (945 g), and Atlantic menhaden (633 g) collectively composed approximately 79.5 percent of the estimated biomass of impinged fish collected in 1977.

Using the raw sample data, a projected total of 55,557 fish weighing approximately 1,488.4 kg was estimated to have been impinged during the study year. Annual estimates of total numbers impinged for the abundant species were:

hogchoker	11,294
spottail shiner	7,903
alewife	7,028
Atlantic menhaden	6,955
white perch	4,219

The diversity and abundance of impinged fish varied seasonally; the largest number of fish impinged occurred in October and the lowest number of fish impinged occurred in January. Impingement of hogchokers, the most abundant species impinged, peaked in October. Absent only in January, the spottail shiner was the most frequently impinged species throughout the year, with a maximum number impinged in August. Impingement primarily affected small, young-of-the-year individuals.

The number of impinged fish collected in 2005-2006 was less than the number collected in 1977 (Table 10). In spite of higher numbers of blue catfish and blue crab in 2005-2006, the higher total numbers in 1977 resulted primarily from higher totals of spottail shiner, alewife, hogchoker, and Atlantic menhaden. In terms of total annual impingement estimates for Chesterfield Power Station, the 2005-2006 estimate (32,969) was less than

the 1977 estimate (55,557). The reasons for the annual differences are not entirely evident, but can result from many factors including actual changes in species populations over the years, differences in meteorology and hydrology, or other unknown factors. In the case of the blue catfish, however, Jenkins and Burkhead (1994) reported that the species was first stocked in the James River in 1975, so its population may not have been sufficiently developed by 1977 for it to show up in impingement samples.

3.2.7 Impingement Summary

- An impingement study was carried out at Chesterfield Power Station from June 2005 through May 2005. Sampling occurred twice per month and included 16, 10-minute screen-wash sampling periods over each 24-hour sampling event.

- A total of 221 fish and shellfish weighing 6.37 kg was collected from the traveling screens. Twenty-one species of finfish representing 12 families, and 3 invertebrate taxa including blue crab were collected in screen-wash samples.

- Impingement abundance was highest from June through December 2005.

- Sixty-two percent of organisms were impinged during nighttime. Blueback herring, channel catfish, black crappie, and blue crab were notably more abundant at night.

- Impingement rates were slightly higher during ebb tides.

- Water quality measurements during impingement sampling were typical for estuarine environments, and gave no indication of stress, such as low dissolved oxygen readings.

- Impinged finfish were primarily the smaller, younger individuals.

- A total of 32,969 fish and shellfish were estimated to have been impinged at Chesterfield Power Station over the year, based on maximum cooling-water flow rates. Blue crab was most abundant overall (9,403 individuals); most abundant finfish were blue catfish (4,540 individuals), channel catfish (2,737 individuals), and blueback herring (2,990 individuals).

- Approximately twice as many finfish were impinged in the 1977 study than in the current 2005-2006 study. The greatest contributors to the higher numbers in 1977 were gizzard shad, spottail shiner, alewife, and hogchoker. Conversely, blue catfish was the second-most abundant species impinged in 2005-2006, but was not recorded in 1977, possibly due to its very recent introduction in 1975.

- The impingement "community" was similar to that documented in Dominion Resources' ambient juvenile/adult sampling program in the river. However, relative abundance of some species varied between the two programs, i.e., spottail shiner and white perch accounted for a much greater proportion of the river catch than the impingement catch. Conversely, blueback herring and blue crab accounted for a greater proportion of the impingement catch relative to the river catch. This was attributed to different "sampling biases" between the programs (i.e. trawling, gill netting and seining methods used in the ambient juvenile/adult sampling versus the plant's intake system as a sampling method).

- The fish and shellfish collected in all of the studies in 2005-2006 were considered representative for that year.

4.0 ENTRAINMENT STUDY AT CHESTERFIELD POWER STATION

4.1 METHODS

4.1.1 Entrainment Sampling and Processing

Entrainment sampling was carried out at Chesterfield Power Station twice a month from June 2005 through May 2006. Samples were collected from a boat positioned in front of the Unit 6 cooling water intake. During each sampling event, duplicate 10-minute samples were collected from near bottom, mid-depth, and near surface locations four times during the 24-hour period, centered around: 1000, 1600, 2200, and 0400 hours. Samples were collected with ½ -m diameter mouth plankton nets constructed of 505-µm netting, each affixed in a double-net bongo frame. A General Oceanics (GO) 2030R or 2030R6 (low flow) mechanical flowmeter was suspended in the mouth of each net. Flowmeter calibration was periodically checked with a General Oceanics Model 2030CF Flowmeter Calibration Frame.

Samples were preserved in 5 percent buffered formalin containing Rose Bengal dye and transported to the laboratory for processing. Samples were sorted with the aid of lighted magnifying rings to separate organisms from debris. Extremely abundant samples were split with a Folsom plankton splitter to obtain manageable portions for sorting. Subsequent to sorting, some samples containing large numbers of a single organism were sub-sampled with a Henson-Stempel pipette. All fish eggs, larvae, and commercially important shellfish were stored in labeled vials for subsequent identification.

Entrained organisms were identified under magnification. Taxonomic resources included Fuiman et al. (1983), USFWS (1978), Wang and Kernehan (1979), Lippson and Moran (1974), Bullard (2003), and Gosner (1971). For each sample, up to 20 fish larvae of each taxon were measured to the nearest 0.1 mm with an ocular micrometer.

4.1.2 Ambient Ichthyoplankton Sampling

In conjunction with each entrainment sample, samples were also collected from the James River upstream, downstream, and adjacent to the intake centered on the 1000, 1600, 2200 and 0400 hours. These samples were collected with a single 0.5-meter diameter plankton net consisting of 505-µm netting, and with a GO 2030R flowmeter affixed in the net mouth. Stepped-oblique tows were made from a boat for 4.5 minutes

against the prevailing tide, i.e., 1.5 minutes near bottom, 1.5 minutes at mid-depth, and 1.5 minutes near the surface. Sampling locations are illustrated in Figure 5. Sample processing and data handling were as described for entrainment.

4.1.3 Water Quality

Water quality measurements were made with a YSI Model 556 water quality analyzer that was calibrated prior to each sampling event. All water quality parameters (water temperature, dissolved oxygen, pH, and conductivity) were measured at mid-depth in front of the intake in association with each of the 4 entrainment samples during the 24-hour sampling event. During ambient ichthyoplankton sampling in the river, water quality was measured at the mid-point of each sampling transect at surface, mid-depth, and bottom. All biological and water quality data were recorded on standard data sheets.

4.1.4 Data Analysis

All data were entered into an SQL Server database using an Access-based, "front-end" data-entry template. Reports were then printed out and proofed against the original data sheets, and electronic corrections made as necessary. All data manipulations, calculations, and summaries included in this report were performed within the database.

An example of the entrainment calculation sequence is provided in Figure 6 using actual data from one of the sampling events at Chesterfield Power Station. The density of white perch eggs in each individual sample (24 per 24-hour event) is displayed by depth and sampling time. Densities were averaged over the four sampling times, then averaged again to produce an average density for the 24-hour sampling period. This 24-hour average density was then multiplied by the maximum station cooling-water flow in cubic meters, then divided by 100 to calculate the total number of white perch eggs entrained during the 24-hour period. This value was then multiplied by the number of calendar days represented by the 4/17-18/2006 sampling event to project the total number of eggs entrained during that period. This value was then added to the analogous values from the other 23 extrapolation periods during the study year to estimate the total number of white perch eggs entrained during the study year, under maximum cooling-water flow conditions. Additional calculation details are provided in Appendix A.

4.2 RESULTS

4.2.1 Abundance, Distribution, and Composition

During the 2005-2006 study, 40 different taxa and life stages were identified from entrainment samples (Table 11). The preponderance of entrained organisms were young life stages of fish, but young life stages of bivalves, and to a lesser extent, shrimp, were fairly common. Considering only the young life stages of fish, larvae of river herring (a collective term for alewife and blueback herring), *Dorosoma* sp. eggs and larvae, gizzard shad larvae, and bay anchovy eggs were most abundant (Table 12). Many *Dorosoma* sp. eggs and larvae could not confidently be differentiated between gizzard shad and threadfin shad. However given the absence of juvenile or adult threadfin shad in both impingement samples and Dominion Resources' ambient river sampling, and their scarcity in entrainment samples, the *Dorosoma* life stages were most likely predominately gizzard shad.

With the exception of bay anchovy eggs (peak in August 2005) and *Dorosoma* sp. eggs (common in June and July 2005), other common egg and larval forms were most abundant in April and May 2006 (Table 13 and Appendix C). All of the common species shown are typical spring spawners, except that bay anchovy spawn over an extended period, as evidenced by their peak egg density in August 2005.

Densities of common species/life stages varied with time of day (Figure 7). Both river herring larvae and *Dorosoma* sp. eggs were more abundant in early morning (0400 hrs) samples. The peak bay anchovy eggs in late PM may reflect their early evening spawning habit (USFWS 1978). However, given an early evening spawning peak, one would expect high egg densities into the early morning, and this was not the case, for unexplained reasons. Gizzard shad larvae were more abundant in late morning samples, whereas white perch larvae exhibited no particular trend or pattern. Based on this evaluation, entrainment rates are higher at night, and particularly in the early morning, for the most abundant species entrained.

4.2.2 Length Frequency

Lengths were recorded for entrained larvae and the data are recorded in Appendix D. Data for two of the more common species, gizzard shad and white perch, were incorporated into length-frequency tables (Tables 14 – 15). Such displays serve primarily to document the time period, and size group entrained. Both species are abundant during

the spring. Nearly all of the gizzard shad larvae entrained were between 3 and 6 mm. The majority of white perch larvae entrained were between 3 and 4 mm. The majority of larvae of both species were yolk sac larvae, based on data from USFWS (1978).

4.2.3 Monthly and Annual Estimates of Total Entrainment

Entrainment density data were used in conjunction with station cooling-water flow data to estimate the total number of each fish and invertebrate taxon entrained, both on a monthly and on an annual basis, based on maximum cooling-water flow rates (Table 16). The data are proportional to, and mirror the density data in Table 13 and Appendix C, but the numbers are much larger in Table 16 because the numbers are absolute estimates for months and year, rather than densities. Approximately 2.3 billion organisms were estimated to have been entrained in 2005-2006. The most abundant entrained organism on an annual basis was river herring larvae at 760 X 10^6 (combining all alewife, blueback herring, and "river herring" larvae). Gizzard shad larvae were abundant (201.7 X 10^6 for the year), as were bay anchovy eggs (128.3 X 10^6) and *Dorosoma* sp. eggs (275.9 X10^6). The largest numbers of invertebrates entrained annually were bivalve young at 363.8 X 10^6).

4.2.4 Comparison of Entrainment and Ambient River Ichthyoplankton Densities

Mean egg and larval densities of key fish species collected in both entrainment and ambient river samples are displayed in Tables 17 and 18, respectively. All data for ambient river samples are provided in Appendix E. The data in the tables are means of all entrainment and river ambient samples during each sampling event. With the exception of bay anchovy eggs, each species followed similar temporal trends of increasing and decreasing abundance. However, densities differed between the two sampling programs, sometimes substantially. This is illustrated in Figures 8 – 12. During periods of abundance, ambient river densities were typically higher than entrainment densities. These differences were most prominent during a single sampling event, where ambient river densities exceeded entrainment densities by a factor of 2.2 for white perch larvae (15 May 2005) up to a factor of 19.0 for *Dorosoma* sp. eggs (27 June 2005). In contrast, bay anchovy egg densities in entrainment samples ranged from

2.9/100 M^3 on 11 July 2005 to 145.7/100 M^3 on 22 August 2005, a period during which very few bay anchovy eggs were collected in ambient river samples (Table 18).

Mean water quality measurements associated with ambient ichthyoplankton sampling are shown in Table 19.

4.2.5 Comparison of Entrainment Data and Ambient Juvenile and Adult Data

Dominion Resources' quarterly sampling of juvenile and adult fish and shellfish used electrofishing and gill nets (4-6 hr sets) at three locations in the vicinity of Chesterfield Power Station. The experimental gill nets were 300 ft long with six panels consisting of 0.5, 1.0, 1.5, 2.0, 2.5, and 3.0-inch mesh. The results of this program are displayed in Table 8. Twenty-seven species of finfish and a blue crab were collected. White perch, spottail shiner, and gizzard shad were most abundant, together accounting for 64 percent of the catch. In some cases there is good correlation between the field juvenile/adult results and the entrainment results. Gizzard shad were abundant in the juvenile/adult river program and their larvae were relatively abundant in entrainment samples. *Dorosoma* eggs, most of which were probably gizzard shad eggs, were also quite abundant in entrainment samples. Spottail shiner juvenile and adults were abundant in river samples, but spottail shiner was uncommon to rare in entrainment samples. Some unknown aspect of the ecology of spottail shiner larvae renders them less vulnerable to entrainment. Entrained white perch larvae were moderately abundant with a peak of 52/100 M^3 in late May 2006 (Table 17). Although river herring larvae (blueback herring and/or alewife) were the most abundant entrained organism, juveniles/adults were uncommon in ambient river samples which contained only 14 blueback herring (Table 8). Blueback herring was the third most abundant species impinged, but in relatively low numbers as were all other species. There very likely were more blueback herring and/or alewives available in the river than either the ambient or impingement program would suggest.

4.2.6 Historical Studies

Dominion conducted an entrainment study at Chesterfield Power Station from 11 January through 15 December 1977 (Vepco 1977). The sampling procedure consisted of placing paired conical nets outboard of the intake structure for 10-minutes at near surface, midwater, and near bottom depths. Ichthyoplankton samples were collected every six hours over a 24-hour sampling period. All fish eggs and larvae were identified to the lowest practical taxon and counted.

Eggs and/or larvae of 18 species of fish representing 11 families were collected during the 27 sampling days. The results were seasonal with all ichthyoplankton entrained during spring and summer (March through August).

The dominant species of eggs (97 percent) and larvae (83.2 percent) entrained were river herring (a collective term for alewife and blueback herring). Threadfin shad (1.3 percent) and gizzard shad (1.3 percent) were the only other major species having eggs entrained. The spottail shiner (6.9 percent), threadfin shad (5.9 percent), and gizzard shad (1.3 percent) were the other common species of larvae entrained.

Based on the sample data, Vepco (1977) estimated the total number of eggs entrained during the year at 710 X 10^6 and larvae at 150 X 10^6, the majority of which, as noted above, were river herring.

River herring and *Dorosoma* sp. were also the dominant entrained fish taxa in 2005-2006 (Table 12). In terms of absolute numbers entrained, combined eggs and larvae of river herring were similar between the two studies. However, *Dorosoma* sp. eggs and larvae combined were 18 times more abundant in 2005-2006. This difference likely reflects typical year-to-year variation in abundance of young life stages of fish.

4.2.7 Entrainment Summary

- Entrainment and ambient (river) ichthyoplankton studies were carried out concurrently with the impingement sampling program. Sampling was also twice a month and included four sample periods during a 24-hour sampling event, each consisting of two samples each from surface, mid-depth, and bottom of the intake for entrainment, and single oblique tows at three locations in the James River.

- Forty different taxa and life stages of fish and invertebrates were identified during the study. Young life stages of fish dominated the samples, with the larvae of river herring (a collective term for alewife and blueback herring), gizzard shad, and *Dorosoma* species, and eggs of *Dorosoma* species and bay anchovy being most abundant. Young life stages of invertebrates, e.g., bivalves and shrimp, were also common.

- Most young life stages of finfish occurred during the typical spring and summer spawning period, primarily in June and July 2005, and March to May 2006. Bay anchovy eggs peaked in August 2005, consistent with the species' extended spawning period.

- In general, densities of common species in entrainment samples were higher in the afternoon through early morning hours. River herring and *Dorosoma* species eggs were most abundant in early morning (0400 hr) samples.

- Based on maximum cooling-water flow rates at Chesterfield Power Station, an estimated 2.3 billion organisms were entrained during the study year. The largest finfish contributors to this total were river herring larvae (combining all alewife, blueback herring, and "river herring" larvae) (760 million,), gizzard shad larvae (202 million), and bay anchovy eggs (128 million).

- For the more abundant forms, densities in ambient river samples tended to be higher than entrainment densities.

- When the entrainment results were compared to the ambient river juvenile and adult results, several species stood out as dominant in both programs: gizzard shad, white perch, and, to a lesser extent, river herring.

- The fish and shellfish collected in all of the studies in 2005-2006 were considered representative for that year.

5.0 REFERENCES

Bullard, S.G. 2003. Larvae of Anomuran and Brachyuran Crabs of North Carolina. *Crustaceana Monographs* 1.

Carlander, K. 1969. *Handbook of Freshwater Fishery Biology*, Volume One. The Iowa State University Press, Ames, IA. 751 pp.

Carlander, K. 1977. *Handbook of Freshwater Fishery Biology*, Volume Two. The Iowa State University Press, Ames, IA. 431 pp.

Dominion. 2005. *Proposal for Information Collection, Final Rule for Phase II Facilities Cooling Water Intake Structures, Chesterfield Power Station.* Prepared by Dominion Resources Services, Inc. Submitted to Virginia Department of Environmental Quality. 21 February 2005.

Fuiman, L., J. Conner, B. Lathrop, G. Bunyak, D. Snyder, and J. Loss. 1983. State of the art of identification for cyprinid fish larvae from eastern North America. *Trans. Amer. Fish. Soc.* 112:319-332.

Gosner (1971). *Guide to Identification of Marine and Estuarine Invertebrates*. Wiley-Interscience.

Jenkins, R. and N. Burkhead. 1994. *Freshwater Fishes of Virginia.* American Fisheries Society, Bethesda, MD.

Kazyak, P. R. Raesly, and D. Neely. 2003. *Key to the Freshwater Fishes of Maryland.* Maryland Department of Natural Resources, Maryland Biological Stream Survey.

Lippson, A. and L. Moran. 1974. *Manual for Identification of Early Developmental Stages of Fishes of the Potomac River Estuary.* Maryland DNR Power Plant Siting Program. PPSP-MP-13. 282 pp.

Murdy, E., R. Birdsong, and J. Musick. 1997. *Fishes of Chesapeake Bay.* Smithsonian Institution Press, Washington, DC. 324 pp.

Nelson, J., E. Crossman, H. Espinosa-Perez, L. Findley, C. Gilbert, R. Lea, and J. Williams. 2004. *Common and Scientific Names of Fishes from the United States, Canada, and Mexico.* Sixth Edition. American Fisheries Society Special Publication 29, Bethesda, MD.

Rulifson, R. and B. Copeland. 1982. Traveling screens as a sampling gear for vertical distribution studies. *Estuaries* 5(2):82-94.

U.S. Army Corps of Engineers (USACE). Undated. http://el.erdc.usace.army.mil/zebra/zmis/zmishelp4/corbiculidae.htm

USFWS. 1978. *Development of Fishes of the Mid-Atlantic Bight: An Atlas of Egg, Larval, and Juvenile Stages*, Vols. I-VI. U.S. Dept. of Interior.

Virginia Electric and Power Company (Vepco). 1977. *Chesterfield Power Station Impingement and Entrainment Study.* Final Report. Prepared by Virginia Electric and Power, Environmental Services Department, Richmond, VA.

Wang and Kernehan. 1979. *Fishes of the Delaware Estuaries: A guide to the Early Life Histories.* EA Communications, Towson, MD.

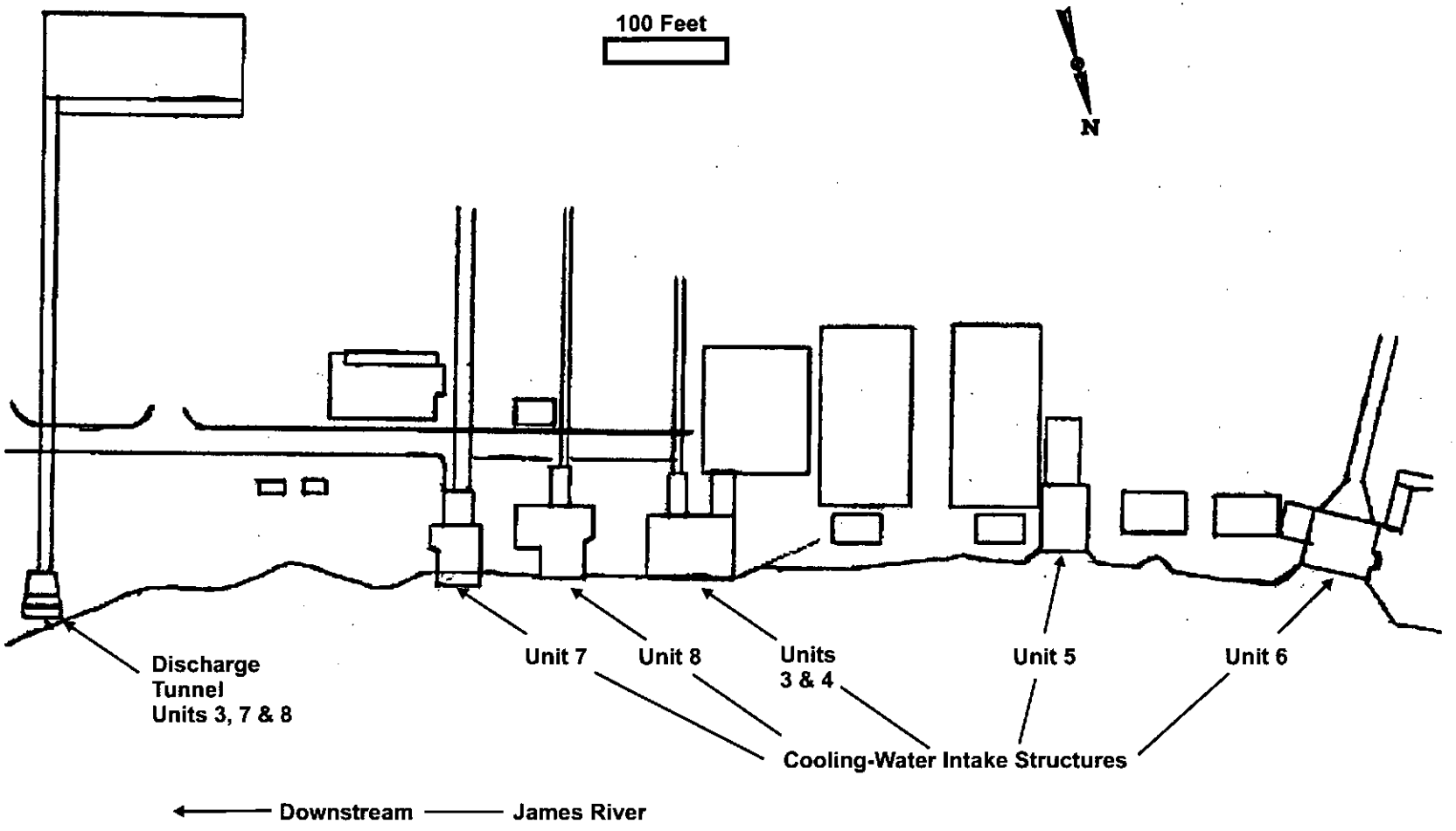


Figure 1. Diagram of the Chesterfield Power Station Cooling-Water Intake Structure Complex on the James River Near Richmond, Virginia.

P:\Projects\Utility\DominionEnergy\Projects\6200301-316b\DraftReports\Chesterfield\Map.cdr

Sample Set:	Sample Hour	Crabs per 10-minute sample		10-minute Periods per Hour		Extrapolated Count per Hour	Station Cooling-Water Flow (M^3)
Blue crab	0800	1	X	6	=	6	99501
11/7-8/2005	0900	0	X	6	=	0	99501
	1000	**0**	X	6	=	0	99501
	1100	**0**	X	6	=	0	99501
	1200	0	X	6	=	0	99501
	1300	0	X	6	=	0	99501
	1400	0	X	6	=	0	99501
	1500	0	X	6	=	0	99501
	1600	**1.5**	X	6	=	9	99501
	1700	**1.5**	X	6	=	9	99501
	1800	3	X	6	=	18	99501
	1900	3	X	6	=	18	108548
	2000	1	X	6	=	6	99501
	2100	3	X	6	=	18	99501
	2200	**2**	X	6	=	12	99501
	2300	**2**	X	6	=	12	99501
	2400	1	X	6	=	6	99501
	0100	0	X	6	=	0	99501
	0200	0	X	6	=	0	99501
	0300	0	X	6	=	0	99501
	0400	**0.5**	X	6	=	3	99501
	0500	**0.5**	X	6	=	3	99501
	0600	1	X	6	=	6	99501
	0700	0	X	6	=	0	99501

ESTIMATED 24-HOUR IMPINGEMENT CATCH= 126

Note: Bold values are estimates for non-sampled hours (due to entrainment sampling) based on the average of the samples prior to and following the gap

ACTUAL 24-HOUR PLANT FLOW= 2,397,071

MAXIMUM POSSIBLE 24-HOUR FLOW= 3,836,624

ADJUSTMENT FACTOR (MAX/ACTUAL FLOW)= 1.60

ESTIMATED 24-HOUR CATCH AT MAX FLOW = 126 x 1.60= 202

Calendar days represented by the 11/7-8/2005 sample set = 14 days

14 days X 202 blue crab = 2,828 in 14-day extrapolation period

Total blue crab impinged during year = 2,828 in 11/7-8/2005 14-day extrapolation period

PLUS 6,575 blue crab impinged during remaining 23 extrapolation periods

= 9,403 blue crab impinged during the study year under max flow

Figure 2 Impingement Calculation Schematic: Extrapolation of Blue Crab Numbers from a Single Sampling Event to the Annual Total, Chesterfield Power Station

Figure 3 Total Number of Fish Impinged per Hourly Sample, Chesterfield Power Station, June 2005 - May 2006

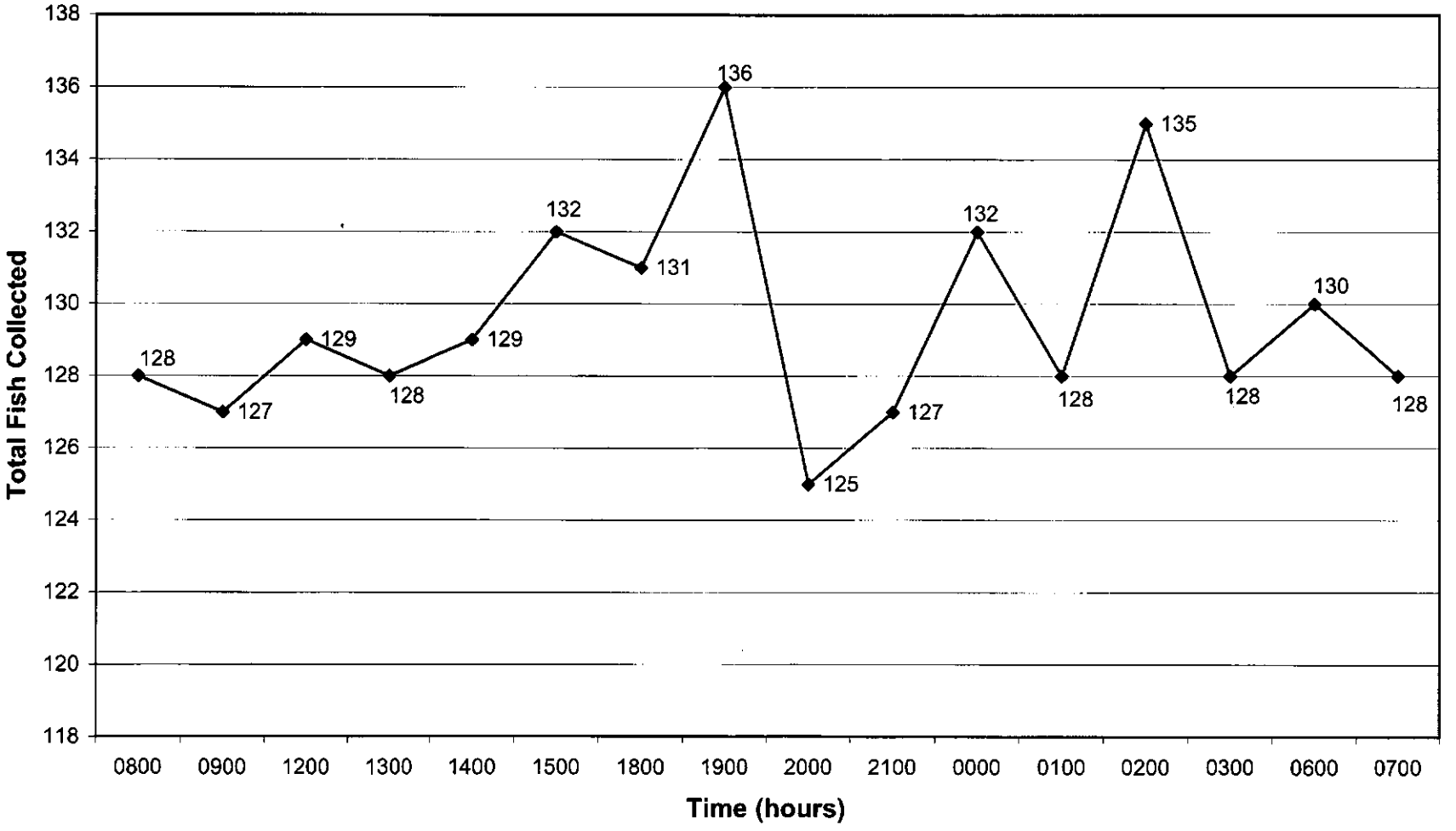


Figure 4 Relationship of Dissolved Oxygen and Water Temperature at Chesterfield Power Station

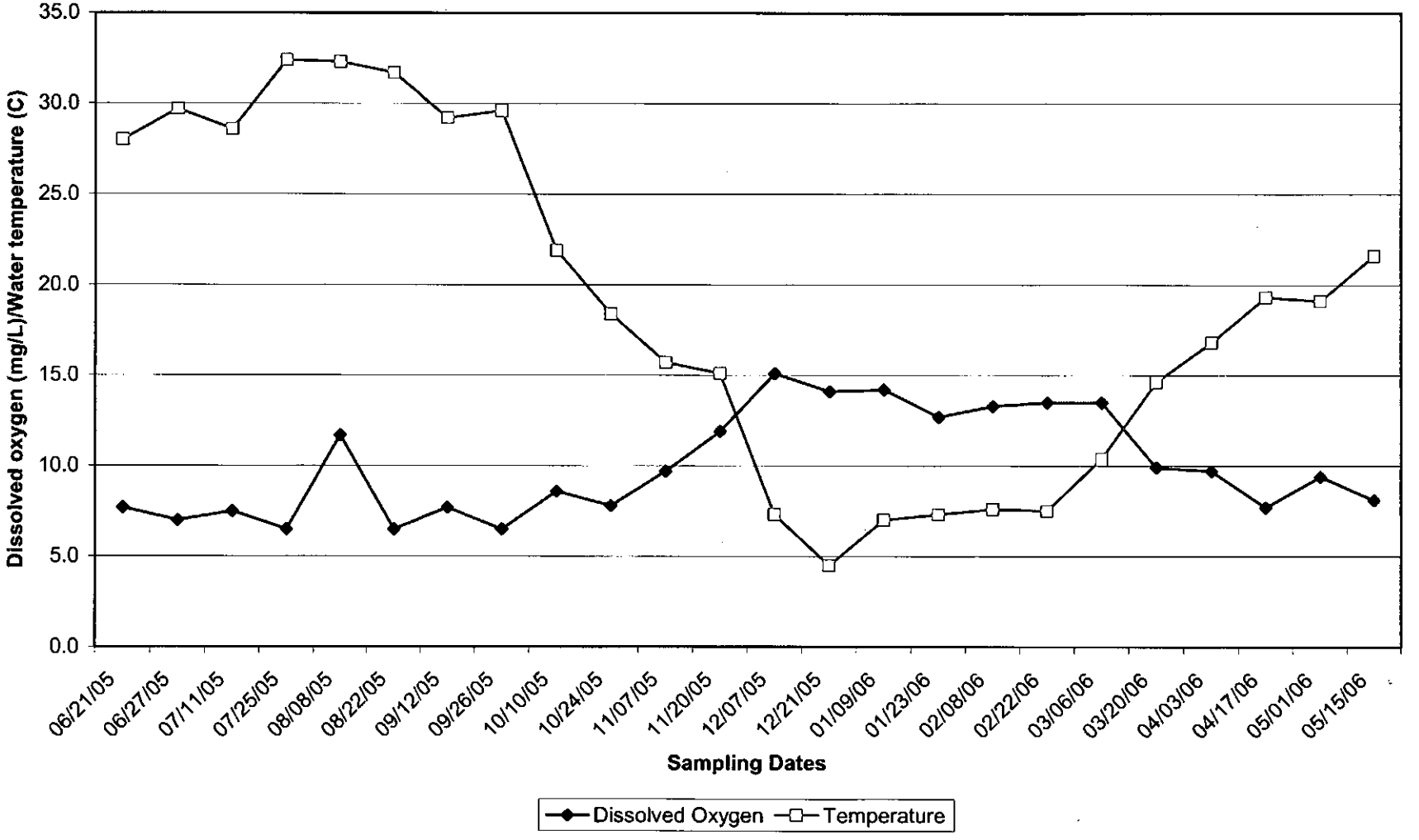


Figure 5

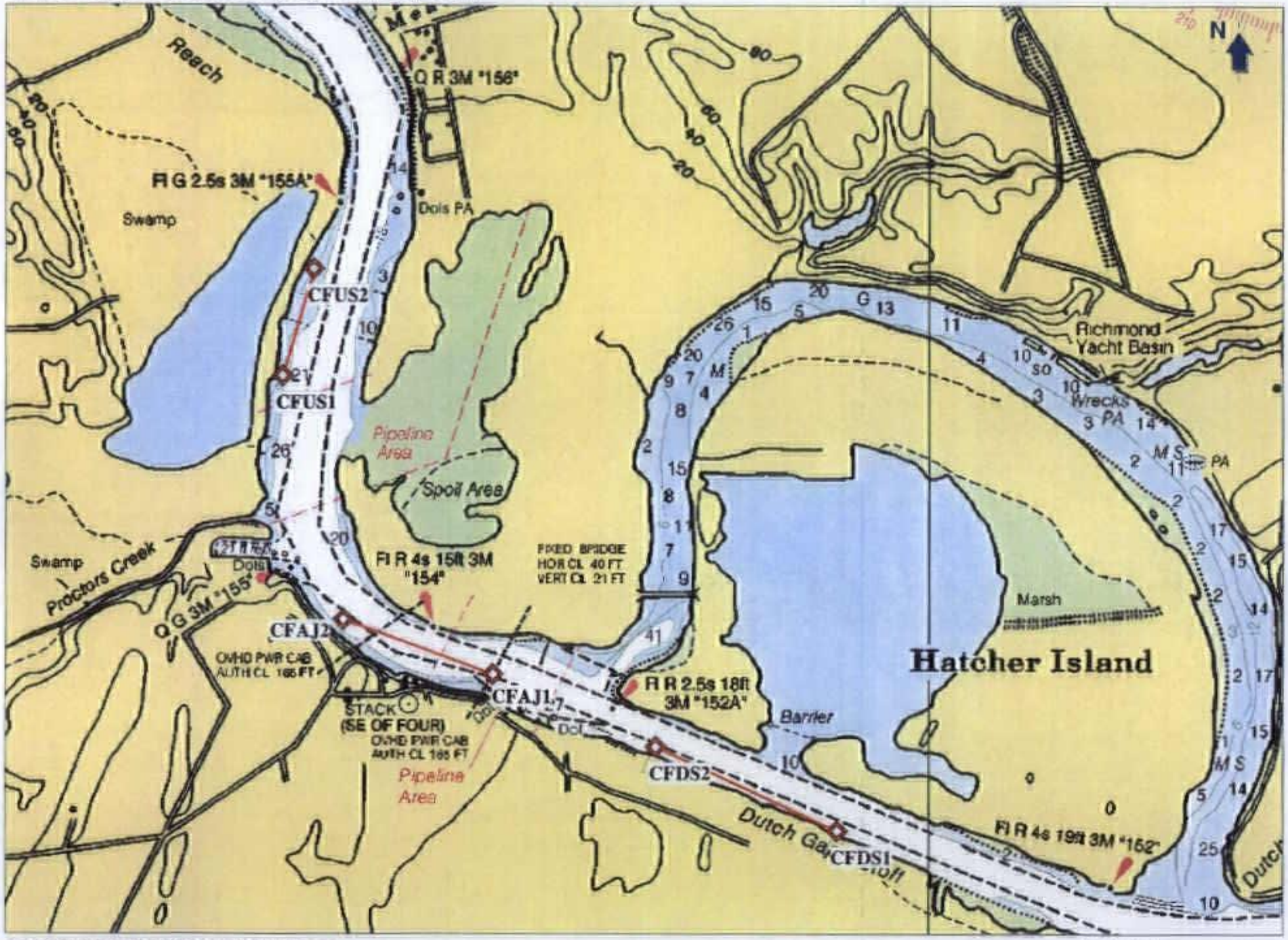
Location of Ambient Ichthyoplankton Tow Tracks at Chesterfield Power Station

Tow tracks shown as red lines with red diamonds marking either end

Endpoints designated as:

CFUS1 (Upstream)
CFUS2 (Upstream)
CFAJ1 (Adjacent)
CFAJ2 (Adjacent)
CFDS1 (Downstream)
CFDS2 (Downstream)

JAMES RIVER JORDAN POINT TO RICHMOND
Chart 12251_2 (BSB Electronic Charts) Depth Units: FEET Datum:



DO NOT USE FOR NAVIGATION PURPOSES
Printed by ChartView™ from Nobeltec Corporation (503) 579-1414

Nautical Miles
0.00 0.10 0.20 0.30 0.40

Number Entrained per 100 Cubic Meters

Sample Set:
White perch eggs
4/17-18/2006

	Surface		Middle		Bottom		Average by Sampling Period
	Left	Right	Left	Right	Left	Right	
10am	0	0	17	34	99	80	38.3
4PM	0	0	0	0	0	23	3.8
10PM	0	0	0	0	12	0	2.0
4AM	0	17	0	0	0	0	2.8
						24-HOUR AVERAGE=	11.8

Maximum plant flow in 24 hours = 3,836,624 M^3

Total eggs entrained in the 24-hour period= 3,836,624 M^3 X 11.8/100 M^3 = 452,722 eggs

Calendar days represented by the 4/17-18/2006 sample set = 15 days

Total eggs entrained during the 15-day period represented by the 4/17-18/2006 sample set = 15 days X 452,7212 eggs = 6,790,830 eggs

Total eggs entrained during the study year = 6,790,830 eggs entrained in 4/17-18/2006 15-day extrapolation period

PLUS

25,014,170 eggs entrained during remaining 23 extrapolation periods

= 31,805,000 eggs entrained during the study year

Figure 6 Entrainment Calculation Schematic: Extrapolation of White Perch Egg Numbers from a Single Sampling Event to the Annual Total, Chesterfield Power Station

Figure 7 Annual Average Density of Selected Species Entrained at Chesterfield Power Station During Different Diel Periods

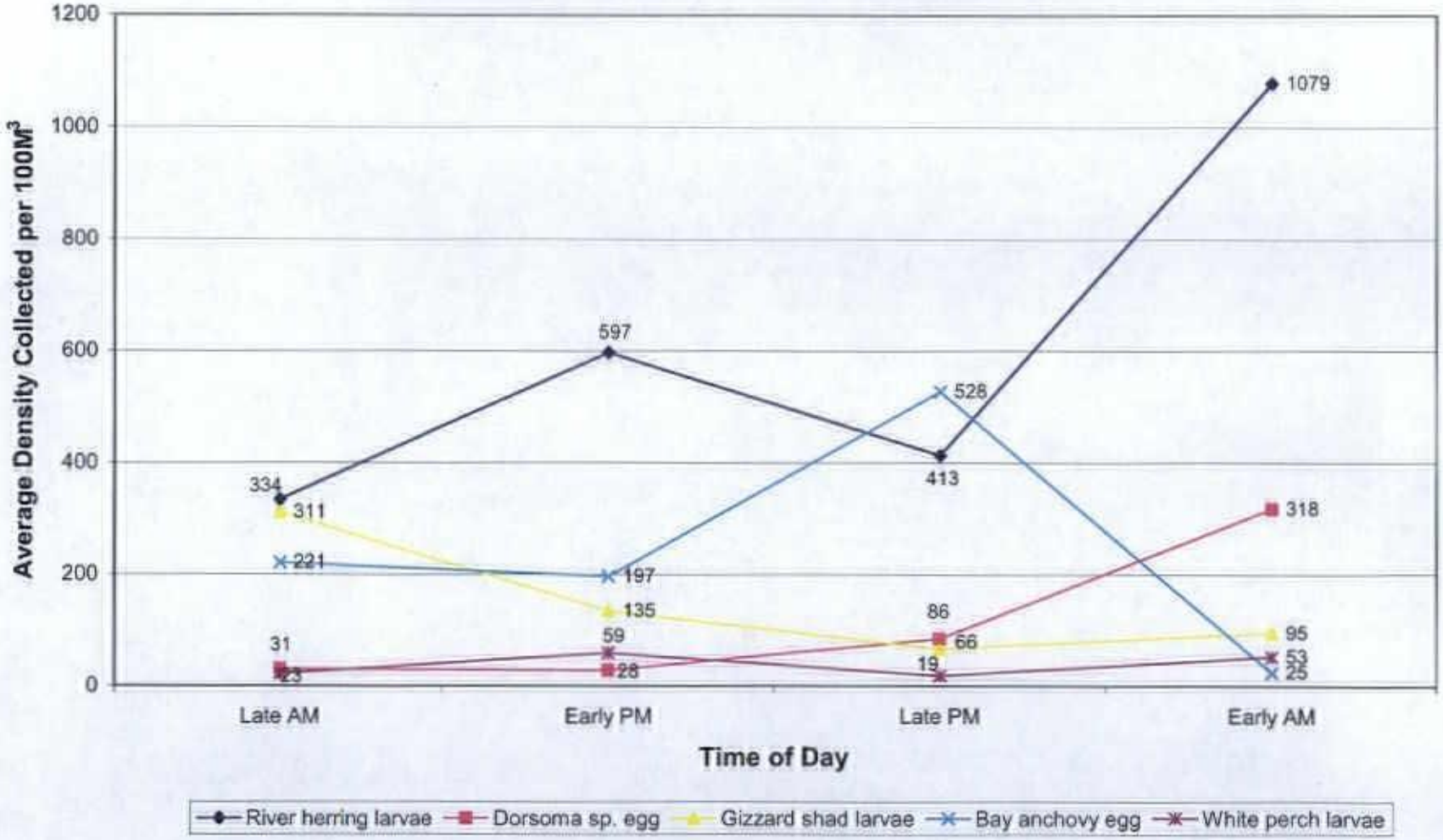


Figure 8 Comparison of Entrainment and Ambient Ichthyoplankton Densities of White Perch Larvae, Chesterfield Power Station

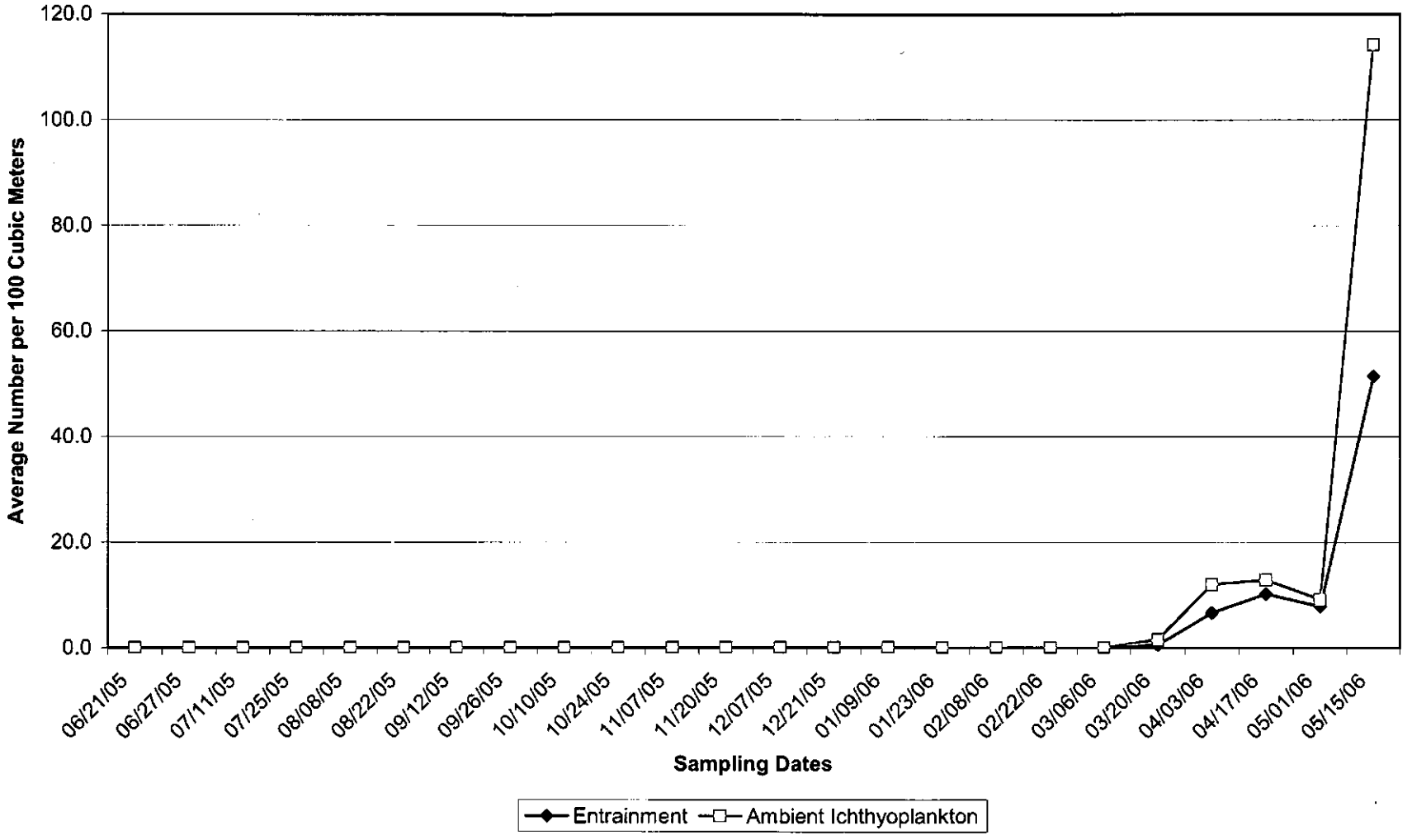


Figure 9 Comparison of Entrainment and Ambient Ichthyoplankton Densities of Dorosoma sp. Eggs, Chesterfield Power Station

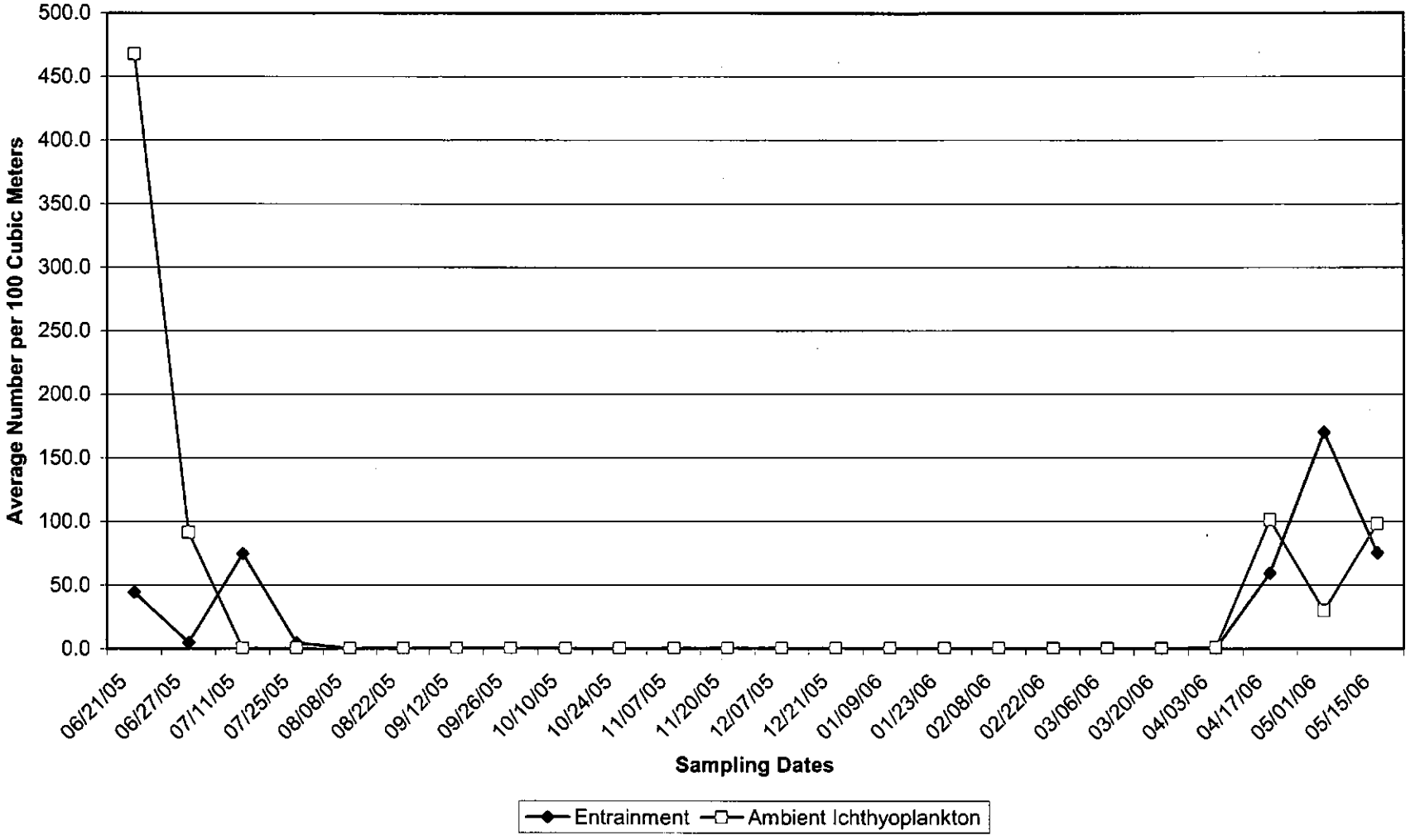


Figure 10 Comparison of Entrainment and Ambient Ichthyoplankton Densities of River Herring Larvae, Chesterfield Power Station

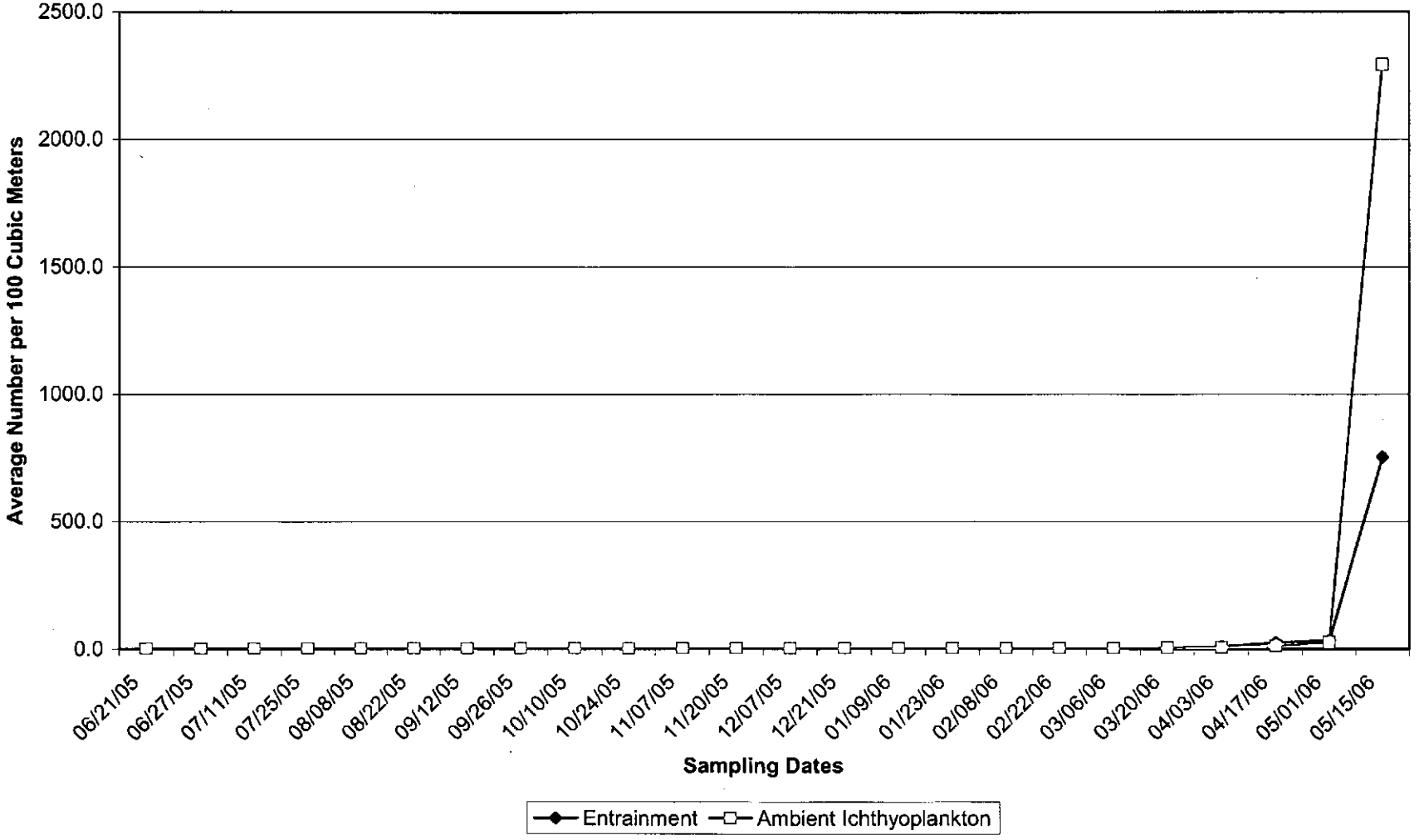


Figure 11 Comparison of Entrainment and Ambient Ichthyoplankton Densities of Gizzard Shad Larvae, Chesterfield Power Station

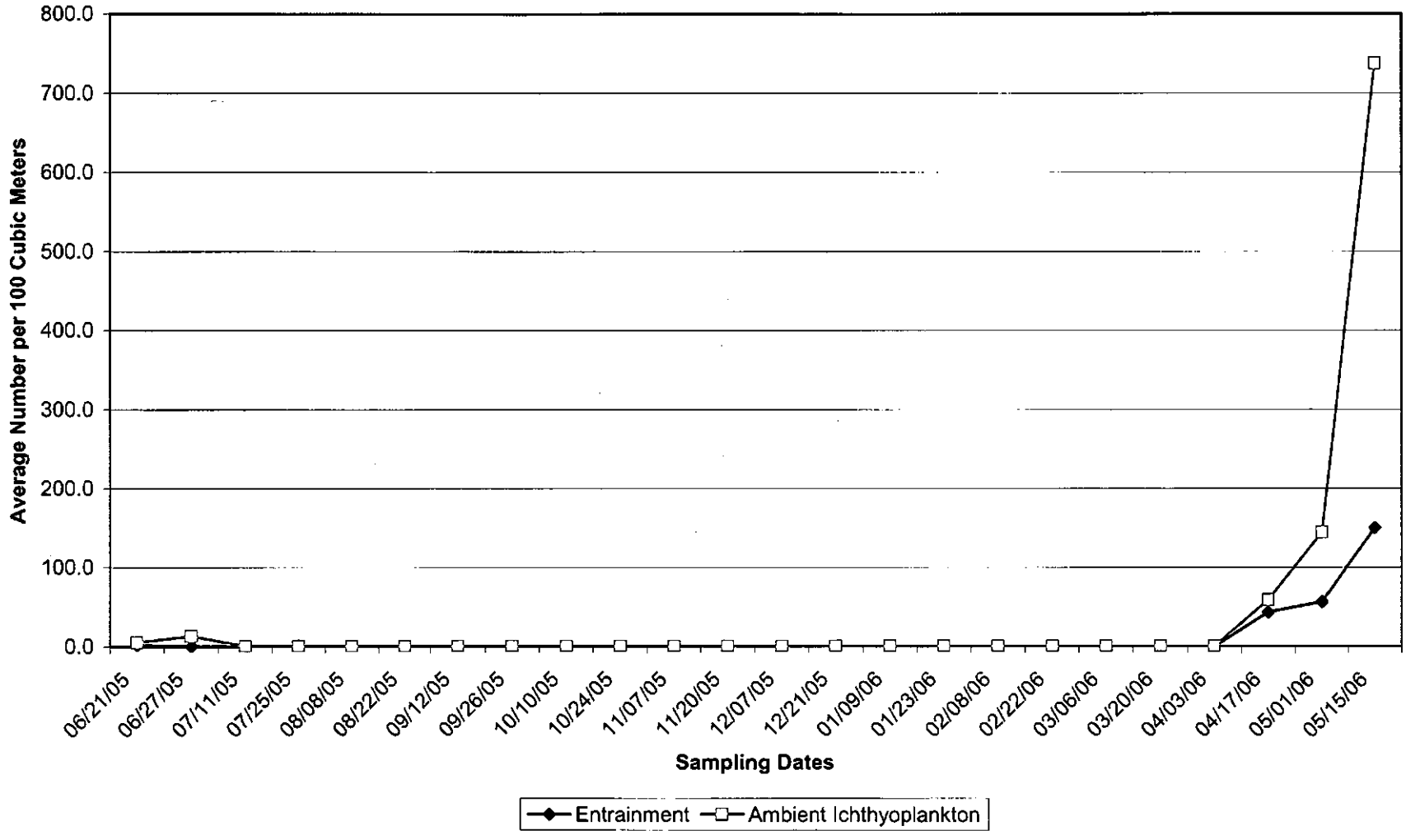


Figure 12 Comparison of Entrainment and Ambient Ichthyoplankton Densities of Bay Anchovy Eggs, Chesterfield Power Station

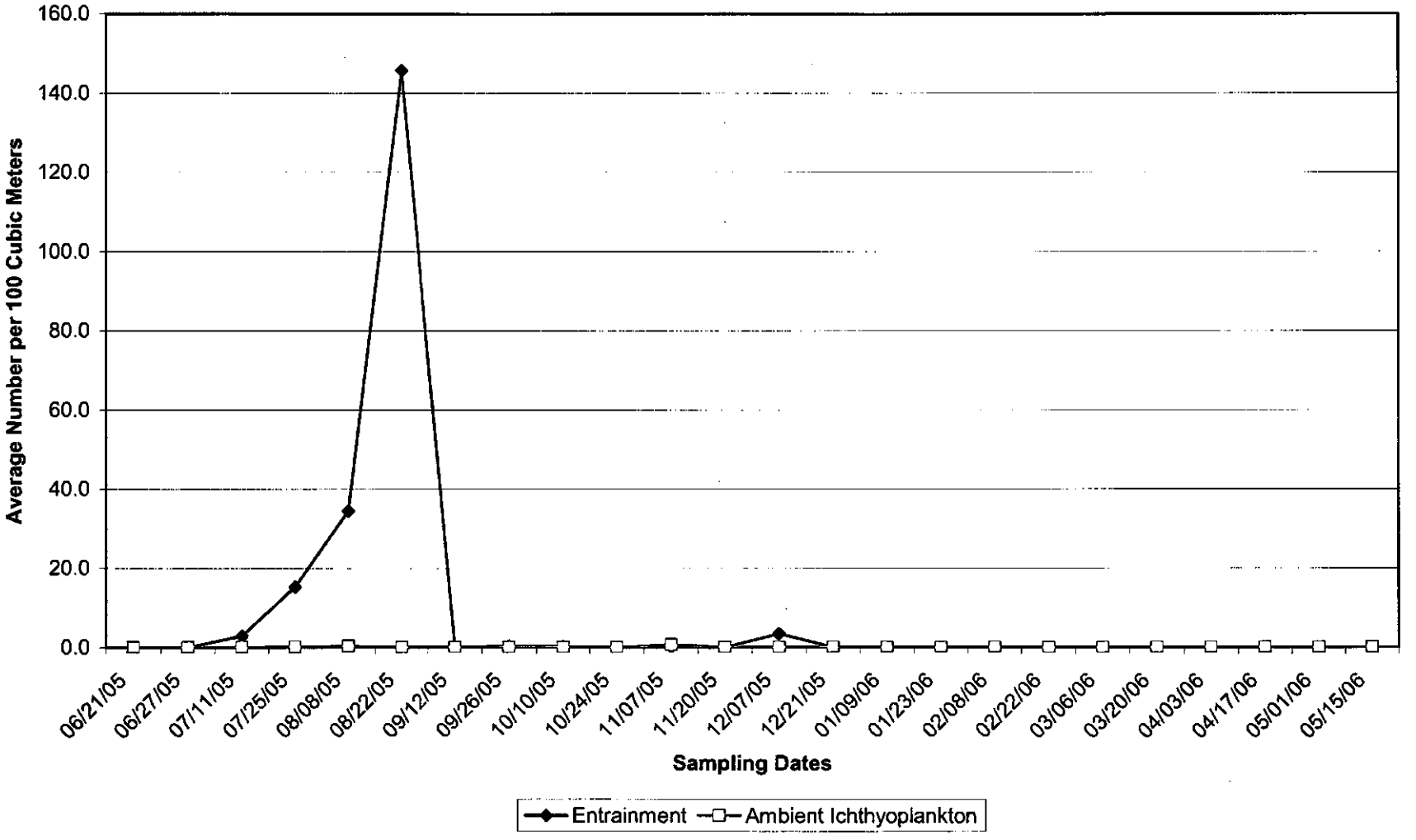


TABLE 1 LIST OF COMMON AND SCIENTIFIC NAMES OF FISH AND SHELLFISH MENTIONED IN THIS REPORT

	Family	Common Name	Scientific name
Acipenseridae	Sturgeons	Atlantic sturgeon	Acipenser oxyrinchus
Lepisosteidae	Gars	Longnose gar	Lepisosteus osseus
Anguillidae	Freshwater eels	American eel	Anguilla rostrata
Engraulidae	Anchovies	Bay anchovy	Anchoa mitchilli
Clupeidae	Herrings	Blueback herring	Alosa aestivalis
		Alewife	Alosa pseudoharangus
		Hickory shad	Alosa mediocris
		American shad	Alosa sapidissima
		Gizzard shad	Dorosoma cepedianum
		Threadfin shad	Dorosoma petenense
		Atlantic menhaden	Brevoortia tyrannus
Cyprinidae	Carps and minnows	Common carp	Cyprinus carpio
		Spottail shiner	Notropis hudsonius
		Telescope shiner	Notropis telescopus
		Spotfin shiner	Cyprinella spiloptera
		Satinfin shiner	Cyprinella analostana
		Mississippi silvery minnow	Hybognathus nuchalis
		Golden shiner	Notemigonus crysoleucas
Catostomidae	Suckers	White sucker	Catostomus commersonii
Ictaluridae	North American catfishes	White catfish	Ameiurus catus
		Blue catfish	Ictalurus furcatus
		Channel catfish	Ictalurus punctatus
		Flathead catfish	Pylodictis olivaris
Atherinopsidae	New World silversides	Inland silverside	Menidia beryllina
		Atlantic silverside	Menidia menidia
Fundulidae	Topminnows	Banded killifish	Fundulus diaphanus
Moronidae	Temperate basses	White perch	Morone americana
		Striped bass	Morone saxatilis
Centrarchidae	Sunfishes	Redbreast sunfish	Lepomis auritus
		Bluegill	Lepomis macrochirus
		Redear sunfish	Lepomis microlophus
		Green sunfish	Lepomis cyanellus
		Pumpkinseed	Lepomis gibbosus
		Largemouth bass	Micropterus salmoides
		Smallmouth bass	Micropterus dolomieu
		Black crappie	Pomoxis nigromaculatus

TABLE 1 (Continued)

Family		Common Name	Scientific name
Percidae	Perches	Tessellated darter	Etheostoma olmstedi
		Johnny darter	Etheostoma nigrum
		Yellow perch	Perca flavescens
Sciaenidae	Drums and croakers	Spot	Leiostomus xanthurus
Gobiidae	Gobies	Naked goby	Gobiosoma bosc
Achiridae	American soles	Hogchoker	Trinectes maculatus
Corbiculidae	Asiatic clam	Asiatic clam	Corbicula fluminea
Palaemonidae	Grass shrimps	Common grass shrimp	Palaemonetes pugio
Portunidae	Swimming crabs	Blue crab	Callinectes sapidus

Note: Common and scientific names follow Nelson et al. (2004). Shellfish names follow Gosner (1971) and USACE (undated).

TABLE 2 RANKED ABUNDANCE AND PERCENT COMPOSITION OF FISH AND SHELLFISH IMPINGED AT CHESTERFIELD POWER STATION, JUNE 2005-MAY 2006

Species	Number	Percent	Weight (gm)	Percent
Blue crab	62	28.1	4158.4	65.3
Blue catfish	29	13.1	1176	18.5
Blueback herring	22	10.0	54.1	0.8
Channel catfish	18	8.1	229	3.6
Black crappie	17	7.7	76.5	1.2
White perch	16	7.2	170.3	2.7
Bluegill	11	5.0	275.6	4.3
Largemouth bass	8	3.6	38.1	0.6
Gizzard shad	5	2.3	45.5	0.7
Spottail shiner	5	2.3	17.6	0.3
American shad	4	1.8	24.3	0.4
Asiatic clam	4	1.8	2.5	<0.1
Alewife	3	1.4	13.3	0.2
Banded killifish	2	0.9	6.7	0.1
Flathead catfish	2	0.9	11	0.2
Inland silverside	2	0.9	6.1	0.1
Tessellated darter	2	0.9	2.5	<0.1
Bay anchovy	1	0.5	1.4	<0.1
Common carp	1	0.5	21.2	0.3
Green sunfish	1	0.5	2	<0.1
Hogchoker	1	0.5	29.5	0.5
Ictaluridae sp.	1	0.5	2.8	<0.1
Spot	1	0.5	0.9	<0.1
Striped bass	1	0.5	1.9	<0.1
Unidentified fish	1	0.5	2.2	<0.1
Common grass shrimp	1	0.5	1.9	<0.1
TOTAL=	221	100	6371.3	100

TABLE 3 MONTHLY IMPINGEMENT CATCH AT CHESTERFIELD POWER STATION, 2005-2006

Species/Taxon	2005							2006					Annual
	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Total
Bay anchovy	0	0	0	1	0	0	0	0	0	0	0	0	1
Blueback herring	0	4	7	9	1	0	0	0	0	1	0	0	22
Alewife	1	1	1	0	0	0	0	0	0	0	0	0	3
American shad	0	1	0	1	2	0	0	0	0	0	0	0	4
Gizzard shad	1	0	0	0	0	1	1	0	0	1	0	1	5
Common carp	0	0	0	0	0	0	0	1	0	0	0	0	1
Spottail shiner	1	1	1	0	0	0	0	1	0	0	1	0	5
Ictaluridae sp.	0	0	0	1	0	0	0	0	0	0	0	0	1
Blue catfish	3	6	4	4	2	3	1	2	1	1	1	1	29
Channel catfish	0	1	0	3	3	2	6	0	0	0	1	2	18
Flathead catfish	0	0	0	0	2	0	0	0	0	0	0	0	2
Inland silverside	1	0	0	0	0	0	1	0	0	0	0	0	2
Banded killifish	0	0	0	0	0	0	2	0	0	0	0	0	2
White perch	0	10	1	0	3	1	1	0	0	0	0	0	16
Striped bass	0	0	0	1	0	0	0	0	0	0	0	0	1
Green sunfish	0	0	0	0	1	0	0	0	0	0	0	0	1
Bluegill	0	1	0	0	0	1	5	2	0	0	2	0	11
Largemouth bass	1	5	0	2	0	0	0	0	0	0	0	0	8
Black crappie	1	14	0	0	0	0	2	0	0	0	0	0	17
Tessellated darter	1	0	0	0	0	0	0	1	0	0	0	0	2
Spot	1	0	0	0	0	0	0	0	0	0	0	0	1
Hogchoker	0	0	0	0	1	0	0	0	0	0	0	0	1
Damaged fish	1	0	0	0	0	0	0	0	0	0	0	0	1
Asiatic clam	1	0	0	0	0	0	0	0	0	3	0	0	4
Common grass shrimp	0	0	0	0	1	0	0	0	0	0	0	0	1
Blue crab	0	3	1	10	29	18	1	0	0	0	0	0	62
Totals=	**13**	**47**	**15**	**32**	**45**	**26**	**20**	**7**	**1**	**6**	**5**	**4**	**221**

TABLE 4 NUMBER OF IMPINGED FISH AND SHELLFISH COLLECTED DURING DAYTIME AND NIGHTTIME HOURS AT CHESTERFIELD POWER STATION, 2005 - 2006

Species/Taxon	Day	Night
Bay anchovy		1
Blueback herring	6	16
Alewife	3	
American shad	2	2
Gizzard shad	2	3
Common carp		1
Spottail shiner	1	4
Ictaluridae sp.	1	
Blue catfish	12	17
Channel catfish	5	13
Flathead catfish		2
Inland silverside	1	1
Banded killifish		2
White perch	6	10
Striped bass	1	
Green sunfish		1
Bluegill	5	6
Largemouth bass	3	5
Black crappie	5	12
Tessellated darter	2	
Spot		1
Hogchoker	1	
Damaged fish	1	
Asiatic clam	4	
Common grass shrimp		1
Blue crab	22	40
Totals=	**83**	**138**

TABLE 5 LENGTH STATISTICS FOR IMPINGED ORGANISMS AT CHESTERFIELD POWER STATION, JUNE 2005 -- MAY 2006

Species/Taxon	N	min mm	max mm	avg mm	std dev mm
Alewife	3	58	84	73	13.6
American shad	4	57	113	89	24.1
Banded killifish	2	70	74	72	2.8
Bay anchovy	1	57	57	57	
Black crappie	17	48	138	63	25.7
Blue catfish	29	62	478	152	87.6
Blueback herring	22	46	88	64	9.0
Bluegill	11	44	163	102	41.7
Channel catfish	18	73	201	111	35.0
Common carp	1	112	112	112	
Flathead catfish	2	66	99	83	23.3
Gizzard shad	5	110	357	166	107.0
Green sunfish	1	47	47	47	
Hogchoker	1	136	136	136	
Ictaluridae sp.	1	75	75	75	
Inland silverside	2	67	88	78	14.8
Largemouth bass	8	47	366	109	107.5
Spot	1	39	39	39	
Spottail shiner	5	42	96	72	22.2
Striped bass	1	61	61	61	
Tessellated darter	2	78	88	83	7.1
White perch	16	41	139	80	33.2
Blue crab*	56	17	203	89	58.3

*Carapace width measured

TABLE 6 MONTHLY AND ANNUAL IMPINGEMENT ESTIMATES AT CHESTERFIELD POWER STATION BASED ON MAXIMUM COOLING-WATER FLOW

Species/Taxon	6-2005	7-2005	8-2005	9-2005	10-2005	11-2005	12-2005	1-2006	2-2006	3-2006	4-2006	5-2006	6-2006	Total Annual Estimate
Bay anchovy	0	0	0	64	19	0	0	0	0	0	0	0	0	**83**
Alewife	89	202	90	0	0	0	0	0	0	0	0	0	0	**382**
Blueback herring	0	555	824	1394	122	0	0	0	7	88	0	0	0	**2990**
American shad	0	86	0	128	206	0	0	0	0	0	0	0	0	**419**
Gizzard shad	89	25	0	0	0	307	93	0	0	233	43	57	0	**847**
Common carp	0	0	0	0	0	0	0	119	0	0	0	0	0	**119**
Spottail shiner	126	183	181	0	0	0	15	242	0	88	265	0	0	**1101**
Blue catfish	267	933	565	494	419	749	116	367	134	211	106	166	14	**4540**
Channel catfish	0	84	0	356	345	342	865	0	0	71	255	390	29	**2737**
Flathead catfish	0	0	0	0	252	0	0	0	0	0	0	0	0	**252**
Ictaluridae sp.	0	0	0	64	19	0	0	0	0	0	0	0	0	**83**
Inland silverside	252	0	0	0	0	0	108	0	0	0	0	0	0	**360**
Banded killifish	0	0	0	0	0	0	324	0	0	0	0	0	0	**324**
White perch	0	1284	181	0	336	307	93	0	0	0	0	0	0	**2200**
Striped bass	0	0	0	114	0	0	0	0	0	0	0	0	0	**114**
Green sunfish	0	0	0	0	168	0	0	0	0	0	0	0	0	**168**
Bluegill	0	168	0	0	19	289	710	356	0	71	212	0	0	**1826**
Black crappie	89	2044	0	0	0	26	185	0	0	0	0	0	0	**2345**
Largemouth bass	44	685	0	192	57	0	0	0	0	0	0	0	0	**978**
Tessellated darter	126	0	0	0	0	0	15	242	0	0	0	0	0	**383**
Spot	252	0	0	0	0	0	0	0	0	0	0	0	0	**252**
Hogchoker	0	0	0	0	168	0	0	0	0	0	0	0	0	**168**
Damaged fish	89	25	0	0	0	0	0	0	0	0	0	0	0	**114**
Blue Crab	0	428	192	942	3976	3649	216	0	0	0	0	0	0	**9403**
Common grass shrimp	0	0	0	0	84	0	0	0	0	0	0	0	0	**84**
Asiatic Clam	89	25	0	0	0	0	0	0	0	582	0	0	0	**696**
Totals=	**1512**	**6728**	**2033**	**3746**	**6191**	**5670**	**2739**	**1327**	**140**	**1344**	**882**	**613**	**43**	**32969**

Note: June 2005 and June 2006 are each partial months.

TABLE 7 MEAN WATER QUALITY VALUES ASSOCIATED WITH IMPINGEMENT SAMPLING, CHESTERFIELD POWER STATION, JUNE 2005 - MAY 2006

Sampling Event	Conductivity (µs/cm)	DO (mg/L)	pH (pH units)	Temperature (Degrees C)
06/21/05	223	7.7	7.8	28.0
06/27/05	263	7.0	7.6	29.7
07/11/05	256	7.5	7.6	28.6
07/22/05	273	6.5	7.6	32.4
08/08/05	314	11.7	8.0	32.3
08/22/05	340	6.5	7.8	31.7
09/12/05	353	7.7	8.1	29.2
09/26/05	293	6.5	7.5	29.6
10/10/05	135	8.6	7.4	21.9
10/24/05	186	7.8	7.8	18.4
11/07/05	236	9.7	7.4	15.7
11/20/05	271	11.9	7.9	15.1
12/07/05	122	15.1	7.4	7.3
12/21/05	121	14.1	7.4	4.5
01/09/06	101	14.2	7.6	7.0
01/23/06	111	12.7	7.3	7.3
02/08/06	119	13.3	7.5	7.6
02/22/06	181	13.5	7.8	7.5
03/06/06	217	13.5	7.4	10.4
03/20/06	223	9.9	7.5	14.6
04/03/06	304	9.7	7.8	16.8
04/17/06	316	7.7	7.6	19.3
05/01/06	197	9.4	7.7	19.1
05/15/06	189	8.1	7.6	21.6

TABLE 8 SUMMARY RESULTS OF QUARTERLY AMBIENT JUVENILE AND ADULT FISH SAMPLING IN THE VICINITY OF CHESTERFIELD POWER STATION, 2005-2006

Species	June	October	February	April	Total
Atlantic sturgeon	1				1
Longnose gar				1	1
American eel		2			2
Bay anchovy		10			10
American shad	1				1
Blueback herring		10		4	14
Gizzard shad	40	59	1	8	108
Common carp	3	17		11	31
Satinfin shiner	10	2	1	8	21
Spotfin shiner	8				8
Telescope shiner				1	1
Spottail shiner	188	73	2		263
Flathead catfish	1	4	1		6
Channel catfish	7	30			37
Blue catfish	32	52		9	93
Inland silverside	19				19
Banded killifish	1		8	1	10
Striped bass	8	19			27
White perch	26	300		19	345
Bluegill	8	32	18	22	80
Redbreast sunfish				1	1
Redear sunfish	1			1	2
Black crappie		1			1
Largemouth bass	5	11	5	9	30
Smallmouth bass		2			2
Johnny darter	2				2
Tessellated darter	1				1
Blue crab			1		1
Totals=	**361**	**624**	**37**	**94**	**1116**

TABLE 9 RANKED ABUNDANCE AND PERCENT COMPOSITION OF IMPINGED FISH COLLECTED AT CHESTERFIELD POWER STATION, JANUARY - DECEMBER 1977 (from Vepco 1977)

Species	Number	Percent	Weight (gm)	Percent
Hogchoker	83	18.8	107	0.8
Spottail shiner	63	14.3	283	2.1
Atlantic menhaden	55	12.5	633	4.8
Alewife	54	12.2	1,719	13.1
White perch	34	7.7	576	4.4
Bluegill	31	7.0	535	4.1
Blueback herring	31	7.0	2,066	15.7
Gizzard shad	20	4.5	5,060	38.4
Channel catfish	17	3.9	945	7.2
Pumpkinseed	10	2.3	257	2.0
Threadfin shad	7	1.6	36	0.3
Black crappie	4	0.9	595	4.5
Mississippi silvery minnow	4	0.9	30	0.2
Redbreast sunfish	4	0.9	33	0.3
Striped bass	4	0.9	11	0.1
White catfish	3	0.7	164	1.2
Tessellated darter	3	0.7	18	0.1
Bay anchovy	3	0.7	5	<0.1
Yellow perch	3	0.7	42	0.3
Spot	3	0.7	43	0.3
Inland silverside	2	0.5	3	<0.1
American eel	2	0.5	1	<0.1
Golden shiner	1	0.2	6	<0.1
Total=	441	100	13,168	100

TABLE 10 COMPARISON OF CURRENT AND HISTORICAL IMPINGEMENT SAMPLE DATA, CHESTERFIELD POWER STATION

Species	2005-2006	1977
Blue crab	62	NA
Blue catfish	29	0
Blueback herring	22	31
Channel catfish	18	17
Black crappie	17	4
White perch	16	34
Bluegill	11	31
Largemouth bass	8	0
Gizzard shad	5	20
Spottail shiner	5	63
American shad	4	0
Asiatic clam	4	NA
Alewife	3	54
Banded killifish	2	0
Flathead catfish	2	0
Inland silverside	2	2
Tessellated darter	2	3
Bay anchovy	1	3
Common carp	1	0
Green sunfish	1	0
Hogchoker	1	83
Ictaluridae sp.	1	0
Spot	1	3
Striped bass	1	4
Unidentified fish	1	0
Common grass shrimp	1	NA
Atlantic menhaden	0	55
Pumpkinseed	0	10
Threadfin shad	0	7
Mississippi silvery minnow	0	4
American eel	0	2
Redbreast sunfish	0	4
White catfish	0	3
Yellow perch	0	3
Golden shiner	0	1
TOTAL=	221	441

NA=not recorded

TABLE 11 AVERAGE DENSITY AND PERCENT COMPOSITION OF ICHTHYOPLANKTON AND MACROINVERTEBRATES ENTRAINED AT CHESTERFIELD POWER STATION, JUNE 2005 -- MAY 2006

Species/Taxon	No./100 M^3	Percent	Cummulative Percent
River herring - larvae	31.61	23.06	23.06
Bivalve - young	26.78	19.53	42.59
Dorsoma sp. - egg	18.07	13.18	55.77
Gizzard shad - larvae	10.55	7.70	63.47
Bay anchovy - egg	8.43	6.15	69.61
Shrimp	6.93	5.06	74.67
Dorsoma sp. - larvae	6.22	4.54	79.21
Fish egg - damaged	4.21	3.07	82.28
River herring - egg	3.42	2.50	84.78
White perch - larvae	3.20	2.33	87.11
White perch - egg	2.36	1.72	88.83
Alewife - larvae	2.28	1.66	90.49
Hickory shad - larvae	2.19	1.60	92.09
Other crab - zoea	2.07	1.51	93.60
Clupeidae sp. - larvae	2.07	1.51	95.11
Alewife - egg	1.26	0.92	96.03
Tessellated darter - larvae	0.95	0.69	96.72
Fish larvae - damaged	0.57	0.41	97.13
Inland silverside - larvae	0.55	0.40	97.53
Hickory shad - egg	0.41	0.30	97.83
Blueback herring - larvae	0.40	0.29	98.12
American shad - egg	0.36	0.26	98.38
Lepomis sp. - larvae	0.29	0.21	98.59
Hogchoker - egg	0.27	0.20	98.79
Spottail shiner - larvae	0.24	0.17	98.97
Inland silverside - egg	0.23	0.17	99.13
Blueback herring - egg	0.21	0.15	99.29
Pomoxis sp. - larvae	0.18	0.13	99.42
Centrarchidae - egg	0.15	0.11	99.53
Bluegill - larvae	0.15	0.11	99.64
Centrarchidae - larvae	0.10	0.08	99.71
Bay anchovy larvae	0.08	0.06	99.77
Centrarchidae - juvenile	0.07	0.05	99.83
Atherinopsidae sp. - egg	0.04	0.03	99.85
Common carp - larvae	0.04	0.03	99.88
Threadfin shad - larvae	0.04	0.03	99.91
Naked goby - larvae	0.02	0.02	99.92
Channel catfish - larvae	0.02	0.02	99.94
Atlantic silverside - larvae	0.01	0.01	99.95
Blue Crab - megalopae	0.01	0.01	99.96
American shad - larvae	0.01	0.01	99.97
Blue catfish - larvae	0.01	0.01	99.98
Atherinopsidae sp. - larvae	0.01	0.01	99.98
White sucker - larvae	0.01	0.01	99.99
Bay anchovy - juvenile	0.01	0.01	99.99
Black crappie - larvae	0.01	0.01	100.00

TABLE 12 AVERAGE DENSITY AND PERCENT COMPOSITION OF ICHTHYOPLANKTON ENTRAINED AT CHESTERFIELD POWER STATION, JUNE 2005 -- MAY 2006

Species/Taxon	No./100 M^3	Percent	Cummulative Percent
River herring - larvae	31.61	31.21	31.21
Dorsoma sp. - egg	18.07	17.84	49.04
Gizzard shad - larvae	10.55	10.42	59.46
Bay anchovy - egg	8.43	8.32	67.78
Dorsoma sp. - larvae	6.22	6.14	73.92
Fish eggs: undetermined/damaged	4.21	4.16	78.08
River herring - egg	3.42	3.38	81.46
White perch larvae	3.20	3.15	84.61
White perch - egg	2.36	2.33	86.94
Alewife larvae	2.28	2.25	89.19
Hickory shad - larvae	2.19	2.16	91.35
Clupeidae sp. - larvae	2.07	2.04	93.39
Alewife - egg	1.26	1.24	94.64
Tesselated darter - larvae	0.95	0.94	95.57
Fish larvae - undetermined/damaged	0.57	0.56	96.13
Inland silverside - larvae	0.55	0.54	96.67
Hickory shad - egg	0.41	0.41	97.08
Blueback herring - larvae	0.40	0.40	97.48
American shad - egg	0.36	0.35	97.83
Lepomis sp. - larvae	0.29	0.28	98.11
Hogchoker - egg	0.27	0.27	98.38
Spottail shiner - larvae	0.24	0.23	98.61
Inland silverside - egg	0.23	0.23	98.84
Blueback herring - egg	0.21	0.21	99.05
Pomoxis sp. - larvae	0.18	0.18	99.23
Centrarchidae sp. - egg	0.15	0.15	99.38
Bluegill - larvae	0.15	0.15	99.52
Centrarchidae sp. - larvae	0.10	0.10	99.63
Bay anchovy - larvae	0.08	0.08	99.71
Centrarchidae - juvenile	0.07	0.07	99.78
Atherinopsidae sp. - egg	0.04	0.04	99.82
Common carp - larvae	0.04	0.04	99.86
Threadfin shad - larvae	0.04	0.03	99.89
Naked goby - larvae	0.02	0.02	99.91
Channel catfish - larvae	0.02	0.02	99.93
Atlantic silverside - larvae	0.01	0.01	99.95
American shad - larvae	0.01	0.01	99.96
Blue catfish - larvae	0.01	0.01	99.97
Atherinopsidae sp. - larvae	0.01	0.01	99.98
White sucker - larvae	0.01	0.01	99.99
Bay anchovy - juvenile	0.01	0.01	99.99
Black crappie - larvae	0.01	0.01	100.00

TABLE 13 MONTHLY DENSITIES (NUMBER PER 100 M^3) OF COMMON ICHTHYOPLANKTON ENTRAINED AT CHESTERFIELD POWER STATION, JUNE 2005 -- MAY 2006

Species/Taxon	2005							2006				
	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
Bay anchovy - egg	0.0	9.1	90.1	0.2	0.1	0.0	1.7	0.0	0.0	0.0	0.0	0.0
Bay anchovy larvae	0.0	0.0	0.0	0.9	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
River herring - egg	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.3	51.5
River herring - larvae	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.9	17.2	393.4
Gizzard shad - larvae	1.2	0.3	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	21.7	103.3
Hickory shad - larvae	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	14.0	12.2
Dorsoma sp. - egg	24.5	39.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	29.8	122.8
White perch - egg	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	16.6	11.7
White perch - larvae	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	8.4	29.6
Tessellated darter - larvae	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8.1	3.3

Note: In this table, "River herring" is combination of three taxa: river herring, alewife, and blueback herring

TABLE 14 LENGTH-FREQUENCY DISTRIBUTION OF ENTRAINED GIZZARD SHAD AT CHESTERFIELD POWER STATION

Date	Mean Length (mm)	N	2 to 2.9 mm	3 to 3.9 mm	4 to 4.9 mm	5 to 5.9 mm	6 to 6.9 mm	7 to 7.9 mm	8 to 8.9 mm
06/21/05	5	4	1	1	1			1	
06/27/05									
07/11/05									
07/25/05	4	2			2				
08/08/05									
08/22/05									
09/12/05	5	1				1			
09/26/05									
10/10/05									
10/24/05									
11/07/05									
11/20/05									
12/07/05									
12/21/05									
01/09/06									
01/23/06									
02/08/06									
02/22/06									
03/06/06									
03/20/06									
04/03/06									
04/17/06	4	109	1	49	44	14			1
05/01/06	5	163		11	64	88			
05/15/06	5	323		11	154	157			1
	Totals:	602	2	72	265	260	0	1	2

TABLE 15 LENGTH-FREQUENCY DISTRIBUTION OF ENTRAINED WHITE PERCH AT CHESTERFIELD POWER STATION

Date	Mean Length (mm)	N	2 to 2.9 mm	3 to 3.9 mm	4 to 4.9 mm	5 to 5.9 mm	6 to 6.9 mm	7 to 7.9 mm
06/21/05								
06/27/05								
07/11/05								
07/25/05								
08/08/05								
08/22/05								
09/12/05								
09/26/05								
10/10/05								
10/24/05								
11/07/05								
11/20/05								
12/07/05								
12/21/05								
01/09/06								
01/23/06								
02/08/06								
02/22/06								
03/06/06								
03/20/06	4	1		1				
04/03/06	3	14	4	7	3			
04/17/06	4	25	2	21	1	1		
05/01/06	3	33	1	31	1			
05/15/06	4	135	1	124	7		2	1
	Totals:	208	8	184	12	1	2	1

TABLE 16 MONTHLY AND ANNUAL ENTRAINMENT ESTIMATES (X 10^6) FOR CHESTERFIELD POWER STATION, JUNE 2005 - MAY 2006

Species/Taxon	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Total
Bay anchovy-fertilized egg	0.0	11.1	109.3	5.7	0.1	0.3	1.8	0.0	0.0	0.0	0.0	0.0	0.0	**128.3**
Bay anchovy-juvenile	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.1**
Bay anchovy-larvae	0.0	0.0	0.0	1.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**1.3**
Blueback herring-fertilized egg	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.1	1.7	0.0	**2.8**
Blueback herring-larvae	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	3.9	1.2	0.0	**5.2**
Alewife-fertilized egg	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10.9	7.7	0.4	**18.9**
Alewife-post-larvae	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.8	19.4	8.2	0.0	**29.5**
American shad-fertilized egg	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	4.2	0.0	0.0	**4.8**
American shad-larvae	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	**0.1**
Gizzard shad-larvae	1.9	0.3	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	38.0	149.6	11.5	**201.6**
Threadfin shad-larvae	0.0	0.3	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.5**
Hickory shad-fertilized egg	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	3.6	0.0	0.0	**4.7**
Hickory shad-larvae	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	17.3	18.4	1.5	**37.2**
River herring-fertilized egg	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.1	69.9	6.0	**76.9**
River herring-larvae	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0	665.3	57.8	**725.1**
Clupeidae sp.-larvae	11.8	3.5	3.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**19.2**
Dorsoma sp.-fertilized egg	37.0	41.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	73.4	118.7	5.8	**275.9**
Dorsoma sp.-larvae	16.8	18.7	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	36.8	5.7	0.0	**78.2**
Dorsoma sp.-unfertilized egg	0.0	1.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**1.9**
White sucker-larvae	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.0	**0.1**
Common carp-larvae	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.3	0.0	**0.5**
Spottail shiner-larvae	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	3.7	0.2	**4.5**
Blue catfish-larvae	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.2**
Channel catfish-larvae	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.3**
Atlantic silverside-larvae	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.0	**0.2**
Inland silverside-fertilized egg	0.7	0.8	1.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**3.4**
Inland silverside-larvae	3.6	1.0	3.7	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.6	0.0	**9.1**
Atherinopsidae sp.-fertilized egg	0.0	0.0	0.0	0.0	0.1	0.2	0.0	0.0	0.0	0.0	0.1	0.1	0.0	**0.5**
Atherinopsidae sp.-larvae	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.2**
Naked goby-larvae	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.3**
White perch-fertilized egg	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.5	18.2	12.7	0.6	**34.0**
White perch-larvae	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.1	9.9	45.8	3.8	**60.6**
Bluegill-post-larvae	0.0	0.2	2.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**2.3**
Black crappie-larvae	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	**0.2**
Centrarchidae -fertilized egg	0.0	0.0	2.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**2.3**

Centrarchidae -juvenile	0.0	0.0	1.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**1.1**

TABLE 16 (Continued)

Species/Taxon	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Total
Centrarchidae -larvae	0.0	1.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**1.4**
Lepomis sp.-larvae	0.8	0.5	3.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**4.4**
Pomoxis spp.-larvae	0.0	0.0	2.6	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	**2.8**
Tessellated darter-larvae	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.4	7.5	3.6	0.2	**12.7**
Hogchoker-fertilized egg	0.0	0.1	3.9	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**4.3**
Blue crab-megalop	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.2**
Fish egg - undetermined/damaged	5.4	3.9	16.3	1.1	0.0	0.0	0.0	0.0	0.0	0.1	29.2	4.7	0.0	**60.8**
Fish larvae - undetrmine/damaged	1.2	1.0	3.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.3	0.6	0.0	**7.1**
Bivalve - young	0.0	77.7	83.5	6.7	28.3	45.4	4.2	5.0	3.4	23.7	76.7	9.1	0.1	**363.8**
Shrimp	0.0	2.3	24.7	7.5	3.9	5.0	22.6	4.7	0.3	3.0	22.3	3.2	0.0	**99.5**
Other crab - zoea	0.0	1.9	13.2	9.1	0.9	1.7	4.0	0.0	0.0	0.0	0.1	0.1	0.0	**31.0**
Total	79.1	168.1	275.2	32.7	33.5	52.6	32.7	9.7	3.7	35.5	378.1	1131.2	88.0	**2320.1**

TABLE 17 DENSITY (#/100 M^3) OF ICHTHYOPLANKTON ENTRAINED AT CHESTERFIELD POWER STATION, JUNE 2005 - MAY 2006

Sample Date	Bay anchovy eggs	Dorosoma sp. eggs	River herring larvae	Gizzard shad larvae	White perch larvae
06/21/05	0.0	44.3	0.0	2.4	0.0
06/27/05	0.0	4.8	0.0	0.0	0.0
07/11/05	2.9	74.8	0.0	0.0	0.0
07/25/05	15.3	4.3	0.0	0.6	0.0
08/08/05	34.5	0.0	0.0	0.0	0.0
08/22/05	145.7	0.0	0.0	0.0	0.0
09/12/05	0.0	0.0	0.0	0.5	0.0
09/26/05	0.3	0.0	0.0	0.0	0.0
10/10/05	0.2	0.0	0.0	0.0	0.0
10/24/05	0.0	0.0	0.0	0.0	0.0
11/07/05	0.0	0.0	0.0	0.0	0.0
11/20/05	0.0	0.0	0.0	0.0	0.0
12/07/05	3.4	0.0	0.0	0.0	0.0
12/21/05	0.0	0.0	0.0	0.0	0.0
01/09/06	0.0	0.0	0.0	0.0	0.0
01/23/06	0.0	0.0	0.0	0.0	0.0
02/08/06	0.0	0.0	0.0	0.0	0.0
02/22/06	0.0	0.0	0.0	0.0	0.0
03/06/06	0.0	0.0	0.0	0.0	0.0
03/20/06	0.0	0.0	1.6	0.0	0.6
04/03/06	0.0	0.6	9.1	0.0	6.6
04/17/06	0.0	59.1	25.2	43.3	10.2
05/01/06	0.0	170.4	33.2	56.5	7.8
05/15/06	0.0	75.2	753.6	150.0	51.5

Note: In this table, "River herring" is combination of three taxa: river herring, alewife, and blueback herring

TABLE 18 DENSITY (#/100 M^3) OF ICHTHYOPLANKTON IN JAMES RIVER AMBIENT ICHTHYOPLANKTON SAMPLES AT CHESTERFIELD POWER STATION, JUNE 2005 - MAY 2006

Sample Date	Bay anchovy eggs	Dorosoma sp. eggs	River herring larvae	Gizzard shad larvae	White perch larvae
06/21/05	0.0	467.8	0.0	5.1	0.0
06/27/05	0.0	91.3	0.3	13.3	0.0
07/11/05	0.0	0.2	0.0	0.0	0.0
07/25/05	0.1	0.0	0.0	0.0	0.0
08/08/05	0.3	0.0	0.0	0.0	0.0
08/22/05	0.0	0.0	0.0	0.0	0.0
09/12/05	0.0	0.0	0.0	0.0	0.0
09/26/05	0.0	0.0	0.0	0.0	0.0
10/10/05	0.0	0.0	0.0	0.0	0.0
10/24/05	0.0	0.0	0.0	0.0	0.0
11/07/05	0.6	0.0	0.0	0.0	0.0
11/20/05	0.0	0.0	0.0	0.0	0.0
12/07/05	0.0	0.0	0.0	0.0	0.0
12/21/05	0.0	0.0	0.0	0.0	0.0
01/09/06	0.0	0.0	0.0	0.0	0.0
01/23/06	0.0	0.0	0.0	0.0	0.0
02/08/06	0.0	0.0	0.0	0.0	0.0
02/22/06	0.0	0.0	0.0	0.0	0.0
03/06/06	0.0	0.0	0.0	0.0	0.0
03/20/06	0.0	0.0	1.6	0.0	1.6
04/03/06	0.0	0.7	4.7	0.0	12.0
04/17/06	0.0	101.1	12.5	58.9	12.9
05/01/06	0.0	29.6	26.0	144.2	9.1
05/15/06	0.0	98.1	2292.6	737.4	114.2

Note: In this table, "River herring" is combination of three taxa: river herring, alewife, and blueback herring

TABLE 19 MEAN WATER QUALITY VALUES ASSOCIATED WITH AMBIENT ICHTHYOPLANKTON SAMPLING, CHESTERFIELD POWER STATION, 2005-2006

Sampling Event	Sampling Station	Conductivity (µs/cm)			DO (mg/L)			pH (pH units)			Temperature (Degrees C)		
		Sur	Mid	Bot	Sur	Mid	Bot	Sur	Mid	Bot	Sur	Mid	Bot
06/21/05	ADJACENT	236	234	232	7.2	6.8	6.5	7.7	7.7	7.6	28.6	28.4	27.9
	DOWNSTREAM	237	236	235	7.3	6.9	7.0	7.8	7.8	7.7	29.1	28.7	28.7
	UPSTREAM	235	234	234	6.8	6.7	6.5	7.8	7.7	7.6	28.2	28.0	27.8
06/27/05	ADJACENT	394	390	394	7.3	6.5	6.5	7.7	7.6	7.2	29.6	28.9	28.4
	DOWNSTREAM	396	393	391	6.9	6.6	6.3	7.6	7.6	7.6	30.0	29.7	29.2
	UPSTREAM	391	388	385	6.6	6.3	6.1	7.6	7.5	7.5	29.1	28.6	28.0
07/11/05	ADJACENT	305	297	295	7.5	7.4	7.2	7.7	7.6	7.6	30.0	29.2	28.6
	DOWNSTREAM	296	292	288	7.2	6.9	6.7	7.7	7.6	7.6	29.9	29.1	28.6
	UPSTREAM	294	289	287	7.3	6.9	6.8	7.7	7.6	7.6	28.8	28.4	28.2
07/25/05	ADJACENT	239	236	249	5.9	5.9	5.7	7.6	7.5	7.5	31.8	31.3	31.3
	DOWNSTREAM	244	240	237	6.0	5.7	5.5	7.6	7.5	7.4	32.7	31.7	31.2
	UPSTREAM	244	242	243	5.9	5.7	5.6	7.5	7.5	7.4	31.3	31.0	30.8
08/08/05	ADJACENT	299	292	286	7.4	7.1	7.0	7.7	7.7	7.6	33.1	32.0	31.5
	DOWNSTREAM	307	294	290	7.5	6.9	6.9	7.7	7.6	7.7	34.3	32.3	31.6
	UPSTREAM	294	291	288	7.5	7.1	7.0	7.7	7.7	7.5	32.5	31.7	30.9
08/22/05	ADJACENT	279	273	266	6.0	5.8	5.8	7.8	7.8	7.7	32.9	31.9	31.0
	DOWNSTREAM	288	273	267	5.9	5.6	5.5	7.8	7.8	7.7	33.8	31.8	30.8
	UPSTREAM	273	264	256	6.0	5.7	5.7	7.9	7.8	7.7	32.1	31.1	30.3
09/12/05	ADJACENT	357	351	345	8.4	8.0	7.8	8.4	8.3	8.2	29.8	28.6	27.6
	DOWNSTREAM	361	352	345	7.8	7.6	7.6	8.3	8.2	8.2	29.8	29.0	28.0
	UPSTREAM	358	353	343	8.7	7.5	7.7	8.5	8.2	8.1	29.9	28.5	27.5
09/26/05	ADJACENT	380	375	373	6.3	6.0	5.8	8.0	7.9	7.8	29.8	29.0	28.6
	DOWNSTREAM	382	377	375	6.1	5.7	5.8	8.0	8.0	7.9	29.9	29.4	28.8
	UPSTREAM	377	376	371	6.4	6.1	6.1	7.8	7.8	7.8	29.2	28.5	27.9
10/10/05	ADJACENT	136	137	138	8.3	8.1	8.0	7.8	7.8	7.7	20.8	20.8	20.8
	DOWNSTREAM	142	140	132	8.0	8.1	8.0	7.8	7.7	7.7	21.0	20.9	20.9
	UPSTREAM	133	133	156	8.2	8.1	8.0	7.6	7.7	7.7	20.7	20.8	20.9
10/24/05	ADJACENT	125	124	119	8.7	7.9	8.0	7.8	7.8	7.8	18.7	18.1	18.0
	DOWNSTREAM	131	125	125	7.7	7.7	7.8	7.8	7.8	7.8	18.4	18.4	18.2
	UPSTREAM	118	119	121	8.2	8.1	8.1	7.8	7.8	7.8	17.8	17.5	17.5
11/07/05	ADJACENT	186	216	229	10.1	9.8	9.7	7.7	7.7	7.6	15.1	15.0	14.9
	DOWNSTREAM	211	209	209	10.1	9.8	9.6	7.7	7.7	7.7	15.6	15.5	15.4
	UPSTREAM	212	213	213	9.6	9.6	9.6	7.8	7.7	7.7	15.0	14.7	14.6
11/20/05	ADJACENT	260	261	262	7.8	7.6	7.4	8.1	8.1	8.0	14.3	14.3	14.3
	DOWNSTREAM	266	266	266	7.9	7.8	7.7	8.1	8.1	8.1	14.7	14.6	14.6
	UPSTREAM	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

ND = No Data due to equipment malfunction

TABLE 19 (Continued)

Sampling Event	Sampling Station	Conductivity (µs/cm)			DO (mg/L)			pH (pH units)			Temperature (Degrees C)		
		Sur	Mid	Bot	Sur	Mid	Bot	Sur	Mid	Bot	Sur	Mid	Bot
12/07/05	ADJACENT	114	114	114	31.7	31.7	31.7	7.2	7.2	7.1	6.4	6.4	6.4
	DOWNSTREAM	114	114	114	32.1	32.0	32.0	7.4	7.3	7.3	7.1	7.0	7.0
	UPSTREAM	113	113	112	11.7	11.5	11.5	7.3	7.2	7.1	6.3	6.3	6.3
12/21/05	ADJACENT	114	115	114	15.1	15.0	15.4	6.9	6.8	6.7	3.7	3.8	3.8
	DOWNSTREAM	118	120	119	12.7	15.0	14.9	7.4	7.1	6.9	4.2	4.1	4.1
	UPSTREAM	112	112	113	14.9	14.8	14.8	7.0	6.9	6.9	3.6	3.6	3.7
01/09/06	ADJACENT	87	87	88	13.0	12.9	12.9	7.5	7.4	7.4	6.3	6.2	6.2
	DOWNSTREAM	90	87	87	12.6	12.6	12.6	7.4	7.4	7.4	7.3	6.7	6.5
	UPSTREAM	85	85	89	13.0	12.9	12.8	7.4	7.3	7.3	6.1	6.1	6.1
01/23/06	ADJACENT	104	108	111	13.0	13.0	13.0	7.0	6.7	6.5	6.6	6.5	6.5
	DOWNSTREAM	105	106	106	13.0	13.1	13.1	7.0	6.8	6.7	6.6	6.6	6.6
	UPSTREAM	106	100	102	12.9	12.8	12.7	7.0	6.8	6.7	6.5	6.5	6.6
02/08/06	ADJACENT	117	116	117	14.0	14.1	14.1	7.4	7.4	7.4	6.7	6.7	6.7
	DOWNSTREAM	116	116	116	13.9	14.0	14.1	7.5	7.5	7.4	6.8	6.8	6.8
	UPSTREAM	116	115	115	14.0	14.1	14.1	7.5	7.5	7.4	6.6	6.6	6.6
02/22/06	ADJACENT	166	170	172	13.3	13.1	12.9	7.8	7.9	7.9	6.8	6.8	6.8
	DOWNSTREAM	162	164	164	12.8	13.0	13.0	7.8	7.8	7.9	7.6	7.2	7.1
	UPSTREAM	160	151	177	13.1	13.1	12.8	7.8	7.8	7.7	6.6	6.6	6.6
03/06/06	ADJACENT	262	246	240	12.4	12.7	12.9	7.9	7.9	7.8	9.7	9.3	9.1
	DOWNSTREAM	240	240	239	11.8	12.3	12.4	7.9	7.8	7.8	10.3	9.9	9.8
	UPSTREAM	243	242	241	12.8	12.9	12.9	8.0	7.9	7.8	9.0	8.9	8.9
03/20/06	ADJACENT	242	238	236	9.0	9.2	9.2	7.4	7.3	7.1	14.2	13.5	13.3
	DOWNSTREAM	243	239	237	9.3	9.3	9.3	7.4	7.3	7.2	15.4	13.8	13.6
	UPSTREAM	233	234	234	9.3	9.3	9.2	7.3	7.2	7.1	12.9	12.9	12.9
04/03/06	ADJACENT	305	303	302	7.7	7.7	7.6	7.4	7.3	7.4	16.4	16.2	16.2
	DOWNSTREAM	307	308	307	7.8	7.8	7.8	7.4	7.4	7.4	16.9	16.6	16.3
	UPSTREAM	301	300	301	7.6	7.5	7.6	7.5	7.5	7.5	16.3	16.2	16.2
04/17/06	ADJACENT	278	279	279	7.9	8.0	8.0	7.6	7.6	7.6	20.0	19.8	19.8
	DOWNSTREAM	283	281	281	7.9	8.0	8.0	7.7	7.7	7.6	20.2	19.9	19.8
	UPSTREAM	273	272	273	7.9	8.0	8.0	7.6	7.6	7.5	19.5	19.6	19.5
05/01/06	ADJACENT	213	215	213	8.5	8.5	8.5	7.4	7.5	7.5	18.7	18.6	18.6
	DOWNSTREAM	212	213	211	8.6	8.7	8.8	7.5	7.6	7.5	20.0	19.1	18.9
	UPSTREAM	210	210	210	8.5	8.6	8.6	7.4	7.5	7.5	18.4	18.4	18.4
05/15/06	ADJACENT	194	196	195	7.3	7.3	7.3	7.5	7.5	7.5	21.5	21.4	21.2
	DOWNSTREAM	194	193	193	7.5	7.3	7.4	7.5	7.5	7.5	22.2	21.5	21.2
	UPSTREAM	195	196	197	7.4	7.3	7.2	7.5	7.5	7.5	21.1	21.0	20.8

APPENDIX A

Impingement, Entrainment, and Ambient Ichthyoplankton Calculation Procedures

A.1. INTRODUCTION

The Dominion Resources 316b database stores plant operating conditions, water quality data, and organism data collected for three main types of sampling events: entrainment, impingement, and ambient ichthyoplankton ("ich") sampling. Data for quarterly juvenile/adult sampling events, which occur at off-site sampling locations, are also stored in the database. One of the main project objectives is to generate estimates of monthly and annual organism estimates based on the collected organism data. This appendix describes the impingement, entrainment, and ambient ichthyoplankton calculation procedures for Chesterfield Power Station.

A.2. SAMPLING SCHEDULE AND EXTRAPOLATION RANGE

The sampling schedule consisted of two parent sampling events per month. Each parent event was considered a 24-hour sampling period.

Each Parent Event date has an assigned "date range" where each date in the range was assigned the same organism estimate that was recorded during the parent event date. The date range is established by counting halfway back to the prior parent event, and halfway forward to the subsequent parent event. A small example for three parent dates is presented below:

Parent Date	Range Start	Range End	Day Count
6/23/2005	6/7/2005	6/25/2005	19
6/29/2005	6/26/2005	7/5/2005	10
7/13/2005	7/6/2005	7/20/2005	15

A.3. IMPINGEMENT CALCULATION PROCEDURES

A.3.1 Overview

Chesterfield Station had five sampling "stations," or specific locations where impingement samples were collected from the screen-wash troughs. The database stores the screen-wash sampling stations, the circulating-water pumps associated with the sampling stations, the flow rate for each circulating-water pump, and the number of traveling screens. The identities of the pumps operating at the time of sample collection were recorded to allow later calculation of sample volumes. The organism estimates and pump flow data were combined to ultimately yield annual organism estimates at plant maximum flow conditions.

At Chesterfield, impingement samples were collected for 10 minutes during each of 16 hours during a 24-hour parent event. Over the 24-hour parent sampling event, 4 sequential 1-hour periods were sampled, followed by a 2-hr hiatus during which entrainment sampling was done, resulting in 16 impingement samples per parent event.

A.3.2 Organism Data

In each sample collected, the organisms were identified by species. For individual organisms the weight and length were recorded. If large numbers of a particular organism were collected (>15), the organisms were combined as a "batch weight" and "batch count." Thus a given sample could have individual and batch organism counts associated with it.

To estimate impingement rates during each 2-hour period that was not sampled, "average" organism counts were inserted for the missing hourly counts. In the example below, the 10:00 and 11:00 hourly samples were missing due to entrainment sampling. Then the average of the previous and subsequent impingement sample counts was applied to the missing hourly samples. Infrequently, scheduled impingement samples were missed due to equipment failure or severe weather conditions, and the same technique was used to extrapolate impingement rates over these periods. If the missing sample happened to be the first hour and there was no "previous" sample, the next available actual sample count was used. For missing samples that were the last, i.e., the 24th hour of the parent event, with no subsequent counts available, the closest previous count was used.

Hour	Count	Average Count for Missing Sample
08:00	15	
09:00	0	
10:00	**Missing**	**5**
11:00	**Missing**	**5**
12:00	10	
13:00	0	

A.3.3 Impingement Flow Calculations

Each hourly sample collected had associated pump flow data. Each pump has a known flow rate (M^3/hour). The combined maximum flows of the pumps at a (sampling) station represent the maximum flow for that (screen wash) station. The combined maximum flows for the five sampling stations at Chesterfield represent the maximum flow for the power station. The 24-hour maximum plant flow for Chesterfield Station is 3,836,624 M^3.

A.3.4 Impingement Parent Event Organism Estimates

For each type of organism, the objective was to calculate a "24-hour organism estimate" at maximum plant flow conditions. This is the "final organism estimate" for the 24-hour parent impingement event.

The 24-hour organism estimate for each parent event was calculated in steps as follows:

1. Calculate the "1-hour" organism estimate: The "raw" organism count collected during an hourly impingement sample is actually a 10-minute sample. The "1-hour" organism estimate is equal to the 10-minute organism count X 6. As described above, impingement counts for hour periods not sampled were estimated as the average of the prior and subsequent actual samples.

2. Calculate sample flow volume: The sample volume is calculated for each "hourly sample." The flow of all pumps operating during the hour is added to get the hourly station flow in M^3/hour units.

3. Calculate final 24-hour maximum flow volume sample estimates: All of the "1-hour" sample estimates are added to get the non-adjusted 24-hr organism estimate. Next, the actual flow volumes from all the samples in the parent event are summed to get the measured (actual) 24-

hr flow volume. If the 24-hour measured flow was not at the maximum rate (all pumps on full) then the (non-adjusted) 24-hour organism estimate was adjusted to the 24-hour maximum flow estimate (Table A-1).

Table A-1 is an example of the 7/11/05 impingement event at Chesterfield for the organism "black crappie." Note that the circulating-water pumps were on full throughout the sampling period, therefore the 132 black crappie estimated to have been impinged during the 24-hour period is the total impingement at maximum cooling-water flow.

Also note that hourly impingement estimates for those hours not sampled (due to entrainment sampling) were based on the average count for the hour before and the hour following the non-sampled period.

A.3.5 Impingement Yearly, Parent Event, and Monthly Organism Estimates

The parent event-date range estimate is calculated as in the following example. The 7/11/05 parent event had a 24-hour maximum flow estimate of 132 for the black crappie example. That final estimate of 132 was applied to the 7/11/05 parent date range of 7/3/05 to 7/16/05, or 14 days in July 2005. This range was established by counting the days halfway back to the prior parent event date, plus the days halfway forward to the subsequent parent event date. For the 10/17/06 parent-event date range, the associated black crappie estimate was 1,848, i.e., 132 black crappie from the parent event times 14 days in the range = 1,848.

For monthly estimates, the parent-event estimate data are still used to assign the fish estimates to each day in the month. For example, the monthly estimate for June 2005 required the use of three parent events as shown below:

Parent date	Start date	End Date
6/09/05	05/27/05	06/12/05
6/15/05	06/13/05	06/25/05
07/0505	06/26/05	07/11/05

The 6/09/05 event spans 12 days in June, the 6/15/05 event spans 13 days in June, and the 7/05/05 event spans 5 days in June. Therefore the June 2005 monthly total of black crappie, for example, would be calculated as the sum of:

06/09/05 parent 24-hour organism estimate * 12 days
06/15/05 parent 24-hour organism estimate * 13 days
07/05/05 parent 24-hour organism estimate * 5 days.

The yearly totals are simply the sum of all the parent, or monthly, total estimates.

Note that the date ranges assigned to each parent event span exactly 365 days for the year.

A.4. ENTRAINMENT DATA

A.4.1 Overview

The entrainment samples were collected in front of an operating pump at one of the plant's intake structures. The sample volume, water quality data, and organism collection occurred at each of the 12 entrainment events, each consisting of a pair of plankton samples at a specific depth. Usually three entrainment events (a sample pair at each of three depths) occurred in a designated "sampling hour." The 12 entrainment events, numbered 1 to 12, grouped three to an hour, typically occurred at the following times for a 24-hour parent event:

Hour Group A: events 1-3 in the 10a.m. hour (10:00)
Hour Group B: events 4-6 in the 4 p.m. hour (16:00)
Hour Group C: events 7-9 in the 10 p.m. hour (22:00)
Hour Group D: events 10-12 in the 4a.m. hour (04:00 – the following day)

Each entrainment event typically had two organism samples and corresponding sample volume measurements collected at a given depth (bottom, middle, or surface) in each of the left and right sampling nets. So for each Hour Group, consisting of three entrainment events, there were usually six samples/volume measurements taken. Below is an example sample listing for events 1,2,3 (Hour Group A):

Example of Entrainment Hourly Group A (3 events, 2 samples each):

Site	Parent Event Date	Ent Date	Ent Time	Event Number	Depth	Right/ Left	FlowMeter	SampleName	FlwNet Count
Chesterfield	10/26/2005	10/26/2005	1106	1	Bottom	L	GO 2030R6 LoFlow	CF-1026-01-LB	1676
Chesterfield	10/26/2005	10/26/2005	1106	1	Bottom	R	GO 2030R6 LoFlow	CF-1026-01-RB	1620
Chesterfield	10/26/2005	10/26/2005	1121	2	Middle	L	GO 2030R6 LoFlow	CF-1026-01-LM	1999
Chesterfield	10/26/2005	10/26/2005	1121	2	Middle	R	GO 2030R6 LoFlow	CF-1026-01-RM	1933
Chesterfield	10/26/2005	10/26/2005	1135	3	Surface	L	GO 2030R6 LoFlow	CF-1026-01-LS	2030
Chesterfield	10/26/2005	10/26/2005	1135	3	Surface	R	GO 2030R6 LoFlow	CF-1026-01-RS	1998

Therefore, there were typically six samples collected in each of four hourly sampling groups, resulting in 24 total entrainment samples collected in a 24-hour parent event period.

A.4.2 Organism Data:

In each sample collected, the organisms were identified by species or lowest practicable taxonomic level and life stage (egg, larvae, juvenile, etc). For individual fish larvae, the length (0.1 mm) was recorded for 20 specimens of each taxon. If large numbers of a particular organism/life stage were collected, the organisms in excess of the 20 measured organisms were combined as a "batch count." Thus a given sample could have individual and batch organism counts associated with it.

A.4.3 Entrainment Sample-Volume Calculations

Each sample collected had a corresponding sample volume measurement. The sample flow through the net was measured with one of two flow meters. For each flow measurement the flow meter initial, final, and net "counts" were recorded. The net count was used in a formula, specific to each

meter, to calculate the water sample volume (in cubic meters) associated with a sample. The flow meters and volume formulas are as follows:

Meter Name	Formula	Factor1	Factor2
GO 2030R	NetCount/9480.774 * 50 = cubic meters	9,480.77	50.00
GO 2030R6 LoFlow	NetCount/4426.282 * 50 = cubic meters	4,426.28	50.00

Using the flow meter ID, formula, and net counts recorded, the final sample volume in cubic meters (M^3) was calculated for each sample, as: (net count / factor1) * factor 2.

A.4.4 Impact of Low Net Flow Counts on Calculations

Occasionally during sampling, one or both flow meters recorded noticeably low counts for the 10-minute sample. Whereas typical flow meter counts could be as high as 3 or 4 thousand, some counts were recorded well below 500. Once all the data were collected and assembled, the low flow counts were investigated by running a series of simulations with different flow meter counts and raw organism counts. These test showed that at counts below 100, organism densities were overestimated by at least 20 percent. For Chesterfield Power Station, 39 of 536 samples, or 7.3 percent, had flow meter counts below 100. These samples were removed from the analysis. None of these deletions resulted in removal of all samples of a parent event. Removal of these samples from the calculations was deemed more accurate and defensible than incorporating low flow-count samples with their associated uncertainty.

A.4.5 Entrainment Parent 24-hour Average Organism Densities

For each species/ life stage of organism, the objective was to calculate a 24-hour average organism density for a standardized 100 M^3 sample volume. This would be considered the final organism density for the 24-hour parent event.

The 24-hour final density for each parent event was calculated in steps as follows:

1. Adjust each organism/life stage count in each sample to the standard "100 M^3" sample volume.

2. The standard volume densities of the four "Hour Groups" (A, B, C, D) were averaged.

3. The four averages were averaged to yield a final "24-hour" average density (#/100 M^3 sample volume).

An example calculation for "white perch larvae" from the Chesterfield 5/1/06 parent date is presented in the Table A-2.

A.4.6 Calculation of Entrainment Final (Annual) Organism Estimates

There are two parent events each month, thus there are 24 parent events per year cycle. Each parent event is assigned a date range, to each date of which the 24-hour final organism estimate for the parent date is applied. The date range for a parent event may span across two different months. Below is a tabulation of parent date ranges for Chesterfield Power Station:

Chesterfield Parent Event dates and Applied Ranges:

Parent Date	Range Start	Range End	Day Count
6/21/2005	6/3/2005	6/23/2005	21
6/27/2005	6/24/2005	7/2/2005	9
7/11/2005	7/3/2005	7/16/2005	14
7/22/2005	7/17/2005	7/30/2005	14
8/8/2005	7/31/2005	8/15/2005	16
8/22/2005	8/16/2005	9/1/2005	17
9/12/2005	9/2/2005	9/20/2005	19
9/26/2005	9/21/2005	10/3/2005	13
10/10/2005	10/4/2005	10/17/2005	14
10/24/2005	10/18/2005	10/30/2005	13
11/7/2005	10/31/2005	11/13/2005	14
11/20/2005	11/14/2005	11/28/2005	15
12/7/2005	11/29/2005	12/14/2005	16
12/21/2005	12/15/2005	12/30/2005	16
1/9/2006	12/31/2005	1/16/2006	17
1/23/2006	1/17/2006	1/30/2006	14
2/8/2006	1/31/2006	2/14/2006	15
2/22/2006	2/15/2006	2/27/2006	13
3/6/2006	2/28/2006	3/13/2006	14
3/20/2006	3/14/2006	3/28/2006	15
4/3/2006	3/29/2006	4/9/2006	12
4/17/2006	4/10/2006	4/24/2006	15
5/1/2006	4/25/2006	5/8/2006	14
5/15/2006	5/9/2006	6/2/2006	25

An annual organism estimate at maximum flow operation, was calculated in three steps:

1. The final 24-hour organism density for each parent event was used with the maximum daily circulating-water flow to calculate the estimated number of organisms entrained during the 24-hour parent event. For example, the maximum 24-hour cooling-water flow at Chesterfield is 3,836,624 M^3. The white perch larvae density in for the Chesterfield 5/1/06 parent event was 0.19/100 M^3 (Table A-2). The 24-hour entrainment estimate adjusted for the maximum flow volume is 7,290 ([3,836,624/100]*0.19).

1. The final 24-hour organism estimate at maximum flow volume was applied to each day in the parent date range. For example, the white perch larvae 24-hour estimate for the Chesterfield 5/1/06 parent-event was 7,290 at maximum flow. The 5/1/06 parent date range was 4/25/06 to 5/8/06 (14 days), therefore the 24-hour maximum flow estimate would be multiplied by 14 to get the final maximum flow-based estimate for that date range.

2. The sums of 24-hour organism estimates (at maximum flow volume) for each date range were then summed to yield the final annual organism entrainment estimate, for maximum flow conditions.

A.4.7 Entrainment Yearly, Parent Event, and Monthly Organism Estimates

The final organism estimates for each parent event are used in the same manner as described previously in Section A.3.5 for the impingement data to generate yearly, parent event, and monthly entrainment organism total estimates.

A.5. AMBIENT ICHTHYOPLANKTON DATA

A.5.1 Overview

The ambient ichthyoplankton ("amb ich") samples were collected at designated locations upstream, downstream, and adjacent to the plant intake. During each parent event there were usually 12 samples collected. The 12 sample events, numbered 1 to 12, grouped three to an hour, typically occurred at the following times for a 24-hour parent event, in concert with in-plant entrainment samples:

Hour Group A: events 1-3 in the 10a.m. hour (10:00)
Hour Group B: events 4-6 in the 4 p.m. hour (16:00)
Hour Group C: events 7-9 in the 10 p.m. hour (22:00)
Hour Group D: events 10-12 in the 4a.m. hour (04:00 – the following day)

The samples consisted of an oblique (surface, mid-depth, bottom) tow at each of three locations. Sample volume calculations were based on counts from flow meters affixed in the mouth of each net.

Example of 12 Ambient Ich Sample Events

Site	Loc	Event Number	Group	Samp Date	Evnt Time	SampName	Depth	Samp Start Time	Samp End Time	Flow-Meter	Net Flow Count
Chesterfield	Downstream	1	A	7/20/2005	1051	CF-0720-01-DS	N/A	1051	1057	GO 2030R	13061
Chesterfield	Adjacent	2	A	7/20/2005	1115	CF-0720-01-AJ	N/A	1115	1121	GO 2030R	13141
Chesterfield	Upstream	3	A	7/20/2005	1140	CF-0720-01-US	N/A	1140	1146	GO 2030R	13050
Chesterfield	Upstream	4	B	7/20/2005	1653	CF-0720-02-US	N/A	1653	1659	GO 2030R	5199
Chesterfield	Adjacent	5	B	7/20/2005	1717	CF-0720-02-AJ	N/A	1717	1723	GO 2030R	12789
Chesterfield	Downstream	6	B	7/20/2005	1738	CF-0720-02-DS	N/A	1738	1744	GO 2030R	12378
Chesterfield	Downstream	7	C	7/20/2005	2240	CF-0720-03-DS	N/A	2240	2246	GO 2030R	13081
Chesterfield	Adjacent	8	C	7/20/2005	2310	CF-0720-03-AJ	N/A	2310	2316	GO 2030R	14073
Chesterfield	Upstream	9	C	7/20/2005	2332	CF-0720-03-US	N/A	2332	2338	GO 2030R	11297
Chesterfield	Downstream	10	D	7/21/2005	0454	CF-0721-04-DS	N/A	0454	0500	GO 2030R	11291
Chesterfield	Adjacent	11	D	7/21/2005	0514	CF-0721-04-AJ	N/A	0514	0520	GO 2030R	9661
Chesterfield	Upstream	12	D	7/21/2005	0529	CF-0721-04-US	N/A	0529	0535	GO 2030R	11244

A.5.2 Organism Data

In each sample collected, the organisms were identified by species or lowest possible taxonomic level and life stage (egg, larvae, juvenile, etc). For individual fish larvae, the length (0.1 mm) was recorded. If large numbers of a particular organism/life stage were collected, the organisms were combined as a "batch count." Thus a given sample could have individual and batch organism counts associated with it.

A.5.3 Ambient Ich Sample-Volume Calculations

Each sample collected had a corresponding water flow (volume) measurement. The flow was measured with a General Oceanics (GO) mechanical flow meter. For each flow measurement the flow meter initial, final, and net (adjusted) "counts" were recorded. The net count was used in a formula to calculate the water sample volume (in cubic meters) associated with a sample. The flow meter and volume formula is as follows:

Meter Name	Formula	Factor1	Factor2
GO 2030R	NetCount/9480.774 * 50 = cubic meters	9,480.77	50.00

Using the flow meter ID, formula, and net counts recorded, the final sample volume in cubic meters (M^3) was calculated for each sample, as: (net count / factor1) * factor 2.

A.5.4 Final Organism Density Calculations

Unlike the impingement and entrainment data, the ambient ich data were not processed into final "yearly estimates." The organism counts for each organism/life stage were presented as average organism densities (#/100 M^3 sample volume) for each 24-hour parent event.

The time duration of the sample is not a factor in the calculations. The 4.5-minute tow time was established, based on experience, to generate a sample volume of roughly 40-60 cubic meters of water. So it is only the flow meter net count (and associated formula) that figures in the calculations.

The process for obtaining the average density was as follows. For each parent event, usually consisting of 12 samples, the raw organism counts were adjusted to a standard density (#/100 M^3). Most actual sample volumes were 40-60 M^3 volume. For example, for a sample volume of 46.7 M^3, and a raw count of 85 bay anchovy larvae, the sample density of bay anchovy larvae is calculated as ([100/46.7]*85= 182 bay anchovy larvae per 100 M^3. When averaged with the remaining 11 samples from the parent event, the result is the organism density representing the entire 24-hour period.

TABLE A-1 CALCULATION SEQUENCE FOR 24-HOUR IMPINGEMENT ESTIMATE FOR BLACK CRAPPIE, 7/11/2005 PARENT EVENT

Dominion Power - Impingment Organism Count Totals (24 Hour)

Site	Date	Organism
Chesterfield	7/11/2005	Black crappie

Station	Hour	# Pumps On	Max Throttle	Count in 10-min sample	Count in 1-Hr	Count Type	Flow Type	Sample Vol. (M3)	Station Max Vol. (M3) in 24	Site Max Vol. (M3) in 24 hr
Station 03	0800	3	F	0	0	M	IMP	22,531	22530.69	3836624
Station 03	0900	3	F	0	0	M	IMP	22,531	22530.69	3836624
Station 03	1000			0	0	EST	EST	22,531	22530.69	3836624
Station 03	1100	3	F	0	0	EST	ENT	22,531	22530.69	3836624
Station 03	1200	3	F	0	0	M	IMP	22,531	22530.69	3836624
Station 03	1300	3	F	0	0	M	IMP	22,531	22530.69	3836624
Station 03	1400	3	F	0	0	M	IMP	22,531	22530.69	3836624
Station 03	1500	3	F	0	0	M	IMP	22,531	22530.69	3836624
Station 03	1600			0	0	EST	EST	22,531	22530.69	3836624
Station 03	1700	3	F	0	0	EST	ENT	22,531	22530.69	3836624
Station 03	1800	3	F	0	0	M	IMP	22,531	22530.69	3836624
Station 03	1900	3	F	0	0	M	IMP	22,531	22530.69	3836624
Station 03	2000	3	F	0	0	M	IMP	22,531	22530.69	3836624
Station 03	2100	3	F	0	0	M	IMP	22,531	22530.69	3836624
Station 03	2200			0	0	EST	EST	22,531	22530.69	3836624
Station 03	2300	3	F	0	0	EST	ENT	22,531	22530.69	3836624
Station 03	0000	3	F	0	0	M	IMP	22,531	22530.69	3836624
Station 03	0100	3	F	1	6	M	IMP	22,531	22530.69	3836624
Station 03	0200	3	F	0	0	M	IMP	22,531	22530.69	3836624
Station 03	0300	3	F	0	0	M	IMP	22,531	22530.69	3836624
Station 03	0400			0	0	EST	EST	22,531	22530.69	3836624
Station 03	0500	3	F	0	0	EST	ENT	22,531	22530.69	3836624
Station 03	0600	3	F	0	0	M	IMP	22,531	22530.69	3836624
Station 03	0700	3	F	0	0	M	IMP	22,531	22530.69	3836624
Station 04	0800	1	F	0	0	M	IMP	7,510	7510.23	3836624
Station 04	0900	1	F	0	0	M	IMP	7,510	7510.23	3836624
Station 04	1000			0	0	EST	EST	7,510	7510.23	3836624
Station 04	1100	1	F	0	0	EST	ENT	7,510	7510.23	3836624
Station 04	1200	1	F	0	0	M	IMP	7,510	7510.23	3836624
Station 04	1300	1	F	0	0	M	IMP	7,510	7510.23	3836624
Station 04	1400	1	F	0	0	M	IMP	7,510	7510.23	3836624
Station 04	1500	1	F	0	0	M	IMP	7,510	7510.23	3836624
Station 04	1600			0	0	EST	EST	7,510	7510.23	3836624
Station 04	1700	1	F	0	0	EST	ENT	7,510	7510.23	3836624
Station 04	1800	1	F	0	0	M	IMP	7,510	7510.23	3836624
Station 04	1900	1	F	0	0	M	IMP	7,510	7510.23	3836624
Station 04	2000	1	F	0	0	M	IMP	7,510	7510.23	3836624

TABLE A-1 CALCULATION SEQUENCE FOR 24-HOUR IMPINGEMENT ESTIMATE FOR BLACK CRAPPIE, 7/11/2005 PARENT EVENT

Dominion Power - Impingment Organism Count Totals (24 Hour)

Site	Date	Organism
Chesterfield	7/11/2005	Black crappie

Station	Hour	# Pumps On	Max Throttle	Count in 10-min sample	Count in 1-Hr	Count Type	Flow Type	Sample Vol. (M3)	Station Max Vol. (M3) in 24	Site Max Vol. (M3) in 24 hr
Station 04	2100	1	F	0	0	M	IMP	7,510	7510.23	3836624
Station 04	2200			0	0	EST	EST	7,510	7510.23	3836624
Station 04	2300	1	F	0	0	EST	ENT	7,510	7510.23	3836624
Station 04	0000	1	F	0	0	M	IMP	7,510	7510.23	3836624
Station 04	0100	1	F	0	0	M	IMP	7,510	7510.23	3836624
Station 04	0200	1	F	0	0	M	IMP	7,510	7510.23	3836624
Station 04	0300	1	F	0	0	M	IMP	7,510	7510.23	3836624
Station 04	0400			0	0	EST	EST	7,510	7510.23	3836624
Station 04	0500	1	F	0	0	EST	ENT	7,510	7510.23	3836624
Station 04	0600	1	F	0	0	M	IMP	7,510	7510.23	3836624
Station 04	0700	1	F	0	0	M	IMP	7,510	7510.23	3836624
Station 05	0800	2	F	0	0	M	IMP	30,152	30152.22	3836624
Station 05	0900	2	F	0	0	M	IMP	30,152	30152.22	3836624
Station 05	1000			0	0	EST	EST	30,152	30152.22	3836624
Station 05	1100	2	F	0	0	EST	ENT	30,152	30152.22	3836624
Station 05	1200	2	F	0	0	M	IMP	30,152	30152.22	3836624
Station 05	1300	2	F	0	0	M	IMP	30,152	30152.22	3836624
Station 05	1400	2	F	0	0	M	IMP	30,152	30152.22	3836624
Station 05	1500	2	F	0	0	M	IMP	30,152	30152.22	3836624
Station 05	1600			0	0	EST	EST	30,152	30152.22	3836624
Station 05	1700	2	F	0	0	EST	ENT	30,152	30152.22	3836624
Station 05	1800	2	F	0	0	M	IMP	30,152	30152.22	3836624
Station 05	1900	2	F	0	0	M	IMP	30,152	30152.22	3836624
Station 05	2000	2	F	0	0	M	IMP	30,152	30152.22	3836624
Station 05	2100	2	F	0	0	M	IMP	30,152	30152.22	3836624
Station 05	2200			0	0	EST	EST	30,152	30152.22	3836624
Station 05	2300	2	F	0	0	EST	ENT	30,152	30152.22	3836624
Station 05	0000	2	F	0	0	M	IMP	30,152	30152.22	3836624
Station 05	0100	2	F	0	0	M	IMP	30,152	30152.22	3836624
Station 05	0200	2	F	0	0	M	IMP	30,152	30152.22	3836624
Station 05	0300	2	F	0	0	M	IMP	30,152	30152.22	3836624
Station 05	0400			0	0	EST	EST	30,152	30152.22	3836624
Station 05	0500	2	F	0	0	EST	ENT	30,152	30152.22	3836624
Station 05	0600	2	F	0	0	M	IMP	30,152	30152.22	3836624
Station 05	0700	2	F	0	0	M	IMP	30,152	30152.22	3836624
Station 06	0800	3	F	0	0	M	IMP	63,480	63479.52	3836624
Station 06	0900	3	F	0	0	M	IMP	63,480	63479.52	3836624

TABLE A-1 CALCULATION SEQUENCE FOR 24-HOUR IMPINGEMENT ESTIMATE FOR BLACK CRAPPIE, 7/11/2005 PARENT EVENT

Dominion Power - Impingment Organism Count Totals (24 Hour)

Site	Date	Organism
Chesterfield	7/11/2005	Black crappie

Station	Hour	# Pumps On	Max Throttle	Count in 10-min sample	Count in 1-Hr	Count Type	Flow Type	Sample Vol. (M3)	Station Max Vol. (M3) in 24	Site Max Vol. (M3) in 24 hr
Station 06	1000			0	0	EST	EST	63,480	63479.52	3836624
Station 06	1100	3	F	0	0	EST	ENT	63,480	63479.52	3836624
Station 06	1200	3	F	0	0	M	IMP	63,480	63479.52	3836624
Station 06	1300	3	F	0	0	M	IMP	63,480	63479.52	3836624
Station 06	1400	3	F	0	0	M	IMP	63,480	63479.52	3836624
Station 06	1500	3	F	0	0	M	IMP	63,480	63479.52	3836624
Station 06	1600			0	0	EST	EST	63,480	63479.52	3836624
Station 06	1700	3	F	0	0	EST	ENT	63,480	63479.52	3836624
Station 06	1800	3	F	0	0	M	IMP	63,480	63479.52	3836624
Station 06	1900	3	F	0	0	M	IMP	63,480	63479.52	3836624
Station 06	2000	3	F	0	0	M	IMP	63,480	63479.52	3836624
Station 06	2100	3	F	0	0	M	IMP	63,480	63479.52	3836624
Station 06	2200			0	0	EST	EST	63,480	63479.52	3836624
Station 06	2300	3	F	0	0	EST	ENT	63,480	63479.52	3836624
Station 06	0000	3	F	0	0	M	IMP	63,480	63479.52	3836624
Station 06	0100	3	F	0	0	M	IMP	63,480	63479.52	3836624
Station 06	0200	3	F	1	6	M	IMP	63,480	63479.52	3836624
Station 06	0300	3	F	0	0	M	IMP	63,480	63479.52	3836624
Station 06	0400			0.5	3	EST	EST	63,480	63479.52	3836624
Station 06	0500	3	F	0.5	3	EST	ENT	63,480	63479.52	3836624
Station 06	0600	3	F	1	6	M	IMP	63,480	63479.52	3836624
Station 06	0700	3	F	0	0	M	IMP	63,480	63479.52	3836624
Station 07	0800	2	F	0	0	M	IMP	18,093	18093.34	3836624
Station 07	0900	2	F	1	6	M	IMP	18,093	18093.34	3836624
Station 07	1000			0.5	3	EST	EST	18,093	18093.34	3836624
Station 07	1100	2	F	0.5	3	EST	ENT	18,093	18093.34	3836624
Station 07	1200	2	F	0	0	M	IMP	18,093	18093.34	3836624
Station 07	1300	2	F	0	0	M	IMP	18,093	18093.34	3836624
Station 07	1400	2	F	0	0	M	IMP	18,093	18093.34	3836624
Station 07	1500	2	F	0	0	M	IMP	18,093	18093.34	3836624
Station 07	1600			0	0	EST	EST	18,093	18093.34	3836624
Station 07	1700	2	F	0	0	EST	ENT	18,093	18093.34	3836624
Station 07	1800	2	F	0	0	M	IMP	18,093	18093.34	3836624
Station 07	1900	2	F	0	0	M	IMP	18,093	18093.34	3836624
Station 07	2000	2	F	0	0	M	IMP	18,093	18093.34	3836624
Station 07	2100	2	F	3	18	M	IMP	18,093	18093.34	3836624
Station 07	2200			3	18	EST	EST	18,093	18093.34	3836624

TABLE A-1 CALCULATION SEQUENCE FOR 24-HOUR IMPINGEMENT ESTIMATE FOR BLACK CRAPPIE, 7/11/2005 PARENT EVENT

Dominion Power - Impingment Organism Count Totals (24 Hour)

Site	Date	Organism
Chesterfield	7/11/2005	Black crappie

Station	Hour	# Pumps On	Max Throttle	Count in 10-min sample	Count in 1-Hr	Count Type	Flow Type	Sample Vol. (M3)	Station Max Vol. (M3) in 24	Site Max Vol. (M3) in 24 hr
Station 07	2300	2	F	3	18	EST	ENT	18,093	18093.34	3836624
Station 07	0000	2	F	3	18	M	IMP	18,093	18093.34	3836624
Station 07	0100	2	F	1	6	M	IMP	18,093	18093.34	3836624
Station 07	0200	2	F	1	6	M	IMP	18,093	18093.34	3836624
Station 07	0300	2	F	0	0	M	IMP	18,093	18093.34	3836624
Station 07	0400			0	0	EST	EST	18,093	18093.34	3836624
Station 07	0500	2	F	0	0	EST	ENT	18,093	18093.34	3836624
Station 07	0600	2	F	0	0	M	IMP	18,093	18093.34	3836624
Station 07	0700	2	F	0	0	M	IMP	18,093	18093.34	3836624
Station 08	0800	2	F	0	0	M	IMP	18,093	18093.34	3836624
Station 08	0900	2	F	0	0	M	IMP	18,093	18093.34	3836624
Station 08	1000			0.5	3	EST	EST	18,093	18093.34	3836624
Station 08	1100	2	F	0.5	3	EST	ENT	18,093	18093.34	3836624
Station 08	1200	2	F	1	6	M	IMP	18,093	18093.34	3836624
Station 08	1300	2	F	0	0	M	IMP	18,093	18093.34	3836624
Station 08	1400	2	F	0	0	M	IMP	18,093	18093.34	3836624
Station 08	1500	2	F	0	0	M	IMP	18,093	18093.34	3836624
Station 08	1600			0	0	EST	EST	18,093	18093.34	3836624
Station 08	1700	2	F	0	0	EST	ENT	18,093	18093.34	3836624
Station 08	1800	2	F	0	0	M	IMP	18,093	18093.34	3836624
Station 08	1900	2	F	0	0	M	IMP	18,093	18093.34	3836624
Station 08	2000	2	F	0	0	M	IMP	18,093	18093.34	3836624
Station 08	2100	2	F	0	0	M	IMP	18,093	18093.34	3836624
Station 08	2200			0	0	EST	EST	18,093	18093.34	3836624
Station 08	2300	2	F	0	0	EST	ENT	18,093	18093.34	3836624
Station 08	0000	2	F	0	0	M	IMP	18,093	18093.34	3836624
Station 08	0100	2	F	0	0	M	IMP	18,093	18093.34	3836624
Station 08	0200	2	F	0	0	M	IMP	18,093	18093.34	3836624
Station 08	0300	2	F	0	0	M	IMP	18,093	18093.34	3836624
Station 08	0400			0	0	EST	EST	18,093	18093.34	3836624
Station 08	0500	2	F	0	0	EST	ENT	18,093	18093.34	3836624
Station 08	0600	2	F	0	0	M	IMP	18,093	18093.34	3836624
Station 08	0700	2	F	0	0	M	IMP	18,093	18093.34	3836624

TABLE A-1 CALCULATION SEQUENCE FOR 24-HOUR IMPINGEMENT ESTIMATE FOR BLACK CRAPPIE, 7/11/2005 PARENT EVENT

Dominion Power - Impingment Organism Count Totals (24 Hour)

Site	Date	Organism
Chesterfield	7/11/2005	Black crappie

Station	Hour	# Pumps On	Max Throttle	Count in 10-min sample	Count in 1-Hr	Count Type	Flow Type	Sample Vol. (M3)	Station Max Vol. (M3) in 24	Site Max Vol. (M3) in 24 hr
Event Counts:	144		**Totals:**	22	132			3,836,623		

24 Hour Flow Volume Actual (m3):	3,836,623	**24 Hour Max Plant Volume (m3)**	3,836,624
		Volume Factor:	1.000
Black crappie		**24-Hour Catch Count at Max Flow Volume:**	132

TABLE A-2 CALCULATION SEQUENCE FOR 24-HOUR ENTRAINMENT DENSITY ESTIMATE FOR WHITE PERCH LARVAE, 05/01/06 PARENT EVENT

Dominion Power - Entrainment Organism Count Averages (24 Hour)

Site	Date	Organism
Chesterfield	5/1/2006	White perch - post-yolk sac larvae

Event Group: A

Event #	Depth	Left/Right	Sample Vol M3	Count in Sample	Indiv or Batch		Count in 100 M3
1	Bottom	L	11.014	0			0.000
1	Bottom	R	11.082	0			0.000
2	Middle	L	22.739	0			0.000
2	Middle	R	22.468	0			0.000
3	Surface	L	22.366	0			0.000
3	Surface	R	21.869	0			0.000
						Event Group Average:	0.000

Event Group: B

Event #	Depth	Left/Right	Sample Vol M3	Count in Sample	Indiv or Batch		Count in 100 M3
4	Bottom	L	11.861	0			0.000
4	Bottom	R	9.590	0			0.000
5	Middle	L	11.036	0			0.000
5	Middle	R	13.860	0			0.000
6	Surface	L	22.197	0			0.000
6	Surface	R	21.858	1	IND	IND	4.575
						Event Group Average:	0.762

Event Group: C

Event #	Depth	Left/Right	Sample Vol M3	Count in Sample	Indiv or Batch		Count in 100 M3
7	Bottom	L	18.142	0			0.000
7	Bottom	R	17.035	0			0.000
8	Middle	L	17.509	0			0.000
8	Middle	R	18.063	0			0.000
9	Surface	L	18.424	0			0.000
9	Surface	R	18.085	0			0.000
						Event Group Average:	0.000

Event Group: D

Event #	Depth	Left/Right	Sample Vol M3	Count in Sample	Indiv or Batch		Count in 100 M3
10	Bottom	L	12.618	0			0.000
10	Bottom	R	8.314	0			0.000
11	Middle	L	3.163	0			0.000
11	Middle	R	5.818	0			0.000
12	Surface	L	3.920	0			0.000
12	Surface	R	7.964	0			0.000
						Event Group Average:	0.000

TABLE A-2 CALCULATION SEQUENCE FOR 24-HOUR ENTRAINMENT DENSITY ESTIMATE FOR WHITE PERCH LARVAE, 05/01/06 PARENT EVENT

Dominion Power - Entrainment Organism Count Averages (24 Hour)

White perch - post-yolk sac larvae	**Average 24-hour in 100m3:**	0.191
	Site Maximum Flow in 24 Hour (m3):	3836624
	Average in 24 Hour (m3) at Max Fow:	7314

APPENDIX B

Impingement Daily Sample Counts

Table B-1 Daily Impingement Counts at Chesterfield Power Station, June 2005 - May 2006

Organism	June		July		August		September		October		November		December		January		February		March		April		May	
	21	27	11	25	8	22	12	26	10	24	7	20	7	21	9	23	8	22	6	20	3	17	1	15
Bay anchovy								1																
Blueback herring				4	6	1	7	2	1										1					
Alewife		1		1	1																			
American shad				1				1	2															
Gizzard shad		1										1	1							1			1	
Common carp																1								
Spottail shiner	1			1	1										1						1			
Ictaluridae sp.								1																
Blue catfish		3	4	2	2	2	2	2	1	1	3			1	1	1	1		1		1			1
Channel catfish			1				2	1	2	1	2		5	1							1		1	1
Flathead catfish									2															
Inland silverside	1													1										
Banded killifish														2										
White perch			5	5	1				3			1	1											
Striped bass							1																	
Green sunfish									1															
Bluegill			1								1		3	2		2					2			
Largemouth bass		1	5					2																
Black crappie		1	13	1									2											
Tessellated darter	1														1									
Spot	1																							
Hogchoker									1															
Damaged fish		1																						
Asiatic clam		1																		3				
Common grass shrimp									1															
Blue crab				3		1	2	8	28	1	13	5		1										
Totals=	**4**	**9**	**29**	**18**	**11**	**4**	**14**	**18**	**42**	**3**	**19**	**7**	**12**	**8**	**3**	**4**	**1**	**0**	**2**	**4**	**5**	**0**	**2**	**2**

APPENDIX C

Entrainment Densities by Sampling Date, All Organisms

TABLE C-1 AVERAGE DENSITIES (#/100M^3) OF ICHTHYOPLANKTON AND MACROINVERTEBRATES ENTRAINED DURING EACH SAMPLING EVENT, CHESTERFIELD POWER STATION, JUNE 2005 -- MAY 2006

	2005														2006									
	Jun		Jul		Aug		Sep		Oct		Nov		Dec		Jan		Feb		Mar		Apr		May	
Species/Taxon	21	27	11	25	8	22	12	26	10	24	7	20	7	21	9	23	8	22	6	20	3	17	1	15
Bay anchovy - fertilized egg	0.0	0.0	2.9	15.3	34.5	145.7	0.0	0.3	0.2	0.0	0.0	0.0	3.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Bay anchovy - yolk-sac larvae	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Bay anchovy - post-yolk sac larvae	0.0	0.0	0.0	0.0	0.0	0.0	0.9	0.2	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Bay anchovy - juvenile	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Blueback herring - fertilized egg	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.9	0.2
Blueback herring - yolk-sac larvae	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.1	4.1	0.0	0.2
Blueback herring - post-yolk sac larvae	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.3	3.6	0.0
Alewife - fertilized egg	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	14.6	10.7	5.0
Alewife - yolk-sac larvae	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.4	4.1	3.5	3.3	0.0
Alewife - post-yolk sac larvae	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	3.6	14.9	23.6	0.0
American shad - fertilized egg	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.9	0.6	7.0	0.0	0.0
American shad - yolk-sac larvae	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0
Gizzard shad - yolk-sac larvae	1.3	0.0	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	42.9	56.5	149.7
Gizzard shad - post-yolk sac larvae	1.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.3
Threadfin shad - post-yolk sac larvae	0.0	0.0	0.0	0.6	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Hickory shad - fertilized egg	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9.0	0.9	0.0	0.0
Hickory shad - yolk-sac larvae	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	14.2	3.0	0.7
Hickory shad - post-yolk sac larvae	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	13.4	2.5	18.2
River herring - fertilized egg	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.7	77.5
River herring - yolk-sac larvae	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.2	0.0	2.8
River herring - post-yolk sac larvae	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.2	2.8	750.6
Clupeidae sp. - post-yolk sac larvae	0.6	42.2	0.0	0.0	6.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
White sucker - yolk-sac larvae	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0
Common carp - yolk-sac larvae	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.9	0.0
Spottail shiner - yolk-sac larvae	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	1.9	0.6
Spottail shiner - post-yolk sac larvae	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.9
Blue catfish - yolk-sac larvae	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Channel catfish - yolk-sac larvae	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Atlantic silverside - post-yolk sac larvae	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0
Inland silverside - fertilized egg	0.8	0.0	0.0	1.3	3.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Inland silverside - yolk-sac larvae	1.5	0.0	0.0	0.0	1.4	4.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0
Inland silverside - post-yolk sac larvae	2.9	0.0	1.6	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6
Atherinopsidae sp. - fertilized egg	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0
Atherinopsidae sp. - post-yolk sac larvae	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Naked goby - post-yolk sac larvae	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
White perch - fertilized egg	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	21.6	11.7	17.3	6.1
White perch - yolk-sac larvae	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	6.6	10.2	7.6	49.3
White perch - post-yolk sac larvae	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	2.2
Dorsoma sp. - fertilized egg	44.3	4.8	71.4	4.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	59.1	170.4	75.2
Dorsoma sp. - unfertilized egg	0.0	0.0	3.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Dorsoma sp. - yolk-sac larvae	2.1	1.7	0.8	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	56.5	17.5	0.0
Dorsoma sp. - post-yolk sac larvae	3.6	31.0	19.6	9.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.1	0.0
Dorsoma sp. - damaged larvae	3.5	1.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Bluegill - post-yolk sac larvae	0.0	0.0	0.0	0.3	0.7	2.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Black crappie - post-yolk sac larvae	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
Centrarchidae - fertilized egg	0.0	0.0	0.0	0.0	1.0	2.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

TABLE C-1 (Continued)

	2005														2006									
	Jun		Jul		Aug		Sep		Oct		Nov		Dec		Jan		Feb		Mar		Apr		May	
Species/Taxon	21	27	11	25	8	22	12	26	10	24	7	20	7	21	9	23	8	22	6	20	3	17	1	15
Centrarchidae - yolk-sac larvae	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Centrarchidae - post-yolk sac larvae	0.0	0.0	0.0	2.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Centrarchidae - juvenile	0.0	0.0	0.0	0.0	0.0	1.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Lepomis sp. - yolk-sac larvae	0.0	0.0	0.0	0.2	0.2	1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Lepomis sp. - post-yolk sac larvae	1.0	0.0	0.0	0.4	3.4	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pomoxis spp. - yolk-sac larvae	0.0	0.0	0.0	0.0	0.0	4.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0
Tessellated darter - yolk-sac larvae	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	11.3	4.4	3.8	2.6
Tessellated darter - post-yolk sac larvae	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.0	0.2
Hogchoker - fertilized egg	0.0	0.0	0.3	0.0	0.0	6.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Undetermined/Damaged Egg	6.7	0.0	4.1	2.3	13.1	14.2	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.1	44.6	13.4	0.6
Undetermined/Damaged Fish	0.2	3.8	1.0	0.0	5.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.4	1.8	0.0
Blue Crab - megalop	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Other crab - zoea	0.0	0.0	0.0	2.3	16.3	6.3	10.3	3.6	0.2	0.5	2.7	0.0	4.8	2.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0
Bivalve - young	0.0	0.0	62.1	77.5	69.9	70.5	4.7	1.6	39.0	7.5	90.8	0.0	1.9	4.7	7.5	0.3	5.1	0.2	14.4	22.8	29.7	105.0	26.4	1.1
Shrimp	0.0	0.0	0.0	1.4	41.1	1.8	8.2	3.6	4.9	1.3	4.8	0.0	33.9	6.7	7.5	0.2	0.6	0.0	0.2	4.7	1.2	33.8	10.4	0.0

APPENDIX D

Length Statistics for Entrained Fish Larvae and Juveniles

TABLE D - 1 LENGTH-STATISTICS FOR ENTRAINED ORGANISMS AT CHESTERFIELD POWER STATION, JUNE 2005 -- MAY 2006

Species/Taxon	N	Min mm	Max mm	Avg mm	Std dev mm
Alewife	185	3.2	11.1	6	1.1
American shad	1	7.5	7.5	8	
Atlantic silverside	1	6	6	6	
Bay anchovy	7	3.5	28	8	8.7
Black crappie	1	8.4	8.4	8	
Blue catfish	1	16.1	16.1	16	
Blueback herring	39	3.4	7.2	5	0.8
Bluegill	4	6.3	9.4	8	1.3
Centrarchidae	4	4.4	10.4	6	2.9
Channel catfish	2	14.4	16.2	15	1.3
Clupeidae sp.	24	3.4	6.5	5	0.7
Common carp	2	4.9	5.1	5	0.1
Dorsoma sp.	253	2.5	6.5	5	0.7
Gizzard shad	602	2.5	8	5	0.6
Hickory shad	184	6	13.1	7	1.0
Inland silverside	15	3.7	6.3	5	0.7
Lepomis sp.	20	4.2	7.5	5	0.7
Naked goby	1	5.3	5.3	5	
Pomoxis sp.	2	2.6	4.5	4	1.3
River herring	488	4.3	8.5	5	0.3
Spottail shiner	28	4.6	8.7	6	1.0
Tessellated darter	70	4.6	6.3	5	0.4
Threadfin shad	3	4.7	12.8	8	4.6
White perch	208	2.2	7.2	4	0.5
White sucker	1	8.2	8.2	8	

APPENDIX E

Density of Ichthyoplankton and Invertebrates in Ambient River Samples at Chesterfield Power Station

TABLE E - 1 DENSITIES (#/100 M^3) OF ICHTHYOPLANKTON AND INVERTEBRATES IN AMBIENT RIVER SAMPLES, CHESTERFIELD POWER STATION

	2005																		2006					
	Jun		Jul		Aug		Sep		Oct		Nov		Dec		Jan		Feb		Mar		Apr		May	
Species/Taxon	21	27	11	25	8	22	12	26	10	24	7	20	7	21	9	23	8	22	6	20	3	17	1	15
Alewife-fertilized egg	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.9	3.8	2.6
Alewife-juvenile	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3
Alewife-post-yolk sac larvae	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.3	7.9	15.2	0.0
Alewife-yolk-sac larvae	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.6	0.7	0.7	5.2	0.0
American eel-juvenile	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.3	1.0	0.2	0.1	0.0	0.0	0.0	0.0
American shad-fertilized egg	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.0	0.5	0.0	0.0
American shad-yolk-sac larvae	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0
Anchoa sp.-post-yolk sac larvae	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Atherinopsidae sp.-fertilized egg	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.4
Atlantic menhaden-juvenile	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0
Banded killifish larvae-undetermined	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Bay anchovy-fertilized egg	0.0	0.0	0.0	0.1	0.3	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Bay anchovy-post-yolk sac larvae	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Bivalve	2.6	12.7	0.6	1.1	109.8	20.6	0.1	0.4	17.0	0.5	35.4	0.1	1.0	0.2	0.0	0.0	0.0	0.2	0.1	14.7	1.1	54.7	13.7	2.6
Blue catfish-juvenile	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Blue catfish-post-yolk sac larvae	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Blue Crab-megalop	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Blueback herring-fertilized egg	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	2.8	1.3
Blueback herring-post-yolk sac larvae	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	1.1	2.0	0.0
Blueback herring-yolk-sac larvae	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	2.6	0.7	0.0
Bluegill-juvenile	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Centrarchidae -fertilized egg	0.4	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Centrarchidae -juvenile	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Centrarchidae -post-yolk sac larvae	0.0	0.2	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Centrarchidae -yolk-sac larvae	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Channel catfish-juvenile	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Channel catfish-yolk-sac larvae	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Clupeidae sp.-fertilized egg	1.3	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	26.9	0.0	0.0
Clupeidae sp.-post-yolk sac larvae	21.1	2.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	1.2	0.0
Clupeidae sp.-undetermined	18.9	10.5	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.5	0.0	0.0
Clupeidae sp.-yolk-sac larvae	2.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Common carp-yolk-sac larvae	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.9	0.0	0.4	0.3	0.0
crab megalopae	0.0	0.0	0.0	0.0	0.1	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
crab zoea	0.0	0.0	0.3	0.0	0.4	0.0	3.8	1.2	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1
Cyprinidae sp.-yolk-sac larvae	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Damaged fish-undetermined	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.6	0.0
Dorsoma sp.-fertilized egg	467.8	91.3	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	101.1	29.6	98.1
Dorsoma sp. larvae-undetermined	0.2	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	14.5	0.0	0.0
Dorsoma sp.-post-yolk sac larvae	2.9	54.6	6.5	3.2	0.4	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.2	0.0	0.0
Dorsoma sp.-unfertilized egg	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Dorsoma sp.-yolk-sac larvae	1.8	1.3	1.3	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.2	158.8	16.3	0.0
egg shell-undetermined	0.0	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Gizzard shad-post-yolk sac larvae	1.1	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.0	456.6
Gizzard shad-yolk-sac larvae	4.0	13.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	58.2	144.2	280.8

TABLE E - 1 (Continued)

	2005																		2006					
	Jun		Jul		Aug		Sep		Oct		Nov		Dec		Jan		Feb		Mar		Apr		May	
Species/Taxon	21	27	11	25	8	22	12	26	10	24	7	20	7	21	9	23	8	22	6	20	3	17	1	15
Hickory shad-fertilized egg	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.3	0.0	0.0
Hickory shad-juvenile	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.3
Hickory shad-post-yolk sac larvae	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	9.0	3.7	9.0
Hickory shad-yolk-sac larvae	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.9	2.8	1.1	0.0
Hogchoker-juvenile	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Inland silverside-fertilized egg	0.7	1.1	0.1	0.4	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0
Inland silverside-juvenile	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.2
Inland silverside-post-yolk sac larvae	0.2	0.2	0.1	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.0
Inland silverside-yolk-sac larvae	0.4	0.0	0.1	0.3	1.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0
Lepomis sp.-juvenile	0.0	0.0	0.0	0.0	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Lepomis sp.-post-yolk sac larvae	1.1	0.0	0.0	0.1	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Lepomis sp.-undetermined	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Lepomis sp.-yolk-sac larvae	0.0	0.0	0.0	0.0	0.4	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Mummichog-yolk-sac larvae	0.0	0.1	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Naked goby-post-yolk sac larvae	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pomoxis sp.-yolk-sac larvae	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.0
Pumpkinseed-post-yolk sac larvae	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
River herring-fertilized egg	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10.3	0.7	118.0
River herring-post-yolk sac larvae	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	2.9	2285.2
River herring-undetermined	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
River herring-yolk-sac larvae	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	7.4
Spottail shiner-adult	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Spottail shiner-juvenile	0.1	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Spottail shiner-post-yolk sac larvae	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1
Spottail shiner-yolk-sac larvae	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.8	0.2
Tessellated darter-adult	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Tessellated darter-juvenile	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0
Tessellated darter-post-yolk sac larvae	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0
Tessellated darter-yolk-sac larvae	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.1	6.3	1.2	0.6
Threadfin shad-post-yolk sac larvae	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Unidentified fish egg	0.2	0.6	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.9	0.8	0.0
Unidentified fish larvae	1.1	0.1	1.6	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	4.4	0.9	0.0
Unidentified shrimp	0.0	0.0	0.0	0.0	0.4	0.2	1.2	1.0	0.1	0.1	0.1	0.0	1.8	1.9	0.3	0.0	0.2	0.1	0.0	0.6	0.3	0.4	1.2	0.0
White perch-fertilized egg	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	12.1	3.4	9.8
White perch-juvenile	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0
White perch-post-yolk sac larvae	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.5
White perch-yolk-sac larvae	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.6	12.0	12.9	9.0	113.7
White sucker-yolk-sac larvae	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0

Attachment 8

Evaluation of Ground Water Monitoring Data

Attachment 8
Ground Water Evaluation
11/18/2015

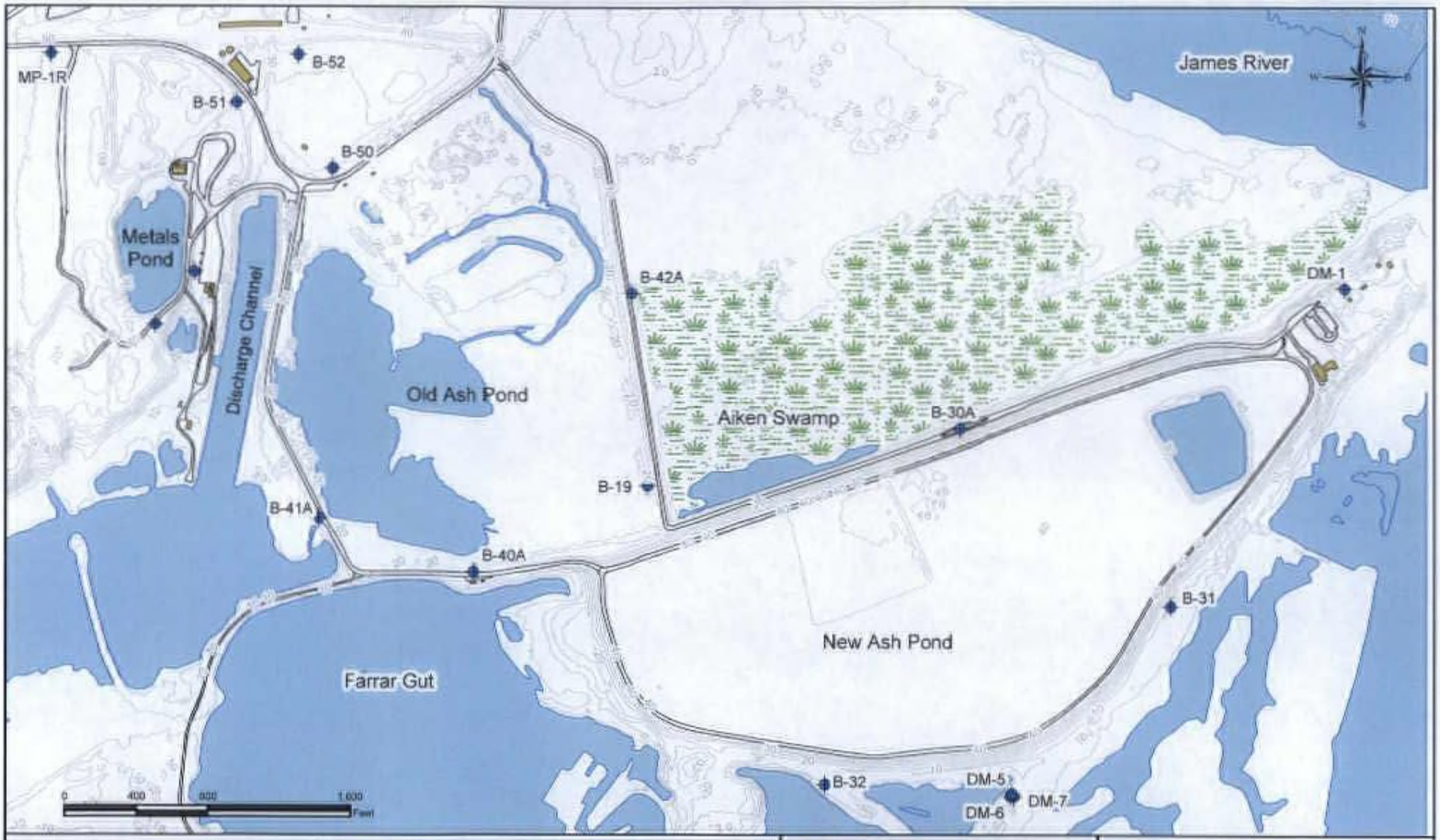
In accordance with the Ground Water Monitoring Plan (GWMP) dated September, 2001, ground water monitoring is performed around three ponds on the Chesterfield site- the metals treatment pond, the Lower Ash Pond (LAP) and the Upper Ash Pond (UAP). See Attachment 1 for the overall layout of the ponds, Attachment 8.a for maps showing the location of the monitoring wells and Attachment 8.b for the approved monitoring plan.

Evaluation of LAP monitoring results for the 2004 permit reissuance identified apparent increases in ground water concentrations of iron, ammonia, molybdenum, and zinc. Suspected ground water quality impacts were also indicated for arsenic, barium, manganese, and vanadium. Consequently, the 2004 permit called for a Corrective Action Plan. Phase I of a Groundwater Quality and Risk Assessment Report was initially submitted February 2007 and subsequently revised in March of 2012. The report included an evaluation of background monitoring well appropriateness. The evaluation determined that neither B-50 nor B-51 are appropriate background wells. Only B-52 remains an appropriate background well, so statistical evaluations were performed to compare downgradient wells to B-52. The following parameters showed Statistically Significant Increases (SSIs) over background concentrations: dissolved arsenic, dissolved barium, dissolved cadmium, dissolved copper, dissolved iron, dissolved manganese, dissolved molybdenum, ammonia, and chloride. A risk analysis was performed and is explained in detail in Attachment 8.d. The Risk Assessment indicates that a complete pathway does not exist for groundwater receptors and that although surface water provides complete pathways for both human and ecological receptors, the GW contamination does not currently pose a risk to the receptors.

The basis for the monitoring program around the UAP was developed in 1984, approximately when the pond was constructed. If contamination is detected in an initial set of downgradient wells, a second set of perimeter wells is to be constructed. If contaminant levels exceed action levels specifically established for this site in the perimeter wells, corrective action is required. See Attachment 8.b. for a detailed description of this program. Attachment 8.c is the second quarter 2012 monitoring report submitted by Virginia Power. That report indicated that monitoring around the UAP has entered the “extended” phase. Groundwater concentrations have not exceeded the Action Levels listed in the GWMP, but Dominion will continue to monitor at the UAP in the extended monitoring phase program and respond accordingly. The above noted determination regarding background wells will impact future evaluations of ground water data at the new ash pond.

The Metals Pond monitoring data was evaluated statistically for differences over background concentrations (MP-1). The chloride, copper, and iron data was first evaluated for normality with the Shapiro-Wilks normality test. Non-normal data was then evaluated with the Wilcoxon Rank Sum test, while normal data was evaluated with the student’s T-test. The data sets for all parameters were found to be non-normal and evaluated with Wilcoxon Rank-Sum test. All parameters with the exception of chloride exhibited no statistically significant increase over background concentrations in downgradient wells. The data showed statistically significant increases in chloride over background concentrations in downgradient well MP-3. Strongly correlated increasing trends were observed in downgradient wells, MP-2 and MP-3, and one hundred percent of the samples collected from MP-3 exceeded GW criteria for chloride. Chloride was added to the monitoring list for wells MP-1R, MP-2, and MP-3 as a result of discharge of flue gas desulfurization purge water into the Metals Pond between 2008 and 2009. The chloride purge water was completely drained from the metals pond on March 20, 2009. Since 2009, a strong increasing trend has been observed in downgradient well MP-3. Consequently, a Corrective Action Plan is needed to address apparent increases in ground water chloride concentrations downgradient of the Metals Pond. See Attachment 8.e for the analysis.

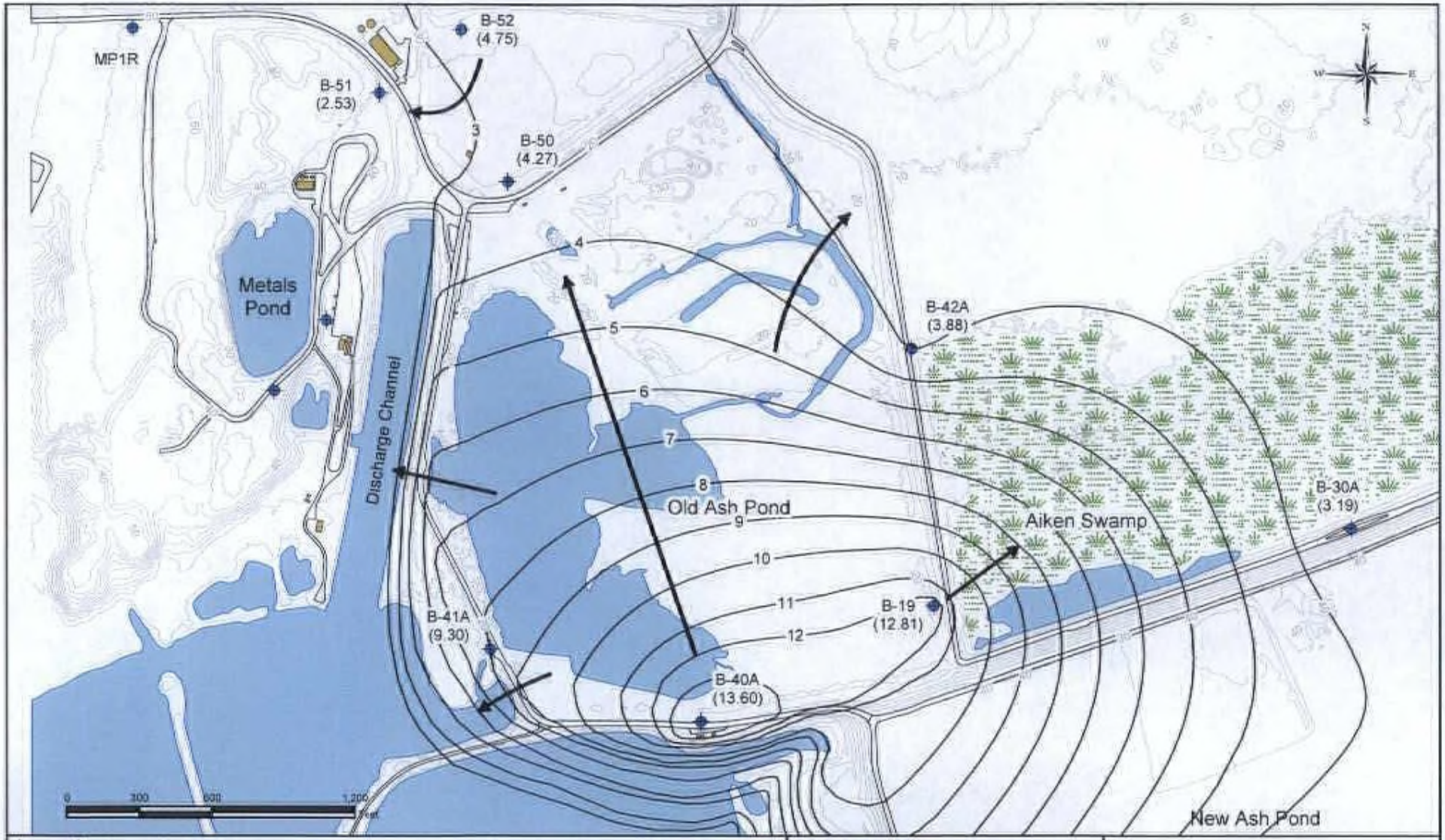
Attachment 8.a.



Legend

- Topographic Contour (feet, mean sea level)
- Roads
- Swamp
- Monitoring Well

URS — URS Corporation, 4905 Dickens Road, Suite 106, Richmond, Virginia 23230		**Figure 3** Groundwater Monitoring Well Location Map
Date: March 2012	Job Number: 11658264	Revised Groundwater Quality & Risk Assessment Report, Chesterfield Power Station, Old Ash Pond, Chester, Virginia
Prepared By: DBC	Reviewed By: KAH	
Scale: 1" = 800'	File Name: Fig 3 GW Loc Map	



Legend

- Potentiometric Contour
- Monitoring Well
- Roads
- Groundwater Flow Direction
- Topographic Contour (feet, mean sea level)
- Surface Water
- Swamp
- (6.23) Groundwater Elevation - 2/6/2012 (feet, mean sea level)

URS

URS Corporation
4905 Dickens Road
Suite 106
Richmond, Virginia 23230

Date: March 2012	Job Number: 11658264
Prepared By: DBC	Reviewed By: KAH
Scale: 1" = 600'	File Name: Fig.4 GW Pot Map

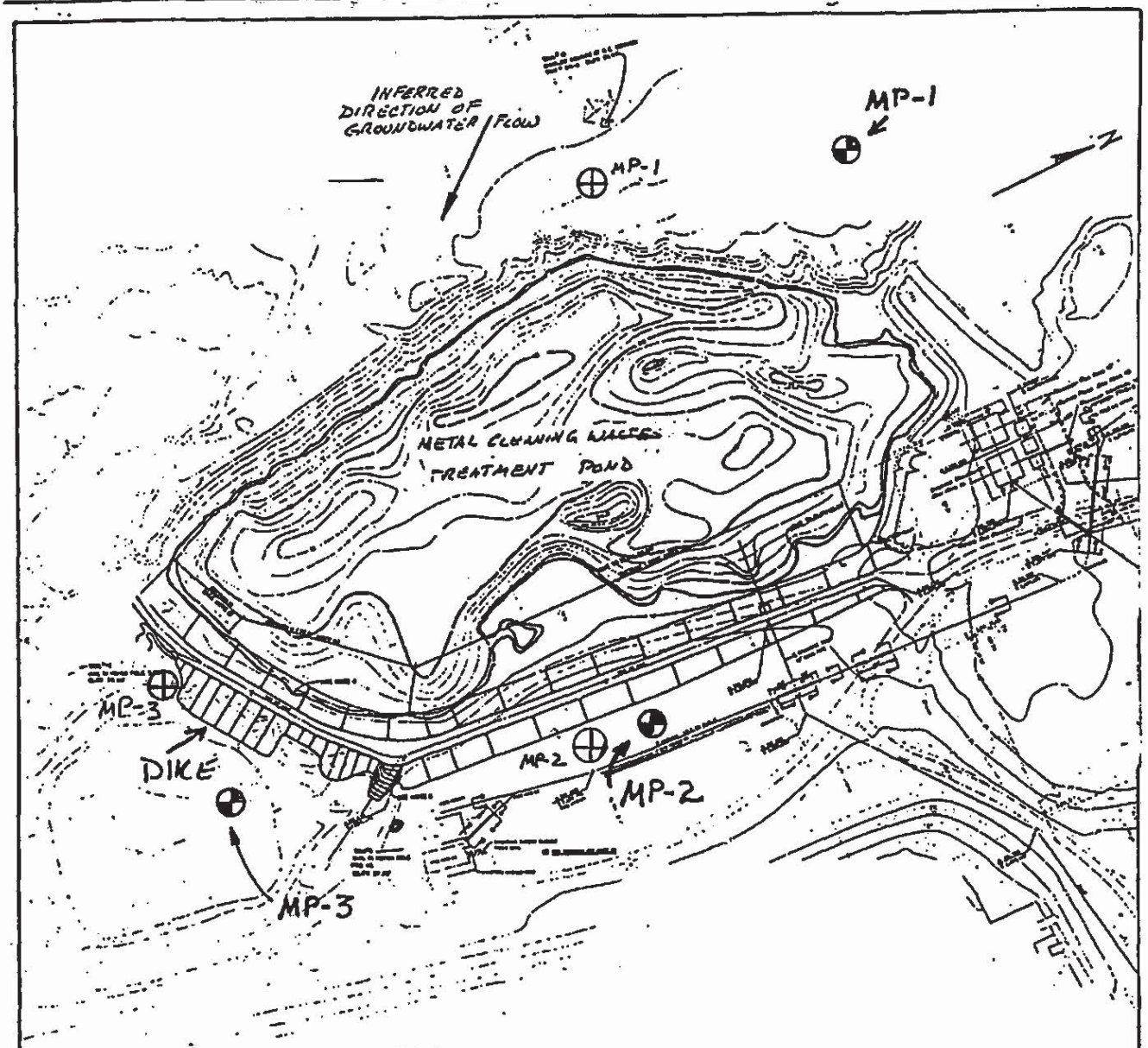
Figure 4
Groundwater Potentiometric Contour Map

Revised Groundwater Quality & Risk Assessment Report
Chesterfield Power Station
Old Ash Pond
Chester, Virginia

Additional Detail - Proposed Well Locations

WWT
09/14/01

ATTACHMENT 1



MONITORING WELL
= ORIGINAL PROPOS LOCATION

= MONITORING WELL ADJUSTED LOCATION (APPROXIMATE)

VIRGINIA POWER

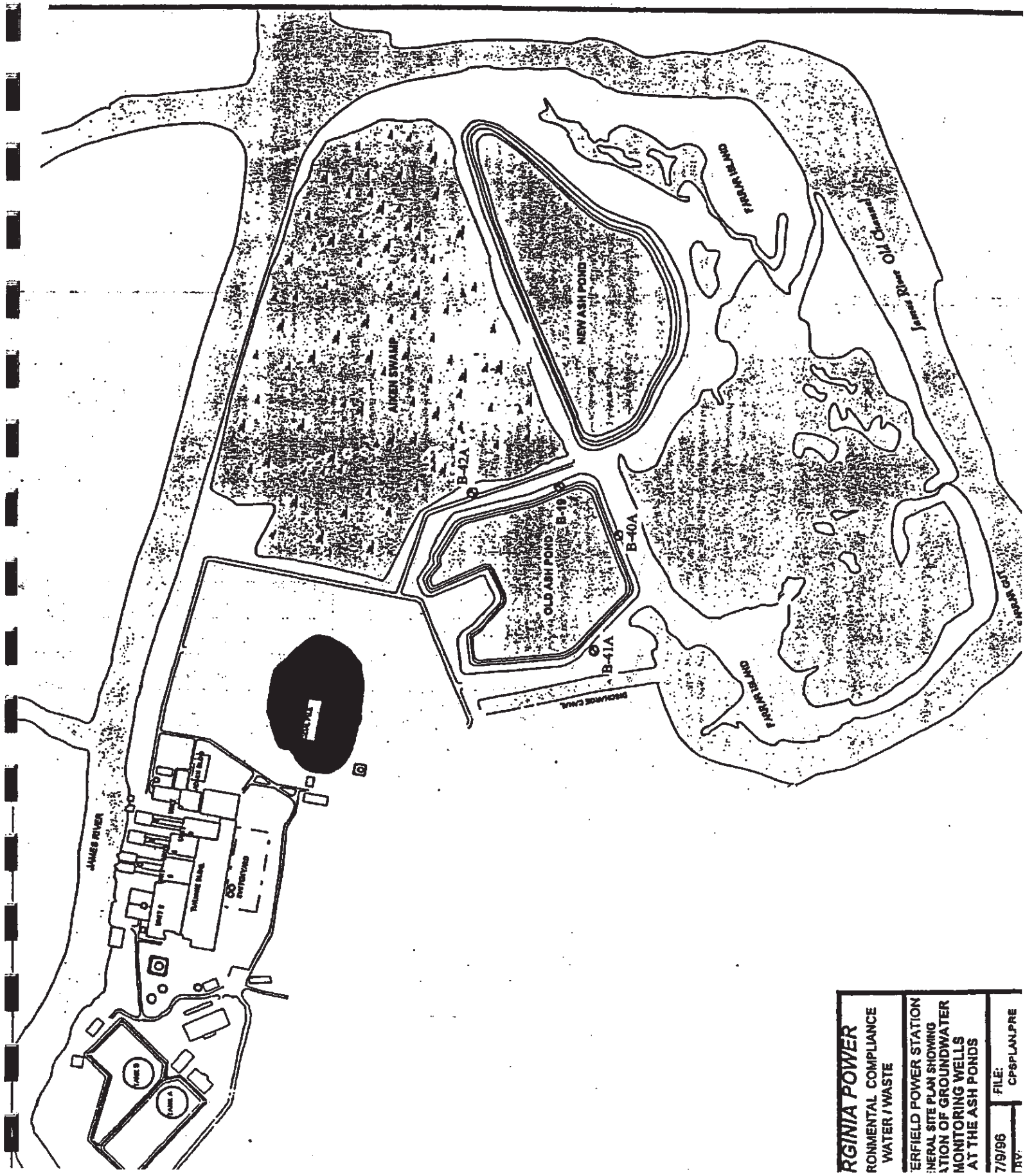
CHESTERFIELD POWER STATION
METAL CLEANING WASTES TREATMENT POND
MONITORING WELL LAYOUT
DATE: 5/12/87 BY: MS

Actual well locations may vary based on site conditions at time of installation.

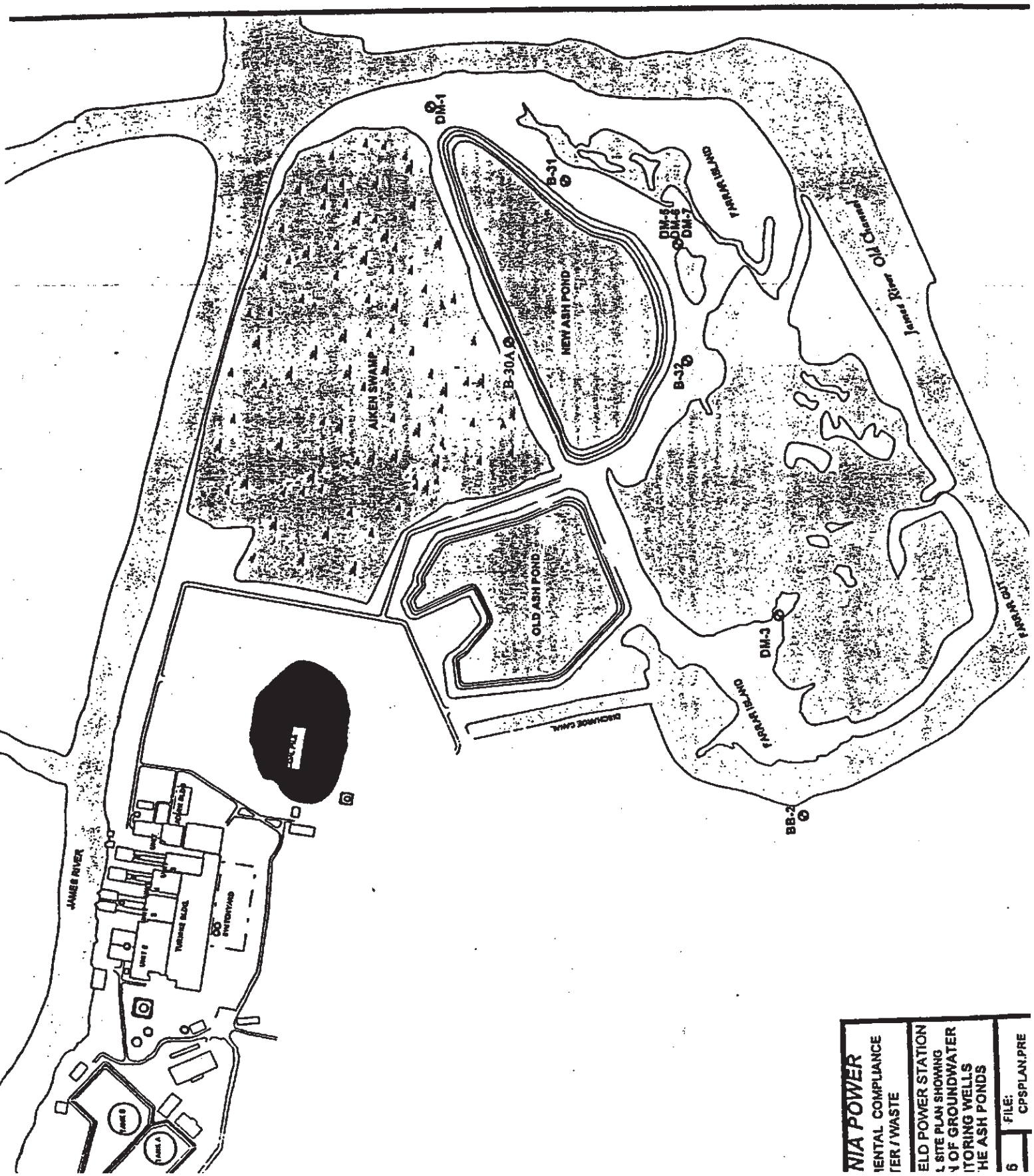
This sketch to accompany the Groundwater Monitoring Plan for Metal Cleaning Wastes Treatment Pond required by the Chesterfield Power Station VPDES Permit VA0004146.

Figure Appendix A-1

Old Ash Pond Monitoring Well Network



New Ash Pond Monitoring Well Network



NIA POWER
IENTAL COMPLIANCE
TER / WASTE
ELD POWER STATION
L SITE PLAN SHOWING
N OF GROUNDWATER
ITORING WELLS
HE ASH PONDS
6
FILE:
CPSPLAN.PRE

Attachment 8.b.

I. GENERAL

The purpose of this plan is to describe the methods and procedures for identifying and evaluating possible impacts to the groundwater from the Dominion Generation (Dominion) Chesterfield Power Station Ash Ponds and Metals Treatment Pond. The monitoring plans for the Old Ash Pond and the Metals Treatment Pond are included in Appendices A and B. Groundwater monitoring associated with Bulk Oil Storage at the facility is conducted under the station's Oil Discharge Contingency Plan program (FC-043539).

The evaluation for the New Ash Pond will include statistical and qualitative analyses of the groundwater monitoring data from the New Ash Pond monitoring well network. The plan also identifies actions to be taken pending the outcome of statistical and qualitative analyses. The monitoring well locations for the New Ash Pond are shown on Figure 1.

In general, the groundwater monitoring at the New Ash Pond is divided into three phases: detection monitoring, extended monitoring, and assessment monitoring. Advancement from one phase to the next is determined by statistical comparisons and trend analysis. The phases are described in the following sections of the plan.

A flow chart delineating the monitoring and action requirements is attached as Figure 2

II. COMPARISONS WITH BACKGROUND

The nature of the previously used groundwater monitoring well network relative to the New Ash Pond is such that there are no true upgradient wells. In previous groundwater monitoring events, Dominion has used offsite wells to perform interwell comparisons. Dominion will provide for more representative interwell comparisons by utilizing upgradient wells in future monitoring events. Within 90 days of the approval of this plan, Dominion will install three wells in the uppermost aquifer in locations appropriate for upgradient use in the New Ash Pond monitoring program. A qualified groundwater scientist has determined the new upgradient well locations based on site topography, existing site conditions (e.g., coal stockpile location), and drill rig access (above and below ground obstructions). The proposed locations are included on Figure 1.

The new upgradient wells will be monitored and the data statistically analyzed on the same frequency as the perimeter wells to identify variations in groundwater not potentially affected by the New Ash Pond. The analysis of the new upgradient wells will assist Dominion in determining the extent to which the groundwater quality is affected naturally or by sources other than the New Ash Pond.

The wells are listed in Table 2.

III. ESTABLISHING BACKGROUND CONCENTRATIONS

Upon completion of the installation of new upgradient wells, Dominion will collect background data from the new wells over a period of four quarters. Following background data collection, Dominion will initiate statistical analyses. For subsequent interwell comparisons, the background data set will consist of all data from the upgradient wells through the event prior to the event being analyzed.

Dominion may adjust or modify the establishment of the background for statistical comparisons, as well as the statistical methodology for evaluating groundwater quality, if it can demonstrate to the Virginia Department of Environmental Quality (VDEQ) that the modifications or adjustments are necessary to provide a more accurate and statistically valid evaluation of impact.

IV. PHASES OF MONITORING

The monitoring will consist of three separate phases: 1) detection monitoring where a short list of parameters is monitored quarterly and the extended list monitored annually; 2) extended monitoring where the groundwater is monitored quarterly for the extended list of parameters; and 3) the assessment phase where additional perimeter wells are installed and monitored quarterly for the extended list of parameters.

In each phase the data will be analyzed statistically to identify significant differences over background (interwell) using the methods described in subsequent sections of this plan.

IV.A Detection Monitoring Phase

The detection monitoring phase consists of quarterly monitoring for the parameters designated in Table 1 as detection parameters, and the associated statistical analysis for significant differences over background.

The groundwater quality data for the perimeter wells will be compared with the upgradient well background data in an interwell analysis to identify potential problems. The interwell analysis will compare the current period data for each perimeter well to the upper prediction limit (UPL) calculated using the pooled data from the upgradient wells through the event prior to the one being evaluated.

Additional types of analyses may be performed annually during the detection monitoring phase to augment the interwell analyses for the annual impact evaluation report. The results of the statistical analyses will be used to prepare an annual report of groundwater quality at the ash ponds.

If an individual detection parameter exceeds the UPL in the interwell analyses for two consecutive quarters in the same perimeter well, then the monitoring will move to the extended phase.

IV.B Extended Monitoring Phase

The extended monitoring phase consists of quarterly monitoring for the entire list of parameters in Table 1, the associated statistical analyses for significant differences over background, and trend analysis. The quarterly monitoring for the extended parameter list will continue for at least four quarters.

If an individual parameter does not exceed the UPL in the interwell analysis for four consecutive quarters in the same perimeter well, or if it can be demonstrated that UPL exceedences are seasonal in nature or below the practicable quantitation limit (PQL), Dominion may return to the detection monitoring phase. Dominion will continue quarterly monitoring of the entire list of parameters until meeting either the above conditions for returning to detection monitoring or the following conditions for proceeding to assessment monitoring.

If an individual parameter exceeds the UPL in the interwell analysis for four consecutive quarters on data above the PQL that is not seasonal in nature in the same perimeter well, additional monitoring will be performed in order to provide trend analysis. If, after at least eight quarters of the additional monitoring, a statistically significant trend is identified for an action level parameter in the same perimeter well using an appropriate statistical method on data above the PQL, Dominion will submit to the VDEQ a plan to extend the monitoring well network beyond the current perimeter. Once that plan is approved and the wells installed, the next phase, assessment monitoring, will commence.

IV.C Assessment Monitoring Phase

The assessment monitoring phase consists of monitoring the extended well network quarterly for the entire list of parameters. If an individual action level is exceeded for three consecutive quarters in the same perimeter well Dominion will notify the VDEQ and, within 90 days, will provide to the VDEQ a detailed plan and schedule for corrective action.

V. DATA ANALYSIS

V.A. Interwell Analysis

The interwell analysis during detection monitoring consists of comparing the current data with the pooled historical data. This is done by pooling the data from all of the upgradient wells for the period through the event prior to the one being evaluated and calculating the UPL. The UPL is calculated using a sitewide error rate of 0.05 with adjustments for the number of comparisons in the analysis. The current monitoring data are then compared to the UPL. Values greater than the UPL are considered to be a significant difference in concentration from the background data. The methodology for these types of comparisons is found in "Statistical Methods for Groundwater Monitoring," by R. D. Gibbons, John Wiley & Sons, 1994. The methodology is similar to the EPA's Analysis of Ground-Water Monitoring Data at RCRA Facilities, Addendum to Interim Final Guidance, Draft, Office of Solid Waste, July 1992.

V.B Trend Analysis

Trend analysis of concentrations in individual wells is useful in evaluating groundwater quality where there has been previous impact. Generally, statistical methods such as regression analysis or the Shewart-Cusum control chart method will be used in conjunction with a qualitative method such as a time plot of the data. Because of the degree of analytical variability below the PQL, the trend analyses will be performed only for those wells and parameters where the measured values are equal to or greater than the PQL. The Dominion PQLS, listed in Table 1, are below the action level values; therefore, the trend analysis will be able to identify quantifiable trends before they reach an action level.

VI. ACTION LEVELS

The action levels listed in Table 1 were developed by Dames & Moore for the original groundwater monitoring plan (August 10, 1984). The methodology used by Dames and Moore is included in Appendix C.

VII. REPORTING

Quarterly reports will be submitted to the VDEQ on the following annual schedule:

First quarter report by April 10
Second quarter report by July 10
Third quarter report by October 10
Fourth quarter report by January 10

Annual report by March 31

The quarterly reports will include a synopsis of the statistical analyses and will note any statistically significant differences and, when applicable, trends identified by the analyses.

The annual report will evaluate the groundwater quality at the site.

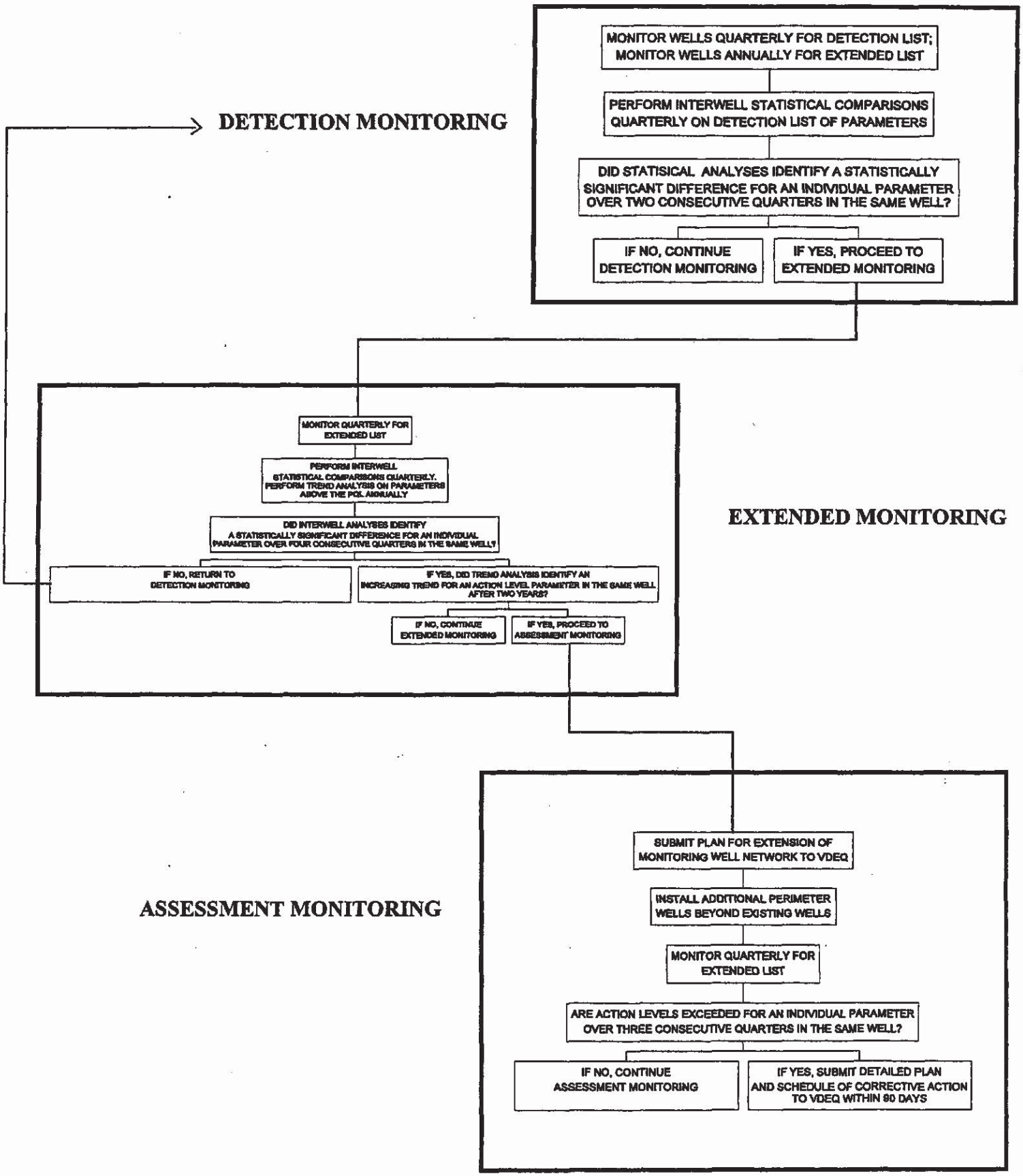
Table 1
New Ash Pond Groundwater Monitoring Parameters

Parameter	Action Level	PQL SW-846	Detection Phase Frequency	Type of Parameter
Groundwater Elevation	NA	NA	Quarterly	Detection
Ammonia	NA	NA	Quarterly	Detection
Copper	2,000 µg/l	10 µg/l	Quarterly	Detection
Chloride	NA	NA	Quarterly	Detection
Conductivity	NA	NA	Quarterly	Detection
Molybdenum	200 µg/l	5.0 µg/l	Quarterly	Detection
Nitrate	NA	50.0 µg/l	Quarterly	Detection
Iron	NA	250.0 µg/l	Quarterly	Detection
pH	NA	NA	Quarterly	Detection
Sulfate	NA	300.0 µg/l	Quarterly	Detection
Total Dissolved Solids (TDS)	NA	NA	Quarterly	Detection
Total Hardness	NA	NA	Quarterly	Detection
Zinc	10,000 µg/l	0.5 µg/l	Quarterly	Detection
Arsenic	100 µg/l	10.0 µg/l	Annually	Extended
Barium	2,000 µg/l	15 µg/l	Annually	Extended
Cadmium	20 µg/l	1.0 µg/l	Annually	Extended
Chromium	100 µg/l	10 µg/l	Annually	Extended
Chromium (hexavalent)	NA	25 µg/l	Annually	Extended
Lead	100 µg/l	10.0 µg/l	Annually	Extended
Manganese	NA	100.0 µg/l	Annually	Extended
Mercury	4 µg/l	1.0 µg/l	Annually	Extended
Selenium	20 µg/l	10 µg/l	Annually	Extended
Silver	10.8 µg/l	10 µg/l	Annually	Extended
Vanadium	200 µg/l	110 µg/l	Annually	Extended

Dissolved metals will be reported

Table 2 New Ash Pond Monitoring Wells	
Perimeter Wells	**Upgradient Wells**
B-30A	B-50
B-31	B-51
B32	B-52
DM-1	
DM-5	
DM-6	
DM-7	

CHESTERFIELD POWER STATION GROUNDWATER MONITORING PLAN - FIGURE 2
ASH PONDS GROUNDWATER MONITORING FLOW CHART



APPENDIX B

GROUNDWATER MONITORING PLAN

FOR

CHESTERFIELD POWER STATION
METAL CLEANING WASTES
TREATMENT POND

VIRGINIA POWER

December 12, 1991

Prepared by:

W. A. Sprouse, Jr., P.E.

Water Quality Department

I. INTRODUCTION

This groundwater monitoring plan is required by VPDES Permit VA0004146 for the Chesterfield Power Station. The facility is owned and operated by Virginia Power and is located in Chesterfield County. The station consists of four coal-fired electric generating units and one combined cycle unit.

Periodically, the waterside of the boiler tubes on the units are chemically cleaned to remove deposits. The wastewater from the process is pumped to the metal cleaning wastes treatment pond where the pH is adjusted to encourage the precipitation of metals. The pond also receives wastewater from air preheater and electrostatic precipitator washes.

The pond is irregularly shaped with approximately 4.5 acres of surface area. The total capacity is approximately 19 million gallons. The clarified water from the pond is discharged as Outfall 104.

In order to determine if the pond is affecting the groundwater quality, three wells will be installed and sampled for dissolved iron, dissolved copper, pH, specific conductivity, and static water levels. Well installation will begin within 60 days after this plan is approved by the VWCB.

II. MONITORING WELLS

Three monitoring wells will be installed at the locations shown in Attachment 1. Each well will be two inches in diameter and constructed in accordance with the Virginia Power specification for monitoring wells (Attachment 2). The screened interval shall be placed below the groundwater table to minimize oxidation due to infiltration of air from the vadose zone.

The proposed well locations have been selected to intercept possible groundwater contamination from the pond based on the inferred direction of groundwater flow to the southeast toward the discharge canal and Farrar Gut. One well, MP-1, will be placed upgradient and will serve as a control well for determining ambient conditions.

III. SAMPLING AND ANALYSIS

The wells will be sampled quarterly for dissolved iron, dissolved copper, pH, and specific conductivity. The quarters will begin in January, April, July, and October of each year. Sampling will commence in the first complete quarter following VWCB approval of this plan. During sampling, personnel will measure and record the static water level in each well. Prior to sampling, the wells will

and chloride beginning 6/88

be purged by removing three well volumes of water or until the well is dry, whichever comes first.

A trip blank will accompany the sampling crew each quarter and a field blank will be prepared. A duplicate sample will be taken from a different well each quarter. A chain of custody form, Attachment 3, will be completed for each round of sampling. Samples will be preserved and analyzed as follows:

Parameter	Protocol Preservation	Container	Method
Iron	4 ml of 1:1 nitric acid	1 liter plastic	EPA 236.1
Copper	4 ml of 1:1 nitric acid	1 liter plastic	EPA 220.1
pH		Determined in Field	
Conductivity		Determined in Field	

Groundwater samples will be obtained by either a bailer or a bladder pump, at the discretion of the sampling crew.

Appropriate statistical methods will be used to evaluate the impact, if any, of the pond on the groundwater.

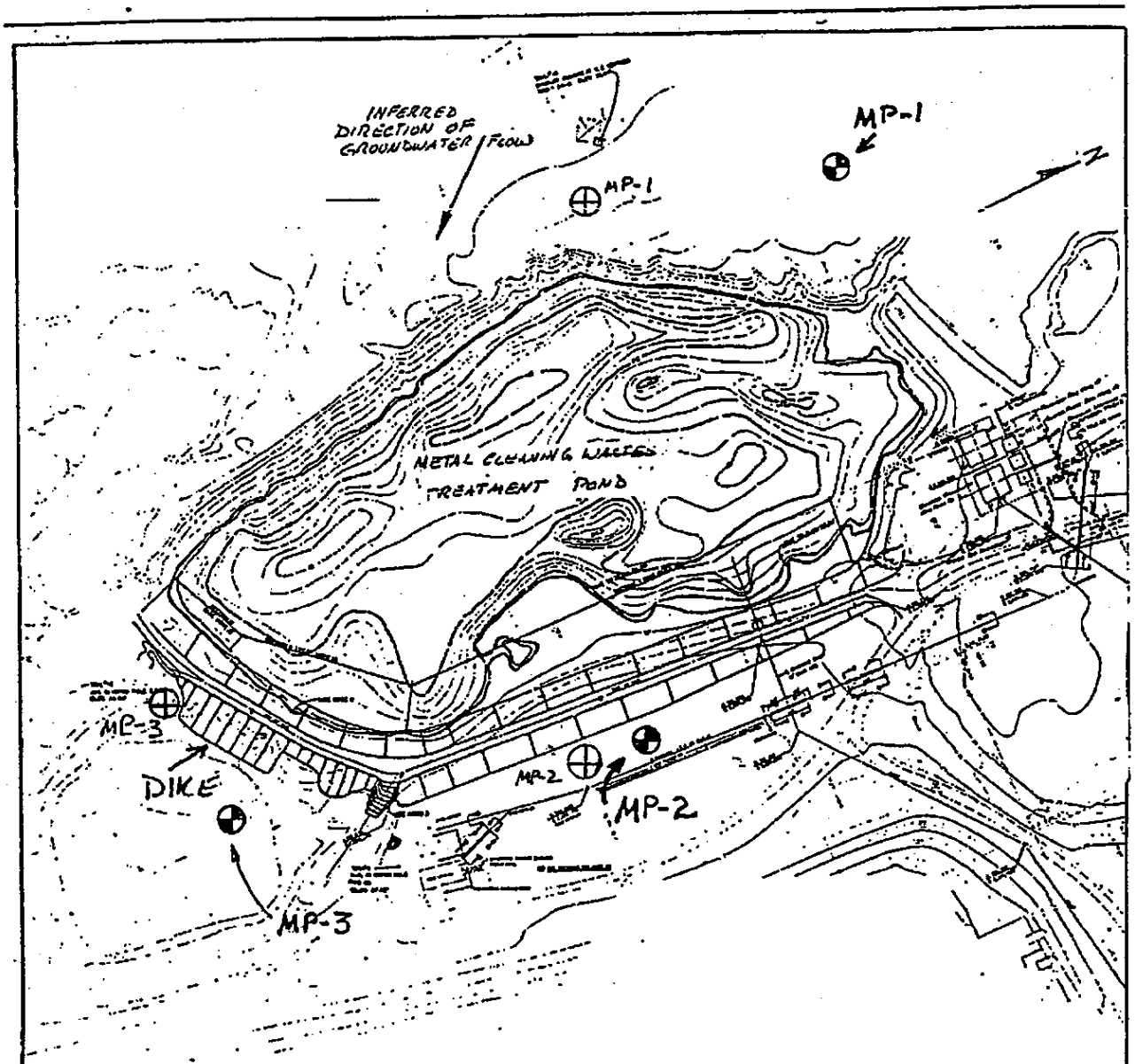
IV. REPORTING

A copy of the laboratory results and water levels will be forwarded to the Virginia Water Control Board, Piedmont Regional Office, by the 10th of the month following the end of the quarter.

V. ATTACHMENTS

Attachment 1 - Topo map showing proposed location of wells.
Attachment 2 - Virginia Power Well Specification.
Attachment 3 - Chain of custody form.

ATTACHMENT 1



MONITORING WELL
= ORIGINAL PROPOS LOCATION

⊕ = MONITORING WELL ADJUSTED LOCATION (APPROXIMATE)

VIRGINIA POWER

CHESTERFIELD POWER STATION
METAL CLEANING WASTES TREATMENT POND
MONITORING WELL LAYOUT
DATE: 5/2/87 BY: MS

Actual well locations may vary based on site conditions at time of installation.

This sketch to accompany the Groundwater Monitoring Plan for Metal Cleaning Wastes Treatment Pond required by the Chesterfield Power Station VPDES Permit VA0004146.

APPENDIX C

Includes:
Appendices A & B
(re: action levels)
from Dames & Moore report
dated August 10, 1984

APPENDIX A
METHODOLOGY FOR DEVELOPMENT OF ACTION LEVELS

Action levels (concentrations not to be exceeded at the site boundary shown in Figure 1) are proposed for toxic metals leached from the ash impoundments. If exceeded, implementation of the proposed corrective action will be required. Factors that must be considered in developing action levels include background water quality (as previously discussed); existence of current exceedances of water quality or action level standards; lateral and vertical distance from potential sources of contamination (ponds); attenuative capacity of subsurface environment, surface water, and other geochemical conditions; site specific hydrologic regime; and future beneficial uses of groundwater underlying the site.

Previously completed studies and available data have provided site specific information on the pattern of groundwater movement and its relationship to the surface water regime. These indicate that the most appropriate locations for setting action levels will be at the site boundaries, where the main component (horizontal) of flow discharges to surface water, and to a lesser degree in the deep wells, as an indicator of limited potential for vertical migration to the deeper aquifers. This approach recognizes that attenuative capacities of subsurface materials and dilution in the aquifer will reduce concentrations of contaminants migrating away from the ponds before they enter surface water.

Given the existing poor quality of shallow groundwater underlying the site and the industrial nature of the surrounding area, we anticipate that no drinking water supplies will be developed here in the future and that expected future beneficial uses of this resource would most likely be limited to some industrial uses. Therefore, we propose that action levels for potential ash contaminants not be limited to EPA's Interim Primary and Proposed Secondary Drinking Water Standards (IPDWS).

As a guideline to setting action levels, a "worst case" contamination scenario was developed for this site by Dr. D.I. Siegel, a specialist in natural water geochemistry. His work is included in Appendix B, and provides a rationale for selecting the action levels. Based on presently available data and worst case conditions, we propose that action levels in the shallow aquifer at the property boundary be set at the levels shown in Table A-1. We also propose that action

TABLE A-1

Action Levels at Site Boundary[a]
Chesterfield Power Station Impoundments

Parameter	Action Level[b] (mg/l)
Arsenic	0.1
Barium	2.0
Cadmium	0.02
Chromium, Total	0.1
Copper	2.0
Lead	0.1
Mercury	0.004
Molybdenum	0.2
Selenium	0.02
Silver	0.1
Vanadium	0.2
Zinc	10

[a]See Figure 1 for location of site boundary.

[b]For parameters whose background standard exceeds the listed action level, exceedances of the background standard instead of the specified action level will result in implementation of corrective action.

levels in the deep wells be set at these same levels. This would be consistent with other action levels, since available data indicate that this groundwater would not be used for human consumption and ultimately discharges to the river, and the "worst case" scenario indicates that these levels would provide adequate protection for surface water.

For those parameters shown to exceed proposed action levels in background data, action levels will be adjusted to that exceedance value so that further degradation does not occur. This will provide a conservative measure against contamination.

APPENDIX B

WORST CASE SCENARIO

APPENDIX B
WORST CASE SCENARIO

Action levels are evaluated using a "worst case" scenario. The scenario for the proposed ash impoundment includes evaluating the effect of maximum trace metal loading (the product of concentration and groundwater volume per unit time) from impoundment leachate to the James River at low flow when dilution of the trace metals would be least.

Maximum concentrations of trace metals leached from the impoundment to the groundwater will be controlled by the following:

1. Ion exchange capacity of clays for metals
2. Sorptive capacity of organics for metals
3. Effect of hydrologic events upon sorption/desorption of metals
4. Effect of hydrologic events on groundwater gradients.

Ion exchange refers to the exchange of a metal occupying a structural position in a clay mineral by another metal. The degree and order of exchange can be quantified by a chemical constant called the distribution coefficient (Kd), which is experimentally determined. Distribution coefficients for the metals of interest--As, Se, V, and Zn--have not been determined for mixed clay soils. Selectivity of a metal for exchange is closely related to the crystalline radius of the metal (Gast, 1977); metals with larger ionic radii are favored in the exchange process. Table B-1 shows that As, Se, V, and Zn would be less involved in ion exchange than Ca and Na, metals that are abundant in groundwater at the site. In fact, the Na-HCO_3 type groundwater at the site (Dames & Moore, 1983) clearly documents the existence of Ca-Na ion exchange as a major geochemical process in the system.

Since ion exchange at the study site is probably dominated by the exchange of Ca for Na, low concentrations of As, Se, V, and Zn in groundwater adjacent to the existing fly ash pond is probably caused by metal sorption and complexation to organic material in the surface materials. The sorptive capabilities of peat and organic material for trace metals is well known (e.g., Chaney and Hundemann, 1979), although little definitive experimental work has been done with the metals of interest. One set of experiments by Rashid (1974) involved passing water containing 10 mg/l of Co, Cu, Ni, and Zn through a column of peat, resulting in significant sorption (Table B-2). Although comparable data are not available for V,

Table B-1

Ionic Radii of Selected Metals

Metal	Radii (angstroms)	Order of Selectivity in Possible Ion Exchange
Ca	0.99	1
Na	0.95	1
Zn	0.79	2
Mg	0.65	3
V	0.65	3
As	0.58	4
Se	0.42	5

Table B-2

(From Rashid, 1974)

Sorption of Selected Trace Metals to Peat

Metal	Sorption (mg/g)
Co	9.6
Cu	67.4
Ni	17.4
Zn	26.1

Se, and As, it is probable that they are sorbed at a similar order of magnitude as these metals.

There is no estimate for the amount of organic material contained in the surficial materials north of the proposed impoundment site through which contaminants would pass, although the widespread wetlands indicate that there is a large source of organics available for sorbing trace metals. It is unlikely that the sorptive capacity of the surficial materials would be exceeded, given the relatively low volumes of leachate that could recharge the groundwater system from the proposed fly ash pond, which is underlain by clayey sediment with low vertical hydraulic conductivity. However, the pH of ground water at the study site is generally acidic (less than 7.0), in part because of organic acids contributed from the wetlands. Precipitation is even more acidic, because of acid rain (Munger and Eisenreich, 1983), and temporary desorption of metals from the organic material could occur during acidic recharge events.

Finally, variations in potential chemical loading to the James River from the impoundment is both controlled by the amount of groundwater discharge, dependent upon the hydraulic gradient and hydraulic conductivity of the porous material, as well as the absolute concentrations of metals.

Evaluation of potential chemical loading to the James River is made difficult by the qualitative understanding of the processes enumerated above. A worst case scenario would involve desorption of metals from aquifer matrix during low flow conditions of the river. During low flow, dilution of the leachate would be least.

A rough calculation of maximum groundwater flux to the river can be done as follows. It is assumed that water in the proposed fly ash pond is at the top of the proposed perimeter dike (42 feet above mean sea level). The average distance from the pond to the Dutch Gap Cutoff Channel is about 2,500 feet. The elevation of the river is about 1 foot above sea level. The maximum gradient would be about:

$$I = \frac{(42 - 1)}{2,500} = 0.0164$$

Groundwater flux is calculated from Darcy's Law. Although vertical recharge to the regional groundwater system will be limited by the very low

vertical hydraulic conductivity of the underlying sediments, it is assumed for this worst case analysis that recharge occurs to more permeable units in hydraulic communication with the river. The assumed lateral hydraulic conductivity of the affected aquifer is 0.0003 ft/s (0.01 cm/s), based on information contained in the Dames & Moore report (July 15, 1983). It is also assumed that the thickness of the aquifer is about 50 feet, twice the maximum thickness of layer 3 (Dames & Moore, 1983). The reach of Dutch Gap Cutoff receiving groundwater discharge from the pond is assumed to be 1 mile in length.

Darcy's Law is: $Q = KAI$

where: Q = discharge

K = hydraulic conductivity

A = cross sectional area

I = hydraulic gradient.

For this analysis:

$$Q = 0.0003 \times 50 \times 5{,}280 \times 0.0164 = 1.30 \text{ cubic feet per second.}$$

For this worst case analysis, it will be assumed that the maximum concentrations of trace metals found in the fly ash leachate are those concentrations found in the possible contaminant plume intersecting the river. Concentrations of metals desorbed during a recharge event would not likely exceed these concentrations. Should the sorptive capacity of the sediments be exceeded in time, the contaminants advected with groundwater would have these concentrations. This analysis ignores the mitigating effects of ion exchange and sorption. Dilution of the groundwater discharge by James River water can be modeled by the following equation:

$$Cd(Vr + Vg) = CrVr + CgVg$$

where: Cd = concentration of metals in river water and groundwater mixture

Cr = concentration of metals in river

Cg = concentration of metals in groundwater

Vr = instantaneous river discharge

Vg = instantaneous groundwater discharge.

It is assumed for the worst case analysis that:

$Cg = 65$ µg/l (maximum concentration in the pond leachate for selenium, which is 6.5 times the maximum concentration allowed in drinking

water; no other fly ash contaminant exceeded its drinking water standard by as large a percentage as selenium, therefore, this analysis is very conservative for other fly ash contaminants)

Cr = 2 µg/l (detection limit of selenium in samples obtained from James River at Dutch Gap cutoff)

Vr = 700 cfs (about the 7-day, 10 year low flow of the James River near the site)

Vg = 1.3 cfs (calculated from Darcy's Law).

The calculation results in river water with a selenium concentration of about 2.1 µg/l, implying an increase of only 0.1 µg/l or 5 percent under worst-case conditions; i.e., conditions assuming maximum hydraulic gradients in the ash impoundment and historic low flow in the James River, using a contaminant concentration observed to have the largest exceedence over drinking water standards, and neglecting the effects of chemical attenuation or dilution in the subsurface environment. The concentration of 2.1 µg/l is still well below the drinking water standard for selenium, which is 10 µg/l.

Based on the worst-case analysis, it can be concluded that possible leachate from the impoundment will not significantly affect the water quality of the river during historic low flow conditions. Therefore, adverse impact on river water quality from fly ash tailings leachate during normal pond operating conditions and normal river flow conditions is highly unlikely. (This neglects chemical attenuation and dilution in the subsurface environment, which will serve to further reduce contaminant concentrations.) As an added safety factor against river water quality degradation and preservation of groundwater for future beneficial uses, an action level equal to less than one-third of the selenium concentration found to have insignificant effects on river water quality is proposed. That is, instead of setting the action level at the site boundary at 65 µg/l (which is highly unlikely to have an adverse impact on river water quality), the action level proposed for selenium is 20 µg/l, only twice the drinking water standard. Since other fly ash contaminants in the tailings ponds are expected to have even less impact on river water quality than selenium, this rationale can be conservatively used in determining action levels for these parameters. That is, action levels for all fly ash contaminants are proposed at twice their drinking water standard, as shown in Table A-1.

Table B-3 presents the results of worst-case analyses performed for all fly ash contaminants for which action levels have been proposed, to illustrate the

Table B-3
Worst-Case Analysis for Mixing of Leachate and River Water

Parameter	Proposed Action Level	Measured River Concentration	Concentration of Leachate - River Mixture	Drinking Water Standard
Arsenic	100	4	4.18	50
Barium	2,000	100	103.52	1,000
Cadmium	20	<5	5.03	10
Chromium	100	<10	10.17	50
Copper	2,000	<20	23.67	1,000
Lead	100	<100	<100	50
Mercury	4	<1	1.01	2
Molybdenum	200	<100	100.19	--
Selenium	20	<2	2.03	10
Silver	100	<10	10.17	50
Vanadium	200	<200	<200	--
Zinc	10,000	60	78.43	5,000

Notes:
1. All concentrations are given in µg/l (ppb).
2. River water quality is determined from tests on samples collected 5-31-84, 6-14-84, and 6-26-84 at Vepco's oil dock and Farrar Gut.
3. Worst-case analysis assumes historic low flow in James River (700 cfs), and leachate flow based on maximum hydraulic gradient (1.3 cfs).

This page has been removed (12/7/84) to show a similar action level of 10.2. Revised copy is attached to this sheet. MAS 8/20/85

Table B-3
Worst-Case Analysis for Mixing of Leachate and River Water

Parameter	Proposed Action Level	Measured River Concentration	Concentration of Leachate - River Mixture	Drinking Water Standard
Arsenic	100	4	4.18	50
Barium	2,000	100	103.52	1,000
Cadmium	20	<5	5.03	10
Chromium	100	<10	10.17	50
Copper	2,000	<20	23.67	1,000
Lead	100	<100	<100	50
Mercury	4	<1	1.01	2
Molybdenum	200	<100	100.19	--
Selenium	20	<2	2.03	10
Silver	10.8	<10	10.17	50
Vanadium	200	<200	<200	--
Zinc	10,000	60	78.43	5,000

Notes:
1. All concentrations are given in µg/l (ppb).
2. River water quality is determined from tests on samples collected 5-31-84, 6-14-84, and 6-26-84 at Vepco's oil dock and Farrar Gut.
3. Worst-case analysis assumes historic low flow in James River (700 cfs), and leachate flow based on maximum hydraulic gradient (1.3 cfs).

insignificance of effects on river quality if contaminants at proposed action level concentrations enter the James River. The analyses are based on measured river water quality. Where contaminant concentrations less than the chemical testing detection limit were observed, the detection limit was used to represent river water quality for purposes of these calculations. In all cases except for lead, river water quality under worst-case conditions is substantially below drinking water standards after mixing with leachate. Since the action level for lead is equal to the detection limit, no increase in the assumed background river water quality is noted. Also, since the detection limit is twice the drinking water standard, future analyses for lead should use a detection limit smaller than 50 μg/l. Table B-3 illustrates that even under worst-case conditions, future beneficial uses of groundwater or surface water at the site will not be adversely affected.

Attachment 8.c.

Dominion Resources Services, Inc.
5000 Dominion Boulevard, Glen Allen, VA 23060
Web Address: www.dom.com

Dominion®

Piedmont Regional Office
JUL 09 2012
RECEIVED

July 5, 2012

Ms. Emilee Adamson
Virginia Department of Environmental Quality
Piedmont Regional Office
4949-A Cox Road
Glen Allen, VA 23060-6295

Re: Chesterfield Power Station – 2012 Second Quarter Groundwater Monitoring Report VPDES Permit VA0004146

Dear Ms. Carpenter:

Attached for your review are the second quarter 2012 groundwater monitoring results for the New Ash Pond, Old Ash Pond, and Metals Pond Facilities at the Chesterfield Power Station. This report contains a summary of analytical data for all three facilities and statistical analyses for the New Ash Pond.

Groundwater monitoring samples were collected on April 4, 2012. Tables 1, 2, and 3 summarize the laboratory analytical results for this latest sampling event for each facility. The New Ash Pond currently monitors under the extended monitoring phase, which includes an extended list of parameters, monitored quarterly.

Complete statistical analyses for detected parameters at the New Ash Pond were performed in accordance with EPA's March 2009 *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities – Unified Guidance* and the Facility Groundwater Monitoring Plan (GMP; 2001). Results of these analyses are presented following the tables in the attachment to this letter. The inter-well analysis compares the data from each downgradient well to the upper prediction limit calculated from the background well data set and therefore identifies Statistically Significant Increases (SSIs) in downgradient wells over background.

Inter-well statistical analyses were performed on detected parameters in downgradient wells from the April 2012 sampling event against historical background well concentrations at the New Ash Pond. Table 4 summarizes the results of inter-well statistical analyses. These statistical analyses indicated SSIs for the following constituents:

- Iron, Dissolved in well B-30A (no action limit listed in the GMP);
- Ammonia in well B-30A (no action limit listed in the GMP); and
- Conductivity in well B-32 (no action limit listed in the GMP).

In accordance with the GMP, trend analyses are to be provided for those monitoring wells and parameters that have indicated four consecutive quarterly SSIs. Currently, there are no parameters

with four consecutive SSIs. Please note groundwater concentrations did not exceeded the Action Levels listed in the GMP during this latest sampling event. Dominion will continue to monitor at the New Ash Pond in the extended monitoring phase program.

As indicated in previous quarterly monitoring reports, chloride was added to the monitoring list for monitoring wells MP-1R, MP-2, and MP-3 as a result of discharge of flue gas desulfurization purge water into the Metals Pond (see Table 3). The chloride purge water was completely drained from the Metals Pond on March 20, 2009.

The reported measurements were obtained by employing methods of analysis that are legally required, or otherwise appropriate to the monitoring objective, and are being reported in accordance with regulatory requirements. The reported measurements truly, accurately and completely represent the observed results of the monitoring required, but only the observed results. Those measurements are subject to the accuracy, precision, detection, and quantitation limitations associated with those methods in the subject sample matrices at the concentrations present in the sample. Any regulatory actions that may be taken based on these measurements must account for those limitations.

If you have any questions or comments regarding the enclosed information, please contact Jason Ericson of Dominion Electrical Environmental Services, at (804) 273-3485.

Certification

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Cathy C. Taylor	Director, Electric Environmental Services
Name of Authorized Agent	Title
Cathy C Taylor	7/5/2012
Signature of Authorized Agent	Date

Attachment

Piedmont Regional Office
JUL 09 2012
RECEIVED

Table 1
Chesterfield Power Station - New Ash Pond
Groundwater Monitoring Well Report for April 4, 2012

			Downgradient Wells							Background Wells			Field QC	
Parameter Name	LOD	LOQ	B-30A	B-31	B-32	DM-1	DM-5	DM-6	DM-7	B-50	B-51	B-52	DM-5 DUP	FIELD BLANK
Metals (mg/L)														
Arsenic, Dissolved	0.003	0.010	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	**0.004** J	NS	<0.003	<0.003	<0.003
Barium, Dissolved	0.003	0.015	**0.340**	**0.017**	**0.043**	**0.052**	**0.295**	**0.008**	**0.013** J	**0.345**	NS	**0.033**	**0.310**	<0.003
Cadmium, Dissolved	0.0003	0.0015	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	NS	**0.0007** J	<0.0003	<0.0003
Chromium, Dissolved	0.001	0.005	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	NS	<0.001	<0.001	<0.001
Chromium (hexavalent)	0.005	0.005	<0.005	<0.005	<0.005	**0.006**	<0.005	<0.005	<0.005	<0.005	NS	<0.005	<0.005	<0.005
Copper, Dissolved	0.001	0.005	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	NS	<0.001	<0.001	<0.001
Iron, Dissolved	0.05	0.25	**21.23**	<0.05	<0.05	**2.19**	<0.05	<0.05	**0.06** J	**4.81**	NS	<0.05	<0.05	<0.05
Lead, Dissolved	0.001	0.005	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	NS	<0.001	<0.001	<0.001
Manganese, Dissolved	0.02	0.05	**1.23**	**0.02** J	**1.91**	**0.27**	**0.48**	**0.03** J	**0.05**	**2.46**	NS	**0.02** J	**0.46**	<0.02
Mercury, Dissolved	0.0002	0.001	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	NS	<0.0002	<0.0002	<0.0002
Molybdenum, Dissolved	0.001	0.005	<0.001	<0.001	<0.001	**0.002** J	<0.001	<0.001	<0.001	<0.001	NS	<0.001	<0.001	<0.001
Selenium, Dissolved	0.003	0.010	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	NS	<0.003	<0.003	<0.003
Silver, Dissolved	0.0001	0.0004	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	NS	<0.0001	<0.0001	<0.0001
Vanadium, Dissolved	0.001	0.005	<0.001	<0.001	<0.001	**0.002** J	<0.001	<0.001	<0.001	<0.001	NS	<0.001	<0.001	<0.001
Zinc, Dissolved	0.01	0.03	**0.018** J	**0.017** J	**0.020** J	**0.035**	**0.019** J	**0.017** J	**0.019** J	**0.019** J	NS	**0.027** J	**0.019** J	<0.01
Water Quality Parameters (mg/L)														
Ammonia	0.01	0.05	**14.28**	**0.01** J	**1.05**	**0.06**	**0.10**	**0.02** J	**0.02** J	**4.14**	NS	**0.01** J	**0.10**	<0.01
Chloride	0.05	0.25	**9.41**	**2.75**	**18.00**	**7.00**	**19.09**	**3.64**	**6.89**	**23.27**	NS	**9.17**	**18.82**	<0.05
Nitrate	0.01	0.05	<0.01	<0.01	**0.02** J	**0.03** J	<0.01	**0.01** J	**0.03** J	<0.01	NS	**1.23**	<0.01	<0.01
Sulfate	0.06	0.30	<0.06	**5.55**	**238.89**	**234.85**	**146.25**	**7.08**	**11.75**	**44.52**	NS	**329.34**	**144.19**	<0.06
Total Dissolved Solids (TDS)	10	10	**185.5**	**43.5**	**597.0**	**393.5**	**437.5**	**96.0**	**91.0**	**298.5**	NS	**485.5**	**473.5**	<10
Total Hardness	3	10	**133.38**	**10.26**	**418.95**	**201.78**	**367.65**	**3.42** J	**13.68**	**256.5**	NS	**290.70**	**367.65**	<3
Field Measurements														
Conductivity (umhos)	N/A	N/A	459	51	929	651	702	90	57	590	NS	596	699	--
Groundwater Elevation (feet)	N/A	N/A	1.62	4.64	1.36	3.89	1.69	1.87	1.57	4.55	NS	5.04	--	--
pH (S.U.)	N/A	N/A	6.35	5.70	6.34	5.61	6.12	7.26	5.24	6.65	NS	5.46	6.11	--
Temperature (Degrees Celsius)	N/A	N/A	17.03	14.62	15.71	15.26	15.20	15.40	15.50	17.73	NS	18.90	15.22	--
Sample Time (hours)	N/A	N/A	1000	1000	1015	920	930	940	945	1100	NS	1110	935	905

Notes:
NS = Not sampled due to insufficient water.
J = Concentration is between LOD and LOQ, and is considered estimated.
LOD = Limit of Detection.
LOQ = Limit of Quantitation.
mg/L = Milligrams per liter.
N/A = Not applicable.
S.U. = Standard Units.
umhos = Micromhos.
Bold font = Detected constituent.

Table 2
Chesterfield Power Station - Old Ash Pond
Groundwater Monitoring Well Report for April 4, 2012

Parameter Name	LOD	LOQ	B-19	B-40A	B-41A	B-41A DUP	B-42A	FIELD BLANK
Metals (mg/L)								
Copper, Dissolved	0.001	0.005	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Iron, Dissolved	0.05	0.25	**19.09**	**16.60**	**21.77**	**20.51**	**8.13**	<0.05
Molybdenum, Dissolved	0.001	0.005	<0.001	<0.001	**0.013**	**0.012**	<0.001	<0.001
Zinc, Dissolved	0.01	0.03	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Water Quality Parameters (mg/L)								
Ammonia	0.01	0.05	**0.43**	**3.62**	**1.94**	**2.50**	**1.07**	**0.01** J
Chloride	0.05	0.25	**17.68**	**103.72**	**191.32**	**191.65**	**16.22**	<0.05
Nitrate	0.01	0.05	**0.02** J	**0.01** J	<0.01	<0.01	<0.01	<0.01
Sulfate	0.06	0.30	**150.95**	**6.47**	**52.53**	**52.40**	**33.25**	<0.06
Total Dissolved Solids (TDS)	10	10	**385.5**	**294.0**	**599.5**	**608.2**	**218.0**	<10
Total Hardness	3	10	**263.34**	**222.30**	**427.50**	**418.95**	**167.58**	<3
Field Measurements								
Conductivity (umhos)	N/A	N/A	636	693	1130	1133	433	--
Groundwater Elevation (feet msl)	N/A	N/A	16.09	13.48	5.68	--	3.66	--
pH (S.U.)	N/A	N/A	6.32	6.55	6.46	6.50	6.15	--
Sample Time (hours)	N/A	N/A	1045	1030	1100	1105	1030	0900
Temperature (Degrees Celsius)	N/A	N/A	14.13	15.32	16.60	16.64	14.79	--

Notes:

Degrees C = Degrees Celsius.
LOD = Limit of Detection.
LOQ = Limit of Quantitation.
mg/L = Milligrams per liter.
msl = Mean sea level.
N/A = Not applicable.
S.U. = Standard Units.
umhos = Micromhos.
Bold font = Detected constituent.

Qualifiers:
J = Concentration is between LOD and LOQ, and is considered estimated.

Table 3
Chesterfield Power Station - Metals Pond
Groundwater Monitoring Well Report for April 4, 2012

Parameter Name	Units	LOD	LOQ	MP-1R	MP-2	MP-2 DUP	MP-3	FIELD BLANK
Copper, Dissolved	mg/L	0.001	0.005	<0.001	<0.001	<0.001	<0.001	<0.001
Iron, Dissolved	mg/L	0.05	0.25	<0.05	**0.10** J	**0.08** J	**0.11** J	<0.05
Chloride	mg/L	0.05	0.25	**38.76**	**31.16**	**33.46**	**248.05**	<0.05
Field Measurements								
Conductivity	UMHOS	N/A	N/A	330	340	342	1062	--
Groundwater Elevation	feet	N/A	N/A	31.24	11.28	--	7.05	--
pH	S.U.	N/A	N/A	6.66	6.08	6.10	5.00	--
Sample Time	hours	N/A	N/A	1210	1145	1150	1155	0855
Temperature	Degrees C	N/A	N/A	18.63	17.13	17.10	17.61	--

Notes:

Degrees C = Degrees Celsius.

J = Concentration is between LOD and LOQ, and is considered estimated.

LOD = Limit of Detection.

LOQ = Limit of Quantitation.

mg/L = Milligrams per liter.

N/A = Not applicable.

S.U. = Standard Units.

umhos = Micromhos.

Bold font = Detected constituent.

Table 4
Summary of Statistical Significance: Inter-well Analysis
Second Quarter 2012
Chesterfield Power Station - New Ash Pond

Parameter Detected Above LOQ	Compliance Well	Inter-well Comparison: Statistically Significant (yes,no)
Barium, Dissolved	B-30A	No
	B-31	No
	B-32	No
	DM-1	No
	DM-5	No
	DM-6	No
	DM-7	No
Chromium (hexavalent)	B-30A	No
	B-31	No
	B-32	No
	DM-1	No
	DM-5	No
	DM-6	No
	DM-7	No
Iron, Dissolved	B-30A	*Yes*
	B-31	No
	B-32	No
	DM-1	No
	DM-5	No
	DM-6	No
	DM-7	No
Manganese, Dissolved	B-30A	No
	B-31	No
	B-32	No
	DM-1	No
	DM-5	No
	DM-6	No
	DM-7	No
Zinc	B-30A	No
	B-31	No
	B-32	No
	DM-1	No
	DM-5	No
	DM-6	No
	DM-7	No
Ammonia	B-30A	*Yes*
	B-31	No
	B-32	No
	DM-1	No
	DM-5	No
	DM-6	No
	DM-7	No

Table 4
Summary of Statistical Significance: Inter-well Analysis
Second Quarter 2012
Chesterfield Power Station - New Ash Pond

Parameter Detected Above LOQ	Compliance Well	Inter-well Comparison: Statistically Significant (yes,no)
Chloride	B-30A	No
	B-31	No
	B-32	No
	DM-1	No
	DM-5	No
	DM-6	No
	DM-7	No
Sulfate	B-30A	No
	B-31	No
	B-32	No
	DM-1	No
	DM-5	No
	DM-6	No
	DM-7	No
Total Dissolved Solids (TDS)	B-30A	No
	B-31	No
	B-32	No
	DM-1	No
	DM-5	No
	DM-6	No
	DM-7	No
Total Hardness	B-30A	No
	B-31	No
	B-32	No
	DM-1	No
	DM-5	No
	DM-6	No
	DM-7	No
Conductivity	B-30A	No
	B-31	No
	B-32	***Yes***
	DM-1	No
	DM-5	No
	DM-6	No
	DM-7	No
pH	B-30A	No
	B-31	No
	B-32	No
	DM-1	No
	DM-5	No
	DM-6	No
	DM-7	No

Notes:

LOQ = Limit of Quantitation

Inter-well Statistical Analyses
for
New Ash Pond

Shapiro-Francia Test of Normality (Continued)

Parameter: pH
Background Locations
Normality Test of Parameter Concentrations
Natural Logarithm Transformation
Total Number of Measurements = 115

i	x(i)	m(i)	sum(m^2)	sum(mx)
66	1.78171	0.173829	54.0196	-71.5083
67	1.79342	0.196779	54.0583	-71.1554
68	1.80006	0.219834	54.1067	-70.7596
69	1.80006	0.240426	54.1645	-70.3269
70	1.80171	0.263715	54.234	69.8517
71	1.81808	0.287147	54.3165	69.3297
72	1.8197	0.308108	54.4114	-68.769
73	1.82938	0.331854	54.5215	68.1619
74	1.83098	0.353118	54.6462	-67.5154
75	1.83258	0.377233	54.7885	-66.8241
76	1.83578	0.401571	54.9498	-66.0869
77	1.84214	0.423405	55.1291	-65.3069
78	1.8516	0.448213	55.33	64.477
79	1.8516	0.473299	55.554	-63.6006
80	1.85786	0.49585	55.7998	-62.6794
81	1.85786	0.521527	56.0718	-61.7105
82	1.85942	0.544642	56.3685	-60.6978
83	1.86253	0.570999	56.6945	-59.6343
84	1.86253	0.597761	57.0518	-58.5209
85	1.86872	0.621911	57.4386	-57.3587
86	1.87026	0.649522	57.8605	-56.144
87	1.88099	0.67449	58.3154	-54.8752
88	1.88251	0.703089	58.8097	-53.5517
89	1.88251	0.732275	59.346	-52.1731
90	1.88707	0.758753	59.9217	-50.7413
91	1.88858	0.789191	60.5445	-49.2509
92	1.89311	0.820379	61.2175	-47.6978
93	1.89762	0.848786	61.938	-46.0871
94	1.90061	0.881587	62.7152	-44.4116
95	1.90061	0.911562	63.5461	-42.6791
96	1.90211	0.946291	64.4416	-40.8791
97	1.90658	0.982202	65.4063	-39.0065
98	1.90806	1.01522	66.437	37.0694
99	1.90954	1.05375	67.5473	-35.0572
100	1.91545	1.0939	68.744	32.9619
101	1.91839	1.13113	70.0234	-30.7919
102	1.91986	1.17499	71.404	-28.5361
103	1.92132	1.21596	72.8826	-26.1999
104	1.92571	1.26464	74.4819	-23.7645
105	1.93152	1.31652	76.2151	-21.2216
106	1.93586	1.36581	78.0805	-18.5776
107	1.94162	1.42554	80.1127	-15.8098
108	1.94734	1.49085	82.3354	-12.9066
109	1.96009	1.55477	84.7527	9.85908
110	1.9615	1.63524	87.4267	-6.65157
111	1.96851	1.71688	90.3744	3.27186
112	1.97547	1.82501	93.705	0.333382
113	1.981	1.95996	97.5465	4.21607
114	2.08194	2.12007	102.041	8.62992
115	2.11384	2.40892	107.844	13.722

Data Set Standard Deviation = 0.126361
Numerator = 188.293
Denominator = 196.305
W Statistic = 0.959191 = 188.293 / 196.305

5% Critical value of 0.976 exceeds 0.959191
Evidence of non-normality at 95% level of significance

Shapiro-Francia Test of Normality
Parameter: pH
Background Locations
Normality Test of Parameter Concentrations
Natural Logarithm Transformation
Total Number of Measurements = 115

i	x(i)	m(i)	sum(m^2)	sum(mx)
1	1.50851	-2.40892	5.80292	-3.63389
2	1.53902	-2.12007	10.2976	-6.89671
3	1.56862	-1.95996	14.1391	-9.97114
4	1.57691	-1.82501	17.4697	-12.849
5	1.58515	-1.71688	20.4174	-15.5705
6	1.58719	-1.63524	23.0914	-18.166
7	1.59331	-1.55477	25.5087	-20.6432
8	1.59534	-1.49085	27.7313	-23.0216
9	1.59534	-1.42554	29.7635	-25.2958
10	1.60944	-1.36581	31.6289	-27.494
11	1.62137	-1.31652	33.3622	-29.6286
12	1.62924	-1.26464	34.9615	-31.689
13	1.6312	-1.21596	36.4401	-33.6725
14	1.63511	-1.17499	37.8206	-35.5937
15	1.63511	-1.13113	39.1001	-37.4432
16	1.639	-1.0939	40.2967	-39.2361
17	1.639	-1.05375	41.4071	-40.9632
18	1.639	-1.01522	42.4378	-42.6271
19	1.64094	-0.982202	43.4025	-44.2389
20	1.64287	-0.946291	44.298	-45.7935
21	1.64287	-0.911562	45.1289	-47.2911
22	1.64481	-0.881587	45.9061	-48.7411
23	1.64481	-0.848786	46.6265	-50.1372
24	1.64673	-0.820379	47.2996	-51.4881
25	1.65441	-0.789191	47.9224	-52.7938
26	1.65632	-0.758753	48.4981	-54.0505
27	1.65823	-0.732275	49.0343	-55.2648
28	1.65823	-0.703089	49.5286	-56.4307
29	1.65823	-0.67449	49.9836	-57.5491
30	1.66582	-0.649522	50.4055	-58.6311
31	1.67147	-0.621911	50.7922	-59.6706
32	1.67147	-0.597761	51.1496	-60.6698
33	1.67147	-0.570999	51.4756	-61.6242
34	1.67147	-0.544642	51.7722	-62.5345
35	1.67147	-0.521527	52.0442	-63.4063
36	1.67335	-0.49585	52.2901	-64.236
37	1.68083	-0.473299	52.5141	-65.0315
38	1.68083	-0.448213	52.715	-65.7849
39	1.6864	-0.423405	52.8943	-66.4989
40	1.6864	-0.401571	53.0555	-67.1761
41	1.6864	-0.377233	53.1978	-67.8123
42	1.68825	-0.353118	53.3225	-68.4085
43	1.69378	-0.331854	53.4326	-68.9705
44	1.69562	-0.308108	53.5276	-69.493
45	1.69745	-0.287147	53.61	-69.9804
46	1.69928	-0.263715	53.6796	-70.4285
47	1.70111	-0.240426	53.7374	-70.8375
48	1.70111	-0.219834	53.7857	-71.2115
49	1.70293	-0.196779	53.8244	-71.5466
50	1.70475	-0.173829	53.8546	-71.8429
51	1.71199	-0.153505	53.8782	-72.1057
52	1.71199	-0.130716	53.8953	-72.3295
53	1.71199	-0.110516	53.9075	-72.5187
54	1.7174	-0.0878447	53.9152	-72.6696
55	1.7174	-0.0652187	53.9195	-72.7816
56	1.72277	-0.0451348	53.9215	-72.8593
57	1.72633	-0.0225612	53.922	-72.8983
58	1.72811	0	53.922	-72.8983
59	1.72811	0.0225612	53.9225	-72.8593
60	1.72988	0.0451348	53.9246	-72.7812
61	1.73342	0.0652187	53.9288	-72.6682
62	1.73519	0.0878447	53.9365	-72.5157
63	1.74746	0.110516	53.9488	-72.3226
64	1.76815	0.130716	53.9658	-72.0915
65	1.78171	0.153505	53.9894	-71.818

Shapiro-Francia Test of Normality (Continued)
Parameter: pH
Background Locations
Normality Test of Parameter Concentrations
Original Data (Not Transformed)
Total Number of Measurements = 115

i	x(i)	m(i)	sum(m^2)	sum(mx)
66	5.94	0.173829	54.0196	-223.265
67	6.01	0.196779	54.0583	-222.082
68	6.05	0.219834	54.1067	-220.752
69	6.05	0.240426	54.1645	-219.298
70	6.06	0.263715	54.234	-217.7
71	6.16	0.287147	54.3165	-215.931
72	6.17	0.308108	54.4114	-214.03
73	6.23	0.331854	54.5215	-211.962
74	6.24	0.353118	54.6462	-209.759
75	6.25	0.377233	54.7885	-207.401
76	6.27	0.401571	54.9498	-204.883
77	6.31	0.423405	55.1291	-202.212
78	6.37	0.448213	55.33	-199.357
79	6.37	0.473299	55.554	-196.342
80	6.41	0.49585	55.7998	-193.163
81	6.41	0.521527	56.0718	-189.82
82	6.42	0.544642	56.3685	-186.324
83	6.44	0.570999	56.6945	-182.646
84	6.44	0.597761	57.0518	-178.797
85	6.48	0.621911	57.4386	-174.767
86	6.49	0.649522	57.8605	-170.552
87	6.56	0.67449	58.3154	-166.127
88	6.57	0.703089	58.8097	-161.508
89	6.57	0.732275	59.346	-156.696
90	6.6	0.758753	59.9217	-151.689
91	6.61	0.789191	60.5445	-146.472
92	6.64	0.820379	61.2175	-141.025
93	6.67	0.848786	61.938	135.363
94	6.69	0.881587	62.7152	-129.466
95	6.69	0.911562	63.5461	-123.367
96	6.7	0.946291	64.4416	-117.027
97	6.73	0.982202	65.4063	-110.417
98	6.74	1.01522	66.437	-103.574
99	6.75	1.05375	67.5473	-96.4616
100	6.79	1.0939	68.744	-89.034
101	6.81	1.13113	70.0234	-81.331
102	6.82	1.17499	71.404	-73.3176
103	6.83	1.21596	72.8826	-65.0126
104	6.86	1.26464	74.4819	-56.3371
105	6.9	1.31652	76.2151	-47.2531
106	6.93	1.36581	78.0805	-37.7881
107	6.97	1.42554	80.1127	-27.8521
108	7.01	1.49085	82.3354	17.4012
109	7.1	1.55477	84.7527	-6.36229
110	7.11	1.63524	87.4267	5.26423
111	7.16	1.71688	90.3744	17.5571
112	7.21	1.82501	93.705	30.7154
113	7.25	1.95996	97.5465	44.9251
114	8.02	2.12007	102.041	61.9281
115	8.28	2.40892	107.844	81.874

Data Set Standard Deviation = 0.760172
Numerator = 6703.35
Denominator = 7104.36
W Statistic = 0.943554 = 6703.35 / 7104.36

5% Critical value of 0.976 exceeds 0.943554
Evidence of non-normality at 95% level of significance

Shapiro-Francia Test of Normality
Parameter: pH
Background Locations
Normality Test of Parameter Concentrations
Original Data (Not Transformed)
Total Number of Measurements = 115

i	x(i)	m(i)	sum(m^2)	sum(mx)
1	4.52	-2.40892	5.80292	-10.8883
2	4.66	-2.12007	10.2976	-20.7679
3	4.8	-1.95996	14.1391	-30.1757
4	4.84	-1.82501	17.4697	-39.0087
5	4.88	-1.71688	20.4174	-47.3871
6	4.89	1.63524	23.0914	-55.3834
7	4.92	-1.55477	25.5087	-63.0329
8	4.93	-1.49085	27.7313	-70.3828
9	4.93	-1.42554	29.7635	-77.4107
10	5	-1.36581	31.6289	-84.2397
11	5.06	-1.31652	33.3622	-90.9013
12	5.1	-1.26464	34.9615	-97.351
13	5.11	-1.21596	36.4401	-103.565
14	5.13	-1.17499	37.8206	-109.592
15	5.13	-1.13113	39.1001	-115.395
16	5.15	-1.0939	40.2967	-121.029
17	5.15	-1.05375	41.4071	-126.455
18	5.15	-1.01522	42.4378	-131.684
19	5.16	-0.982202	43.4025	-136.752
20	5.17	-0.946291	44.298	-141.644
21	5.17	-0.911562	45.1289	-146.357
22	5.18	-0.881587	45.9061	-150.924
23	5.18	-0.848786	46.6265	-155.32
24	5.19	-0.820379	47.2996	-159.578
25	5.23	-0.789191	47.9224	-163.706
26	5.24	-0.758753	48.4981	-167.681
27	5.25	-0.732275	49.0343	-171.526
28	5.25	-0.703089	49.5286	-175.217
29	5.25	-0.67449	49.9836	-178.758
30	5.29	-0.649522	50.4055	-182.194
31	5.32	-0.621911	50.7922	-185.503
32	5.32	-0.597761	51.1496	-188.683
33	5.32	-0.570999	51.4756	-191.72
34	5.32	-0.544642	51.7722	-194.618
35	5.32	-0.521527	52.0442	-197.392
36	5.33	-0.49585	52.2901	-200.035
37	5.37	-0.473299	52.5141	-202.577
38	5.37	-0.448213	52.715	-204.984
39	5.4	-0.423405	52.8943	-207.27
40	5.4	-0.401571	53.0555	-209.439
41	5.4	-0.377233	53.1978	-211.476
42	5.41	-0.353118	53.3225	-213.386
43	5.44	-0.331854	53.4326	-215.191
44	5.45	-0.308108	53.5276	-216.871
45	5.46	-0.287147	53.61	-218.438
46	5.47	-0.263715	53.6796	-219.881
47	5.48	-0.240426	53.7374	-221.199
48	5.48	-0.219834	53.7857	-222.403
49	5.49	-0.196779	53.8244	-223.484
50	5.5	-0.173829	53.8546	-224.44
51	5.54	-0.153505	53.8782	-225.29
52	5.54	-0.130716	53.8953	-226.014
53	5.54	-0.110516	53.9075	-226.626
54	5.57	-0.0878447	53.9152	-227.116
55	5.57	-0.0652187	53.9195	-227.479
56	5.6	-0.0451348	53.9215	-227.732
57	5.62	-0.0225612	53.922	-227.859
58	5.63	0	53.922	-227.859
59	5.63	0.0225612	53.9225	-227.732
60	5.64	0.0451348	53.9246	-227.477
61	5.66	0.0652187	53.9288	-227.108
62	5.67	0.0878447	53.9365	-226.61
63	5.74	0.110516	53.9488	-225.975
64	5.86	0.130716	53.9658	-225.209
65	5.94	0.153505	53.9894	-224.298

Rosner's Test for Outliers (Continued)
Parameter: pH
Background Locations
Original Data (Not Transformed)

Iteration i = 3
Mean of 113 measurements = 5.84558
Std Dev = 0.703349
x(i+1) = 4.52 from measurement 10/2/2002 from location B-52
Rosner Statistic R = |4.52 - 5.84558|/0.703349 = 1.88466
Lambda(116, 4, 0.05) = 3.4148
1.88466 < 3.4148 -- No outliers detected for i = 3

Iteration i = 2
Mean of 114 measurements = 5.86465
Std Dev = 0.729244
x(i+1) = 8.02 from measurement 1/7/2004 from location B-50
Rosner Statistic R = |8.02 - 5.86465|/0.729244 = 2.9556
Lambda(116, 3, 0.05) = 3.4216
2.9556 < 3.4216 -- No outliers detected for i = 2

Iteration i = 1
Mean of 115 measurements = 5.88565
Std Dev = 0.760172
x(i+1) = 8.28 from measurement 7/15/2009 from location B-50
Rosner Statistic R = |8.28 - 5.88565|/0.760172 = 3.14974
Lambda(116, 2, 0.05) = 3.4216
3.14974 < 3.4216 -- No outliers detected for i = 1

Iteration i = 0
Mean of 116 measurements = 5.91862
Std Dev = 0.836014
x(i+1) = 9.71 from measurement 7/7/2010 from location B-50
Rosner Statistic R = |9.71 - 5.91862|/0.836014 = 4.53507
Lambda(116, 1, 0.05) = 3.4248
4.53507 > 3.4248 -- Measurement 7/7/2010 for location B-50 is an outlier

1 OUTLIER DETECTED - EXTREME VALUE IDENTIFIED; WILL REMOVE

Rosner's Test for Outliers
Parameter: pH
Background Locations
Original Data (Not Transformed)

Data set mean = 5.91862

10 most extreme of 116 measurements
by order of magnitude difference from the mean

1	7/7/2010	B-50	9.71	3.79138
2	7/15/2009	B-50	8.28	2.36138
3	1/7/2004	B-50	8.02	2.10138
4	10/2/2002	B-52	4.52	-1.39862
5	4/13/2011	B-50	7.25	1.33138
6	7/7/2010	B-52	7.21	1.29138
7	1/8/2003	B-51	4.66	-1.25862
8	11/15/2001	B-50	7.16	1.24138
9	4/7/2004	B-50	7.11	1.19138
10	4/4/2007	B-50	7.1	1.18138

Iteration i = 9
Mean of 107 measurements = 5.81907
Std Dev = 0.651616
x(i+1) = 7.1 from measurement 4/4/2007 from location B-50
Rosner Statistic R = |7.1 - 5.81907|/0.651616 = 1.96578
Lambda(116, 10, 0.05) = 3.398
1.96578 < 3.398 -- No outliers detected for i = 9

Iteration i = 8
Mean of 108 measurements = 5.83102
Std Dev = 0.660352
x(i+1) = 7.11 from measurement 4/7/2004 from location B-50
Rosner Statistic R = |7.11 - 5.83102|/0.660352 = 1.93682
Lambda(116, 9, 0.05) = 3.40136
1.93682 < 3.40136 -- No outliers detected for i = 8

Iteration i = 7
Mean of 109 measurements = 5.84321
Std Dev = 0.669501
x(i+1) = 7.16 from measurement 11/15/2001 from location B-50
Rosner Statistic R = |7.16 - 5.84321|/0.669501 = 1.96682
Lambda(116, 8, 0.05) = 3.40472
1.96682 < 3.40472 -- No outliers detected for i = 7

Iteration i = 6
Mean of 110 measurements = 5.83245
Std Dev = 0.675904
x(i+1) = 4.66 from measurement 1/8/2003 from location B-51
Rosner Statistic R = |4.66 - 5.83245|/0.675904 = 1.73465
Lambda(116, 7, 0.05) = 3.40808
1.73465 < 3.40808 -- No outliers detected for i = 6

Iteration i = 5
Mean of 111 measurements = 5.84486
Std Dev = 0.685411
x(i+1) = 7.21 from measurement 7/7/2010 from location B-52
Rosner Statistic R = |7.21 - 5.84486|/0.685411 = 1.9917
Lambda(116, 6, 0.05) = 3.41144
1.9917 < 3.41144 -- No outliers detected for i = 5

Iteration i = 4
Mean of 112 measurements = 5.85741
Std Dev = 0.695115
x(i+1) = 7.25 from measurement 4/13/2011 from location B-50
Rosner Statistic R = |7.25 - 5.85741|/0.695115 = 2.00339
Lambda(116, 5, 0.05) = 3.4148
2.00339 < 3.4148 -- No outliers detected for i = 4

Concentrations (S.U.) - Continued
Parameter: pH
Original Data (Not Transformed)
Percent Non-Detects: 0%
Total Background Measurements: 116
There are 3 background locations

Loc.	Meas.	ND	Date	Conc.	Original
			10/22/2008	5.5	5.5
			1/13/2009	6.61	6.61
			4/8/2009	5.25	5.25
			7/15/2009	6.44	6.44
			1/7/2010	5.13	5.13
			4/7/2010	5.94	5.94
			7/7/2010	6.42	6.42
			8/16/2011	5.23	5.23
			10/26/2011	5.11	5.11
B-50	42	0 (0%)	11/15/2001	7.16	7.16
			1/16/2002	6.69	6.69
			4/3/2002	6.41	6.41
			7/2/2002	6.37	6.37
			10/2/2002	6.31	6.31
			1/8/2003	6.05	6.05
			4/2/2003	6.82	6.82
			7/23/2003	6.93	6.93
			10/2/2003	6.97	6.97
			1/7/2004	8.02	8.02
			4/7/2004	7.11	7.11
			7/13/2004	6.06	6.06
			10/6/2004	6.37	6.37
			1/6/2005	6.73	6.73
			4/6/2005	6.25	6.25
			7/27/2005	6.67	6.67
			10/13/2005	6.27	6.27
			1/5/2006	6.79	6.79
			4/6/2006	6.7	6.7
			7/25/2006	6.64	6.64
			10/11/2006	7.01	7.01
			1/4/2007	6.83	6.83
			4/4/2007	7.1	7.1
			7/12/2007	6.44	6.44
			10/10/2007	5.94	5.94
			1/16/2008	6.16	6.16
			4/3/2008	6.74	6.74
			7/23/2008	6.48	6.48
			10/22/2008	6.9	6.9
			1/13/2009	6.56	6.56
			4/8/2009	6.81	6.81
			7/15/2009	8.28	8.28
			10/8/2009	6.69	6.69
			1/7/2010	6.57	6.57
			4/7/2010	6.41	6.41
			7/7/2010	9.71	9.71
			12/8/2010	6.49	6.49
			2/3/2011	6.23	6.23
			4/13/2011	7.25	7.25
			8/16/2011	6.86	6.86
			10/26/2011	6.6	6.6
			1/18/2012	6.75	6.75

Concentrations (S.U.)
Parameter: pH
Original Data (Not Transformed)
Percent Non-Detects: 0%
Total Background Measurements: 116
There are 3 background locations

Loc.	Meas.	ND	Date	Conc.	Original
B-52	42	0 (0%)	11/15/2001	5	5
			1/16/2002	5.25	5.25
			4/3/2002	5.64	5.64
			7/2/2002	4.89	4.89
			10/2/2002	4.52	4.52
			1/8/2003	5.4	5.4
			4/2/2003	5.29	5.29
			7/23/2003	5.63	5.63
			10/2/2003	5.49	5.49
			1/7/2004	5.66	5.66
			4/7/2004	5.57	5.57
			7/13/2004	4.92	4.92
			10/6/2004	4.88	4.88
			1/6/2005	6.24	6.24
			4/6/2005	5.63	5.63
			7/27/2005	5.13	5.13
			10/13/2005	5.54	5.54
			1/5/2006	5.32	5.32
			4/6/2006	5.15	5.15
			7/25/2006	5.15	5.15
			10/11/2006	5.54	5.54
			1/4/2007	5.32	5.32
			4/4/2007	5.32	5.32
			7/12/2007	6.01	6.01
			10/10/2007	5.25	5.25
			1/16/2008	5.45	5.45
			4/3/2008	5.6	5.6
			7/23/2008	5.15	5.15
			10/22/2008	5.57	5.57
			1/13/2009	4.84	4.84
			4/8/2009	5.44	5.44
			7/15/2009	6.57	6.57
			10/8/2009	5.47	5.47
			1/7/2010	5.48	5.48
			4/7/2010	6.05	6.05
			7/7/2010	7.21	7.21
			12/8/2010	5.1	5.1
			2/3/2011	5.46	5.46
			4/13/2011	4.93	4.93
			8/16/2011	5.33	5.33
			10/26/2011	4.93	4.93
			1/18/2012	5.24	5.24
B-51	32	0 (0%)	11/15/2001	5.32	5.32
			10/2/2002	4.8	4.8
			1/8/2003	4.66	4.66
			4/2/2003	6.17	6.17
			7/23/2003	5.4	5.4
			10/2/2003	5.67	5.67
			1/7/2004	5.37	5.37
			4/7/2004	5.17	5.17
			7/13/2004	5.17	5.17
			10/6/2004	5.06	5.06
			1/6/2005	5.18	5.18
			4/6/2005	5.41	5.41
			7/27/2005	5.86	5.86
			10/13/2005	5.37	5.37
			1/5/2006	5.16	5.16
			4/6/2006	5.19	5.19
			7/25/2006	5.74	5.74
			10/11/2006	5.54	5.54
			1/4/2007	5.32	5.32
			4/4/2007	5.4	5.4
			7/12/2007	5.18	5.18
			10/10/2007	5.62	5.62
			7/23/2008	5.48	5.48

Non-Parametric Prediction Interval
Inter-Well Comparison
Parameter: Conductivity
Original Data (Not Transformed)

Number of comparisons = 7
Future Samples (k) = **1**
Recent Dates = 1
Background Measurements (n) = 116
Maximum Background Value = 880
Confidence Level = 99%
False Positive Rate = 1%

Location	Date	Count	Mean	Significant
B-30A	4/4/2012	1	459	FALSE
B-32	4/4/2012	1	929	**TRUE**
B 31	4/4/2012	1	51	FALSE
DM 1	4/4/2012	1	651	FALSE
DM-7	4/4/2012	1	57	FALSE
DM-6	4/4/2012	1	90	FALSE
DM-5	4/4/2012	1	702	FALSE

Shapiro-Francia Test of Normality (Continued)
Parameter: Conductivity
Background Locations
Normality Test of Parameter Concentrations
Natural Logarithm Transformation
Total Number of Measurements = 116

i	x(i)	m(i)	sum(m^2)	sum(mx)
66	6.42162	0.163659	54.4516	-236.746
67	6.42487	0.184017	54.4854	-235.564
68	6.42649	0.207012	54.5283	-234.234
69	6.42811	0.227545	54.5801	-232.771
70	6.44095	0.250759	54.643	-231.156
71	6.44889	0.271509	54.7167	-229.405
72	6.48004	0.294992	54.8037	-227.493
73	6.48768	0.316004	54.9036	-225.443
74	6.49979	0.33981	55.019	-223.235
75	6.50429	0.363809	55.1514	-220.868
76	6.50877	0.385321	55.2999	-218.36
77	6.51471	0.409735	55.4677	-215.691
78	6.51767	0.431644	55.6541	-212.878
79	6.52503	0.456542	55.8625	-209.899
80	6.52649	0.478914	56.0918	-206.773
81	6.53379	0.504372	56.3462	-203.478
82	6.53669	0.52728	56.6243	-200.031
83	6.53814	0.553384	56.9305	-196.413
84	6.55108	0.576911	57.2633	-192.634
85	6.55393	0.603765	57.6278	-188.677
86	6.56808	0.631062	58.0261	-184.532
87	6.57647	0.655726	58.4561	-180.219
88	6.57647	0.68396	58.9239	-175.721
89	6.57786	0.709522	59.4273	-171.054
90	6.59987	0.738846	59.9732	-166.178
91	6.59987	0.765456	60.5591	-161.126
92	6.6053	0.796056	61.1928	-155.868
93	6.61338	0.823893	61.8716	-150.419
94	6.61473	0.855996	62.6043	-144.757
95	6.61874	0.885291	63.3881	-138.897
96	6.62007	0.919183	64.233	-132.812
97	6.62007	0.954165	65.1434	-126.496
98	6.62007	0.986272	66.1161	-119.966
99	6.62274	1.02365	67.164	-113.187
100	6.63332	1.05812	68.2836	-106.168
101	6.64249	1.09847	69.4903	-98.8716
102	6.64769	1.1359	70.7805	-91.3205
103	6.65544	1.18	72.1729	-83.4671
104	6.66313	1.22123	73.6643	-75.3299
105	6.66696	1.27024	75.2778	-66.8613
106	6.67077	1.31652	77.011	-58.0791
107	6.69208	1.3722	78.894	-48.8962
108	6.69703	1.4325	80.9461	-39.3026
109	6.70441	1.49085	83.1687	-29.3073
110	6.72623	1.56322	85.6124	-18.7927
111	6.74406	1.63524	88.2864	-7.76463
112	6.74876	1.72793	91.2721	3.89676
113	6.7511	1.82501	94.6027	16.2176
114	6.75344	1.95996	98.4442	29.454
115	6.77537	2.12007	102.939	43.8183
116	6.77992	2.40892	108.742	60.1506

Data Set Standard Deviation = 0.596736
Numerator = 3618.09
Denominator = 4453.07
W Statistic = 0.812495 = 3618.09 / 4453.07

5% Critical value of 0.976 exceeds 0.812495
Evidence of non-normality at 95% level of significance

Shapiro-Francia Test of Normality
Parameter: Conductivity
Background Locations
Normality Test of Parameter Concentrations
Natural Logarithm Transformation
Total Number of Measurements = 116

i	x(i)	m(i)	sum(m^2)	sum(mx)
1	4.06044	-2.40892	5.80292	-9.7813
2	4.68213	-2.12007	10.2976	-19.7077
3	5.07517	-1.95996	14.1391	-29.6549
4	5.20949	-1.82501	17.4697	-39.1627
5	5.20949	-1.72793	20.4554	-48.1639
6	5.22036	-1.63524	23.1294	-56.7004
7	5.22036	-1.56322	25.5731	-64.8609
8	5.22575	-1.49085	27.7957	-72.6518
9	5.23111	-1.4325	29.8478	-80.1453
10	5.25227	-1.3722	31.7308	-87.3525
11	5.26269	-1.31652	33.464	-94.281
12	5.273	-1.27024	35.0775	-100.979
13	5.273	-1.22123	36.5689	-107.418
14	5.273	-1.18	37.9613	-113.641
15	5.27811	-1.1359	39.2515	-119.636
16	5.2832	-1.09847	40.4582	-125.439
17	5.28827	-1.05812	41.5778	-131.035
18	5.28827	-1.02365	42.6257	-136.448
19	5.2933	-0.986272	43.5984	-141.669
20	5.2933	-0.954165	44.5088	-146.72
21	5.29832	-0.919183	45.3537	-151.59
22	5.3033	-0.885291	46.1375	-156.285
23	5.32301	-0.855996	46.8702	-160.841
24	5.32301	-0.823893	47.549	-165.227
25	5.33272	-0.796056	48.1827	-169.472
26	5.33754	-0.765456	48.7686	-173.558
27	5.34233	-0.738846	49.3145	-177.505
28	5.34711	-0.709522	49.8179	-181.299
29	5.37064	-0.68396	50.2857	-184.972
30	5.3845	-0.655726	50.7157	-188.503
31	5.3845	-0.631062	51.114	-191.901
32	5.38907	-0.603765	51.4785	-195.154
33	5.39816	-0.576911	51.8113	-198.269
34	6.03309	-0.553384	52.1175	-201.607
35	6.1334	-0.52728	52.3956	-204.841
36	6.16961	-0.504372	52.65	-207.953
37	6.17379	-0.478914	52.8793	-210.91
38	6.18826	-0.456542	53.0877	-213.735
39	6.19644	-0.431644	53.2741	-216.41
40	6.25383	-0.409735	53.4419	-218.972
41	6.25575	-0.385321	53.5904	-221.383
42	6.2672	-0.363809	53.7228	-223.663
43	6.27288	-0.33981	53.8382	-225.794
44	6.27852	-0.316004	53.9381	-227.778
45	6.28413	-0.294992	54.0251	-229.632
46	6.28786	-0.271509	54.0988	-231.339
47	6.28786	-0.250759	54.1617	-232.916
48	6.28972	-0.227545	54.2135	-234.347
49	6.30262	-0.207012	54.2564	-235.652
50	6.30262	-0.184017	54.2902	-236.812
51	6.30445	-0.163659	54.317	-237.843
52	6.30628	-0.140835	54.3368	-238.732
53	6.3081	-0.12061	54.3514	-239.492
54	6.32436	-0.0979139	54.361	-240.112
55	6.34564	-0.0752698	54.3666	-240.589
56	6.34739	-0.0551734	54.3697	-240.94
57	6.35611	-0.0325917	54.3707	-241.147
58	6.36819	-0.0125328	54.3709	-241.227
59	6.37332	0.0125328	54.3711	-241.147
60	6.37673	0.0325917	54.3721	-240.939
61	6.40192	0.0551734	54.3752	-240.586
62	6.41017	0.0752698	54.3808	-240.103
63	6.41017	0.0979139	54.3904	-239.475
64	6.41673	0.12061	54.405	-238.702
65	6.41999	0.140835	54.4248	-237.797

Shapiro-Francia Test of Normality (Continued)

Parameter: Conductivity
Background Locations
Normality Test of Parameter Concentrations
Original Data (Not Transformed)
Total Number of Measurements = 116

i	x(i)	m(i)	sum(m^2)	sum(mx)
66	615	0.163659	54.4516	-10030.1
67	617	0.184017	54.4854	-9916.6
68	618	0.207012	54.5283	-9788.66
69	619	0.227545	54.5801	-9647.81
70	627	0.250759	54.643	-9490.59
71	632	0.271509	54.7167	-9318.99
72	652	0.294992	54.8037	-9126.66
73	657	0.316004	54.9036	-8919.04
74	665	0.33981	55.019	-8693.07
75	668	0.363809	55.1514	-8450.04
76	671	0.385321	55.2999	-8191.49
77	675	0.409735	55.4677	-7914.92
78	677	0.431644	55.6541	-7622.7
79	682	0.456542	55.8625	-7311.34
80	683	0.478914	56.0918	-6984.24
81	688	0.504372	56.3462	-6637.23
82	690	0.52728	56.6243	-6273.41
83	691	0.553384	56.9305	-5891.02
84	700	0.576911	57.2633	-5487.18
85	702	0.603765	57.6278	-5063.34
86	712	0.631062	58.0261	-4614.02
87	718	0.655726	58.4561	-4143.21
88	718	0.68396	58.9239	-3652.13
89	719	0.709522	59.4273	-3141.98
90	735	0.738846	59.9732	-2598.93
91	735	0.765456	60.5591	-2036.32
92	739	0.796056	61.1928	-1448.04
93	745	0.823893	61.8716	-834.236
94	746	0.855996	62.6043	-195.663
95	749	0.885291	63.3881	467.42
96	750	0.919183	64.233	1156.81
97	750	0.954165	65.1434	1872.43
98	750	0.986272	66.1161	2612.13
99	752	1.02365	67.164	3381.92
100	760	1.05812	68.2836	4186.09
101	767	1.09847	69.4903	5028.62
102	771	1.1359	70.7805	5904.4
103	777	1.18	72.1729	6821.26
104	783	1.22123	73.6643	7777.48
105	786	1.27024	75.2778	8775.88
106	789	1.31652	77.011	9814.62
107	806	1.3722	78.894	10920.6
108	810	1.4325	80.9461	12080.9
109	816	1.49085	83.1687	13297.5
110	834	1.56322	85.6124	14601.2
111	849	1.63524	88.2864	15989.5
112	853	1.72793	91.2721	17463.4
113	855	1.82501	94.6027	19023.8
114	857	1.95996	98.4442	20703.5
115	876	2.12007	102.939	22560.7
116	880	2.40892	108.742	24680.5

Data Set Standard Deviation = 233.335
Numerator = 6.09129e+008
Denominator = 6.80855e+008
W Statistic = 0.894653 = 6.09129e+008 / 6.80855e+008

5% Critical value of 0.976 exceeds 0.894653
Evidence of non-normality at 95% level of significance

Shapiro-Francia Test of Normality
Parameter: Conductivity
Background Locations
Normality Test of Parameter Concentrations
Original Data (Not Transformed)
Total Number of Measurements = 116

i	x(i)	m(i)	sum(m^2)	sum(mx)
1	58	-2.40892	5.80292	-139.718
2	108	-2.12007	10.2976	-368.685
3	160	-1.95996	14.1391	-682.279
4	183	-1.82501	17.4697	-1016.25
5	183	-1.72793	20.4554	-1332.47
6	185	-1.63524	23.1294	-1634.98
7	185	-1.56322	25.5731	-1924.18
8	186	-1.49085	27.7957	-2201.48
9	187	-1.4325	29.8478	-2469.36
10	191	-1.3722	31.7308	-2731.45
11	193	-1.31652	33.464	-2985.54
12	195	-1.27024	35.0775	-3233.23
13	195	-1.22123	36.5689	-3471.37
14	195	-1.18	37.9613	-3701.47
15	196	-1.1359	39.2515	-3924.11
16	197	-1.09847	40.4582	-4140.51
17	198	-1.05812	41.5778	-4350.02
18	198	-1.02365	42.6257	-4552.7
19	199	-0.986272	43.5984	-4748.97
20	199	-0.954165	44.5088	-4938.85
21	200	-0.919183	45.3537	-5122.68
22	201	-0.885291	46.1375	-5300.63
23	205	-0.855996	46.8702	-5476.1
24	205	-0.823893	47.549	-5645
25	207	-0.796056	48.1827	-5809.79
26	208	-0.765456	48.7686	-5969
27	209	-0.738846	49.3145	-6123.42
28	210	-0.709522	49.8179	-6272.42
29	215	-0.68396	50.2857	-6419.47
30	218	-0.655726	50.7157	-6562.42
31	218	-0.631062	51.114	-6699.99
32	219	-0.603765	51.4785	-6832.22
33	221	-0.576911	51.8113	-6959.71
34	417	-0.553384	52.1175	-7190.47
35	461	-0.52728	52.3956	-7433.55
36	478	-0.504372	52.65	-7674.64
37	480	-0.478914	52.8793	-7904.52
38	487	-0.456542	53.0877	-8126.85
39	491	-0.431644	53.2741	-8338.79
40	520	-0.409735	53.4419	-8551.85
41	521	-0.385321	53.5904	-8752.61
42	527	-0.363809	53.7228	-8944.33
43	530	-0.33981	53.8382	-9124.43
44	533	-0.316004	53.9381	-9292.86
45	536	-0.294992	54.0251	-9450.98
46	538	-0.271509	54.0988	-9597.05
47	538	-0.250759	54.1617	-9731.96
48	539	-0.227545	54.2135	-9854.61
49	546	-0.207012	54.2564	-9967.63
50	546	-0.184017	54.2902	-10068.1
51	547	-0.163659	54.317	-10157.6
52	548	-0.140835	54.3368	-10234.8
53	549	-0.12061	54.3514	-10301
54	558	-0.0979139	54.361	-10355.7
55	570	-0.0752698	54.3666	-10398.6
56	571	-0.0551734	54.3697	-10430.1
57	576	-0.0325917	54.3707	-10448.8
58	583	-0.0125328	54.3709	-10456.1
59	586	0.0125328	54.3711	-10448.8
60	588	0.0325917	54.3721	-10429.6
61	603	0.0551734	54.3752	-10396.4
62	608	0.0752698	54.3808	-10350.6
63	608	0.0979139	54.3904	-10291.1
64	612	0.12061	54.405	-10217.3
65	614	0.140835	54.4248	-10130.8

Rosner's Test for Outliers (Continued)
Parameter: Conductivity
Background Locations
Original Data (Not Transformed)

Iteration i = 3
Mean of 113 measurements = 538.283
Std Dev = 225.923
x(i+1) = 880 from measurement 4/3/2002 from location B-50
Rosner Statistic R = |880 - 538.283|/225.923 = 1.51254
Lambda(116, 4, 0.05) = 3.4148
1.51254 < 3.4148 -- No outliers detected for i = 3

Iteration i = 2
Mean of 114 measurements = 534.965
Std Dev = 227.694
x(i+1) = 160 from measurement 1/4/2007 from location B-51
Rosner Statistic R = |160 - 534.965|/227.694 = 1.64679
Lambda(116, 3, 0.05) = 3.4216
1.64679 < 3.4216 -- No outliers detected for i = 2

Iteration i = 1
Mean of 115 measurements = 531.252
Std Dev = 230.163
x(i+1) = 108 from measurement 4/2/2003 from location B-50
Rosner Statistic R = |108 - 531.252|/230.163 = 1.83892
Lambda(116, 2, 0.05) = 3.4216
1.83892 < 3.4216 -- No outliers detected for i = 1

Iteration i = 0
Mean of 116 measurements = 527.172
Std Dev = 233.335
x(i+1) = 58 from measurement 10/2/2003 from location B-51
Rosner Statistic R = |58 - 527.172|/233.335 = 2.01072
Lambda(116, 1, 0.05) = 3.4248
2.01072 < 3.4248 -- No outliers detected for i = 0

NO OUTLIERS DETECTED

Rosner's Test for Outliers
Parameter: Conductivity
Background Locations
Original Data (Not Transformed)

Data set mean = 527.172

10 most extreme of 116 measurements
by order of magnitude difference from the mean

1	10/2/2003	B-51	58	-469.172
2	4/2/2003	B-50	108	-419.172
3	1/4/2007	B-51	160	-367.172
4	4/3/2002	B-50	880	352.828
5	10/13/2005	B-52	876	348.828
6	8/16/2011	B-51	183	-344.172
7	4/6/2005	B-51	183	344.172
8	4/2/2003	B-51	185	-342.172
9	4/4/2007	B-51	185	-342.172
10	1/7/2010	B-51	186	-341.172

Iteration i = 9
Mean of 107 measurements = 545.178
Std Dev = 216.722
x(i+1) = 186 from measurement 1/7/2010 from location B-51
Rosner Statistic R = |186 - 545.178|/216.722 = 1.65732
Lambda(116, 10, 0.05) = 3.398
1.65732 < 3.398 -- No outliers detected for i = 9

Iteration i = 8
Mean of 108 measurements = 541.843
Std Dev = 218.473
x(i+1) = 185 from measurement 4/4/2007 from location B-51
Rosner Statistic R = |185 - 541.843|/218.473 = 1.63335
Lambda(116, 9, 0.05) = 3.40136
1.63335 < 3.40136 -- No outliers detected for i = 8

Iteration i = 7
Mean of 109 measurements = 538.569
Std Dev = 220.129
x(i+1) = 185 from measurement 4/2/2003 from location B-51
Rosner Statistic R = |185 - 538.569|/220.129 = 1.60619
Lambda(116, 8, 0.05) = 3.40472
1.60619 < 3.40472 -- No outliers detected for i = 7

Iteration i = 6
Mean of 110 measurements = 535.336
Std Dev = 221.724
x(i+1) = 183 from measurement 4/6/2005 from location B-51
Rosner Statistic R = |183 - 535.336|/221.724 = 1.58908
Lambda(116, 7, 0.05) = 3.40808
1.58908 < 3.40808 -- No outliers detected for i = 6

Iteration i = 5
Mean of 111 measurements = 532.162
Std Dev = 223.233
x(i+1) = 183 from measurement 8/16/2011 from location B-51
Rosner Statistic R = |183 - 532.162|/223.233 = 1.56411
Lambda(116, 6, 0.05) = 3.41144
1.56411 < 3.41144 -- No outliers detected for i = 5

Iteration i = 4
Mean of 112 measurements = 535.232
Std Dev = 224.588
x(i+1) = 876 from measurement 10/13/2005 from location B-52
Rosner Statistic R = |876 - 535.232|/224.588 = 1.5173
Lambda(116, 5, 0.05) = 3.4148
1.5173 < 3.4148 -- No outliers detected for i = 4

Concentrations (umhos) - Continued
Parameter: Conductivity
Original Data (Not Transformed)
Percent Background Non-Detects: 0%
Total Background Measurements: 116
There are 3 background locations

Loc.	Meas.	ND	Date	Conc.	Original
			10/22/2008	195	195
			1/13/2009	195	195
			4/8/2009	191	191
			7/15/2009	198	198
			1/7/2010	186	186
			4/7/2010	198	198
			7/7/2010	208	208
			8/16/2011	183	183
			10/26/2011	197	197
B-50	42	0 (0%)	11/15/2001	816	816
			1/16/2002	857	857
			4/3/2002	880	880
			7/2/2002	735	735
			10/2/2002	810	810
			1/8/2003	849	849
			4/2/2003	108	108
			7/23/2003	806	806
			10/2/2003	750	750
			1/7/2004	834	834
			4/7/2004	783	783
			7/13/2004	855	855
			10/6/2004	767	767
			1/6/2005	760	760
			4/6/2005	786	786
			7/27/2005	750	750
			10/13/2005	789	789
			1/5/2006	752	752
			4/6/2006	749	749
			7/25/2006	735	735
			10/11/2006	750	750
			1/4/2007	777	777
			4/4/2007	746	746
			7/12/2007	718	718
			10/10/2007	718	718
			1/16/2008	677	677
			4/3/2008	691	691
			7/23/2008	668	668
			10/22/2008	683	683
			1/13/2009	671	671
			4/8/2009	688	688
			7/15/2009	617	617
			10/8/2009	608	608
			1/7/2010	682	682
			4/7/2010	700	700
			7/7/2010	652	652
			12/8/2010	619	619
			2/3/2011	586	586
			4/13/2011	614	614
			8/16/2011	608	608
			10/26/2011	618	618
			1/18/2012	612	612

Concentrations (umhos)
Parameter: Conductivity
Original Data (Not Transformed)
Percent Background Non-Detects: 0%
Total Background Measurements: 116
There are 3 background locations

Loc.	Meas.	ND	Date	Conc.	Original
B-52	42	0 (0%)	11/15/2001	461	461
			1/16/2002	570	570
			4/3/2002	615	615
			7/2/2002	480	480
			10/2/2002	547	547
			1/8/2003	627	627
			4/2/2003	417	417
			7/23/2003	487	487
			10/2/2003	771	771
			1/7/2004	530	530
			4/7/2004	739	739
			7/13/2004	533	533
			10/6/2004	536	536
			1/6/2005	745	745
			4/6/2005	538	538
			7/27/2005	520	520
			10/13/2005	876	876
			1/5/2006	558	558
			4/6/2006	546	546
			7/25/2006	588	588
			10/11/2006	853	853
			1/4/2007	712	712
			4/4/2007	576	576
			7/12/2007	478	478
			10/10/2007	632	632
			1/16/2008	549	549
			4/3/2008	571	571
			7/23/2008	538	538
			10/22/2008	527	527
			1/13/2009	548	548
			4/8/2009	546	546
			7/15/2009	690	690
			10/8/2009	491	491
			1/7/2010	665	665
			4/7/2010	719	719
			7/7/2010	521	521
			12/8/2010	539	539
			2/3/2011	583	583
			4/13/2011	603	603
			8/16/2011	675	675
			10/26/2011	657	657
			1/18/2012	702	702
B-51	32	0 (0%)	11/15/2001	205	205
			10/2/2002	200	200
			1/8/2003	219	219
			4/2/2003	185	185
			7/23/2003	209	209
			10/2/2003	58	58
			1/7/2004	193	193
			4/7/2004	195	195
			7/13/2004	218	218
			10/6/2004	199	199
			1/6/2005	207	207
			4/6/2005	183	183
			7/27/2005	218	218
			10/13/2005	221	221
			1/5/2006	201	201
			4/6/2006	215	215
			7/25/2006	199	199
			10/11/2006	205	205
			1/4/2007	160	160
			4/4/2007	185	185
			7/12/2007	187	187
			10/10/2007	196	196
			7/23/2008	210	210

Non-Parametric Prediction Interval
Inter-Well Comparison
Parameter: Total Hardness
Original Data (Not Transformed)

Number of comparisons = 7
Future Samples (k) = 1
Recent Dates = 1
Background Measurements (n) = 116
Maximum Background Value = 453
Confidence Level = 99%
False Positive Rate = 1%

Location	Date	Count	Mean	Significant
B-30A	4/4/2012	1	133.38	FALSE
B-32	4/4/2012	1	418.95	FALSE
B-31	4/4/2012	1	10.26	FALSE
DM-1	4/4/2012	1	201.78	FALSE
DM-7	4/4/2012	1	13.68	FALSE
DM-6	4/4/2012	1	3.42	FALSE
DM-5	4/4/2012	1	367.65	FALSE

Shapiro-Francia Test of Normality (Continued)
Parameter: Total Hardness
Background Locations
Normality Test of Parameter Concentrations
Natural Logarithm Transformation
Total Number of Measurements = 116

i	x(i)	m(i)	sum(m^2)	sum(mx)
66	5.63636	0.163659	54.4516	-177.3
67	5.63636	0.184017	54.4854	-176.263
68	5.63636	0.207012	54.5283	-175.096
69	5.64848	0.227545	54.5801	-173.81
70	5.66046	0.250759	54.643	-172.391
71	5.66046	0.271509	54.7167	-170.854
72	5.66046	0.294992	54.8037	-169.184
73	5.67229	0.316004	54.9036	-167.392
74	5.67229	0.33981	55.019	-165.464
75	5.67229	0.363809	55.1514	-163.401
76	5.67229	0.385321	55.2999	-161.215
77	5.67229	0.409735	55.4677	-158.891
78	5.67229	0.431644	55.6541	-156.443
79	5.68399	0.456542	55.8625	-153.848
80	5.69555	0.478914	56.0918	-151.12
81	5.70128	0.504372	56.3462	-148.244
82	5.70698	0.52728	56.6243	-145.235
83	5.72945	0.553384	56.9305	-142.065
84	5.72945	0.576911	57.2633	-138.759
85	5.75143	0.603765	57.6278	-135.287
86	5.75143	0.631062	58.0261	-131.657
87	5.76224	0.655726	58.4561	-127.879
88	5.77294	0.68396	58.9239	-123.93
89	5.78352	0.709522	59.4273	-119.827
90	5.79399	0.738846	59.9732	-115.546
91	5.79399	0.765456	60.5591	-111.111
92	5.81461	0.796056	61.1928	-106.482
93	5.82476	0.823893	61.8716	-101.683
94	5.83481	0.855996	62.6043	-96.6885
95	5.83481	0.885291	63.3881	-91.523
96	5.83481	0.919183	64.233	-86.1597
97	5.83481	0.954165	65.1434	-80.5924
98	5.83481	0.986272	66.1161	-74.8377
99	5.83481	1.02365	67.164	-68.8648
100	5.83481	1.05812	68.2836	-62.6909
101	5.83481	1.09847	69.4903	-56.2815
102	5.83481	1.1359	70.7805	-49.6538
103	5.83481	1.18	72.1729	-42.7687
104	5.83481	1.22123	73.6643	-35.6431
105	5.84476	1.27024	75.2778	-28.2189
106	5.8595	1.31652	77.011	-20.5047
107	5.8595	1.3722	78.894	-12.4643
108	5.89779	1.4325	80.9461	-4.01566
109	5.90247	1.49085	83.1687	4.78405
110	5.91177	1.56322	85.6124	14.0255
111	5.92557	1.63524	88.2864	23.7152
112	5.93012	1.72793	91.2721	33.962
113	5.95259	1.82501	94.6027	44.8255
114	6.01713	1.95996	98.4442	56.6189
115	6.07776	2.12007	102.939	69.5041
116	6.11589	2.40892	108.742	84.2368

Data Set Standard Deviation = 0.861824
Numerator = 7095.84
Denominator = 9288.2
W Statistic = 0.763964 = 7095.84 / 9288.2

5% Critical value of 0.976 exceeds 0.763964
Evidence of non-normality at 95% level of significance

Shapiro-Francia Test of Normality
Parameter: Total Hardness
Background Locations
Normality Test of Parameter Concentrations
Natural Logarithm Transformation
Total Number of Measurements = 116

i	x(i)	m(i)	sum(m^2)	sum(mx)
1	3.48093	-2.40892	5.80292	-8.3853
2	3.48093	-2.12007	10.2976	-15.7651
3	3.53223	-1.95996	14.1391	-22.6881
4	3.53223	-1.82501	17.4697	-29.1345
5	3.58102	-1.72793	20.4554	-35.3222
6	3.58102	-1.63524	23.1294	-41.178
7	3.58102	-1.56322	25.5731	-46.7759
8	3.62754	-1.49085	27.7957	-52.1841
9	3.62754	-1.4325	29.8478	-57.3805
10	3.67199	1.3722	31.7308	-62.4192
11	3.67199	-1.31652	33.464	-67.2535
12	3.67199	-1.27024	35.0775	-71.9178
13	3.71455	-1.22123	36.5689	-76.4541
14	3.71455	-1.18	37.9613	-80.8373
15	3.75537	-1.1359	39.2515	-85.103
16	3.75537	-1.09847	40.4582	-89.2281
17	3.75537	-1.05812	41.5778	-93.2018
18	3.79459	-1.02365	42.6257	-97.0861
19	3.79459	-0.986272	43.5984	-100.829
20	3.83233	-0.954165	44.5088	-104.485
21	3.83233	-0.919183	45.3537	-108.008
22	3.83233	-0.885291	46.1375	-111.401
23	3.8687	-0.855996	46.8702	-114.712
24	3.8687	-0.823893	47.549	-117.9
25	3.90379	-0.796056	48.1827	-121.007
26	3.90379	-0.765456	48.7686	-123.995
27	4.00223	0.738846	49.3145	-126.952
28	4.09184	-0.709522	49.8179	-129.856
29	4.12001	-0.68396	50.2857	-132.674
30	4.22537	-0.655726	50.7157	-135.444
31	4.27416	-0.631062	51.114	-138.142
32	4.85398	-0.603765	51.4785	-141.072
33	5.10084	-0.576911	51.8113	-144.015
34	5.25499	-0.553384	52.1175	-146.923
35	5.28137	-0.52728	52.3956	-149.708
36	5.29867	-0.504372	52.65	-152.38
37	5.34568	-0.478914	52.8793	-154.94
38	5.35677	-0.456542	53.0877	-157.386
39	5.35677	-0.431644	53.2741	-159.698
40	5.36481	-0.409735	53.4419	-161.896
41	5.38852	-0.385321	53.5904	-163.973
42	5.38852	-0.363809	53.7228	-165.933
43	5.39631	-0.33981	53.8382	-167.767
44	5.43433	-0.316004	53.9381	-169.484
45	5.44915	-0.294992	54.0251	-171.091
46	5.44915	-0.271509	54.0988	-172.571
47	5.47814	-0.250759	54.1617	-173.945
48	5.47814	-0.227545	54.2135	-175.191
49	5.51323	-0.207012	54.2564	-176.333
50	5.5201	-0.184017	54.2902	-177.348
51	5.53371	-0.163659	54.317	-178.254
52	5.54713	-0.140835	54.3368	-179.035
53	5.54713	-0.12061	54.3514	-179.704
54	5.54713	-0.0979139	54.361	-180.247
55	5.56037	-0.0752698	54.3666	-180.666
56	5.57348	-0.0551734	54.3697	-180.973
57	5.58635	-0.0325917	54.3707	-181.155
58	5.59274	-0.0125328	54.3709	-181.226
59	5.59909	0.0125328	54.3711	-181.155
60	5.61167	0.0325917	54.3721	-180.972
61	5.61167	0.0551734	54.3752	-180.663
62	5.61167	0.0752698	54.3808	-180.24
63	5.61167	0.0979139	54.3904	-179.691
64	5.61167	0.12061	54.405	-179.014
65	5.62409	0.140835	54.4248	-178.222

Shapiro-Francia Test of Normality (Continued)

Parameter: Total Hardness
Background Locations
Normality Test of Parameter Concentrations
Original Data (Not Transformed)
Total Number of Measurements = 116

i	x(i)	m(i)	sum(m^2)	sum(mx)
66	280.44	0.163659	54.4516	-3049.22
67	280.44	0.184017	54.4854	-2997.62
68	280.44	0.207012	54.5283	-2939.56
69	283.86	0.227545	54.5801	-2874.97
70	287.28	0.250759	54.643	-2802.93
71	287.28	0.271509	54.7167	-2724.94
72	287.28	0.294992	54.8037	-2640.19
73	290.7	0.316004	54.9036	-2548.33
74	290.7	0.33981	55.019	-2449.55
75	290.7	0.363809	55.1514	-2343.79
76	290.7	0.385321	55.2999	-2231.77
77	290.7	0.409735	55.4677	-2112.66
78	290.7	0.431644	55.6541	-1987.18
79	294.12	0.456542	55.8625	-1852.91
80	297.54	0.478914	56.0918	-1710.41
81	299.25	0.504372	56.3462	-1559.48
82	300.96	0.52728	56.6243	-1400.79
83	307.8	0.553384	56.9305	-1230.45
84	307.8	0.576911	57.2633	-1052.88
85	314.64	0.603765	57.6278	-862.913
86	314.64	0.631062	58.0261	-664.356
87	318.06	0.655726	58.4561	-455.796
88	321.48	0.68396	58.9239	-235.916
89	324.9	0.709522	59.4273	-5.39239
90	328.32	0.738846	59.9732	237.186
91	328.32	0.765456	60.5591	488.5
92	335.16	0.796056	61.1928	755.306
93	338.58	0.823893	61.8716	1034.26
94	342	0.855996	62.6043	1327.01
95	342	0.885291	63.3881	1629.78
96	342	0.919183	64.233	1944.14
97	342	0.954165	65.1434	2270.46
98	342	0.986272	66.1161	2607.77
99	342	1.02365	67.164	2957.86
100	342	1.05812	68.2836	3319.74
101	342	1.09847	69.4903	3695.41
102	342	1.1359	70.7805	4083.89
103	342	1.18	72.1729	4487.45
104	342	1.22123	73.6643	4905.11
105	345.42	1.27024	75.2778	5343.87
106	350.55	1.31652	77.011	5805.38
107	350.55	1.3722	78.894	6286.41
108	364.23	1.4325	80.9461	6808.17
109	365.94	1.49085	83.1687	7353.73
110	369.36	1.56322	85.6124	7931.12
111	374.49	1.63524	88.2864	8543.5
112	376.2	1.72793	91.2721	9193.55
113	384.75	1.82501	94.6027	9895.72
114	410.4	1.95996	98.4442	10700.1
115	436.05	2.12007	102.939	11624.5
116	453	2.40892	108.742	12715.8

Data Set Standard Deviation = 121.228
Numerator = 1.61691e+008
Denominator = 1.83782e+008
W Statistic = 0.879798 = 1.61691e+008 / 1.83782e+008

5% Critical value of 0.976 exceeds 0.879798
Evidence of non-normality at 95% level of significance

Shapiro-Francia Test of Normality
Parameter: Total Hardness
Background Locations
Normality Test of Parameter Concentrations
Original Data (Not Transformed)
Total Number of Measurements = 116

i	x(i)	m(i)	sum(m^2)	sum(mx)
1	32.49	-2.40892	5.80292	-78.2659
2	32.49	-2.12007	10.2976	-147.147
3	34.2	-1.95996	14.1391	-214.178
4	34.2	-1.82501	17.4697	-276.593
5	35.91	-1.72793	20.4554	-338.643
6	35.91	-1.63524	23.1294	-397.364
7	35.91	-1.56322	25.5731	-453.499
8	37.62	-1.49085	27.7957	-509.585
9	37.62	-1.4325	29.8478	-563.476
10	39.33	-1.3722	31.7308	-617.445
11	39.33	-1.31652	33.464	-669.224
12	39.33	-1.27024	35.0775	-719.182
13	41.04	-1.22123	36.5689	-769.301
14	41.04	-1.18	37.9613	-817.729
15	42.75	-1.1359	39.2515	-866.288
16	42.75	-1.09847	40.4582	-913.248
17	42.75	-1.05812	41.5778	-958.482
18	44.46	-1.02365	42.6257	-1003.99
19	44.46	-0.986272	43.5984	-1047.84
20	46.17	-0.954165	44.5088	-1091.9
21	46.17	-0.919183	45.3537	-1134.34
22	46.17	-0.885291	46.1375	-1175.21
23	47.88	-0.855996	46.8702	-1216.19
24	47.88	-0.823893	47.549	-1255.64
25	49.59	-0.796056	48.1827	-1295.12
26	49.59	-0.765456	48.7686	-1333.08
27	54.72	-0.738846	49.3145	-1373.51
28	59.85	-0.709522	49.8179	-1415.97
29	61.56	-0.68396	50.2857	-1458.08
30	68.4	-0.655726	50.7157	-1502.93
31	71.82	-0.631062	51.114	-1548.25
32	128.25	-0.603765	51.4785	-1625.68
33	164.16	-0.576911	51.8113	-1720.39
34	191.52	-0.553384	52.1175	-1826.37
35	196.64	-0.52728	52.3956	-1930.06
36	200.07	-0.504372	52.65	-2030.97
37	209.7	-0.478914	52.8793	-2131.4
38	212.04	-0.456542	53.0877	-2228.2
39	212.04	-0.431644	53.2741	-2319.73
40	213.75	-0.409735	53.4419	-2407.31
41	218.88	-0.385321	53.5904	-2491.65
42	218.88	-0.363809	53.7228	-2571.28
43	220.59	-0.33981	53.8382	-2646.24
44	229.14	-0.316004	53.9381	-2718.65
45	232.56	-0.294992	54.0251	-2787.25
46	232.56	-0.271509	54.0988	-2850.39
47	239.4	-0.250759	54.1617	-2910.42
48	239.4	-0.227545	54.2135	-2964.9
49	247.95	-0.207012	54.2564	-3016.23
50	249.66	-0.184017	54.2902	-3062.17
51	253.08	-0.163659	54.317	-3103.59
52	256.5	-0.140835	54.3368	-3139.71
53	256.5	-0.12061	54.3514	-3170.65
54	256.5	-0.0979139	54.361	-3195.76
55	259.92	-0.0752698	54.3666	-3215.33
56	263.35	-0.0551734	54.3697	-3229.86
57	266.76	-0.0325917	54.3707	-3238.55
58	268.47	-0.0125328	54.3709	-3241.92
59	270.18	0.0125328	54.3711	-3238.53
60	273.6	0.0325917	54.3721	-3229.61
61	273.6	0.0551734	54.3752	-3214.52
62	273.6	0.0752698	54.3808	-3193.92
63	273.6	0.0979139	54.3904	-3167.13
64	273.6	0.12061	54.405	-3134.14
65	277.02	0.140835	54.4248	-3095.12

Rosner's Test for Outliers (Continued)
Parameter: Total Hardness
Background Locations
Original Data (Not Transformed)

Iteration i = 3
Mean of 113 measurements = 224.08
Std Dev = 117.89
x(i+1) = 32.49 from measurement 10/11/2006 from location B-51
Rosner Statistic R = |32.49 - 224.08|/117.89 = 1.62516
Lambda(116, 4, 0.05) = 3.4148
1.62516 < 3.4148 -- No outliers detected for i = 3

Iteration i = 2
Mean of 114 measurements = 222.399
Std Dev = 118.731
x(i+1) = 32.49 from measurement 1/7/2010 from location B-51
Rosner Statistic R = |32.49 - 222.399|/118.731 = 1.5995
Lambda(116, 3, 0.05) = 3.4216
1.5995 < 3.4216 -- No outliers detected for i = 2

Iteration i = 1
Mean of 115 measurements = 224.257
Std Dev = 119.876
x(i+1) = 436.05 from measurement 4/3/2002 from location B-50
Rosner Statistic R = |436.05 - 224.257|/119.876 = 1.76677
Lambda(116, 2, 0.05) = 3.4216
1.76677 < 3.4216 -- No outliers detected for i = 1

Iteration i = 0
Mean of 116 measurements = 226.229
Std Dev = 121.228
x(i+1) = 453 from measurement 7/2/2002 from location B-50
Rosner Statistic R = |453 - 226.229|/121.228 = 1.87061
Lambda(116, 1, 0.05) = 3.4248
1.87061 < 3.4248 No outliers detected for i = 0

NO OUTLIERS DETECTED

Rosner's Test for Outliers
Parameter: Total Hardness
Background Locations
Original Data (Not Transformed)

Data set mean = 226.229

10 most extreme of 116 measurements
by order of magnitude difference from the mean

1	7/2/2002	B-50	453	226.771
2	4/3/2002	B-50	436.05	209.821
3	1/7/2010	B-51	32.49	-193.739
4	10/11/2006	B-51	32.49	-193.739
5	4/2/2003	B-51	34.2	-192.029
6	7/7/2010	B-51	34.2	-192.029
7	4/7/2010	B-51	35.91	-190.319
8	4/8/2009	B-51	35.91	-190.319
9	7/23/2003	B-51	35.91	-190.319
10	1/5/2006	B-51	37.62	-188.609

Iteration i = 9
Mean of 107 measurements = 234.696
Std Dev = 111.992
x(i+1) = 37.62 from measurement 1/5/2006 from location B-51
Rosner Statistic R = |37.62 - 234.696|/111.992 = 1.75973
Lambda(116, 10, 0.05) = 3.398
1.75973 < 3.398 -- No outliers detected for i = 9

Iteration i = 8
Mean of 108 measurements = 232.855
Std Dev = 113.097
x(i+1) = 35.91 from measurement 7/23/2003 from location B-51
Rosner Statistic R = |35.91 - 232.855|/113.097 = 1.74138
Lambda(116, 9, 0.05) = 3.40136
1.74138 < 3.40136 -- No outliers detected for i = 8

Iteration i = 7
Mean of 109 measurements = 231.048
Std Dev = 114.142
x(i+1) = 35.91 from measurement 4/8/2009 from location B-51
Rosner Statistic R = |35.91 - 231.048|/114.142 = 1.70962
Lambda(116, 8, 0.05) = 3.40472
1.70962 < 3.40472 -- No outliers detected for i = 7

Iteration i = 6
Mean of 110 measurements = 229.274
Std Dev = 115.13
x(i+1) = 35.91 from measurement 4/7/2010 from location B-51
Rosner Statistic R = |35.91 - 229.274|/115.13 = 1.67953
Lambda(116, 7, 0.05) = 3.40808
1.67953 < 3.40808 -- No outliers detected for i = 6

Iteration i = 5
Mean of 111 measurements = 227.517
Std Dev = 116.092
x(i+1) = 34.2 from measurement 7/7/2010 from location B-51
Rosner Statistic R = |34.2 - 227.517|/116.092 = 1.66521
Lambda(116, 6, 0.05) = 3.41144
1.66521 < 3.41144 -- No outliers detected for i = 5

Iteration i = 4
Mean of 112 measurements = 225.791
Std Dev = 117.002
x(i+1) = 34.2 from measurement 4/2/2003 from location B-51
Rosner Statistic R = |34.2 - 225.791|/117.002 = 1.6375
Lambda(116, 5, 0.05) = 3.4148
1.6375 < 3.4148 -- No outliers detected for i = 4

Concentrations (mg/L) - Continued
Parameter: Total Hardness
Original Data (Not Transformed)
Percent Background Non-Detects: 0%
Total Background Measurements: 116
There are 3 background locations

Loc.	Meas.	ND	Date	Conc.	Original
			10/22/2008	61.56	61.56
			1/13/2009	37.62	37.62
			4/8/2009	35.91	35.91
			7/15/2009	44.46	44.46
			1/7/2010	32.49	32.49
			4/7/2010	35.91	35.91
			7/7/2010	34.2	34.2
			8/16/2011	39.33	39.33
			10/26/2011	49.59	49.59
B-50	42	0 (0%)	11/15/2001	290.7	290.7
			1/16/2002	384.75	384.75
			4/3/2002	436.05	436.05
			7/2/2002	453	453
			10/2/2002	342	342
			1/8/2003	410.4	410.4
			4/2/2003	342	342
			7/23/2003	342	342
			10/2/2003	338.58	338.58
			1/7/2004	342	342
			4/7/2004	350.55	350.55
			7/13/2004	342	342
			10/6/2004	342	342
			1/6/2005	318.06	318.06
			4/6/2005	328.32	328.32
			7/27/2005	342	342
			10/13/2005	321.48	321.48
			1/5/2006	350.55	350.55
			4/6/2006	342	342
			7/25/2006	314.64	314.64
			10/11/2006	376.2	376.2
			1/4/2007	342	342
			4/4/2007	335.16	335.16
			7/12/2007	328.32	328.32
			10/10/2007	342	342
			1/16/2008	307.8	307.8
			4/3/2008	294.12	294.12
			7/23/2008	324.9	324.9
			10/22/2008	273.6	273.6
			1/13/2009	287.28	287.28
			4/8/2009	290.7	290.7
			7/15/2009	290.7	290.7
			10/8/2009	263.35	263.35
			1/7/2010	280.44	280.44
			4/7/2010	287.28	287.28
			7/7/2010	277.02	277.02
			12/8/2010	299.25	299.25
			2/3/2011	253.08	253.08
			4/13/2011	256.5	256.5
			8/16/2011	273.6	273.6
			10/26/2011	273.6	273.6
			1/18/2012	270.18	270.18

Concentrations (mg/L)
Parameter: Total Hardness
Original Data (Not Transformed)
Percent Background Non-Detects: 0%
Total Background Measurements: 116
There are 3 background locations

Loc.	Meas.	ND	Date	Conc.	Original
B-52	42	0 (0%)	11/15/2001	164.16	164.16
			1/16/2002	213.75	213.75
			4/3/2002	239.4	239.4
			7/2/2002	364.23	364.23
			10/2/2002	374.49	374.49
			1/8/2003	342	342
			4/2/2003	345.42	345.42
			7/23/2003	369.36	369.36
			10/2/2003	191.52	191.52
			1/7/2004	268.47	268.47
			4/7/2004	220.59	220.59
			7/13/2004	232.56	232.56
			10/6/2004	287.28	287.28
			1/6/2005	232.56	232.56
			4/6/2005	290.7	290.7
			7/27/2005	365.94	365.94
			10/13/2005	307.8	307.8
			1/5/2006	256.5	256.5
			4/6/2006	280.44	280.44
			7/25/2006	300.96	300.96
			10/11/2006	249.66	249.66
			1/4/2007	200.07	200.07
			4/4/2007	297.54	297.54
			7/12/2007	229.14	229.14
			10/10/2007	247.95	247.95
			1/16/2008	209.7	209.7
			4/3/2008	266.76	266.76
			7/23/2008	218.88	218.88
			10/22/2008	212.04	212.04
			1/13/2009	212.04	212.04
			4/8/2009	314.64	314.64
			7/15/2009	196.64	196.64
			10/8/2009	273.6	273.6
			1/7/2010	290.7	290.7
			4/7/2010	280.44	280.44
			7/7/2010	283.86	283.86
			12/8/2010	290.7	290.7
			2/3/2011	256.5	256.5
			4/13/2011	273.6	273.6
			8/16/2011	259.92	259.92
			10/26/2011	218.88	218.88
			1/18/2012	239.4	239.4
B-51	32	0 (0%)	11/15/2001	128.25	128.25
			10/2/2002	54.72	54.72
			1/8/2003	47.88	47.88
			4/2/2003	34.2	34.2
			7/23/2003	35.91	35.91
			10/2/2003	41.04	41.04
			1/7/2004	46.17	46.17
			4/7/2004	41.04	41.04
			7/13/2004	42.75	42.75
			10/6/2004	42.75	42.75
			1/6/2005	39.33	39.33
			4/6/2005	42.75	42.75
			7/27/2005	46.17	46.17
			10/13/2005	49.59	49.59
			1/5/2006	37.62	37.62
			4/6/2006	68.4	68.4
			7/25/2006	47.88	47.88
			10/11/2006	32.49	32.49
			1/4/2007	46.17	46.17
			4/4/2007	44.46	44.46
			7/12/2007	39.33	39.33
			10/10/2007	71.82	71.82
			7/23/2008	59.85	59.85

Non-Parametric Prediction Interval
Inter-Well Comparison
Parameter: Total Dissolved Solids (TDS)
Original Data (Not Transformed)

Number of comparisons = 7
Future Samples (k) = 1
Recent Dates = 1
Background Measurements (n) = 116
Maximum Background Value = 805
Confidence Level = 99%
False Positive Rate = 1%

Location	Date	Count	Mean	Significant
B-30A	4/4/2012	1	185.5	FALSE
B-32	4/4/2012	1	597	FALSE
B-31	4/4/2012	1	43.5	FALSE
DM-1	4/4/2012	1	393.5	FALSE
DM-7	4/4/2012	1	91	FALSE
DM-6	4/4/2012	1	96	FALSE
DM-5	4/4/2012	1	437.5	FALSE

Shapiro-Francia Test of Normality (Continued)
Parameter: Total Dissolved Solids (TDS)
Background Locations
Normality Test of Parameter Concentrations
Natural Logarithm Transformation
Total Number of Measurements = 116

i	x(i)	m(i)	sum(m^2)	sum(mx)
66	6.04501	0.163659	54.4516	-224.945
67	6.05678	0.184017	54.4854	-223.831
68	6.05912	0.207012	54.5283	-222.577
69	6.06611	0.227545	54.5801	-221.196
70	6.06958	0.250759	54.643	-219.674
71	6.08222	0.271509	54.7167	-218.023
72	6.08222	0.294992	54.8037	-216.229
73	6.08677	0.316004	54.9036	-214.305
74	6.09018	0.33981	55.019	-212.236
75	6.09582	0.363809	55.1514	-210.018
76	6.10032	0.385321	55.2999	-207.667
77	6.10032	0.409735	55.4677	-205.168
78	6.10144	0.431644	55.6541	-202.534
79	6.11147	0.456542	55.8625	-199.744
80	6.11368	0.478914	56.0918	-196.816
81	6.12249	0.504372	56.3462	-193.728
82	6.12468	0.52728	56.6243	-190.499
83	6.14204	0.553384	56.9305	-187.1
84	6.14526	0.576911	57.2633	-183.555
85	6.1506	0.603765	57.6278	-179.841
86	6.16856	0.631062	58.0261	-175.948
87	6.17379	0.655726	58.4561	-171.9
88	6.18312	0.68396	58.9239	-167.671
89	6.18724	0.709522	59.4273	-163.281
90	6.22059	0.738846	59.9732	-158.685
91	6.22456	0.765456	60.5591	-153.92
92	6.24222	0.796056	61.1928	-148.951
93	6.2432	0.823893	61.8716	-143.807
94	6.2519	0.855996	62.6043	-138.456
95	6.26435	0.885291	63.3881	-132.91
96	6.27004	0.919183	64.233	-127.147
97	6.27382	0.954165	65.1434	-121.16
98	6.28133	0.986272	66.1161	-114.965
99	6.29249	1.02365	67.164	-108.524
100	6.31173	1.05812	68.2836	-101.845
101	6.31626	1.09847	69.4903	-94.9072
102	6.32972	1.1359	70.7805	-87.7173
103	6.32972	1.18	72.1729	-80.2483
104	6.35089	1.22123	73.6643	-72.4924
105	6.3699	1.27024	75.2778	-64.4011
106	6.3894	1.31652	77.011	-55.9893
107	6.39359	1.3722	78.894	-47.216
108	6.41673	1.4325	80.9461	-38.024
109	6.44889	1.49085	83.1687	-28.4097
110	6.4708	1.56322	85.6124	-18.2944
111	6.47928	1.63524	88.2864	-7.69923
112	6.53669	1.72793	91.2721	3.59572
113	6.58064	1.82501	94.6027	15.6054
114	6.62007	1.95996	98.4442	28.5805
115	6.64379	2.12007	102.939	42.6658
116	6.69084	2.40892	108.742	58.7835

Data Set Standard Deviation = 0.550578
Numerator = 3455.5
Denominator = 3790.81
W Statistic = 0.911547 = 3455.5 / 3790.81

5% Critical value of 0.976 exceeds 0.911547
Evidence of non-normality at 95% level of significance

Shapiro-Francia Test of Normality
Parameter: Total Dissolved Solids (TDS)
Background Locations
Normality Test of Parameter Concentrations
Natural Logarithm Transformation
Total Number of Measurements = 116

i	x(i)	m(i)	sum(m^2)	sum(mx)
1	3.95124	-2.40892	5.80292	-9.51825
2	4.62006	-2.12007	10.2976	-19.3131
3	4.62986	-1.95996	14.1391	-28.3874
4	4.67563	-1.82501	17.4697	-36.9205
5	4.7185	-1.72793	20.4554	-45.0737
6	4.82028	-1.63524	23.1294	-52.956
7	4.84024	-1.56322	25.5731	-60.5224
8	4.85593	-1.49085	27.7957	67.7619
9	4.8752	-1.4325	29.8478	-74.7456
10	4.89035	-1.3722	31.7308	-81.4562
11	4.90527	-1.31652	33.464	-87.9141
12	4.94521	-1.27024	35.0775	-94.1956
13	4.96494	-1.22123	36.5689	-100.259
14	4.99043	-1.18	37.9613	-106.148
15	4.99383	-1.1359	39.2515	-111.82
16	5.04343	-1.09847	40.4582	-117.36
17	5.046	-1.05812	41.5778	-122.699
18	5.05943	-1.02365	42.6257	-127.879
19	5.12694	-0.986272	43.5984	-132.935
20	5.16479	-0.954165	44.5088	-137.863
21	5.16764	-0.919183	45.3537	-142.613
22	5.20401	-0.885291	46.1375	-147.22
23	5.20401	-0.855996	46.8702	-151.675
24	5.21494	-0.823893	47.549	-155.971
25	5.22036	0.796056	48.1827	-160.127
26	5.23111	-0.765456	48.7686	-164.131
27	5.24175	-0.738846	49.3145	-168.004
28	5.26786	-0.709522	49.8179	-171.742
29	5.29832	0.68396	50.2857	-175.366
30	5.45959	-0.655726	50.7157	-178.946
31	5.53733	-0.631062	51.114	-182.44
32	5.60396	-0.603765	51.4785	-185.824
33	5.64368	-0.576911	51.8113	-189.079
34	5.68358	-0.553384	52.1175	-192.225
35	5.69709	-0.52728	52.3956	-195.229
36	5.70378	-0.504372	52.65	-198.105
37	5.78074	-0.478914	52.8793	-200.874
38	5.78843	-0.456542	53.0877	-203.517
39	5.79301	-0.431644	53.2741	-206.017
40	5.81264	-0.409735	53.4419	-208.399
41	5.81413	-0.385321	53.5904	-210.639
42	5.8186	-0.363809	53.7228	-212.756
43	5.82747	-0.33981	53.8382	-214.736
44	5.83188	-0.316004	53.9381	-216.579
45	5.84932	-0.294992	54.0251	-218.305
46	5.86079	-0.271509	54.0988	-219.896
47	5.86363	-0.250759	54.1617	-221.366
48	5.88332	-0.227545	54.2135	-222.705
49	5.89302	-0.207012	54.2564	-223.925
50	5.8999	-0.184017	54.2902	-225.01
51	5.8999	-0.163659	54.317	-225.976
52	5.92559	-0.140835	54.3368	-226.811
53	5.94673	-0.12061	54.3514	-227.528
54	5.95324	-0.0979139	54.361	-228.111
55	5.96615	-0.0752698	54.3666	-228.56
56	5.98015	-0.0551734	54.3697	-228.89
57	5.98268	-0.0325917	54.3707	-229.085
58	5.98519	-0.0125328	54.3709	-229.16
59	5.99396	0.0125328	54.3711	-229.085
60	5.99894	0.0325917	54.3721	-228.889
61	6.01859	0.0551734	54.3752	-228.557
62	6.02102	0.0752698	54.3808	-228.104
63	6.02102	0.0979139	54.3904	-227.514
64	6.04025	0.12061	54.405	-226.786
65	6.04263	0.140835	54.4248	-225.935

Shapiro-Francia Test of Normality (Continued)
Parameter: Total Dissolved Solids (TDS)
Background Locations
Normality Test of Parameter Concentrations
Original Data (Not Transformed)
Total Number of Measurements = 116

i	x(i)	m(i)	sum(m^2)	sum(mx)
66	422	0.163659	54.4516	-7582.49
67	427	0.184017	54.4854	-7503.91
68	428	0.207012	54.5283	-7415.31
69	431	0.227545	54.5801	-7317.24
70	432.5	0.250759	54.643	-7208.79
71	438	0.271509	54.7167	-7089.87
72	438	0.294992	54.8037	-6960.66
73	440	0.316004	54.9036	-6821.62
74	441.5	0.33981	55.019	-6671.59
75	444	0.363809	55.1514	-6510.06
76	446	0.385321	55.2999	-6338.21
77	446	0.409735	55.4677	-6155.47
78	446.5	0.431644	55.6541	-5962.74
79	451	0.456542	55.8625	-5756.84
80	452	0.478914	56.0918	-5540.37
81	456	0.504372	56.3462	-5310.37
82	457	0.52728	56.6243	-5069.41
83	465	0.553384	56.9305	-4812.08
84	466.5	0.576911	57.2633	-4542.95
85	469	0.603765	57.6278	-4259.79
86	477.5	0.631062	58.0261	-3958.46
87	480	0.655726	58.4561	-3643.71
88	484.5	0.68396	58.9239	-3312.33
89	486.5	0.709522	59.4273	-2967.15
90	503	0.738846	59.9732	-2595.51
91	505	0.765456	60.5591	-2208.95
92	514	0.796056	61.1928	-1799.78
93	514.5	0.823893	61.8716	-1375.89
94	519	0.855996	62.6043	-931.624
95	525.5	0.885291	63.3881	-466.404
96	528.5	0.919183	64.233	19.3848
97	530.5	0.954165	65.1434	525.569
98	534.5	0.986272	66.1161	1052.73
99	540.5	1.02365	67.164	1606.02
100	551	1.05812	68.2836	2189.04
101	553.5	1.09847	69.4903	2797.04
102	561	1.1359	70.7805	3434.28
103	561	1.18	72.1729	4096.26
104	573	1.22123	73.6643	4796.03
105	584	1.27024	75.2778	5537.84
106	595.5	1.31652	77.011	6321.83
107	598	1.3722	78.894	7142.41
108	612	1.4325	80.9461	8019.1
109	632	1.49085	83.1687	8961.32
110	646	1.56322	85.6124	9971.16
111	651.5	1.63524	88.2864	11036.5
112	690	1.72793	91.2721	12228.8
113	721	1.82501	94.6027	13544.6
114	750	1.95996	98.4442	15014.6
115	768	2.12007	102.939	16642.8
116	805	2.40892	108.742	18582

Data Set Standard Deviation = 168.374
Numerator = 3.4529e+008
Denominator = 3.54523e+008
W Statistic = 0.973956 = 3.4529e+008 / 3.54523e+008

5% Critical value of 0.976 exceeds 0.973956
Evidence of non-normality at 95% level of significance

Shapiro-Francia Test of Normality
Parameter: Total Dissolved Solids (TDS)
Background Locations
Normality Test of Parameter Concentrations
Original Data (Not Transformed)
Total Number of Measurements = 116

i	x(i)	m(i)	sum(m^2)	sum(mx)
1	52	-2.40892	5.80292	-125.264
2	101.5	-2.12007	10.2976	-340.451
3	102.5	-1.95996	14.1391	-541.347
4	107.3	-1.82501	17.4697	-737.17
5	112	-1.72793	20.4554	-930.698
6	124	-1.63524	23.1294	-1133.47
7	126.5	-1.56322	25.5731	-1331.22
8	128.5	-1.49085	27.7957	-1522.79
9	131	-1.4325	29.8478	-1710.45
10	133	-1.3722	31.7308	-1892.95
11	135	-1.31652	33.464	-2070.68
12	140.5	-1.27024	35.0775	-2249.15
13	143.3	-1.22123	36.5689	-2424.15
14	147	-1.18	37.9613	-2597.61
15	147.5	-1.1359	39.2515	-2765.16
16	155	-1.09847	40.4582	-2935.42
17	155.4	-1.05812	41.5778	-3099.85
18	157.5	-1.02365	42.6257	-3261.08
19	168.5	-0.986272	43.5984	-3427.26
20	175	-0.954165	44.5088	-3594.24
21	175.5	-0.919183	45.3537	-3755.56
22	182	-0.885291	46.1375	-3916.68
23	182	-0.855996	46.8702	-4072.47
24	184	-0.823893	47.549	-4224.07
25	185	-0.796056	48.1827	-4371.34
26	187	-0.765456	48.7686	-4514.48
27	189	-0.738846	49.3145	-4654.12
28	194	-0.709522	49.8179	-4791.77
29	200	-0.68396	50.2857	-4928.56
30	235	-0.655726	50.7157	-5082.66
31	254	-0.631062	51.114	-5242.95
32	271.5	-0.603765	51.4785	-5406.87
33	282.5	-0.576911	51.8113	-5569.85
34	294	-0.553384	52.1175	-5732.54
35	298	-0.52728	52.3956	-5889.67
36	300	-0.504372	52.65	-6040.98
37	324	-0.478914	52.8793	-6196.15
38	326.5	-0.456542	53.0877	-6345.21
39	328	-0.431644	53.2741	-6486.79
40	334.5	-0.409735	53.4419	-6623.85
41	335	-0.385321	53.5904	-6752.93
42	336.5	-0.363809	53.7228	-6875.35
43	339.5	-0.33981	53.8382	-6990.72
44	341	-0.316004	53.9381	-7098.47
45	347	-0.294992	54.0251	-7200.84
46	351	-0.271509	54.0988	-7296.14
47	352	-0.250759	54.1617	-7384.4
48	359	-0.227545	54.2135	-7466.09
49	362.5	-0.207012	54.2564	-7541.13
50	365	-0.184017	54.2902	-7608.3
51	365	-0.163659	54.317	-7668.04
52	374.5	-0.140835	54.3368	-7720.78
53	382.5	-0.12061	54.3514	-7766.91
54	385	-0.0979139	54.361	-7804.61
55	390	-0.0752698	54.3666	-7833.96
56	395.5	-0.0551734	54.3697	-7855.78
57	396.5	-0.0325917	54.3707	-7868.71
58	397.5	-0.0125328	54.3709	-7873.69
59	401	0.0125328	54.3711	-7868.66
60	403	0.0325917	54.3721	-7855.53
61	411	0.0551734	54.3752	-7832.85
62	412	0.0752698	54.3808	-7801.84
63	412	0.0979139	54.3904	-7761.5
64	420	0.12061	54.405	-7710.84
65	421	0.140835	54.4248	-7651.55

Rosner's Test for Outliers (Continued)
Parameter: Total Dissolved Solids (TDS)
Background Locations
Original Data (Not Transformed)

Iteration i = 3
Mean of 113 measurements = 368.093
Std Dev = 157.445
x(i+1) = 721 from measurement 4/6/2006 from location B-52
Rosner Statistic R = |721 - 368.093|/157.445 = 2.24146
Lambda(116, 4, 0.05) = 3.4148
2.24146 < 3.4148 -- No outliers detected for i = 3

Iteration i = 2
Mean of 114 measurements = 371.443
Std Dev = 160.776
x(i+1) = 750 from measurement 4/6/2005 from location B-52
Rosner Statistic R = |750 - 371.443|/160.776 = 2.35456
Lambda(116, 3, 0.05) = 3.4216
2.35456 < 3.4216 -- No outliers detected for i = 2

Iteration i = 1
Mean of 115 measurements = 374.891
Std Dev = 164.286
x(i+1) = 768 from measurement 7/25/2006 from location B-52
Rosner Statistic R = |768 - 374.891|/164.286 = 2.39284
Lambda(116, 2, 0.05) = 3.4216
2.39284 < 3.4216 -- No outliers detected for i = 1

Iteration i = 0
Mean of 116 measurements = 378.599
Std Dev = 168.374
x(i+1) = 805 from measurement 1/6/2005 from location B-52
Rosner Statistic R = |805 - 378.599|/168.374 = 2.53246
Lambda(116, 1, 0.05) = 3.4248
2.53246 < 3.4248 -- No outliers detected for i = 0

NO OUTLIERS DETECTED

Rosner's Test for Outliers
Parameter: Total Dissolved Solids (TDS)
Background Locations
Original Data (Not Transformed)

Data set mean = 378.599

10 most extreme of 116 measurements
by order of magnitude difference from the mean

1	1/6/2005	B-52	805	426.401
2	7/25/2006	B-52	768	389.401
3	4/6/2005	B-52	750	371.401
4	4/6/2006	B-52	721	342.401
5	4/4/2007	B-51	52	-326.599
6	7/13/2004	B-52	690	311.401
7	7/25/2006	B-51	101.5	-277.099
8	1/13/2009	B-51	102.5	-276.099
9	7/27/2005	B-52	651.5	272.901
10	4/8/2009	B-51	107.3	-271.299

Iteration i = 9
Mean of 107 measurements = 367.065
Std Dev = 144.922
x(i+1) = 107.3 from measurement 4/8/2009 from location B-51
Rosner Statistic R = |107.3 - 367.065|/144.922 = 1.79245
Lambda(116, 10, 0.05) = 3.398
1.79245 < 3.398 -- No outliers detected for i = 9

Iteration i = 8
Mean of 108 measurements = 369.699
Std Dev = 146.817
x(i+1) = 651.5 from measurement 7/27/2005 from location B-52
Rosner Statistic R = |651.5 - 369.699|/146.817 = 1.91941
Lambda(116, 9, 0.05) = 3.40136
1.91941 < 3.40136 -- No outliers detected for i = 8

Iteration i = 7
Mean of 109 measurements = 367.248
Std Dev = 148.359
x(i+1) = 102.5 from measurement 1/13/2009 from location B-51
Rosner Statistic R = |102.5 - 367.248|/148.359 = 1.7845
Lambda(116, 8, 0.05) = 3.40472
1.7845 < 3.40472 -- No outliers detected for i = 7

Iteration i = 6
Mean of 110 measurements = 364.832
Std Dev = 149.835
x(i+1) = 101.5 from measurement 7/25/2006 from location B-51
Rosner Statistic R = |101.5 - 364.832|/149.835 = 1.75748
Lambda(116, 7, 0.05) = 3.40808
1.75748 < 3.40808 -- No outliers detected for i = 6

Iteration i = 5
Mean of 111 measurements = 367.761
Std Dev = 152.312
x(i+1) = 690 from measurement 7/13/2004 from location B-52
Rosner Statistic R = |690 - 367.761|/152.312 = 2.11564
Lambda(116, 6, 0.05) = 3.41144
2.11564 < 3.41144 -- No outliers detected for i = 5

Iteration i = 4
Mean of 112 measurements = 364.942
Std Dev = 154.532
x(i+1) = 52 from measurement 4/4/2007 from location B-51
Rosner Statistic R = |52 - 364.942|/154.532 = 2.02509
Lambda(116, 5, 0.05) = 3.4148
2.02509 < 3.4148 -- No outliers detected for i = 4

Concentrations (mg/L) - Continued
Parameter: Total Dissolved Solids (TDS)
Original Data (Not Transformed)
Percent Background Non-Detects: 0%
Total Background Measurements: 116
There are 3 background locations

Loc.	Meas.	ND	Date	Conc.	Original
			10/22/2008	294	294
			1/13/2009	102.5	102.5
			4/8/2009	107.3	107.3
			7/15/2009	282.5	282.5
			1/7/2010	143.3	143.3
			4/7/2010	155.4	155.4
			7/7/2010	184	184
			8/16/2011	128.5	128.5
			10/26/2011	112	112
B-50	42	0 (0%)	11/15/2001	452	452
			1/16/2002	457	457
			4/3/2002	401	401
			7/2/2002	428	428
			10/2/2002	446	446
			1/8/2003	446.5	446.5
			4/2/2003	432.5	432.5
			7/23/2003	451	451
			10/2/2003	505	505
			1/7/2004	254	254
			4/7/2004	484.5	484.5
			7/13/2004	427	427
			10/6/2004	446	446
			1/6/2005	438	438
			4/6/2005	135	135
			7/27/2005	385	385
			10/13/2005	420	420
			1/5/2006	412	412
			4/6/2006	422	422
			7/25/2006	395.5	395.5
			10/11/2006	403	403
			1/4/2007	421	421
			4/4/2007	397.5	397.5
			7/12/2007	412	412
			10/10/2007	362.5	362.5
			1/16/2008	374.5	374.5
			4/3/2008	365	365
			7/23/2008	411	411
			10/22/2008	365	365
			1/13/2009	334.5	334.5
			4/8/2009	352	352
			7/15/2009	326.5	326.5
			10/8/2009	339.5	339.5
			1/7/2010	324	324
			4/7/2010	351	351
			7/7/2010	336.5	336.5
			12/8/2010	465	465
			2/3/2011	347	347
			4/13/2011	382.5	382.5
			8/16/2011	328	328
			10/26/2011	298	298
			1/18/2012	300	300

Concentrations (mg/L)
Parameter: Total Dissolved Solids (TDS)
Original Data (Not Transformed)
Percent Background Non-Detects: 0%
Total Background Measurements: 116
There are 3 background locations

Loc.	Meas.	ND	Date	Conc.	Original
B-52	42	0 (0%)	11/15/2001	271.5	271.5
			1/16/2002	480	480
			4/3/2002	486.5	486.5
			7/2/2002	534.5	534.5
			10/2/2002	598	598
			1/8/2003	440	440
			4/2/2003	514	514
			7/23/2003	519	519
			10/2/2003	456	456
			1/7/2004	584	584
			4/7/2004	573	573
			7/13/2004	690	690
			10/6/2004	612	612
			1/6/2005	805	805
			4/6/2005	750	750
			7/27/2005	651.5	651.5
			10/13/2005	503	503
			1/5/2006	632	632
			4/6/2006	721	721
			7/25/2006	768	768
			10/11/2006	438	438
			1/4/2007	561	561
			4/4/2007	514.5	514.5
			7/12/2007	477.5	477.5
			10/10/2007	390	390
			1/16/2008	396.5	396.5
			4/3/2008	551	551
			7/23/2008	553.5	553.5
			10/22/2008	530.5	530.5
			1/13/2009	335	335
			4/8/2009	469	469
			7/15/2009	444	444
			10/8/2009	540.5	540.5
			1/7/2010	431	431
			4/7/2010	561	561
			7/7/2010	595.5	595.5
			17/8/2010	341	341
			2/3/2011	528.5	528.5
			4/13/2011	646	646
			8/16/2011	525.5	525.5
			10/26/2011	359	359
			1/18/2012	466.5	466.5
B-51	32	0 (0%)	11/15/2001	126.5	126.5
			10/2/2002	157.5	157.5
			1/8/2003	168.5	168.5
			4/2/2003	124	124
			7/23/2003	140.5	140.5
			10/2/2003	185	185
			1/7/2004	131	131
			4/7/2004	175.5	175.5
			7/13/2004	182	182
			10/6/2004	187	187
			1/6/2005	200	200
			4/6/2005	441.5	441.5
			7/27/2005	189	189
			10/13/2005	182	182
			1/5/2006	147.5	147.5
			4/6/2006	175	175
			7/25/2006	101.5	101.5
			10/11/2006	147	147
			1/4/2007	133	133
			4/4/2007	52	52
			7/12/2007	194	194
			10/10/2007	155	155
			7/23/2008	235	235

Non-Parametric Prediction Interval
Inter-Well Comparison
Parameter: Sulfate
Original Data (Not Transformed)

Number of comparisons = 7
Future Samples (k) = 1
Recent Dates = 1
Background Measurements (n) = 116
Maximum Background Value = 439.51
Confidence Level = 99%
False Positive Rate = 1%

Location	Date	Count	Mean	Significant
B-30A	4/4/2012	1	0.3	FALSE
B-32	4/4/2012	1	238.89	FALSE
B-31	4/4/2012	1	5.55	FALSE
DM-1	4/4/2012	1	234.85	FALSE
DM-7	4/4/2012	1	11.75	FALSE
DM-6	4/4/2012	1	7.08	FALSE
DM-5	4/4/2012	1	146.25	FALSE

Shapiro-Francia Test of Normality (Continued)

Parameter: Sulfate
Background Locations
Normality Test of Parameter Concentrations
Natural Logarithm Transformation
Total Number of Measurements = 116

i	x(i)	m(i)	sum(m^2)	sum(mx)
66	3.94951	0.163659	54.4516	-149.197
67	3.99489	0.184017	54.4854	-148.462
68	4.01458	0.207012	54.5283	-147.631
69	4.04323	0.227545	54.5801	-146.711
70	4.06354	0.250759	54.643	-145.692
71	4.07889	0.271509	54.7167	-144.585
72	4.10446	0.294992	54.8037	-143.374
73	4.14393	0.316004	54.9036	-142.065
74	4.32281	0.33981	55.019	-140.596
75	5.23692	0.363809	55.1514	-138.69
76	5.24976	0.385321	55.2999	-136.668
77	5.27413	0.409735	55.4677	-134.507
78	5.30866	0.431644	55.6541	-132.215
79	5.3272	0.456542	55.8625	-129.783
80	5.36584	0.478914	56.0918	-127.213
81	5.41801	0.504372	56.3462	-124.481
82	5.42477	0.52728	56.6243	-121.62
83	5.43525	0.553384	56.9305	-118.612
84	5.44397	0.576911	57.2633	-115.472
85	5.44889	0.603765	57.6278	-112.182
86	5.49417	0.631062	58.0261	-108.715
87	5.50065	0.655726	58.4561	-105.108
88	5.51383	0.68396	58.9239	-101.337
89	5.52454	0.709522	59.4273	-97.4167
90	5.52824	0.738846	59.9732	-93.3322
91	5.52875	0.765456	60.5591	-89.1002
92	5.55853	0.796056	61.1928	-84.6753
93	5.56685	0.823893	61.8716	-80.0888
94	5.57811	0.855996	62.6043	-75.314
95	5.60488	0.885291	63.3881	-70.352
96	5.61502	0.919183	64.233	-65.1908
97	5.64255	0.954165	65.1434	-59.8069
98	5.66494	0.986272	66.1161	-54.2197
99	5.68017	1.02365	67.164	-48.4052
100	5.68096	1.05812	68.2836	-42.394
101	5.71518	1.09847	69.4903	-36.1161
102	5.72919	1.1359	70.7805	-29.6083
103	5.75149	1.18	72.1729	-22.8216
104	5.75637	1.22123	73.6643	-15.7917
105	5.76353	1.27024	75.2778	-8.47067
106	5.76751	1.31652	77.011	-0.877622
107	5.83053	1.3722	78.894	7.12306
108	5.83968	1.4325	80.9461	15.4884
109	5.85252	1.49085	83.1687	24.2137
110	5.87796	1.56322	85.6124	33.4022
111	5.89123	1.63524	88.2864	43.0358
112	5.9125	1.72793	91.2721	53.2522
113	5.94657	1.82501	94.6027	64.1047
114	5.96781	1.95996	98.4442	75.8014
115	6.00566	2.12007	102.939	88.5338
116	6.08566	2.40892	108.742	103.194

Data Set Standard Deviation = 1.01884
Numerator = 10648.9
Denominator = 12981
W Statistic = 0.82035 = 10648.9 / 12981

5% Critical value of 0.976 exceeds 0.82035
Evidence of non-normality at 95% level of significance

Shapiro-Francia Test of Normality
Parameter: Sulfate
Background Locations
Normality Test of Parameter Concentrations
Natural Logarithm Transformation
Total Number of Measurements = 116

i	x(i)	m(i)	sum(m^2)	sum(mx)
1	3.168	-2.40892	5.80292	-7.63148
2	3.23475	-2.12007	10.2976	-14.4894
3	3.24415	-1.95996	14.1391	-20.8478
4	3.25154	-1.82501	17.4697	-26.7819
5	3.26576	-1.72793	20.4554	-32.4249
6	3.27526	-1.63524	23.1294	-37.7807
7	3.28989	-1.56322	25.5731	-42.9235
8	3.2988	-1.49085	27.7957	-47.8415
9	3.2988	-1.4325	29.8478	-52.5671
10	3.30285	-1.3722	31.7308	-57.0993
11	3.31091	-1.31652	33.464	-61.4581
12	3.31491	-1.27024	35.0775	-65.6689
13	3.32719	-1.22123	36.5689	-69.7321
14	3.33113	-1.18	37.9613	-73.6629
15	3.33149	-1.1359	39.2515	-77.4471
16	3.33256	-1.09847	40.4582	-81.1078
17	3.33328	-1.05812	41.5778	-84.6348
18	3.33613	-1.02365	42.6257	-88.0498
19	3.33968	-0.986272	43.5984	-91.3437
20	3.3418	-0.954165	44.5088	-94.5323
21	3.34392	-0.919183	45.3537	-97.606
22	3.34815	-0.885291	46.1375	-100.57
23	3.35201	-0.855996	46.8702	-103.439
24	3.3728	-0.823893	47.549	-106.218
25	3.37348	-0.796056	48.1827	-108.904
26	3.37656	-0.765456	48.7686	-111.488
27	3.37929	-0.738846	49.3145	-113.985
28	3.38031	-0.709522	49.8179	-116.383
29	3.38031	-0.68396	50.2857	-118.695
30	3.38507	-0.655726	50.7157	-120.915
31	3.38507	-0.631062	51.114	-123.051
32	3.39618	-0.603765	51.4785	-125.102
33	3.40983	-0.576911	51.8113	-127.069
34	3.46292	-0.553384	52.1175	-128.985
35	3.4886	-0.52728	52.3956	-130.825
36	3.49134	-0.504372	52.65	-132.586
37	3.5476	-0.478914	52.8793	-134.285
38	3.55392	-0.456542	53.0877	-135.907
39	3.56048	-0.431644	53.2741	-137.444
40	3.57487	-0.409735	53.4419	-138.909
41	3.58712	-0.385321	53.5904	-140.291
42	3.61281	-0.363809	53.7228	-141.605
43	3.63521	-0.33981	53.8382	-142.841
44	3.6504	-0.316004	53.9381	-143.994
45	3.66407	-0.294992	54.0251	-145.075
46	3.67021	-0.271509	54.0988	-146.072
47	3.69337	-0.250759	54.1617	-146.998
48	3.6961	-0.227545	54.2135	-147.839
49	3.7281	-0.207012	54.2564	-148.611
50	3.73457	-0.184017	54.2902	-149.298
51	3.74266	-0.163659	54.317	-149.91
52	3.75185	-0.140835	54.3368	-150.439
53	3.75887	-0.12061	54.3514	-150.892
54	3.76073	-0.0979139	54.361	-151.26
55	3.781	-0.0752698	54.3666	-151.545
56	3.78191	-0.0551734	54.3697	-151.754
57	3.78986	-0.0325917	54.3707	-151.877
58	3.80844	-0.0125328	54.3709	-151.925
59	3.80977	0.0125328	54.3711	-151.877
60	3.86199	0.0325917	54.3721	-151.751
61	3.86912	0.0551734	54.3752	-151.538
62	3.87888	0.0752698	54.3808	-151.246
63	3.88547	0.0979139	54.3904	-150.865
64	3.89264	0.12061	54.405	-150.396
65	3.919	0.140835	54.4248	-149.844

Shapiro-Francia Test of Normality (Continued)
Parameter: Sulfate
Background Locations
Normality Test of Parameter Concentrations
Original Data (Not Transformed)
Total Number of Measurements = 116

i	x(i)	m(i)	sum(m^2)	sum(mx)
66	51.91	0.163659	54.4516	-1270.12
67	54.32	0.184017	54.4854	-1260.13
68	55.4	0.207012	54.5283	-1248.66
69	57.01	0.227545	54.5801	-1235.69
70	58.18	0.250759	54.643	-1221.1
71	59.08	0.271509	54.7167	-1205.06
72	60.61	0.294992	54.8037	-1187.18
73	63.05	0.316004	54.9036	-1167.25
74	75.4	0.33981	55.019	-1141.63
75	188.09	0.363809	55.1514	-1073.2
76	190.52	0.385321	55.2999	-999.792
77	195.22	0.409735	55.4677	-919.804
78	202.08	0.431644	55.6541	-832.577
79	205.86	0.456542	55.8625	-738.593
80	213.97	0.478914	56.0918	-636.12
81	225.43	0.504372	56.3462	-522.42
82	226.96	0.52728	56.6243	-402.748
83	229.35	0.553384	56.9305	-275.829
84	231.36	0.576911	57.2633	-142.355
85	232.5	0.603765	57.6278	-1.9801
86	243.27	0.631062	58.0261	151.538
87	244.85	0.655726	58.4561	312.093
88	248.1	0.68396	58.9239	481.784
89	250.77	0.709522	59.4273	659.71
90	251.7	0.738846	59.9732	845.678
91	251.83	0.765456	60.5591	1038.44
92	259.44	0.796056	61.1928	1244.97
93	261.61	0.823893	61.8716	1460.51
94	264.57	0.855996	62.6043	1686.98
95	271.75	0.885291	63.3881	1927.56
96	274.52	0.919183	64.233	2179.89
97	282.18	0.954165	65.1434	2449.14
98	288.57	0.986272	66.1161	2733.75
99	293	1.02365	67.164	3033.68
100	293.23	1.05812	68.2836	3343.95
101	303.44	1.09847	69.4903	3677.27
102	307.72	1.1359	70.7805	4026.81
103	314.66	1.18	72.1729	4398.11
104	316.2	1.22123	73.6643	4784.26
105	318.47	1.27024	75.2778	5188.79
106	319.74	1.31652	77.011	5609.74
107	340.54	1.3722	78.894	6077.03
108	343.67	1.4325	80.9461	6569.34
109	348.11	1.49085	83.1687	7088.32
110	357.08	1.56322	85.6124	7646.51
111	361.85	1.63524	88.2864	8238.22
112	369.63	1.72793	91.2721	8876.92
113	382.44	1.82501	94.6027	9574.87
114	390.65	1.95996	98.4442	10340.5
115	405.72	2.12007	102.939	11200.7
116	439.51	2.40892	108.742	12259.4

Data Set Standard Deviation = 125.28
Numerator = 1.50294e+008
Denominator = 1.96271e+008
W Statistic = 0.765744 = 1.50294e+008 / 1.96271e+008

5% Critical value of 0.976 exceeds 0.765744
Evidence of non-normality at 95% level of significance

Shapiro-Francia Test of Normality
Parameter: Sulfate
Background Locations
Normality Test of Parameter Concentrations
Original Data (Not Transformed)
Total Number of Measurements = 116

i	x(i)	m(i)	sum(m^2)	sum(mx)
1	23.76	-2.40892	5.80292	-57.236
2	25.4	-2.12007	10.2976	-111.086
3	25.64	-1.95996	14.1391	-161.339
4	25.83	-1.82501	17.4697	-208.479
5	26.2	-1.72793	20.4554	-253.751
6	26.45	-1.63524	23.1294	-297.003
7	26.84	-1.56322	25.5731	-338.96
8	27.08	-1.49085	27.7957	-379.332
9	27.08	-1.4325	29.8478	-418.124
10	27.19	-1.3722	31.7308	-455.434
11	27.41	-1.31652	33.464	-491.52
12	27.52	-1.27024	35.0775	-526.477
13	27.86	-1.22123	36.5689	-560.501
14	27.97	-1.18	37.9613	-593.505
15	27.98	-1.1359	39.2515	-625.288
16	28.01	-1.09847	40.4582	-656.056
17	28.03	-1.05812	41.5778	-685.715
18	28.11	-1.02365	42.6257	-714.49
19	28.21	-0.986272	43.5984	-742.312
20	28.27	-0.954165	44.5088	-769.287
21	28.33	-0.919183	45.3537	-795.327
22	28.45	-0.885291	46.1375	-820.514
23	28.56	-0.855996	46.8702	-844.961
24	29.16	-0.823893	47.549	-868.986
25	29.18	-0.796056	48.1827	-892.215
26	29.27	-0.765456	48.7686	-914.619
27	29.35	-0.738846	49.3145	-936.305
28	29.38	-0.709522	49.8179	-957.15
29	29.38	-0.68396	50.2857	-977.245
30	29.52	-0.655726	50.7157	-996.602
31	29.52	-0.631062	51.114	-1015.23
32	29.85	-0.603765	51.4785	-1033.25
33	30.26	-0.576911	51.8113	-1050.71
34	31.91	-0.553384	52.1175	-1068.37
35	32.74	-0.52728	52.3956	-1085.63
36	32.83	-0.504372	52.65	-1102.19
37	34.73	-0.478914	52.8793	-1118.82
38	34.95	-0.456542	53.0877	-1134.78
39	35.18	-0.431644	53.2741	-1149.97
40	35.69	-0.409735	53.4419	-1164.59
41	36.13	-0.385321	53.5904	-1178.51
42	37.07	-0.363809	53.7228	-1192
43	37.91	-0.33981	53.8382	-1204.88
44	38.49	-0.316004	53.9381	-1217.04
45	39.02	-0.294992	54.0251	-1228.55
46	39.26	-0.271509	54.0988	-1239.21
47	40.18	-0.250759	54.1617	-1249.29
48	40.29	-0.227545	54.2135	-1258.46
49	41.6	-0.207012	54.2564	-1267.07
50	41.87	-0.184017	54.2902	-1274.77
51	42.21	-0.163659	54.317	-1281.68
52	42.6	-0.140835	54.3368	-1287.68
53	42.9	-0.12061	54.3514	-1292.85
54	42.98	-0.0979139	54.361	-1297.06
55	43.86	-0.0752698	54.3666	-1300.36
56	43.9	-0.0551734	54.3697	-1302.79
57	44.25	-0.0325917	54.3707	-1304.23
58	45.08	-0.0125328	54.3709	-1304.79
59	45.14	0.0125328	54.3711	-1304.23
60	47.56	0.0325917	54.3721	-1302.68
61	47.9	0.0551734	54.3752	-1300.03
62	48.37	0.0752698	54.3808	-1296.39
63	48.69	0.0979139	54.3904	-1291.63
64	49.04	0.12061	54.405	-1285.71
65	50.35	0.140835	54.4248	-1278.62

Rosner's Test for Outliers (Continued)

Parameter: Sulfate

Background Locations

Original Data (Not Transformed)

Iteration i = 3
Mean of 113 measurements = 119.248
Std Dev = 117.765
x(i+1) = 382.44 from measurement 10/2/2003 from location B-52
Rosner Statistic R = |382.44 - 119.248|/117.765 = 2.23489
Lambda(116, 4, 0.05) = 3.4148
2.23489 < 3.4148 -- No outliers detected for i = 3

Iteration i = 2
Mean of 114 measurements = 121.628
Std Dev = 119.967
x(i+1) = 390.65 from measurement 10/2/2002 from location B-52
Rosner Statistic R = |390.65 - 121.628|/119.967 = 2.24247
Lambda(116, 3, 0.05) = 3.4216
2.24247 < 3.4216 -- No outliers detected for i = 2

Iteration i = 1
Mean of 115 measurements = 124.099
Std Dev = 122.342
x(i+1) = 405.72 from measurement 10/13/2005 from location B-52
Rosner Statistic R = |405.72 - 124.099|/122.342 = 2.30192
Lambda(116, 2, 0.05) = 3.4216
2.30192 < 3.4216 -- No outliers detected for i = 1

Iteration i = 0
Mean of 116 measurements = 126.818
Std Dev = 125.28
x(i+1) = 439.51 from measurement 7/27/2005 from location B-52
Rosner Statistic R = |439.51 - 126.818|/125.28 = 2.49595
Lambda(116, 1, 0.05) = 3.4248
2.49595 < 3.4248 -- No outliers detected for i = 0

NO OUTLIERS DETECTED

Rosner's Test for Outliers
Parameter: Sulfate
Background Locations
Original Data (Not Transformed)

Data set mean = 126.818

10 most extreme of 116 measurements
by order of magnitude difference from the mean

1	7/27/2005	B-52	439.51	312.692
2	10/13/2005	B-52	405.72	278.902
3	10/2/2002	B-52	390.65	263.832
4	10/2/2003	B-52	382.44	255.622
5	4/3/2002	B-52	369.63	242.812
6	1/8/2003	B-52	361.85	235.032
7	1/5/2006	B-52	357.08	230.262
8	7/23/2003	B-52	348.11	221.292
9	4/8/2009	B-52	343.67	216.852
10	7/13/2004	B-52	340.54	213.722

Iteration i = 9
Mean of 107 measurements = 105.721
Std Dev = 105.669
x(i+1) = 340.54 from measurement 7/13/2004 from location B-52
Rosner Statistic R = |340.54 - 105.721|/105.669 = 2.22222
Lambda(116, 10, 0.05) = 3.398
2.22222 < 3.398 -- No outliers detected for i = 9

Iteration i = 8
Mean of 108 measurements = 107.925
Std Dev = 107.637
x(i+1) = 343.67 from measurement 4/8/2009 from location B-52
Rosner Statistic R = |343.67 - 107.925|/107.637 = 2.19018
Lambda(116, 9, 0.05) = 3.40136
2.19018 < 3.40136 -- No outliers detected for i = 8

Iteration i = 7
Mean of 109 measurements = 110.128
Std Dev = 109.58
x(i+1) = 348.11 from measurement 7/23/2003 from location B-52
Rosner Statistic R = |348.11 - 110.128|/109.58 = 2.17177
Lambda(116, 8, 0.05) = 3.40472
2.17177 < 3.40472 -- No outliers detected for i = 7

Iteration i = 6
Mean of 110 measurements = 112.373
Std Dev = 111.589
x(i+1) = 357.08 from measurement 1/5/2006 from location B-52
Rosner Statistic R = |357.08 - 112.373|/111.589 = 2.19294
Lambda(116, 7, 0.05) = 3.40808
2.19294 < 3.40808 -- No outliers detected for i = 6

Iteration i = 5
Mean of 111 measurements = 114.621
Std Dev = 113.576
x(i+1) = 361.85 from measurement 1/8/2003 from location B-52
Rosner Statistic R = |361.85 - 114.621|/113.576 = 2.17677
Lambda(116, 6, 0.05) = 3.41144
2.17677 < 3.41144 -- No outliers detected for i = 5

Iteration i = 4
Mean of 112 measurements = 116.898
Std Dev = 115.602
x(i+1) = 369.63 from measurement 4/3/2002 from location B-52
Rosner Statistic R = |369.63 - 116.898|/115.602 = 2.18622
Lambda(116, 5, 0.05) = 3.4148
2.18622 < 3.4148 -- No outliers detected for i = 4

Concentrations (mg/L) - Continued
Parameter: Sulfate
Original Data (Not Transformed)
Percent Background Non-Detects: 0%
Total Background Measurements: 116
There are 3 background locations

Loc.	Meas.	ND	Date	Conc.	Original
			10/22/2008	28.03	28.03
			1/13/2009	27.52	27.52
			4/8/2009	29.35	29.35
			7/15/2009	28.56	28.56
			1/7/2010	25.83	25.83
			4/7/2010	27.08	27.08
			7/7/2010	26.84	26.84
			8/16/2011	27.97	27.97
			10/26/2011	27.41	27.41
B-50	42	0 (0%)	11/15/2001	75.4	75.4
			1/16/2002	47.56	47.56
			4/3/2002	50.35	50.35
			7/2/2002	41.87	41.87
			10/2/2002	39.02	39.02
			1/8/2003	34.73	34.73
			4/2/2003	35.18	35.18
			7/23/2003	44.25	44.25
			10/2/2003	43.9	43.9
			1/7/2004	48.69	48.69
			4/7/2004	60.61	60.61
			7/13/2004	51.91	51.91
			10/6/2004	49.04	49.04
			1/6/2005	59.08	59.08
			4/6/2005	57.01	57.01
			7/27/2005	54.32	54.32
			10/13/2005	58.18	58.18
			1/5/2006	63.05	63.05
			4/6/2006	45.08	45.08
			7/25/2006	47.9	47.9
			10/11/2006	43.86	43.86
			1/4/2007	42.98	42.98
			4/4/2007	42.21	42.21
			7/12/2007	42.6	42.6
			10/10/2007	40.18	40.18
			1/16/2008	48.37	48.37
			4/3/2008	41.6	41.6
			7/23/2008	37.91	37.91
			10/22/2008	37.07	37.07
			1/13/2009	42.9	42.9
			4/8/2009	35.69	35.69
			7/15/2009	34.95	34.95
			10/8/2009	39.26	39.26
			1/7/2010	29.85	29.85
			4/7/2010	29.52	29.52
			7/7/2010	29.38	29.38
			12/8/2010	36.13	36.13
			2/3/2011	38.49	38.49
			4/13/2011	32.74	32.74
			8/16/2011	32.83	32.83
			10/26/2011	40.29	40.29
			1/18/2012	45.14	45.14

Concentrations (mg/L)
Parameter: Sulfate
Original Data (Not Transformed)
Percent Background Non-Detects: 0%
Total Background Measurements: 116
There are 3 background locations

Loc.	Meas.	ND	Date	Conc.	Original
B-52	42	0 (0%)	11/15/2001	190.52	190.52
			1/16/2002	251.83	251.83
			4/3/2002	369.63	369.63
			7/2/2002	314.66	314.66
			10/2/2002	390.65	390.65
			1/8/2003	361.85	361.85
			4/2/2003	202.08	202.08
			7/23/2003	348.11	348.11
			10/2/2003	382.44	382.44
			1/7/2004	248.1	248.1
			4/7/2004	213.97	213.97
			7/13/2004	340.54	340.54
			10/6/2004	261.61	261.61
			1/6/2005	195.22	195.22
			4/6/2005	225.43	225.43
			7/27/2005	439.51	439.51
			10/13/2005	405.72	405.72
			1/5/2006	357.08	357.08
			4/6/2006	251.7	251.7
			7/25/2006	274.52	274.52
			10/11/2006	319.74	319.74
			1/4/2007	205.86	205.86
			4/4/2007	264.57	264.57
			7/12/2007	229.35	229.35
			10/10/2007	250.77	250.77
			1/16/2008	259.44	259.44
			4/3/2008	282.18	282.18
			7/23/2008	232.5	232.5
			10/22/2008	243.27	243.27
			1/13/2009	244.85	244.85
			4/8/2009	343.67	343.67
			7/15/2009	293	293
			10/8/2009	271.75	271.75
			1/7/2010	318.47	318.47
			4/7/2010	288.57	288.57
			7/7/2010	231.36	231.36
			12/8/2010	303.44	303.44
			2/3/2011	307.72	307.72
			4/13/2011	293.23	293.23
			8/16/2011	316.2	316.2
			10/26/2011	188.09	188.09
			1/18/2012	226.96	226.96
B-51	32	0 (0%)	11/15/2001	25.4	25.4
			10/2/2002	55.4	55.4
			1/8/2003	31.91	31.91
			4/2/2003	28.27	28.27
			7/23/2003	26.2	26.2
			10/2/2003	25.64	25.64
			1/7/2004	28.21	28.21
			4/7/2004	27.86	27.86
			7/13/2004	30.26	30.26
			10/6/2004	27.19	27.19
			1/6/2005	29.18	29.18
			4/6/2005	29.16	29.16
			7/27/2005	27.98	27.98
			10/13/2005	27.08	27.08
			1/5/2006	23.76	23.76
			4/6/2006	28.45	28.45
			7/25/2006	28.33	28.33
			10/11/2006	26.45	26.45
			1/4/2007	29.27	29.27
			4/4/2007	29.52	29.52
			7/12/2007	29.38	29.38
			10/10/2007	28.11	28.11
			7/23/2008	28.01	28.01

Non-Parametric Prediction Interval
Inter-Well Comparison
Parameter: Chloride
Original Data (Not Transformed)

Number of comparisons = 7
Future Samples (k) = 1
Recent Dates = 1
Background Measurements (n) = 116
Maximum Background Value = 30.37
Confidence Level = 99%
False Positive Rate = 1%

Location	Date	Count	Mean	Significant
B-30A	4/4/2012	1	9.41	FALSE
B-32	4/4/2012	1	18	FALSE
B-31	4/4/2012	1	2.75	FALSE
DM-1	4/4/2012	1	7	FALSE
DM-7	4/4/2012	1	6.89	FALSE
DM-6	4/4/2012	1	3.64	FALSE
DM-5	4/4/2012	1	19.09	FALSE

Shapiro-Francia Test of Normality (Continued)
Parameter: Chloride
Background Locations
Normality Test of Parameter Concentrations
Natural Logarithm Transformation
Total Number of Measurements = 116

i	x(i)	m(i)	sum(m^2)	sum(mx)
66	2.98265	0.163659	54.4516	-93.1108
67	2.98619	0.184017	54.4854	-92.5613
68	2.98871	0.207012	54.5283	-91.9426
69	2.99223	0.227545	54.5801	-91.2617
70	3.01553	0.250759	54.643	-90.5055
71	3.0282	0.271509	54.7167	-89.6833
72	3.04118	0.294992	54.8037	-88.7862
73	3.054	0.316004	54.9036	-87.8211
74	3.06058	0.33981	55.019	-86.7811
75	3.06199	0.363809	55.1514	-85.6671
76	3.06433	0.385321	55.2999	-84.4864
77	3.07038	0.409735	55.4677	-83.2283
78	3.09195	0.431644	55.6541	-81.8937
79	3.09286	0.456542	55.8625	-80.4817
80	3.09784	0.478914	56.0918	-78.9981
81	3.10548	0.504372	56.3462	-77.4318
82	3.10906	0.52728	56.6243	-75.7924
83	3.125	0.553384	56.9305	-74.0631
84	3.12632	0.576911	57.2633	-72.2595
85	3.13332	0.603765	57.6278	-70.3677
86	3.14243	0.631062	58.0261	-68.3847
87	3.14329	0.655726	58.4561	-66.3235
88	3.17555	0.68396	58.9239	-64.1516
89	3.1954	0.709522	59.4273	-61.8844
90	3.20112	0.738846	59.9732	-59.5192
91	3.20761	0.765456	60.5591	-57.0639
92	3.22008	0.796056	61.1928	-54.5006
93	3.22127	0.823893	61.8716	-51.8466
94	3.22724	0.855996	62.6043	-49.0841
95	3.23475	0.885291	63.3881	-46.2204
96	3.24298	0.919183	64.233	-43.2395
97	3.24454	0.954165	65.1434	-40.1437
98	3.25037	0.986272	66.1161	-36.9379
99	3.25963	1.02365	67.164	-33.6012
100	3.2604	1.05812	68.2836	-30.1513
101	3.26957	1.09847	69.4903	-26.5598
102	3.27526	1.1359	70.7805	-22.8394
103	3.28016	1.18	72.1729	-18.9688
104	3.28129	1.22123	73.6643	-14.9616
105	3.28279	1.27024	75.2778	-10.7917
106	3.28915	1.31652	77.011	-6.46147
107	3.30138	1.3722	78.894	-1.93131
108	3.30762	1.4325	80.9461	2.80687
109	3.31127	1.49085	83.1687	7.74349
110	3.312	1.56322	85.6124	12.9209
111	3.32611	1.63524	88.2864	18.3599
112	3.33256	1.72793	91.2721	24.1183
113	3.34145	1.82501	94.6027	30.2165
114	3.3555	1.95996	98.4442	36.7931
115	3.35899	2.12007	102.939	43.9144
116	3.41346	2.40892	108.742	52.1371

Data Set Standard Deviation = 0.496211
Numerator = 2718.28
Denominator = 3079.12
W Statistic = 0.88281 = 2718.28 / 3079.12

5% Critical value of 0.976 exceeds 0.88281
Evidence of non-normality at 95% level of significance

Shapiro-Francia Test of Normality
Parameter: Chloride
Background Locations
Normality Test of Parameter Concentrations
Natural Logarithm Transformation
Total Number of Measurements = 116

i	x(i)	m(i)	sum(m^2)	sum(mx)
1	1.83737	-2.40892	5.80292	-4.42608
2	1.90509	-2.12007	10.2976	-8.465
3	1.95727	-1.95996	14.1391	-12.3012
4	1.96009	-1.82501	17.4697	-15.8784
5	1.96571	-1.72793	20.4554	-19.275
6	1.99334	-1.63524	23.1294	-22.5346
7	2.05796	-1.56322	25.5731	-25.7516
8	2.05924	-1.49085	27.7957	-28.8216
9	2.05924	-1.4325	29.8478	-31.7715
10	2.06433	-1.3722	31.7308	-34.6042
11	2.07191	-1.31652	33.464	-37.3319
12	2.08691	-1.27024	35.0775	-39.9828
13	2.08815	-1.22123	36.5689	-42.5329
14	2.08815	-1.18	37.9613	-44.9969
15	2.10169	-1.1359	39.2515	-47.3842
16	2.10535	-1.09847	40.4582	-49.6969
17	2.11384	-1.05812	41.5778	-51.9336
18	2.11986	-1.02365	42.6257	-54.1036
19	2.12106	-0.986272	43.5984	-56.1955
20	2.12465	-0.954165	44.5088	-58.2228
21	2.12585	-0.919183	45.3537	-60.1768
22	2.12704	-0.885291	46.1375	-62.0599
23	2.13889	-0.855996	46.8702	-63.8908
24	2.14124	-0.823893	47.549	-65.6549
25	2.14476	-0.796056	48.1827	-67.3623
26	2.14476	-0.765456	48.7686	-69.004
27	2.14943	-0.738846	49.3145	-70.5921
28	2.15176	-0.709522	49.8179	72.1188
29	2.15292	-0.68396	50.2857	-73.5913
30	2.15409	-0.655726	50.7157	-75.0038
31	2.15871	-0.631062	51.114	-76.3661
32	2.16102	-0.603765	51.4785	-77.6709
33	2.16791	-0.576911	51.8113	-78.9215
34	2.16791	-0.553384	52.1175	-80.1212
35	2.17929	-0.52728	52.3956	-81.2703
36	2.18605	-0.504372	52.65	-82.3729
37	2.18717	-0.478914	52.8793	-83.4204
38	2.19389	-0.456542	53.0877	-84.422
39	2.20827	-0.431644	53.2741	-85.3752
40	2.23431	-0.409735	53.4419	-86.2906
41	2.28646	-0.385321	53.5904	-87.1717
42	2.3263	-0.363809	53.7228	-88.018
43	2.37955	-0.33981	53.8382	-88.8266
44	2.3988	-0.316004	53.9381	-89.5846
45	2.45531	-0.294992	54.0251	-90.3089
46	2.54475	-0.271509	54.0988	-90.9998
47	2.54553	-0.250759	54.1617	-91.6381
48	2.55645	-0.227545	54.2135	-92.2199
49	2.59525	-0.207012	54.2564	-92.7571
50	2.65886	-0.184017	54.2902	-93.2464
51	2.72392	-0.163659	54.317	-93.6922
52	2.74019	-0.140835	54.3368	-94.0781
53	2.76506	-0.12061	54.3514	-94.4116
54	2.76946	-0.0979139	54.361	-94.6828
55	2.78068	-0.0752698	54.3666	-94.8921
56	2.78316	-0.0551734	54.3697	-95.0456
57	2.87582	-0.0325917	54.3707	-95.1393
58	2.8792	-0.0125328	54.3709	-95.1754
59	2.88032	0.0125328	54.3711	-95.1393
60	2.88144	0.0325917	54.3721	-95.0454
61	2.88536	0.0551734	54.3752	-94.8862
62	2.93439	0.0752698	54.3808	-94.6654
63	2.94286	0.0979139	54.3904	-94.3772
64	2.97553	0.12061	54.405	-94.0183
65	2.97808	0.140835	54.4248	-93.5989

Shapiro-Francia Test of Normality (Continued)
Parameter: Chloride
Background Locations
Normality Test of Parameter Concentrations
Original Data (Not Transformed)
Total Number of Measurements = 116

i	x(i)	m(i)	sum(m^2)	sum(mx)
66	19.74	0.163659	54.4516	-361.705
67	19.81	0.184017	54.4854	-358.06
68	19.86	0.207012	54.5283	-353.948
69	19.93	0.227545	54.5801	-349.413
70	20.4	0.250759	54.643	-344.298
71	20.66	0.271509	54.7167	-338.688
72	20.93	0.294992	54.8037	-332.514
73	21.2	0.316004	54.9036	-325.815
74	21.34	0.33981	55.019	-318.563
75	21.37	0.363809	55.1514	-310.789
76	21.42	0.385321	55.2999	-302.535
77	21.55	0.409735	55.4677	-293.705
78	22.02	0.431644	55.6541	-284.201
79	22.04	0.456542	55.8625	-274.138
80	22.15	0.478914	56.0918	-263.53
81	22.32	0.504372	56.3462	-252.273
82	22.4	0.52728	56.6243	-240.462
83	22.76	0.553384	56.9305	-227.867
84	22.79	0.576911	57.2633	-214.719
85	22.95	0.603765	57.6278	-200.863
86	23.16	0.631062	58.0261	-186.247
87	23.18	0.655726	58.4561	-171.048
88	23.94	0.68396	58.9239	-154.673
89	24.42	0.709522	59.4273	-137.347
90	24.56	0.738846	59.9732	-119.201
91	24.72	0.765456	60.5591	-100.279
92	25.03	0.796056	61.1928	-80.3536
93	25.06	0.823893	61.8716	-59.7068
94	25.21	0.855996	62.6043	-38.1271
95	25.4	0.885291	63.3881	-15.6408
96	25.61	0.919183	64.233	7.89952
97	25.65	0.954165	65.1434	32.3738
98	25.8	0.986272	66.1161	57.8197
99	26.04	1.02365	67.164	84.4756
100	26.06	1.05812	68.2836	112.05
101	26.3	1.09847	69.4903	140.94
102	26.45	1.1359	70.7805	170.984
103	26.58	1.18	72.1729	202.349
104	26.61	1.22123	73.6643	234.846
105	26.65	1.27024	75.2778	268.698
106	26.82	1.31652	77.011	304.007
107	27.15	1.3722	78.894	341.262
108	27.32	1.4325	80.9461	380.398
109	27.42	1.49085	83.1687	421.277
110	27.44	1.56322	85.6124	464.172
111	27.83	1.63524	88.2864	509.681
112	28.01	1.72793	91.2721	558.08
113	28.26	1.82501	94.6027	609.655
114	28.66	1.95996	98.4442	665.827
115	28.76	2.12007	102.939	726.8
116	30.37	2.40892	108.742	799.959

Data Set Standard Deviation = 7.54895
Numerator = 639935
Denominator = 712636
W Statistic = 0.897983 = 639935 / 712636

5% Critical value of 0.976 exceeds 0.897983
Evidence of non-normality at 95% level of significance

Shapiro-Francia Test of Normality
Parameter: Chloride
Background Locations
Normality Test of Parameter Concentrations
Original Data (Not Transformed)
Total Number of Measurements = 116

i	x(i)	m(i)	sum(m^2)	sum(mx)
1	6.28	-2.40892	5.80292	-15.128
2	6.72	-2.12007	10.2976	-29.3749
3	7.08	-1.95996	14.1391	-43.2514
4	7.1	-1.82501	17.4697	-56.209
5	7.14	-1.72793	20.4554	-68.5464
6	7.34	-1.63524	23.1294	-80.549
7	7.83	-1.56322	25.5731	-92.789
8	7.84	-1.49085	27.7957	-104.477
9	7.84	-1.4325	29.8478	-115.708
10	7.88	-1.3722	31.7308	-126.521
11	7.94	-1.31652	33.464	-136.974
12	8.06	-1.27024	35.0775	-147.212
13	8.07	-1.22123	36.5689	-157.068
14	8.07	-1.18	37.9613	-166.59
15	8.18	-1.1359	39.2515	-175.882
16	8.21	-1.09847	40.4582	-184.9
17	8.28	-1.05812	41.5778	-193.662
18	8.33	-1.02365	42.6257	-202.189
19	8.34	-0.986272	43.5984	-210.414
20	8.37	-0.954165	44.5088	-218.401
21	8.38	-0.919183	45.3537	-226.103
22	8.39	-0.885291	46.1375	-233.531
23	8.49	-0.855996	46.8702	-240.798
24	8.51	-0.823893	47.549	-247.81
25	8.54	-0.796056	48.1827	-254.608
26	8.54	-0.765456	48.7686	-261.145
27	8.58	-0.738846	49.3145	-267.484
28	8.6	-0.709522	49.8179	-273.586
29	8.61	-0.68396	50.2857	-279.475
30	8.62	-0.655726	50.7157	-285.127
31	8.66	-0.631062	51.114	-290.592
32	8.68	-0.603765	51.4785	-295.833
33	8.74	-0.576911	51.8113	-300.875
34	8.74	-0.553384	52.1175	-305.712
35	8.84	-0.52728	52.3956	-310.373
36	8.9	-0.504372	52.65	-314.862
37	8.91	-0.478914	52.8793	-319.129
38	8.97	-0.456542	53.0877	-323.224
39	9.1	-0.431644	53.2741	-327.152
40	9.34	-0.409735	53.4419	-330.979
41	9.84	-0.385321	53.5904	-334.771
42	10.24	-0.363809	53.7228	-338.496
43	10.8	-0.33981	53.8382	-342.166
44	11.01	-0.316004	53.9381	-345.645
45	11.65	-0.294992	54.0251	-349.082
46	12.74	-0.271509	54.0988	-352.541
47	12.75	-0.250759	54.1617	-355.738
48	12.89	-0.227545	54.2135	-358.671
49	13.4	-0.207012	54.2564	-361.445
50	14.28	-0.184017	54.2902	-364.073
51	15.24	-0.163659	54.317	-366.567
52	15.49	-0.140835	54.3368	-368.749
53	15.88	-0.12061	54.3514	-370.664
54	15.95	-0.0979139	54.361	-372.226
55	16.13	-0.0752698	54.3666	-373.44
56	16.17	-0.0551734	54.3697	-374.332
57	17.74	-0.0325917	54.3707	-374.91
58	17.8	-0.0125328	54.3709	-375.133
59	17.82	0.0125328	54.3711	-374.91
60	17.84	0.0325917	54.3721	-374.328
61	17.91	0.0551734	54.3752	-373.34
62	18.81	0.0752698	54.3808	-371.924
63	18.97	0.0979139	54.3904	-370.067
64	19.6	0.12061	54.405	-367.703
65	19.65	0.140835	54.4248	-364.936

Rosner's Test for Outliers
Parameter: Chloride
Background Locations
Original Data (Not Transformed)

Iteration i = 3
Mean of 113 measurements = 16.4952
Std Dev = 7.36497
x(i+1) = 28.26 from measurement 10/11/2006 from location B-50
Rosner Statistic R = |28.26 - 16.4952|/7.36497 = 1.5974
Lambda(116, 4, 0.05) = 3.4148
1.5974 < 3.4148 -- No outliers detected for i = 3

Iteration i = 2
Mean of 114 measurements = 16.6019
Std Dev = 7.4203
x(i+1) = 28.66 from measurement 7/23/2008 from location B-51
Rosner Statistic R = |28.66 - 16.6019|/7.4203 = 1.62501
Lambda(116, 3, 0.05) = 3.4216
1.62501 < 3.4216 -- No outliers detected for i = 2

Iteration i = 1
Mean of 115 measurements = 16.7077
Std Dev = 7.47417
x(i+1) = 28.76 from measurement 10/26/2011 from location B-52
Rosner Statistic R = |28.76 - 16.7077|/7.47417 = 1.61253
Lambda(116, 2, 0.05) = 3.4216
1.61253 < 3.4216 -- No outliers detected for i = 1

Iteration i = 0
Mean of 116 measurements = 16.8254
Std Dev = 7.54895
x(i+1) = 30.37 from measurement 1/4/2007 from location B-50
Rosner Statistic R = |30.37 - 16.8254|/7.54895 = 1.79423
Lambda(116, 1, 0.05) = 3.4248
1.79423 < 3.4248 -- No outliers detected for i = 0

NO OUTLIERS DETECTED

Rosner's Test for Outliers
Parameter: Chloride
Background Locations
Original Data (Not Transformed)

Data set mean = 16.8254

10 most extreme of 116 measurements
by order of magnitude difference from the mean

1	1/4/2007	B-50	30.37	13.5446
2	10/26/2011	B-52	28.76	11.9346
3	7/23/2008	B-51	28.66	11.8346
4	10/11/2006	B-50	28.26	11.4346
5	4/4/2007	B-51	28.01	11.1846
6	7/27/2005	B-51	27.83	11.0046
7	1/7/2010	B-51	27.44	10.6146
8	10/13/2005	B-51	27.42	10.5946
9	1/7/2004	B-50	6.28	10.5454
10	10/11/2006	B-51	27.32	10.4946

Iteration i = 9
Mean of 107 measurements = 16.0628
Std Dev = 7.07922
x(i+1) = 27.32 from measurement 10/11/2006 from location B-51
Rosner Statistic R = |27.32 - 16.0628|/7.07922 = 1.59018
Lambda(116, 10, 0.05) = 3.398
1.59018 < 3.398 – No outliers detected for i = 9

Iteration i = 8
Mean of 108 measurements = 15.9722
Std Dev = 7.10866
x(i+1) = 6.28 from measurement 1/7/2004 from location B-50
Rosner Statistic R = |6.28 - 15.9722|/7.10866 = 1.36344
Lambda(116, 9, 0.05) = 3.40136
1.36344 < 3.40136 -- No outliers detected for i = 8

Iteration i = 7
Mean of 109 measurements = 16.0772
Std Dev = 7.16013
x(i+1) = 27.42 from measurement 10/13/2005 from location B-51
Rosner Statistic R = |27.42 - 16.0772|/7.16013 = 1.58415
Lambda(116, 8, 0.05) = 3.40472
1.58415 < 3.40472 -- No outliers detected for i = 7

Iteration i = 6
Mean of 110 measurements = 16.1805
Std Dev = 7.20908
x(i+1) = 27.44 from measurement 1/7/2010 from location B-51
Rosner Statistic R = |27.44 - 16.1805|/7.20908 = 1.56184
Lambda(116, 7, 0.05) = 3.40808
1.56184 < 3.40808 -- No outliers detected for i = 6

Iteration i = 5
Mean of 111 measurements = 16.2855
Std Dev = 7.26093
x(i+1) = 27.83 from measurement 7/27/2005 from location B-51
Rosner Statistic R = |27.83 - 16.2855|/7.26093 = 1.58995
Lambda(116, 6, 0.05) = 3.41144
1.58995 < 3.41144 -- No outliers detected for i = 5

Iteration i = 4
Mean of 112 measurements = 16.3902
Std Dev = 7.31255
x(i+1) = 28.01 from measurement 4/4/2007 from location B-51
Rosner Statistic R = |28.01 - 16.3902|/7.31255 = 1.58902
Lambda(116, 5, 0.05) = 3.4148
1.58902 < 3.4148 -- No outliers detected for i = 4

Concentrations (mg/L) - Continued
Parameter: Chloride
Original Data (Not Transformed)
Percent Background Non-Detects: 0%
Total Background Measurements: 116
There are 3 background locations

Loc.	Meas.	ND	Date	Conc.	Original
			10/22/2008	26.58	26.58
			1/13/2009	25.65	25.65
			4/8/2009	26.06	26.06
			7/15/2009	25.21	25.21
			1/7/2010	27.44	27.44
			4/7/2010	25.61	25.61
			7/7/2010	24.42	24.42
			8/16/2011	22.95	22.95
			10/26/2011	20.93	20.93
B-50	42	0 (0%)	11/15/2001	15.49	15.49
			1/16/2002	21.2	21.2
			4/3/2002	20.4	20.4
			7/2/2002	17.84	17.84
			10/2/2002	17.8	17.8
			1/8/2003	15.88	15.88
			4/2/2003	7.1	7.1
			7/23/2003	12.75	12.75
			10/2/2003	12.89	12.89
			1/7/2004	6.28	6.28
			4/7/2004	10.8	10.8
			7/13/2004	11.65	11.65
			10/6/2004	12.74	12.74
			1/6/2005	7.84	7.84
			4/6/2005	15.95	15.95
			7/27/2005	18.81	18.81
			10/13/2005	22.02	22.02
			1/5/2006	19.65	19.65
			4/6/2006	21.42	21.42
			7/25/2006	24.56	24.56
			10/11/2006	28.26	28.26
			1/4/2007	30.37	30.37
			4/4/2007	25.8	25.8
			7/12/2007	23.16	23.16
			10/10/2007	22.4	22.4
			1/16/2008	23.18	23.18
			4/3/2008	19.81	19.81
			7/23/2008	17.74	17.74
			10/22/2008	16.17	16.17
			1/13/2009	17.82	17.82
			4/8/2009	14.28	14.28
			7/15/2009	13.4	13.4
			10/8/2009	15.24	15.24
			1/7/2010	16.13	16.13
			4/7/2010	18.97	18.97
			7/7/2010	19.74	19.74
			12/8/2010	19.93	19.93
			2/3/2011	19.86	19.86
			4/13/2011	20.66	20.66
			8/16/2011	21.55	21.55
			10/26/2011	19.6	19.6
			1/18/2012	22.79	22.79

Concentrations (mg/L)
Parameter: Chloride
Original Data (Not Transformed)
Percent Background Non-Detects: 0%
Total Background Measurements: 116
There are 3 background locations

Loc.	Meas.	ND	Date	Conc.	Original
B-52	42	0 (0%)	11/15/2001	7.14	7.14
			1/16/2002	7.34	7.34
			4/3/2002	8.97	8.97
			7/2/2002	8.54	8.54
			10/2/2002	8.9	8.9
			1/8/2003	10.24	10.24
			4/2/2003	7.83	7.83
			7/23/2003	8.18	8.18
			10/2/2003	8.39	8.39
			1/7/2004	7.84	7.84
			4/7/2004	7.88	7.88
			7/13/2004	8.37	8.37
			10/6/2004	8.68	8.68
			1/6/2005	9.84	9.84
			4/6/2005	7.94	7.94
			7/27/2005	8.07	8.07
			10/13/2005	8.49	8.49
			1/5/2006	6.72	6.72
			4/6/2006	7.08	7.08
			7/25/2006	8.21	8.21
			10/11/2006	8.28	8.28
			1/4/2007	8.07	8.07
			4/4/2007	8.06	8.06
			7/12/2007	8.38	8.38
			10/10/2007	8.66	8.66
			1/16/2008	8.54	8.54
			4/3/2008	8.34	8.34
			7/23/2008	8.61	8.61
			10/22/2008	8.33	8.33
			1/13/2009	8.6	8.6
			4/8/2009	8.58	8.58
			7/15/2009	8.51	8.51
			10/8/2009	9.1	9.1
			1/7/2010	8.91	8.91
			4/7/2010	8.62	8.62
			7/7/2010	8.74	8.74
			12/8/2010	8.74	8.74
			2/3/2011	8.84	8.84
			4/13/2011	9.34	9.34
			8/16/2011	11.01	11.01
			10/26/2011	28.76	28.76
			1/18/2012	17.91	17.91
B-51	32	0 (0%)	11/15/2001	22.76	22.76
			10/2/2002	25.03	25.03
			1/8/2003	26.61	26.61
			4/2/2003	25.4	25.4
			7/23/2003	25.06	25.06
			10/2/2003	24.72	24.72
			1/7/2004	22.32	22.32
			4/7/2004	22.04	22.04
			7/13/2004	21.34	21.34
			10/6/2004	22.15	22.15
			1/6/2005	23.94	23.94
			4/6/2005	26.82	26.82
			7/27/2005	27.83	27.83
			10/13/2005	27.42	27.42
			1/5/2006	21.37	21.37
			4/6/2006	27.15	27.15
			7/25/2006	26.65	26.65
			10/11/2006	27.32	27.32
			1/4/2007	26.04	26.04
			4/4/2007	28.01	28.01
			7/12/2007	26.3	26.3
			10/10/2007	26.45	26.45
			7/23/2008	28.66	28.66

Non-Parametric Prediction Interval
Inter-Well Comparison
Parameter: Ammonia
Original Data (Not Transformed)
Non-Detects Replaced with Quantitation Limit

Number of comparisons = 7
Future Samples (k) = 1
Recent Dates = 1
Background Measurements (n) = 116
Maximum Background Value = 6.95
Confidence Level = 99%
False Positive Rate = 1%

Location	Date	Count	Mean	Significant
B-30A	4/4/2012	1	14.28	TRUE
B-32	4/4/2012	1	1.05	FALSE
B-31	4/4/2012	1	0.01	FALSE
DM-1	4/4/2012	1	0.06	FALSE
DM-7	4/4/2012	1	0.02	FALSE
DM-6	4/4/2012	1	0.02	FALSE
DM-5	4/4/2012	1	0.1	FALSE

Shapiro-Francia Test of Normality (Continued)
Parameter: Ammonia
Background Locations
Normality Test of Parameter Concentrations
Natural Logarithm Transformation
Non-Detects Replaced with 1/2 LOQ
Total Number of Measurements = 116

i	x(i)	m(i)	sum(m^2)	sum(mx)
66	-3.50656	0.163659	54.4516	189.19
67	-3.50656	0.184017	54.4854	188.545
68	-3.50656	0.207012	54.5283	187.819
69	-3.50656	0.227545	54.5801	187.021
70	-3.50656	0.250759	54.643	186.142
71	-3.21888	0.271509	54.7167	185.268
72	-3.21888	0.294992	54.8037	184.318
73	-2.40795	0.316004	54.9036	183.557
74	-1.89712	0.33981	55.019	182.913
75	-1.83258	0.363809	55.1514	182.246
76	0.548121	0.385321	55.2999	182.457
77	1.30833	0.409735	55.4677	182.993
78	1.39872	0.431644	55.6541	183.597
79	1.40118	0.456542	55.8625	184.237
80	1.47247	0.478914	56.0918	184.942
81	1.48614	0.504372	56.3462	185.692
82	1.51293	0.52728	56.6243	186.489
83	1.51513	0.553384	56.9305	187.328
84	1.53256	0.576911	57.2633	188.212
85	1.53902	0.603765	57.6278	189.141
86	1.54543	0.631062	58.0261	190.116
87	1.55181	0.655726	58.4561	191.134
88	1.55604	0.68396	58.9239	192.198
89	1.55814	0.709522	59.4273	193.304
90	1.57277	0.738846	59.9732	194.466
91	1.57691	0.765456	60.5591	195.673
92	1.57691	0.796056	61.1928	196.928
93	1.58309	0.823893	61.8716	198.232
94	1.60342	0.855996	62.6043	199.605
95	1.60543	0.885291	63.3881	201.026
96	1.60543	0.919183	64.233	202.502
97	1.61144	0.954165	65.1434	204.04
98	1.61939	0.986272	66.1161	205.637
99	1.62137	1.02365	67.164	207.296
100	1.62728	1.05812	68.2836	209.018
101	1.639	1.09847	69.4903	210.819
102	1.639	1.1359	70.7805	212.68
103	1.64287	1.18	72.1729	214.619
104	1.65058	1.22123	73.6643	216.635
105	1.65823	1.27024	75.2778	218.741
106	1.66582	1.31652	77.011	220.934
107	1.69562	1.3722	78.894	223.261
108	1.69745	1.4325	80.9461	225.692
109	1.70656	1.49085	83.1687	228.237
110	1.71199	1.56322	85.6124	230.913
111	1.73166	1.63524	88.2864	233.745
112	1.74047	1.72793	91.2721	236.752
113	1.74746	1.82501	94.6027	239.941
114	1.85942	1.95996	98.4442	243.585
115	1.90211	2.12007	102.939	247.618
116	1.93874	2.40892	108.742	252.288

Data Set Standard Deviation = 2.63914
Numerator = 63649.4
Denominator = 87100.5
W Statistic = 0.730758 = 63649.4 / 87100.5

5% Critical value of 0.976 exceeds 0.730758
Evidence of non-normality at 95% level of significance

Shapiro-Francia Test of Normality
Parameter: Ammonia
Background Locations
Normality Test of Parameter Concentrations
Natural Logarithm Transformation
Non-Detects Replaced with 1/2 LOQ
Total Number of Measurements = 116

i	x(i)	m(i)	sum(m^2)	sum(mx)
1	-4.60517	-2.40892	5.80292	11.0935
2	-4.60517	-2.12007	10.2976	20.8568
3	-4.60517	-1.95996	14.1391	29.8827
4	-4.60517	-1.82501	17.4697	38.2872
5	-4.60517	-1.72793	20.4554	46.2446
6	-4.60517	-1.63524	23.1294	53.7751
7	-4.60517	-1.56322	25.5731	60.974
8	-4.60517	-1.49085	27.7957	67.8397
9	-4.60517	-1.4325	29.8478	74.4366
10	-4.60517	-1.3722	31.7308	80.7558
11	-4.60517	-1.31652	33.464	86.8186
12	-4.60517	-1.27024	35.0775	92.6683
13	-4.60517	-1.22123	36.5689	98.2923
14	-3.91202	-1.18	37.9613	102.908
15	-3.91202	-1.1359	39.2515	107.352
16	-3.91202	-1.09847	40.4582	111.649
17	-3.91202	-1.05812	41.5778	115.789
18	-3.91202	-1.02365	42.6257	119.793
19	-3.91202	-0.986272	43.5984	123.652
20	-3.91202	-0.954165	44.5088	127.384
21	-3.91202	-0.919183	45.3537	130.98
22	-3.91202	-0.885291	46.1375	134.443
23	-3.91202	-0.855996	46.8702	137.792
24	-3.91202	-0.823893	47.549	141.015
25	-3.91202	-0.796056	48.1827	144.129
26	-3.91202	-0.765456	48.7686	147.124
27	-3.91202	-0.738846	49.3145	150.014
28	-3.91202	-0.709522	49.8179	152.79
29	-3.91202	-0.68396	50.2857	155.466
30	-3.91202	-0.655726	50.7157	158.031
31	-3.91202	-0.631062	51.114	160.5
32	-3.91202	-0.603765	51.4785	162.862
33	-3.91202	-0.576911	51.8113	165.118
34	-3.91202	-0.553384	52.1175	167.283
35	-3.91202	-0.52728	52.3956	169.346
36	-3.91202	-0.504372	52.65	171.319
37	-3.91202	-0.478914	52.8793	173.193
38	-3.91202	-0.456542	53.0877	174.979
39	-3.91202	-0.431644	53.2741	176.667
40	-3.91202	-0.409735	53.4419	178.27
41	-3.91202	-0.385321	53.5904	179.777
42	-3.91202	-0.363809	53.7228	181.201
43	-3.91202	-0.33981	53.8382	182.53
44	-3.91202	-0.316004	53.9381	183.766
45	-3.68888	-0.294992	54.0251	184.854
46	-3.68888	-0.271509	54.0988	185.856
47	-3.68888	-0.250759	54.1617	186.781
48	-3.68888	-0.227545	54.2135	187.62
49	-3.68888	-0.207012	54.2564	188.384
50	-3.68888	-0.184017	54.2902	189.063
51	-3.68888	-0.163659	54.317	189.667
52	-3.68888	-0.140835	54.3368	190.186
53	-3.68888	-0.12061	54.3514	190.631
54	-3.68888	-0.0979139	54.361	190.992
55	-3.68888	-0.0752698	54.3666	191.27
56	-3.68888	-0.0551734	54.3697	191.473
57	-3.68888	-0.0325917	54.3707	191.594
58	-3.68888	-0.0125328	54.3709	191.64
59	-3.50656	0.0125328	54.3711	191.596
60	-3.50656	0.0325917	54.3721	191.482
61	-3.50656	0.0551734	54.3752	191.288
62	-3.50656	0.0752698	54.3808	191.024
63	-3.50656	0.0979139	54.3904	190.681
64	-3.50656	0.12061	54.405	190.258
65	-3.50656	0.140835	54.4248	189.764

Shapiro-Francia Test of Normality (Continued)

Parameter: Ammonia
Background Locations
Normality Test of Parameter Concentrations
Original Data (Not Transformed)
Non-Detects Replaced with 1/2 LOQ
Total Number of Measurements = 116

i	x(i)	m(i)	sum(m^2)	sum(mx)
66	0.03	0.163659	54.4516	-0.682823
67	0.03	0.184017	54.4854	-0.677303
68	0.03	0.207012	54.5283	-0.671092
69	0.03	0.227545	54.5801	-0.664266
70	0.03	0.250759	54.643	-0.656743
71	0.04	0.271509	54.7167	-0.645883
72	0.04	0.294992	54.8037	-0.634083
73	0.09	0.316004	54.9036	-0.605643
74	0.15	0.33981	55.019	-0.554671
75	0.16	0.363809	55.1514	-0.496462
76	1.73	0.385321	55.2999	0.170144
77	3.7	0.409735	55.4677	1.68616
78	4.05	0.431644	55.6541	3.43432
79	4.06	0.456542	55.8625	5.28788
80	4.36	0.478914	56.0918	7.37595
81	4.42	0.504372	56.3462	9.60527
82	4.54	0.52728	56.6243	11.9991
83	4.55	0.553384	56.9305	14.517
84	4.63	0.576911	57.2633	17.1881
85	4.66	0.603765	57.6278	20.0017
86	4.69	0.631062	58.0261	22.9613
87	4.72	0.655726	58.4561	26.0564
88	4.74	0.68396	58.9239	29.2983
89	4.75	0.709522	59.4273	32.6686
90	4.82	0.738846	59.9732	36.2298
91	4.84	0.765456	60.5591	39.9346
92	4.84	0.796056	61.1928	43.7875
93	4.87	0.823893	61.8716	47.7999
94	4.97	0.855996	62.6043	52.0542
95	4.98	0.885291	63.3881	56.4629
96	4.98	0.919183	64.233	61.0405
97	5.01	0.954165	65.1434	65.8208
98	5.05	0.986272	66.1161	70.8015
99	5.06	1.02365	67.164	75.9812
100	5.09	1.05812	68.2836	81.367
101	5.15	1.09847	69.4903	87.0241
102	5.15	1.1359	70.7805	92.874
103	5.17	1.18	72.1729	98.9746
104	5.21	1.22123	73.6643	105.337
105	5.25	1.27024	75.2778	112.006
106	5.29	1.31652	77.011	118.97
107	5.45	1.3722	78.894	126.449
108	5.46	1.4325	80.9461	134.27
109	5.51	1.49085	83.1687	142.485
110	5.54	1.56322	85.6124	151.145
111	5.65	1.63524	88.2864	160.384
112	5.7	1.72793	91.2721	170.233
113	5.74	1.82501	94.6027	180.709
114	6.42	1.95996	98.4442	193.292
115	6.7	2.12007	102.939	207.496
116	6.95	2.40892	108.742	224.238

Data Set Standard Deviation = 2.43128
Numerator = 50287.9
Denominator = 73920.6
W Statistic = 0.680228 = 50282.9 / 73920.6

5% Critical value of 0.976 exceeds 0.680228
Evidence of non-normality at 95% level of significance

Shapiro-Francia Test of Normality
Parameter: Ammonia
Background Locations
Normality Test of Parameter Concentrations
Original Data (Not Transformed)
Non-Detects Replaced with 1/2 LOQ
Total Number of Measurements = 116

i	x(i)	m(i)	sum(m^2)	sum(mx)
1	0.01	-2.40892	5.80292	-0.0240892
2	0.01	-2.12007	10.2976	-0.0452899
3	0.01	-1.95996	14.1391	-0.0648895
4	0.01	-1.82501	17.4697	-0.0831396
5	0.01	-1.72793	20.4554	-0.100419
6	0.01	-1.63524	23.1294	-0.116771
7	0.01	-1.56322	25.5731	-0.132403
8	0.01	-1.49085	27.7957	-0.147312
9	0.01	-1.4325	29.8478	-0.161637
10	0.01	-1.3722	31.7308	-0.175359
11	0.01	-1.31652	33.464	-0.188524
12	0.01	-1.27024	35.0775	-0.201227
13	0.01	-1.22123	36.5689	-0.213439
14	0.02	-1.18	37.9613	-0.237039
15	0.02	-1.1359	39.2515	-0.259757
16	0.02	-1.09847	40.4582	-0.281726
17	0.02	-1.05812	41.5778	-0.302889
18	0.02	-1.02365	42.6257	-0.323362
19	0.02	-0.986272	43.5984	-0.343087
20	0.02	-0.954165	44.5088	-0.36217
21	0.02	-0.919183	45.3537	-0.380554
22	0.02	-0.885291	46.1375	-0.39826
23	0.02	-0.855996	46.8702	-0.41538
24	0.02	-0.823893	47.549	-0.431858
25	0.02	-0.796056	48.1827	-0.447779
26	0.02	-0.765456	48.7686	-0.463088
27	0.02	-0.738846	49.3145	-0.477865
28	0.02	-0.709522	49.8179	-0.492055
29	0.02	-0.68396	50.2857	-0.505735
30	0.02	-0.655726	50.7157	-0.518849
31	0.02	-0.631062	51.114	-0.53147
32	0.02	-0.603765	51.4785	-0.543546
33	0.02	-0.576911	51.8113	-0.555084
34	0.02	-0.553384	52.1175	-0.566151
35	0.02	-0.52728	52.3956	-0.576697
36	0.02	-0.504372	52.65	-0.586785
37	0.02	-0.478914	52.8793	-0.596363
38	0.02	-0.456542	53.0877	-0.605494
39	0.02	-0.431644	53.2741	-0.614127
40	0.02	-0.409735	53.4419	-0.622321
41	0.02	-0.385321	53.5904	-0.630028
42	0.02	-0.363809	53.7228	-0.637304
43	0.02	-0.33981	53.8382	-0.6441
44	0.02	-0.316004	53.9381	-0.65042
45	0.025	-0.294992	54.0251	-0.657795
46	0.025	-0.271509	54.0988	-0.664583
47	0.025	-0.250759	54.1617	-0.670852
48	0.025	-0.227545	54.2135	-0.67654
49	0.025	-0.207012	54.2564	-0.681716
50	0.025	-0.184017	54.2902	-0.686316
51	0.025	-0.163659	54.317	-0.690407
52	0.025	-0.140835	54.3368	-0.693928
53	0.025	-0.12061	54.3514	-0.696944
54	0.025	-0.0979139	54.361	-0.699391
55	0.025	-0.0752698	54.3666	-0.701273
56	0.025	-0.0551734	54.3697	-0.702653
57	0.025	-0.0325917	54.3707	-0.703467
58	0.025	-0.0125328	54.3709	-0.703781
59	0.03	0.0125328	54.3711	-0.703405
60	0.03	0.0325917	54.3721	-0.702427
61	0.03	0.0551734	54.3752	-0.700772
62	0.03	0.0752698	54.3808	-0.698514
63	0.03	0.0979139	54.3904	-0.695576
64	0.03	0.12061	54.405	-0.691958
65	0.03	0.140835	54.4248	-0.687733

Rosner's Test for Outliers (Continued)
Parameter: Ammonia
Background Locations
Original Data (Not Transformed)
Non-Detects Replaced with Quantitation Limit

Iteration i = 3
Mean of 113 measurements = 1.65195
Std Dev = 2.32272
x(i+1) = 5.74 from measurement 11/15/2001 from location B-50
Rosner Statistic R = |5.74 - 1.65195|/2.32272 = 1.76003
Lambda(116, 4, 0.05) = 3.4148
1.76003 < 3.4148 -- No outliers detected for i = 3

Iteration i = 2
Mean of 114 measurements = 1.69377
Std Dev = 2.35515
x(i+1) = 6.42 from measurement 7/23/2003 from location B-50
Rosner Statistic R = |6.42 - 1.69377|/2.35515 = 2.00677
Lambda(116, 3, 0.05) = 3.4216
2.00677 < 3.4216 -- No outliers detected for i = 2

Iteration i = 1
Mean of 115 measurements = 1.7373
Std Dev = 2.39081
x(i+1) = 6.7 from measurement 1/13/2009 from location B-50
Rosner Statistic R = |6.7 - 1.7373|/2.39081 = 2.07574
Lambda(116, 2, 0.05) = 3.4216
2.07574 < 3.4216 -- No outliers detected for i = 1

Iteration i = 0
Mean of 116 measurements = 1.78224
Std Dev = 2.4291
x(i+1) = 6.95 from measurement 1/8/2003 from location B-50
Rosner Statistic R = |6.95 - 1.78224|/2.4291 = 2.12744
Lambda(116, 1, 0.05) = 3.4248
2.12744 < 3.4248 -- No outliers detected for i = 0

NO OUTLIERS DETECTED

Rosner's Test for Outliers
Parameter: Ammonia
Background Locations
Original Data (Not Transformed)
Non-Detects Replaced with Quantitation Limit

Data set mean = 1.78224

10 most extreme of 116 measurements
by order of magnitude difference from the mean

1	1/8/2003	B-50	6.95	5.16776
2	1/13/2009	B-50	6.7	4.91776
3	7/23/2003	B-50	6.42	4.63776
4	11/15/2001	B-50	5.74	3.95776
5	4/8/2009	B-50	5.7	3.91776
6	4/6/2005	B-50	5.65	3.86776
7	1/16/2002	B-50	5.54	3.75776
8	4/2/2003	B-50	5.51	3.72776
9	4/3/2002	B-50	5.46	3.67776
10	7/13/2004	B-50	5.45	3.66776

Iteration i = 9
Mean of 107 measurements = 1.43056
Std Dev = 2.18359
x(i+1) = 5.45 from measurement 7/13/2004 from location B-50
Rosner Statistic R = |5.45 - 1.43056|/2.18359 = 1.84075
Lambda(116, 10, 0.05) = 3.398
1.84075 < 3.398 -- No outliers detected for i = 9

Iteration i = 8
Mean of 108 measurements = 1.46787
Std Dev = 2.20767
x(i+1) = 5.46 from measurement 4/3/2002 from location B-50
Rosner Statistic R = |5.46 - 1.46787|/2.20767 = 1.8083
Lambda(116, 9, 0.05) = 3.40136
1.8083 < 3.40136 -- No outliers detected for i = 8

Iteration i = 7
Mean of 109 measurements = 1.50495
Std Dev = 2.23128
x(i+1) = 5.51 from measurement 4/2/2003 from location B-50
Rosner Statistic R = |5.51 - 1.50495|/2.23128 = 1.79496
Lambda(116, 8, 0.05) = 3.40472
1.79496 < 3.40472 -- No outliers detected for i = 7

Iteration i = 6
Mean of 110 measurements = 1.54164
Std Dev = 2.25409
x(i+1) = 5.54 from measurement 1/16/2002 from location B-50
Rosner Statistic R = |5.54 - 1.54164|/2.25409 = 1.77382
Lambda(116, 7, 0.05) = 3.40808
1.77382 < 3.40808 -- No outliers detected for i = 6

Iteration i = 5
Mean of 111 measurements = 1.57865
Std Dev = 2.27745
x(i+1) = 5.65 from measurement 4/6/2005 from location B-50
Rosner Statistic R = |5.65 - 1.57865|/2.27745 = 1.78768
Lambda(116, 6, 0.05) = 3.41144
1.78768 < 3.41144 -- No outliers detected for i = 5

Iteration i = 4
Mean of 112 measurements = 1.61545
Std Dev = 2.30038
x(i+1) = 5.7 from measurement 4/8/2009 from location B-50
Rosner Statistic R = |5.7 - 1.61545|/2.30038 = 1.7756
Lambda(116, 5, 0.05) = 3.4148
1.7756 < 3.4148 -- No outliers detected for i = 4

Concentrations (mg/L) - Continued
Parameter: Ammonia
Original Data (Not Transformed)
Non-Detects Replaced with Quantitation Limit
Percent Background Non-Detects: 12.0690%
Total Background Measurements: 116
There are 3 background locations

Loc.	Meas.	ND	Date	Conc.	Original
			7/23/2008	0.03 J,B	0.03 J,B
			10/22/2008	0.02 J, B	0.02 J, B
			1/13/2009	0.01 J	0.01 J
			4/8/2009	0.01 J,B	0.01 J,B
			7/15/2009	0.03 J,B	0.03 J,B
			1/7/2010	0.02 J,B	0.02 J,B
			4/7/2010	0.02 J,B	0.02 J,B
			7/7/2010	0.02 J	0.02 J
			8/16/2011	0.02 J	0.02 J
			10/26/2011	0.02 J	0.02 J
B-50	42	0 (0%)	11/15/2001	5.74	5.74
			1/16/2002	5.54	5.54
			4/3/2002	5.46	5.46
			7/2/2002	0.15	0.15
			10/2/2002	5.17	5.17
			1/8/2003	6.95	6.95
			4/2/2003	5.51	5.51
			7/23/2003	6.42	6.42
			10/2/2003	5.21	5.21
			1/7/2004	4.87	4.87
			4/7/2004	5.29	5.29
			7/13/2004	5.45	5.45
			10/6/2004	4.97	4.97
			1/6/2005	5.15	5.15
			4/6/2005	5.65	5.65
			7/27/2005	4.98	4.98
			10/13/2005	4.55	4.55
			1/5/2006	4.82	4.82
			4/6/2006	4.98	4.98
			7/25/2006	5.25	5.25
			10/11/2006	5.15	5.15
			1/4/2007	4.84	4.84
			4/4/2007	3.7	3.7
			7/12/2007	4.74	4.74
			10/10/2007	5.06	5.06
			1/16/2008	4.42	4.42
			4/3/2008	5.01	5.01
			7/23/2008	5.05	5.05
			10/22/2008	4.72	4.72
			1/13/2009	6.7	6.7
			4/8/2009	5.7	5.7
			7/15/2009	4.63	4.63
			10/8/2009	4.66	4.66
			1/7/2010	4.69	4.69
			4/7/2010	4.05	4.05
			7/7/2010	4.06	4.06
			12/8/2010	5.09	5.09
			2/3/2011	4.84	4.84
			4/13/2011	4.36	4.36
			8/16/2011	1.73	1.73
			10/26/2011	4.54	4.54
			1/18/2012	4.75	4.75

Concentrations (mg/L)
Parameter: Ammonia
Original Data (Not Transformed)
Non-Detects Replaced with Quantitation Limit
Percent Background Non-Detects: 12.0690%
Total Background Measurements: 116
There are 3 background locations

Loc.	Meas.	ND	Date	Conc.	Original
B-52	42	12 (28.5714%)	11/15/2001	0.09	0.09
			1/16/2002	0.03 J	0.03 J
			4/3/2002	0.02 J	0.02 J
			7/2/2002	0.02 J	0.02 J
			10/2/2002	0.01 J	0.01 J
			1/8/2003	0.01 J	0.01 J
			4/2/2003	0.02 J	0.02 J
			7/23/2003	ND<0.05	ND<0.05
			10/2/2003	ND<0.05	ND<0.05
			1/7/2004	ND<0.05	ND<0.05
			4/7/2004	0.02 J	0.02 J
			7/13/2004	0.02 JB	0.02 JB
			10/6/2004	0.01 JB	0.01 JB
			1/6/2005	0.02 JB	0.02 JB
			4/6/2005	ND<0.05	ND<0.05
			7/27/2005	0.02 J	0.02 J
			10/13/2005	0.02 JB	0.02 JB
			1/5/2006	0.02 JB	0.02 JB
			4/6/2006	0.02 JB	0.02 JB
			7/25/2006	0.02 J	0.02 J
			10/11/2006	ND<0.05	ND<0.05
			1/4/2007	ND<0.05	ND<0.05
			4/4/2007	ND<0.05	ND<0.05
			7/12/2007	ND<0.05	ND<0.05
			10/10/2007	ND<0.05	ND<0.05
			1/16/2008	0.01 J	0.01 J
			4/3/2008	0.02 J	0.02 J
			7/23/2008	0.02 J,B	0.02 J,B
			10/22/2008	ND<0.05	ND<0.05
			1/13/2009	ND<0.05	ND<0.05
			4/8/2009	ND<0.05	ND<0.05
			7/15/2009	0.02 J,B	0.02 J,B
			10/8/2009	0.02 J,B	0.02 J,B
			1/7/2010	0.02 J,B	0.02 J,B
			4/7/2010	0.01 J,B	0.01 J,B
			7/7/2010	0.02 J	0.02 J
			12/8/2010	0.02 J	0.02 J
			2/3/2011	0.04 J,B	0.04 J,B
			4/13/2011	0.02 J	0.02 J
			8/16/2011	0.02 J	0.02 J
			10/26/2011	0.01 J	0.01 J
			1/18/2012	0.01 J,B	0.01 J,B
B-51	32	2 (6.25%)	11/15/2001	0.16	0.16
			10/2/2002	0.02 J	0.02 J
			1/8/2003	0.02 J	0.02 J
			4/2/2003	0.03 J	0.03 J
			7/23/2003	ND<0.05	ND<0.05
			10/2/2003	ND<0.05	ND<0.05
			1/7/2004	0.03 J	0.03 J
			4/7/2004	0.02 J	0.02 J
			7/13/2004	0.03 JB	0.03 JB
			10/6/2004	0.03 JB	0.03 JB
			1/6/2005	0.03 JB	0.03 JB
			4/6/2005	0.02 J	0.02 J
			7/27/2005	0.04 J	0.04 J
			10/13/2005	0.03 JB	0.03 JB
			1/5/2006	0.03 JB	0.03 JB
			4/6/2006	0.03 JB	0.03 JB
			7/25/2006	0.03 J	0.03 J
			10/11/2006	0.01 J,B	0.01 J,B
			1/4/2007	0.02 J	0.02 J
			4/4/2007	0.01 J	0.01 J
			7/12/2007	0.01 J	0.01 J
			10/10/2007	0.01 J	0.01 J

Non-Parametric Prediction Interval
Inter-Well Comparison
Parameter: Zinc, Dissolved
Original Data (Not Transformed)
Non-Detects Replaced with Quantitation Limit

Number of comparisons = 7
Future Samples (k) = 1
Recent Dates = 1
Background Measurements (n) = 116
Maximum Background Value = 0.041
Confidence Level = 99%
False Positive Rate = 1%

Location	Date	Count	Mean	Significant
B-30A	4/4/2012	1	0.018	FALSE
B-32	4/4/2012	1	0.02	FALSE
DM-7	4/4/2012	1	0.019	FALSE
DM-6	4/4/2012	1	0.017	FALSE
B-31	4/4/2012	1	0.017	FALSE
DM-5	4/4/2012	1	0.019	FALSE
DM-1	4/4/2012	1	0.035	FALSE

Shapiro-Francia Test of Normality (Continued)
Parameter: Zinc, Dissolved
Background Locations
Normality Test of Parameter Concentrations
Natural Logarithm Transformation
Non-Detects Replaced with Quantitation Limit
Total Number of Measurements = 116

i	x(i)	m(i)	sum(m^2)	sum(mx)
66	-3.50656	0.163659	54.4516	193.087
67	-3.50656	0.184017	54.4854	192.442
68	-3.50656	0.207012	54.5283	191.716
69	-3.50656	0.227545	54.5801	190.918
70	-3.50656	0.250759	54.643	190.038
71	-3.50656	0.271509	54.7167	189.086
72	-3.50656	0.294992	54.8037	188.052
73	-3.50656	0.316004	54.9036	186.944
74	-3.50656	0.33981	55.019	185.752
75	-3.50656	0.363809	55.1514	184.477
76	-3.50656	0.385321	55.2999	183.125
77	-3.50656	0.409735	55.4677	181.689
78	-3.50656	0.431644	55.6541	180.175
79	-3.50656	0.456542	55.8625	178.574
80	-3.50656	0.478914	56.0918	176.895
81	-3.50656	0.504372	56.3462	175.126
82	-3.50656	0.52728	56.6243	173.277
83	-3.50656	0.553384	56.9305	171.337
84	-3.50656	0.576911	57.2633	169.314
85	-3.50656	0.603765	57.6278	167.197
86	-3.50656	0.631062	58.0261	164.984
87	-3.50656	0.655726	58.4561	162.685
88	-3.50656	0.68396	58.9239	160.286
89	-3.50656	0.709522	59.4273	157.798
90	-3.50656	0.738846	59.9732	155.207
91	-3.50656	0.765456	60.5591	152.523
92	-3.50656	0.796056	61.1928	149.732
93	-3.50656	0.823893	61.8716	146.843
94	-3.50656	0.855996	62.6043	143.841
95	-3.50656	0.885291	63.3881	140.737
96	-3.50656	0.919183	64.233	137.514
97	-3.50656	0.954165	65.1434	134.168
98	-3.50656	0.986272	66.1161	130.71
99	-3.50656	1.02365	67.164	127.12
100	-3.50656	1.05812	68.2836	123.41
101	-3.50656	1.09847	69.4903	119.558
102	-3.50656	1.1359	70.7805	115.575
103	-3.50656	1.18	72.1729	111.437
104	-3.50656	1.22123	73.6643	107.155
105	-3.50656	1.27024	75.2778	102.701
106	-3.50656	1.31652	77.011	98.0841
107	-3.50656	1.3722	78.894	93.2724
108	-3.50656	1.4325	80.9461	88.2492
109	-3.50656	1.49085	83.1687	83.0214
110	-3.50656	1.56322	85.6124	77.5399
111	-3.50656	1.63524	88.2864	71.8059
112	-3.47377	1.72793	91.2721	65.8034
113	-3.44202	1.82501	94.6027	59.5217
114	-3.41125	1.95996	98.4442	52.8358
115	-3.29684	2.12007	102.939	45.8463
116	-3.19418	2.40892	108.742	38.1517

Data Set Standard Deviation = 0.377096
Numerator = 1455.56
Denominator = 1778.27
W Statistic = 0.818523 = 1455.56 / 1778.27

5% Critical value of 0.976 exceeds 0.818523
Evidence of non-normality at 95% level of significance

Shapiro-Francia Test of Normality
Parameter: Zinc, Dissolved
Background Locations
Normality Test of Parameter Concentrations
Natural Logarithm Transformation
Non-Detects Replaced with Quantitation Limit
Total Number of Measurements = 116

i	x(i)	m(i)	sum(m^2)	sum(mx)
1	-4.60517	-2.40892	5.80292	11.0935
2	-4.60517	-2.12007	10.2976	20.8568
3	-4.60517	-1.95996	14.1391	29.8827
4	-4.50986	-1.82501	17.4697	38.1133
5	-4.50986	-1.72793	20.4554	45.906
6	-4.50986	-1.63524	23.1294	53.2807
7	-4.50986	-1.56322	25.5731	60.3306
8	-4.42285	-1.49085	27.7957	66.9244
9	-4.42285	-1.4325	29.8478	73.2601
10	-4.42285	-1.3722	31.7308	79.3292
11	-4.42285	-1.31652	33.464	85.152
12	-4.42285	-1.27024	35.0775	90.77
13	-4.34281	-1.22123	36.5689	96.0736
14	-4.34281	1.18	37.9613	101.198
15	-4.34281	-1.1359	39.2515	106.131
16	-4.34281	-1.09847	40.4582	110.902
17	-4.34281	-1.05812	41.5778	115.497
18	-4.2687	-1.02365	42.6257	119.866
19	-4.2687	-0.986272	43.5984	124.076
20	-4.2687	-0.954165	44.5088	128.15
21	-4.2687	-0.919183	45.3537	132.073
22	-4.2687	-0.885291	46.1375	135.852
23	-4.2687	-0.855996	46.8702	139.506
24	-4.2687	-0.823893	47.549	143.023
25	-4.19971	-0.796056	48.1827	146.366
26	-4.19971	-0.765456	48.7686	149.581
27	-4.19971	-0.738846	49.3145	152.684
28	-4.19971	-0.709522	49.8179	155.664
29	-4.13517	-0.68396	50.2857	158.492
30	-4.13517	-0.655726	50.7157	161.204
31	-4.13517	-0.631062	51.114	163.813
32	-4.07454	-0.603765	51.4785	166.273
33	-4.07454	-0.576911	51.8113	168.674
34	-4.01738	-0.553384	52.1175	170.847
35	-4.01738	-0.52728	52.3956	172.965
36	-4.01738	-0.504372	52.65	174.992
37	-3.96332	-0.478914	52.8793	176.89
38	-3.96332	-0.456542	53.0877	178.699
39	-3.96332	-0.431644	53.2741	180.41
40	-3.96332	-0.409735	53.4419	182.034
41	-3.96332	-0.385321	53.5904	183.561
42	-3.91202	-0.363809	53.7228	184.984
43	-3.91202	-0.33981	53.8382	186.313
44	-3.86323	-0.316004	53.9381	187.534
45	-3.86323	-0.294992	54.0251	188.674
46	-3.86323	-0.271509	54.0988	189.723
47	-3.81671	-0.250759	54.1617	190.68
48	-3.77226	-0.227545	54.2135	191.538
49	-3.77226	-0.207012	54.2564	192.319
50	-3.77226	-0.184017	54.2902	193.013
51	-3.7297	-0.163659	54.317	193.624
52	-3.61192	-0.140835	54.3368	194.132
53	-3.57555	-0.12061	54.3514	194.564
54	-3.57555	-0.0979139	54.361	194.914
55	-3.57555	-0.0752698	54.3666	195.183
56	-3.54046	-0.0551734	54.3697	195.378
57	-3.50656	-0.0325917	54.3707	195.493
58	-3.50656	-0.0125328	54.3709	195.536
59	-3.50656	0.0125328	54.3711	195.493
60	-3.50656	0.0325917	54.3721	195.378
61	-3.50656	0.0551734	54.3752	195.185
62	-3.50656	0.0752698	54.3808	194.921
63	-3.50656	0.0979139	54.3904	194.577
64	-3.50656	0.12061	54.405	194.155
65	-3.50656	0.140835	54.4248	193.661

Shapiro-Francia Test of Normality (Continued)
Parameter: Zinc, Dissolved
Background Locations
Normality Test of Parameter Concentrations
Original Data (Not Transformed)
Non-Detects Replaced with Quantitation Limit
Total Number of Measurements = 116

i	x(i)	m(i)	sum(m^2)	sum(mx)
66	0.03	0.163659	54.4516	-0.602704
67	0.03	0.184017	54.4854	-0.597184
68	0.03	0.207012	54.5283	-0.590973
69	0.03	0.227545	54.5801	-0.584147
70	0.03	0.250759	54.643	-0.576624
71	0.03	0.271509	54.7167	-0.568479
72	0.03	0.294992	54.8037	-0.559629
73	0.03	0.316004	54.9036	-0.550149
74	0.03	0.33981	55.019	-0.539955
75	0.03	0.363809	55.1514	-0.529041
76	0.03	0.385321	55.2999	-0.517481
77	0.03	0.409735	55.4677	-0.505189
78	0.03	0.431644	55.6541	-0.49224
79	0.03	0.456542	55.8625	-0.478543
80	0.03	0.478914	56.0918	-0.464176
81	0.03	0.504372	56.3462	-0.449045
82	0.03	0.52728	56.6243	-0.433226
83	0.03	0.553384	56.9305	-0.416625
84	0.03	0.576911	57.2633	-0.399317
85	0.03	0.603765	57.6278	-0.381205
86	0.03	0.631062	58.0261	-0.362273
87	0.03	0.655726	58.4561	-0.342601
88	0.03	0.68396	58.9239	-0.322082
89	0.03	0.709522	59.4273	-0.300796
90	0.03	0.738846	59.9732	-0.278631
91	0.03	0.765456	60.5591	-0.255667
92	0.03	0.796056	61.1928	-0.231786
93	0.03	0.823893	61.8716	-0.207069
94	0.03	0.855996	62.6043	-0.181389
95	0.03	0.885291	63.3881	-0.15483
96	0.03	0.919183	64.233	-0.127255
97	0.03	0.954165	65.1434	-0.0986298
98	0.03	0.986272	66.1161	-0.0690417
99	0.03	1.02365	67.164	-0.0383321
100	0.03	1.05812	68.2836	-0.00658846
101	0.03	1.09847	69.4903	0.0263656
102	0.03	1.1359	70.7805	0.0604425
103	0.03	1.18	72.1729	0.0958425
104	0.03	1.22123	73.6643	0.132479
105	0.03	1.27024	75.2778	0.170586
106	0.03	1.31652	77.011	0.210082
107	0.03	1.3722	78.894	0.251248
108	0.03	1.4325	80.9461	0.294223
109	0.03	1.49085	83.1687	0.338949
110	0.03	1.56322	85.6124	0.385846
111	0.03	1.63524	88.2864	0.434903
112	0.031	1.72793	91.2721	0.488469
113	0.032	1.82501	94.6027	0.546869
114	0.033	1.95996	98.4442	0.611547
115	0.037	2.12007	102.939	0.68999
116	0.041	2.40892	108.742	0.788756

Data Set Standard Deviation = 0.00775399
Numerator = 0.622136
Denominator = 0.751875
W Statistic = 0.827446 = 0.622136 / 0.751875

5% Critical value of 0.976 exceeds 0.827446
Evidence of non-normality at 95% level of significance

Shapiro-Francia Test of Normality
Parameter: Zinc, Dissolved
Background Locations
Normality Test of Parameter Concentrations
Original Data (Not Transformed)
Non-Detects Replaced with Quantitation Limit
Total Number of Measurements = 116

i	x(i)	m(i)	sum(m^2)	sum(mx)
1	0.01	-2.40892	5.80292	-0.0240892
2	0.01	-2.12007	10.2976	-0.0452899
3	0.01	-1.95996	14.1391	-0.0648895
4	0.011	-1.82501	17.4697	-0.0849646
5	0.011	-1.72793	20.4554	-0.103972
6	0.011	-1.63524	23.1294	-0.121959
7	0.011	-1.56322	25.5731	-0.139155
8	0.012	-1.49085	27.7957	-0.157045
9	0.012	-1.4325	29.8478	-0.174235
10	0.012	-1.3722	31.7308	-0.190702
11	0.012	-1.31652	33.464	-0.2065
12	0.012	-1.27024	35.0775	-0.221743
13	0.013	-1.22123	36.5689	-0.237619
14	0.013	-1.18	37.9613	-0.252959
15	0.013	-1.1359	39.2515	-0.267725
16	0.013	-1.09847	40.4582	-0.282005
17	0.013	-1.05812	41.5778	-0.295761
18	0.014	-1.02365	42.6257	-0.310092
19	0.014	-0.986272	43.5984	-0.3239
20	0.014	-0.954165	44.5088	-0.337258
21	0.014	-0.919183	45.3537	-0.350127
22	0.014	-0.885291	46.1375	-0.362521
23	0.014	-0.855996	46.8702	-0.374505
24	0.014	-0.823893	47.549	-0.386039
25	0.015	-0.796056	48.1827	-0.39798
26	0.015	-0.765456	48.7686	-0.409462
27	0.015	-0.738846	49.3145	-0.420545
28	0.015	-0.709522	49.8179	-0.431188
29	0.016	-0.68396	50.2857	-0.442131
30	0.016	-0.655726	50.7157	-0.452623
31	0.016	-0.631062	51.114	-0.462719
32	0.017	-0.603765	51.4785	-0.472983
33	0.017	-0.576911	51.8113	-0.482791
34	0.018	-0.553384	52.1175	-0.492752
35	0.018	-0.52728	52.3956	-0.502243
36	0.018	-0.504372	52.65	-0.511322
37	0.019	-0.478914	52.8793	-0.520421
38	0.019	-0.456542	53.0877	-0.529095
39	0.019	-0.431644	53.2741	-0.537297
40	0.019	-0.409735	53.4419	-0.545081
41	0.019	-0.385321	53.5904	-0.552403
42	0.02	-0.363809	53.7228	-0.559679
43	0.02	-0.33981	53.8382	-0.566475
44	0.021	-0.316004	53.9381	-0.573111
45	0.021	-0.294992	54.0251	-0.579306
46	0.021	-0.271509	54.0988	-0.585008
47	0.022	-0.250759	54.1617	-0.590524
48	0.023	-0.227545	54.2135	-0.595758
49	0.023	-0.207012	54.2564	-0.600519
50	0.023	-0.184017	54.2902	-0.604752
51	0.024	-0.163659	54.317	-0.608679
52	0.027	-0.140835	54.3368	-0.612482
53	0.028	-0.12061	54.3514	-0.615859
54	0.028	-0.0979139	54.361	-0.618601
55	0.028	-0.0752698	54.3666	-0.620708
56	0.029	-0.0551734	54.3697	-0.622308
57	0.03	-0.0325917	54.3707	-0.623286
58	0.03	-0.0125328	54.3709	-0.623662
59	0.03	0.0125328	54.3711	-0.623286
60	0.03	0.0325917	54.3721	-0.622308
61	0.03	0.0551734	54.3752	-0.620653
62	0.03	0.0752698	54.3808	-0.618395
63	0.03	0.0979139	54.3904	-0.615457
64	0.03	0.12061	54.405	-0.611839
65	0.03	0.140835	54.4248	-0.607614

Rosner's Test for Outliers (Continued)
Parameter: Zinc, Dissolved
Background Locations
Original Data (Not Transformed)
Non-Detects Replaced-with Quantitation Limit

Iteration i = 3
Mean of 113 measurements = 0.0239735
Std Dev = 0.00746116
x(i+1) = 0.01 from measurement 7/27/2005 from location B-51
Rosner Statistic R = |0.01 - 0.0239735|/0.00746116 = 1.87283
Lambda(116, 4, 0.05) = 3.4148
1.87283 < 3.4148 -- No outliers detected for i = 3

Iteration i = 2
Mean of 114 measurements = 0.0238509
Std Dev = 0.00754248
x(i+1) = 0.01 from measurement 7/7/2010 from location B-51
Rosner Statistic R = |0.01 - 0.0238509|/0.00754248 = 1.83638
Lambda(116, 3, 0.05) = 3.4216
1.83638 < 3.4216 -- No outliers detected for i = 2

Iteration i = 1
Mean of 115 measurements = 0.0237304
Std Dev = 0.0076196
x(i+1) = 0.01 from measurement 4/6/2006 from location B-52
Rosner Statistic R = |0.01 - 0.0237304|/0.0076196 = 1.80199
Lambda(116, 2, 0.05) = 3.4216
1.80199 < 3.4216 -- No outliers detected for i = 1

Iteration i = 0
Mean of 116 measurements = 0.0238793
Std Dev = 0.00775399
x(i+1) = 0.041 from measurement 10/10/2007 from location B-51
Rosner Statistic R = |0.041 - 0.0238793|/0.00775399 = 2.20798
Lambda(116, 1, 0.05) = 3.4248
2.20798 < 3.4248 -- No outliers detected for i = 0

NO OUTLIERS DETECTED

Rosner's Test for Outliers
Parameter: Zinc, Dissolved
Background Locations
Original Data (Not Transformed)
Non-Detects Replaced with Quantitation Limit

Data set mean = 0.0238793

10 most extreme of 116 measurements
by order of magnitude difference from the mean

1	10/10/2007	B-51	0.041	0.0171207
2	4/6/2006	B-52	0.01 J	-0.0138793
3	7/7/2010	B-51	0.01 J	-0.0138793
4	7/27/2005	B-51	0.01 J	-0.0138793
5	11/15/2001	B-52	0.037	0.0131207
6	1/13/2009	B-52	0.011 J	-0.0128793
7	10/8/2009	B-52	0.011 J	-0.0128793
8	4/8/2009	B-52	0.011 J	-0.0128793
9	12/8/2010	B-52	0.011 J	-0.0128793
10	7/15/2009	B-52	0.012 J	-0.0118793

Iteration i = 9
Mean of 107 measurements = 0.0244673
Std Dev = 0.00698424
x(i+1) = 0.012 from measurement 7/15/2009 from location B-52
Rosner Statistic R = |0.012 - 0.0244673|/0.00698424 = 1.78506
Lambda(116, 10, 0.05) = 3.398
1.78506 < 3.398 -- No outliers detected for i = 9

Iteration i = 8
Mean of 108 measurements = 0.0243426
Std Dev = 0.00707128
x(i+1) = 0.011 from measurement 12/8/2010 from location B-52
Rosner Statistic R = |0.011 - 0.0243426|/0.00707128 = 1.88687
Lambda(116, 9, 0.05) = 3.40136
1.88687 < 3.40136 -- No outliers detected for i = 8

Iteration i = 7
Mean of 109 measurements = 0.0242202
Std Dev = 0.00715355
x(i+1) = 0.011 from measurement 4/8/2009 from location B-52
Rosner Statistic R = |0.011 - 0.0242202|/0.00715355 = 1.84806
Lambda(116, 8, 0.05) = 3.40472
1.84806 < 3.40472 -- No outliers detected for i = 7

Iteration i = 6
Mean of 110 measurements = 0.0241
Std Dev = 0.00723137
x(i+1) = 0.011 from measurement 10/8/2009 from location B-52
Rosner Statistic R = |0.011 - 0.0241|/0.00723137 = 1.81155
Lambda(116, 7, 0.05) = 3.40808
1.81155 < 3.40808 -- No outliers detected for i = 6

Iteration i = 5
Mean of 111 measurements = 0.023982
Std Dev = 0.00730502
x(i+1) = 0.011 from measurement 1/13/2009 from location B-52
Rosner Statistic R = |0.011 - 0.023982|/0.00730502 = 1.77713
Lambda(116, 6, 0.05) = 3.41144
1.77713 < 3.41144 -- No outliers detected for i = 5

Iteration i = 4
Mean of 112 measurements = 0.0240982
Std Dev = 0.00737534
x(i+1) = 0.037 from measurement 11/15/2001 from location B-52
Rosner Statistic R = |0.037 - 0.0240982|/0.00737534 = 1.74931
Lambda(116, 5, 0.05) = 3.4148
1.74931 < 3.4148 -- No outliers detected for i = 4

Concentrations (mg/L) - Continued
Parameter: Zinc, Dissolved
Original Data (Not Transformed)
Non-Detects Replaced with Quantitation Limit
Percent Background Non-Detects: 44.8276%
Total Background Measurements: 116
There are 3 background locations

Loc.	Meas.	ND	Date	Conc.	Original
			7/23/2008	ND<0.03	ND<0.03
			10/22/2008	0.015 J	0.015 J
			1/13/2009	0.018 J	0.018 J
			4/8/2009	0.014 J	0.014 J
			7/15/2009	0.021 J	0.021 J
			1/7/2010	0.023 J	0.023 J
			4/7/2010	0.019 J	0.019 J
			7/7/2010	0.01 J	0.01 J
			8/16/2011	0.024 J	0.024 J
			10/26/2011	ND<0.03	ND<0.03
B-50	42	39 (92.8571%)	11/15/2001	0.014 J	0.014 J
			1/16/2002	ND<0.03	ND<0.03
			4/3/2002	ND<0.03	ND<0.03
			7/2/2002	ND<0.03	ND<0.03
			10/2/2002	ND<0.03	ND<0.03
			1/8/2003	ND<0.03	ND<0.03
			4/2/2003	ND<0.03	ND<0.03
			7/23/2003	ND<0.03	ND<0.03
			10/2/2003	ND<0.03	ND<0.03
			1/7/2004	ND<0.03	ND<0.03
			4/7/2004	ND<0.03	ND<0.03
			7/13/2004	ND<0.03	ND<0.03
			10/6/2004	ND<0.03	ND<0.03
			1/6/2005	ND<0.03	ND<0.03
			4/6/2005	ND<0.03	ND<0.03
			7/27/2005	ND<0.03	ND<0.03
			10/13/2005	ND<0.03	ND<0.03
			1/5/2006	ND<0.03	ND<0.03
			4/6/2006	ND<0.03	ND<0.03
			7/25/2006	ND<0.03	ND<0.03
			10/11/2006	ND<0.03	ND<0.03
			1/4/2007	ND<0.03	ND<0.03
			4/4/2007	ND<0.03	ND<0.03
			7/12/2007	ND<0.03	ND<0.03
			10/10/2007	0.012 J	0.012 J
			1/16/2008	ND<0.03	ND<0.03
			4/3/2008	ND<0.03	ND<0.03
			7/23/2008	ND<0.03	ND<0.03
			10/22/2008	ND<0.03	ND<0.03
			1/13/2009	ND<0.03	ND<0.03
			4/8/2009	ND<0.03	ND<0.03
			7/15/2009	ND<0.03	ND<0.03
			10/8/2009	ND<0.03	ND<0.03
			1/7/2010	ND<0.03	ND<0.03
			4/7/2010	ND<0.03	ND<0.03
			7/7/2010	ND<0.03	ND<0.03
			12/8/2010	ND<0.03	ND<0.03
			2/3/2011	ND<0.03	ND<0.03
			4/13/2011	ND<0.03	ND<0.03
			8/16/2011	0.014 J	0.014 J
			10/26/2011	ND<0.03	ND<0.03
			1/18/2012	ND<0.03	ND<0.03

Concentrations (mg/L)
Parameter: Zinc, Dissolved
Original Data (Not Transformed)
Non-Detects Replaced with Quantitation Limit
Percent Background Non-Detects: 44.8276%
Total Background Measurements: 116
There are 3 background locations

Loc.	Meas.	ND	Date	Conc.	Original
B-52	42	4 (9.52381%)	11/15/2001	0.037	0.037
			1/16/2002	0.032	0.032
			4/3/2002	0.03	0.03
			7/2/2002	0.018 J	0.018 J
			10/2/2002	0.017 J	0.017 J
			1/8/2003	0.018 J	0.018 J
			4/2/2003	0.013 J	0.013 J
			7/23/2003	0.023 J	0.023 J
			10/2/2003	0.013 J	0.013 J
			1/7/2004	0.029 J	0.029 J
			4/7/2004	0.03	0.03
			7/13/2004	0.021 J	0.021 J
			10/6/2004	0.03	0.03
			1/6/2005	0.022 J	0.022 J
			4/6/2005	0.028 J	0.028 J
			7/27/2005	0.019 J	0.019 J
			10/13/2005	0.012 J	0.012 J
			1/5/2006	0.019 J	0.019 J
			4/6/2006	0.01 J	0.01 J
			7/25/2006	0.012 J	0.012 J
			10/11/2006	0.015 J	0.015 J
			1/4/2007	0.016 J	0.016 J
			4/4/2007	0.015 J	0.015 J
			7/12/2007	ND<0.03	ND<0.03
			10/10/2007	0.031	0.031
			1/16/2008	ND<0.03	ND<0.03
			4/3/2008	0.014 J	0.014 J
			7/23/2008	0.016 J	0.016 J
			10/22/2008	0.015 J	0.015 J
			1/13/2009	0.011 J	0.011 J
			4/8/2009	0.011 J	0.011 J
			7/15/2009	0.012 J	0.012 J
			10/8/2009	0.011 J	0.011 J
			1/7/2010	ND<0.03	ND<0.03
			4/7/2010	0.014 J	0.014 J
			7/7/2010	ND<0.03	ND<0.03
			12/8/2010	0.011 J	0.011 J
			2/3/2011	0.019 J	0.019 J
			4/13/2011	0.023 J	0.023 J
			8/16/2011	0.027 J	0.027 J
			10/26/2011	0.016 J	0.016 J
			1/18/2012	0.028 J	0.028 J
B-51	32	9 (28.125%)	11/15/2001	0.028 J	0.028 J
			10/2/2002	ND<0.03	ND<0.03
			1/8/2003	ND<0.03	ND<0.03
			4/2/2003	0.013 J	0.013 J
			7/23/2003	ND<0.03	ND<0.03
			10/2/2003	0.033	0.033
			1/7/2004	0.013 J	0.013 J
			4/7/2004	0.02 J	0.02 J
			7/13/2004	ND<0.03	ND<0.03
			10/6/2004	0.021 J	0.021 J
			1/6/2005	0.014 J	0.014 J
			4/6/2005	ND<0.03	ND<0.03
			7/27/2005	0.01 J	0.01 J
			10/13/2005	ND<0.03	ND<0.03
			1/5/2006	0.019 J	0.019 J
			4/6/2006	ND<0.03	ND<0.03
			7/25/2006	0.012 J	0.012 J
			10/11/2006	0.017 J	0.017 J
			1/4/2007	0.02 J	0.02 J
			4/4/2007	0.013 J	0.013 J
			7/12/2007	0.014 J	0.014 J
			10/10/2007	0.041	0.041

Non-Parametric Prediction Interval
Inter-Well Comparison
Parameter: Manganese, Dissolved
Original Data (Not Transformed)
Non-Detects Replaced with Quantitation Limit

Number of comparisons = 7
Future Samples (k) = 1
Recent Dates = 1
Background Measurements (n) = 103
Maximum Background Value = 4.42
Confidence Level = 99%
False Positive Rate = 1%

Location	Date	Count	Mean	Significant
B-30A	4/4/2012	1	1.23	FALSE
B-32	4/4/2012	1	1.91	FALSE
DM-7	4/4/2012	1	0.05	FALSE
DM-6	4/4/2012	1	0.03	FALSE
B-31	4/4/2012	1	0.02	FALSE
DM-5	4/4/2012	1	0.48	FALSE
DM-1	4/4/2012	1	0.27	FALSE

Shapiro-Francia Test of Normality (Continued)

Parameter: Manganese, Dissolved
Background Locations
Normality Test of Parameter Concentrations
Natural Logarithm Transformation
Non-Detects Replaced with 1/2 LOQ
Total Number of Measurements = 103

i	x(i)	m(i)	sum(m^2)	sum(mx)
66	0.576613	0.345126	48.5642	139.173
67	0.815365	0.371856	48.7025	139.476
68	0.883768	0.396142	48.8594	139.826
69	0.920283	0.423405	49.0387	140.216
70	0.95935	0.450985	49.2421	140.649
71	0.963174	0.476105	49.4688	141.107
72	0.963174	0.504372	49.7232	141.593
73	0.963174	0.530162	50.0042	142.104
74	1.0043	0.559237	50.317	142.665
75	1.04732	0.588793	50.6637	143.282
76	1.07158	0.615839	51.0429	143.942
77	1.08181	0.646431	51.4608	144.641
78	1.09861	0.67449	51.9157	145.382
79	1.11186	0.706302	52.4146	146.167
80	1.19089	0.738846	52.9605	147.047
81	1.20597	0.768821	53.5516	147.974
82	1.22083	0.802956	54.1963	148.955
83	1.22964	0.838054	54.8986	149.985
84	1.23547	0.87055	55.6565	151.061
85	1.24703	0.907769	56.4805	152.193
86	1.25276	0.942375	57.3686	153.373
87	1.25846	0.982202	58.3333	154.609
88	1.26413	1.02365	59.3812	155.903
89	1.31641	1.06252	60.5102	157.302
90	1.335	1.10768	61.7371	158.781
91	1.33763	1.15035	63.0604	160.32
92	1.35067	1.20036	64.5013	161.941
93	1.35584	1.25357	66.0727	163.641
94	1.37118	1.30469	67.7749	165.43
95	1.37372	1.36581	69.6403	167.306
96	1.41099	1.4325	71.6924	169.327
97	1.41099	1.49852	73.938	171.441
98	1.41342	1.58047	76.4358	173.675
99	1.43746	1.66456	79.2066	176.068
100	1.46326	1.77438	82.355	178.664
101	1.47018	1.91103	86.007	181.474
102	1.48614	2.07485	90.312	184.557
103	1.48614	2.36561	95.9082	188.073

Data Set Standard Deviation = 2.10883
Numerator = 35371.5
Denominator = 43504.9
W Statistic = 0.813046 = 35371.5 / 43504.9

5% Critical value of 0.976 exceeds 0.813046
Evidence of non-normality at 95% level of significance

Shapiro-Francia Test of Normality
Parameter: Manganese, Dissolved
Background Locations
Normality Test of Parameter Concentrations
Natural Logarithm Transformation
Non-Detects Replaced with 1/2 LOQ
Total Number of Measurements = 103

i	x(i)	m(i)	sum(m^2)	sum(mx)
1	-3.91202	-2.36561	5.59613	9.25434
2	-3.91202	-2.07485	9.90113	17.3712
3	-3.91202	-1.91103	13.5532	24.8472
4	-3.91202	-1.77438	16.7016	31.7886
5	-3.91202	-1.66456	19.4723	38.3004
6	-3.91202	-1.58047	21.9702	44.4832
7	-3.91202	-1.49852	24.2158	50.3454
8	-3.91202	-1.4325	26.2678	55.9494
9	-3.91202	-1.36581	28.1333	61.2925
10	-3.91202	-1.30469	29.8355	66.3965
11	-3.50656	-1.25357	31.4069	70.7922
12	-3.50656	-1.20036	32.8478	75.0013
13	-3.50656	-1.15035	34.1711	79.0351
14	-3.50656	-1.10768	35.398	82.9192
15	-3.50656	-1.06252	36.527	86.645
16	-3.50656	-1.02365	37.5748	90.2345
17	-3.50656	-0.982202	38.5396	93.6786
18	-3.50656	-0.942375	39.4276	96.9831
19	-3.50656	-0.907769	40.2517	100.166
20	-3.50656	-0.87055	41.0095	103.219
21	-3.21888	-0.838054	41.7119	105.916
22	-3.21888	-0.802956	42.3566	108.501
23	-3.21888	-0.768821	42.9477	110.976
24	-3.21888	-0.738846	43.4936	113.354
25	-3.21888	-0.706302	43.9924	115.628
26	-3.21888	-0.67449	44.4474	117.799
27	-3.21888	-0.646431	44.8652	119.879
28	-3.21888	-0.615839	45.2445	121.862
29	-2.99573	-0.588793	45.5912	123.626
30	-2.99573	-0.559237	45.9039	125.301
31	-2.99573	-0.530162	46.185	126.889
32	-2.99573	-0.504372	46.4394	128.4
33	-2.99573	-0.476105	46.6661	129.826
34	-2.99573	-0.450985	46.8695	131.177
35	-2.99573	-0.423405	47.0487	132.446
36	-2.99573	-0.396142	47.2057	133.633
37	-2.99573	-0.371856	47.3439	134.747
38	-2.99573	-0.345126	47.463	135.781
39	-2.99573	-0.318639	47.5646	136.735
40	-2.99573	-0.294992	47.6516	137.619
41	-2.99573	-0.268908	47.7239	138.424
42	-2.99573	-0.24559	47.7842	139.16
43	-2.99573	-0.219834	47.8325	139.819
44	-2.81341	-0.194225	47.8703	140.365
45	-2.81341	-0.171285	47.8996	140.847
46	-2.81341	-0.1459	47.9209	141.257
47	-2.81341	-0.123135	47.9361	141.604
48	-2.81341	-0.0979139	47.9456	141.879
49	-2.81341	-0.0727562	47.9509	142.084
50	-2.65926	-0.0501541	47.9535	142.217
51	-2.65926	-0.0250691	47.9541	142.284
52	-2.40795	0	47.9541	142.284
53	-2.40795	0.0250691	47.9547	142.224
54	-2.30259	0.0501541	47.9572	142.108
55	-2.12026	0.0727562	47.9625	141.954
56	-2.04022	0.0979139	47.9721	141.754
57	-1.96611	0.123135	47.9873	141.512
58	-1.96611	0.1459	48.0086	141.225
59	-1.89712	0.171285	48.0379	140.9
60	-1.83258	0.194225	48.0756	140.544
61	-1.83258	0.219834	48.1239	140.142
62	-1.83258	0.24559	48.1843	139.691
63	-1.60944	0.268908	48.2566	139.259
64	-1.17118	0.294992	48.3436	138.913
65	0.19062	0.318639	48.4451	138.974

Shapiro-Francia Test of Normality (Continued)
Parameter: Manganese, Dissolved
Background Locations
Normality Test of Parameter Concentrations
Original Data (Not Transformed)
Non-Detects Replaced with 1/2 LOQ
Total Number of Measurements = 103

i	x(i)	m(i)	sum(m^2)	sum(mx)
66	1.78	0.345126	48.5642	0.103305
67	2.26	0.371856	48.7025	0.9437
68	2.42	0.396142	48.8594	1.90236
69	2.51	0.423405	49.0387	2.96511
70	2.61	0.450985	49.2421	4.14218
71	2.62	0.476105	49.4688	5.38958
72	2.62	0.504372	49.7232	6.71103
73	2.62	0.530162	50.0042	8.10005
74	2.73	0.559237	50.317	9.62677
75	2.85	0.588793	50.6637	11.3048
76	2.92	0.615839	51.0429	13.1031
77	2.95	0.646431	51.4608	15.0101
78	3	0.67449	51.9157	17.0335
79	3.04	0.706302	52.4146	19.1807
80	3.29	0.738846	52.9605	21.6115
81	3.34	0.768821	53.5516	24.1793
82	3.39	0.802956	54.1963	26.9014
83	3.42	0.838054	54.8986	29.7675
84	3.44	0.87055	55.6565	32.7622
85	3.48	0.907769	56.4805	35.9212
86	3.5	0.942375	57.3686	39.2196
87	3.52	0.982202	58.3333	42.6769
88	3.54	1.02365	59.3812	46.3006
89	3.73	1.06252	60.5102	50.2638
90	3.8	1.10768	61.7371	54.473
91	3.81	1.15035	63.0604	58.8559
92	3.86	1.20036	64.5013	63.4892
93	3.88	1.25357	66.0727	68.3531
94	3.94	1.30469	67.7749	73.4935
95	3.95	1.36581	69.6403	78.8885
96	4.1	1.4325	71.6924	84.7617
97	4.1	1.49852	73.938	90.9057
98	4.11	1.58047	76.4358	97.4014
99	4.21	1.66456	79.2066	104.409
100	4.32	1.77438	82.355	112.074
101	4.35	1.91103	86.007	120.387
102	4.42	2.07485	90.312	129.558
103	4.42	2.36561	95.9082	140.014

Data Set Standard Deviation = 1.66086
Numerator = 19604
Denominator = 26985.1
W Statistic = 0.726476 = 19604 / 26985.1

5% Critical value of 0.976 exceeds 0.726476
Evidence of non-normality at 95% level of significance

Shapiro-Francia Test of Normality
Parameter: Manganese, Dissolved
Background Locations
Normality Test of Parameter Concentrations
Original Data (Not Transformed)
Non-Detects Replaced with 1/2 LOQ
Total Number of Measurements = 103

i	x(i)	m(i)	sum(m^2)	sum(mx)
1	0.02	-2.36561	5.59613	-0.0473123
2	0.02	-2.07485	9.90113	-0.0888092
3	0.02	-1.91103	13.5532	-0.12703
4	0.02	-1.77438	16.7016	-0.162517
5	0.02	-1.66456	19.4723	-0.195809
6	0.02	-1.58047	21.9702	-0.227418
7	0.02	-1.49852	24.2158	-0.257388
8	0.02	-1.4325	26.2678	-0.286038
9	0.02	-1.36581	28.1333	-0.313354
10	0.02	-1.30469	29.8355	-0.339448
11	0.03	-1.25357	31.4069	-0.377055
12	0.03	-1.20036	32.8478	-0.413066
13	0.03	-1.15035	34.1711	-0.447576
14	0.03	-1.10768	35.398	-0.480807
15	0.03	-1.06252	36.527	-0.512682
16	0.03	-1.02365	37.5748	-0.543392
17	0.03	-0.982202	38.5396	-0.572858
18	0.03	-0.942375	39.4276	-0.601129
19	0.03	-0.907769	40.2517	-0.628362
20	0.03	-0.87055	41.0095	-0.654479
21	0.04	-0.838054	41.7119	-0.688001
22	0.04	-0.802956	42.3566	-0.720119
23	0.04	-0.768821	42.9477	-0.750872
24	0.04	-0.738846	43.4936	-0.780426
25	0.04	-0.706302	43.9924	-0.808678
26	0.04	-0.67449	44.4474	-0.835658
27	0.04	-0.646431	44.8652	-0.861515
28	0.04	-0.615839	45.2445	-0.886149
29	0.05	-0.588793	45.5912	0.915588
30	0.05	-0.559237	45.9039	-0.94355
31	0.05	-0.530162	46.185	-0.970058
32	0.05	-0.504372	46.4394	-0.995277
33	0.05	-0.476105	46.6661	-1.01908
34	0.05	-0.450985	46.8695	-1.04163
35	0.05	-0.423405	47.0487	-1.0628
36	0.05	-0.396142	47.2057	-1.08261
37	0.05	-0.371856	47.3439	-1.1012
38	0.05	-0.345126	47.463	-1.11846
39	0.05	-0.318639	47.5646	-1.13439
40	0.05	-0.294992	47.6516	-1.14914
41	0.05	-0.268908	47.7239	-1.16258
42	0.05	-0.24559	47.7842	-1.17486
43	0.05	-0.219834	47.8325	-1.18586
44	0.06	-0.194225	47.8703	-1.19751
45	0.06	-0.171285	47.8996	-1.20779
46	0.06	-0.1459	47.9209	-1.21654
47	0.06	-0.123135	47.9361	-1.22393
48	0.06	-0.0979139	47.9456	-1.2298
49	0.06	-0.0727562	47.9509	-1.23417
50	0.07	-0.0501541	47.9535	-1.23768
51	0.07	-0.0250691	47.9541	-1.23943
52	0.09	0	47.9541	-1.23943
53	0.09	0.0250691	47.9547	-1.23718
54	0.1	0.0501541	47.9572	-1.23216
55	0.12	0.0727562	47.9625	-1.22343
56	0.13	0.0979139	47.9721	-1.2107
57	0.14	0.123135	47.9873	-1.19346
58	0.14	0.1459	48.0086	-1.17304
59	0.15	0.171285	48.0379	-1.14735
60	0.16	0.194225	48.0756	-1.11627
61	0.16	0.219834	48.1239	-1.0811
62	0.16	0.24559	48.1843	-1.0418
63	0.2	0.268908	48.2566	-0.98802
64	0.31	0.294992	48.3436	-0.896572
65	1.21	0.318639	48.4451	-0.511019

Rosner's Test for Outliers (Continued)
Parameter: Manganese, Dissolved
Background Locations
Original Data (Not Transformed)
Non-Detects Replaced with Quantitation Limit

Iteration i = 3
Mean of 100 measurements = 1.2139
Std Dev = 1.59109
x(i+1) = 4.32 from measurement 11/15/2001 from location B-50
Rosner Statistic R = |4.32 - 1.2139|/1.59109 = 1.95218
Lambda(103, 4, 0.05) = 3.3784
1.95218 < 3.3784 -- No outliers detected for i = 3

Iteration i = 2
Mean of 101 measurements = 1.24495
Std Dev = 1.61358
x(i+1) = 4.35 from measurement 1/6/2005 from location B-50
Rosner Statistic R = |4.35 - 1.24495|/1.61358 = 1.92432
Lambda(103, 3, 0.05) = 3.3878
1.92432 < 3.3878 -- No outliers detected for i = 2

Iteration i = 1
Mean of 102 measurements = 1.27608
Std Dev = 1.63606
x(i+1) = 4.42 from measurement 4/7/2004 from location B-50
Rosner Statistic R = |4.42 - 1.27608|/1.63606 = 1.92164
Lambda(103, 2, 0.05) = 3.3878
1.92164 < 3.3878 -- No outliers detected for i = 1

Iteration i = 0
Mean of 103 measurements = 1.3066
Std Dev = 1.65723
x(i+1) = 4.42 from measurement 7/13/2004 from location B-50
Rosner Statistic R = |4.42 - 1.3066|/1.65723 = 1.87867
Lambda(103, 1, 0.05) = 3.3884
1.87867 < 3.3884 -- No outliers detected for i = 0

NO OUTLIERS DETECTED

Rosner's Test for Outliers
Parameter: Manganese, Dissolved
Background Locations
Original Data (Not Transformed)
Non-Detects Replaced with Quantitation Limit

Data set mean = 1.3066

10 most extreme of 103 measurements
by order of magnitude difference from the mean

1	7/13/2004	B-50	4.42	3.1134
2	4/7/2004	B-50	4.42	3.1134
3	1/6/2005	B-50	4.35	3.0434
4	11/15/2001	B-50	4.32	3.0134
5	10/6/2004	B-50	4.21	2.9034
6	4/4/2007	B-50	4.11	2.8034
7	10/2/2003	B-50	4.1	2.7934
8	1/7/2004	B-50	4.1	2.7934
9	4/6/2005	B-50	3.95	2.6434
10	1/5/2006	B-50	3.94	2.6334

Iteration i = 9
Mean of 94 measurements = 1.02766
Std Dev = 1.4525
x(i+1) = 3.94 from measurement 1/5/2006 from location B-50
Rosner Statistic R = |3.94 - 1.02766|/1.4525 = 2.00505
Lambda(103, 10, 0.05) = 3.359
2.00505 < 3.359 -- No outliers detected for i = 9

Iteration i = 8
Mean of 95 measurements = 1.05842
Std Dev = 1.47554
x(i+1) = 3.95 from measurement 4/6/2005 from location B-50
Rosner Statistic R = |3.95 - 1.05842|/1.47554 = 1.95967
Lambda(103, 9, 0.05) = 3.36288
1.95967 < 3.36288 -- No outliers detected for i = 8

Iteration i = 7
Mean of 96 measurements = 1.0901
Std Dev = 1.50022
x(i+1) = 4.1 from measurement 1/7/2004 from location B-50
Rosner Statistic R = |4.1 - 1.0901|/1.50022 = 2.0063
Lambda(103, 8, 0.05) = 3.36676
2.0063 < 3.36676 -- No outliers detected for i = 7

Iteration i = 6
Mean of 97 measurements = 1.12113
Std Dev = 1.52336
x(i+1) = 4.1 from measurement 10/2/2003 from location B-50
Rosner Statistic R = |4.1 - 1.12113|/1.52336 = 1.95546
Lambda(103, 7, 0.05) = 3.37064
1.95546 < 3.37064 -- No outliers detected for i = 6

Iteration i = 5
Mean of 98 measurements = 1.15163
Std Dev = 1.54527
x(i+1) = 4.11 from measurement 4/4/2007 from location B-50
Rosner Statistic R = |4.11 - 1.15163|/1.54527 = 1.91447
Lambda(103, 6, 0.05) = 3.37452
1.91447 < 3.37452 -- No outliers detected for i = 5

Iteration i = 4
Mean of 99 measurements = 1.18253
Std Dev = 1.56779
x(i+1) = 4.21 from measurement 10/6/2004 from location B-50
Rosner Statistic R = |4.21 - 1.18253|/1.56779 = 1.93105
Lambda(103, 5, 0.05) = 3.3784
1.93105 < 3.3784 -- No outliers detected for i = 4

Concentrations (mg/L) - Continued
Parameter: Manganese, Dissolved
Original Data (Not Transformed)
Non-Detects Replaced with Quantitation Limit
Percent Background Non-Detects: 9.7087%
Total Background Measurements: 103
There are 3 background locations

Loc.	Meas.	ND	Date	Conc.	Original
B-50	37	0 (0%)	11/15/2001	4.32	4.32
			4/3/2002	3.88	3.88
			4/2/2003	3.8	3.8
			10/2/2003	4.1	4.1
			1/7/2004	4.1	4.1
			4/7/2004	4.42	4.42
			7/13/2004	4.42	4.42
			10/6/2004	4.21	4.21
			1/6/2005	4.35	4.35
			4/6/2005	3.95	3.95
			7/27/2005	3.52	3.52
			10/13/2005	3.73	3.73
			1/5/2006	3.94	3.94
			4/6/2006	3.39	3.39
			7/25/2006	3.42	3.42
			10/11/2006	3.48	3.48
			1/4/2007	3.81	3.81
			4/4/2007	4.11	4.11
			7/12/2007	3.86	3.86
			10/10/2007	3.29	3.29
			1/16/2008	2.92	2.92
			4/3/2008	3.44	3.44
			7/23/2008	2.61	2.61
			10/22/2008	2.73	2.73
			1/13/2009	3.04	3.04
			4/8/2009	3.5	3.5
			7/15/2009	2.62	2.62
			10/8/2009	2.26	2.26
			1/7/2010	3.34	3.34
			4/7/2010	3.54	3.54
			7/7/2010	2.85	2.85
			12/8/2010	2.62	2.62
			2/3/2011	2.42	2.42
			4/13/2011	2.51	2.51
			8/16/2011	3	3
			10/26/2011	2.62	2.62
			1/18/2012	2.95	2.95

Concentrations (mg/L)
Parameter: Manganese, Dissolved
Original Data (Not Transformed)
Non-Detects Replaced with Quantitation Limit
Percent Background Non-Detects: 9.7087%
Total Background Measurements: 103
There are 3 background locations

Loc.	Meas.	ND	Date	Conc.	Original
B-S2	37	1 (2.7027%)	11/15/2001	1.78	1.78
			4/3/2002	1.21	1.21
			4/2/2003	0.2	0.2
			10/2/2003	0.16	0.16
			1/7/2004	0.15	0.15
			4/7/2004	0.16	0.16
			7/13/2004	0.12	0.12
			10/6/2004	0.14	0.14
			1/6/2005	0.16	0.16
			4/6/2005	0.13	0.13
			7/27/2005	0.14	0.14
			10/13/2005	0.04 J	0.04 J
			1/5/2006	0.09 J	0.09 J
			4/6/2006	0.03 J	0.03 J
			7/25/2006	0.05 J	0.05 J
			10/11/2006	0.04 J	0.04 J
			1/4/2007	0.1	0.1
			4/4/2007	0.07 J	0.07 J
			7/12/2007	0.06 J	0.06 J
			10/10/2007	0.06 J	0.06 J
			1/16/2008	0.04 J	0.04 J
			4/3/2008	0.07 J	0.07 J
			7/23/2008	0.06 J	0.06 J
			10/22/2008	0.04 J	0.04 J
			1/13/2009	0.09 J	0.09 J
			4/8/2009	0.03 J	0.03 J
			7/15/2009	0.03 J	0.03 J
			10/8/2009	0.05 J	0.05 J
			1/7/2010	0.02 J	0.02 J
			4/7/2010	ND<0.1	ND<0.1
			7/7/2010	0.03 J	0.03 J
			12/8/2010	0.02 J	0.02 J
			2/3/2011	0.04 J	0.04 J
			4/13/2011	0.02 J	0.02 J
			8/16/2011	0.03 J	0.03 J
			10/26/2011	0.06	0.06
			1/18/2012	0.02 J	0.02 J
B-S1	29	9 (31.0345%)	11/15/2001	0.31	0.31
			4/2/2003	0.06 J	0.06 J
			10/2/2003	0.06 J	0.06 J
			1/7/2004	0.05 J	0.05 J
			4/7/2004	0.05 J	0.05 J
			7/13/2004	0.03 J	0.03 J
			10/6/2004	0.04 J	0.04 J
			1/6/2005	0.02 J	0.02 J
			4/6/2005	ND<0.1	ND<0.1
			7/27/2005	0.04 J	0.04 J
			10/13/2005	0.02 J	0.02 J
			1/5/2006	0.05 J	0.05 J
			4/6/2006	ND<0.1	ND<0.1
			7/25/2006	0.03 J	0.03 J
			10/11/2006	ND<0.1	ND<0.1
			1/4/2007	0.03 J	0.03 J
			4/4/2007	0.03 J	0.03 J
			7/12/2007	0.02 J	0.02 J
			10/10/2007	0.02 J	0.02 J
			7/23/2008	ND<0.1	ND<0.1
			10/22/2008	ND<0.1	ND<0.1
			1/13/2009	0.04 J	0.04 J
			4/8/2009	ND<0.1	ND<0.1
			7/15/2009	ND<0.1	ND<0.1
			1/7/2010	ND<0.1	ND<0.1
			4/7/2010	ND<0.1	ND<0.1
			7/7/2010	0.02 J	0.02 J
			8/16/2011	0.02 J	0.02 J
			10/26/2011	0.03 J	0.03 J

Non-Parametric Prediction Interval
Inter-Well Comparison
Parameter: Iron, Dissolved
Original Data (Not Transformed)
Non-Detects Replaced with Quantitation Limit

Number of comparisons = 7
Future Samples (k) = 1
Recent Dates = 1
Background Measurements (n) = 116
Maximum Background Value = 18.4
Confidence Level = 99%
False Positive Rate = 1%

Location	Date	Count	Mean	Significant
B-30A	4/4/2012	1	21.23	TRUE
B-32	4/4/2012	1	0.25	FALSE
B-31	4/4/2012	1	0.25	FALSE
DM-1	4/4/2012	1	2.19	FALSE
DM-7	4/4/2012	1	0.06	FALSE
DM-6	4/4/2012	1	0.25	FALSE
DM-5	4/4/2012	1	0.25	FALSE

Shapiro-Francia Test of Normality (Continued)
Parameter: Iron, Dissolved
Background Locations
Normality Test of Parameter Concentrations
Natural Logarithm Transformation
Non-Detects Replaced with Quantitation Limit
Total Number of Measurements = 116

i	x(i)	m(i)	sum(m^2)	sum(mx)
66	-1.38629	0.163659	54.4516	96.4244
67	-1.38629	0.184017	54.4854	96.1693
68	-1.38629	0.207012	54.5283	95.8824
69	-1.38629	0.227545	54.5801	95.5669
70	-1.38629	0.250759	54.643	95.2193
71	-1.38629	0.271509	54.7167	94.8429
72	-1.38629	0.294992	54.8037	94.434
73	-0.597837	0.316004	54.9036	94.245
74	-0.579818	0.33981	55.019	94.048
75	-0.371064	0.363809	55.1514	93.913
76	-0.34249	0.385321	55.2999	93.781
77	0.494696	0.409735	55.4677	93.9837
78	0.559616	0.431644	55.6541	94.2253
79	0.828552	0.456542	55.8625	94.6036
80	1.08856	0.478914	56.0918	95.1249
81	1.09527	0.504372	56.3462	95.6773
82	1.12817	0.52728	56.6243	96.2722
83	1.24415	0.553384	56.9305	96.9607
84	1.27536	0.576911	57.2633	97.6964
85	1.35584	0.603765	57.6278	98.515
86	1.38629	0.631062	58.0261	99.3899
87	1.45629	0.655726	58.4561	100.345
88	1.4816	0.68396	58.9239	101.358
89	1.58924	0.709522	59.4273	102.486
90	1.59737	0.738846	59.9732	103.666
91	1.6901	0.765456	60.5591	104.96
92	1.77834	0.796056	61.1928	106.375
93	1.78842	0.823893	61.8716	107.849
94	1.79509	0.855996	62.6043	109.385
95	1.96431	0.885291	63.3881	111.124
96	2.04511	0.919183	64.233	113.004
97	2.13417	0.954165	65.1434	115.041
98	2.20937	0.986272	66.1161	117.22
99	2.23001	1.02365	67.164	119.502
100	2.25863	1.05812	68.2836	121.892
101	2.26384	1.09847	69.4903	124.379
102	2.31944	1.1359	70.7805	127.014
103	2.32825	1.18	72.1729	129.761
104	2.3302	1.22123	73.6643	132.607
105	2.33892	1.27024	75.2778	135.578
106	2.3988	1.31652	77.011	138.736
107	2.45445	1.3722	78.894	142.104
108	2.56879	1.4325	80.9461	145.784
109	2.61667	1.49085	83.1687	149.685
110	2.65886	1.56322	85.6124	153.841
111	2.71734	1.63524	88.2864	158.285
112	2.73046	1.72793	91.2721	163.003
113	2.80215	1.82501	94.6027	168.116
114	2.81421	1.95996	98.4442	173.632
115	2.83615	2.12007	102.939	179.645
116	2.91235	2.40892	108.742	186.661

Data Set Standard Deviation = 1.81321
Numerator = 34842.2
Denominator = 41114.3
W Statistic = 0.847449 = 34842.2 / 41114.3

5% Critical value of 0.976 exceeds 0.847449
Evidence of non-normality at 95% level of significance

Shapiro-Francia Test of Normality
Parameter: Iron, Dissolved
Background Locations
Normality Test of Parameter Concentrations
Natural Logarithm Transformation
Non-Detects Replaced with Quantitation Limit
Total Number of Measurements = 116

i	x(i)	m(i)	sum(m^2)	sum(mx)
1	-2.99573	-2.40892	5.80292	7.21649
2	-2.81341	-2.12007	10.2976	13.1811
3	-2.81341	-1.95996	14.1391	18.6953
4	-2.81341	-1.82501	17.4697	23.8298
5	-2.81341	-1.72793	20.4554	28.6912
6	-2.81341	-1.63524	23.1294	33.2917
7	-2.81341	-1.56322	25.5731	37.6897
8	-2.81341	-1.49085	27.7957	41.8841
9	-2.65926	-1.4325	29.8478	45.6935
10	-2.65926	-1.3722	31.7308	49.3426
11	-2.65926	-1.31652	33.464	52.8435
12	-2.52573	-1.27024	35.0775	56.0518
13	-2.52573	-1.22123	36.5689	59.1363
14	-2.52573	-1.18	37.9613	62.1167
15	-2.30259	-1.1359	39.2515	64.7322
16	-2.20727	-1.09847	40.4582	67.1568
17	-2.20727	-1.05812	41.5778	69.4923
18	-1.96611	-1.02365	42.6257	71.505
19	-1.60944	-0.986272	43.5984	73.0923
20	-1.42712	-0.954165	44.5088	74.454
21	-1.38629	-0.919183	45.3537	75.7283
22	-1.38629	-0.885291	46.1375	76.9555
23	-1.38629	-0.855996	46.8702	78.1422
24	-1.38629	-0.823893	47.549	79.2844
25	-1.38629	-0.796056	48.1827	80.3879
26	-1.38629	-0.765456	48.7686	81.4491
27	-1.38629	-0.738846	49.3145	82.4733
28	-1.38629	-0.709522	49.8179	83.4569
29	-1.38629	-0.68396	50.2857	84.4051
30	-1.38629	-0.655726	50.7157	85.3141
31	-1.38629	-0.631062	51.114	86.189
32	-1.38629	-0.603765	51.4785	87.026
33	-1.38629	-0.576911	51.8113	87.8257
34	-1.38629	-0.553384	52.1175	88.5929
35	-1.38629	-0.52728	52.3956	89.3239
36	-1.38629	-0.504372	52.65	90.0231
37	-1.38629	-0.478914	52.8793	90.687
38	-1.38629	-0.456542	53.0877	91.3199
39	-1.38629	-0.431644	53.2741	91.9183
40	-1.38629	-0.409735	53.4419	92.4863
41	-1.38629	-0.385321	53.5904	93.0205
42	-1.38629	-0.363809	53.7228	93.5248
43	-1.38629	-0.33981	53.8382	93.9959
44	-1.38629	-0.316004	53.9381	94.434
45	-1.38629	-0.294992	54.0251	94.8429
46	-1.38629	-0.271509	54.0988	95.2193
47	-1.38629	-0.250759	54.1617	95.5669
48	-1.38629	-0.227545	54.2135	95.8824
49	-1.38629	-0.207012	54.2564	96.1693
50	-1.38629	-0.184017	54.2902	96.4244
51	-1.38629	-0.163659	54.317	96.6513
52	-1.38629	-0.140835	54.3368	96.8466
53	-1.38629	-0.12061	54.3514	97.0138
54	-1.38629	-0.0979139	54.361	97.1495
55	-1.38629	-0.0752698	54.3666	97.2538
56	-1.38629	-0.0551734	54.3697	97.3303
57	-1.38629	-0.0325917	54.3707	97.3755
58	-1.38629	-0.0125328	54.3709	97.3929
59	-1.38629	0.0125328	54.3711	97.3755
60	-1.38629	0.0325917	54.3721	97.3303
61	-1.38629	0.0551734	54.3752	97.2538
62	-1.38629	0.0752698	54.3808	97.1495
63	-1.38629	0.0979139	54.3904	97.0138
64	-1.38629	0.12061	54.405	96.8466
65	-1.38629	0.140835	54.4248	96.6513

Shapiro-Francia Test of Normality (Continued)
Parameter: Iron, Dissolved
Background Locations
Normality Test of Parameter Concentrations
Original Data (Not Transformed)
Non-Detects Replaced with Quantitation Limit
Total Number of Measurements = 116

i	x(i)	m(i)	sum(m^2)	sum(mx)
66	0.25	0.163659	54.4516	-6.32445
67	0.25	0.184017	54.4854	-6.27844
68	0.25	0.207012	54.5283	-6.22669
69	0.25	0.227545	54.5801	-6.1698
70	0.25	0.250759	54.643	-6.10711
71	0.25	0.271509	54.7167	-6.03923
72	0.25	0.294992	54.8037	-5.96549
73	0.55	0.316004	54.9036	-5.79168
74	0.56	0.33981	55.019	-5.60139
75	0.69	0.363809	55.1514	-5.35036
76	0.71	0.385321	55.2999	-5.07678
77	1.64	0.409735	55.4677	-4.40482
78	1.75	0.431644	55.6541	-3.64944
79	2.29	0.456542	55.8625	-2.60396
80	2.97	0.478914	56.0918	-1.18159
81	2.99	0.504372	56.3462	0.326486
82	3.09	0.52728	56.6243	1.95578
83	3.47	0.553384	56.9305	3.87602
84	3.58	0.576911	57.2633	5.94136
85	3.88	0.603765	57.6278	8.28397
86	4	0.631062	58.0261	10.8082
87	4.29	0.655726	58.4561	13.6213
88	4.4	0.68396	58.9239	16.6307
89	4.9	0.709522	59.4273	20.1074
90	4.94	0.738846	59.9732	23.7573
91	5.42	0.765456	60.5591	27.906
92	5.92	0.796056	61.1928	32.6187
93	5.98	0.823893	61.8716	37.5456
94	6.02	0.855996	62.6043	42.6987
95	7.13	0.885291	63.3881	49.0108
96	7.73	0.919183	64.233	56.1161
97	8.45	0.954165	65.1434	64.1788
98	9.11	0.986272	66.1161	73.1637
99	9.3	1.02365	67.164	82.6837
100	9.57	1.05812	68.2836	92.8099
101	9.62	1.09847	69.4903	103.377
102	10.17	1.1359	70.7805	114.929
103	10.26	1.18	72.1729	127.036
104	10.28	1.22123	73.6643	139.59
105	10.37	1.27024	75.2778	152.763
106	11.01	1.31652	77.011	167.258
107	11.64	1.3722	78.894	183.23
108	13.05	1.4325	80.9461	201.924
109	13.69	1.49085	83.1687	222.334
110	14.28	1.56322	85.6124	244.657
111	15.14	1.63524	88.2864	269.414
112	15.34	1.72793	91.2721	295.921
113	16.48	1.82501	94.6027	325.997
114	16.68	1.95996	98.4442	358.689
115	17.05	2.12007	102.939	394.836
116	18.4	2.40892	108.742	439.16

Data Set Standard Deviation = 4.8125
Numerator = 192862
Denominator = 289625
W Statistic = 0.665902 = 192862 / 289625

5% Critical value of 0.976 exceeds 0.665902
Evidence of non-normality at 95% level of significance

Shapiro-Francia Test of Normality
Parameter: Iron, Dissolved
Background Locations
Normality Test of Parameter Concentrations
Original Data (Not Transformed)
Non-Detects Replaced with Quantitation Limit
Total Number of Measurements = 116

i	x(i)	m(i)	sum(m^2)	sum(mx)
1	0.05	-2.40892	5.80292	-0.120446
2	0.06	-2.12007	10.2976	-0.24765
3	0.06	-1.95996	14.1391	-0.365248
4	0.06	-1.82501	17.4697	-0.474748
5	0.06	-1.72793	20.4554	-0.578424
6	0.06	-1.63524	23.1294	-0.676538
7	0.06	-1.56322	25.5731	-0.770332
8	0.06	-1.49085	27.7957	-0.859783
9	0.07	-1.4325	29.8478	-0.960058
10	0.07	-1.3722	31.7308	-1.05611
11	0.07	-1.31652	33.464	-1.14827
12	0.08	-1.27024	35.0775	-1.24989
13	0.08	-1.22123	36.5689	-1.34759
14	0.08	-1.18	37.9613	-1.44199
15	0.1	-1.1359	39.2515	-1.55558
16	0.11	-1.09847	40.4582	-1.67641
17	0.11	-1.05812	41.5778	-1.7928
18	0.14	-1.02365	42.6257	-1.93611
19	0.2	-0.986272	43.5984	-2.13337
20	0.24	-0.954165	44.5088	-2.36237
21	0.25	-0.919183	45.3537	-2.59216
22	0.25	-0.885291	46.1375	-2.81348
23	0.25	-0.855996	46.8702	-3.02748
24	0.25	-0.823893	47.549	-3.23346
25	0.25	-0.796056	48.1827	-3.43247
26	0.25	-0.765456	48.7686	-3.62383
27	0.25	-0.738846	49.3145	-3.80855
28	0.25	-0.709522	49.8179	-3.98593
29	0.25	-0.68396	50.2857	-4.15692
30	0.25	-0.655726	50.7157	-4.32085
31	0.25	-0.631062	51.114	-4.47861
32	0.25	-0.603765	51.4785	-4.62955
33	0.25	-0.576911	51.8113	-4.77378
34	0.25	-0.553384	52.1175	-4.91213
35	0.25	-0.52728	52.3956	-5.04395
36	0.25	-0.504372	52.65	-5.17004
37	0.25	-0.478914	52.8793	-5.28977
38	0.25	-0.456542	53.0877	-5.40391
39	0.25	-0.431644	53.2741	-5.51182
40	0.25	-0.409735	53.4419	-5.61425
41	0.25	-0.385321	53.5904	-5.71058
42	0.25	-0.363809	53.7228	-5.80153
43	0.25	-0.33981	53.8382	-5.88649
44	0.25	-0.316004	53.9381	-5.96549
45	0.25	-0.294992	54.0251	-6.03923
46	0.25	-0.271509	54.0988	-6.10711
47	0.25	-0.250759	54.1617	-6.1698
48	0.25	-0.227545	54.2135	-6.22669
49	0.25	-0.207012	54.2564	-6.27844
50	0.25	-0.184017	54.2902	-6.32445
51	0.25	-0.163659	54.317	-6.36536
52	0.25	-0.140835	54.3368	-6.40057
53	0.25	-0.12061	54.3514	-6.43072
54	0.25	-0.0979139	54.361	-6.4552
55	0.25	-0.0752698	54.3666	-6.47402
56	0.25	0.0551734	54.3697	-6.48781
57	0.25	-0.0325917	54.3707	-6.49596
58	0.25	-0.0125328	54.3709	-6.49909
59	0.25	0.0125328	54.3711	-6.49596
60	0.25	0.0325917	54.3721	-6.48781
61	0.25	0.0551734	54.3752	-6.47402
62	0.25	0.0752698	54.3808	-6.4552
63	0.25	0.0979139	54.3904	-6.43072
64	0.25	0.12061	54.405	-6.40057
65	0.25	0.140835	54.4248	-6.36536

Rosner's Test for Outliers (Continued)
Parameter: Iron, Dissolved
Background Locations
Original Data (Not Transformed)
Non-Detects Replaced with Quantitation Limit

Iteration i = 3
Mean of 113 measurements = 2.66796
Std Dev = 4.25685
x(i+1) = 16.48 from measurement 1/4/2007 from location B-50
Rosner Statistic R = |16.48 - 2.66796|/4.25685 = 3.24466
Lambda(116, 4, 0.05) = 3.4148
3.24466 < 3.4148 -- No outliers detected for i = 3

Iteration i = 2
Mean of 114 measurements = 2.79088
Std Dev = 4.43652
x(i+1) = 16.68 from measurement 10/6/2004 from location B-50
Rosner Statistic R = |16.68 - 2.79088|/4.43652 = 3.13064
Lambda(116, 3, 0.05) = 3.4216
3.13064 < 3.4216 -- No outliers detected for i = 2

Iteration i = 1
Mean of 115 measurements = 2.91487
Std Dev = 4.61281
x(i+1) = 17.05 from measurement 10/2/2003 from location B-50
Rosner Statistic R = |17.05 - 2.91487|/4.61281 = 3.06432
Lambda(116, 2, 0.05) = 3.4216
3.06432 < 3.4216 -- No outliers detected for i = 1

Iteration i = 0
Mean of 116 measurements = 3.04836
Std Dev = 4.8125
x(i+1) = 18.4 from measurement 4/7/2010 from location B-50
Rosner Statistic R = |18.4 - 3.04836|/4.8125 = 3.18995
Lambda(116, 1, 0.05) = 3.4248
3.18995 < 3.4248 -- No outliers detected for i = 0

NO OUTLIERS DETECTED

Rosner's Test for Outliers
Parameter: Iron, Dissolved
Background Locations
Original Data (Not Transformed)
Non-Detects Replaced with Quantitation Limit

Data set mean = 3.04836

10 most extreme of 116 measurements
by order of magnitude difference from the mean

1	4/7/2010	B-50	18.4	15.3516
2	10/2/2003	B-50	17.05	14.0016
3	10/6/2004	B-50	16.68	13.6316
4	1/4/2007	B-50	16.48	13.4316
5	1/7/2004	B-50	15.34	12.2916
6	1/5/2006	B-50	15.14	12.0916
7	4/4/2007	B-50	14.28	11.2316
8	1/7/2010	B-50	13.69	10.6416
9	1/6/2005	B-50	13.05	10.0016
10	7/13/2004	B-50	11.64	8.59164

Iteration i = 9
Mean of 107 measurements = 1.99533
Std Dev = 3.23615
x(i+1) = 11.64 from measurement 7/13/2004 from location B-50
Rosner Statistic R = |11.64 - 1.99533|/3.23615 = 2.9803
Lambda(116, 10, 0.05) = 3.398
2.9803 < 3.398 -- No outliers detected for i = 9

Iteration i = 8
Mean of 108 measurements = 2.09769
Std Dev = 3.39209
x(i+1) = 13.05 from measurement 1/6/2005 from location B-50
Rosner Statistic R = |13.05 - 2.09769|/3.39209 = 3.22878
Lambda(116, 9, 0.05) = 3.40136
3.22878 < 3.40136 -- No outliers detected for i = 8

Iteration i = 7
Mean of 109 measurements = 2.20404
Std Dev = 3.55424
x(i+1) = 13.69 from measurement 1/7/2010 from location B-50
Rosner Statistic R = |13.69 - 2.20404|/3.55424 = 3.23162
Lambda(116, 8, 0.05) = 3.40472
3.23162 < 3.40472 -- No outliers detected for i = 7

Iteration i = 6
Mean of 110 measurements = 2.31382
Std Dev = 3.72054
x(i+1) = 14.28 from measurement 4/4/2007 from location B-50
Rosner Statistic R = |14.28 - 2.31382|/3.72054 = 3.21625
Lambda(116, 7, 0.05) = 3.40808
3.21625 < 3.40808 -- No outliers detected for i = 6

Iteration i = 5
Mean of 111 measurements = 2.42937
Std Dev = 3.89855
x(i+1) = 15.14 from measurement 1/5/2006 from location B-50
Rosner Statistic R = |15.14 - 2.42937|/3.89855 = 3.26035
Lambda(116, 6, 0.05) = 3.41144
3.26035 < 3.41144 -- No outliers detected for i = 5

Iteration i = 4
Mean of 112 measurements = 2.54464
Std Dev = 4.06817
x(i+1) = 15.34 from measurement 1/7/2004 from location B-50
Rosner Statistic R = |15.34 - 2.54464|/4.06817 = 3.14524
Lambda(116, 5, 0.05) = 3.4148
3.14524 < 3.4148 -- No outliers detected for i = 4

Concentrations (mg/L) - Continued
Parameter: Iron, Dissolved
Original Data (Not Transformed)
Non-Detects Replaced with Quantitation Limit
Percent Background Non-Detects: 44.8276%
Total Background Measurements: 116
There are 3 background locations

Loc.	Meas.	ND	Date	Conc.	Original
			7/23/2008	0.06 J	0.06 J
			10/22/2008	0.06 J	0.06 J
			1/13/2009	0.08 J	0.08 J
			4/8/2009	ND<0.25	ND<0.25
			7/15/2009	ND<0.25	ND<0.25
			1/7/2010	0.07 J	0.07 J
			4/7/2010	ND<0.25	ND<0.25
			7/7/2010	0.06 J	0.06 J
			8/16/2011	ND<0.25	ND<0.25
			10/26/2011	0.06 J	0.06 J
B-50	42	0 (0%)	11/15/2001	0.55	0.55
			1/16/2002	9.57	9.57
			4/3/2002	11.01	11.01
			7/2/2002	0.69	0.69
			10/2/2002	1.75	1.75
			1/8/2003	9.62	9.62
			4/2/2003	5.42	5.42
			7/23/2003	8.45	8.45
			10/2/2003	17.05	17.05
			1/7/2004	15.34	15.34
			4/7/2004	10.28	10.28
			7/13/2004	11.64	11.64
			10/6/2004	16.68	16.68
			1/6/2005	13.05	13.05
			4/6/2005	9.3	9.3
			7/27/2005	3.09	3.09
			10/13/2005	2.99	2.99
			1/5/2006	15.14	15.14
			4/6/2006	10.17	10.17
			7/25/2006	4.94	4.94
			10/11/2006	5.92	5.92
			1/4/2007	16.48	16.48
			4/4/2007	14.28	14.28
			7/12/2007	7.73	7.73
			10/10/2007	4.9	4.9
			1/16/2008	3.47	3.47
			4/3/2008	10.37	10.37
			7/23/2008	4.29	4.29
			10/22/2008	3.88	3.88
			1/13/2009	6.02	6.02
			4/8/2009	10.26	10.26
			7/15/2009	3.58	3.58
			10/8/2009	2.29	2.29
			1/7/2010	13.69	13.69
			4/7/2010	18.4	18.4
			7/7/2010	9.11	9.11
			12/8/2010	5.98	5.98
			2/3/2011	1.64	1.64
			4/13/2011	4	4
			8/16/2011	7.13	7.13
			10/26/2011	4.4	4.4
			1/18/2012	2.97	2.97

Concentrations (mg/L)
Parameter: Iron, Dissolved
Original Data (Not Transformed)
Non-Detects Replaced with Quantitation Limit
Percent Background Non-Detects: 44.8276%
Total Background Measurements: 116
There are 3 background locations

Loc.	Meas.	ND	Date	Conc.	Original
B-52	42	30 (71.4286%)	11/15/2001	0.71	0.71
			1/16/2002	0.56	0.56
			4/3/2002	0.24 J	0.24 J
			7/2/2002	0.2 J	0.2 J
			10/2/2002	ND<0.25	ND<0.25
			1/8/2003	ND<0.25	ND<0.25
			4/2/2003	ND<0.25	ND<0.25
			7/23/2003	ND<0.25	ND<0.25
			10/2/2003	ND<0.25	ND<0.25
			1/7/2004	ND<0.25	ND<0.25
			4/7/2004	ND<0.25	ND<0.25
			7/13/2004	ND<0.25	ND<0.25
			10/6/2004	0.07 J	0.07 J
			1/6/2005	ND<0.25	ND<0.25
			4/6/2005	ND<0.25	ND<0.25
			7/27/2005	ND<0.25	ND<0.25
			10/13/2005	ND<0.25	ND<0.25
			1/5/2006	ND<0.25	ND<0.25
			4/6/2006	ND<0.25	ND<0.25
			7/25/2006	ND<0.25	ND<0.25
			10/11/2006	0.08 J	0.08 J
			1/4/2007	ND<0.25	ND<0.25
			4/4/2007	ND<0.25	ND<0.25
			7/12/2007	ND<0.25	ND<0.25
			10/10/2007	ND<0.25	ND<0.25
			1/16/2008	ND<0.25	ND<0.25
			4/3/2008	0.07 J	0.07 J
			7/23/2008	ND<0.25	ND<0.25
			10/22/2008	0.1 J	0.1 J
			1/13/2009	0.06 J	0.06 J
			4/8/2009	0.08 J	0.08 J
			7/15/2009	0.11 J	0.11 J
			10/8/2009	ND<0.25	ND<0.25
			1/7/2010	0.11 J	0.11 J
			4/7/2010	ND<0.25	ND<0.25
			7/7/2010	ND<0.25	ND<0.25
			12/8/2010	ND<0.25	ND<0.25
			2/3/2011	ND<0.25	ND<0.25
			4/13/2011	ND<0.25	ND<0.25
			8/16/2011	ND<0.25	ND<0.25
			10/26/2011	ND<0.25	ND<0.25
			1/18/2012	ND<0.25	ND<0.25
B-51	32	22 (68.75%)	11/15/2001	0.14 J	0.14 J
			10/2/2002	ND<0.25	ND<0.25
			1/8/2003	ND<0.25	ND<0.25
			4/2/2003	ND<0.25	ND<0.25
			7/23/2003	ND<0.25	ND<0.25
			10/2/2003	ND<0.25	ND<0.25
			1/7/2004	ND<0.25	ND<0.25
			4/7/2004	ND<0.25	ND<0.25
			7/13/2004	ND<0.25	ND<0.25
			10/6/2004	0.06 J	0.06 J
			1/6/2005	ND<0.25	ND<0.25
			4/6/2005	0.06 J	0.06 J
			7/27/2005	ND<0.25	ND<0.25
			10/13/2005	ND<0.25	ND<0.25
			1/5/2006	ND<0.25	ND<0.25
			4/6/2006	ND<0.25	ND<0.25
			7/25/2006	ND<0.25	ND<0.25
			10/11/2006	0.05 J	0.05 J
			1/4/2007	ND<0.25	ND<0.25
			4/4/2007	ND<0.25	ND<0.25
			7/12/2007	ND<0.25	ND<0.25
			10/10/2007	ND<0.25	ND<0.25

Non-Parametric Prediction Interval
Inter-Well Comparison
Parameter: Chromium (hexavalent)
Original Data (Not Transformed)
Non-Detects Replaced with Quantitation Limit

Number of comparisons = 7
Future Samples (k) = 1
Recent Dates = 1
Background Measurements (n) = 103
Maximum Background Value = LOQ = 0.05
Confidence Level = 99%
False Positive Rate = 1%

Location	Date	Count	Mean	Significant
B-30A	4/4/2012	1	0.005	FALSE
B-32	4/4/2012	1	0.005	FALSE
B-31	4/4/2012	1	0.005	FALSE
DM-1	4/4/2012	1	0.006	FALSE
DM-7	4/4/2012	1	0.005	FALSE
DM-6	4/4/2012	1	0.005	FALSE
DM-5	4/4/2012	1	0.005	FALSE

Rosner's Test for Outliers (Continued)
Parameter: Chromium (hexavalent)
Background Locations
Original Data (Not Transformed)
Non-Detects Replaced with Quantitation Limit

Iteration i = 3
Mean of 100 measurements = 0.04195
Std Dev = 0.0158097
x(i+1) = 0.005 from measurement 4/13/2011 from location B-50
Rosner Statistic R = |0.005 - 0.04195|/0.0158097 = 2.33717
Lambda(103, 4, 0.05) = 3.3784
2.33717 < 3.3784 -- No outliers detected for i = 3

Iteration i = 2
Mean of 101 measurements = 0.0415842
Std Dev = 0.0161544
x(i+1) = 0.005 from measurement 8/16/2011 from location B-50
Rosner Statistic R = |0.005 - 0.0415842|/0.0161544 = 2.26465
Lambda(103, 3, 0.05) = 3.3878
2.26465 < 3.3878 -- No outliers detected for i = 2

Iteration i = 1
Mean of 102 measurements = 0.0412255
Std Dev = 0.0164774
x(i+1) = 0.005 from measurement 10/26/2011 from location B-50
Rosner Statistic R = |0.005 - 0.0412255|/0.0164774 = 2.1985
Lambda(103, 2, 0.05) = 3.3878
2.1985 < 3.3878 -- No outliers detected for i = 1

Iteration i = 0
Mean of 103 measurements = 0.0408738
Std Dev = 0.0167804
x(i+1) = 0.005 from measurement 1/18/2012 from location B-50
Rosner Statistic R = |0.005 - 0.0408738|/0.0167804 = 2.13784
Lambda(103, 1, 0.05) = 3.3884
2.13784 < 3.3884 -- No outliers detected for i = 0

NO OUTLIERS DETECTED

Rosner's Test for Outliers
Parameter: Chromium (hexavalent)
Background Locations
Original Data (Not Transformed)
Non-Detects Replaced with Quantitation Limit

Data set mean = 0.0408738

10 most extreme of 103 measurements
by order of magnitude difference from the mean

1	1/18/2012	B-50	ND<0.005	-0.0358738
2	10/26/2011	B-50	ND<0.005	-0.0358738
3	8/16/2011	B-50	ND<0.005	-0.0358738
4	4/13/2011	B-50	ND<0.005	-0.0358738
5	8/16/2011	B-51	ND<0.005	-0.0358738
6	12/8/2010	B-50	ND<0.005	-0.0358738
7	10/26/2011	B-52	ND<0.005	-0.0358738
8	10/26/2011	B-51	ND<0.005	-0.0358738
9	4/13/2011	B-52	ND<0.005	-0.0358738
10	1/18/2012	B-52	ND<0.005	-0.0358738

Iteration i = 9
Mean of 94 measurements = 0.0443085
Std Dev = 0.0131288
x(i+1) = 0.005 from measurement 1/18/2012 from location B-52
Rosner Statistic R = |0.005 - 0.0443085|/0.0131288 = 2.99406
Lambda(103, 10, 0.05) = 3.359
2.99406 < 3.359 -- No outliers detected for i = 9

Iteration i = 8
Mean of 95 measurements = 0.0438947
Std Dev = 0.0136674
x(i+1) = 0.005 from measurement 4/13/2011 from location B-52
Rosner Statistic R = |0.005 - 0.0438947|/0.0136674 = 2.84581
Lambda(103, 9, 0.05) = 3.36288
2.84581 < 3.36288 -- No outliers detected for i = 8

Iteration i = 7
Mean of 96 measurements = 0.0434896
Std Dev = 0.014163
x(i+1) = 0.005 from measurement 10/26/2011 from location B-51
Rosner Statistic R = |0.005 - 0.0434896|/0.014163 = 2.71762
Lambda(103, 8, 0.05) = 3.36676
2.71762 < 3.36676 -- No outliers detected for i = 7

Iteration i = 6
Mean of 97 measurements = 0.0430928
Std Dev = 0.014621
x(i+1) = 0.005 from measurement 10/26/2011 from location B-52
Rosner Statistic R = |0.005 - 0.0430928|/0.014621 = 2.60535
Lambda(103, 7, 0.05) = 3.37064
2.60535 < 3.37064 -- No outliers detected for i = 6

Iteration i = 5
Mean of 98 measurements = 0.0427041
Std Dev = 0.0150458
x(i+1) = 0.005 from measurement 12/8/2010 from location B-50
Rosner Statistic R = |0.005 - 0.0427041|/0.0150458 = 2.50596
Lambda(103, 6, 0.05) = 3.37452
2.50596 < 3.37452 -- No outliers detected for i = 5

Iteration i = 4
Mean of 99 measurements = 0.0423232
Std Dev = 0.015441
x(i+1) = 0.005 from measurement 8/16/2011 from location B-51
Rosner Statistic R = |0.005 - 0.0423232|/0.015441 = 2.41715
Lambda(103, 5, 0.05) = 3.3784
2.41715 < 3.3784 -- No outliers detected for i = 4

Concentrations (mg/L) - Continued
Parameter: Chromium (hexavalent)
Original Data (Not Transformed)
Non-Detects Replaced with Quantitation Limit
Percent Background Non-Detects: 100%
Total Background Measurements: 103
There are 3 background locations

Loc.	Meas.	ND	Date	Conc.	Original
B-50	37	37 (100%)	11/15/2001	ND<0.01	ND<0.01
			4/3/2002	ND<0.01	ND<0.01
			4/2/2003	ND<0.05	ND<0.05
			10/9/2003	ND<0.05	ND<0.05
			1/7/2004	ND<0.05	ND<0.05
			4/7/2004	ND<0.05	ND<0.05
			7/13/2004	ND<0.05	ND<0.05
			10/6/2004	ND<0.05	ND<0.05
			1/6/2005	ND<0.05	ND<0.05
			4/6/2005	ND<0.05	ND<0.05
			7/27/2005	ND<0.05	ND<0.05
			10/13/2005	ND<0.05	ND<0.05
			1/5/2006	ND<0.05	ND<0.05
			4/6/2006	ND<0.05	ND<0.05
			7/25/2006	ND<0.05	ND<0.05
			10/11/2006	ND<0.05	ND<0.05
			1/4/2007	ND<0.05	ND<0.05
			4/4/2007	ND<0.05	ND<0.05
			7/12/2007	ND<0.05	ND<0.05
			10/10/2007	ND<0.05	ND<0.05
			1/16/2008	ND<0.05	ND<0.05
			4/3/2008	ND<0.05	ND<0.05
			7/23/2008	ND<0.05	ND<0.05
			10/22/2008	ND<0.05	ND<0.05
			1/14/2009	ND<0.05	ND<0.05
			4/8/2009	ND<0.05	ND<0.05
			7/15/2009	ND<0.05	ND<0.05
			10/8/2009	ND<0.05	ND<0.05
			1/7/2010	ND<0.05	ND<0.05
			4/7/2010	ND<0.025	ND<0.025
			7//2010	ND<0.025	ND<0.025
			12/8/2010	ND<0.005	ND<0.005
			2/3/2011	ND<0.025	ND<0.025
			4/13/2011	ND<0.005	ND<0.005
			8/16/2011	ND<0.005	ND<0.005
			10/26/2011	ND<0.005	ND<0.005
			1/18/2012	ND<0.005	ND<0.005

Concentrations (mg/L)
Parameter: Chromium (hexavalent)
Original Data (Not Transformed)
Non-Detects Replaced with Quantitation Limit
Percent Background Non-Detects: 100%
Total Background Measurements: 103
There are 3 background locations

Loc.	Meas.	ND	Date	Conc.	Original
B-52	37	37 (100%)	11/15/2001	ND<0.01	ND<0.01
			4/3/2002	ND<0.01	ND<0.01
			4/2/2003	ND<0.05	ND<0.05
			10/9/2003	ND<0.05	ND<0.05
			1/7/2004	ND<0.05	ND<0.05
			4/7/2004	ND<0.05	ND<0.05
			7/13/2004	ND<0.05	ND<0.05
			10/6/2004	ND<0.05	ND<0.05
			1/6/2005	ND<0.05	ND<0.05
			4/6/2005	ND<0.05	ND<0.05
			7/27/2005	ND<0.05	ND<0.05
			10/13/2005	ND<0.05	ND<0.05
			1/5/2006	ND<0.05	ND<0.05
			4/6/2006	ND<0.05	ND<0.05
			7/25/2006	ND<0.05	ND<0.05
			10/11/2006	ND<0.05	ND<0.05
			1/4/2007	ND<0.05	ND<0.05
			4/4/2007	ND<0.05	ND<0.05
			7/12/2007	ND<0.05	ND<0.05
			10/10/2007	ND<0.05	ND<0.05
			1/16/2008	ND<0.05	ND<0.05
			4/3/2008	ND<0.05	ND<0.05
			7/23/2008	ND<0.05	ND<0.05
			10/22/2008	ND<0.05	ND<0.05
			1/14/2009	ND<0.05	ND<0.05
			4/8/2009	ND<0.05	ND<0.05
			7/15/2009	ND<0.05	ND<0.05
			10/8/2009	ND<0.05	ND<0.05
			1/7/2010	ND<0.05	ND<0.05
			4/7/2010	ND<0.025	ND<0.025
			7/7/2010	ND<0.025	ND<0.025
			12/8/2010	ND<0.005	ND<0.005
			2/3/2011	ND<0.025	ND<0.025
			4/13/2011	ND<0.005	ND<0.005
			8/16/2011	ND<0.005	ND<0.005
			10/26/2011	ND<0.005	ND<0.005
			1/18/2012	ND<0.005	ND<0.005
B-51	29	29 (100%)	11/15/2001	ND<0.01	ND<0.01
			4/2/2003	ND<0.05	ND<0.05
			10/9/2003	ND<0.05	ND<0.05
			1/7/2004	ND<0.05	ND<0.05
			4/7/2004	ND<0.05	ND<0.05
			7/13/2004	ND<0.05	ND<0.05
			10/6/2004	ND<0.05	ND<0.05
			1/6/2005	ND<0.05	ND<0.05
			4/6/2005	ND<0.05	ND<0.05
			7/27/2005	ND<0.05	ND<0.05
			10/13/2005	ND<0.05	ND<0.05
			1/5/2006	ND<0.05	ND<0.05
			4/6/2006	ND<0.05	ND<0.05
			7/25/2006	ND<0.05	ND<0.05
			10/11/2006	ND<0.05	ND<0.05
			1/4/2007	ND<0.05	ND<0.05
			4/4/2007	ND<0.05	ND<0.05
			7/12/2007	ND<0.05	ND<0.05
			10/10/2007	ND<0.05	ND<0.05
			7/23/2008	ND<0.05	ND<0.05
			10/22/2008	ND<0.05	ND<0.05
			1/14/2009	ND<0.05	ND<0.05
			4/8/2009	ND<0.05	ND<0.05
			7/15/2009	ND<0.05	ND<0.05
			1/7/2010	ND<0.05	ND<0.05
			4/7/2010	ND<0.025	ND<0.025
			7/7/2010	ND<0.025	ND<0.025
			8/16/2011	ND<0.005	ND<0.005
			10/26/2011	ND<0.005	ND<0.005

Non-Parametric Prediction Interval
Inter-Well Comparison
Parameter: Barium, Dissolved
Original Data (Not Transformed)

Number of comparisons = 7
Future Samples (k) = 1
Recent Dates = 1
Background Measurements (n) = 103
Maximum Background Value = 0.418
Confidence Level = 99%
False Positive Rate = 1%

Location	Date	Count	Mean	Significant
B-30A	4/4/2012	1	0.34	FALSE
B-32	4/4/2012	1	0.043	FALSE
DM-7	4/4/2012	1	0.013	FALSE
DM-6	4/4/2012	1	0.008	FALSE
B-31	4/4/2012	1	0.017	FALSE
DM-5	4/4/2012	1	0.295	FALSE
DM-1	4/4/2012	1	0.052	FALSE

Shapiro-Francia Test of Normality (Continued)
Parameter: Barium, Dissolved
Background Locations
Normality Test of Parameter Concentrations
Natural Logarithm Transformation
Total Number of Measurements = 103

i	x(i)	m(i)	sum(m^2)	sum(mx)
66	-1.92415	0.345126	48.5642	159.078
67	-1.91732	0.371856	48.7025	158.365
68	-1.91054	0.396142	48.8594	157.608
69	-1.89048	0.423405	49.0387	156.808
70	-1.88387	0.450985	49.2421	155.958
71	-1.8579	0.476105	49.4688	155.074
72	-1.85151	0.504372	49.7232	154.14
73	-1.82635	0.530162	50.0042	153.172
74	-1.78976	0.559237	50.317	152.171
75	-1.7148	0.588793	50.6637	151.161
76	-1.7148	0.615839	51.0429	150.105
77	-1.69282	0.646431	51.4608	149.011
78	-1.66601	0.67449	51.9157	147.887
79	-1.6399	0.706302	52.4146	146.729
80	-1.61445	0.738846	52.9605	145.536
81	-1.58475	0.768821	53.5516	144.318
82	-1.54178	0.802956	54.1963	143.08
83	-1.53248	0.838054	54.8986	141.795
84	-1.49165	0.87055	55.6565	140.497
85	-1.47403	0.907769	56.4805	139.159
86	-1.46534	0.942375	57.3686	137.778
87	-1.44817	0.982202	58.3333	136.355
88	-1.4397	1.02365	59.3812	134.882
89	-1.41469	1.06252	60.5102	133.379
90	-1.3823	1.10768	61.7371	131.847
91	-1.3548	1.15035	63.0604	130.289
92	-1.3356	1.20036	64.5013	128.686
93	-1.33181	1.25357	66.0727	127.016
94	-1.32803	1.30469	67.7749	125.284
95	-1.31304	1.36581	69.6403	123.49
96	-1.2694	1.4325	71.6924	121.672
97	-1.20397	1.49852	73.938	119.868
98	-1.20397	1.58047	76.4358	117.965
99	-1.17766	1.66456	79.2066	116.004
100	-0.994252	1.77438	82.355	114.24
101	-0.972861	1.91103	86.007	112.381
102	-0.941609	2.07485	90.312	110.427
103	-0.872274	2.36561	95.9082	108.364

Data Set Standard Deviation = 1.14496
Numerator = 11742.7
Denominator = 12824.4
W Statistic = 0.915654 = 11742.7 / 12824.4

5% Critical value of 0.976 exceeds 0.915654
Evidence of non-normality at 95% level of significance

Shapiro-Francia Test of Normality
Parameter: Barium, Dissolved
Background Locations
Normality Test of Parameter Concentrations
Natural Logarithm Transformation
Total Number of Measurements = 103

i	x(i)	m(i)	sum(m^2)	sum(mx)
1	-4.60517	-2.36561	5.59613	10.8941
2	-4.60517	-2.07485	9.90113	20.4491
3	-4.60517	-1.91103	13.5532	29.2497
4	-4.50986	-1.77438	16.7016	37.2519
5	-4.50986	-1.66456	19.4723	44.7588
6	-4.50986	-1.58047	21.9702	51.8865
7	-4.42285	-1.49852	24.2158	58.5142
8	-4.42285	-1.4325	26.2678	64.85
9	-4.34281	-1.36581	28.1333	70.7814
10	-4.34281	-1.30469	29.8355	76.4474
11	-4.2687	-1.25357	31.4069	81.7985
12	-4.2687	-1.20036	32.8478	86.9225
13	-4.19971	-1.15035	34.1711	91.7536
14	-4.13517	-1.10768	35.398	96.334
15	-4.13517	-1.06252	36.527	100.728
16	-4.07454	-1.02365	37.5748	104.899
17	-4.07454	-0.982202	38.5396	108.901
18	-4.01738	-0.942375	39.4276	112.687
19	-4.01738	-0.907769	40.2517	116.333
20	-4.01738	-0.87055	41.0095	119.831
21	-4.01738	-0.838054	41.7119	123.198
22	-3.96332	-0.802956	42.3566	126.38
23	-3.96332	-0.768821	42.9477	129.427
24	-3.96332	-0.738846	43.4936	132.355
25	-3.91202	-0.706302	43.9924	135.118
26	-3.91202	-0.67449	44.4474	137.757
27	-3.86323	-0.646431	44.8652	140.254
28	-3.81671	-0.615839	45.2445	142.605
29	-3.81671	-0.588793	45.5912	144.852
30	-3.7297	-0.559237	45.9039	146.938
31	-3.68888	-0.530162	46.185	148.893
32	-3.61192	-0.504372	46.4394	150.715
33	-3.61192	-0.476105	46.6661	152.435
34	-3.50656	-0.450985	46.8695	154.016
35	-3.41125	-0.423405	47.0487	155.461
36	-3.27017	-0.396142	47.2057	156.756
37	-3.10109	-0.371856	47.3439	157.909
38	-2.74887	-0.345126	47.463	158.858
39	-2.74887	-0.318639	47.5646	159.734
40	-2.65926	-0.294992	47.6516	160.518
41	-2.6173	-0.268908	47.7239	161.222
42	-2.44185	-0.24559	47.7842	161.822
43	-2.44185	-0.219834	47.8325	162.359
44	-2.40795	-0.194225	47.8703	162.826
45	-2.40795	-0.171285	47.8996	163.239
46	-2.3969	-0.1459	47.9209	163.588
47	-2.34341	-0.123135	47.9361	163.877
48	-2.34341	-0.0979139	47.9456	164.106
49	-2.33304	-0.0727562	47.9509	164.276
50	-2.32279	-0.0501541	47.9535	164.393
51	-2.29263	-0.0250691	47.9541	164.45
52	-2.26336	0	47.9541	164.45
53	-2.26336	0.0250691	47.9547	164.393
54	-2.24432	0.0501541	47.9572	164.281
55	-2.23493	0.0727562	47.9625	164.118
56	-2.23493	0.0979139	47.9721	163.899
57	-2.23493	0.123135	47.9873	163.624
58	-2.18037	0.1459	48.0086	163.306
59	-2.18037	0.171285	48.0379	162.933
60	-2.17156	0.194225	48.0756	162.511
61	-2.12026	0.219834	48.1239	162.045
62	-2.10373	0.24559	48.1843	161.528
63	-2.05573	0.268908	48.2566	160.975
64	-2.02495	0.294992	48.3436	160.378
65	-1.9951	0.318639	48.4451	159.742

Shapiro-Francia Test of Normality (Continued)
Parameter: Barium, Dissolved
Background Locations
Normality Test of Parameter Concentrations
Original Data (Not Transformed)
Total Number of Measurements = 103

i	x(i)	m(i)	sum(m^2)	sum(mx)
66	0.146	0.345126	48.5642	-0.481521
67	0.147	0.371856	48.7025	-0.426858
68	0.148	0.396142	48.8594	-0.368229
69	0.151	0.423405	49.0387	-0.304295
70	0.152	0.450985	49.2421	-0.235745
71	0.156	0.476105	49.4688	-0.161473
72	0.157	0.504372	49.7232	-0.0822868
73	0.161	0.530162	50.0042	0.0030692
74	0.167	0.559237	50.317	0.0964618
75	0.18	0.588793	50.6637	0.202445
76	0.18	0.615839	51.0429	0.313296
77	0.184	0.646431	51.4608	0.432239
78	0.189	0.67449	51.9157	0.559718
79	0.194	0.706302	52.4146	0.69674
80	0.199	0.738846	52.9605	0.843771
81	0.205	0.768821	53.5516	1.00138
82	0.214	0.802956	54.1963	1.17321
83	0.216	0.838054	54.8986	1.35423
84	0.225	0.87055	55.6565	1.55011
85	0.229	0.907769	56.4805	1.75798
86	0.231	0.942375	57.3686	1.97567
87	0.235	0.982202	58.3333	2.20649
88	0.237	1.02365	59.3812	2.4491
89	0.243	1.06252	60.5102	2.70729
90	0.251	1.10768	61.7371	2.98532
91	0.258	1.15035	63.0604	3.28211
92	0.263	1.20036	64.5013	3.5978
93	0.264	1.25357	66.0727	3.92874
94	0.265	1.30469	67.7749	4.27448
95	0.269	1.36581	69.6403	4.64189
96	0.281	1.4325	71.6924	5.04442
97	0.3	1.49852	73.938	5.49397
98	0.3	1.58047	76.4358	5.96811
99	0.308	1.66456	79.2066	6.4808
100	0.37	1.77438	82.355	7.13732
101	0.378	1.91103	86.007	7.85969
102	0.39	2.07485	90.312	8.66888
103	0.418	2.36561	95.9082	9.65771

Data Set Standard Deviation = 0.102801
Numerator = 93.2713
Denominator = 103.383
W Statistic = 0.902191 = 93.2713 / 103.383

5% Critical value of 0.976 exceeds 0.902191
Evidence of non-normality at 95% level of significance

Shapiro-Francia Test of Normality
Parameter: Barium, Dissolved
Background Locations
Normality Test of Parameter Concentrations
Original Data (Not Transformed)
Total Number of Measurements = 103

i	x(i)	m(i)	sum(m^2)	sum(mx)
1	0.01	-2.36561	5.59613	-0.0236561
2	0.01	-2.07485	9.90113	-0.0444046
3	0.01	-1.91103	13.5532	-0.0635149
4	0.011	-1.77438	16.7016	-0.0830331
5	0.011	-1.66456	19.4723	-0.101343
6	0.011	-1.58047	21.9702	-0.118728
7	0.012	-1.49852	24.2158	-0.136711
8	0.012	-1.4325	26.2678	-0.153901
9	0.013	-1.36581	28.1333	-0.171656
10	0.013	-1.30469	29.8355	-0.188617
11	0.014	-1.25357	31.4069	-0.206167
12	0.014	-1.20036	32.8478	-0.222972
13	0.015	-1.15035	34.1711	-0.240227
14	0.016	-1.10768	35.398	-0.25795
15	0.016	-1.06252	36.527	-0.27495
16	0.017	-1.02365	37.5748	-0.292353
17	0.017	-0.982202	38.5396	-0.30905
18	0.018	-0.942375	39.4276	-0.326013
19	0.018	-0.907769	40.2517	-0.342353
20	0.018	-0.87055	41.0095	-0.358022
21	0.018	-0.838054	41.7119	-0.373107
22	0.019	-0.802956	42.3566	-0.388364
23	0.019	-0.768821	42.9477	-0.402971
24	0.019	-0.738846	43.4936	-0.417009
25	0.02	-0.706302	43.9924	-0.431135
26	0.02	-0.67449	44.4474	-0.444625
27	0.021	-0.646431	44.8652	-0.4582
28	0.022	-0.615839	45.2445	-0.471749
29	0.022	-0.588793	45.5912	-0.484702
30	0.024	-0.559237	45.9039	-0.498124
31	0.025	-0.530162	46.185	-0.511378
32	0.027	-0.504372	46.4394	-0.524996
33	0.027	-0.476105	46.6661	-0.537851
34	0.03	-0.450985	46.8695	-0.55138
35	0.033	-0.423405	47.0487	-0.565353
36	0.038	-0.396142	47.2057	-0.580406
37	0.045	-0.371856	47.3439	-0.59714
38	0.064	-0.345126	47.463	-0.619228
39	0.064	-0.318639	47.5646	-0.63962
40	0.07	-0.294992	47.6516	-0.66027
41	0.073	-0.268908	47.7239	-0.6799
42	0.087	-0.24559	47.7842	-0.701267
43	0.087	-0.219834	47.8325	-0.720392
44	0.09	-0.194225	47.8703	-0.737872
45	0.09	-0.171285	47.8996	-0.753288
46	0.091	-0.1459	47.9209	-0.766565
47	0.096	-0.123135	47.9361	-0.778386
48	0.096	-0.0979139	47.9456	-0.787786
49	0.097	-0.0727562	47.9509	-0.794843
50	0.098	-0.0501541	47.9535	-0.799758
51	0.101	-0.0250691	47.9541	-0.80229
52	0.104	0	47.9541	-0.80229
53	0.104	0.0250691	47.9547	-0.799683
54	0.106	0.0501541	47.9572	-0.794367
55	0.107	0.0727562	47.9625	-0.786582
56	0.107	0.0979139	47.9721	-0.776105
57	0.107	0.123135	47.9873	-0.762929
58	0.113	0.1459	48.0086	-0.746443
59	0.113	0.171285	48.0379	-0.727087
60	0.114	0.194225	48.0756	-0.704946
61	0:12	0.219834	48.1239	-0.678566
62	0.122	0.24559	48.1843	-0.648604
63	0.128	0.268908	48.2566	-0.614184
64	0.132	0.294992	48.3436	-0.575245
65	0.136	0.318639	48.4451	-0.53191

Rosner's Test for Outliers (Continued)
Parameter: Barium, Dissolved
Background Locations
Original Data (Not Transformed)

Iteration i = 3
Mean of 100 measurements = 0.11197
Std Dev = 0.09229
x(i+1) = 0.37 from measurement 10/10/2007 from location B-50
Rosner Statistic R = |0.37 - 0.11197|/0.09229 = 2.79586
Lambda(103, 4, 0.05) = 3.3784
2.79586 < 3.3784 -- No outliers detected for i = 3

Iteration i = 2
Mean of 101 measurements = 0.114604
Std Dev = 0.0955666
x(i+1) = 0.378 from measurement 4/2/2003 from location B-50
Rosner Statistic R = |0.378 - 0.114604|/0.0955666 = 2.75615
Lambda(103, 3, 0.05) = 3.3878
2.75615 < 3.3878 -- No outliers detected for i = 2

Iteration i = 1
Mean of 102 measurements = 0.117304
Std Dev = 0.0989248
x(i+1) = 0.39 from measurement 10/2/2003 from location B-50
Rosner Statistic R = |0.39 - 0.117304|/0.0989248 = 2.7566
Lambda(103, 2, 0.05) = 3.3878
2.7566 < 3.3878 -- No outliers detected for i = 1

Iteration i = 0
Mean of 103 measurements = 0.120223
Std Dev = 0.102801
x(i+1) = 0.418 from measurement 10/6/2004 from location B-50
Rosner Statistic R = |0.418 - 0.120223|/0.102801 = 2.89664
Lambda(103, 1, 0.05) = 3.3884
2.89664 < 3.3884 -- No outliers detected for i = 0

NO OUTLIERS DETECTED

Rosner's Test for Outliers
Parameter: Barium, Dissolved
Background Locations
Original Data (Not Transformed)

Data set mean = 0.120223

10 most extreme of 103 measurements
by order of magnitude difference from the mean

1	10/6/2004	B-50	0.418	0.297777
2	10/2/2003	B-50	0.39	0.269777
3	4/2/2003	B-50	0.378	0.257777
4	10/10/2007	B-50	0.37	0.249777
5	1/4/2007	B-50	0.308	0.187777
6	1/7/2010	B-50	0.3	0.179777
7	11/15/2001	B-50	0.3	0.179777
8	4/4/2007	B-50	0.281	0.160777
9	7/13/2004	B-50	0.269	0.148777
10	7/23/2008	B-50	0.265	0.144777

Iteration i = 9
Mean of 94 measurements = 0.0996702
Std Dev = 0.0803259
x(i+1) = 0.265 from measurement 7/23/2008 from location B-50
Rosner Statistic R = |0.265 - 0.0996702|/0.0803259 = 2.05824
Lambda(103, 10, 0.05) = 3.359
2.05824 < 3.359 -- No outliers detected for i = 9

Iteration i = 8
Mean of 95 measurements = 0.101453
Std Dev = 0.0817644
x(i+1) = 0.269 from measurement 7/13/2004 from location B-50
Rosner Statistic R = |0.269 - 0.101453|/0.0817644 = 2.04915
Lambda(103, 9, 0.05) = 3.36288
2.04915 < 3.36288 -- No outliers detected for i = 8

Iteration i = 7
Mean of 96 measurements = 0.103323
Std Dev = 0.0833718
x(i+1) = 0.281 from measurement 4/4/2007 from location B-50
Rosner Statistic R = |0.281 - 0.103323|/0.0833718 = 2.13114
Lambda(103, 8, 0.05) = 3.36676
2.13114 < 3.36676 -- No outliers detected for i = 7

Iteration i = 6
Mean of 97 measurements = 0.105351
Std Dev = 0.0853067
x(i+1) = 0.3 from measurement 11/15/2001 from location B-50
Rosner Statistic R = |0.3 - 0.105351|/0.0853067 = 2.28176
Lambda(103, 7, 0.05) = 3.37064
2.28176 < 3.37064 -- No outliers detected for i = 6

Iteration i = 5
Mean of 98 measurements = 0.107337
Std Dev = 0.0871139
x(i+1) = 0.3 from measurement 1/7/2010 from location B-50
Rosner Statistic R = |0.3 - 0.107337|/0.0871139 = 2.21163
Lambda(103, 6, 0.05) = 3.37452
2.21163 < 3.37452 -- No outliers detected for i = 5

Iteration i = 4
Mean of 99 measurements = 0.109364
Std Dev = 0.0889838
x(i+1) = 0.308 from measurement 1/4/2007 from location B-50
Rosner Statistic R = |0.308 - 0.109364|/0.0889838 = 2.23228
Lambda(103, 5, 0.05) = 3.3784
2.23228 < 3.3784 -- No outliers detected for i = 4

Concentrations (mg/L) - Continued
Parameter: Barium, Dissolved
Original Data (Not Transformed)
Percent Background Non-Detects: 0%
Total Background Measurements: 103
There are 3 background locations

Loc.	Meas.	ND	Date	Conc.	Original
B-50	37	0 (0%)	11/15/2001	0.3	0.3
			4/3/2002	0.229	0.229
			4/2/2003	0.378	0.378
			10/2/2003	0.39	0.39
			1/7/2004	0.263	0.263
			4/7/2004	0.251	0.251
			7/13/2004	0.269	0.269
			10/6/2004	0.418	0.418
			1/6/2005	0.147	0.147
			4/6/2005	0.189	0.189
			7/27/2005	0.156	0.156
			10/13/2005	0.184	0.184
			1/5/2006	0.237	0.237
			4/6/2006	0.258	0.258
			7/25/2006	0.235	0.235
			10/11/2006	0.225	0.225
			1/4/2007	0.308	0.308
			4/4/2007	0.281	0.281
			7/12/2007	0.194	0.194
			10/10/2007	0.37	0.37
			1/16/2008	0.216	0.216
			4/3/2008	0.12	0.12
			7/23/2008	0.265	0.265
			10/22/2008	0.107	0.107
			1/13/2009	0.091	0.091
			4/8/2009	0.18	0.18
			7/15/2009	0.157	0.157
			10/8/2009	0.113	0.113
			1/7/2010	0.3	0.3
			4/7/2010	0.243	0.243
			7/7/2010	0.264	0.264
			12/8/2010	0.167	0.167
			2/3/2011	0.09	0.09
			4/13/2011	0.18	0.18
			8/16/2011	0.205	0.205
			10/26/2011	0.231	0.231
			1/18/2012	0.146	0.146

Concentrations (mg/L)
Parameter: Barium, Dissolved
Original Data (Not Transformed)
Percent Background Non-Detects: 0%
Total Background Measurements: 103
There are 3 background locations

Loc.	Meas.	ND	Date	Conc.	Original
B-52	37	0 (0%)	11/15/2001	0.025	0.025
			4/3/2002	0.02	0.02
			4/2/2003	0.027	0.027
			10/2/2003	0.022	0.022
			1/7/2004	0.019	0.019
			4/7/2004	0.012 J	0.012 J
			7/13/2004	0.016	0.016
			10/6/2004	0.038	0.038
			1/6/2005	0.011 J	0.011 J
			4/6/2005	0.012 J	0.012 J
			7/27/2005	0.018	0.018
			10/13/2005	0.018	0.018
			1/5/2006	0.024	0.024
			4/6/2006	0.017	0.017
			7/25/2006	0.019	0.019
			10/11/2006	0.02	0.02
			1/4/2007	0.018	0.018
			4/4/2007	0.014 J	0.014 J
			7/12/2007	0.011 J	0.011 J
			10/10/2007	0.033	0.033
			1/16/2008	0.03	0.03
			4/3/2008	0.01 J	0.01 J
			7/23/2008	0.017	0.017
			10/22/2008	0.013 J	0.013 J
			1/13/2009	0.01 J	0.01 J
			4/8/2009	0.027	0.027
			7/15/2009	0.015	0.015
			10/8/2009	0.013	0.013
			1/7/2010	0.045	0.045
			4/7/2010	0.016	0.016
			7/7/2010	0.021	0.021
			12/8/2010	0.018	0.018
			2/3/2011	0.019	0.019
			4/13/2011	0.011 J	0.011 J
			8/16/2011	0.014 J	0.014 J
			10/26/2011	0.022	0.022
			1/18/2012	0.01 J	0.01 J
B-51	29	0 (0%)	11/15/2001	0.087	0.087
			4/2/2003	0.151	0.151
			10/2/2003	0.152	0.152
			1/7/2004	0.096	0.096
			4/7/2004	0.122	0.122
			7/13/2004	0.101	0.101
			10/6/2004	0.199	0.199
			1/6/2005	0.073	0.073
			4/6/2005	0.087	0.087
			7/27/2005	0.104	0.104
			10/13/2005	0.106	0.106
			1/5/2006	0.113	0.113
			4/6/2006	0.107	0.107
			7/25/2006	0.128	0.128
			10/11/2006	0.104	0.104
			1/4/2007	0.114	0.114
			4/4/2007	0.161	0.161
			7/12/2007	0.09	0.09
			10/10/2007	0.214	0.214
			7/23/2008	0.132	0.132
			10/22/2008	0.064	0.064
			1/13/2009	0.07	0.07
			4/8/2009	0.148	0.148
			7/15/2009	0.097	0.097
			1/7/2010	0.107	0.107
			4/7/2010	0.096	0.096
			7/7/2010	0.136	0.136
			8/16/2011	0.098	0.098
			10/26/2011	0.064	0.064

Attachment 8.d.

MEMORANDUM

DEPARTMENT OF ENVIRONMENTAL QUALITY
Piedmont Regional Office

4949-A Cox Road **Glen Allen, VA 23060** **804/527-5020**

SUBJECT: VPDES Permit No. VA0004146
Chesterfield Power Station
Groundwater Quality and Risk Assessment Report- Phase I

TO: Curtis J. Linderman, P.E., Water Permit Manager

FROM: Emilee Carpenter, Water Permit Writer

DATE: February 8, 2013

COPIES: Donald Hintz, Dominion's Electric Environmental Services Group

Type of Report: Groundwater Quality and Risk Assessment Report – Phase I

Description: Phase I of the Groundwater Quality and Risk Assessment Report was submitted in accordance with Part I.B.7.b of the 2004 VPDES permit. Ground water monitoring data indicated that groundwater in the vicinity of the old ash pond has been affected, so DEQ requested a Corrective Action Plan (CAP) and schedule for assessing ground water contamination attributed to the Old Ash Pond in the 2004 permit. The report was initially submitted in February 2007, and subsequently revised in March of 2012. The goal of the report is to characterize the quality of groundwater in the area of the Old Ash Pond, assess current potential risk to human health and the environment from identified releases to groundwater, and evaluate whether corrective action or other actions are appropriate at the Facility. The report addresses the following:

1) Evaluation of Aquifer Characteristics:
   a. An updated potentiometric map based on 2012 GW elevations indicates radial flow away from the Old Ash Pond. The Old Ash Pond is bordered to the north by the Facility, to the West by the Facility discharge channel, to the south by the surface waters of Farrar Gut, to the east by Aiken Swamp, and to the southeast by the New Ash Pond.
   b. Hydraulic aquifer slug tests indicate overall average hydraulic conductivity of 0.52 ft/day.
   c. Average groundwater flow velocity beneath the Site is 5.36 ft/year

2) Evaluation of Background Monitoring Well Appropriateness:
   a. The background wells approved in the 2001 Groundwater Monitoring Plan (GWMP) were B-50, B-51 and B-52.
   b. Subsequent evaluation of the potentiometric map developed in 2012 indicates that wells B-50 and B-51 are located downgradient of the Old Ash Pond; however, B-52 remains an appropriate background well.
   c. Well B-51 does not meet performance standards as it has been dry 50% of the time over the last two years.
3) Characterization of Nature and Extent of Contamination
   a. Constituents of Potential Concern (COPC) were identified by comparing detected

constituents to EPA Regional Screening Levels (RSLs) for tap water (T-RSLs) and National Primary Drinking Water Regulations Maximum Contaminant Levels (MCLs). Analytes detected at a concentration higher than the corresponding T-RSL or MCL were selected as COPC. The following constituents were identified: dissolved arsenic, dissolved cadmium, dissolved iron, dissolved manganese, dissolved molybdenum.

b. Upper Prediction Limit (UPL) statistical analyses were used to evaluate the presence of statistically significant increases (SSIs) above background concentrations. Well B-52 was used as the sole background well. Data sets were evaluated for outliers using Dixon's test (Data sets less than 25) or Rosner's Test (data sets larger than 25). The appropriate method for UPL analysis was then determined based on the percent of non-detect data in the set and the normality of the distribution. Parametric and non-parametric approaches were chosen accordingly to perform the 95% Prediction Interval Analysis. The following parameters showed SSIs over background concentrations: dissolved arsenic, dissolved barium, dissolved copper, dissolved iron, dissolved manganese, dissolved molybdenum, ammonia, and chloride. Background statistical evaluations also indicate that identified COPC from 3.a above also show SSI above site background levels.

4) Identification of Human Health and Environmental Receptors:
   a. Groundwater:
      i. Although none of the groundwater sources at the site or on bordering industrial parcels are currently used as drinking water sources, human health receptors of contaminated groundwater are based on the assumption that the groundwater is used as drinking water. The only current scenario receptors are construction workers. Future hypothetical receptors are Commercial/Industrial workers and child and adult residents.
      ii. Exposure pathways to human receptors include ingestion, dermal absorption and inhalation.
   b. Surface water:
      i. Surface water receptors include Farrar Gut and Aiken Swamp. Contamination of surface waters presents potential risks to both human health and aquatic life.
      ii. Exposure pathways to human receptors include recreational use and potential future public water supply use. Exposure to aquatic organisms is chronic ambient environmental conditions.
5) Assessment of Risk to Identified Receptors:
   a. Groundwater: To evaluate the risk of hypothetical current or future use of groundwater on site for potable applications (i.e. drinking, showering, etc.), a Human Health Risk Assessment (HHRA) was performed consistent with EPA guidance, Interim Final Risk Assessment Guidance for Superfund (RAGS) and other EPA Region III resources and guidance documents.
      i. COPC were identified for the April 2011 sampling results by comparing detected constituent concentrations to EPA Regional Screening Levels and National Primary Drinking Water Regulations, MCLs. Analytes detected at a concentration higher than the corresponding RSL or MCL are selected as COPC.
      ii. Constituents identified as COPC are as follows: dissolved iron, dissolved manganese, dissolved arsenic, dissolved molybdenum, and dissolved cadmium.
      iii. Carcinogenic COPC were not identified in the groundwater, so an associated risk was not calculated. Non-carcinogenic risks were calculated in cumulative for each exposure pathway to form a Hazard Index (HI), which accounts for simultaneous exposure to multiple COPC.

iv. Elevated HIs were found for future receptors due to iron and manganese if the groundwater were to be used as drinking/bathing water and partly due to ammonia inhalation in a shower scenario.

v. Groundwater at the site is not currently nor expected in the future to be used as tap water for drinking, washing or bathing; therefore, the exposure pathway is incomplete.

b. Surface Water: A two-tiered screening approach was used to evaluate potential risks. Surface water data were collected from 3 locations in Aiken Swamp, 4 locations in Farrar Gut and one background location upstream of the Facility in the James River.

i. Tier I consists of comparing receptor surface water data to background surface water data to determine whether an increase over background is observed. If an increase is observed, a potential effect on water quality is identified and the Tier II comparison must be performed.

ii. Tier II consists of comparison of surface water data to conservative human and ecological risk screening criteria.

1. Aiken Swamp:

a. Tier I: Background concentrations for arsenic, barium, iron, manganese, vanadium, zinc, ammonia, chloride and sulfate were exceeded in 2006. The 2012 sampling event identified a smaller number of constituents that exceeded background: iron, manganese, ammonia and chloride.

b. Tier II: As a swamp, it is highly unlikely that this receptor will be used in the future as a public water supply (PWS). Consequently, Aiken Swamp was screened against the Virginia Water Quality Standards for freshwater aquatic life (chronic toxicity) and for Human Health-"all other surface waters." Observed concentrations were below the criteria; consequently, it does not appear a potential risk is posed to human or aquatic life in Aiken Swamp.

2. Farrar Gut:

a. Tier I: Background concentrations for barium, chromium, copper, manganese, molybdenum, vanadium, zinc, and sulfate were exceeded in 2006. The 2012 sampling event identified background exceedances for barium, iron, manganese, molybdenum, ammonia, chloride, nitrate and sulfate.

b. Tier II:

i. Surface water data was compared to VWQS for public water supplies and all other surface waters. Observed concentrations were below the standards, with the exception of iron and manganese standards for PWSs. Iron and manganese standards for PWS are established based on the aesthetic quality of drinking water and apply at the drinking water intake. Therefore, it does not appear that the surface water poses a potential risk with regard to human health.

ii. Surface water data was also compared to the VWQS for fresh water aquatic species (chronic toxicity). All observed concentrations were below the standards with the exception of a single hexavalent chromium sample collected in 2006. The observed concentration of total hexavalent chromium exceeded the standard by 1 µg/L. The standard is expressed in terms of dissolved hexavalent chromium, which was not detected in any of the surface water samples. Consequently, the results did not indicate a potential risk to aquatic life in Farrar Gut.

iii. While surface water is a complete pathway for both human and ecological receptors, the human health and aquatic life risk screenings did not indicate a current risk to receptors from discharges of site groundwater to surface water.

6) Evaluation of the need for remedial alternatives:
   a. In a subsequent submittal, dated November 29, 2012 Dominion proposed to address future risk assessment and corrective action through Phase II of the report. Dominion proposes to establish groundwater action levels in a manner similar to the approach used for the New Ash Pond.
      i. Action levels will be established for the Constituents of Potential Concern (COPCs) in the Revised Groundwater Quality and Risk Assessment Report.
      ii. Submittal of Phase II of the Report will be required within 180 days of the effective date of the reissued permit. This requirement will be addressed in the groundwater monitoring special condition of the reissued permit

Recommendation: Staff recommends approval of Phase I of the Groundwater Quality and Risk Assessment Report. Approval is contingent upon submittal of a Phase II report to address future risk assessment and corrective action. In addition to the proposed action level approach for COPCs identified above, the permittee must also address migration of the groundwater contaminant plume onto neighboring industrial properties and ensure that Ground Water Standards and Criteria are met at the property boundary.

Approved: As recommended by staff.

_____

Curtis J. Linderman, P.E.
Water Permit Manager,
VA Department of Environmental Quality

Date: February 12, 2013

Attachment 8.e

Metals Pond Statistical Analysis

Groundwater Monitoring Data Analysis (v.3)

Facility Name:	Chesterfield Power Station
Permit No.:	VA0004146
Monitoring Parameter:	Chloride
Applicable GW Standard (if none leave blank):	
Applicable GW Criteria (if none leave blank):	50
Concentration Units (all data):	mg/L

	Data Entry					
Well Designation ►	MP-1R	MP-2	MP-3			
Sample or Report Date (ascending)	Background Well Data	Compliance Well #1	Compliance Well #2	Compliance Well #3	Compliance Well #4	Compliance Well #5
1 7/23/2008	41.71	7.77	59.1			
2 10/22/2008	27.42	6.98	58.34			
3 1/13/2009	19.02	7.41	57.7			
4 4/8/2009	37.24	7.05	57.2			
5 7/15/2009	34.42	7.1	54.92			
6 10/8/2009	19.44	7.28	60.9			
7 1/7/2010	21.29	7.59	61			
8 4/7/2010	17.13	12.99	65.43			
9 7/17/2010	18.3	21.34	76.08			
10 12/8/2010	23.41	28.09	104.37			
11 2/3/2011	21.38	19	117.3			
12 4/13/2011	19.72	18.95	133.93			
13 8/16/2011	34.84	29.36	148.74			
14 10/16/2011	34.81	11.52	178.03			
15 1/18/2012	40.55	23.83	220.02			
16 4/4/2012	38.76	31.16	248.05			
17 7/25/2012	37.61	67.45	301.91			
18 11/7/2012	43.18	70.01	346.14			
19 1/9/2013	37.03	88.76	377.38			
20 7/24/2013	40.6	64.79	411.7			
21 10/29/2013	42.91	138.97	504.09			
22 6/16/2014	27.5	116.98	519.01			
23 7/31/2014	39.84	132.87	542.02			
24 11/5/2014	47.5	260.02	553.98			
25 1/7/2015	37.24	197.27	276.08			
26 4/1/2015	30.57	227.55	508.78			
27 8/4/2015	45.84	231.52	546.83			
28						
29						
30						
31						
32						
33						
34						
35						
36						
37						
38						
39						
40						
41						
42						
43						
44						
45						
46						
47						
48						
49						
50						

Results: Significance to Background **

		Distribution Tests		Non-normal Test	Normal Tests	
		Shapiro-Wilk Normality Test	Shapiro-Wilk Log Normality Test	Wilcoxon Rank Sum Test	T-test	T-test (lognormal)
MP-1R	Background Well	Not normal	Not normal	N/A		
MP-2	Compliance Well #1	Not normal	Normal	Not Significant	Significant	Not Significant
MP-3	Compliance Well #2	Not normal	Not normal	Significant	Significant	Significant
	Compliance Well #3					
	Compliance Well #4					
	Compliance Well #5					

** Please note that the above cells will appear blank in cases where a test cannot be conducted due to lack of data, or if the test assumptions are invalid due to lack of data variation.

Results: Linear Regression Trend Analysis and Interpretation of Data

		Regression Line Slope	Pearson Correlation (R)	Interpretation	
				Linear Trend	Degree of Data Linearity
MP-1R	Background Well	0.006469165	0.535493342	Slight Increase	Moderately Strong
MP-2	Compliance Well #1	0.088060386	0.880081746	Slight Increase	Very Strong
MP-3	Compliance Well #2	0.220412265	0.931182607	Slight Increase	Very Strong
	Compliance Well #3				
	Compliance Well #4				
	Compliance Well #5				

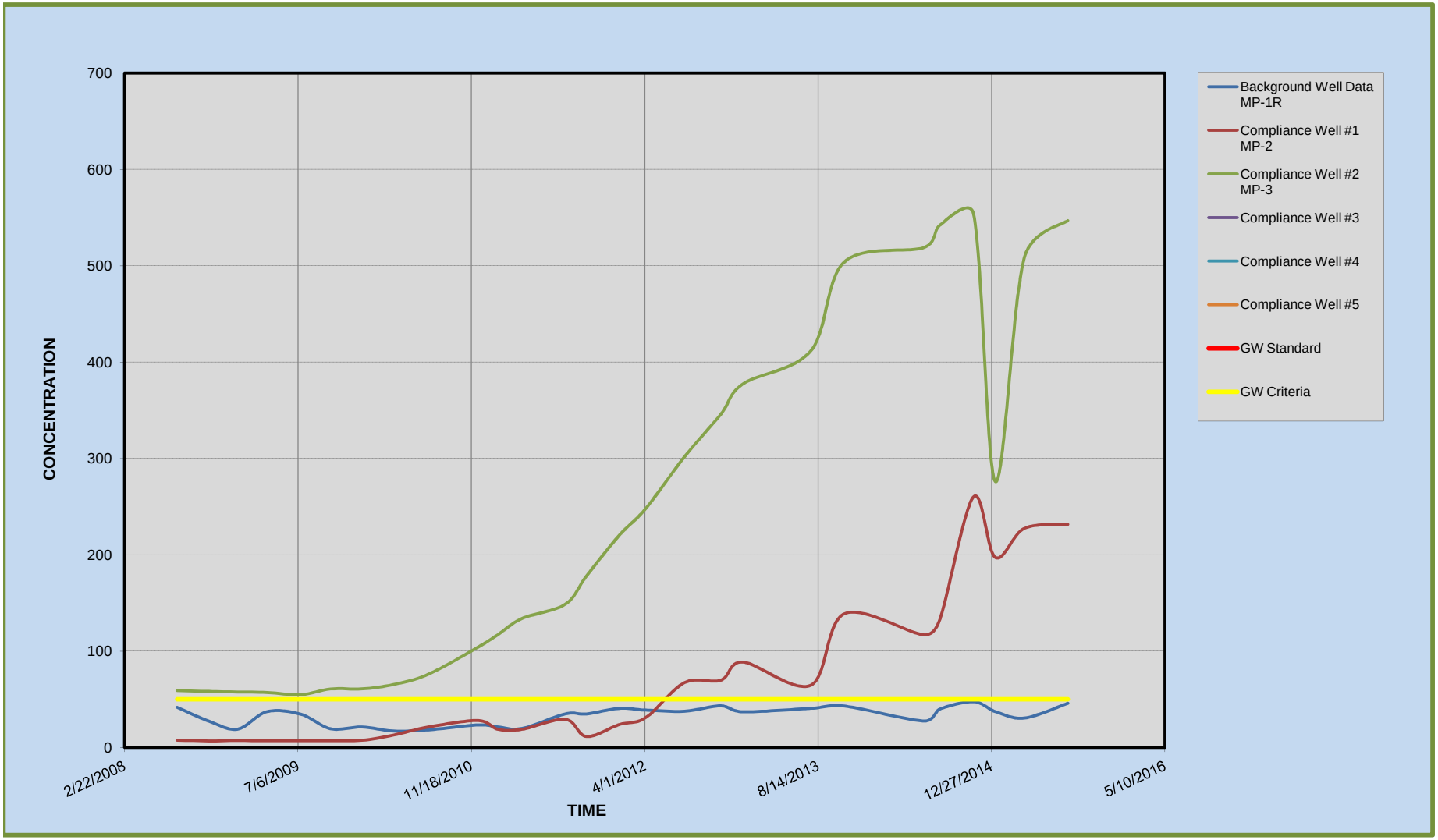
Results: Groundwater Standards/Criteria Comparison

		Groundwater Standard		Groundwater Criteria		Total No. of Data Points
		No. Violations of GW Standard	% Violations of GW Standard	No. Violations of GW Criteria	% Violations of GW Criteria	
MP-1R	Background Well			0	0%	27
MP-2	Compliance Well #1			11	40.7%	27
MP-3	Compliance Well #2			27	100%	27
	Compliance Well #3					
	Compliance Well #4					
	Compliance Well #5					

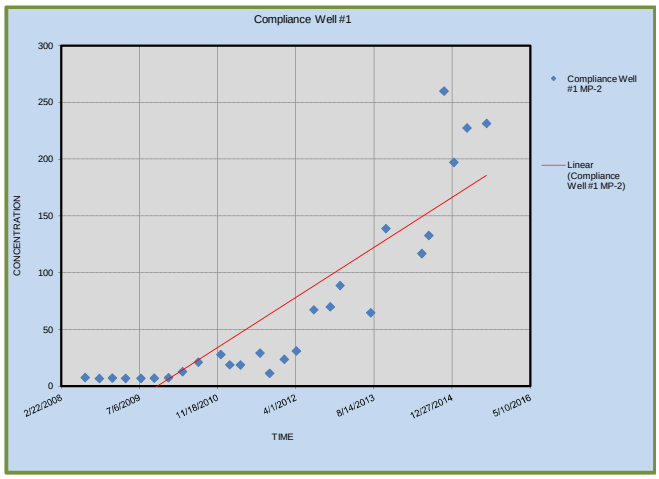
Results: Basic Statistics (less-than values ignored)

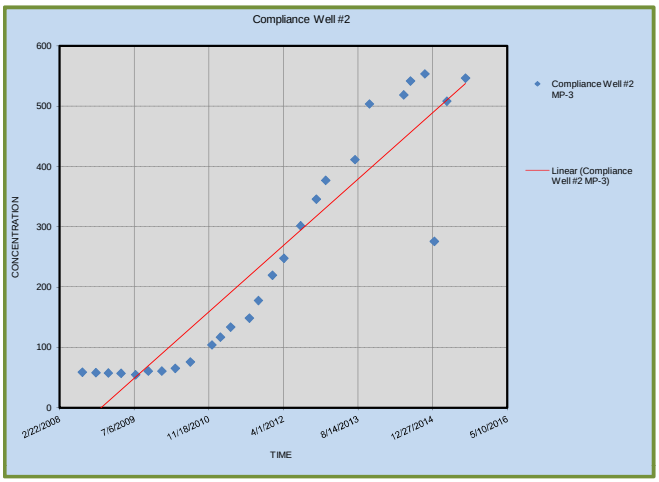
		Maximum Value	Minimum Value	Average		
MP-1R	Background Well	47.500	17.130	32.565		
MP-2	Compliance Well #1	260.020	6.980	68.282		
MP-3	Compliance Well #2	553.980	54.920	244.038		
	Compliance Well #3					
	Compliance Well #4					
	Compliance Well #5					

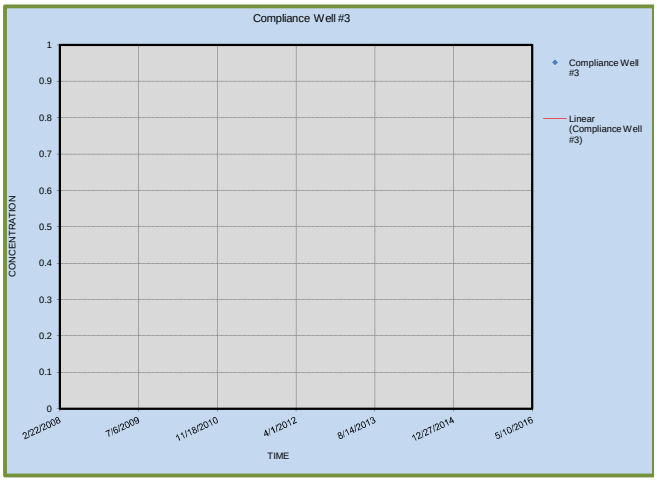
Chesterfield Power Station: Groundwater Monitoring Data for Chloride

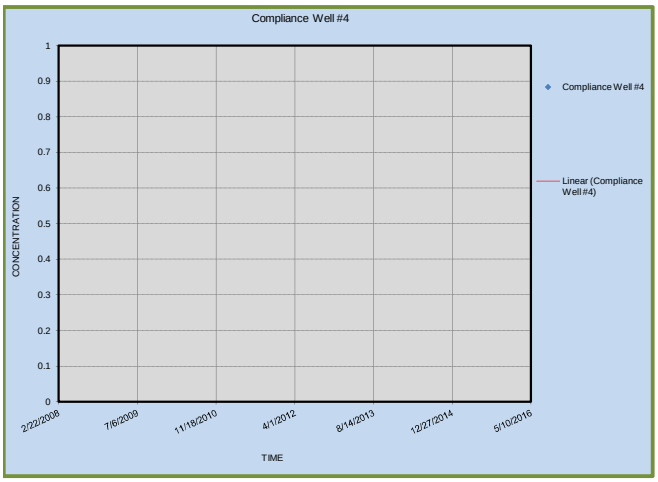


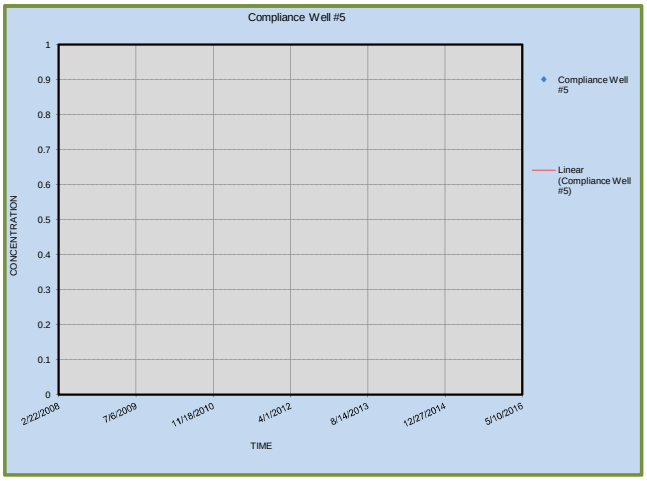
Chesterfield Power Station: Groundwater Monitoring Regression Trends for Chloride











Groundwater Monitoring Data Analysis (v.3)

Facility Name:	Chesterfield Power Station
Permit No.:	VA0004146
Monitoring Parameter:	Copper
Applicable GW Standard (if none leave blank):	1000
Applicable GW Criteria (if none leave blank):	
Concentration Units (all data):	ug/l

	Data Entry					
Well Designation ►	MP-1R	MP-2	MP-3			
Sample or Report Date (ascending)	Background Well Data	Compliance Well #1	Compliance Well #2	Compliance Well #3	Compliance Well #4	Compliance Well #5
1 7/23/2008	2	1	1			
2 10/22/2008	1	1	1			
3 1/13/2009	1	1	2			
4 4/8/2009	1	1	1			
5 7/15/2009	1	1	1			
6 10/8/2009	1	1	1			
7 1/7/2010	1	1	2			
8 4/7/2010	1	1	2			
9 7/17/2010	1	1	1			
10 12/8/2010	2	1	1			
11 2/3/2011	1	1	1			
12 4/13/2011	1	4	1			
13 8/16/2011	1	1	1			
14 10/16/2011	1	1	2			
15 1/18/2012	1	1	1			
16 4/4/2012	1	1	1			
17 7/25/2012	1	1	1			
18 11/7/2012	1	1	2			
19 1/9/2013	1	1	3			
20 7/24/2013	1	1	2			
21 10/29/2013	1	1	3			
22 6/16/2014	1	1	1			
23 7/31/2014	1	1	2			
24 11/5/2014	1	1	2			
25 1/7/2015	1	1	2			
26 4/1/2015	3	1	3			
27 8/4/2015	2	1	2			
28						
29						
30						
31						
32						
33						
34						
35						
36						
37						
38						
39						
40						
41						
42						
43						
44						
45						
46						
47						
48						
49						
50						

Results: Significance to Background **

		Distribution Tests		Non-normal Test	Normal Tests	
		Shapiro-Wilk Normality Test	Shapiro-Wilk Log Normality Test	Wilcoxon Rank Sum Test	T-test	T-test (lognormal)
MP-1R	Background Well	Not normal	Not normal	N/A		
MP-2	Compliance Well #1	Not normal	Not normal	Not Significant	Not Significant	Not Significant
MP-3	Compliance Well #2	Not normal	Not normal	Not Significant	Significant	Significant
	Compliance Well #3					
	Compliance Well #4					
	Compliance Well #5					

** Please note that the above cells will appear blank in cases where a test cannot be conducted due to lack of data, or if the test assumptions are invalid due to lack of data variation.

Results: Linear Regression Trend Analysis and Interpretation of Data

		Regression Line Slope	Pearson Correlation (R)	Interpretation	
				Linear Trend	Degree of Data Linearity
MP-1R	Background Well	0.000131668	0.21572338	Slight Increase	Very Weak
MP-2	Compliance Well #1	-4.43497E-05	-0.060830539	Slight Decrease	Very Weak
MP-3	Compliance Well #2	0.000463816	0.529329719	Slight Increase	Moderately Strong
	Compliance Well #3				
	Compliance Well #4				
	Compliance Well #5				

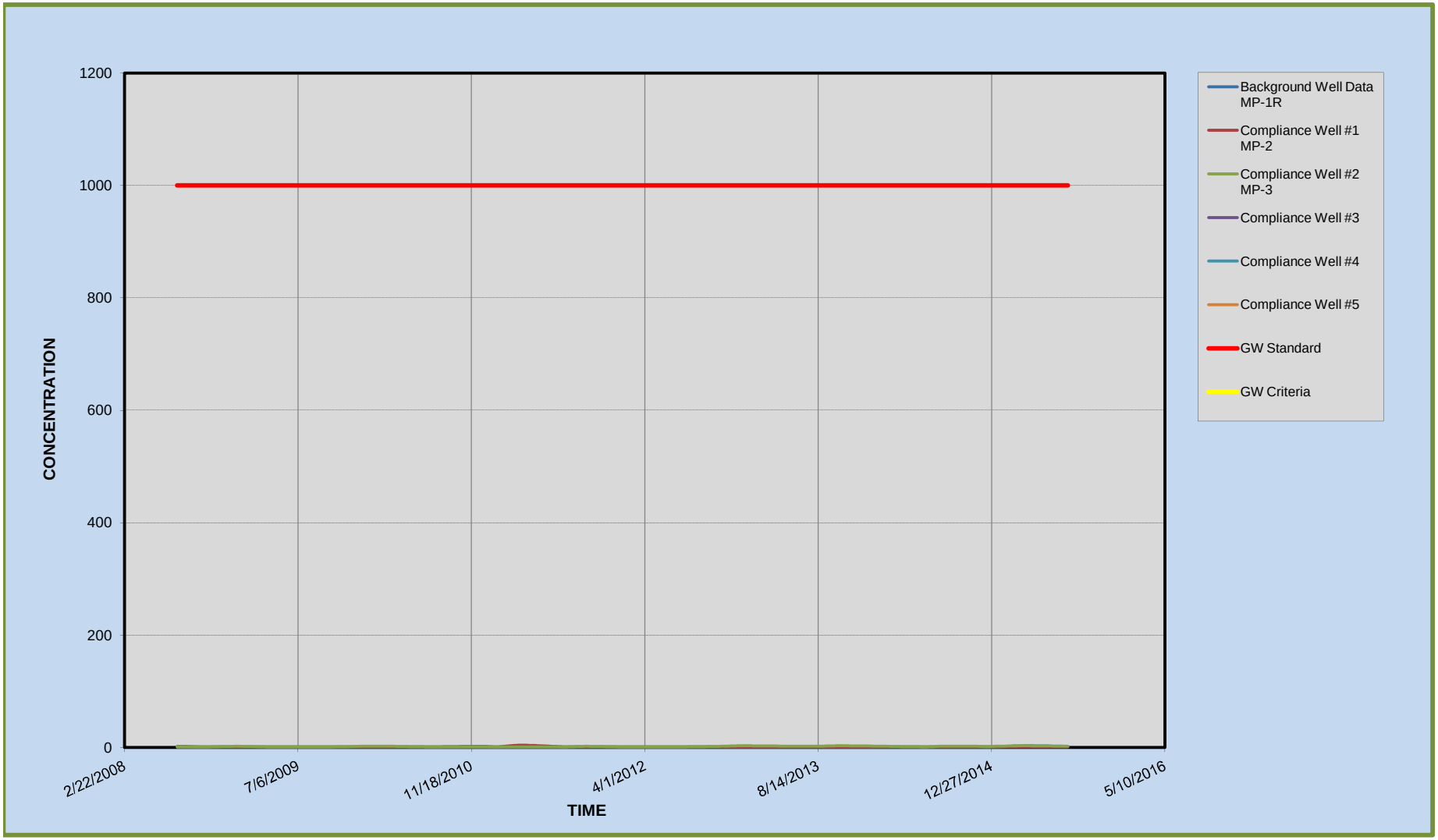
Results: Groundwater Standards/Criteria Comparison

		Groundwater Standard		Groundwater Criteria		Total No. of Data Points
		No. Violations of GW Standard	% Violations of GW Standard	No. Violations of GW Criteria	% Violations of GW Criteria	
MP-1R	Background Well	0	0%			27
MP-2	Compliance Well #1	0	0%			27
MP-3	Compliance Well #2	0	0%			27
	Compliance Well #3					
	Compliance Well #4					
	Compliance Well #5					

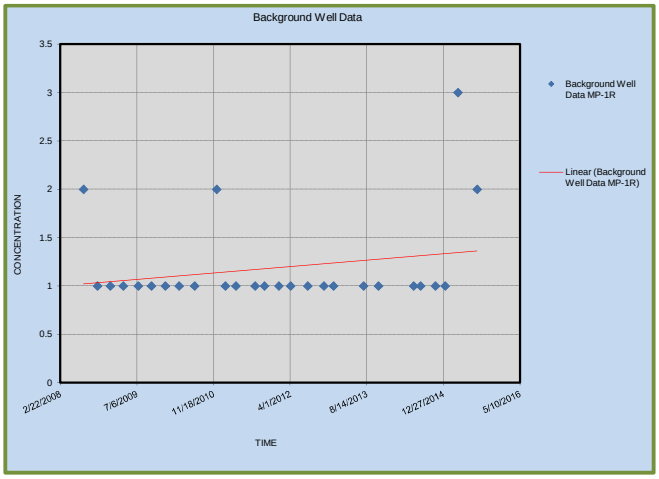
Results: Basic Statistics (less-than values ignored)

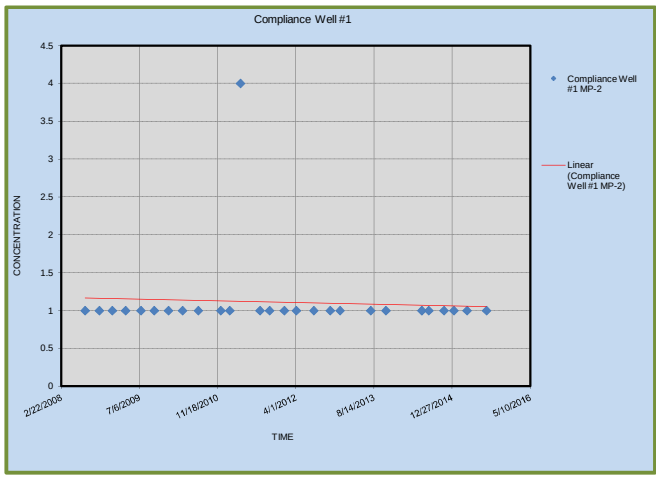
		Maximum Value	Minimum Value	Average		
MP-1R	Background Well	3.000	1.000	1.185		
MP-2	Compliance Well #1	4.000	1.000	1.111		
MP-3	Compliance Well #2	3.000	1.000	1.593		
	Compliance Well #3					
	Compliance Well #4					
	Compliance Well #5					

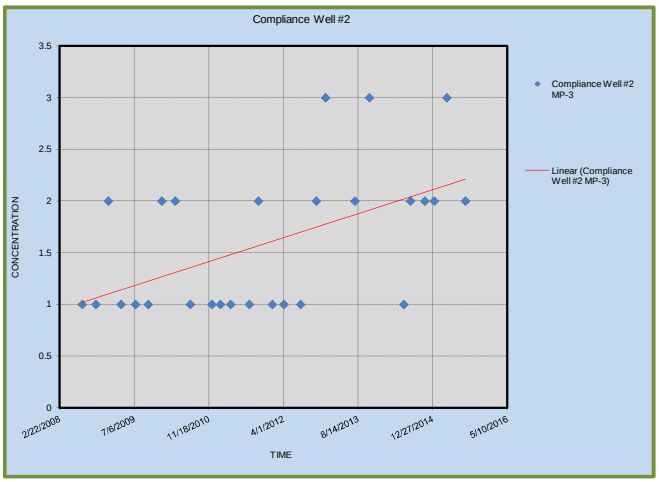
Chesterfield Power Station: Groundwater Monitoring Data for Copper

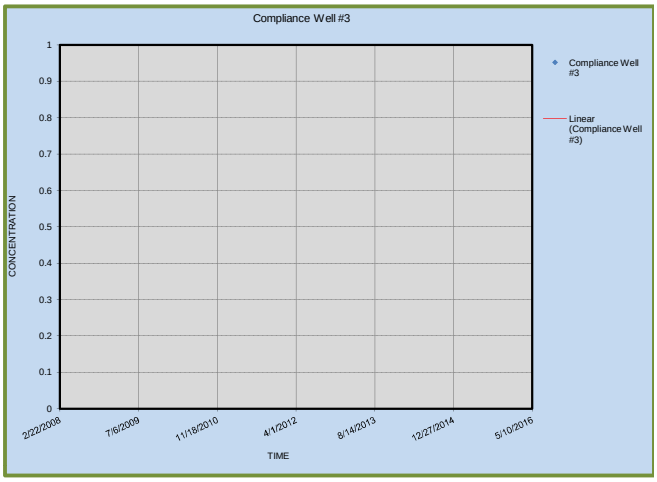


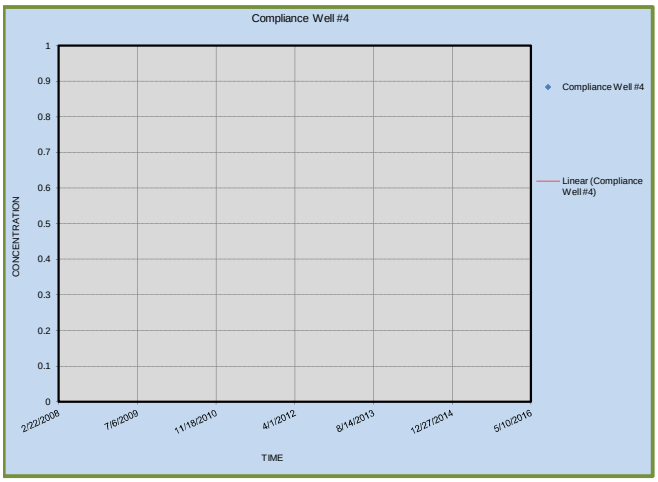
Chesterfield Power Station: Groundwater Monitoring Regression Trends for Copper

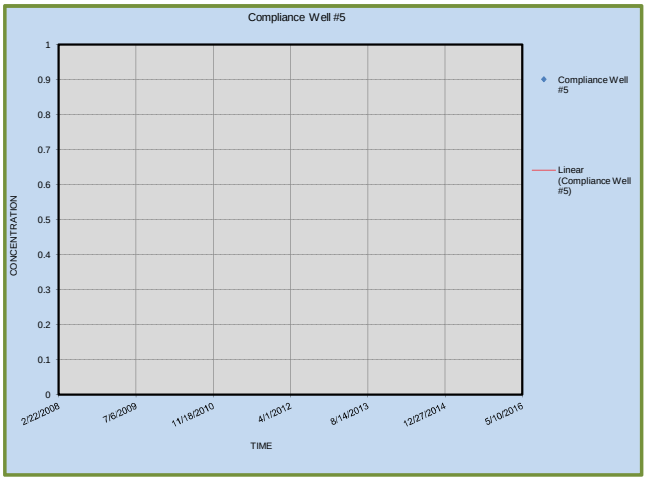












Groundwater Monitoring Data Analysis (v.3)

Facility Name:	Chesterfield Power Station
Permit No.:	VA0004146
Monitoring Parameter:	Iron
Applicable GW Standard (if none leave blank):	
Applicable GW Criteria (if none leave blank):	0.3
Concentration Units (all data):	mg/L

	Data Entry					
Well Designation ►	MP-1R	MP-2	MP-3			
Sample or Report Date (ascending)	Background Well Data	Compliance Well #1	Compliance Well #2	Compliance Well #3	Compliance Well #4	Compliance Well #5
1 7/23/2008	0.09	0.05	0.05			
2 10/22/2008	0.09	0.18	0.05			
3 1/13/2009	0.06	0.07	0.05			
4 4/8/2009	0.05	0.05	0.05			
5 7/15/2009	0.1	0.09	0.05			
6 10/8/2009	0.09	0.05	0.05			
7 1/7/2010	0.05	0.16	0.05			
8 4/7/2010	0.05	0.05	0.05			
9 7/17/2010	0.05	0.08	0.05			
10 12/8/2010	0.05	2.26	0.42			
11 2/3/2011	0.05	0.8	0.05			
12 4/13/2011	0.05	0.7	0.05			
13 8/16/2011	0.06	0.12	0.05			
14 10/16/2011	0.05	0.06	0.05			
15 1/18/2012	0.05	0.05	0.05			
16 4/4/2012	0.05	0.1	0.11			
17 7/25/2012	0.05	6.35	0.05			
18 11/7/2012	0.05	1.18	0.05			
19 1/9/2013	0.05	0.05	0.05			
20 7/24/2013	0.05	0.26	0.05			
21 10/29/2013	0.05	5.26	0.05			
22 6/16/2014	0.05	0.2	0.05			
23 7/31/2014	0.05	1.34	0.05			
24 11/5/2014	0.94	15.57	0.28			
25 1/7/2015	0.05	1.88	0.19			
26 4/1/2015	9.16	3.02	3.94			
27 8/4/2015	0.52	5.56	0.56			
28						
29						
30						
31						
32						
33						
34						
35						
36						
37						
38						
39						
40						
41						
42						
43						
44						
45						
46						
47						
48						
49						
50						

Results: Significance to Background **

		Distribution Tests		Non-normal Test	Normal Tests	
		Shapiro-Wilk Normality Test	Shapiro-Wilk Log Normality Test	Wilcoxon Rank Sum Test	T-test	T-test (lognormal)
MP-1R	Background Well	Not normal	Not normal	N/A		
MP-2	Compliance Well #1	Not normal	Normal	Not Significant	Significant	Significant
MP-3	Compliance Well #2	Not normal	Not normal	Not Significant	Not Significant	Not Significant
	Compliance Well #3					
	Compliance Well #4					
	Compliance Well #5					

** Please note that the above cells will appear blank in cases where a test cannot be conducted due to lack of data, or if the test assumptions are invalid due to lack of data variation.

Results: Linear Regression Trend Analysis and Interpretation of Data

		Regression Line Slope	Pearson Correlation (R)	Interpretation	
				Linear Trend	Degree of Data Linearity
MP-1R	Background Well	0.000760068	0.343556253	Slight Increase	Moderately Weak
MP-2	Compliance Well #1	0.002138148	0.509783302	Slight Increase	Moderately Strong
MP-3	Compliance Well #2	0.000346605	0.366235677	Slight Increase	Moderately Weak
	Compliance Well #3				
	Compliance Well #4				
	Compliance Well #5				

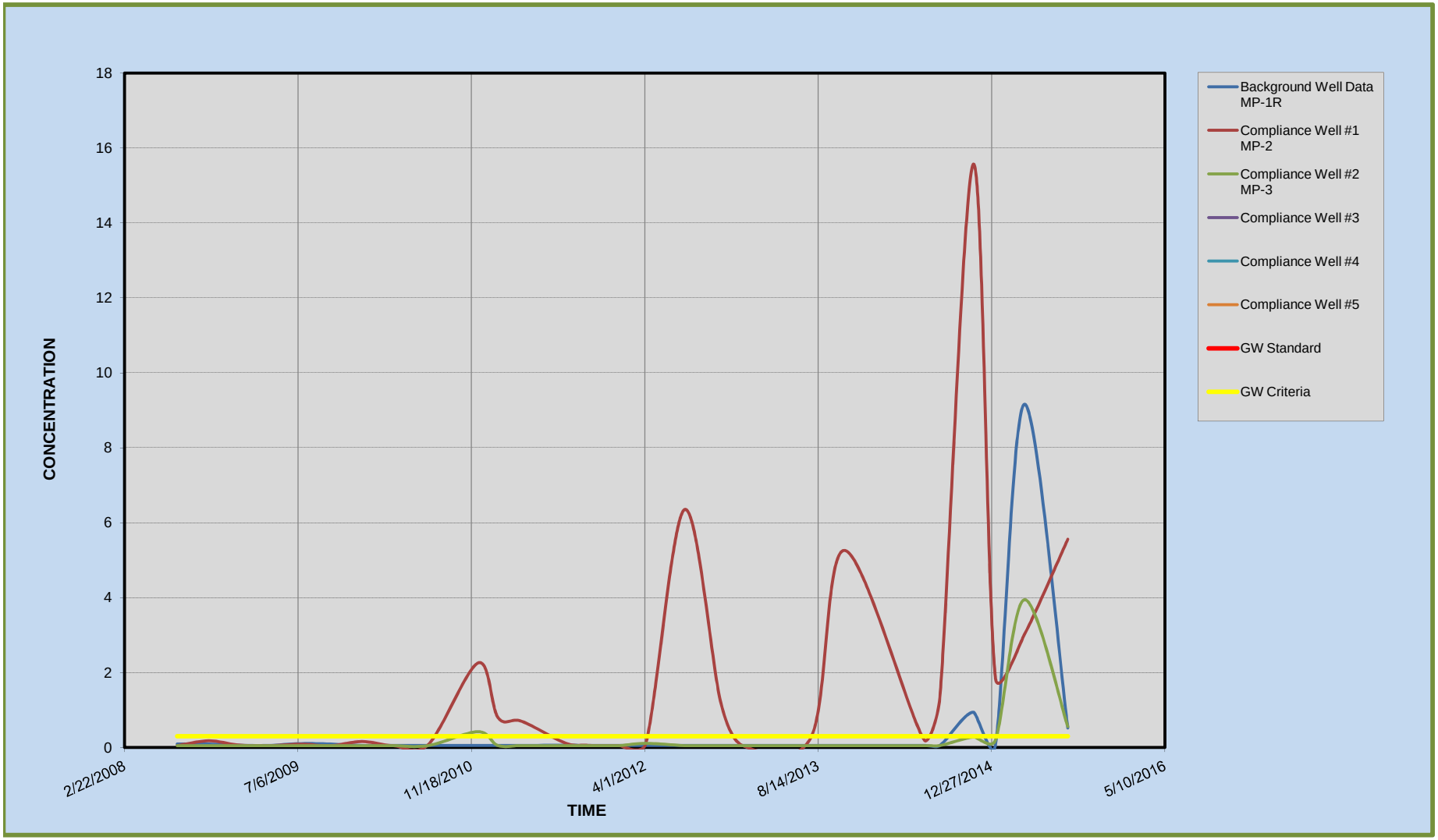
Results: Groundwater Standards/Criteria Comparison

		Groundwater Standard		Groundwater Criteria		Total No. of Data Points
		No. Violations of GW Standard	% Violations of GW Standard	No. Violations of GW Criteria	% Violations of GW Criteria	
MP-1R	Background Well			3	11.1%	27
MP-2	Compliance Well #1			11	40.7%	27
MP-3	Compliance Well #2			3	11.1%	27
	Compliance Well #3					
	Compliance Well #4					
	Compliance Well #5					

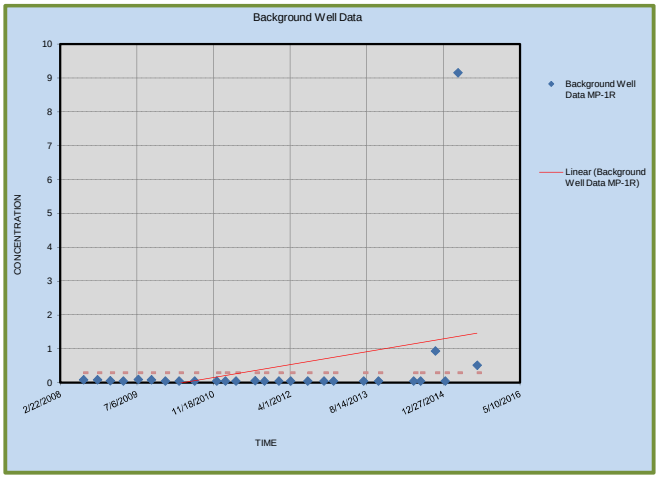
Results: Basic Statistics (less-than values ignored)

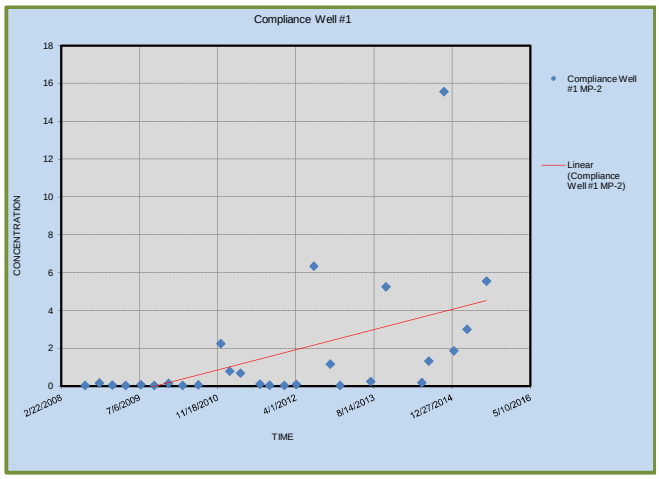
		Maximum Value	Minimum Value	Average		
MP-1R	Background Well	9.160	0.050	0.445		
MP-2	Compliance Well #1	15.570	0.050	1.687		
MP-3	Compliance Well #2	3.940	0.050	0.243		
	Compliance Well #3					
	Compliance Well #4					
	Compliance Well #5					

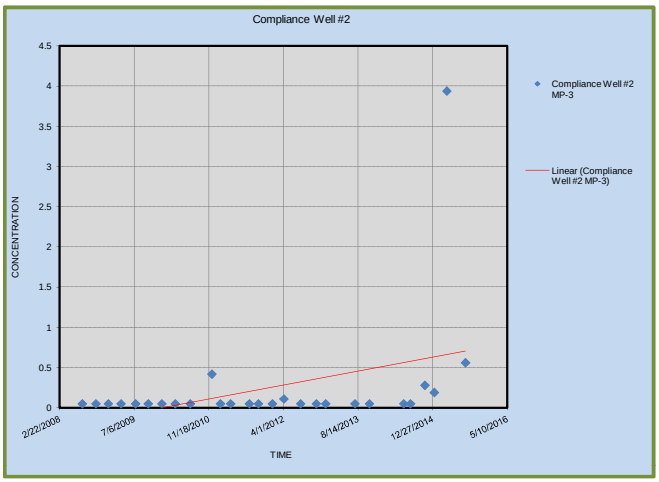
Chesterfield Power Station: Groundwater Monitoring Data for Iron

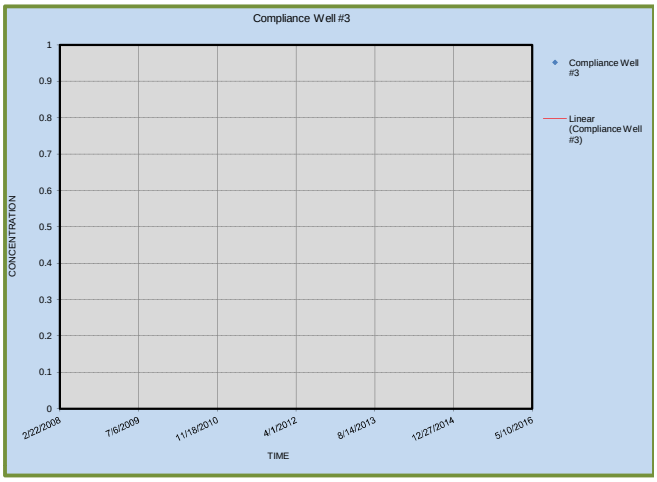


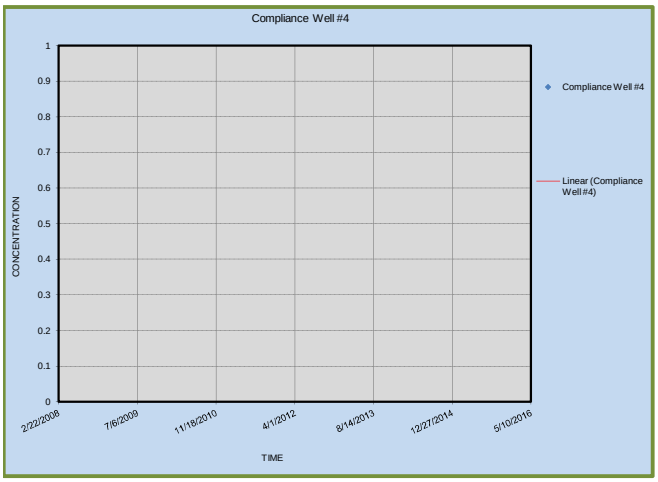
Chesterfield Power Station: Groundwater Monitoring Regression Trends for Iron

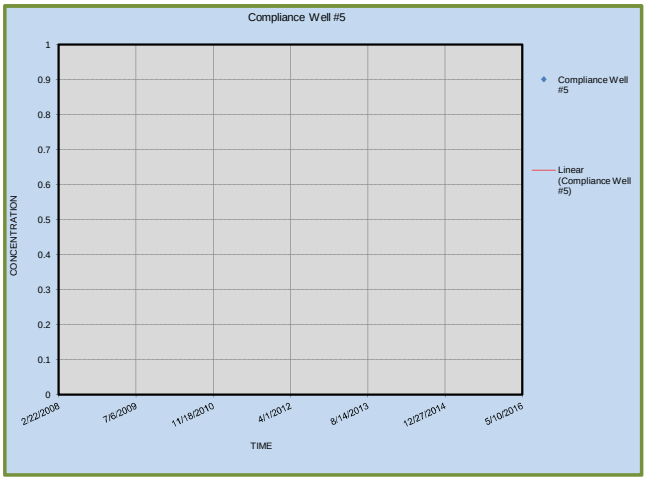












Groundwater Data and Analysis Summary for pH

East Field

Facility Name:	Chesterfield Power Station		
Permit Number:	VA0004146	Date:	11/19/2015
Parameter:	pH	Units:	SU
Upgradient Well Designation		MP-1R	
Downgradient Well Designation		MP-2	
Downgradient Well Designation		MP-3	
Downgradient Well Designation			
Downgradient Well Designation			
Downgradient Well Designation			
Applicable Groundwater Standard:		**6.5-9.0**	**SU**
Applicable Groundwater Criteria:		**NA**	

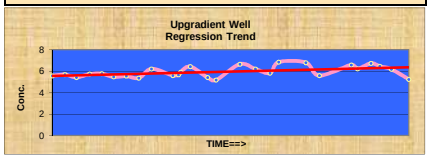
	Significant difference from Upgradient Well using parametric test?	Trend Analysis R-Sq.	Trend Analysis Slope
MP-2	NO	0.0000	0.0000
MP-3	NO	0.1165	-0.0002
	#DIV/0!		
	#DIV/0!		
	#DIV/0!		

	Groundwater Monitoring Report Date	MP-1R (Upgradient Well)	MP-2	MP-3
1	7/23/2008	5.58	6.14	5.63
2	10/22/2008	5.7	6.04	5.64
3	1/13/2009	5.43	5.89	5.3
4	4/18/2009	5.75	5.89	5.59
5	7/15/2009	5.78	5.57	6.02
6	10/8/2009	5.48	6.32	5.7
7	1/7/2010	5.56	6.42	5.45
8	4/7/2010	5.37	5.75	5.58
9	7/7/2010	6.22	6.09	6.86
10	12/8/2010	5.61	5.71	5.2
11	2/3/2011	5.92	5.67	5.43
12	4/13/2011	6.44	6.35	5.07
13	8/16/2011	5.42	5.74	5.04
14	10/16/2011	5.19	5.94	5.44
15	1/18/2011	5.68	6.32	5.44
16	4/4/2012	6.66	6.08	5
17	7/25/2012	6.21	5.4	5.18
18	11/7/2012	5.83	5.49	5.08
19	1/9/2013	6.86	5.9	5.24
20	7/24/2013	6.8	6	6.17
21	10/29/2013	5.6	5.75	4.76
22	6/16/2014	6.59	6.07	5.47
23	7/31/2014	6.23	6.3	5.69
24	11/5/2014	6.74	5.15	4.68
25	1/7/2015	6.47	6.06	6
26	4/1/2015	6.19	5.48	4.84
27	8/4/2015	5.25	7.25	5.01
28				
29				
30				
31				
32				
33				
34				
35				
36				
37				
38				
39				
40				
	St.Dev. ►	0.51	0.41	0.47
	Mean ►	5.95	5.95	5.43
	Is the Mean greater than 3X St.Dev. ? ►	YES	YES	YES

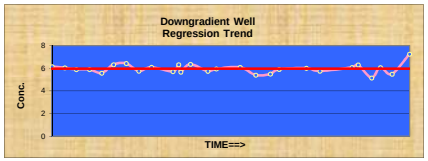
Note: The comparison of the Mean to three times the Standard Deviation may help to determine if there is a statistically significant change in the trend of a data set. If any of the cells above contain "NO", this may be an indication of a sudden increase or decrease in concentration of the parameter. This should only be used as a flag and not the basis for any final decisions regarding the acceptability of the data.

Linear Regressions:

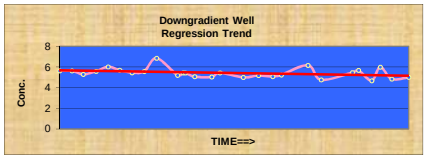
MP-1R (Upgradient Well)

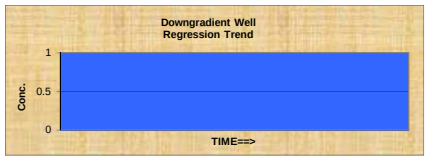


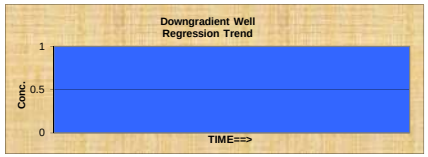
MP-2

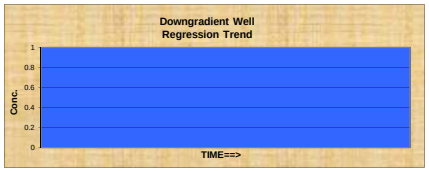


MP-3

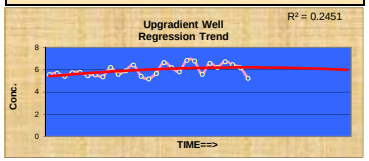


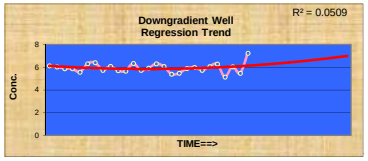


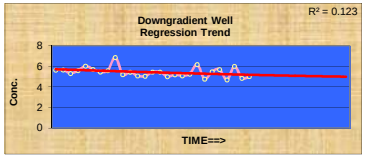


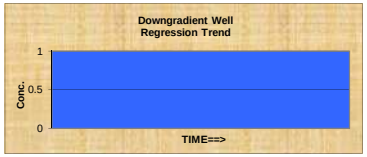


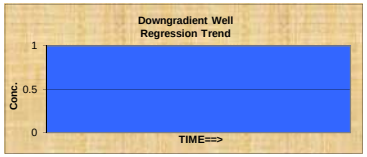
Polynomial Regressions:

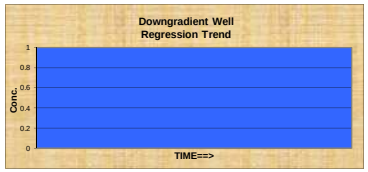


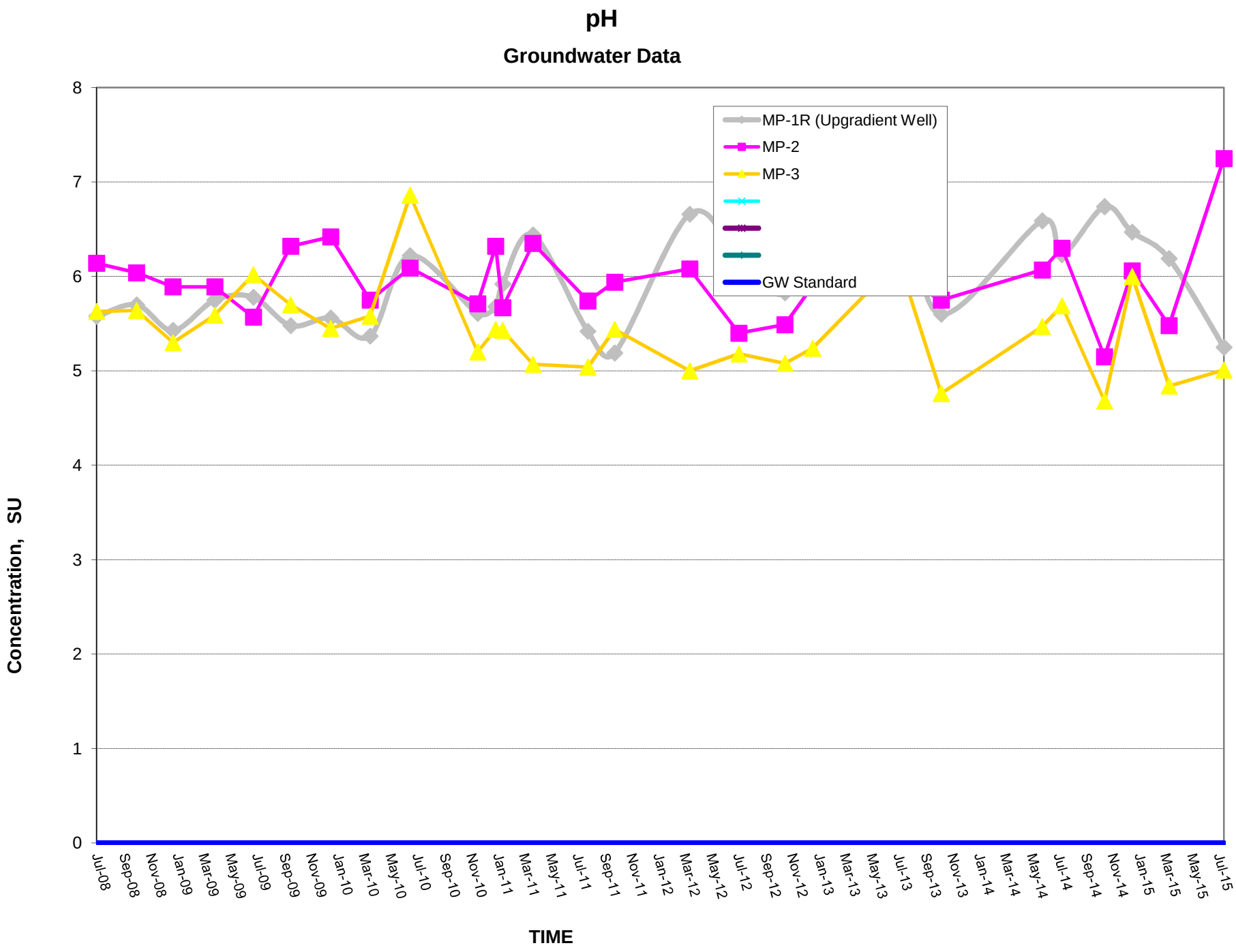











pH
Groundwater Data
MP-1R (Upgradient Well)
MP-2
MP-3
GW Standard
Concentration, SU
TIME
0
1
2
3
4
5
6
7
8
Jul-08
Sep-08
Nov-08
Jan-09
Mar-09
May-09
Jul-09
Sep-09
Nov-09
Jan-10
Mar-10
May-10
Jul-10
Sep-10
Nov-10
Jan-11
Mar-11
May-11
Jul-11
Sep-11
Nov-11
Jan-12
Mar-12
May-12
Jul-12
Sep-12
Nov-12
Jan-13
Mar-13
May-13
Jul-13
Sep-13
Nov-13
Jan-14
Mar-14
May-14
Jul-14
Sep-14
Nov-14
Jan-15
Mar-15
May-15
Jul-15

Attachment 9

Discussion of WET Testing

MEMORANDUM

DEPARTMENT OF ENVIRONMENTAL QUALITY
Piedmont Regional Office

4949-A Cox Road **Glen Allen, VA 23060** **804/527-5020**

SUBJECT: Dominion Virginia Power — Chesterfield Power Station
Review of Whole Effluent Toxicity Testing Data

TO: Deborah DeBiasi, State coordinator for Whole Effluent Toxicity Program,

FROM: Joseph Bryan, PRO

DATE: May 13, 2016

COPIES: File

Facility Description

The Chesterfield Power Station generates electricity using steam produced by the combustion of coal, natural gas and fuel oil. The Station has a generating capacity of 1750 megawatts (maximum dependable capacity of 1631 megawatts in the summer and 1731 megawatts in the winter).

Outfalls 001, 002 and 003 are all non-contact cooling water discharges of 212 MGD, 89 MGD and 753 MGD, respectively (maximum of the 30 day averages as reflected in the DMR data summary). Outfalls 001 and 002 discharge to the main stem of the James River and Outfall 003 discharges to the head of Farrar Gut.

A low volume wastewater treatment system (LVWWTS) is proposed at the facility. The LVWWTS will receive low volume wastes currently routed to the Lower Ash Pond. The proposed system will discharge through internal outfall 301 into the thermal discharge channel for Outfall 003.

Outfall 004 is the discharge from the Lower Ash Pond (LAP) to the head of Farrar Gut. In past permits, the receiving water body has been considered a flow-through system with Outfall 003 dominating the stream flow. In this permit, Outfall 004 is evaluated as if discharging to a dry ditch with no dilution. The maximum of the 30-day average max flow is 22.41 MGD (as reflected in the Discharge Monitoring Report (DMR) data summary). The LAP receives various low volume waste streams including treated flue gas desulfurization (FGD) wastewater and treated metals cleaning waste. It is anticipated that closure activities will begin on the LAP in July 2017 which will include dewatering the LAP and closing in place the coal combustion residuals (CCRs). Once the closure activities begin, the discharge flow rate will decrease to 5 MGD, and it is likely that the wastewater characteristics will change. For the purposes of this evaluation, the pre-closure operation of the LAP and the closure operation of the LAP will be considered individually.

Outfall 005 is the discharge from the Upper Ash Pond (UAP) to Farrar Gut at a point approximately 0.4 mile upstream from Farrar Gut's confluence with the James River. Farrar Gut is considered tidal; therefore, tidal dilution ratios are used in the evaluation. The maximum of the 30-day average max flow is 4.05 MGD (as reflected in the DMR data summary). The UAP is used to dispose of dewatered ash from the LAP. The use of the UAP is addressed in the "Revised Closure Plan, Upper (East) Ash Pond, Chesterfield Power Station, Chesterfield County, Virginia" dated September 2003 and approved by the staff of the DEQ by letter dated September 12, 2003 and revised April 1, 2015. The discharge at Outfall 005 consists of runoff from the exposed coal in the UAP which has been treated in a large sedimentation pond that was constructed at the eastern end of the UAP. Like the LAP, it is

anticipated that closure activities will begin on the UAP in July 2017. The UAP closure activities will be similar in nature to the LAP closure activities. The discharge rate during closure is estimated at 1.5 MGD, and it is likely that the wastewater characteristics will change. For the purposes of this evaluation, the pre-closure operation of the UAP and the closure operation of the UAP will be considered individually.

WET Requirements in the Existing Permit

The permit was reissued December 10, 2004.

The permit requires annual acute and chronic toxicity testing using Ceriodaphnia dubia at Outfalls 001, 002, and 003. A 24-hour flow proportioned composite sample is required at Outfalls 001 through 003.

A chronic toxicity permit limitation was assigned to Outfall 004 in the 2004 reissuance. The limit was assigned with a compliance schedule of four years. Consequently, annual acute and chronic toxicity testing were required until the limitation became effective. The limitation became effective in December of 2008. Quarterly monitoring and reporting of chronic toxicity to demonstrate compliance with the permit limitation began in January of 2009. Consequently, the annual acute toxicity test for 2009 was not required. The chronic limitation is considered protective of both acute and chronic toxicity.

The permit also requires that four sets of toxicity tests, at least 30 days apart, be conducted at Outfall 005. Acute and chronic testing with *Ceriodaphnia dubia* and *Pimephales promelas* was required using grab samples. Chronic tests are required only if discharge occurs over five consecutive days. An evaluation of the four test results indicated that a WET limit was not necessary, and the tests were conducted annually afterwards.

Data Summary

Attached are summary sheets for each outfall, outlining the 2004 permit cycle data. The IWCs for the chronic testing in the existing permit are stated at the top of the summary sheets for each outfall.

All annual testing met the appropriate criteria.

The IWCs in the permit to be reissued are as follows:

1. For discharges to the main channel of the James River — Outfalls 001 and 002 — the tidal defaults of 2 to 1 dilution for acute effects and 2 to 1 for chronic effects are used. The defaults result in a required acute endpoint of NOAEC = 100% and a chronic endpoint of NOEC = 35%. These values were generated using WETLIM10 (attached).
2. Outfall 101 (UAP and LAP Effluent - Closure) will discharge through Outfall 001 or 002 to the main channel of the James River. As discussed above, the wastewater characteristics will likely change during closure activities of the UAP and LAP moving toward higher toxicity. The discharge is evaluated as if it is a new discharge with no previous monitoring data. WETLIM10 generated WLAs based on 2:1 acute and 2:1 chronic tidal dilutions. These WLAs have been established as WET limitations. The limitations are as follows:

   Acute: NOAEC = 100%
   Chronic: NOEC = 35%

   Closure flows will be manually pumped allowing for a more continuous flows. Twenty-four hour flow proportional composite sampling is assigned for this limitation.
3. The IWC for Outfall 003 is 100%. Farrar Gut would have a small, tidally fluctuating flow without the discharges from Virginia Power. Given the large volume of discharge at Outfall 003, an IWC of 100% is appropriate, thus a chronic endpoint of NOEC greater than or equal to 69% is proposed. This approach is consistent with the approach used to develop effluent limitations in the permit. The required acute endpoint is NOAEC = 100%. The endpoints were generated using WETLIM10 (attached). Because the facility is reconfiguring the treatment systems in response to the closure of the LAP and UAP, a new internal outfall (Outfall 301) will discharge into the thermal discharge

channel for outfall 003. The internal outfall will discharge wastewater including treated wastes from the FGD WWTP and Metals Cleaning Pond along with various other low volume wastes from the facility. Therefore, monitoring will be required quarterly for the first 10 quarters once Outfall 301 commences discharging. The results will be evaluated for reasonable potential. If no reasonable potential is demonstrated, the monitoring frequency will become annual.

4. Outfall 004, which discharges to Farrar Gut was modeled as a discharge to a dry ditch with no dilution. The modeling is consistent with the approach used to develop effluent limitations in the permit.

   a. 004 – Pre-Drawdown - WETLIM10 was used to calculate the WLAs for Outfall 004. The resultant WLAs were entered in the STATS.exe program along with data generated during the 2004 permit cycle for chronic toxicity (Attachment 4). STATS.exe determined reasonable potential exists for the discharge to exceed the WLA; and, therefore, a limitation is needed. The 2004 limitation of 50 TU_c is replaced with a more stringent limit of 1.36 TU_c in this reissuance. Twenty-four hour flow proportional composite sampling is assigned for this limitation.

5. Outfall 005 - Outfall 005 also discharges to Farrar Gut but further downstream in proximity to the confluence with the main stem of the James River. Tidal flow with dilution factors of 2:1 for acute flows and 2:1 for chronic flows were used in the analysis.

   a. 005 - Pre-Drawdown - WETLIM10 was used to calculate the test endpoints for Outfall 005, which generated the following required endpoints: an acute endpoint of NOAEC = 100% and a chronic endpoint of NOEC = 35%. These endpoints are assigned to Outfall 005 in this permit reissuance. Because the discharge is intermittent and dependent on rainfall, grab samples are assigned for Outfall 005 – Pre-Drawdown.

<u>Conclusions and Recommendations</u>

Based on a review of the 2004 permit cycle data, Outfalls 001, 002, 003 and 005 – Pre-Drawdown successfully met the decision criteria for acute and chronic toxicity. Annual acute and chronic testing as prescribed in the 2004 permit shall continue in the 2016 permit for outfalls 001, 002, and 005 – Pre-Drawdown. Outfall 003 will be monitored quarterly for the first 10 calendar quarters after commencement of discharge from the LVWWTS and then re-evaluated for reasonable potential.

For Outfall 004 – Pre-Drawdown, a maximum chronic WET limitation of 50 toxicity units became effective in December 2008 and quarterly monitoring began in January, 2009. The quarterly test results have demonstrated compliance with the limitation. The reasonable potential analysis indicated a need for a chronic toxicity limit of 1.36 TU_c. This limit will replace the existing chronic toxicity limitation for Outfall 004 – Pre-Drawdown of 50 TU_c as a final limit after a 4 year schedule of compliance. The current limit will be retained as an interim limit.

As described above, the LAP and UAP are scheduled to begin closure activities in the third quarter of 2017. Once these activities begin, the potential for the wastewater characteristics to change necessitates treating Outfall 101 as a new discharge. Based on PJ, the WET limits for the closure phase of operation from Outfall 101 have been revised in the permit condition below.

The proposed permit language is as follows (the reporting dates are consistent with the current permit):

<u>Whole Effluent Toxicity (WET) Testing Program</u>

a. Outfalls 001 and 002:

   (1) In accordance with the schedule in I.C.18.g(1) below, the permittee shall perform acute and chronic annual toxicity testing on Outfalls 001 and 002 using 24 hour flow-proportioned composite samples for the duration of the permit.

   The acute test to use is:

   48 Hour Static Acute test using *Ceriodaphnia dubia*

These acute tests shall be conducted using 5 geometric dilutions of effluent with a minimum of 4 replicates, with 5 organisms in each. The NOAEC (No Observed Adverse Effect Concentration), as determined by hypothesis testing, shall be reported. The LC_{50} should also be determined and noted on the submitted report. Tests in which the control survival is less than 90% are not acceptable.

The chronic test to use is:

Chronic 3-Brood Survival and Reproduction Static Renewal Test using *Ceriodaphnia dubia*

These chronic tests shall be conducted in such a manner and at sufficient dilutions (minimum of five dilutions, derived geometrically) to determine the "No Observed Effect Concentration" (NOEC) for survival and reproduction. Results which cannot be quantified (i.e., a “less than” NOEC value) are not acceptable, and a retest will have to be performed. A retest of a non-acceptable test must be performed during the same compliance period as the test it is replacing. Express the test NOEC as TU_c (Chronic Toxicity Units), by dividing 100/NOEC. The LC_{50} at 48 hours and the IC_{25} shall also be reported.

The permittee may provide additional samples to address data variability; these data shall be reported and may be included in the evaluation of effluent toxicity. Test procedures and reporting shall be in accordance with the WET testing methods cited in 40 CFR 136.3.

(2) The test dilutions shall be able to determine compliance with the following endpoints:

(a) Acute tests:

Outfall 001 NOAEC = 100% effluent
Outfall 002 NOAEC = 100% effluent

(b) Chronic tests:

Outfall 001 NOEC $\geq$ 35% effluent equivalent to a TU_c of $\leq$2.85
Outfall 002 NOEC $\geq$ 35% effluent equivalent to a TU_c of $\leq$2.85

(3) The test data for each outfall will be evaluated statistically by DEQ for reasonable potential at the conclusion of the test period. The data may be evaluated sooner if requested by the permittee, or if toxicity has been noted. Should DEQ evaluation of the data indicate that a limit is needed, the permit may be modified or, alternatively, revoked and reissued to include a WET limit and compliance schedule for that outfall. Following written notification from DEQ of the need for including a WET limitation, the toxicity tests of Part I.C.18.a(1) for that outfall may be discontinued.

(4) The permit may be modified or revoked and reissued to include pollutant specific limits in lieu of a WET limit should it be demonstrated that toxicity is due to specific parameters. The pollutant specific limits must control the toxicity of the effluent.

b. Outfall 101 – UAP and LAP Effluent – Closure – Acute and Chronic WET Limit Testing:

(1) The Whole Effluent Toxicity limitations of Part I.A.2 become effective upon commencement of closure activities as defined in Part I.C.25. The permittee shall conduct monthly tests using a composite sample comprised of hourly grabs for the period of discharge, not to exceed 24 hours.

(2) WET Limits

(a) Acute tests: NOAEC = 100%.

(b) Chronic tests: NOEC $\geq$ 35% effluent, equivalent to a TU_c of ≤2.85.

(3) The acute tests to use are:

48 Hour Static Acute test using *Ceriodaphnia dubia*

48-Hour Static Acute test using *Pimephales promelas*

These single dilution acute tests are to be conducted using a minimum of 4 replicates, with 5 organisms each, for the control and 100% effluent. The NOAEC (No Observed Adverse Effect Concentration) shall be reported as either =100% or <100% (less than 100%). The effluent will be in compliance if the survival of the test organisms in both the control and 100% effluent exposures equals or exceeds 90%. If the survival in the effluent is less than 90% and this value is significantly different from the control survival, as determined by hypothesis testing, the NOAEC is less than 100% and the effluent is not in compliance. Tests in which control survival is less than 90% are not acceptable. A retest of a non-acceptable test must be performed during the same compliance period as the .test it is replacing. Test procedures and reporting shall be in accordance with the WET testing methods cited in 40CFR 136.3.

The chronic tests to use are:

Chronic 3-Brood Static Renewal Survival and Reproduction Test using *Ceriodaphnia dubia*

Chronic 7-Day Static Renewal Survival and Growth Test using *Pimephales promelas*

These chronic tests shall be conducted in such a manner and at sufficient dilutions (minimum of five dilutions, derived geometrically) to determine the "No Observed Effect Concentration" (NOEC) for survival and reproduction or growth. The test endpoint (limit) must be represented by a dilution, and should be bracketed by at least one dilution above and one dilution below it. Results which cannot be determined (i.e., a “less than” NOEC value) are not acceptable, and a retest will have to be performed. A retest of a non-acceptable test must be performed during the same compliance period as the test it is replacing. Express the test NOEC as TU_c (Chronic Toxic Units), by dividing 100/NOEC for DMR reporting. The 48 hour LC_{50} and IC_{25} should be included on the submitted test reports.

(4) One copy of each toxicity test report shall be submitted to the Piedmont Regional Office in accordance with the reporting schedule in Part I.C.18.g(5) below. Test procedures and reporting shall be in accordance with the WET testing methods cited in 40 CFR 136.3.

(5) The permit may be modified or revoked and reissued to include pollutant specific limits in lieu of a WET limit should it be demonstrated that toxicity is due to specific parameters. The pollutant specific limits must control the toxicity of the effluent.

(6) Frequency of Testing

Monthly testing is required as indicated in Part I.A.2 and I.A.4 of this permit, beginning upon commencement of closure activities as defined in Part I.C.25

c. Outfall 003 – Pre-LVWWTS Discharge:

(1) In accordance with the schedule in Part I.C.18.g(1) below, the permittee shall perform annual acute and chronic toxicity tests of final effluent at Outfall 003 – Pre-LVWWTS Discharge using 24 hour flow-proportioned composite samples for the duration of the permit.

The acute tests shall be:

48 Hour Static Acute test using *Ceriodaphnia dubia*

48 Hour Static Acute test using *Pimephales promelas*

These acute tests shall be conducted using 5 geometric dilutions of effluent with a minimum of 4 replicates, with 5 organisms in each. The NOAEC (No Observed Adverse Effect Concentration), as determined by hypothesis testing, shall be reported. The LC_{50} should also be determined and noted on the submitted report. Tests in which the control survival is less than 90% are not acceptable.

The chronic tests shall be:

Chronic 3-Brood Survival and Reproduction Static Renewal Test using *Ceriodaphnia dubia*

Chronic 7-day Survival and Growth Static Renewal test using *Pimephales promelas*

These chronic tests shall be conducted in such a manner and at sufficient dilutions (minimum of five dilutions, derived geometrically) to determine the "No Observed Effect Concentration" (NOEC) for survival and reproduction. Results which cannot be quantified (i.e., a “less than” NOEC value) are not acceptable, and a retest will have to be performed. A retest of a non-acceptable test must be performed during the same compliance period as the test it is replacing. Express the test NOEC as TU_c (Chronic Toxicity Units), by dividing 100/NOEC. The LC_{50} at 48 hours and the IC_{25} shall also be reported.

(2) The test dilutions shall be able to determine compliance with the following endpoints:

(a) Acute tests: NOAEC = 100% effluent

(b) Chronic tests: NOEC $\geq$ 69% effluent equivalent to a TU_c of $\leq$1.44

(3) The permittee may provide additional samples to address data variability. These data shall be reported and may be included in the evaluation of effluent toxicity. Test procedures and reporting shall be in accordance with the WET testing methods cited in 40CFR 136.3

(4) The test data for each outfall will be evaluated statistically by DEQ for reasonable potential at the conclusion of the test period. The data may be evaluated sooner if requested by the permittee, or if toxicity has been noted. Should DEQ evaluation of the data indicate that a limit is needed, the permit may be modified or, alternatively, revoked and reissued to include a WET limit and compliance schedule for that outfall. Following written notification from DEQ of the need for including a WET limitation, the toxicity tests of Part I.C.18.c(1) for that outfall may be discontinued.

(5) The permit may be modified or revoked and reissued to include pollutant specific limits in lieu of a WET limit should it be demonstrated that toxicity is due to specific parameters. The pollutant specific limits must control the toxicity of the effluent.

If evaluation of the data indicates that a limitation is not needed, annual acute and chronic testing shall commence in accordance with the remaining schedule in I.C.18.h(1) below.

d. Outfall 003 – LVWWTS Discharge:
Final WET testing requirements for Outfall 003 (LVWWTS Discharge) shall become effective upon commencement of discharge from the LVWWTS. The WET testing shall be conducted as described above in Part I.C.18.c except that the testing shall be conducted in accordance with the schedule in Part I.C.18.g(2) below.

e. Outfall 004 – Pre-Drawdown - Chronic WET Limit Testing:

(1) The quarterly chronic tests required in Part I.A.8 of this permit to meet the interim limit of 50 and final limit of an NOEC ≥ 73%, equivalent to TU_c of $\leq$1.36 shall be:

Chronic 3-Brood Static Renewal Survival and Reproduction Tests using *Ceriodaphnia dubia*

These tests shall be conducted, using 24 hour flow-proportioned composite samples, in such a manner and at sufficient dilutions (minimum of five dilutions, derived geometrically) to determine the "No Observed Effect Concentration" (NOEC) for survival and reproduction. The test endpoint (limit) shall be represented by a dilution, and at least one dilution above and one dilution below it. Results which cannot be determined (i.e., a “less than” NOEC value) are not acceptable, and a retest shall be performed. A retest of a non-acceptable test must be performed during the same compliance period as the test it is replacing. For reporting on the DMR, the NOEC is to be expressed in Chronic Toxicity Units (TU_C), which is obtained by dividing 100 by the test NOEC. The LC_{50} at 48 hours and the IC_{25} shall also be reported.

(2) One copy of each toxicity test report shall be submitted to the Piedmont Regional Office in accordance with the reporting schedule in Part I.C.18.g(3) below. Test procedures and reporting shall be in accordance with the WET testing methods cited in 40 CFR 136.3.

(3) The permit may be modified or revoked and reissued to include pollutant specific limits in lieu of a WET limit should it be demonstrated that toxicity is due to specific parameters. The pollutant specific limits must control the toxicity of the effluent.

(4) Upon the commencement of discharge from the LAP to Outfall 101, WET testing at Outfall 004 may be discontinued.

f. Outfall 005 – Pre-Drawdown – Acute and Chronic WET Testing:

(1) In accordance with the schedule in Part I.C.18.g(1) below, the permittee shall perform annual acute and chronic toxicity tests of final effluent at Outfall 005 – Pre-Drawdown. Grab samples shall be taken for this discharge during Pre-Drawdown activities. Chronic tests are required only if discharge occurs over five consecutive days. The permittee shall maintain a record of the dates that a discharge occurs at Outfall 005 and provide it to the Department upon request.

The acute tests shall be:

48 Hour Static Acute test using *Ceriodaphnia dubia*

48 Hour Static Acute test using *Pimephales promelas*

These acute tests shall be conducted using 5 geometric dilutions of effluent with a minimum of 4 replicates, with 5 organisms in each. The NOAEC (No Observed Adverse Effect Concentration), as determined by hypothesis testing, shall be reported. The LC_{50} should also be determined and noted on the submitted report. Tests in which the control survival is less than 90% are not acceptable.

The chronic tests shall be:

Chronic 3-Brood Survival and Reproduction Static Renewal Test using *Ceriodaphnia dubia*

Chronic 7-day Survival and Growth Static Renewal test using *Pimephales promelas*

These chronic tests shall be conducted in such a manner and at sufficient dilutions (minimum of five dilutions, derived geometrically) to determine the "No Observed Effect Concentration" (NOEC) for survival and reproduction or growth. The LC_{50} at 48 hours and the IC_{25} shall also be reported. Results which cannot be quantified (i.e., a “less than” NOEC value) are not acceptable, and a retest shall be performed. The retest of a non-acceptable test shall be performed during the same compliance

period as the test it is replacing. Express the test LC_{50} as TU_a (Acute Toxicity Units), by dividing $100/LC_{50}$. Express the test NOEC as TU_c (Chronic Toxicity Units), by dividing 100/NOEC. The LC_{50} at 48 hours and the IC_{25} shall also be reported.

(2) The test dilutions shall be able to determine compliance with the following endpoints:

(a) Acute tests: NOAEC = 100%.

(b) Chronic tests: NOEC $\geq$ 35% effluent, equivalent to a TU_c of ≤2.85.

(3) The permittee may provide additional samples to address data variability. These data shall be reported and may be included in the evaluation of effluent toxicity. Test procedures and reporting shall be in accordance with the WET testing methods cited in 40CFR 136.3

(4) The test data will be evaluated statistically by DEQ for reasonable potential at the conclusion of the test period. The data may be evaluated sooner if requested by the permittee, or if toxicity has been noted. Should DEQ evaluation of the data indicate that a limit is needed, the permit may be modified or, alternatively, revoked and reissued to include a WET limit and compliance schedule. Following written notification from DEQ of the need for including a WET limitation, the toxicity tests of Part I.C.18.f(1) may be discontinued.

(5) The permit may be modified or revoked and reissued to include pollutant specific limits should it be demonstrated that toxicity is due to specific parameters. The pollutant specific limits must control the toxicity of the effluent.

If evaluation of the data indicates that a limitation is not needed, annual acute and chronic testing shall commence in accordance with the remaining schedule in Part I.C.18.g(1) below.

g. Reporting Schedule:

(1) The permittee shall report the results of the toxicity testing on Outfalls 001, 002, 003 - Pre-LVWWTS Discharge, and 005 – Pre-Drawdown as appropriate, and supply to the Piedmont Regional Office one copy of each of the toxicity test reports specified in this WET Monitoring Program. The compliance period in which each test shall be performed is established as annual (consecutive 12 months) periods based on the effective date of the permit. Reports shall be submitted no later than the 10th of the month following the end of each compliance period.

Compliance Period	Monitoring Period	Report Due
1st Annual	TBD	TBD
2nd Annual	TBD	TBD
3rd Annual	TBD	TBD
4th Annual	TBD	TBD

(2) WET testing for Outfall 003 – (LVWWTS Discharge) shall begin upon the commencement of discharge from the LVWWTS in accordance with the schedule below. The permittee shall report the results of the toxicity testing on Outfalls 003 - LVWWTS Discharge, and supply to the Piedmont Regional Office one copy of each of the toxicity test reports specified in this WET Monitoring Program. The compliance period in which each test shall be performed is established as calendar quarters for the first 10 quarters. Reports shall be submitted no later than the 10th of the month following the end of each compliance period.

Compliance Period	Monitoring Period	Report Due
1st Quarterly	TBD	TBD
2nd Quarterly	TBD	TBD
3rd Quarterly	TBD	TBD
4th Quarterly	TBD	TBD
5th Quarterly	TBD	TBD
6th Quarterly	TBD	TBD
7th Quarterly	TBD	TBD
8th Quarterly	TBD	TBD
9th Quarterly	TBD	TBD
10th Quarterly	TBD	TBD
1st Annual	TBD	TBD
2nd Annual	TBD	TBD

(3) Reporting for the Outfall 004 – Pre-Drawdown WET limitations shall be conducted quarterly and reported on the DMR as required in Part I.A.8 of this permit. One copy of the toxicity test report associated with each test, shall be submitted in hard copy or by email concurrent with the DMR on which the test result is reported.

(4) Reporting for the Outfall 101 WET limitations shall be conducted monthly and reported on the DMR as required in Part I.A.11 of this permit. Monthly monitoring will continue until dewatering activities associated with closure activities are completed. One copy of the toxicity test report associated with each test shall be submitted in hard copy or by email concurrent with the DMR on which the test result is reported.

Sub-attachment 1

VPDES Permit VA0004146 — Dominion Chesterfield Power Station (**Outfall 001**)

Permit endpoints: LC50 > 50%

NOEC > 2%

Results of acute toxicity tests during term of current permit:

TEST DATE	*Ceriodaphnia dubia*		Laboratory
	LC50	PERCENT SURVIVAL IN 100% EFFLUENT	
February 2005	>100	100	Coastal Bioanalysts
June 2005	>100	100	Coastal Bioanalysts
June 2006	>100	100	Coastal Bioanalysts
January 2008	>100	95	Coastal Bioanalysts
July 2008	>100	100	Coastal Bioanalysts
February 2010	>100	100	Coastal Bioanalysts
April 2011	>100	90	Coastal Bioanalysts
March 2012	>100	100	Coastal Bioanalysts
July 2013	>100	100	Coastal Bioanalysts
August 2014	>100	100	Coastal Bioanalysts
June2015	>100	100	Coastal Bioanalysts

Results of chronic toxicity tests during term of current permit:

TEST DATE**	*Ceriodaphnia dubia*		Laboratory
	Survival	Reproduction	
February 2005	100	100	Coastal Bioanalysts
June 2005	100	100	Coastal Bioanalysts
June 2006	100	100	Coastal Bioanalysts
January 2008	100	100	Coastal Bioanalysts
July 2008	100	100	Coastal Bioanalysts
February 2010	100	100	Coastal Bioanalysts
April 2011	100	100	Coastal Bioanalysts
March 2012	100	100	Coastal Bioanalysts
July 2013	100	100	Coastal Bioanalysts
August 2014	100	100	Coastal Bioanalysts
June 2015	100	100	Coastal Bioanalysts

Discussion

Acute toxicity is not indicated.

Chronic toxicity is not indicated.

The proposed permit requires the continuation of annual acute and chronic WET testing with *Ceriodaphnia dubia.* The results of those tests will be evaluated for reasonable potential at the conclusion of the permit term or sooner if toxicity is noted and appropriate effluent limitations established.

Sub-attachment 2

VPDES Permit VA0004146 — Dominion Chesterfield Power Station (**Outfall 002**)

Permit endpoints: LC50 > 50%

NOEC > 2%

Results of acute toxicity tests during term of current permit:

TEST DATE	***Ceriodaphnia dubia***		**Laboratory**
	LC50	PERCENT SURVIVAL IN 100% EFFLUENT	
February 2005	>100	100	Coastal Bioanalysts
June 2005	>100	95	Coastal Bioanalysts
June 2006	>100	95	Coastal Bioanalysts
January 2008	>100	80	Coastal Bioanalysts
July 2008	>100	100	Coastal Bioanalysts
February 2010	>100	95	Coastal Bioanalysts
April 2011	>100	95	Coastal Bioanalysts
June 2012	>100	100	Coastal Bioanalysts
July 2013	>100	100	Coastal Bioanalysts
August 2014	>100	100	Coastal Bioanalysts
June 2015	>100	100	Coastal Bioanalysts

Results of chronic toxicity tests during term of current permit:

TEST DATE**	**NOEC-** ***Ceriodaphnia dubia***		**Laboratory**
	Survival	Reproduction	
February 2005	100	100	Coastal Bioanalysts
June 2005	100	100	Coastal Bioanalysts
June 2006	100	100	Coastal Bioanalysts
January 2008	100	100	Coastal Bioanalysts
July 2008	100	100	Coastal Bioanalysts
February 2010	100	100	Coastal Bioanalysts
April 2011	100	100	Coastal Bioanalysts
June 2012	100	100	Coastal Bioanalysts
July 2013	100	100	Coastal Bioanalysts
August 2014	100	100	Coastal Bioanalysts
June 2015	100	100	Coastal Bioanalysts

Discussion

Acute toxicity is not indicated.

Chronic toxicity is not indicated.

The proposed permit requires the continuation of annual acute and chronic WET testing with *Ceriodaphnia dubia.* The results of those tests will be evaluated for reasonable potential at the conclusion of the permit term, or sooner if toxicity is noted, and appropriate effluent limitations established.

Sub-attachment 3

VPDES Permit VA0004146 — Dominion Chesterfield Power Station (**Outfall 003**)

Permit endpoints: LC50 > 100%
NOEC > 100%

Results of acute toxicity tests during term of current permit:

TEST DATE	***Ceriodaphnia dubia***		**Laboratory**
	LC50	PERCENT SURVIVAL IN 100% EFFLUENT	
February 2005	>100	100	Coastal Bioanalysts
June 2005	>100	100	Coastal Bioanalysts
June 2006	>100	100	Coastal Bioanalysts
January 2008	>100	95	Coastal Bioanalysts
July 2008	>100	100	Coastal Bioanalysts
February 2010	>100	100	Coastal Bioanalysts
April 2011	>100	100	Coastal Bioanalysts
March 2012	>100	100	Coastal Bioanalysts
July2013	>100	100	Coastal Bioanalysts
August 2014	>100	100	Coastal Bioanalysts
June 2015	>100	100	Coastal Bioanalysts

Results of chronic toxicity tests during term of current permit:

TEST DATE**	**NOEC-** ***Ceriodaphnia dubia***		**Laboratory**
	Survival	Reproduction	
February 2005	100	100	Coastal Bioanalysts
June 2005	100	100	Coastal Bioanalysts
June 2006	100	100	Coastal Bioanalysts
January 2008	100	100	Coastal Bioanalysts
July 2008	100	100	Coastal Bioanalysts
February 2010	100	100	Coastal Bioanalysts
April 2011	100	100	Coastal Bioanalysts
March 2012	100	100	Coastal Bioanalysts
July 2013	100	100	Coastal Bioanalysts
August 2014	100	100	Coastal Bioanalysts
June 2015	100	100	Coastal Bioanalysts

Discussion

Acute toxicity is not indicated.

Chronic toxicity is not indicated.

The proposed permit requires the continuation of annual acute and chronic WET testing with *Ceriodaphnia dubia.* The results of those tests will be evaluated for reasonable potential at the conclusion of the permit term or sooner if toxicity is noted, and appropriate effluent limitations established. Upon commencement of discharge from the LVWWTS, WET testing monitoring frequency for outfall 003 will increase to quarterly monitoring for the first 10 quarters. If no potential for toxicity is demonstrated, the monitoring will resume on an annual basis.

Sub-attachment 4

VPDES Permit VA0004146 — Dominion Chesterfield Power Station (**Outfall 004**)

Permit endpoints: LC50 > 13%
NOEC > 2%

Results of acute toxicity tests during term of current permit:

TEST DATE	***Ceriodaphnia dubia***		**Laboratory**
	LC50	PERCENT SURVIVAL IN 100% EFFLUENT	
February 2005	>37	NR	Coastal Bioanalysts
June 2005	>37	NR	Coastal Bioanalysts
June 2006	>100	100	Coastal Bioanalysts
January 2008	>100	90	Coastal Bioanalysts
July 2008	NR	NR	Coastal Bioanalysts

Results of chronic toxicity tests during term of current permit:

TEST DATE	**NOEC** ***Ceriodaphnia dubia***		**Laboratory**
	Survival	Reproduction	
April 2005	100	4	Coastal Bioanalysts
August 2005	100	32	Coastal Bioanalysts
June 2006	100	32	Coastal Bioanalysts
January 2008	100	100	Coastal Bioanalysts
July 2008	100	32	Coastal Bioanalysts
February 2009	100	100	Coastal Bioanalysts
May 2009	100	32	Coastal Bioanalysts
August 2009	100	32	Coastal Bioanalysts
Novermber 2009	100	100	Coastal Bioanalysts
January 2010	100	32	Coastal Bioanalysts
August 2010	100	32	Coastal Bioanalysts
November 2010	100	100	Coastal Bioanalysts
January 2011	100	32	Coastal Bioanalysts
April 2011	100	32	Coastal Bioanalysts
July 2011	100	100	Coastal Bioanalysts
October 2011	100	100	Coastal Bioanalysts
January 2012	100	100	Coastal Bioanalysts
April 2012	100	100	Coastal Bioanalysts
June 2012	100	100	Coastal Bioanalysts

July 2012	100	32	Coastal Bioanalysts
October 2012	100	100	Coastal Bioanalysts
January 2013	100	100	Coastal Bioanalysts
July 2013	100	100	Coastal Bioanalysts
October 2013	100	100	Coastal Bioanalysts
January 2014	100	100	Coastal Bioanalysts
April 2014	100	100	Coastal Bioanalysts
August 2014	100	100	Coastal Bioanalysts
October 2014	100	100	Coastal Bioanalysts
February 2015	100	100	Coastal Bioanalysts
May 2015	100	100	Coastal Bioanalysts
July 2015	100	100	Coastal Bioanalysts

Discussion

Acute toxicity is not indicated.
In the February and June 2005 tests, the acute test ratios did not include 100% effluent; consequently, survival in 100% effluent cannot be reported.

Chronic toxicity is not indicated.

A WET limitation was assigned to Outfall 004 in the 2004 permit reissuance. The permittee was allowed a four year schedule of compliance before the limitation became effective. The limitation was effective as of Dec. 10, 2008. Monitoring began in January and reporting on a quarterly basis followed. The results received to date indicate compliance with the limitation.

Attachment 5

VPDES Permit VA0004146 — Dominion Chesterfield Power Station (**Outfall 005**)

Permit endpoints: LC50 > 10% effluent
NOEC > 1% effluent

Results of acute toxicity tests during term of current permit:

TEST DATE	***Ceriodaphnia dubia***		***Pimephales promelas***		**Laboratory**
	LC50	PERCENT SURVIVAL IN 100% EFFLUENT	LC50	PERCENT SURVIVAL IN 100% EFFLUENT	
August 2004	>100	100	>100	95	Coastal Bioanalysts
October 2004	>100	100	>100	100	Coastal Bioanalysts
May 2005	>100	100	>100	100	Coastal Bioanalysts
February 2006	>100	100	>100	100	Coastal Bioanalysts
August 2006	>100	100	>100	100	Coastal Bioanalysts
March 2007	>100	100	>100	95	Coastal Bioanalysts
January 2008	>100	100	>100	100	Coastal Bioanalysts

January 2010	>100	100	>100	95	Coastal Bioanalysts
January 2011	>100	100	>100	100	Coastal Bioanalysts
March 2012	>100	100	>100	100	Coastal Bioanalysts
February 2013	>100	100	>100	100	Coastal Bioanalysts
January 2014	>100	100	>100	100	Coastal Bioanalysts
June 2015	>100	100	>100	100	Coastal Bioanalysts

Discussion

Acute toxicity is not indicated.

Per Part I.B.18.c.(1) of the 2004 permit, chronic toxicity tests are only required if the discharge occurs over five consecutive days. Outfall 005 did not discharge for five consecutive days over the permit term; consequently, no chronic toxicity tests were performed.

Part I.B.18.c.(3) of the 2004 permit states that testing may be reduced to one species if the results of the data sets establish that one of the species (*C. dubia* or *P. promelas*) is less sensitive to the effluent. The tests noted above do not establish a less sensitive species for which testing could be discontinued.

Consequently, the proposed permit requires the continuation of acute and chronic WET testing with *Ceriodaphnia dubia* and *Pimephales promelas.* Because of the infrequency of the discharge (4 months of discharge between August 2008 and June 2015), the schedule will require 4 tests at least 30 days apart over the course of the permit term. This is consistent with the 2004 permitting approach. The results of those tests will be evaluated for reasonable potential at the conclusion of the permit term, or sooner if toxicity is noted, and appropriate effluent limitations established.

Spreadsheet for determination of WET test endpoints or WET limits

Excel 97
Revision Date: 12/13/13
File: WETLIM10.xls
(MIX.EXE required also)

Acute Endpoint/Permit Limit — **Use as LC_{50} in Special Condition, as TUa on DMR**

ACUTE	100% =	NOAEC	LC_{50} =	NA	% Use as	NA	TUa
ACUTE WLAa		0.6					

Note: Inform the permittee that if the mean of the data exceeds this TUa: 1.0 a limit may result using STATS.EXE

Chronic Endpoint/Permit Limit — **Use as NOEC in Special Condition, as TUc on DMR**

CHRONIC	2.925149368	TU_c	NOEC =	35	% Use as	2.85	TU_c
BOTH*	6.000000147	TU_c	NOEC =	17	% Use as	5.88	TU_c
AML	2.925149368	TU_c	NOEC =	35	% Use as	2.85	TU_c

ACUTE WLAa,c	6	
CHRONIC WLAc	2	

Note: Inform the permittee that if the mean of the data exceeds this TUc: 1.20207454 a limit may result using STATS.EXE

* Both means acute expressed as chronic

Enter data in the cells with blue type:

Entry Date:	05/13/16	
Facility Name:		
VPDES Number:	VA0004146	
Outfall Number:	001 and 002	

% Flow to be used from MIX.EXE

Plant Flow:	1	MGD		
Acute 1Q10:	NA	MGD	100	%
Chronic 7Q10:	NA	MGD	100	%

Diffuser /modeling study?

Enter Y/N	Y		
Acute	2	:1	
Chronic	2	:1	

Are data available to calculate CV? (Y/N)	N	(Minimum of 10 data points, same species, needed)	Go to Page 2
Are data available to calculate ACR? (Y/N)	N	(NOEC<LC50, do not use greater/less than data)	Go to Page 3

NOTE: If the IWCa is >33%, specify the NOAEC = 100% test/endpoint for use

IWC_a	50	%	Plant flow/plant flow + 1Q10
IWC_c	50	%	Plant flow/plant flow + 7Q10
Dilution, acute	2		100/IWCa
Dilution, chronic	2		100/IWCc
WLA_a	0.6		Instream criterion (0.3 TUa) X's Dilution, acute
WLA_c	2		Instream criterion (1.0 TUc) X's Dilution, chronic
$WLA_{a,c}$	6		ACR X's WLA_a - converts acute WLA to chronic units
ACR -acute/chronic ratio	10		LC50/NOEC (Default is 10 - if data are available, use tables Page 3)
CV-Coefficient of variation	0.6		Default of 0.6 - if data are available, use tables Page 2)
Constants eA	0.4109447		Default = 0.41
eB	0.6010373		Default = 0.60
eC	2.4334175		Default = 2.43
eD	2.4334175		Default = 2.43 (1 samp) No. of samples 1

****The Maximum Daily Limit is calculated from the lowest LTA, X's eC. The LTAa,c and MDL using it are driven by the ACR.**

$LTA_{a,c}$	2.4656682	WLAa,c X's eA							
LTA_c	1.2020746	WLAc X's eB					Rounded NOEC's		%
MDL** with $LTA_{a,c}$	6.000000147	TU_c	NOEC =	16.666666	(Protects from acute/chronic toxicity)		NOEC =	17	%
MDL** with LTA_c	2.925149368	TU_c	NOEC =	34.186288	(Protects from chronic toxicity)		NOEC =	35	%
AML with lowest LTA	2.925149368	TU_c	NOEC =	34.186288	Lowest LTA X's eD		NOEC =	35	

IF ONLY ACUTE ENDPOINT/LIMIT IS NEEDED, CONVERT MDL FROM TU_c to TU_a

							Rounded LC50's		%
MDL with $LTA_{a,c}$	0.600000015	TU_a	LC50 =	166.666663	%	Use NOAEC=100%	LC50 =	NA	%
MDL with LTA_c	0.292514937	TU_a	LC50 =	341.862884	%	Use NOAEC=100%	LC50 =	NA	

Page 2 - Follow the directions to develop a site specific CV (coefficient of variation)

IF YOU HAVE AT LEAST 10 DATA POINTS THAT ARE QUANTIFIABLE (NOT "<" OR ">") FOR A SPECIES, ENTER THE DATA IN EITHER COLUMN "G" (VERTEBRATE) OR COLUMN "J" (INVERTEBRATE). THE 'CV' WILL BE PICKED UP FOR THE CALCULATIONS BELOW. THE DEFAULT VALUES FOR eA, eB, AND eC WILL CHANGE IF THE 'CV' IS ANYTHING OTHER THAN 0.6.

	Vertebrate IC_{25} Data or LC_{50} Data	LN of data	Invertebrate IC_{25} Data or LC_{50} Data	LN of data
	**********		**********	
1			1	
2			2	
3			3	
4			4	
5			5	
6			6	
7			7	
8			8	
9			9	
10			10	
11			11	
12			12	
13			13	
14			14	
15			15	
16			16	
17			17	
18			18	
19			19	
20			20	
St Dev	NEED DATA	NEED DATA	St Dev	NEED DATA	NEED DATA
Mean	0	0	Mean	0	0
Variance	0	0.000000	Variance	0	0.000000
CV	0		CV	0	

Coefficient of Variation for effluent tests

CV = 0.6 (Default 0.6)

δ^2 = 0.3074847

δ = 0.554513029

Using the log variance to develop eA

(P. 100, step 2a of TSD)

Z = 1.881 (97% probability stat from table

A = -0.88929666

eA = 0.410944686

Using the log variance to develop eB

(P. 100, step 2b of TSD)

δ_4^2 = 0.086177696

δ_4 = 0.293560379

B = -0.50909823

eB = 0.601037335

Using the log variance to develop eC

(P. 100, step 4a of TSD)

δ^2 = 0.3074847

δ = 0.554513029

C = 0.889296658

eC = 2.433417525

Using the log variance to develop eD

(P. 100, step 4b of TSD)

n = 1 This number will most likely stay as "1", for 1 sample/month.

δ_n^2 = 0.3074847

δ_n = 0.554513029

D = 0.889296658

eD = 2.433417525

Page 3 - Follow directions to develop a site specific ACR (Acute to Chronic Ratio)

To determine Acute/Chronic Ratio (ACR), insert usable data below. Usable data is defined as valid paired test results, acute and chronic, tested at the same temperature, same species. The chronic NOEC must be less than the acute LC_{50}, since the ACR divides the LC_{50} by the NOEC. LC_{50}'s >100% should not be used.

Table 1. ACR using Vertebrate data

Set #	LC_{50}	NOEC	Test ACR	Logarithm	Geomean	Antilog	ACR to Use
1	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	NO DATA
2	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	NO DATA
3	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	NO DATA
4	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	NO DATA
5	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	NO DATA
6	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	NO DATA
7	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	NO DATA
8	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	NO DATA
9	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	NO DATA
10	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	NO DATA
				ACR for vertebrate data:			0

Table 1. Result:	Vertebrate ACR	0
Table 2. Result:	Invertebrate ACR	0
	Lowest ACR	Default to 10

Table 2. ACR using Invertebrate data

Set #	LC_{50}	NOEC	Test ACR	Logarithm	Geomean	Antilog	ACR to Use
1	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	NO DATA
2	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	NO DATA
3	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	NO DATA
4	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	NO DATA
5	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	NO DATA
6	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	NO DATA
7	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	NO DATA
8	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	NO DATA
9	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	NO DATA
10	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	NO DATA
				ACR for vertebrate data:			0

Convert LC_{50}'s and NOEC's to Chronic TU's
for use in WLA.EXE

Table 3. **ACR used: 10**

	Enter LC_{50}	TUc	Enter NOEC	TUc
1		NO DATA		NO DATA
2		NO DATA		NO DATA
3		NO DATA		NO DATA
4		NO DATA		NO DATA
5		NO DATA		NO DATA
6		NO DATA		NO DATA
7		NO DATA		NO DATA
8		NO DATA		NO DATA
9		NO DATA		NO DATA
10		NO DATA		NO DATA
11		NO DATA		NO DATA
12		NO DATA		NO DATA
13		NO DATA		NO DATA
14		NO DATA		NO DATA
15		NO DATA		NO DATA
16		NO DATA		NO DATA
17		NO DATA		NO DATA
18		NO DATA		NO DATA
19		NO DATA		NO DATA
20		NO DATA		NO DATA

If WLA.EXE determines that an acute limit is needed, you need to convert the TUc answer you get to TUa and then an LC50, enter it here: NO DATA %LC_{50}

NO DATA TUa

DILUTION SERIES TO RECOMMEND

Table 4.

	Monitoring % Effluent	Monitoring TUc	Limit % Effluent	Limit TUc
Dilution series based on data mean	83.2	1.202075		
Dilution series to use for limit			35	2.8571429
Dilution factor to recommend:	0.9120829		0.591608	
Dilution series to recommend:	100.0	1.00	100.0	1.00
	91.2	1.10	59.2	1.69
	83.2	1.20	35.0	2.86
	75.9	1.32	20.7	4.83
	69.20	1.44	12.3	8.16
Extra dilutions if needed	63.12	1.58	7.2	13.80
	57.57	1.74	4.3	23.32

Cell: I9
Comment:
This is assuming that the data are Type 2 data (none of the data in the data set are censored - "<" or ">").

Cell: K18
Comment: This is assuming that the data are Type 2 data (none of the data in the data set are censored - "<" or ">").

Cell: J22
Comment: Remember to change the "N" to "Y" if you have ratios entered, otherwise, they won't be used in the calculations.

Cell: C40
Comment:
If you have entered data to calculate an ACR on page 3, and this is still defaulted to "10", make sure you have selected "Y" in cell E21

Cell: C41
Comment: If you have entered data to calculate an effluent specific CV on page 2, and this is still defaulted to "0.6", make sure you have selected "Y" in cell E20

Cell: L48
Comment:
See Row 151 for the appropriate dilution series to use for these NOEC's

Cell: G62
Comment:
Vertebrates are:
Pimephales promelas
Oncorhynchus mykiss
Cyprinodon variegatus

Cell: J62
Comment:
Invertebrates are:
Ceriodaphnia dubia
Mysidopsis bahia

Cell: C117
Comment: Vertebrates are:

Pimephales promelas
Cyprinodon variegatus

Cell: M119
Comment: The ACR has been picked up from cell C34 on Page 1. If you have paired data to calculate an ACR, enter it in the tables to the left, and make sure you have a "Y" in cell E21 on Page 1. Otherwise, the default of 10 will be used to convert your acute data.

Cell: M121
Comment: If you are only concerned with acute data, you can enter it in the NOEC column for conversion and the number calculated will be equivalent to the TUa. The calculation is the same: 100/NOEC = TUc or 100/LC50 = TUa.

Cell: C138
Comment: Invertebrates are:

Ceriodaphnia dubia
Mysidopsis bahia

Spreadsheet for determination of WET test endpoints or WET limits

Excel 97
Revision Date: 12/13/13
File: WETLIM10.xls
(MIX.EXE required also)

Acute Endpoint/Permit Limit — **Use as LC_{50} in Special Condition, as TUa on DMR**

ACUTE	100% =	NOAEC	LC_{50} =	NA	% Use as	NA	TUa
ACUTE WLAa		0.6					

Note: Inform the permittee that if the mean of the data exceeds this TUa: 1.0 a limit may result using STATS.EXE

Chronic Endpoint/Permit Limit — **Use as NOEC in Special Condition, as TUc on DMR**

CHRONIC	2.925149368	TU_c	NOEC =	35	% Use as	2.85	TU_c
BOTH*	6.000000147	TU_c	NOEC =	17	% Use as	5.88	TU_c
AML	2.925149368	TU_c	NOEC =	35	% Use as	2.85	TU_c

ACUTE WLAa,c	6
CHRONIC WLAc	2

* Both means acute expressed as chronic

Note: Inform the permittee that if the mean of the data exceeds this TUc: 1.20207454 a limit may result using STATS.EXE

Enter data in the cells with blue type:

Entry Date:	06/02/16
Facility Name:	
VPDES Number:	VA0004146
Outfall Number:	101 - UAP/LAP Closure

% Flow to be used from MIX.EXE

Plant Flow:	1.5	MGD	
Acute 1Q10:		MGD	100 %
Chronic 7Q10:		MGD	100 %

Diffuser /modeling study?

Enter Y/N	y		
Acute	2	:1	
Chronic	2	:1	

Are data available to calculate CV? (Y/N)	N	(Minimum of 10 data points, same species, needed)	Go to Page 2
Are data available to calculate ACR? (Y/N)	N	(NOEC<LC50, do not use greater/less than data)	Go to Page 3

NOTE: If the IWCa is >33%, specify the NOAEC = 100% test/endpoint for use

IWC_a	50	%	Plant flow/plant flow + 1Q10
IWC_c	50	%	Plant flow/plant flow + 7Q10
Dilution, acute	2		100/IWCa
Dilution, chronic	2		100/IWCc
WLA_a	0.6		Instream criterion (0.3 TUa) X's Dilution, acute
WLA_c	2		Instream criterion (1.0 TUc) X's Dilution, chronic
$WLA_{a,c}$	6		ACR X's WLA_a - converts acute WLA to chronic units
ACR -acute/chronic ratio	10		LC50/NOEC (Default is 10 - if data are available, use tables Page 3)
CV-Coefficient of variatior	0.6		Default of 0.6 - if data are available, use tables Page 2)
Constants eA	0.4109447		Default = 0.41
eB	0.6010373		Default = 0.60
eC	2.4334175		Default = 2.43
eD	2.4334175		Default = 2.43 (1 samp) No. of sample: 1

****The Maximum Daily Limit is calculated from the lowest LTA, X's eC. The LTAa,c and MDL using it are driven by the ACR.**

$LTA_{a,c}$	2.4656682	WLAa,c X's eA						
LTA_c	1.2020746	WLAc X's eB					Rounded NOEC's	%
MDL** with $LTA_{a,c}$	6.000000147	TU_c	NOEC =	16.666666	(Protects from acute/chronic toxicity)		NOEC = 17	%
MDL** with LTA_c	2.925149368	TU_c	NOEC =	34.186288	(Protects from chronic toxicity)		NOEC = 35	%
AML with lowest LTA	2.925149368	TU_c	NOEC =	34.186288	Lowest LTA X's eD		NOEC = 35	

IF ONLY ACUTE ENDPOINT/LIMIT IS NEEDED, CONVERT MDL FROM TU_c to TU_a

							Rounded LC50's	%
MDL with $LTA_{a,c}$	0.600000015	TU_a	LC50 =	166.666663	%	Use NOAEC=100%	LC50 = NA	%
MDL with LTA_c	0.292514937	TU_a	LC50 =	341.862884	%	Use NOAEC=100%	LC50 = NA	

Page 2 - Follow the directions to develop a site specific CV (coefficient of variation)

IF YOU HAVE AT LEAST 10 DATA POINTS THAT ARE QUANTIFIABLE (NOT "<" OR ">") FOR A SPECIES, ENTER THE DATA IN EITHER COLUMN "G" (VERTEBRATE) OR COLUMN "J" (INVERTEBRATE). THE 'CV' WILL BE PICKED UP FOR THE CALCULATIONS BELOW. THE DEFAULT VALUES FOR eA, eB, AND eC WILL CHANGE IF THE 'CV' IS ANYTHING OTHER THAN 0.6.

	Vertebrate IC_{25} Data or LC_{50} Data	LN of data	Invertebrate IC_{25} Data or LC_{50} Data	LN of data
	**********		**********	
1			1	
2			2	
3			3	
4			4	
5			5	
6			6	
7			7	
8			8	
9			9	
10			10	
11			11	
12			12	
13			13	
14			14	
15			15	
16			16	
17			17	
18			18	
19			19	
20			20	
St Dev	NEED DATA	NEED DATA	St Dev	NEED DATA	NEED DATA
Mean	0	0	Mean	0	0
Variance	0	0.000000	Variance	0	0.000000
CV	0		CV	0	

Coefficient of Variation for effluent tests

CV = 0.6 (Default 0.6)

δ^2 = 0.3074847

δ = 0.554513029

Using the log variance to develop eA

(P. 100, step 2a of TSD)

Z = 1.881 (97% probability stat from table

A = -0.88929666

eA = 0.410944686

Using the log variance to develop eB

(P. 100, step 2b of TSD)

δ_4^2 = 0.086177696

δ_4 = 0.293560379

B = -0.50909823

eB = 0.601037335

Using the log variance to develop eC

(P. 100, step 4a of TSD)

δ^2 = 0.3074847

δ = 0.554513029

C = 0.889296658

eC = 2.433417525

Using the log variance to develop eD

(P. 100, step 4b of TSD)

n = 1 This number will most likely stay as "1", for 1 sample/month.

δ_n^2 = 0.3074847

δ_n = 0.554513029

D = 0.889296658

eD = 2.433417525

Page 3 - Follow directions to develop a site specific ACR (Acute to Chronic Ratio)

To determine Acute/Chronic Ratio (ACR), insert usable data below. Usable data is defined as valid paired test results, acute and chronic, tested at the same temperature, same species. The chronic NOEC must be less than the acute LC_{50}, since the ACR divides the LC_{50} by the NOEC. LC_{50}'s >100% should not be used.

Table 1. ACR using Vertebrate data

Set #	LC_{50}	NOEC	Test ACR	Logarithm	Geomean	Antilog	ACR to Use
1	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	NO DATA
2	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	NO DATA
3	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	NO DATA
4	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	NO DATA
5	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	NO DATA
6	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	NO DATA
7	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	NO DATA
8	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	NO DATA
9	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	NO DATA
10	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	NO DATA
				ACR for vertebrate data:			0

Table 1. Result:	Vertebrate ACR	0
Table 2. Result:	Invertebrate ACR	0
	Lowest ACR	Default to 10

Table 2. ACR using Invertebrate data

Set #	LC_{50}	NOEC	Test ACR	Logarithm	Geomean	Antilog	ACR to Use
1	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	NO DATA
2	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	NO DATA
3	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	NO DATA
4	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	NO DATA
5	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	NO DATA
6	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	NO DATA
7	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	NO DATA
8	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	NO DATA
9	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	NO DATA
10	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	NO DATA
				ACR for vertebrate data:			0

Convert LC_{50}'s and NOEC's to Chronic TU's for use in WLA.EXE

Table 3. **ACR used: 10**

	Enter LC_{50}	TUc	Enter NOEC	TUc
1	>100	#DIV/0!	100	1.000000
2	>100	#DIV/0!	100	1.000000
3	>100	#DIV/0!	100	1.000000
4	>100	#DIV/0!	100	1.000000
5		NO DATA		NO DATA
6		NO DATA		NO DATA
7		NO DATA		NO DATA
8		NO DATA		NO DATA
9		NO DATA		NO DATA
10		NO DATA		NO DATA
11		NO DATA		NO DATA
12		NO DATA		NO DATA
13		NO DATA		NO DATA
14		NO DATA		NO DATA
15		NO DATA		NO DATA
16		NO DATA		NO DATA
17		NO DATA		NO DATA
18		NO DATA		NO DATA
19		NO DATA		NO DATA
20		NO DATA		NO DATA

If WLA.EXE determines that an acute limit is needed, you need to convert the TUc answer you get to TUa and then an LC50, enter it here:

NO DATA	$\%LC_{50}$
NO DATA	TUa

DILUTION SERIES TO RECOMMEND

Table 4.

	Monitoring % Effluent	Monitoring TUc	Limit % Effluent	Limit TUc
Dilution series based on data mean	83.2	1.202075		
Dilution series to use for limit			35	2.8571429
Dilution factor to recommend:	0.9120829		0.591608	
Dilution series to recommend:	100.0	1.00	100.0	1.00
	91.2	1.10	59.2	1.69
	83.2	1.20	35.0	2.86
	75.9	1.32	20.7	4.83
	69.20	1.44	12.3	8.16
Extra dilutions if needed	63.12	1.58	7.2	13.80
	57.57	1.74	4.3	23.32

Cell: I9
Comment:
This is assuming that the data are Type 2 data (none of the data in the data set are censored - "<" or ">").

Cell: K18
Comment: This is assuming that the data are Type 2 data (none of the data in the data set are censored - "<" or ">").

Cell: J22
Comment: Remember to change the "N" to "Y" if you have ratios entered, otherwise, they won't be used in the calculations.

Cell: C40
Comment:
If you have entered data to calculate an ACR on page 3, and this is still defaulted to "10", make sure you have selected "Y" in cell E21

Cell: C41
Comment: If you have entered data to calculate an effluent specific CV on page 2, and this is still defaulted to "0.6", make sure you have selected "Y" in cell E20

Cell: L48
Comment:
See Row 151 for the appropriate dilution series to use for these NOEC's

Cell: G62
Comment:
Vertebrates are:
Pimephales promelas
Oncorhynchus mykiss
Cyprinodon variegatus

Cell: J62
Comment:
Invertebrates are:
Ceriodaphnia dubia
Mysidopsis bahia

Cell: C117
Comment: Vertebrates are:

Pimephales promelas
Cyprinodon variegatus

Cell: M119
Comment: The ACR has been picked up from cell C34 on Page 1. If you have paired data to calculate an ACR, enter it in the tables to the left, and make sure you have a "Y" in cell E21 on Page 1. Otherwise, the default of 10 will be used to convert your acute data.

Cell: M121
Comment: If you are only concerned with acute data, you can enter it in the NOEC column for conversion and the number calculated will be equivalent to the TUa. The calculation is the same: 100/NOEC = TUc or 100/LC50 = TUa.

Cell: C138
Comment: Invertebrates are:

Ceriodaphnia dubia
Mysidopsis bahia

Spreadsheet for determination of WET test endpoints or WET limits

Excel 97
Revision Date: 12/13/13
File: WETLIM10.xls
(MIX.EXE required also)

Acute Endpoint/Permit Limit — **Use as LC_{50} in Special Condition, as TUa on DMR**

ACUTE	100% =	NOAEC	LC_{50} =	NA	% Use as	NA	TUa

ACUTE WLAa 0.3

Note: Inform the permittee that if the mean of the data exceeds this TUa: 1.0 a limit may result using STATS.EXE

Chronic Endpoint/Permit Limit — **Use as NOEC in Special Condition, as TUc on DMR**

CHRONIC	1.462574684	TU_c	NOEC =	69	% Use as	1.44	TU_c
BOTH*	3.000000074	TU_c	NOEC =	34	% Use as	2.94	TU_c
AML	1.462574684	TU_c	NOEC =	69	% Use as	1.44	TU_c

ACUTE WLAa,c 3
CHRONIC WLAc 1
* Both means acute expressed as chronic

Note: Inform the permittee that if the mean of the data exceeds this TUc: 1.0 a limit may result using STATS.EXE

Enter data in the cells with blue type:

Entry Date:	05/13/16
Facility Name:	
VPDES Number:	VA0004146
Outfall Number:	003

% Flow to be used from MIX.EXE

Diffuser /modeling study?

Plant Flow:	757	MGD		Enter Y/N	n
Acute 1Q10:	0	MGD	100 %	Acute	1 :1
Chronic 7Q10:	0	MGD	100 %	Chronic	1 :1

Are data available to calculate CV? (Y/N) N (Minimum of 10 data points, same species, needed) Go to Page 2
Are data available to calculate ACR? (Y/N) N (NOEC<LC50, do not use greater/less than data) Go to Page 3

IWC_a	100	%	Plant flow/plant flow + 1Q10
IWC_c	100	%	Plant flow/plant flow + 7Q10

NOTE: If the IWCa is >33%, specify the NOAEC = 100% test/endpoint for use

Dilution, acute	1	100/IWCa
Dilution, chronic	1	100/IWCc
WLA_a	0.3	Instream criterion (0.3 TUa) X's Dilution, acute
WLA_c	1	Instream criterion (1.0 TUc) X's Dilution, chronic
$WLA_{a,c}$	3	ACR X's WLA_a - converts acute WLA to chronic units
ACR -acute/chronic ratio	10	LC50/NOEC (Default is 10 - if data are available, use tables Page 3)
CV-Coefficient of variation	0.6	Default of 0.6 - if data are available, use tables Page 2)
Constants eA	0.4109447	Default = 0.41
eB	0.6010373	Default = 0.60
eC	2.4334175	Default = 2.43
eD	2.4334175	Default = 2.43 (1 samp) No. of samples 1

****The Maximum Daily Limit is calculated from the lowest LTA, X's eC. The LTAa,c and MDL using it are driven by the ACR.**

$LTA_{a,c}$	1.2328341	WLAa,c X's eA						
LTA_c	0.6010373	WLAc X's eB					Rounded NOEC's	%
MDL** with $LTA_{a,c}$	3.000000074	TU_c	NOEC =	33.333333	(Protects from acute/chronic toxicity)		NOEC = 34	%
MDL** with LTA_c	1.462574684	TU_c	NOEC =	68.372577	(Protects from chronic toxicity)		NOEC = 69	%
AML with lowest LTA	1.462574684	TU_c	NOEC =	68.372577	Lowest LTA X's eD		NOEC = 69	

IF ONLY ACUTE ENDPOINT/LIMIT IS NEEDED, CONVERT MDL FROM TU_c to TU_a

							Rounded LC50's	%
MDL with $LTA_{a,c}$	0.300000007	TU_a	LC50 =	333.333325	%	Use NOAEC=100%	LC50 = NA	%
MDL with LTA_c	0.146257468	TU_a	LC50 =	683.725769	%	Use NOAEC=100%	LC50 = NA	

Page 2 - Follow the directions to develop a site specific CV (coefficient of variation)

IF YOU HAVE AT LEAST 10 DATA POINTS THAT ARE QUANTIFIABLE (NOT "<" OR ">") FOR A SPECIES, ENTER THE DATA IN EITHER COLUMN "G" (VERTEBRATE) OR COLUMN "J" (INVERTEBRATE). THE 'CV' WILL BE PICKED UP FOR THE CALCULATIONS BELOW. THE DEFAULT VALUES FOR eA, eB, AND eC WILL CHANGE IF THE 'CV' IS ANYTHING OTHER THAN 0.6.

	Vertebrate IC_{25} Data or LC_{50} Data	LN of data	Invertebrate IC_{25} Data or LC_{50} Data	LN of data
	**********		**********	
1			1	
2			2	
3			3	
4			4	
5			5	
6			6	
7			7	
8			8	
9			9	
10			10	
11			11	
12			12	
13			13	
14			14	
15			15	
16			16	
17			17	
18			18	
19			19	
20			20	
St Dev	NEED DATA	NEED DATA	St Dev	NEED DATA	NEED DATA
Mean	0	0	Mean	0	0
Variance	0	0.000000	Variance	0	0.000000
CV	0		CV	0	

Coefficient of Variation for effluent tests

CV = 0.6 (Default 0.6)

δ^2 = 0.3074847

δ = 0.554513029

Using the log variance to develop eA

(P. 100, step 2a of TSD)

Z = 1.881 (97% probability stat from table

A = -0.88929666

eA = 0.410944686

Using the log variance to develop eB

(P. 100, step 2b of TSD)

δ_4^2 = 0.086177696

δ_4 = 0.293560379

B = -0.50909823

eB = 0.601037335

Using the log variance to develop eC

(P. 100, step 4a of TSD)

δ^2 = 0.3074847

δ = 0.554513029

C = 0.889296658

eC = 2.433417525

Using the log variance to develop eD

(P. 100, step 4b of TSD)

n = 1 This number will most likely stay as "1", for 1 sample/month.

δ_n^2 = 0.3074847

δ_n = 0.554513029

D = 0.889296658

eD = 2.433417525

Page 3 - Follow directions to develop a site specific ACR (Acute to Chronic Ratio)

To determine Acute/Chronic Ratio (ACR), insert usable data below. Usable data is defined as valid paired test results, acute and chronic, tested at the same temperature, same species. The chronic NOEC must be less than the acute LC_{50}, since the ACR divides the LC_{50} by the NOEC. LC_{50}'s >100% should not be used.

Table 1. ACR using Vertebrate data

Set #	LC_{50}	NOEC	Test ACR	Logarithm	Geomean	Antilog	ACR to Use
1	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	NO DATA
2	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	NO DATA
3	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	NO DATA
4	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	NO DATA
5	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	NO DATA
6	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	NO DATA
7	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	NO DATA
8	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	NO DATA
9	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	NO DATA
10	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	NO DATA
				ACR for vertebrate data:			0

Table 1. Result:	Vertebrate ACR	0
Table 2. Result:	Invertebrate ACR	0
	Lowest ACR	Default to 10

Table 2. ACR using Invertebrate data

Set #	LC_{50}	NOEC	Test ACR	Logarithm	Geomean	Antilog	ACR to Use
1	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	NO DATA
2	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	NO DATA
3	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	NO DATA
4	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	NO DATA
5	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	NO DATA
6	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	NO DATA
7	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	NO DATA
8	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	NO DATA
9	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	NO DATA
10	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	NO DATA
				ACR for vertebrate data:			0

Convert LC_{50}'s and NOEC's to Chronic TU's for use in WLA.EXE

Table 3. **ACR used: 10**

	Enter LC_{50}	TUc	Enter NOEC	TUc
1	>100	#DIV/0!	100	1.000000
2	>100	#DIV/0!	100	1.000000
3	>100	#DIV/0!	100	1.000000
4	>100	#DIV/0!	100	1.000000
5	>100	#DIV/0!	100	1.000000
6	>100	#DIV/0!	100	1.000000
7	>100	#DIV/0!	100	1.000000
8	>100	#DIV/0!	100	1.000000
9	>100	#DIV/0!	100	1.000000
10	>100	#DIV/0!	100	1.000000
11		NO DATA		NO DATA
12		NO DATA		NO DATA
13		NO DATA		NO DATA
14		NO DATA		NO DATA
15		NO DATA		NO DATA
16		NO DATA		NO DATA
17		NO DATA		NO DATA
18		NO DATA		NO DATA
19		NO DATA		NO DATA
20		NO DATA		NO DATA

If WLA.EXE determines that an acute limit is needed, you need to convert the TUc answer you get to TUa and then an LC50, enter it here:

NO DATA	$\%LC_{50}$
NO DATA	TUa

DILUTION SERIES TO RECOMMEND

Table 4.

	Monitoring % Effluent	Monitoring TUc	Limit % Effluent	Limit TUc
Dilution series based on data mean	100	1.0		
Dilution series to use for limit			69	1.4492754
Dilution factor to recommend:	0.5		0.8306624	
Dilution series to recommend:	100.0	1.00	100.0	1.00
	50.0	2.00	83.1	1.20
	25.0	4.00	69.0	1.45
	12.5	8.00	57.3	1.74
	6.25	16.00	47.6	2.10
Extra dilutions if needed	3.12	32.05	39.5	2.53
	1.56	64.10	32.9	3.04

Cell: I9
Comment:
This is assuming that the data are Type 2 data (none of the data in the data set are censored - "<" or ">").

Cell: K18
Comment: This is assuming that the data are Type 2 data (none of the data in the data set are censored - "<" or ">").

Cell: J22
Comment: Remember to change the "N" to "Y" if you have ratios entered, otherwise, they won't be used in the calculations.

Cell: C40
Comment:
If you have entered data to calculate an ACR on page 3, and this is still defaulted to "10", make sure you have selected "Y" in cell E21

Cell: C41
Comment: If you have entered data to calculate an effluent specific CV on page 2, and this is still defaulted to "0.6", make sure you have selected "Y" in cell E20

Cell: L48
Comment:
See Row 151 for the appropriate dilution series to use for these NOEC's

Cell: G62
Comment:
Vertebrates are:
Pimephales promelas
Oncorhynchus mykiss
Cyprinodon variegatus

Cell: J62
Comment:
Invertebrates are:
Ceriodaphnia dubia
Mysidopsis bahia

Cell: C117
Comment: Vertebrates are:

Pimephales promelas
Cyprinodon variegatus

Cell: M119
Comment: The ACR has been picked up from cell C34 on Page 1. If you have paired data to calculate an ACR, enter it in the tables to the left, and make sure you have a "Y" in cell E21 on Page 1. Otherwise, the default of 10 will be used to convert your acute data.

Cell: M121
Comment: If you are only concerned with acute data, you can enter it in the NOEC column for conversion and the number calculated will be equivalent to the TUa. The calculation is the same: 100/NOEC = TUc or 100/LC50 = TUa.

Cell: C138
Comment: Invertebrates are:

Ceriodaphnia dubia
Mysidopsis bahia

Spreadsheet for determination of WET test endpoints or WET limits

Excel 97
Revision Date: 12/13/13
File: WETLIM10.xls
(MIX.EXE required also)

Acute Endpoint/Permit Limit — **Use as LC_{50} in Special Condition, as TUa on DMR**

ACUTE	100% =	NOAEC	LC_{50} =	NA	% Use as	NA	TUa

ACUTE WLAa 0.3

Note: Inform the permittee that if the mean of the data exceeds this TUa: 1.0 a limit may result using STATS.EXE

Chronic Endpoint/Permit Limit — **Use as NOEC in Special Condition, as TUc on DMR**

CHRONIC	1.462574684	TU_c	NOEC =	69	% Use as	1.44	TU_c
BOTH*	3.000000074	TU_c	NOEC =	34	% Use as	2.94	TU_c
AML	1.462574684	TU_c	NOEC =	69	% Use as	1.44	TU_c

ACUTE WLAa,c 3
CHRONIC WLAc 1
* Both means acute expressed as chronic

Note: Inform the permittee that if the mean of the data exceeds this TUc: 1.0 a limit may result using STATS.EXE

Enter data in the cells with blue type:

Entry Date:	05/13/16
Facility Name:	
VPDES Number:	VA0004146
Outfall Number:	004 Pre-Closure

% Flow to be used from MIX.EXE

Plant Flow:	22.41	MGD	
Acute 1Q10:	0	MGD	0 %
Chronic 7Q10:	0	MGD	0 %

Diffuser /modeling study?

Enter Y/N	n		
Acute	2	:1	
Chronic	2	:1	

Are data available to calculate CV? (Y/N) N (Minimum of 10 data points, same species, needed) Go to Page 2
Are data available to calculate ACR? (Y/N) N (NOEC<LC50, do not use greater/less than data) Go to Page 3

IWC_a	100	%	Plant flow/plant flow + 1Q10
IWC_c	100	%	Plant flow/plant flow + 7Q10

NOTE: If the IWCa is >33%, specify the NOAEC = 100% test/endpoint for use

Dilution, acute	1	100/IWCa
Dilution, chronic	1	100/IWCc
WLA_a	0.3	Instream criterion (0.3 TUa) X's Dilution, acute
WLA_c	1	Instream criterion (1.0 TUc) X's Dilution, chronic
$WLA_{a,c}$	3	ACR X's WLA_a - converts acute WLA to chronic units
ACR -acute/chronic ratio	10	LC50/NOEC (Default is 10 - if data are available, use tables Page 3)
CV-Coefficient of variation	0.6	Default of 0.6 - if data are available, use tables Page 2)
Constants eA	0.4109447	Default = 0.41
eB	0.6010373	Default = 0.60
eC	2.4334175	Default = 2.43
eD	2.4334175	Default = 2.43 (1 samp) No. of samples 1

****The Maximum Daily Limit is calculated from the lowest LTA, X's eC. The LTAa,c and MDL using it are driven by the ACR.**

$LTA_{a,c}$	1.2328341	WLAa,c X's eA						
LTA_c	0.6010373	WLAc X's eB					Rounded NOEC's	%
MDL** with $LTA_{a,c}$	3.000000074	TU_c	NOEC =	33.333333	(Protects from acute/chronic toxicity)		NOEC = 34	%
MDL** with LTA_c	1.462574684	TU_c	NOEC =	68.372577	(Protects from chronic toxicity)		NOEC = 69	%
AML with lowest LTA	1.462574684	TU_c	NOEC =	68.372577	Lowest LTA X's eD		NOEC = 69	

IF ONLY ACUTE ENDPOINT/LIMIT IS NEEDED, CONVERT MDL FROM TU_c to TU_a

							Rounded LC50's	%
MDL with $LTA_{a,c}$	0.300000007	TU_a	LC50 =	333.333325	%	Use NOAEC=100%	LC50 = NA	%
MDL with LTA_c	0.146257468	TU_a	LC50 =	683.725769	%	Use NOAEC=100%	LC50 = NA	

Page 2 - Follow the directions to develop a site specific CV (coefficient of variation)

IF YOU HAVE AT LEAST 10 DATA POINTS THAT ARE QUANTIFIABLE (NOT "<" OR ">") FOR A SPECIES, ENTER THE DATA IN EITHER COLUMN "G" (VERTEBRATE) OR COLUMN "J" (INVERTEBRATE). THE 'CV' WILL BE PICKED UP FOR THE CALCULATIONS BELOW. THE DEFAULT VALUES FOR eA, eB, AND eC WILL CHANGE IF THE 'CV' IS ANYTHING OTHER THAN 0.6.

	Vertebrate IC_{25} Data or LC_{50} Data	LN of data	Invertebrate IC_{25} Data or LC_{50} Data	LN of data
	**********		**********	
1			1	
2			2	
3			3	
4			4	
5			5	
6			6	
7			7	
8			8	
9			9	
10			10	
11			11	
12			12	
13			13	
14			14	
15			15	
16			16	
17			17	
18			18	
19			19	
20			20	
St Dev	NEED DATA	NEED DATA	St Dev	NEED DATA	NEED DATA
Mean	0	0	Mean	0	0
Variance	0	0.000000	Variance	0	0.000000
CV	0		CV	0	

Coefficient of Variation for effluent tests

CV = 0.6 (Default 0.6)

δ^2 = 0.3074847

δ = 0.554513029

Using the log variance to develop eA

(P. 100, step 2a of TSD)

Z = 1.881 (97% probability stat from table

A = -0.88929666

eA = 0.410944686

Using the log variance to develop eB

(P. 100, step 2b of TSD)

δ_4^2 = 0.086177696

δ_4 = 0.293560379

B = -0.50909823

eB = 0.601037335

Using the log variance to develop eC

(P. 100, step 4a of TSD)

δ^2 = 0.3074847

δ = 0.554513029

C = 0.889296658

eC = 2.433417525

Using the log variance to develop eD

(P. 100, step 4b of TSD)

n = 1 This number will most likely stay as "1", for 1 sample/month.

δ_n^2 = 0.3074847

δ_n = 0.554513029

D = 0.889296658

eD = 2.433417525

Page 3 - Follow directions to develop a site specific ACR (Acute to Chronic Ratio)

To determine Acute/Chronic Ratio (ACR), insert usable data below. Usable data is defined as valid paired test results, acute and chronic, tested at the same temperature, same species. The chronic NOEC must be less than the acute LC_{50}, since the ACR divides the LC_{50} by the NOEC. LC_{50}'s >100% should not be used.

Table 1. ACR using Vertebrate data

Set #	LC_{50}	NOEC	Test ACR	Logarithm	Geomean	Antilog	ACR to Use
1	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	NO DATA
2	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	NO DATA
3	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	NO DATA
4	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	NO DATA
5	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	NO DATA
6	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	NO DATA
7	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	NO DATA
8	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	NO DATA
9	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	NO DATA
10	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	NO DATA
				ACR for vertebrate data:			0

Table 1. Result:	Vertebrate ACR	0
Table 2. Result:	Invertebrate ACR	0
	Lowest ACR	Default to 10

Table 2. ACR using Invertebrate data

Set #	LC_{50}	NOEC	Test ACR	Logarithm	Geomean	Antilog	ACR to Use
1	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	NO DATA
2	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	NO DATA
3	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	NO DATA
4	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	NO DATA
5	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	NO DATA
6	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	NO DATA
7	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	NO DATA
8	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	NO DATA
9	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	NO DATA
10	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	NO DATA
				ACR for vertebrate data:			0

Convert LC_{50}'s and NOEC's to Chronic TU's for use in WLA.EXE

Table 3. **ACR used: 10**

	Enter LC_{50}	TUc	Enter NOEC	TUc
1	100	10.000000	100	1.000000
2	100	10.000000	32	3.125000
3	100	10.000000	32	3.125000
4	100	10.000000	100	1.000000
5	100	10.000000	100	1.000000
6	100	10.000000	100	1.000000
7	100	10.000000	100	1.000000
8	100	10.000000	100	1.000000
9	100	10.000000	32	3.125000
10	100	10.000000	100	1.000000
11	100	10.000000	100	1.000000
12	100	10.000000	100	1.000000
13	100	10.000000	100	1.000000
14	100	10.000000	100	1.000000
15	100	10.000000	100	1.000000
16	100	10.000000	100	1.000000
17	100	10.000000	100	1.000000
18	100	10.000000	100	1.000000
19	100	10.000000	100	1.000000
20	100	10.000000	100	1.000000

If WLA.EXE determines that an acute limit is needed, you need to convert the TUc answer you get to TUa and then an LC50, enter it here:

NO DATA	$\%LC_{50}$
NO DATA	TUa

DILUTION SERIES TO RECOMMEND

Table 4.

	Monitoring % Effluent	Monitoring TUc	Limit % Effluent	Limit TUc
Dilution series based on data mean	100	1.0		
Dilution series to use for limit			69	1.4492754
Dilution factor to recommend:	0.5		0.8306624	
Dilution series to recommend:	100.0	1.00	100.0	1.00
	50.0	2.00	83.1	1.20
	25.0	4.00	69.0	1.45
	12.5	8.00	57.3	1.74
	6.25	16.00	47.6	2.10
Extra dilutions if needed	3.12	32.05	39.5	2.53
	1.56	64.10	32.9	3.04

Cell: I9
Comment:
This is assuming that the data are Type 2 data (none of the data in the data set are censored - "<" or ">").

Cell: K18
Comment: This is assuming that the data are Type 2 data (none of the data in the data set are censored - "<" or ">").

Cell: J22
Comment: Remember to change the "N" to "Y" if you have ratios entered, otherwise, they won't be used in the calculations.

Cell: C40
Comment:
If you have entered data to calculate an ACR on page 3, and this is still defaulted to "10", make sure you have selected "Y" in cell E21

Cell: C41
Comment: If you have entered data to calculate an effluent specific CV on page 2, and this is still defaulted to "0.6", make sure you have selected "Y" in cell E20

Cell: L48
Comment:
See Row 151 for the appropriate dilution series to use for these NOEC's

Cell: G62
Comment:
Vertebrates are:
Pimephales promelas
Oncorhynchus mykiss
Cyprinodon variegatus

Cell: J62
Comment:
Invertebrates are:
Ceriodaphnia dubia
Mysidopsis bahia

Cell: C117
Comment: Vertebrates are:

Pimephales promelas
Cyprinodon variegatus

Cell: M119
Comment: The ACR has been picked up from cell C34 on Page 1. If you have paired data to calculate an ACR, enter it in the tables to the left, and make sure you have a "Y" in cell E21 on Page 1. Otherwise, the default of 10 will be used to convert your acute data.

Cell: M121
Comment: If you are only concerned with acute data, you can enter it in the NOEC column for conversion and the number calculated will be equivalent to the TUa. The calculation is the same: 100/NOEC = TUc or 100/LC50 = TUa.

Cell: C138
Comment: Invertebrates are:

Ceriodaphnia dubia
Mysidopsis bahia

3/8/2016 3:46:04 PM

Facility = Chesterfield Power Station 004 - Pre-Closure
Chemical = WET
Chronic averaging period = 4
WLAa = 3
WLAc = 1
Q.L. = 1
# samples/mo. = 1
# samples/wk. = 1

Summary of Statistics:

observations = 20
Expected Value = 1.29501
Variance = .320205
C.V. = 0.436957
97th percentile daily values = 2.60502
97th percentile 4 day average = 1.89911
97th percentile 30 day average= 1.48934
< Q.L. = 0
Model used = lognormal

A limit is needed based on Chronic Toxicity
Maximum Daily Limit = 1.37170472201948
Average Weekly limit = 1.37170472201948
Average Monthly LImit = 1.37170472201948

The data are:

1
3.13
3.13
1
1
1
1
1
3.13
1
1
1
1
1
1
1
1
1
1
1

Spreadsheet for determination of WET test endpoints or WET limits

Excel 97
Revision Date: 12/13/13
File: WETLIM10.xls
(MIX.EXE required also)

Acute Endpoint/Permit Limit — **Use as LC_{50} in Special Condition, as TUa on DMR**

ACUTE	100% =	NOAEC	LC_{50} =	NA	% Use as	NA	TUa
ACUTE WLAa		0.6					

Note: Inform the permittee that if the mean of the data exceeds this TUa: 1.0 a limit may result using STATS.EXE

Chronic Endpoint/Permit Limit — **Use as NOEC in Special Condition, as TUc on DMR**

CHRONIC	2.925149368	TU_c	NOEC =	35	% Use as	2.85	TU_c
BOTH*	6.000000147	TU_c	NOEC =	17	% Use as	5.88	TU_c
AML	2.925149368	TU_c	NOEC =	35	% Use as	2.85	TU_c

ACUTE WLAa,c	6
CHRONIC WLAc	2

* Both means acute expressed as chronic

Note: Inform the permittee that if the mean of the data exceeds this TUc: 1.20207454 a limit may result using STATS.EXE

Enter data in the cells with blue type:

Entry Date:	05/13/16
Facility Name:	
VPDES Number:	VA0004146
Outfall Number:	005 Pre-Closure

% Flow to be used from MIX.EXE

Plant Flow:	4.05	MGD	
Acute 1Q10:		MGD	100 %
Chronic 7Q10:		MGD	100 %

Diffuser /modeling study?

Enter Y/N	y	
Acute	2	:1
Chronic	2	:1

Are data available to calculate CV? (Y/N)	N	(Minimum of 10 data points, same species, needed) — Go to Page 2
Are data available to calculate ACR? (Y/N)	N	(NOEC<LC50, do not use greater/less than data) — Go to Page 3

IWC_a	50	%	Plant flow/plant flow + 1Q10
IWC_c	50	%	Plant flow/plant flow + 7Q10

NOTE: If the IWCa is >33%, specify the NOAEC = 100% test/endpoint for use

Dilution, acute	2	100/IWCa
Dilution, chronic	2	100/IWCc
WLA_a	0.6	Instream criterion (0.3 TUa) X's Dilution, acute
WLA_c	2	Instream criterion (1.0 TUc) X's Dilution, chronic
$WLA_{a,c}$	6	ACR X's WLA_a - converts acute WLA to chronic units
ACR -acute/chronic ratio	10	LC50/NOEC (Default is 10 - if data are available, use tables Page 3)
CV-Coefficient of variation	0.6	Default of 0.6 - if data are available, use tables Page 2)
Constants eA	0.4109447	Default = 0.41
eB	0.6010373	Default = 0.60
eC	2.4334175	Default = 2.43
eD	2.4334175	Default = 2.43 (1 samp) No. of samples 1

****The Maximum Daily Limit is calculated from the lowest LTA, X's eC. The LTAa,c and MDL using it are driven by the ACR.**

$LTA_{a,c}$	2.4656682	WLAa,c X's eA						
LTA_c	1.2020746	WLAc X's eB					Rounded NOEC's	%
MDL** with $LTA_{a,c}$	6.000000147	TU_c	NOEC =	16.666666	(Protects from acute/chronic toxicity)		NOEC = 17	%
MDL** with LTA_c	2.925149368	TU_c	NOEC =	34.186288	(Protects from chronic toxicity)		NOEC = 35	%
AML with lowest LTA	2.925149368	TU_c	NOEC =	34.186288	Lowest LTA X's eD		NOEC = 35	

IF ONLY ACUTE ENDPOINT/LIMIT IS NEEDED, CONVERT MDL FROM TU_c to TU_a

							Rounded LC50's	%
MDL with $LTA_{a,c}$	0.600000015	TU_a	LC50 =	166.666663	%	Use NOAEC=100%	LC50 = NA	%
MDL with LTA_c	0.292514937	TU_a	LC50 =	341.862884	%	Use NOAEC=100%	LC50 = NA	

Page 2 - Follow the directions to develop a site specific CV (coefficient of variation)

IF YOU HAVE AT LEAST 10 DATA POINTS THAT ARE QUANTIFIABLE (NOT "<" OR ">") FOR A SPECIES, ENTER THE DATA IN EITHER COLUMN "G" (VERTEBRATE) OR COLUMN "J" (INVERTEBRATE). THE 'CV' WILL BE PICKED UP FOR THE CALCULATIONS BELOW. THE DEFAULT VALUES FOR eA, eB, AND eC WILL CHANGE IF THE 'CV' IS ANYTHING OTHER THAN 0.6.

	Vertebrate IC_{25} Data or LC_{50} Data	LN of data	Invertebrate IC_{25} Data or LC_{50} Data	LN of data
	**********		**********	
1			1	
2			2	
3			3	
4			4	
5			5	
6			6	
7			7	
8			8	
9			9	
10			10	
11			11	
12			12	
13			13	
14			14	
15			15	
16			16	
17			17	
18			18	
19			19	
20			20	
St Dev	NEED DATA	NEED DATA	St Dev	NEED DATA	NEED DATA
Mean	0	0	Mean	0	0
Variance	0	0.000000	Variance	0	0.000000
CV	0		CV	0	

Coefficient of Variation for effluent tests

CV = 0.6 (Default 0.6)

δ^2 = 0.3074847

δ = 0.554513029

Using the log variance to develop eA

(P. 100, step 2a of TSD)

Z = 1.881 (97% probability stat from table

A = -0.88929666

eA = 0.410944686

Using the log variance to develop eB

(P. 100, step 2b of TSD)

δ_4^2 = 0.086177696

δ_4 = 0.293560379

B = -0.50909823

eB = 0.601037335

Using the log variance to develop eC

(P. 100, step 4a of TSD)

δ^2 = 0.3074847

δ = 0.554513029

C = 0.889296658

eC = 2.433417525

Using the log variance to develop eD

(P. 100, step 4b of TSD)

n = 1 This number will most likely stay as "1", for 1 sample/month.

δ_n^2 = 0.3074847

δ_n = 0.554513029

D = 0.889296658

eD = 2.433417525

Page 3 - Follow directions to develop a site specific ACR (Acute to Chronic Ratio)

To determine Acute/Chronic Ratio (ACR), insert usable data below. Usable data is defined as valid paired test results, acute and chronic, tested at the same temperature, same species. The chronic NOEC must be less than the acute LC_{50}, since the ACR divides the LC_{50} by the NOEC. LC_{50}'s >100% should not be used.

Table 1. ACR using Vertebrate data

Set #	LC_{50}	NOEC	Test ACR	Logarithm	Geomean	Antilog	ACR to Use
1	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	NO DATA
2	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	NO DATA
3	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	NO DATA
4	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	NO DATA
5	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	NO DATA
6	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	NO DATA
7	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	NO DATA
8	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	NO DATA
9	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	NO DATA
10	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	NO DATA
				ACR for vertebrate data:			0

Table 1. Result:	Vertebrate ACR	0
Table 2. Result:	Invertebrate ACR	0
	Lowest ACR	Default to 10

Table 2. ACR using Invertebrate data

Set #	LC_{50}	NOEC	Test ACR	Logarithm	Geomean	Antilog	ACR to Use
1	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	NO DATA
2	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	NO DATA
3	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	NO DATA
4	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	NO DATA
5	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	NO DATA
6	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	NO DATA
7	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	NO DATA
8	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	NO DATA
9	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	NO DATA
10	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	NO DATA
				ACR for vertebrate data:			0

Convert LC_{50}'s and NOEC's to Chronic TU's for use in WLA.EXE

Table 3. **ACR used: 10**

	Enter LC_{50}	TUc	Enter NOEC	TUc
1	>100	#DIV/0!	100	1.000000
2	>100	#DIV/0!	100	1.000000
3	>100	#DIV/0!	100	1.000000
4	>100	#DIV/0!	100	1.000000
5		NO DATA		NO DATA
6		NO DATA		NO DATA
7		NO DATA		NO DATA
8		NO DATA		NO DATA
9		NO DATA		NO DATA
10		NO DATA		NO DATA
11		NO DATA		NO DATA
12		NO DATA		NO DATA
13		NO DATA		NO DATA
14		NO DATA		NO DATA
15		NO DATA		NO DATA
16		NO DATA		NO DATA
17		NO DATA		NO DATA
18		NO DATA		NO DATA
19		NO DATA		NO DATA
20		NO DATA		NO DATA

If WLA.EXE determines that an acute limit is needed, you need to convert the TUc answer you get to TUa and then an LC50, enter it here:

NO DATA	$\%LC_{50}$
NO DATA	TUa

DILUTION SERIES TO RECOMMEND

Table 4.

	Monitoring % Effluent	Monitoring TUc	Limit % Effluent	Limit TUc
Dilution series based on data mean	83.2	1.202075		
Dilution series to use for limit			35	2.8571429
Dilution factor to recommend:	0.9120829		0.591608	
Dilution series to recommend:	100.0	1.00	100.0	1.00
	91.2	1.10	59.2	1.69
	83.2	1.20	35.0	2.86
	75.9	1.32	20.7	4.83
	69.20	1.44	12.3	8.16
Extra dilutions if needed	63.12	1.58	7.2	13.80
	57.57	1.74	4.3	23.32

Cell: I9
Comment:
This is assuming that the data are Type 2 data (none of the data in the data set are censored - "<" or ">").

Cell: K18
Comment: This is assuming that the data are Type 2 data (none of the data in the data set are censored - "<" or ">").

Cell: J22
Comment: Remember to change the "N" to "Y" if you have ratios entered, otherwise, they won't be used in the calculations.

Cell: C40
Comment:
If you have entered data to calculate an ACR on page 3, and this is still defaulted to "10", make sure you have selected "Y" in cell E21

Cell: C41
Comment: If you have entered data to calculate an effluent specific CV on page 2, and this is still defaulted to "0.6", make sure you have selected "Y" in cell E20

Cell: L48
Comment:
See Row 151 for the appropriate dilution series to use for these NOEC's

Cell: G62
Comment:
Vertebrates are:
Pimephales promelas
Oncorhynchus mykiss
Cyprinodon variegatus

Cell: J62
Comment:
Invertebrates are:
Ceriodaphnia dubia
Mysidopsis bahia

Cell: C117
Comment: Vertebrates are:

Pimephales promelas
Cyprinodon variegatus

Cell: M119
Comment: The ACR has been picked up from cell C34 on Page 1. If you have paired data to calculate an ACR, enter it in the tables to the left, and make sure you have a "Y" in cell E21 on Page 1. Otherwise, the default of 10 will be used to convert your acute data.

Cell: M121
Comment: If you are only concerned with acute data, you can enter it in the NOEC column for conversion and the number calculated will be equivalent to the TUa. The calculation is the same: 100/NOEC = TUc or 100/LC50 = TUa.

Cell: C138
Comment: Invertebrates are:

Ceriodaphnia dubia
Mysidopsis bahia

2004 Evaluation and Limitation Development

Spreadsheet for determination of WET test endpoints or WET limits

1															
2		**Spreadsheet for determination of WET test endpoints or WET limits**													
3															
4		**Excel 97**			**Acute Endpoint/Permit Limit**			**Use as LC_{50} in Special Condition, as TUa on DMR**							
5		**Revision Date: 06/07/04**													
6		**File: WETLIM10.xls**			**ACUTE**	**7.94123884**	**TUa**	**LC_{50} =**	**13**	**% Use as**	**7.69**	**TUa**			
7		**(MIX.EXE required also)**													
8					**ACUTE WLAa**		**16.2888889**	Note: Inform the permittee that if the mean of the data exceeds							
9								this TUa:	**2.23127667**	a limit may result using WLA.EXE					
10															
11					**Chronic Endpoint/Permit Limit**			**Use as NOEC in Special Condition, as TUc on DMR**							
12															
13					**CHRONIC**	**79.4123884**	**TU_c**	**NOEC =**	**2**	**% Use as**	**50.00**	**TU_c**			
14					**BOTH***	**162.8888929**	**TU_c**	**NOEC =**	**1**	**% Use as**	**100.00**	**TU_c**			
15	**Enter data in the cells with blue type:**				**AML**	**79.4123884**	**TU_c**	**NOEC =**	**2**	**% Use as**	**50.00**	**TU_c**			
16															
17	Entry Date:		06/15/04		**ACUTE WLAa,c**		**162.888889**		Note: Inform the permittee that if the mean						
18	Facility Name:		VaP-Chesterfield		**CHRONIC WLAc**		**54.2962963**		of the data exceeds this TUc:			**32.6340978**			
19	VPDES Number:		VA0004146		* Both means acute expressed as chronic				a limit may result using WLA.EXE						
20	Outfall Number:		4												
21					**% Flow to be used from MIX.EXE**				**Difuser /modeling study?**						
22	Plant Flow:		13.5	MGD					Enter Y/N	N					
23	Acute 1Q10:		719.5	MGD	100	%			Acute	1	:1				
24	Chronic 7Q10:		719.5	MGD	100	%			Chronic	1	:1				
25															
26	Are data available to calculate CV? (Y/N)				N	(Minimum of 10 data points, same species, needed)					Go to Page 2				
27	Are data available to calculate ACR? (Y/N)				N	(NOEC<LC50, do not use greater/less than data)					Go to Page 3				
28															
29															
30	IWC_a		1.84174625	%	Plant flow/plant flow + 1Q10		**NOTE: If the IWCa is >33%, specify the**								
31	IWC_c		1.84174625	%	Plant flow/plant flow + 7Q10		**NOAEC = 100% test/endpoint for use**								
32															
33	Dilution, acute		54.2962963		100/IWCa										
34	Dilution, chronic		54.2962963		100/IWCc										
35															
36	WLA_a		16.2888889	Instream criterion (0.3 TUa) X's Dilution, acute											
37	WLA_c		54.2962963	Instream criterion (1.0 TUc) X's Dilution, chronic											
38	$WLA_{a,c}$		162.888889	ACR X's WLA_a - converts acute WLA to chronic units											
39															
40	ACR -acute/chronic ratio		10	LC50/NOEC (Default is 10 - if data are available, use tables Page 3)											
41	CV-Coefficient of variatior		0.6	Default of 0.6 - if data are available, use tables Page 2)											
42	Constants	eA	0.4109447	Default = 0.41											
43		eB	0.6010373	Default = 0.60											
44		eC	2.4334175	Default = 2.43											
45		eD	2.4334175	Default = 2.43 (1 samp)			****The Maximum Daily Limit is calculated from the lowest**								
46							**LTA, X's eC. The LTAa,c and MDL using it are driven by the ACR.**								
47	$LTA_{a,c}$		66.9383256	WLAa,c X's eA											
48	LTA_c		32.6340993	WLAc X's eB							Rounded NOEC's		%		
49	MDL** with $LTA_{a,c}$		162.888893	TU_c	NOEC =	0.613915	(Protects from acute/chronic toxicity)				NOEC =	1	%		
50	MDL** with LTA_c		79.4123884	TU_c	NOEC =	1.259249	(Protects from chronic toxicity)				NOEC =	2	%		
51	AML with lowest LTA		79.4123884	TU_c	NOEC =	1.259249	Lowest LTA X's eD				NOEC =	2			
52															
53	IF ONLY ACUTE ENDPOINT/LIMIT IS NEEDED, CONVERT MDL FROM TU_c to TU_a														
54											Rounded LC50's		%		
55	MDL with $LTA_{a,c}$		16.2888893	TU_a	LC50 =	6.139154	%				LC50 =	7	%		
56	MDL with LTA_c		7.94123884	TU_a	LC50 =	12.592494	%				LC50 =	13			
57															
58															

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
59															
60		**Page 2 - Follow the directions to develop a site specific CV (coefficient of variation)**													
61															
62		IF YOU HAVE AT LEAST 10 DATA POINTS THAT					Vertebrate			Invertebrate					
63		ARE QUANTIFIABLE (NOT "<" OR ">")					IC_{25} Data			IC_{25} Data					
64		FOR A SPECIES, ENTER THE DATA IN EITHER					or			or					
65		COLUMN "G" (VERTEBRATE) OR COLUMN					LC_{50} Data	LN of data		LC_{50} Data	LN of data				
66		"J" (INVERTEBRATE). THE 'CV' WILL BE					**********			**********					
67		PICKED UP FOR THE CALCULATIONS				1	0		1	4.7	1.547563				
68		BELOW. THE DEFAULT VALUES FOR eA,				2			2	14.3	2.660260				
69		eB, AND eC WILL CHANGE IF THE 'CV' IS				3			3	5	1.609438				
70		ANYTHING OTHER THAN 0.6.				4			4	3	1.098612				
71						5			5	2.8	1.029619				
72						6			6	8.1	2.091864				
73						7			7	33.7	3.517498				
74		Coefficient of Variation for effluent tests				8			8	6.4	1.856298				
75						9			9	100	4.605170				
76		CV =	2.92801801	(Default 0.6)		10			10	100	4.605170				
77						11			11	100	4.605170				
78		δ^2 =	2.25897687			12			12	100	4.605170				
79		δ =	1.50298931			13			13	100	4.605170				
80						14			14	100	4.605170				
81		Using the log variance to develop eA				15			15	100	4.605170				
82			(P. 100, step 2a of TSD)			16			16						
83		Z = 1.881 (97% probability stat from table				17			17						
84		A =	-1.6976345			18			18						
85		eA =	0.18311618			19			19						
86						20			20						
87		Using the log variance to develop eB													
88			(P. 100, step 2b of TSD)			St Dev	NEED DATA	NEED DATA	St Dev	47.176275	1.5029893				
89		δ_4^2 =	1.14528032			Mean	0	0	Mean	51.866667	3.1764895				
90		δ_4 =	1.0701777			Variance	0	0.000000	Variance	2225.601	2.258977				
91		B =	-1.4403641			CV	0		CV	2.928018					
92		eB =	0.23684151												
93															
94		Using the log variance to develop eC													
95			(P. 100, step 4a of TSD)												
96															
97		δ^2 =	2.25897687												
98		δ =	1.50298931												
99		C =	1.69763446												
100		eC =	5.46101385												
101															
102		Using the log variance to develop eD													
103			(P. 100, step 4b of TSD)												
104		n =	1	This number will most likely stay as "1", for 1 sample/month.											
105		δ_n^2 =	2.25897687												
106		δ_n =	1.50298931												
107		D =	1.69763446												
108		eD =	5.46101385												
109															

Page 3 - Follow directions to develop a site specific ACR (Acute to Chronic Ratio)

To determine Acute/Chronic Ratio (ACR), insert usable data below. Usable data is defined as valid paired test results, acute and chronic, tested at the same temperature, same species. The chronic NOEC must be less than the acute LC_{50}, since the ACR divides the LC_{50} by the NOEC. LC_{50}'s >100% should not be used.

Table 1. ACR using Vertebrate data

Set #	LC_{50}	NOEC	Test ACR	Logarithm	Geomean	Antilog	ACR to Use
1	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	NO DATA
2	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	NO DATA
3	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	NO DATA
4	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	NO DATA
5	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	NO DATA
6	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	NO DATA
7	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	NO DATA
8	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	NO DATA
9	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	NO DATA
10	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	NO DATA

ACR for vertebrate data: 0

Table 1. Result:	Vertebrate ACR	0
Table 2. Result:	Invertebrate ACR	0
	Lowest ACR	Default to 10

Table 2. ACR using Invertebrate data

Set #	LC_{50}	NOEC	Test ACR	Logarithm	Geomean	Antilog	ACR to Use
1	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	NO DATA
2	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	NO DATA
3	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	NO DATA
4	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	NO DATA
5	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	NO DATA
6	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	NO DATA
7	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	NO DATA
8	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	NO DATA
9	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	NO DATA
10	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	NO DATA

ACR for vertebrate data: 0

Convert LC_{50}'s and NOEC's to Chronic TU's for use in WLA.EXE

Table 3. ACR used: 10

	Enter LC_{50}	TUc	Enter NOEC	TUc
1		NO DATA		NO DATA
2		NO DATA		NO DATA
3		NO DATA		NO DATA
4		NO DATA		NO DATA
5		NO DATA		NO DATA
6		NO DATA		NO DATA
7		NO DATA		NO DATA
8		NO DATA		NO DATA
9		NO DATA		NO DATA
10		NO DATA		NO DATA
11		NO DATA		NO DATA
12		NO DATA		NO DATA
13		NO DATA		NO DATA
14		NO DATA		NO DATA
15		NO DATA		NO DATA
16		NO DATA		NO DATA
17		NO DATA		NO DATA
18		NO DATA		NO DATA
19		NO DATA		NO DATA
20		NO DATA		NO DATA

If WLA.EXE determines that an acute limit is needed, you need to convert the TUc answer you get to TUa and then an LC50, enter it here: NO DATA $\%LC_{50}$

NO DATA TUa

DILUTION SERIES TO RECOMMEND

Table 4.

	Monitoring % Effluent	Monitoring TUc	Limit % Effluent	Limit TUc
Dilution series based on data mean	3.1	32.634098		
Dilution series to use for limit			2	50
Dilution factor to recommend:	0.1750508		0.1414214	
Dilution series to recommend:	100.0	1.00	100.0	1.00
	17.5	5.71	14.1	7.07
	3.1	32.63	2.0	50.00
	0.5	186.43	0.3	353.55
	0.09	1064.98	0.0	2500.00
Extra dilutions if needed	0.02	6083.86	0.0	17677.67
	0.00	34754.80	0.0	125000.00

Cell: I9
Comment:

Cell: K18
Comment: This is assuming that the data are Type 2 data (none of the data in the data set are censored - "<" or ">").

Cell: J22
Comment: Remember to change the "N" to "Y" if you have ratios entered, otherwise, they won't be used in the calculations.

Cell: C40
Comment:
If you have entered data to calculate an ACR on page 3, and this is still defaulted to "10", make sure you have selected "Y" in cell E21

Cell: C41
Comment: If you have entered data to calculate an effluent specific CV on page 2, and this is still defaulted to "0.6", make sure you have selected "Y" in cell E20

Cell: L48
Comment:
See Row 151 for the appropriate dilution series to use for these NOEC's

Cell: G62
Comment:
Vertebrates are:
Pimephales promelas
Oncorhynchus mykiss
Cyprinodon variegatus

Cell: J62
Comment:
Invertebrates are:
Ceriodaphnia dubia
Mysidopsis bahia

Cell: C117
Comment: Vertebrates are:

Pimephales promelas
Cyprinodon variegatus

Cell: M119
Comment: The ACR has been picked up from cell C34 on Page 1. If you have paired data to calculate an ACR, enter it in the tables to the left, and make sure you have a "Y" in cell E21 on Page 1. Otherwise, the default of 10 will be used to convert your acute data.

Cell: M121
Comment: If you are only concerned with acute data, you can enter it in the NOEC column for conversion and the number calculated will be equivalent to the TUa. The calculation is the same: 100/NOEC = TUc or 100/LC50 = TUa.

Cell: C138
Comment: Invertebrates are:

Ceriodaphnia dubia
Mysidopsis bahia

2004 Evaluation and Limitation Development

Facility = VaP-Chesterfield Outfall 004
Chemical = Chronic WET
Chronic averaging period = 4
WLAa = 162.889
WLAc = 54.296
Q.L. = 1
# samples/mo. = 1
# samples/wk. = 1

Summary of Statistics:

observations = 16
Expected Value = 45.4784
Variance = 78606.1
C.V. = 6.164856
97th percentile daily values = 266.605
97th percentile 4 day average = 251.118
97th percentile 30 day average = 141.762
< Q.L. = 0
Model used = lognormal

A limit is needed based on Chronic Toxicity
Maximum Daily Limit = 57.6444980410129
Average Weekly limit = 57.6444980410129
Average Monthly Limit = 57.6444980410129

The data are:

1
1
1
1
1
1
20
4
50
50
50
50
50
50
1
50

The chronic toxicity data for reproduction are entered above in chronic toxicity units (TU_C), which are calculated by dividing 100 by the NOEC. Example: For a NOEC of 100%, TU_C equals 100 ÷ 100% = 1.

The permit limitation is derived as follows from the limit indicated above:

Calculate NOEC of indicated limit: 100 ÷ 57.64 = 1.74%, which is rounded to 2%.

Calculate TU_C of NOEC of 2%: 100 ÷ 2% = 50 TU_C

Attachment 10

NPDES Permit Rating Work Sheet

NPDES PERMIT RATING WORK SHEET

☐ Regular Addition
☐ Discretionary Addition
☐ Score change, but no status change
☐ Deletion

NPDES NO. VA0004146

Facility Name: Dominion Chesterfield Power Station

City: Chesterfield County

Receiving Water: James River/Farrar Gut

Reach Number: _____

Is this facility a steam electric power plant (SIC=4911) with one or more of the following characteristics? 1. Power output 500 MW or greater (not using a cooling pond/lake) 2. A nuclear power plant 3. Cooling water discharge greater than 25% of the receiving stream's 7Q10 flow rate ☒ YES; score is 600 (stop here) ☐ NO (continue)		*Is this permit for a municipal separate storm sewer serving a population greater than 100,000?* ☐ YES; score is 700 (stop here) ☐ NO (continue)

FACTOR 1: Toxic Pollutant Potential

PCS SIC Code: _____ Primary SIC Code: _____ Other SIC Codes: _____
Industrial Subcategory Code: _____ (Code 000 if no subcategory)

Determine the Toxicity potential from Appendix A. Be sure to use the TOTAL toxicity potential column and check one)

Toxicity Group	Code	Points	Toxicity Group	Code	Points	Toxicity Group	Code	Points
☐ No process waste streams	0	0	☐ 3.	3	15	☐ 7.	7	35
☐ 1.	1	5	☐ 4.	4	20	☐ 8.	8	40
☐ 2.	2	10	☐ 5.	5	25	☐ 9.	9	45
			☐ 6.	6	30	☐ 10.	10	50

Code Number Checked: _____

Total Points Factor 1: _____

FACTOR 2: Flow/Stream Flow Volume (*Complete either Section A or Section B; check only one)*

Section A ? Wastewater Flow Only Considered

Wastewater Type (See Instructions)		Code	Points
Type I: Flow < 5 MGD	☐	11	0
Flow 5 to 10 MGD	☐	12	10
Flow > 10 to 50 MGD	☐	13	20
Flow > 50 MGD	☐	14	30
Type II: Flow < 1 MGD	☐	21	10
Flow 1 to 5 MGD	☐	22	20
Flow > 5 to 10 MGD	☐	23	30
Flow > 10 MGD	☐	24	50
Type III: Flow < 1 MGD	☐	31	0
Flow 1 to 5 MGD	☐	32	10
Flow > 5 to 10 MGD	☐	33	20
Flow > 10 MGD	☐	34	30

Section B ? Wastewater and Stream Flow Considered

Wastewater Type (See Instructions)	Percent of instream Wastewater Concentration at Receiving Stream Low Flow		Code	Points
Type I/III:	< 10 %	☐	41	0
	10 % to < 50 %	☐	42	10
	> 50 %	☐	43	20
Type II:	< 10 %	☐	51	0
	10 % to <50 %	☐	52	20
	> 50 %	☐	53	30

Code Checked from Section A or B: _____

Total Points Factor 2: _____

FACTOR 3: Conventional Pollutants

(only when limited by the permit)

A. Oxygen Demanding Pollutant: (check one) ☐ BOD ☐ COD ☐ Other:_____

			Code	Points
Permit Limits: (check one)	☐	< 100 lbs/day	1	0
	☐	100 to 1000 lbs/day	2	5
	☐	> 1000 to 3000 lbs/day	3	15
	☐	> 3000 lbs/day	4	20

Code Checked: ___

Points Scored:_____

B. Total Suspended Solids (TSS)

			Code	Points
Permit Limits: (check one)	☐	< 100 lbs/day	1	0
	☐	100 to 1000 lbs/day	2	5
	☐	> 1000 to 5000 lbs/day	3	15
	☐	> 5000 lbs/day	4	20

Code Checked: _____

Points Scored: _____

C. Nitrogen Pollutant: (check one) ☐ Ammonia ☐ Other: _____

		Nitrogen Equivalent	*Code*	*Points*
Permit Limits: (check one)	☐	< 300 lbs/day	1	0
	☐	300 to 1000 lbs/day	2	5
	☐	> 1000 to 3000 lbs/day	3	15
	☐	> 3000 lbs/day	4	20

Code Checked: _____

Points Scored:_____

Total Points Factor 3: _____

FACTOR 4: Public Health Impact

Is there a public drinking water supply located within 50 miles downstream of the effluent discharge (this includes any body of water to which the receiving water is a tributary)? A public drinking water supply may include infiltration galleries, or other methods of conveyance that ultimately get water from the above referenced supply.

☐ YES (If yes, check toxicity potential number below)

☐ NO (If no, go to Factor 5)

Determine the *human health* toxicity potential from Appendix A. Use the same SIC code and subcategory reference as in Factor 1. (Be sure to use the human health toxicity group column ? check one below)

Toxicity Group	Code	Points	Toxicity Group	Code	Points	Toxicity Group	Code	Points
☐ No process waste streams	0	0	☐ 3.	3	0	☐ 7.	7	15
☐ 1.	1	0	☐ 4.	4	0	☐ 8.	8	20
☐ 2.	2	0	☐ 5.	5	5	☐ 9.	9	25
			☐ 6.	6	10	☐ 10.	10	30

Code Number Checked: _____

Total Points Factor 4:_____

FACTOR 5: Water Quality Factors

A. *Is (or will) one or more of the effluent discharge limits based on water quality factors of the receiving stream (rather than technology-based federal effluent guidelines, or technology-based state effluent guidelines), or has a wasteload allocation been assigned to the discharge:*

		Code	Points
☐	Yes	1	10
☐	No	2	0

B. *Is the receiving water in compliance with applicable water quality standards for pollutants that are water quality limited in the permit?*

		Code	Points
☐	Yes	1	0
☐	No	2	5

C. *Does the effluent discharged from this facility exhibit the reasonable potential to violate water quality standards due to wh ole effluent toxicity?*

		Code	Points
☐	Yes	1	10
☐	No	2	0

Code Number Checked: A __ B __ C __

Points Factor 5: A __ + B __ + C __ = ___ TOTAL

FACTOR 6: Proximity to Near Coastal Waters

A. *Base Score: Enter flow code here (from Factor 2):___*

Enter the multiplication factor that corresponds to the flow code: ___

Check appropriate facility HPRI Code (from PCS):

	HPRI#	*Code*	*HPRI Score*
☐	1	1	20
☐	2	2	0
☐	3	3	30
☐	4	4	0
☐	5	5	20

HPRI code checked: ___

Flow Code	*Multiplication Factor*
11, 31, or 41	0.00
12, 32, or 42	0.05
13, 33, or 43	0.10
14 or 34	0.15
21 or 51	0.10
22 or 52	0.30
23 or 53	0.60
24	1.00

Base Score: (HPRI Score) ____ X (Multiplication Factor) ____ = ____ (TOTAL POINTS)

B. *Additional Points* ☐ *NEP Program*
For a facility that has an HPRI code of 3, does the facility discharge to one of the estuaries enrolled in the National Estuary Protection (NEP) program (see instructions) or the Chesapeake Bay?

	Code	Points
☐ Yes	1	10
☐ No	2	0

C. *Additional Points* ☐ *Great Lakes Area of Concern*
For a facility that has an HPRI code of 5, does the facility discharge any of the pollutants of concern into one of the Great Lakes' 31 areas of concern (see Instructions)

	Code	Points
☐ Yes	1	10
☐ No	2	0

Code Number Checked: A __ B __ C __

Points Factor 6: A __ + B __ + C __ = ___ TOTAL

SCORE SUMMARY

Factor	Description	Total Points
1	Toxic Pollutant Potential	____
2	Flows/Streamflow Volume	____
3	Conventional Pollutants	____
4	Public Health Impacts	____
5	Water Quality Factors	____
6	Proximity to Near Coastal Waters	____
	TOTAL (Factors 1 through 6)	____

S1. Is the total score equal to or greater than 80? ☒ Yes (Facility is a major) ☐ No

S2. If the answer to the above questions is no, would you like this facility to be discretionary major?

☐ No

☐ Yes (Add 500 points to the above score and provide reason below:

Reason:

NEW SCORE: _____

OLD SCORE: _____

Emilee C. Adamson
Permit Reviewer's Name

(804) 527-5072
Phone Number

8.24.12
Date

Attachment 11

Site Visit Memo

MEMORANDUM

DEPARTMENT OF ENVIRONMENTAL QUALITY
Piedmont Regional Office

4949-A Cox Road **Glen Allen, VA 23060** **804/527-5020**

SUBJECT: Dominion Virginia Power – Chesterfield Power Station
Site Visit Report

DATE: December 21, 2009

Ray Jenkins, Tamira Cohen and I performed an announced site visit on December 16, 2009 at Dominion's Chesterfield Power Station. The Dominion representatives present were Dawn Garber, Ken Roller, Rick Woolard, Amelia Boschen, and Carissa Agnese.

We planned the site visit to incorporate both the VPDES IP and the Industrial Storm Water GP. This memo will focus on the IP aspects of the facility as the ISWGP is handled separately by Tamira Cohen.

The Chesterfield Power Station generates electricity using steam produced by the combustion of coal, natural gas and fuel oil. The Station has a generating capacity of 1750 megawatts (maximum dependable capacity of 1631 megawatts in the summer and 1731 megawatts in the winter).

Outfalls 001, 002 and 003 are all non-contact cooling water discharges of 211 MGD, 89 MGD and 757 MGD (maximums), respectively. Outfalls 001 and 002 discharge to the main stem of the James River. Outfall 003 discharges to the head of Farrar Gut. Outfall 001 discharges cooling water from Units 7 and 8, which are combined cycle gas turbines. Outfall 002 discharges cooling water from Unit 3, and Outfall 003 discharges cooling water from Units 4, 5, and 6. Units 3 through 6 are pulverized coal boilers, and represent the majority of electricity generation.

Outfall 004 is the discharge from the old ash pond to the head of Farrar Gut. Process wastewater throughout the station (including WTP effluent, FGD WWTP effluent, boiler blowdown, etc) is routed through the master sump and ultimately discharges to the old ash pond. Wet fly ash is sluiced directly to the old ash pond and pretreated wastewater from the metals pond is discharged directly to the old ash pond. Several of the influent waste streams are pretreated individually. The master sump initially discharges to the master sump pond, which provides for settling and O&G removal through a series of booms. The master sump pond discharges to the old ash pond.

Outfall 005 is the discharge from the new ash pond or Upper (East) Ash Pond to Farrar Gut at a point approximately 0.4 mile upstream from Farrar Gut's confluence with the James River. The new ash pond is currently used to dispose of dewatered ash from the old ash pond. The use of the new pond is addressed in the "Revised Closure Plan, Upper (East) Ash Pond, Chesterfield Power Station, Chesterfield County, Virginia" dated September 2003 and approved by the staff of the DEQ by letter dated September 12, 2003. The discharge at Outfall 005 consists of runoff from the disposed ash after treatment in a large sedimentation pond that was constructed at the eastern end of the pond. This pond typically discharges only 2-3 months out of the year for less than 4 consecutive days.

The site visit involved a general overview of the industrial process and a more in depth review of the installed air and water pollution control technology. The industrial activity as described above is primarily related to coal fired power generation. Coal is transported in on rail and stored in delineated piles according to sulfur content. Storm water drainage from the coal pile is directed to the old ash pond, and subsequently discharged through Outfall 004. Number 2 fuel oil for the combined cycle turbines is delivered by barge and stored in an 11 million gallon above ground storage tank with secondary containment. Above ground petroleum storage tanks are managed by the LUST/AST program.

Burning coal generates air pollutants (primarily NOx and SO_2) and ash (bottom ash and fly ash), both of which are managed in an effort to protect the environment. Bottom ash is collected from the bottom of the boilers and either reused in aggregates or land-filled. Fly ash is entrained in the flue gas and collected primarily through vacuum bags, which capture the vast majority of fly ash. Additional fly ash is inadvertently captured during the SCR process. After collection, wet ash is sluiced to the old ash pond, where sedimentation occurs. The wet ash is actively dredged from the inlet channel to the old ash pond, allowed to dewater, and then trucked to the new ash pond for disposal.

NOx and SO_2 are addressed by installed treatment systems: selective catalytic reduction (SCR) and Flue Gas Desulfurization (FGD). The SCR is a means of converting nitrogen oxides (NOx) with the aid of a catalyst and reductant (aqueous ammonia) into diatomic nitrogen and water. Aqueous ammonia is injected into flue gas, before the gas passes through the catalyst chamber where 70-95% of the NOx is converted. An unintended byproduct of this process is additional fly ash capture from the flue gas. The ash from the SCR is directed to the old ash pond.

The FGD system (currently operating for Unit 6) removes sulfur dioxide by injecting lime slurry into flue gas. Calcium carbonate reacts with sulfur dioxide to form calcium sulfite (gypsum) and carbon dioxide. Lime is delivered to the site via barge, transported by conveyer and stored under cover. Limestone is pulverized in a ball mill and blended with treated effluent from Proctor's Creek WWTP to create a lime slurry. The slurry is then injected into the absorber with a constant recycle that generates a continuous slurry shower. Efficiency of Sulfur dioxide removal is compromised as the density of the slurry increases. So, at a prescribed density range, the slurry is wasted to hydroclones that dewater the slurry to 50% water content. Further dewatering is achieved with the vacuum filter drying belt, which reduces the water content to below 10%. The resultant solid is gypsum that can be sold for beneficial use. Gypsum is stored under cover and transported to the customer (currently USG) by barge. The wastewater that is drawn off at each stage is captured and recycled back as make-up water for the lime slurry. Gypsum quality is affected by chloride concentration; therefore, at high chloride concentrations the wastewater goes through a secondary hydroclone to purge chloride saturated water and still recycle the cleaner water back as make-up. FGD units are expected to achieve approximately 97% reduction in sulfur dioxide emissions, and they generate nearly twice as much gypsum as the lime that feeds the process. Chesterfield's FGD treatment system is a state of the art and highly automated process. The process is closely monitored via computer integrated remote sensing and manual sampling to keep it in operation. Chesterfield will not bypass the FGD system. Consequently, FGD operation is critical to keeping the power generating units online, and the system is managed accordingly.

The FGD waste stream is purged to the FGD wastewater treatment plant where the wastewater is pretreated before being discharged to the master sump, which discharges to the master sump pond, then to the old ash pond and ultimately Outfall 004. The wastewater treatment is a batched process based on FGD operation. The wastewater plant is currently operating at approximately 12 hour intervals. The treatment plant consists of wastewater equalization, pH elevation, gypsum desaturation, heavy metal precipitation, coagulation, flocculation, clarification, ph adjustment, and sludge dewatering. Dewatered sludge is land-filled or beneficially used in aggregates. The wastewater treatment is achieved through chemical addition. All chemicals are accounted for on

the VPDES Reissuance application and appeared to be stored under cover and with secondary containment where necessary.

Boiler water must be exceptionally clean to protect the turbines and maintain efficiency; consequently, county water is treated onsite through filtration, reverse osmosis, and demineralization. Wastewater from the water treatment plant is directed to the old ash pond. The purified water is then used in the boilers to generate the steam that turns the turbines. Thereafter, the steam is run through condensers that use non contact cooling water, where the steam condenses and is recycled back through the boiler. The cooling water used in the condenser is drawn from the James River through 6 intakes. Each cooling water intake is equipped with a bar screen to remove debris and a travelling screen to remove smaller material (including entrained fish). The travelling screen is continually backwashed with untreated river water. These backwashes are discharged directly to the river (Outfalls 006 through 011 in the 2004 permit). Sodium hypochlorite is injected as a biocide in the cooling water before it enters the condenser. An intensive re-plumbing project was undertaken during the 2004 permit cycle in order to relocate the chlorine injection points downstream of where screen backwash water is pulled off of the cooling water headers. During the site visit, we observed several of the relocated injection points. In recent months, the facility has been adding sawdust to the intake for Unit 5 in order to plug minor leaks in the condenser tubing for that Unit. Bob Booterbaugh met us at the sawdust addition location to explain the process and answer any questions. The sawdust method is a standard procedure used to address minor pinhole leaks. Staff is planning condenser maintenance and re-tubing in 2011.

On the day of our visit, the Power Station was operating at full capacity with all six boilers on line. The site is under an ongoing construction project to build a second FGD system to service Units 3, 4, and 5. The projected completion date is in 2011. Construction aside, the station appeared to be operating as normal. Standard housekeeping was well-attended, especially given the active construction. The visit included the following: a brief walk through the power station and master sump area, barge area, water intakes (screen backwashes), reuse intake (screen backwash), sawdust addition procedure, SCR process, FGD process, FGD wastewater treatment system, metals treatment pond, upper and lower ash ponds, ground water monitoring well locations, recovery wells and toe drains for the new ash pond, process water outfalls (001-005) and SW outfalls (001-008, 009-017). No obvious stream impacts were observed at any of the outfalls. Ash pond management seemed to be progressing in accordance with the closure plan for the new pond. The facility appears to be in compliance with its VPDES individual permit and the staff has no recommendations at this time.

/ecc

Attachment 12

Proposed Conceptual Engineering Report Permit Language

SECTION E

Proposed Conceptual Engineering Report Permit Language

Other Requirements and Special Conditions

Commencing with the use of mechanical methods to draw down surface water from the Lower Ash Pond and the Upper Ash Pond sediment basin for the purposes of closure, all water from the decanting/dewatering process shall be treated prior to discharge. Any such discharge that exceeds one or more of the following trigger concentrations, as determined by inline process sampling, shall be routed through enhanced treatment prior to discharge:

Parameter:	Enhanced Treatment Trigger (ug/L):
Arsenic	100
Selenium	5.0
Lead	7.4
Copper	6.0
Antimony	640
Thallium	0.47

For purposes of inline process sampling, samples will be collected every 4 hours at an in-process point immediately prior to the enhanced treatment module(s), and analytical results will be returned within approximately one (1) hour after collection. This sampling is in addition to the effluent compliance monitoring required by this permit. The permittee shall maintain a log with the inline process sampling results and the times that enhanced treatment begins and ends. The log shall be available to DEQ upon request.

Prior to constructing the Centralized Source Water Treatment System (CSWTS), the permittee shall submit a final Conceptual Engineering Report (CER) to DEQ. The CER shall describe each module in the treatment and enhanced treatment process. DEQ approval shall be secured prior to constructing the CSWTS. The permittee shall construct the CSWTS in accordance with the approved CER. No later than 14 days following completion of construction of any project for which a CER has been approved, written notification shall be submitted to the DEQ-Piedmont Regional Office certifying that, based on an inspection of the project, construction was completed in accordance with the approved CER. The written notification shall be certified by a professional engineer licensed in the Commonwealth of Virginia or signed in accordance with Part II.K of this permit. The installed CSWTS shall be operated to achieve design treatment and effluent concentrations. Approval by DEQ does not relieve the owner of the responsibility for the correction of design and/or operational deficiencies. Noncompliance with the CER shall be deemed a violation of this permit.

Attachment 13

Draft Owner Comments and DEQ Responses

Dominion Resource Services, Inc.
5000 Dominion Boulevard, Glen Allen, VA 23060
dom.com

May 31, 2016

VIA EMAIL

Emilee Adamson
Virginia Department of Environmental Quality
Piedmont Regional Office
4949-A Cox Road
Glen Allen, VA 23060

RE: Dominion – Chesterfield Power Station
Comments on Draft VPDES Permit No. VA0004146

Dear Ms. Adamson,

Enclosed are Dominion's comments on the draft VPDES permit for the subject facility. We appreciate the opportunity to provide these comments and look forward to working with you during the remainder of the permitting process.

Should you have any questions or require additional information, please contact Ken Roller at 804-273-3494 or kenneth.roller@dom.com.

Sincerely,

Paula A. Hamel
Director, Generation Environmental Services

Attachments

Owner Comments & DEQ Responses on the Draft VPDES Permit for Dominion's Chesterfield Power Station VPDES Permit No. VA0004146		
Section	**Dominion Comment**	**DEQ Response**
	Draft Permit	
I.A.1.c	A new condition has been included that requires that effluent samples from Outfall 001 be collected after dechlorination. Dominion requests that this condition be reworded to require collection of the samples downstream from the point of dechlorination.	Accepted for clarification.
I.A.2	The narrative at the top of this condition requires that monitoring and limitations on this discharge last "until complete closure of both [ash ponds]". Dominion requests that this narrative be rewritten as follows: "During the period beginning with the commencement of drawdown at the Upper Ash Pond (UAP) or Lower Ash Pond (LAP), whichever occurs first, and lasting until ~~complete closure of both~~ completion of dewatering activities, or the permit's expiration date, whichever occurs sooner, the permittee is authorized to discharge from outfall serial number 101 – UAP and LAP Effluent – Closure (process wastewater from dewatering activities in the UAP and LAP). Any process wastewater mechanically removed from the UAP and LAP for purpose of closure is defined as process wastewater from dewatering activities."	Language regarding the completion of dewatering was incorporated in the draft. Language was also added to better define Closure in Part I.C.24 and a reference included in Part I.A.2.
I.A.2	We question the need to include Dissolved Oxygen and TOC monitoring and limits on the dewatering discharge and request that these parameters be removed from the permit.	Denied; all parameters from the current discharge of Outfalls 004 and 005 were carried over to the dewatering discharge. Outfall 004 included monitoring for Dissolved Oxygen and a limitation for TOC; therefore, they are carried forward to the discharge through Outfall 101.
I.A.2	The permit requires 24-hour composite samples for the CCR parameters with 3 per Week sampling requirements. There is also a requirement that the samples be collected at least 48-hours apart. Dominion requests that the sample type for these parameters be changed to 4-hour composite for consistency with our other permits with dewatering discharges.	Accepted to be consistent with other permits addressing pond closure discharges.

Owner Comments & DEQ Responses on the Draft VPDES Permit for Dominion's Chesterfield Power Station VPDES Permit No. VA0004146		
Section	**Dominion Comment**	**DEQ Response**
I.A.2	In the definition of "3 per Week" it says that the "permittee shall receive results for parameters identified with a monitoring frequency of '3 per Week' within four business days of taking the sample." To make this condition consistent with the Possum Point and Bremo Permits, Dominion requests that this sentence be rewritten as follows: "The permittee shall contract to receive results for parameters identified with a monitoring frequency of 3 per Week within four business days of taking the samples."	Denied; the permit language is clear as is.
I.A.2	Dominion requests that the requirement to report loading (kg/d) for TSS, O&G (i.e., NL) be changed to NA. We question the need to report loading for these parameters.	Accepted; reporting for loading is not necessary and does not present new information.
I.A.2	Dominion requests that the requirement for annual monitoring of TPH be removed from the permit. TPH is not a parameter of concern for this discharge.	Denied; all parameters from the current discharge of the LAP and UAP were carried over to the dewatering discharge. Outfall 004 (LAP) included monitoring for TPH; therefore, it is carried forward to the discharge through Outfall 101.
I.A.3	Footnote (4): The word "temperature" should be included after "discharge" and before "shall" in the first sentence.	Accepted for clarification.
I.A.3.c	A new condition has been added that requires effluent samples from Outfall 002 be collected after dechlorination. Dominion requests that this condition be reworded to require collection of the samples downstream from the point of dechlorination.	Accepted for clarification
I.A.4	The narrative at the top of this condition requires that monitoring and limitations on this discharge last "until complete closure of both [ash ponds]". Dominion requests that this narrative be rewritten as follows: "During the period beginning with the commencement of drawdown at the Upper Ash Pond (UAP) or Lower Ash Pond (LAP), whichever occurs first, and lasting until ~~complete closure of both~~ completion of dewatering activities, or the permit's expiration date, whichever occurs sooner, the permittee is authorized to discharge	Outfall 201 has been removed from the permit. The discharge from the CSWTS (LAP and UAP dewatering treatment) will now be designated solely as Outfall 101 and is authorized to discharge through either Outfall 001 or 002.

Owner Comments & DEQ Responses on the Draft VPDES Permit for Dominion's Chesterfield Power Station VPDES Permit No. VA0004146		
Section	**Dominion Comment**	**DEQ Response**
	from outfall serial number 101 – UAP and LAP Effluent – Closure (process wastewater from dewatering activities in the UAP and LAP). Any process wastewater mechanically removed from the UAP and LAP for purpose of closure is defined as process wastewater from dewatering activities."	
I.A.4	In the definition of "3 per Week" it says that the "permittee shall receive results for parameters identified with a monitoring frequency of '3 per Week' within four business days of taking the sample." To make this condition consistent with the Possum Point and Bremo Permits, Dominion requests that this sentence be rewritten as follows: "The permittee shall contract to receive results for parameters identified with a monitoring frequency of 3 per Week within four business days of taking the samples."	Outfall 201 has been removed from the permit. The discharge from the CSWTS (LAP and UAP dewatering treatment) will now be designated solely as Outfall 101 and is authorized to discharge through either Outfall 001 or 002.
I.A.4	The permit requires 24-hour composite samples for the CCR parameters with 3 per Week sampling requirements. There is also a requirement that the samples be collected at least 48-hours apart. Dominion requests that the sample type for these parameters be changed to 4-hour composite for consistency with our other permits with dewatering discharges.	Outfall 201 has been removed from the permit. The discharge from the CSWTS (LAP and UAP dewatering treatment) will now be designated solely as Outfall 101 and is authorized to discharge through either Outfall 001 or 002.
I.A.4	Dominion requests that the requirement for annual monitoring of TPH be removed from the permit. TPH is not a parameter of concern for this discharge.	Outfall 201 has been removed from the permit. The discharge from the CSWTS (LAP and UAP dewatering treatment) will now be designated solely as Outfall 101 and is authorized to discharge through either Outfall 001 or 002.
I.A.4	Dominion requests that the requirement to report loading (kg/d) for TSS and O&G be changed to NA consistent with I.A.2 above. We question the need to report loading for these parameters.	Outfall 201 has been removed from the permit. The discharge from the CSWTS (LAP and UAP dewatering treatment) will now be designated solely as Outfall 101 and is authorized to discharge through either Outfall 001 or 002.

Owner Comments & DEQ Responses on the Draft VPDES Permit for Dominion's Chesterfield Power Station VPDES Permit No. VA0004146		
Section	**Dominion Comment**	**DEQ Response**
I.A.5.c	A new condition has been included that requires effluent samples from Outfall 003 be collected after dechlorination. Dominion requests that this condition be reworded to require collection of the samples downstream from the point of dechlorination.	Accepted for clarification.
I.A.6	A maximum daily TSS limit of 50 mg/L has been included on this discharge for the life of the permit. Dominion requests that 50 mg/L be included as an interim limit that remains effective until the commencement of discharge from the Coal Pile Runoff Metals Treatment System (Outfall 305), at which time the final Low Volume Waste ELG TSS limit of 100 mg/L would become effective as the final TSS limit on Outfall 301.	Denied; a TSS limit of 50 mg/L will be included for the discharge from Outfall 305 (Coal Pile Runoff Metals Treatment System) and Outfall 301 (LVWWTP).
I.A.6	A limit for Heptachlor has been included (0.015 ug/L) for the Outfall 301 discharge. Heptachlor was reported by our contract laboratory as present in samples collected from two wastestreams: FGD Plant (0.1 ug/L) and FGD Yard Sump (0.092 ug/L). Dominion has re-evalated the reports of these analyses and believes that there is sufficient reason to question the validity of the results. First, the use of heptachlor has been banned since the 1980's and is not present in any products used at the Chesterfield Power Station. In addition, there was some issue with cleanup and extraction of the sample. On page 3 of the report, the lab states under ORGANIC PREP 3510C: During the extraction the sample formed a precipitate, and turned the solvent bright purple. A large amount of precipitate formed during the extraction. This indicates that the extraction may contain co-extracted matter that may cause falsely high results. Further, the method requires that any detected compound be verified by a confirmation column/detector. The results for both Heptachlor and Heptachlor epoxide are qualified "P", indicating the confirmation column/detector results did not sufficiently match the original results. Finally, two of the surrogates	Accepted; DEQ recognizes that the validity of the initial analysis results is in question. Given the fact that additional data has been provided indicating that the pollutant is absent and is not used at the site, the limitation has been removed. However, heptachlor will be monitored in this permit on a semi-annual (1 per 6 month) basis in order to ensure its absence.

Owner Comments & DEQ Responses on the Draft VPDES Permit for Dominion's Chesterfield Power Station VPDES Permit No. VA0004146		
Section	**Dominion Comment**	**DEQ Response**
	listed were also qualified on this analysis. One compound was qualified as "outside control limits" and the other had the previously mentioned P qualifier. These surrogate results further indicate that there was likely an issue with the extraction and the results are questionable. Given the above, Dominion believes that there is sufficient reason to question the validity of the heptachlor concentrations reported by our lab. Consequently, we request that DEQ remove the limit for this parameter and replace it with a monitoring requirement.	
I.A.6.(2)	Footnote (2) states that no discharge of fly ash or bottom ash transport water is permitted from this outfall. The definition of Transport Water, presented in Appendix A of the preamble to the ELG rule, contains the following sentence excluding certain wastewater sources from the definition: "Transport water does not include low volume, short duration discharges of wastewater from minor leaks (*e.g.,* leaks from valve packing, pipe flanges, or piping) or minor maintenance events (*e.g.,* replacement of valves or pipe sections)." Dominion requests that this clarification sentence be added to the end of Footnote (2).	Accepted for clarification.
I.A.6	The nutrient loadings associated with the UAP and LAP are monitored under the station's Nutrient General Permit. These loadings will eventually be transferred to the LVWWTS. Consequently, Dominion requests that this be recognized in a new condition similar to that included on Outfalls 101 and 201 as follows: "This facility has Total Nitrogen and Total Phosphorus calendar year load limits associated with <u>wastestreams that will be relocated to</u> this outfall and are included in the current Registration List under Registration Number VAN040086, enforceable under the General VPDES Watershed Permit Regulation for Total Nitrogen and Total Phosphorus Discharges and Nutrient Trading in the Chesapeake Watershed in Virginia."	Accepted for clarification.

Owner Comments & DEQ Responses on the Draft VPDES Permit for Dominion's Chesterfield Power Station VPDES Permit No. VA0004146		
Section	**Dominion Comment**	**DEQ Response**
I.A.7	Dominion requests that the monitoring frequencies for all parameters be reduced to 1 per Month from 1 per Week.	Denied; this is a new discharge and 1 per week monitoring is appropriate at this time.
I.A.7	Dominion requests that the last two sentences in the definition of 2G/24-HC be deleted. This will allow for more flexibility in collection of the samples while still providing a minimum of eight hours between the two samples.	Accepted.
I.A.9	Dominion requests that the monitoring frequencies for all parameters be reduced to 1 per Month from 1 per Week.	Denied; this is a new discharge and 1 per week monitoring is appropriate at this time.
I.A.9	Dominion requests that the Sample Type for flow be changed from "Calculated" to "Estimated" consistent with Outfall 302/402.	Denied; the sample type for Flow has been revised to "Calculated" for Outfalls 302 and 402.
I.A.10	Dominion requests that the monitoring frequencies for flow and TSS be reduced to 1 per Month from 1 per Week.	Denied; this is a new discharge and 1 per week monitoring is appropriate at this time. Flow has been revised to 1 per Day.
I.A.10	Dominion requests that the Sample Type for flow be changed from "Calculated" to "Estimated" consistent with Outfall 302/402.	Denied; the sample type for Flow has been revised to "Calculated" for Outfalls 302 and 402.
I.A.11	DEQ has included interim and final effluent limits for ammonia, thallium, and selenium on the LAP discharge Outfall 004 Pre-Drawdown. The final limits are extremely restrictive and were developed assuming no mixing zone. A four-year compliance schedule to meet the new limits has been included in Special Condition I.B.4. Similarly, a new WET limit of 1.36 has been included on Outfall 004. This new WET limit is much more restrictive than the existing WET limit of 50 TUc and, like the new chemical-specific limits, is based on an assumption of no mixing zone; however, unlike the chemical-specific limits no schedule of compliance is allowed for the new WET limit. Dominion requests a four-year compliance schedule for the new WET limit and requests interim limits and monitoring consistent with existing requirements.	Accepted; chronic WET limits have been included in the compliance schedule in Part I.B.4 of the permit.
I.A.13	Dominion requests that the Daily Maximum Final Limit for Nitrate/Nitrite be changed to 17 from 17.0 to make it consistent with	Accepted; the trailing zero was included in error.

Owner Comments & DEQ Responses on the Draft VPDES Permit for Dominion's Chesterfield Power Station VPDES Permit No. VA0004146		
Section	**Dominion Comment**	**DEQ Response**
	other limitations on Outfall 402 and Outfall 302.	
I.A.13	Dominion requests that the last two sentences in the definition of 2G/24-HC be deleted. This will allow for more flexibility in collection of the samples while still providing a minimum of eight hours between the two samples.	Accepted.
I.A.14	Dominion requests that the requirement to report loading (kg/d) for Oil and Grease and TSS be changed to NA. We question the need to report loading for these parameters.	Accepted; reporting for loading is not necessary and does not present new information.
I.B.1, 2, 3 and 4	Compliance schedules. Please include the outfall designations and descriptions (i.e., Outfall 301 – LVWWTS) to which each compliance schedule refers.	Accepted.
I.B.3	Dominion requests a four-year schedule to come into compliance with the TSS, As, Hg, and O&G limits on Outfall 304. This schedule is consistent with the compliance schedules for the new Coal Pile Runoff Metals Treatment System and for the LVWWTS Outfall 301. A four-year schedule will allow Dominion time to fully design, construct, test, and commission the treatment system with consideration for its integration into the new LVWWTS. It should be noted that actual leachate generation from the FFCP Management Facility is not anticipated during the first 11 to 12 months after issuance of the permit. In addition, we request that the following sentence be added to the end of the last paragraph in condition I.B.3: "In the event the leachate is directed to the FGD WWTP for treatment and discharge through Outfall 302 as allowed in Part I.A.7.b, this compliance schedule would not apply and the discharge would be subject to the compliance schedule in I.B.2."	Following receipt of the gantt chart for the proposed design, construction and commission of this treatment facility, the Department agrees that a 4 year schedule of compliance is appropriate for this discharge.
I.B.4	This section contains the compliance schedule for Outfall 004 (existing LAP discharge) to come into compliance with the new WQBELs.	Accepted.

Owner Comments & DEQ Responses on the Draft VPDES Permit for Dominion's Chesterfield Power Station VPDES Permit No. VA0004146		
Section	**Dominion Comment**	**DEQ Response**
	Dominion requests that the new chronic WET limit be incorporated into this section.	
I.C.5	Operations and Maintenance Manual Requirement: The opening paragraph to this condition requires that Dominion maintain an O&M Manual for the treatment works that is in accordance with Sewage Collection and Treatment Regulations. The Chesterfield Power Station does not operate a sewage treatment plant and requests that this requirement be removed from the permit.	Accepted; this language was included in error.
I.C.10	Low Level PCB Sampling for Internal Outfall 301: This condition requires that we collect two samples from Outfall 301 for low level PCB analyses. The requirements for the analyses are similar to other Dominion permits; however, Outfall 301 may not be fully compliant with final effluent limits until four years following the effective date of the permit. Part I.C.10.d requires that the data be submitted to DEQ no later than one year from the effective date of the permit, which will not be possible. Dominion requests that this condition be removed from this permit.	Denied; PCB sampling is required to inform the TMDL. The condition has been revised to require reporting of the data within one year of the commencement of discharge from this outfall.
I.C.12	Dominion requests that DEQ include two additional uncontaminated river water discharges: 1) raw water make-up to the clarifier and (2) service water (untreated river water) that is used for fly ash conditioning.	Accepted; these discharges have been included with language clarifying that they are considered uncontaminated prior to their use in the clarifier and for fly ash conditioning.
I.C.13	Units 7 & 8 do not burn coal. Dominion requests that this condition be removed from the permit.	Accepted; because fly ash transport water is not generated from Units 7 & 8, the Department agrees that this condition is unnecessary.
I.C.15.a	This section specifies quantification levels (QLs) that are to be achieved in analyses to determine compliance with the permit. The QLs included for ammonia, nitrate/nitrite and chloride, 0.05 mg/L, 0.25 mg/L and 0.05 mg/L, respectively, are well below those necessary to determine compliance with permit limitations. For example, the most restrictive proposed limit for nitrate/nitrite is 4.4	Accepted; the requested QLs are reasonable values that demonstrate compliance with the associated limitations.

Owner Comments & DEQ Responses on the Draft VPDES Permit for Dominion's Chesterfield Power Station VPDES Permit No. VA0004146		
Section	**Dominion Comment**	**DEQ Response**
	mg/L monthly average (final limit Outfall 302). Similarly, the most restrictive chloride limit is 360 mg/L monthly average (final limits Outfalls 101 and 201). With respect to ammonia, the most restrictive limit is 0.61 mg/L (final limit Outfall 004); however, this limit does not become effective until 4-years following the permit reissuance and the next most restrictive ammonia limit is the interim Outfall 004 limit of 13 mg/L monthly average. Consequently, Dominion requests that the QLs for nitrate/nitrite and chloride be changed to 0.5 mg/L and 10 mg/L, respectively. For ammonia, we request the QL be changed to 0.2 mg/L.	
I.C.17	Treatment Works Closure Plan: Dominion requests that this condition be modified to exclude the LAP and UAP closures, which will be closed under solid waste regulations, and the temporary dewatering treatment system (CSWTS).	Accepted for clarification.
I.C.18.b.(1)	Dominion requests that the following sentence be added at the end of this condition: "WET testing of Outfalls 101 and 201 shall begin during the first full month following the initiation of discharge."	Accepted for clarification.
I.C.18.b.(4)	It appears that the reference to I.C.18.g(5) in this condition should be to I.C.18.g(4).	Revised.
I.C.18.g.(4)	Dominion has requested that DEQ include interim and final WET limits on Outfall 004 consistent with the new WQBELs for chemical-specific parameters (see above). For consistency with this request, Dominion asks that DEQ modify condition I.C.18.g(3) to include the words "interim and final" after "WET" and before "limitations". It also appears that the reference to I.A.10 in this condition should be to conditions I.A.2 and I.A.4.	Accepted; the condition has been revised to reflect the interim limitations for Outfall 004.
I.C.22	The first paragraph of this condition says that treated wastewater "that exceeds one or more of the following trigger concentrations, as determined by inline process sampling, shall be routed through enhanced treatment (alumina adsorption, and weak acid cation	Accepted; treatment technology will be reviewed and approved through the CER during the permit term. We understand that committing to the specific technology at this time will not allow the flexibility needed to

Owner Comments & DEQ Responses on the Draft VPDES Permit for Dominion's Chesterfield Power Station VPDES Permit No. VA0004146		
Section	**Dominion Comment**	**DEQ Response**
	exchange) prior to discharge". Dominion has not selected the enhanced treatment that will be employed for use with the LAP and UAP closure discharges. Consequently, we request that the treatment technologies (alumina adsorption, and weak acid cation exchange) presented in this condition be removed. Alternatively, insertion of "for example, but not limited to" prior to the mentioned technologies would be acceptable.	respond to the treatment challenges and provide optimal treatment of the wastewater.
I.C.22	This condition contains the following requirement: "In addition to the DMR, the permittee shall submit a monthly summary report of the treated decanting/dewatering discharge no later than the 10th day of the month after monitoring takes place. The summary report shall contain the inline process sampling logs and the dates, times and durations that enhanced treatment was employed." Dominion requests that the last sentence in this condition be revised as follows: "The summary report shall contain the dates that enhanced treatment was turned on or off." This would align Chesterfield's requirements with those for Bremo and Possum Point.	Accepted; the language has been revised to require the dates and times that enhanced treatment is turned on and off. Per the condition the logs are required to be maintained and be made available to the Department upon request.
I.C.25	Ash Pond Closure Discharge. Dominion requests that the last sentence in this condition be changed to the following to better define the point for initiation of the ash pond closure discharge: "Drawdown is defined as the use of mechanical methods to remove surface water in the LAP and UAP sediment basin below the existing outfall structure for the purposes of closure."	This language has been clarified to better define the initiation of closure and drawdown. In response to information provided by the permittee, we have included measurements associated with the outfall structure. Intentional lowering of the elevation below those points will be considered drawdown and will trigger the closure conditions.
I.C.28	Dominion received DCR review of our drawdown slope stability evaluation and their recommendation for a drawdown rate of 2 feet per day. We request that this drawdown rate be included in the permit.	Accepted; 2' per day has been approved by DCR.
I.D.1	Condition I.D.1 provides "The permittee shall implement interim Best Technology Available (BTA) measures to minimize impingement and	Accepted; the former language was included in error.

Owner Comments & DEQ Responses on the Draft VPDES Permit for Dominion's Chesterfield Power Station VPDES Permit No. VA0004146		
Section	**Dominion Comment**	**DEQ Response**
	entrainment (I&E) mortality and adverse impacts. Each operating cooling water intake structure (CWIS) shall utilize a modified traveling screen, low-pressure screen wash system, and a fish return system in a manner that minimizes the impingement and entrainment (I&E) of aquatic species." This condition indicates that the facility currently utilizes "modified travelling screens" and a low-pressure screen wash system. The rationale for this condition (Page 27-28 of the Fact Sheet) references information provided to DEQ for the Surry Power Station. It appears that the permit condition is specific to the Surry Power Station and is not accurate for the Chesterfield Power Station. Dominion provided DEQ information on the existing CWISs and travelling screens at the Chesterfield Power Station in an April 29, 2015 submittal (Page 731-740 of the Fact Sheet Attachments in Attachment 7). Condition D.1 should be revised to reflect the CWIS at the Chesterfield Power Station. Suggested language is below: ""The permittee shall implement interim Best Technology Available (BTA) measures to minimize impingement and entrainment (I&E) mortality and adverse impacts. Each operating cooling water intake structure (CWIS) shall utilize a curtain wall, travelling screens, spray wash systems and debris return."	
Fact Sheet		
p.16	Under Outfalls 101 and 201: Dominion requests that the last sentence in this paragraph be reworded as follows to better clarify when the closure limitations will become effective and for consistency with the draft permit: "The closure effluent limitations become effective upon the use of mechanical methods to remove	We have made clarifications consistent with permit revisions.

Owner Comments & DEQ Responses on the Draft VPDES Permit for Dominion's Chesterfield Power Station VPDES Permit No. VA0004146		
Section	**Dominion Comment**	**DEQ Response**
	surface water in the LAP and UAP sediment basin below the existing outfall structure for the purposes of closure."	
p.17	On the fourth line of the first paragraph, it implies that the LAP toe drain has been historically treated by the LAP. The LAP toe drain has not yet been constructed.	Accepted.
p.18	pH, Total Suspended Solids (TSS), Oil and Grease (O&G): In this section the Federal Effluent Guidelines (FEGs) for TSS as applied to the LVWWTS are discussed. The FEG of 50 mg/L is being applied to Outfall 301 because the Coal Pile Runoff Treatment Facility will not be attaining compliance with the 50 mg/L TSS limit prior to operation of the LVWWTS. However, the Coal Pile Runoff Treatment Facility to reduce TSS concentrations will be operational on or before the date when the LVWWTS (Outfall 301) must comply with the associated WQBELs. Consequently, Dominion requests that the last sentence in this paragraph be rewritten as follows: "Therefore, the most stringent maximum TSS concentration limitation, 50 mg/L, is applied to Outfall 301 until such time as the new Coal Pile Runoff Treatment Facility commences operation."	Denied; see response above.
p.18	Heptachlor limit on Outfall 301: Dominion is requesting that the heptachlor limit be replaced with a monitoring only requirement given substantial uncertainty concerning the validity of the analytical results.	Accepted; see response above.
p.19	Middle of 4th paragraph is a discussion about the 2-year compliance schedule to meet the ELG limits on the leachate wastestream. This section also addresses the possibility of relocating the wastestream to the FGD WWTP. As stated above, Dominion requests a four year schedule to attain compliance with the ELG limits. We request that this section be revised to recognize the longer compliance schedule.	Accepted; see response above.
p.22	Item 19. Compliance schedule: Need to update this section relative to the compliance schedule for Outfall 002, which is no longer	Accepted; this language was included in error.

Owner Comments & DEQ Responses on the Draft VPDES Permit for Dominion's Chesterfield Power Station VPDES Permit No. VA0004146		
Section	**Dominion Comment**	**DEQ Response**
	applicable.	
p.23	Paragraph 3 discusses the landfill leachate and the 2-year compliance schedule. As discussed above, Dominion is requesting a 4-year compliance schedule for this discharge and, consequently, we request that this section be updated to recognize the 4-year schedule.	Accepted; see response above.
Fact Sheet Attachments		
p. 79	The construction sequence shown is obsolete and should be removed.	Revised; this document was included in error.
p.109	Dominion suggests removing "Attachment 5" from the top of this page as this section is located within Fact Sheet Attachment 4.	Revised for clarification.
p. 206	Outfall 002 Reasonable Potential analysis for copper. The chronic averaging period is shown as 30 days. This should be 4 days. The change should not affect the statistics and the results of the RP should stay the same.	Revised.
p. 209	We can't make out the parameter (possibly dissolved manganese) in the row just above sulfate. Need to expand the height of this row.	Revised.
p.253	Suggest rewriting footnote (1) in table to say "VAWQS <u>human health criteria</u> for these parameters…"	Revised for clarity.
p.283	This section describes the decision to use 2:1 acute and chronic dilution ratios for Outfalls 101 and 201 as follows: "Outfalls 101 and 201 discharge to Outfalls 001 and 002, respectively, which in turn discharge to the tidal James River. Because of the challenge in modeling tidal discharges, dilution ratios of 2:1 acute and 2:1 chronic were assumed." The use of 2:1 dilution ratio for chronic is considerably more restrictive than the 50:1 dilution that has historically been used. Dominion requests that this fact be specifically recognized in this section.	Language added.
p.283	This section states: "As previously stated, internal Outfalls 101 and 201 discharge to Outfalls 001 and 002. As such, background concentrations for 001 and 002 were applied to internal Outfalls 101	Revised for clarity.

Owner Comments & DEQ Responses on the Draft VPDES Permit for Dominion's Chesterfield Power Station VPDES Permit No. VA0004146		
Section	**Dominion Comment**	**DEQ Response**
	and 201." The limits for internal Outfalls 101 and 201 were developed as if they are direct discharges to the James River (i.e., no dilution by the cooling water is provided). Examination of the MSTRANTI spreadsheet for 101/102 shows that DEQ appropriately used the background concentrations for the James River that were also used to develop the WLAs for Outfalls 001 and 002. To clarify this, Dominion suggests rewriting the above sentence as follows: "Even though Outfalls 101 and 201 discharge to Outfalls 001 and 002, they are being permitted as if they are direct discharges to the James River (i.e., no dilution by either cooling water outfall is provided). As such, James River background concentrations were used in establishing the WLAs for Outfalls 101 and 201."	
p.908	There appears to be an email in this section from the U.S. Fish and Wildlife Service to DEQ that should probably be relocated to Attachment 16 – Other Agency Comments.	Removed; document included in error.

Bryan, Joseph (DEQ)

From: Kenneth Roller (Services - 6) <kenneth.roller@dom.com>
Sent: Friday, June 03, 2016 9:48 AM
To: Bryan, Joseph (DEQ); Adamson, Emilee (DEQ)
Subject: RE: Preliminary Revisions - Chesterfield Power Station draft Permit/FS
Attachments: 16E0834_2 AWS_ADR_STD_DL_LS 06 01 2016 1429.pdf

Emilee and Bryan,

We have only one additional comment on the permit. We request that condition I.C.16 be rewritten as follows to clarify that the CSWTS is excluded:

I.C.16 The LAP and UAP closures are excluded from the requirements of this special condition as they will be closed in accordance with solid waste regulations, and the temporary dewatering treatment system (CSWTS) discussed in Part I.C.21 is also excluded from the requirements of this special condition.

With respect to heptachlor. After giving the initial results a harder review we decided to collect additional samples from the FGD WWTP discharge and the FGD yard sump. We also tested the Proctors Creek WWTP effluent makeup water to the FGD scrubber as well as James River water prior to use at the station. The results of these analyses are attached. Heptachlor was not detected (<0.005 ug/L) in any of the samples.

Please call if you have any additional questions.

Thanks for all of your work on this permit to get it to this point.

Ken Roller
Supervisor, Environmental Regulations
Dominion
Electric Environmental Services
(804) 273-3494 Office
(804) 592-7825 Cell

From: Bryan, Joseph (DEQ) [mailto:Joseph.Bryan@deq.virginia.gov]
Sent: Thursday, June 02, 2016 5:42 PM
To: Kenneth Roller (Services - 6)
Cc: Adamson, Emilee (DEQ)
Subject: Preliminary Revisions - Chesterfield Power Station draft Permit/FS

Good evening,

A revised version of the permit, fact sheet, and public notice are available at the following link:

http://www.deq.virginia.gov/fileshare/wps/VA0004146%20Chesterfield%20Power%20Station/Owner%20Review%20Package/06022016%20Documents/

These files are in Word format and contain preliminary changes (in tracked changes) that will be reviewed closely in the morning. We will transmit copies of the finalized documents along with a response to comments tomorrow.

Thank you,

Joseph B. Bryan
VPDES Water Permit Writer
VA DEQ - Piedmont Regional Office
804.527.5012
joseph.bryan@deq.virginia.gov
www.deq.virginia.gov

CONFIDENTIALITY NOTICE: This electronic message contains information which may be legally confidential and or privileged and does not in any case represent a firm ENERGY COMMODITY bid or offer relating thereto which binds the sender without an additional express written confirmation to that effect. The information is intended solely for the individual or entity named above and access by anyone else is unauthorized. If you are not the intended recipient, any disclosure, copying, distribution, or use of the contents of this information is prohibited and may be unlawful. If you have received this electronic transmission in error, please reply immediately to the sender that you have received the message in error, and delete it. Thank you.

Bryan, Joseph (DEQ)

To: Adamson, Emilee (DEQ)
Subject: RE: Chesterfield PS - Heptachlor justification

From: Beverly Wood (Generation - 3) [mailto:beverly.wood@dom.com]
Sent: Friday, June 03, 2016 12:21 PM
To: Adamson, Emilee (DEQ)
Cc: Kenneth Roller (Services - 6)
Subject: Chesterfield PS - Heptachlor justification

Emilee,
In response to the heptachlor concern,
the only authorized use for heptachlor is to kill fire ants in underground transformers. We don t treat for fire ants because they are not a concern in this area, nor do we have any underground transformers at Chesterfield.

If you have any other questions or concerns, please don't hesitate to reach out to me.

Best regards,

Beverly Wood
Supervisor - Environmental and Chemistry CPS & BE Power Stations
804-796-6350 (office)
804-229-0691 (cell)

CONFIDENTIALITY NOTICE: This electronic message contains information which may be legally confidential and or privileged and does not in any case represent a firm ENERGY COMMODITY bid or offer relating thereto which binds the sender without an additional express written confirmation to that effect. The information is intended solely for the individual or entity named above and access by anyone else is unauthorized. If you are not the intended recipient, any disclosure, copying, distribution, or use of the contents of this information is prohibited and may be unlawful. If you have received this electronic transmission in error, please reply immediately to the sender that you have received the message in error, and delete it. Thank you.

Air Water & Soil Laboratories, Inc.
1941 Reymet Road
Richmond, VA 23237
(804)-358-8295 - Telephone
(804)-358-8297 - Fax

Analysis Detects Report

Date Issued:

Client Name:

Client Site ID:

Submitted To:

Laboratory Sample ID: **Client Sample ID:**

Parameter	Samp ID	Reference Method	Sample Results	Qual	DL	LOQ	Dil. Factor	Units

There are no reportable results for target analytes in this report.

Note that this report is not the "Certificate of Analysis". This report only lists the target analytes that displayed concentrations that exceeded the detection limit specified for that analyte. For a complete listing of all analytes requested and the results of the analysis see the " Certificate of Analysis".

AIR WATER & SOIL LABORATORIES, INC.

1941 Reymet Road ● Richmond, Virginia 23237 ● Tel: (804)-358-8295 Fax: (804)-358-8297

Certificate of Analysis

Final Report

Laboratory Order ID 16E0834

Client Name:	Dominion Virginia Power - Chesterfield 500 Coxendale Road Chester, VA 23836	Date Received:	May 31, 2016 12:51
		Date Issued:	June 1, 2016 14:29
Submitted To:	Jessica S. Sterling	Project Number:	[none]
		Purchase Order:	70301696
Client Site I.D.:	Rush Pest Project		

Enclosed are the results of analyses for samples received by the laboratory on 05/31/2016 12:51. If you have any questions concerning this report, please feel free to contact the laboratory.

Sincerely,

Ted Soyars

Ted Soyars
Laboratory Manager

End Notes:
The test results listed in this report relate only to the samples submitted to the laboratory and as received by the Laboratory.

Unless otherwise noted, the test results for solid materials are calculated on a wet weight basis. Analyses for pH, dissolved oxygen, temperature, residual chlorine and sulfite that are performed in the laboratory do not meet NELAC requirements due to extremely short holding times. These analyses should be performed in the field. The results of field analyses performed by the Sampler included in the Certificate of Analysis are done so at the client's request and are not included in the laboratory's fields of certification nor have they been audited for adherence to a reference method or procedure.

The signature on the final report certifies that these results conform to all applicable NELAC standards unless otherwise specified. For a complete list of the Laboratory's NELAC certified parameters please contact customer service.

This report shall not be reproduced except in full without the expressed and written approval of an authorized representative of Air Water & Soil Laboratories, Inc.

ACCREDITED IN ACCORDANCE WITH nelac Commonwealth of Virginia, DCLS Accreditation # 460021

NWBOC EDWOSB CERTIFIED

CERTIFIED SWaM Small, Women and Minority-Owned Supplier Diversity Strengthens the Commonwealth by the Virginia Department of Minority Business Enterprise

Air Water & Soil Laboratories, Inc.
1941 Reymet Road
Richmond, Virginia 23237
(804)-358-8295 - Telephone
(804)-358-8297 - Fax

Certificate of Analysis

Client Name: Dominion Virginia Power - Chesterfield

Date Issued: 6/1/2016 2:29:38PM

Client Site I.D.: Rush Pest Project

Submitted To: Jessica S. Sterling

ANALYTICAL REPORT FOR SAMPLES

Sample ID	Laboratory ID	Matrix	Date Sampled	Date Received
Proctor's Creek	16E0834-01	Waste Water	05/31/2016 12:19	05/31/2016 12:51
River Water	16E0834-02	Waste Water	05/31/2016 12:35	05/31/2016 12:51
Waste Water Treatment Effluent	16E0834-03	Waste Water	05/31/2016 12:10	05/31/2016 12:51
FGD Yard Sump #1	16E0834-04	Waste Water	05/31/2016 12:25	05/31/2016 12:51

Air Water & Soil Laboratories, Inc.
1941 Reymet Road
Richmond, Virginia 23237
(804)-358-8295 - Telephone
(804)-358-8297 - Fax

Certificate of Analysis

Client Name: Dominion Virginia Power - Chesterfield

Date Issued: 6/1/2016 2:29:38PM

Client Site I.D.: Rush Pest Project

Submitted To: Jessica S. Sterling

Client Sample ID: **Proctor's Creek** **Laboratory Sample ID:** **16E0834-01**

Parameter	Samp ID	CAS	Reference Method	Sample Prep Date/Time	Analyzed Date/Time	Sample Results	Qual	DL	LOQ	DF	Units	Analyst
Organochlorine Pesticides and PCBs by GC/ECD												
Heptachlor	01	76-44-8	EPA608	05/31/2016 13:34	05/31/2016 17:16	BLOD		0.005	0.053	1	ug/L	SKS
Surr: TCMX	*01*		*65.0 %*	*18-112*	*05/31/2016 13:34*	*05/31/2016 17:16*						
Surr: DCB	*01*		*65.0 %*	*27-131*	*05/31/2016 13:34*	*05/31/2016 17:16*						

Air Water & Soil Laboratories, Inc.
1941 Reymet Road
Richmond, Virginia 23237
(804)-358-8295 - Telephone
(804)-358-8297 - Fax

Certificate of Analysis

Client Name: Dominion Virginia Power - Chesterfield

Date Issued: 6/1/2016 2:29:38PM

Client Site I.D.: Rush Pest Project

Submitted To: Jessica S. Sterling

Client Sample ID: **River Water** **Laboratory Sample ID:** **16E0834-02**

Parameter	Samp ID	CAS	Reference Method	Sample Prep Date/Time	Analyzed Date/Time	Sample Results	Qual	DL	LOQ	DF	Units	Analyst
Organochlorine Pesticides and PCBs by GC/ECD												
Heptachlor	02	76-44-8	EPA608	05/31/2016 13:34	05/31/2016 17:34	BLOD		0.005	0.051	1	ug/L	SKS
Surr: TCMX	*02*		*35.0 %*	*18-112*	*05/31/2016 13:34*	*05/31/2016 17:34*						
Surr: DCB	*02*		*65.0 %*	*27-131*	*05/31/2016 13:34*	*05/31/2016 17:34*						

Air Water & Soil Laboratories, Inc.
1941 Reymet Road
Richmond, Virginia 23237
(804)-358-8295 - Telephone
(804)-358-8297 - Fax

Certificate of Analysis

Client Name: Dominion Virginia Power - Chesterfield

Date Issued: 6/1/2016 2:29:38PM

Client Site I.D.: Rush Pest Project

Submitted To: Jessica S. Sterling

Client Sample ID: **Waste Water Treatment Effluent** **Laboratory Sample ID:** **16E0834-03**

Parameter	Samp ID	CAS	Reference Method	Sample Prep Date/Time	Analyzed Date/Time	Sample Results	Qual	DL	LOQ	DF	Units	Analyst
Organochlorine Pesticides and PCBs by GC/ECD												
Heptachlor	03	76-44-8	EPA608	05/31/2016 13:34	05/31/2016 17:53	BLOD		0.005	0.052	1	ug/L	SKS
Surr: TCMX	*03*		*30.0 %*	*18-112*	*05/31/2016 13:34*	*05/31/2016 17:53*						
Surr: DCB	*03*		*110 %*	*27-131*	*05/31/2016 13:34*	*05/31/2016 17:53*						

Air Water & Soil Laboratories, Inc.
1941 Reymet Road
Richmond, Virginia 23237
(804)-358-8295 - Telephone
(804)-358-8297 - Fax

Certificate of Analysis

Client Name: Dominion Virginia Power - Chesterfield

Date Issued: 6/1/2016 2:29:38PM

Client Site I.D.: Rush Pest Project

Submitted To: Jessica S. Sterling

Client Sample ID: **FGD Yard Sump #1** **Laboratory Sample ID:** **16E0834-04**

Parameter	Samp ID	CAS	Reference Method	Sample Prep Date/Time	Analyzed Date/Time	Sample Results	Qual	DL	LOQ	DF	Units	Analyst
Organochlorine Pesticides and PCBs by GC/ECD												
Heptachlor	04	76-44-8	EPA608	05/31/2016 13:34	05/31/2016 18:11	BLOD		0.005	0.052	1	ug/L	SKS
Surr: TCMX	*04*	*45.0 %*	*18-112*	*05/31/2016 13:34*	*05/31/2016 18:11*							
Surr: DCB	*04*	*60.0 %*	*27-131*	*05/31/2016 13:34*	*05/31/2016 18:11*							

Air Water & Soil Laboratories, Inc.
1941 Reymet Road
Richmond, Virginia 23237
(804)-358-8295 - Telephone
(804)-358-8297 - Fax

Certificate of Analysis

Client Name: Dominion Virginia Power - Chesterfield

Date Issued: 6/1/2016 2:29:38PM

Client Site I.D.: Rush Pest Project

Submitted To: Jessica S. Sterling

Organochlorine Pesticides and PCBs by GC/ECD - Quality Control

Air Water and Soil Laboratories, Inc.

Analyte	Result	LOQ	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qual
Batch BZE0851 - SW3510C										
Blank (BZE0851-BLK1)				Prepared & Analyzed: 05/31/2016						
Heptachlor	BLOD	0.050	ug/L							
Surr: TCMX	*0.0700*		ug/L	*0.200*		*35.0*	*18-112*			
Surr: TCMX [2C]	*0.0700*		ug/L	*0.200*		*35.0*	*18-112*			
Surr: DCB	*0.100*		ug/L	*0.200*		*50.0*	*27-131*			
Surr: DCB [2C]	*0.110*		ug/L	*0.200*		*55.0*	*27-131*			
LCS (BZE0851-BS1)				Prepared & Analyzed: 05/31/2016						
Heptachlor	0.040	0.050	ug/L	0.100		40.0	23-134			J
Surr: TCMX	*0.0700*		ug/L	*0.200*		*35.0*	*18-112*			
Surr: TCMX [2C]	*0.0800*		ug/L	*0.200*		*40.0*	*18-112*			
Surr: DCB	*0.120*		ug/L	*0.200*		*60.0*	*27-131*			
Surr: DCB [2C]	*0.120*		ug/L	*0.200*		*60.0*	*27-131*			
LCS (BZE0851-BS3)				Prepared & Analyzed: 05/31/2016						
Heptachlor	BLOD	0.050	ug/L				23-134			
Surr: TCMX [2C]	*ND*		ug/L	*0.200*			*18-112*			
Surr: TCMX	*ND*		ug/L	*0.200*			*18-112*			
Surr: DCB	*ND*		ug/L	*0.200*			*27-131*			
Surr: DCB [2C]	*ND*		ug/L	*0.200*			*27-131*			
LCS (BZE0851-BS4)				Prepared & Analyzed: 05/31/2016						
Heptachlor	BLOD	0.050	ug/L				23-134			
Surr: TCMX	*ND*		ug/L	*0.200*			*18-112*			
Surr: TCMX [2C]	*ND*		ug/L	*0.200*			*18-112*			
Surr: DCB	*ND*		ug/L	*0.200*			*27-131*			
Surr: DCB [2C]	*ND*		ug/L	*0.200*			*27-131*			

Air Water & Soil Laboratories, Inc.
1941 Reymet Road
Richmond, Virginia 23237
(804)-358-8295 - Telephone
(804)-358-8297 - Fax

Certificate of Analysis

Client Name: Dominion Virginia Power - Chesterfield

Date Issued: 6/1/2016 2:29:38PM

Client Site I.D.: Rush Pest Project

Submitted To: Jessica S. Sterling

Organochlorine Pesticides and PCBs by GC/ECD - Quality Control

Air Water and Soil Laboratories, Inc.

Analyte	Result	LOQ	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qual
Batch BZE0851 - SW3510C										
Matrix Spike (BZE0851-MS1)	**Source: 16E0777-08**			Prepared & Analyzed: 05/31/2016						
Heptachlor	0.063	0.053	ug/L	0.105	BLOD	60.0	23-134			
Surr: TCMX	*0.126*		ug/L	*0.211*		*60.0*	*18-112*			
Surr: TCMX [2C]	*0.0947*		ug/L	*0.211*		*45.0*	*18-112*			
Surr: DCB	*0.126*		ug/L	*0.211*		*60.0*	*27-131*			
Surr: DCB [2C]	*ND*		ug/L	*0.211*			*27-131*			
Matrix Spike Dup (BZE0851-MSD1)	**Source: 16E0777-08**			Prepared & Analyzed: 05/31/2016						
Heptachlor	0.074	0.053	ug/L	0.106	BLOD	70.0	23-134	16.4	20	
Surr: TCMX [2C]	*0.128*		ug/L	*0.213*		*60.0*	*18-112*			
Surr: TCMX	*0.128*		ug/L	*0.213*		*60.0*	*18-112*			
Surr: DCB	*0.0851*		ug/L	*0.213*		*40.0*	*27-131*			
Surr: DCB [2C]	*ND*		ug/L	*0.213*			*27-131*			

Analytical Summary

Sample ID	Preparation Factors Initial / Final	Method	Batch ID	Sequence ID	Calibration ID
Organochlorine Pesticides and PCBs by GC/ECD			**Preparation Method:**	**SW3510C**	
16E0834-01	950 mL / 1.00 mL	EPA608	BZE0851	SZE0950	AE60044
16E0834-02	980 mL / 1.00 mL	EPA608	BZE0851	SZE0950	AE60044
16E0834-03	970 mL / 1.00 mL	EPA608	BZE0851	SZE0950	AE60044
16E0834-04	970 mL / 1.00 mL	EPA608	BZE0851	SZE0950	AE60044

Air Water & Soil Laboratories, Inc.
1941 Reymet Road
Richmond, Virginia 23237
(804)-358-8295 - Telephone
(804)-358-8297 - Fax

Certificate of Analysis

Client Name: Dominion Virginia Power - Chesterfield

Date Issued: 6/1/2016 2:29:38PM

Client Site I.D.: Rush Pest Project

Submitted To: Jessica S. Sterling

Certified Analyses included in this Report

Analyte	Certifications
EPA608 in Non-Potable Water	
Heptachlor	NC,VELAP

Code	Description	Cert Number	Expires
MdDOE	Maryland DE Drinking Water	341	12/31/2016
NC	North Carolina DENR	495	12/31/2016
PADEP	NELAC-Pennsylvania	001	10/31/2016
VELAP Certificate #4337	NELAC-Virginia Certificate #8271	460021	06/15/2016
WVDEP	West Virginia DEP	350	11/30/2016

Air Water & Soil Laboratories, Inc.
1941 Reymet Road
Richmond, Virginia 23237
(804)-358-8295 - Telephone
(804)-358-8297 - Fax

Certificate of Analysis

Client Name: Dominion Virginia Power - Chesterfield

Date Issued: 6/1/2016 2:29:38PM

Client Site I.D.: Rush Pest Project

Submitted To: Jessica S. Sterling

Qualifiers and Definitions

J	The reported result is an estimated value.
RPD	Relative Percent Difference
Qual	Qualifers
-RE	Denotes sample was re-analyzed
LOD	Limit of Detection
BLOD	Below Limit of Detection
LOQ	Limit of Quantitation
DF	Dilution Factor
TIC	Tentatively Identified Compounds are compounds that are identified by comparing the analyte mass spectral pattern with the NIST spectral library . A TIC spectral match is reported when the pattern is at least 75% consistent with the published pattern. Compound concentrations are estimated and are calculated using an internal standard response factor of 1.

AIR WATER & SOIL LABORATORIES, INC.

1941 REYMET ROAD
RICHMOND, VIRGINIA 23237
(804) 358-8295 PHONE
(804)358-8297 FAX

Chain of Custody
Form #: D1331
Rev. 1.0
Effective: Feb 14, 2014

CHAIN OF CUSTODY

PAGE 1 OF 1

COMPANY NAME: Dominion Virginia Power CPS	INVOICE TO:	PROJECT NAME/Quote #:
CONTACT: Jessica Sterling	INVOICE CONTACT:	SITE NAME:
ADDRESS: 500 Coxendale Rd Chester, VA	INVOICE ADDRESS:	PROJECT NUMBER:
PHONE #: 757-816-6199 (cell)	INVOICE PHONE #:	P.O. #:
FAX #: EMAIL: jessica.s.sterling@dom.com		Pretreatment Program:
Is sample for compliance reporting? (YES) NO	Is sample from a chlorinated supply? YES (NO)	PWS I.D. #:
SAMPLER NAME (PRINT): Jessica Sterling	SAMPLER SIGNATURE: Jessica Sterling	Turn Around Time: 1 Day(s)

Matrix Codes: WW=Waste Water/Storm Water GW=Ground Water DW=Drinking Water S=Soil/Solids OR=Organic A=Air WP=Wipe OT=Other

CLIENT SAMPLE I.D.	Grab	Composite	Field Filtered (Dissolved Metals)	Composite Start Date	Composite Start Time	Grab Date or Composite Stop Date	Grab Time or Composite Stop Time	Time Preserved	Matrix (See Codes)	Number of Containers	ANALYSIS / (PRESERVATIVE): Heptachlor							COMMENTS: Preservative Codes: N=Nitric Acid C=Hydrochloric Acid S=Sulfuric Acid H=Sodium Hydroxide A=Ascorbic Acid Z=Zinc Acetate T=Sodium Thiosulfate M=Methanol; PLEASE NOTE PRESERVATIVE(S), INTERFERENCE CHECKS or PUMP RATE (L/min)
1) Proctor's Creek	X					5/31/16	12:19				X							
2) River Water	X						12:35				X							
3) Waste Water Treatment Effluent	X						12:10				X							
4) FGD Yard Sump #1	X						12:25				X							
5)																		
6)																		
7)																		
8)																		
9)																		
10)																		

RELINQUISHED:	DATE / TIME	RECEIVED:	DATE / TIME
Jessica Sterling	5/31/16 12:50	[illegible]	5-31-16 12:51

QC Data Package: Level I ☐ Level II ☒ Level III ☐ Level IV ☐

LAB USE ONLY COOLER TEMP 7.8 °C

Dominion Virginia 16E0834
Rush Pest Project
Recd: 05/31/2016 Due: 06/01/2016

v130325002

D1331 AWS COC_v140214.xls

AIR WATER SOIL
1941 Reymet Road • Richmond, Virginia 23237 • Tel : (804) 358-8295 Fax: (804) 358-8297

Sample Conditions Checklist

Opened by: (Initials) KSnow **Lab ID No.:** 16E0834

Date Cooler Opened: 5-31-16

		YES	NO	N/A
1.	How were samples received? Fed Ex ☐ UPS ☐ Courier ☐ Walk In ☑			
2.	Were custody seals used?	☐	☑	☐
3.	If yes, are custody seals unbroken and intact at the date and time of arrival?	☐	☐	☑
4.	Are the custody papers filled out completely and correctly?	☑	☐	☐
5.	Do all bottle labels agree with custody papers?	☑	☐	☐
7.	Is the temperature blank or representative sample within acceptable limits? (above freezing to 6°C)	☐	☑	☐
8.	If NO, are the samples just taken and received on ice?	☑	☐	☐
9.	Are all samples within holding time for requested laboratory tests?	☑	☐	☐
10.	Is a sufficient amount of sample provided to perform the tests indicated?	☑	☐	☐
11.	Are all samples in proper containers for the analyses requested?	☑	☐	☐
12.	Are all samples appropriately preserved for the analyses requested?	☑	☐	☐
13.	Are all volatile organic containers free of headspace?	☐	☐	☑
14.	Are all TOX containers free of headspace?	☐	☐	☑
15.	Is Trip blank provided with each VOC sample set? Circle applicable method: (Document if trip blank is not received with the sample set)	☐	☐	☑

EPA 8011 EPA 504 EPA 8260 EPA 624

RSK-175 EPA 8015 (GRO) EPA 8021

EPA 524 *GRO Wisconsin DNR (water and/or methanol trip blank must be provided)

* See preservation log for Wisconsin soil DRO.

COMMENTS

Jessica notified at drop off of temp. KSnow 6-1-16.

~~FOR LAB USE ONLY:~~

CrVI preserved date/time: _____

Buffer Sol'n ID: _____ Analyst intials: _____

1N NaOH ID: _____ or 5N NaOH ID: _____

Attachment 14

EPA Comments, Dominion and DEQ Responses

Attachment 15

Public Comments and DEQ Responses

Attachment 16

Other Agency Comments

VIRGINIA DEPARTMENT OF ENVIRONMENTAL QUALITY	**VPDES PERMITS** **Threatened and Endangered Species Coordination**
To: ☒ DGIF, Environmental Review Coordinator ☐ DCR ☒ USFWS, T/E Review Coordinator **From: Brian Wrenn, Piedmont Regional Office**	**Date Sent: 12/16/2015** **Permit Number: VA0004146**
Facility Name: Chesterfield Power Station **Contact: Ken Roller** **Phone: 804-273-3494** **Address: 500 Coxendale Rd., Chester, VA 23836**	**Location:** **USGS Quadrangle: Drewrys Bluff** **Latitude/Longitude: 37°22'19" -77°23'04"** **Receiving Stream: James River** **Receiving Stream Flow Statistics used for Permit:** **See Attachment A**
Effluent Characteristics and Max Daily Flow: **Once through Cooling water, low volume wastewater and wastewater from coal ash impoundments** **See attachment B and attached existing permit**	**Species Search Results (or attach database report and map):** **See attached map and species list**

Attach draft permit effluent limits page if available or attach existing effluent limits page (make sure it is clear in your email which one it is – draft current or existing).

DGIF email: Gladys.Cason@dgif.virginia.gov
USFWS email: margaret_byrne@fws.gov
DCR: If Natural Heritage Data Explorer (NHDE) has the needed information DCR does not need this form. If you have additional information you wish to add, you may do so in the comments field on the NHDE form. DCR will contact you directly if they need more information.

VaFWIS Initial Project Assessment Report Compiled on 12/16/2015, 3:14:13 PM

Help

Known or likely to occur within a **2 mile radius around point 37,22,19.0 -77,23,04.0**
in **041 Chesterfield County, 087 Henrico County, VA**

View Map of Site Location

520 Known or Likely Species ordered by Status Concern for Conservation
(displaying first 27) (27 species with Status* or Tier I** or Tier II**)

BOVA Code	Status*	Tier**	Common Name	Scientific Name	Confirmed	Database(s)
060017	FESE	I	Spinymussel, James	Pleurobema collina		BOVA
010032	FESE	II	Sturgeon, Atlantic	Acipenser oxyrinchus	Yes	BOVA,SppObs
060003	FESE	II	Wedgemussel, dwarf	Alasmidonta heterodon		BOVA
050022	FT		Bat, northern long-eared	Myotis septentrionalis		BOVA
040096	ST	I	Falcon, peregrine	Falco peregrinus		BOVA
040129	ST	I	Sandpiper, upland	Bartramia longicauda		BOVA
040293	ST	I	Shrike, loggerhead	Lanius ludovicianus		BOVA
020002	ST	II	Treefrog, barking	Hyla gratiosa		BOVA
060173	FSST	II	Pigtoe, Atlantic	Fusconaia masoni		BOVA
040292	ST		Shrike, migrant loggerhead	Lanius ludovicianus migrans		BOVA
040093	FS	II	Eagle, bald	Haliaeetus leucocephalus	Yes	BOVA,BAEANests
060029	FS	III	Lance, yellow	Elliptio lanceolata		BOVA
010038	FS	IV	Alewife	Alosa pseudoharengus	Yes	BOVA,SppObs
100001	FS	IV	fritillary, Diana	Speyeria diana		BOVA
010045	FS		Herring, blueback	Alosa aestivalis	Yes	BOVA,SppObs
030063	CC	III	Turtle, spotted	Clemmys guttata		BOVA
010077		I	Shiner, bridle	Notropis bifrenatus		BOVA
040225		I	Sapsucker, yellow-bellied	Sphyrapicus varius		BOVA
040319		I	Warbler, black-throated green	Dendroica virens		BOVA
060084		I	Pigtoe, Virginia	Lexingtonia		BOVA

				subplana		
040052		II	Duck, American black	Anas rubripes		BOVA
040029		II	Heron, little blue	Egretta caerulea caerulea		BOVA
040036		II	Night-heron, yellow-crowned	Nyctanassa violacea violacea		BOVA
040213		II	Owl, northern saw-whet	Aegolius acadicus	Yes	BOVA,SppObs
040105		II	Rail, king	Rallus elegans		BOVA,Habitat
040320		II	Warbler, cerulean	Setophaga cerulea		BOVA
040266		II	Wren, winter	Troglodytes troglodytes	Yes	BOVA,SppObs

To view **All 520 species** View 520

* FE=Federal Endangered; FT=Federal Threatened; SE=State Endangered; ST=State Threatened; FC=Federal Candidate; FS=Federal Species of Concern; CC=Collection Concern

** I=VA Wildlife Action Plan - Tier I - Critical Conservation Need; II=VA Wildlife Action Plan - Tier II - Very High Conservation Need; III=VA Wildlife Action Plan - Tier III - High Conservation Need; IV=VA Wildlife Action Plan - Tier IV - Moderate Conservation Need

View Map of All Query Results from All Observation Tables

Bat Colonies or Hibernacula: **Not Known**

Anadromous Fish Use Streams (1 records)

View Map of All Anadromous Fish Use Streams

Stream ID	Stream Name	Reach Status	Anadromous Fish Species			View Map
			Different Species	Highest TE*	Highest Tier**	
C92	James River 1	Confirmed	6	FC	IV	Yes

Impediments to Fish Passage (2 records)

View Map of All Fish Impediments

ID	Name	River	View Map
1040	CHESTERFIELD POWER STATION	TR-JAMES RIVER	Yes
1302	I-95	PROCTORS CREEK	Yes

Colonial Water Bird Survey (2 records)

View Map of All Query Results Colonial Water Bird Survey

			N Species			

Colony_Name	N Obs	Latest Date	Different Species	Highest TE*	Highest Tier**	View Map
Henricus	1	Apr 28 2003	1			Yes
Aiken Swamp/Dutch Gap Cut	1	Jun 1 1993	1			Yes

Displayed 2 Colonial Water Bird Survey

Threatened and Endangered Waters

N/A

Managed Trout Streams

N/A

Bald Eagle Concentration Areas and Roosts

N/A

Bald Eagle Nests (4 records)

View Map of All Query Results
Bald Eagle Nests

Nest	N Obs	Latest Date	DGIF Nest Status	View Map
CD0804	7	Apr 18 2011	RECENTLY ACTIVE	Yes
CD1103	2	Apr 18 2011	RECENTLY ACTIVE	Yes
CD9901	22	Apr 18 2011	UNKNOWN	Yes
HE0801	8	Apr 18 2011	RECENTLY ACTIVE	Yes

Displayed 4 Bald Eagle Nests

Habitat Predicted for Aquatic WAP Tier I & II Species

N/A

Habitat Predicted for Terrestrial WAP Tier I & II Species

BOVA Code	Status*	Tier**	Common Name	Scientific Name	View Map
040105		II	Rail, king	Rallus elegans	Yes

Public Holdings: (1 names)

Name	Agency	Level

Richmond National Battlefield Park	National Park Service	Federal

Compiled on 12/16/2015, 3:14:25 PM I697259.0 report=IPA searchType= R dist= 3218 poi= 37,22,19.0 -77,23,04.0

PixelSize=64; Anadromous=0.258455; BECAR=0.571389; Bats=0.20488; Buffer=0.100406; County=2.101898; Impediments=0.610634; Init=1.438994; PublicLands=0.349506; SppObs=4.212984; TEWaters=0.205327; TierReaches=0.272465; TierTerrestrial=0.73343; Total=31.489; Tracking_BOVA=19.841866; Trout=0.61543

Attachment A

OUTFALLS	001	002	003	301	302	303	004	401	402	005
Receiving Stream	James River, Main Channel	James River, Main Channel	James River (Farrar Gut)	Internal Discharge to OF 003	Internal Discharge to OF 003	Internal Discharge to OF 003	James River (Farrar Gut)	Internal Discharge to OF 004	Internal Discharge to OF 004	James River (Farrar Gut)
Lat/Lon	N 37º22'58" W 77º22'51"	N 37º22'58" W º22'48"	N 37º 22' 19" W 77º 23' 4"	N 37°22'71" W 77°23"02"	N 37°22'58" W 77°23"10"	N 37°22'35" W 77°23"04"	N 37º22'18" W 77º22'54"	N 37º22'35" W 77º23'04"	N 37º22'58" W 77º23'09"	N 37º22'20" W 77º21'50"
Basin	James River (Lower)	James River (Lower)	James River (Lower)	James River (Lower)	James River (Lower)	James River (Lower)	James River (Lower)	James River (Lower)	James River (Lower)	James River (Lower)
Subbasin	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Section	1	1	1	NA	NA	NA	1	NA	NA	1
Class	II	II	II	NA	NA	NA	II	NA	NA	II
Special Standards	bb	bb	bb	NA	NA	NA	bb	NA	NA	bb
River Mile	2-JMS097.70	2-JMS097.70	2-JMC003.77	NA	NA	NA	2-JMC003.75	NA	NA	2-JMC000.37
Low Flow 1Q10 (MGD)*	TIDAL	TIDAL	0	NA	NA	NA	270	NA	NA	TIDAL
Low Flow 7Q10 (MGD)*	TIDAL	TIDAL	0	NA	NA	NA	270	NA	NA	TIDAL
Low Flow 30Q10 (MGD)*	TIDAL	TIDAL	0	NA	NA	NA	270	NA	NA	TIDAL
Low Flow 30Q5 (MGD)*	TIDAL	TIDAL	0	NA	NA	NA	270	NA	NA	TIDAL
High Flow 1Q10 (MGD)*	TIDAL	TIDAL	0	NA	NA	NA	270	NA	NA	TIDAL
High Flow 7Q10 (MGD)*	TIDAL	TIDAL	0	NA	NA	NA	270	NA	NA	TIDAL
High Flow 30Q10	TIDAL	TIDAL	0	NA	NA	NA	270	NA	NA	TIDAL

OUTFALLS	001	002	003	301	302	303	004	401	402	005
(MGD)*										
HM (MGD)*	TIDAL	TIDAL	0	NA	NA	NA	270	NA	NA	TIDAL
Tidal	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
303(d) list**	Category 5D	Category 5D	Category 4A	Category 4A	Category 4A	Category 4A	Category 4A	Category 4A	Category 4A	Category 4A

*The James River is tidally influenced at the discharge points. Flow frequencies cannot be determined for tidal waters; therefore, the tidal default dilution ratios are used to evaluate outfalls 001, 002, and 003. Farrar Gut is also tidal; however, the gut is dominated by the discharge from the power station's Outfall 003. The 10th percentile of effluent flow from Outfall 003 is therefore used as the ambient flow for the analysis of Outfall 004. Outfall 003 discharges at the head of Farrar Gut, so Outfall 003 is treated as if discharging to a free-flowing intermittent stream.

** Category 5D means the Water Quality Standard is not attained where TMDLs for a pollutant(s) have been developed but one or more pollutants are still causing impairment requiring additional TMDL development. Category 4A means the water is impaired or threatened for one or more designated uses but does not require a TMDL because the TMDL for specific pollutant(s) is complete and US EPA approved.

Attachment B

Outfall Number	**Wastewater Source**	**Treatment**	**Flow, MGD *(maximum of 30-day averages)***
001	Cooling Water from Units 7 and 8	Dechlorination	212
002	Cooling Water from Unit 3	Dechlorination	89
003	Cooling Water from Units 4, 5, and 6	Dechlorination	753
301	Discharge from Low Volume Wastewater Treatment System (LVWWTS) – will receive coal pile retention basin discharge, master sump effluent, FGD yard sump effluent, bottom ash handling area runoff, sierra ditch stormwater runoff, upper ash pond (UAP) toe drain discharge, lower ash pond (LAP) toe drain discharge, leachate and contact stormwater from Fossil Fuel Combustion Product (FFCP) Management Facility, Discharge from Internal Outfalls 302 and 303 (see discussions for Internal Outfalls 302 and 303 below)	Sedimentation, oil and grease removal, neutralization	13.29*
302	FGD wastewater	Wastewater equalization, pH elevation, gypsum desaturation, heavy metal precipitation, coagulation, flocculation, clarification, pH adjustment, and sludge dewatering. Wastewater treatment is achieved through chemical addition. See **Attachment 2**.	0.11
303	Metals Cleaning Wastewater	Lime addition, mixing, and chemical precipitation	2.7
004	Discharge from old ash pond – receives ash sluice water and wastewater from sumps throughout the station (low volume wastes,	Settling, skimming. Some of the sources to	17.47

	non-chemical cleaning wastes, screen backwash associated with reuse of Proctor's Creek WWTP effluent, wastewater from the station's car wash (non-chemical), storm water from the Unit 6 FGD runoff collection system, coal pile runoff, Water Treatment Plant wastewater, a portion of Drainage Area 4 and various other onsite tank containment areas including the station's light oil storage tank. Outfall 004 also receives the treated discharge from the metals treatment pond and the treated discharge from the FGD WWTP.	the old ash pond receive treatment prior to discharge to the ash pond. There is also occasional chemical coagulation and pH adjustment as needed. See **Attachment 2**.	
401	Metal cleaning wastewater	See Internal Outfall 303 above.	2.7
402	FGD wastewater	See Internal Outfall 302 above.	0.11
005	Storm water runoff from coal ash pond closure and recovery wells/toe drains.	Settling, skimming	4.05 *(Max of 30 day maximum)*

Bryan, Joseph (DEQ)

From: Bryan, Joseph (DEQ)
Sent: Friday, May 27, 2016 12:39 PM
To: ProjectReview (DGIF); nhreview (DCR); Susan_Lingenfelser@fws.gov
Subject: RE: Updates to the Application: ESSLog 36478; VPDES VA 0004146; re-issuance of existing permit with major modification to discharge coal ash treatment/product water for the Chesterfield Power Station, VA
Attachments: CPS VPDES Application Additional Information DEQ Submittal 23 May 2016.pdf

Good afternoon,

Attached is the updated addendum for the Chesterfield Power Station (VPDES permit VA0004146).

To reiterate, any updates or additions to your previous comments can be submitted during the 45 day public comment period that begins with public notice. The public comment period will also include a public hearing. You will be notified when the public notice is published.

Thank you,

Joseph B. Bryan
VPDES Water Permit Writer
VA DEQ - Piedmont Regional Office
804.527.5012
joseph.bryan@deq.virginia.gov
www.deq.virginia.gov

From: ProjectReview (DGIF)
Sent: Friday, May 20, 2016 2:22 PM
To: Bryan, Joseph (DEQ); nhreview (DCR); Susan_Lingenfelser@fws.gov
Cc: ProjectReview (DGIF)
Subject: Updates to the Application: ESSLog 36478; VPDES VA 0004146; re-issuance of existing permit with major modification to discharge coal ash treatment/product water for the Chesterfield Power Station, VA

Thank you for the update. We look forward to receiving the updated application when it is ready for review.

Please note, Brett Hillman is no longer with the USFWS Virginia Field Office. Suggest sending all future correspondence c/o Susan Lingenfelser, USFWS.

Thanks.

Ernie Aschenbach
Environmental Services Biologist
Virginia Dept. of Game and Inland Fisheries
Phone: (804) 367-2733
Email: Ernie.Aschenbach@dgif.virginia.gov

We moved! Our new address is:

Physical
7870 Villa Park Dr, Suite 400
Henrico, VA 23228

Mailing

P O Box 90778
Henrico, VA 23228

From: Bryan, Joseph (DEQ)
Sent: Friday, May 20, 2016 2:14 PM
To: nhreview (DCR); ProjectReview (DGIF); Hillman, Brett
Subject: T&E Coordination - Chesterfield Power Station - VA0004146 - Updates to the Application

Good afternoon,

The addendum to the application for the Chesterfield Power Station (VPDES permit VA0004146) has been significantly updated.

Most notably, the Lower and Upper Ash Pond discharges will be consolidated, treated, and sent via Internal Outfall 101 or 201 to either Outfall 001 or 002, respectively. Outfalls 001 and 002 discharge to the main stem of the James River. Previously, the ash pond discharges were going to be directed to Outfalls 004 and 005 which discharge to Farrar Gut.

We're expecting a final submittal of the updated addendum early next week. That submittal will be forwarded to you as soon as it arrives.

Any updates or additions to your previous comments can be submitted during the 45 day public comment period that begins with public notice. The public comment period will also include a public hearing. You will be notified when the public notice is published.

Let me know if you have any questions.

Thank you,

Joseph B. Bryan
VPDES Water Permit Writer
VA DEQ - Piedmont Regional Office
804.527.5012
joseph.bryan@deq.virginia.gov
www.deq.virginia.gov

Molly Joseph Ward
Secretary of Natural Resources

Clyde E. Cristman
Director

COMMONWEALTH of VIRGINIA

DEPARTMENT OF CONSERVATION AND RECREATION

Rochelle Altholz
Deputy Director of Administration and Finance

David C. Dowling
Deputy Director of Soil and Water Conservation and Dam Safety

Thomas L. Smith
Deputy Director of Operations

April 20, 2016

Mr. Michael Winters, P.E.
Dominion Power Generation Engineering
5000 Dominion Boulevard
Glen Allen, VA 23060

Re: Chesterfield Power Station Upper Ash Pond Dam (Inventory #04145) and Chesterfield Power Station Lower Ash Pond Dam (Inventory #00823) - Rapid Drawdown Stability Analysis

Dear Mr. Winters:

I received and reviewed the Rapid Drawdown Stability Analysis for the Chesterfield Power Station Upper Ash Pond Dam and the Chesterfield Power Station Lower Ash Pond Dam signed by your engineer Mr. Scott Kenneth Sheridan, PE #045360, dated December 27, 2015. As discussed in my email from February 24th, the proposed maximum drawdown rate for these facilities of 2 feet per day is acceptable.

Should you have any questions or comments, please do not hesitate to contact me by telephone at 804) 786-1359 or by email at steven.snell@dcr.virginia.gov.

With best regards,

Steve Snell, P.E.
Regional Engineer
Virginia Department of Conservation and Recreation
Dam Safety & Floodplain Management
600 East Main St., 24th floor
Richmond, VA 23219
PH (804) 786-1359

cc David C. Dowling, Deputy Director of Dam Safety and Floodplain Management and Soil and Water Conservation, Virginia Department of Conservation and Recreation
Melanie D. Davenport, Director Division of Water Quality Programs, Virginia Department of Environmental Quality

Wrenn, Brian (DEQ)

From: Baird, Alice (DCR)
Sent: Tuesday, February 16, 2016 4:51 PM
To: Wrenn, Brian (DEQ)
Subject: FW: VA0004146, Chesterfield Power Station
Attachments: 70238, revised DEQ VA0004146, Chesterfield Power Station.docx

Brian,

Here is a copy of the revised comments for the above above referenced project. The comments are in word format and can be printed for your records. Also species rank information is available at http://www.dcr.virginia.gov/natural-heritage/help for your reference.

Please send a confirmation e-mail upon receipt of our comments. Let us know if you have any questions.

Thank you for your request.

From: nhreview (DCR)
Sent: Tuesday, February 16, 2016 3:04 PM
To: Allan.brockenbrough@deq.virginia.gov
Subject: VA0004146, Chesterfield Power Station

Mr. Brockenbrough,

Please find attached the DCR-DNH comments for the above referenced project. The comments are in word format and can be printed for your records. Also species rank information is available at http://www.dcr.virginia.gov/natural-heritage/help for your reference.

Please send a confirmation e-mail upon receipt of our comments. Let us know if you have any questions.

Thank you for your request.

Alli Baird, CLA, ASLA
VADCR - Division of Natural Heritage
600 East Main Street, 24th Floor
Richmond, VA 23219
804-692-0984
alice.baird@dcr.virginia.gov

Molly Joseph Ward
Secretary of Natural Resources

Clyde E. Cristman
Director

COMMONWEALTH of VIRGINIA
DEPARTMENT OF CONSERVATION AND RECREATION

Joe Elton
Deputy Director of Operations

Rochelle Altholz
Deputy Director of Administration and Finance

David Dowling
Deputy Director of Soil and Water and Dam Safety

MEMORANDUM

DATE: January 8, 2016, revised February 16, 2016

TO: Allan Brockenbrough, DEQ

FROM: Alli Baird, DCR-DNH

SUBJECT: VA0004146, Chesterfield Power Station
Due January 15, 2016

The Department of Conservation and Recreation's Division of Natural Heritage (DCR) has searched its Biotics Data System for occurrences of natural heritage resources from the area outlined on the submitted map. Natural heritage resources are defined as the habitat of rare, threatened, or endangered plant and animal species, unique or exemplary natural communities, and significant geologic formations.

Biotics documents the presence of natural heritage resources within two miles of the project area. As a result of further clarification of the permit conditions, and the distance to the resources, DCR does not anticipate that this project will adversely impact these natural heritage resources.

There are no State Natural Area Preserves under DCR's jurisdiction in the project vicinity.

Under a Memorandum of Agreement established between the Virginia Department of Agriculture and Consumer Services (VDACS) and the DCR, DCR represents VDACS in comments regarding potential impacts on state-listed threatened and endangered plant and insect species. The current activity will not affect any documented state-listed plants or insects.

New and updated information is continually added to Biotics. Please re-submit project information and map for an update on this natural heritage information if the scope of the project changes and/or six months has passed before it is utilized.

The Virginia Department of Game and Inland Fisheries (VDGIF) maintains a database of wildlife locations, including threatened and endangered species, trout streams, and anadromous fish waters that may contain information not documented in this letter. Their database may be accessed from http://vafwis.org/fwis/ or contact Ernie Aschenbach at 804-367-2733 or Ernie.Aschenbach@dgif.virginia.gov.

Thank you for the opportunity to comment on this project.

Wrenn, Brian (DEQ)

From: Hillman, Brett [brett_hillman@fws.gov]
Sent: Tuesday, January 05, 2016 11:08 AM
To: Wrenn, Brian (DEQ)
Subject: Re: T&E coordination for VA0004146 Chesterfield Power Station

Hi Brian,

Thanks again for sending along these documents to review. The federally listed endangered Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*) is known to occur in the James River near the Chesterfield Power Station and may therefore be impacted from discharges.

The main concern we have regarding the planned changes at this facility is the potential for the discharge of high concentrations of metals and other contaminants during the ash pond closure process. We expressed similar concerns about the discharge of ash pond dewatering water from Dominion's Bremo Power Station. Under that proposed permit, DEQ relies on a complete mix assumption although complete mixing will not occur for 9 to 11 miles downstream of the discharge. If the Chesterfield Power Station VPDES permit, once drafted, relies on a similar mix assumption for the discharge of ash pond dewatering water, we will likely have concerns about impacts to the Atlantic sturgeon.

Please let me know if you have any questions or comments.

Best,
Brett

Brett Hillman
Fish and Wildlife Biologist
U.S. Fish & Wildlife Service
Virginia Field Office
6669 Short Lane
Gloucester, VA 23061

Phone: 804-824-2420
Fax: 804-693-9032
Email: brett_hillman@fws.gov

On Thu, Dec 17, 2015 at 3:58 PM, Hillman, Brett <brett_hillman@fws.gov> wrote:
OK, I'm on board! I'll look this over and get comments to you as soon as I can.

Brett

Brett Hillman
Fish and Wildlife Biologist

U.S. Fish & Wildlife Service
Virginia Field Office
6669 Short Lane
Gloucester, VA 23061

Phone: 804-824-2420
Fax: 804-693-9032
Email: brett_hillman@fws.gov

On Thu, Dec 17, 2015 at 12:02 PM, Wrenn, Brian (DEQ) <Brian.Wrenn@deq.virginia.gov> wrote:

We're mainly looking for any concerns you have regarding the discharges and the planned changes at the station on T&E species in the area. Obviously, once we have draft documents, you'll have more to chew on from a T&E review. But we wanted to get some initial comments about the application and addendums.

Thanks,

Brian Wrenn

804-527-5015

From: Hillman, Brett [mailto:brett_hillman@fws.gov]
Sent: Thursday, December 17, 2015 10:20 AM

To: Wrenn, Brian (DEQ)
Subject: Re: T&E coordination for VA0004146 Chesterfield Power Station

Thanks Brian. This is probably a dumb question, but what would you like the the agencies (USFWS and NOAA) to review and comment on at this point?

Brett

Brett Hillman

Fish and Wildlife Biologist

U.S. Fish & Wildlife Service

Virginia Field Office

6669 Short Lane

Gloucester, VA 23061

Phone: 804-824-2420

Fax: 804-693-9032

Email: brett_hillman@fws.gov

On Thu, Dec 17, 2015 at 9:29 AM, Wrenn, Brian (DEQ) <Brian.Wrenn@deq.virginia.gov> wrote:

The application on the fileshare includes documents from 2009 through 2015. An addendum to the application was submitted in July 2015 as part of the pond closure plans. We are in the process of drafting a permit and fact sheet, but those will likely not be available until mid January.

Thanks,

Brian Wrenn

804-527-5015

From: Hillman, Brett [mailto:brett_hillman@fws.gov]
Sent: Thursday, December 17, 2015 9:14 AM
To: Wrenn, Brian (DEQ)
Subject: Re: T&E coordination for VA0004146 Chesterfield Power Station

Thanks, Brian. Has the permittee submitted an application? The one on the fileshare site looks like the application from the last permit cycle. And have you drafted a fact sheet yet?

Thanks!

Brett

Brett Hillman

Fish and Wildlife Biologist

U.S. Fish & Wildlife Service

Virginia Field Office

6669 Short Lane

Gloucester, VA 23061

Phone: 804-824-2420

Fax: 804-693-9032

Email: brett_hillman@fws.gov

On Wed, Dec 16, 2015 at 4:14 PM, Wrenn, Brian (DEQ) <Brian.Wrenn@deq.virginia.gov> wrote:

Please find on the DEQ fileshare a coordination request form with attachments and VPDES application for the subject permit. If you have any questions regarding this request, please do not hesitate to contact me. Thanks.

Brian L. Wrenn

VPDES Technical Reviewer

VA DEQ - Piedmont Regional Office

804-527-5015 (Ph.)

804-527-5106 (FAX)

brian.wrenn@deq.virginia.gov

www.deq.virginia.gov

Wrenn, Brian (DEQ)

From: Hillman, Brett [brett_hillman@fws.gov]
Sent: Thursday, May 07, 2015 10:54 AM
To: Wrenn, Brian (DEQ)
Cc: David.L.O'Brien@noaa.gov; simeon.hahn@noaa.gov
Subject: VA0004146 Chesterfield Power Station 316(b) Coordination - USFWS Comments

Hi Brian,

Thanks for providing us with the opportunity to comment on the reissuance of this permit with respect to the new 316(b) rules.

The federally listed endangered Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*) is known to occur in the lower James River. According to the 2005-2006 Impingement Mortality and Entrainment Characterization Report, one sturgeon was observed in the vicinity of Chesterfield Power Station's cooling water intake structure during ambient fish sampling. Therefore, sturgeon may be at risk of entrainment or impingement at this facility's intake.

According to the April 29, 2015 letter from Dominion addressed to you, Dominion will be conducting a series of three studies in the future: a Comprehensive Technology and Cost Evaluation Study, a Benefits Valuation Study, and a Non-water Quality and Other Impacts Study. It is our understanding that if the costs of bringing a facility's cooling water intake structure into compliance with the new 316(b) rules outweigh the benefits of doing so, then the facility may be eligible for less stringent standards. We request that benefits to endangered species, both direct and indirect, resulting from decreased impingement mortality and entrainment be accounted for in these studies.

The Greater Atlantic Region of NOAA Fisheries has jurisdiction over the Atlantic sturgeon in the Chesapeake Bay. If you have not done so already, we recommend you contact Dave O'Brien and/or Simeon Hahn of that agency regarding 316(b) review of this permit. They are both copied on this email.

Thanks again for coordinating. Please let me know if you have any questions.

Best,
Brett

Brett Hillman
Fish and Wildlife Biologist
U.S. Fish & Wildlife Service
Virginia Field Office
6669 Short Lane
Gloucester, VA 23061

Phone: 804-824-2420

Fax: 804-693-9032
Email: brett_hillman@fws.gov