VPDES PERMIT PROGRAM FACT SHEET

This document gives pertinent information concerning the reissuance of the VPDES permit listed below. This permit is being processed as a Major Municipal permit. The effluent limitations contained in this permit will maintain the Water Quality Standards of 9 VAC 25-260-00 et seq. The discharge results from the operation of a sewage treatment plant serving the City of Winchester and parts of Frederick County. This proposed permit action consists of reissuing the permit with revisions to the permit requirements, as needed, due to changes in applicable laws, guidance, and available technical information.
SIC Code: 4952 (Sewerage Systems)

1. Facility Name and Mailing Address: Opequon Water Reclamation Facility
P.O. Box 43
Winchester, VA 22604

Location: 3100 Berryville Pike, Winchester, VA 22603

2. Permit No.: VA0065552 Existing Permit Expiration Date: February 11, 2006

3. Owner Contact: Name: Jesse W. Moffett
Title: Executive Director
Telephone Number: (540) 722-3579

4. Application Complete Date: November 14, 2005
Permit Drafted By: Trevor H. Wallace Date: December 07, 2005
DEQ – Valley Regional Office

Reviewed By: Paula D. Linnoff Date: 12/12/05
Date: _____

Public Notice Comment Period: 6/5/2006 to 7/5/2006

5. Receiving Stream Name: Opequon Creek River Mile: 32.66
Basin: Potomac Subbasin: Potomac Section: 11 Class: IV
Special Standards: pH
303(d) list? [X] Yes [ ] No
Tidal Waters? [ ] Yes [X] No

See **APPENDIX B** for critical flow information.

6. Planning Information:

[X] The discharge is in conformance with the existing planning documents for the area.
[ ] The discharge is not addressed in any planning document but will be included when the plan is updated.

7. Operator License Requirements: Class I

8. Reliability Class: II (assigned February 7, 1985)

9. Permit Characterization:

( ) Private ( ) Federal ( ) State (X) POTW ( ) PVOTW
( ) Possible Interstate Effect ( ) Interim Limits in Other Document

10. Description of Wastewaters and Treatment Facilities:
APPENDIX A

Total Number of Outfalls = 1

Operation and Maintenance (O&M) Manual: approved April 17, 2002
Sludge Handling/Disposal: Sludge is disposed in the Frederick County Regional Landfill.

11. Discharge Location and Receiving Waters Information:
APPENDIX B

USGS Topo Quad Name: Stephenson
USGS Topo Quad Number: 217A

12. Antidegradation Review & Comments: Tier: 1

The State Water Control Board's Water Quality Standards (WQS) includes an antidegradation policy (9 VAC 25-260-30). All state surface waters are provided one of three levels of antidegradation protection. For Tier 1 or existing use protection, existing uses of the water body and the water quality to protect these uses must be maintained. Tier 2 water bodies have water quality that is better than the water quality standards. Significant lowering of the water quality of Tier 2 waters is not allowed without an evaluation of the economic and social impacts. Tier 3 water bodies are exceptional waters and are so designated by regulatory amendment. The antidegradation policy prohibits new or expanded discharges into exceptional waters.

The antidegradation review begins with a Tier determination. The Opequon Water Reclamation Facility (OWRF) discharges to a segment of Opequon Creek, which is classified as Tier 1. This finding is based on the fact that the receiving stream is on the EPA 303(d) list with an approved TMDL for the General Standard (Benthic). Antidegradation baselines are not calculated for Tier 1 waters; however, permit limits for this reissuance were set such that Water Quality Standards will be maintained.

13. Site Inspection: Date: November 18 & 20, 2003 Performed by: Lisa M. Kelly

14. Effluent Screening and Effluent Limitations:
APPENDIX C

15. Toxics Management Program Requirements:
APPENDIX D

16. Permit Changes and Bases for Special Conditions:
APPENDIX E

17. Material Storage: This permit requires that the facility's O&M Manual include information to address the management of wastes, fluids, and pollutants which may be present at the facility, to avoid unauthorized discharge of such materials (9 VAC 25-31-280.B.2.).

18. Antibacksliding Review: Limits for ammonia-N and TRC are less stringent than the current annual limits. Also, limits for chloride were removed from the permit at this reissuance. See Appendix C for an evaluation which demonstrates why the relaxation and removal of these limits is acceptable. This permit complies with Antibacksliding provisions of the VPDES Permit Regulation, 9 VAC 25-31-220.L.

19. 303(d) List Considerations: The facility discharges to a stream segment listed in the currently approved 303(d) list. The stream is listed as impaired due to elevated bacteria levels and for not meeting the

General Standard (Benthics). The facility is allocated 2.12 x 10^{13} cfu/yr E. coli and 505.71 metric tons/yr TSS in the currently approved TMDL for Opequon Creek.

20. Regulation of Users per 9 VAC 25-31-280.B.9: N/A

21. Storm Water:
Application Required per 9 VAC 25-151? [X] Yes [ ] No

A No Exposure Certification statement was submitted with the application in lieu of a storm water application. The statement was reviewed and approved with the reissuance of the permit.

If "No," check one: N/A
[ ] This facility does not have a design flow ≥ 1.0 MGD, nor is it required to have an approved POTW pretreatment program under 9 VAC 25-31-10 et seq.
[ ] This facility's SIC Code(s) and activities do not fall within the categories for which a Storm Water Application submittal is required.

22. Public Notice Information: All pertinent information is on file, and may be inspected and copied by contacting Trevor Wallace at: DEQ-Valley Regional Office, P.O. Box 3000, Harrisonburg, Virginia 22801, Telephone No. (540) 574-7807, thwallace@deq.virginia.gov.

Persons may comment in writing or by email to the DEQ on the proposed permit action, and may request a public hearing, during the comment period. Comments shall include the name, address, and telephone number of the writer, and shall contain a complete, concise statement of the factual basis for comments. Only those comments received within this period will be considered. The DEQ may decide to hold a public hearing if public response is significant. Requests for public hearings shall state the reason why a hearing is requested, the nature of the issues proposed to be raised in the public hearing and a brief explanation of how the requester's interests would be directly and adversely affected by the proposed permit action. Following the comment period, the Board will make a determination regarding the proposed permit action. This determination will become effective, unless the DEQ grants a public hearing. Due notice of any public hearing will be given.

23. Historical Record:

EVENT	DATE
VPDES PERMIT ISSUANCE w/ DAF = 5.0 MGD. Limits for: $CBOD_5$, NH_3-N, TSS, TRC, DO, pH	2/7/85
VPDES PERMIT MODIFICATION w/ DAF = 5.0 MGD. Limits for: $CBOD_5$, NH_3-N, TSS, TRC, DO, pH	2/11/87
VPDES PERMIT REISSUANCE w/ DAF = 6.25 MGD. Limits for: $CBOD_5$, NH_3-N, TSS, TRC, DO, pH, Fecal Coliform	2/11/91
VPDES PERMIT REISSUANCE w/ DAF = 6.25 MGD. Limits for: $CBOD_5$, NH_3-N, TSS, TRC, DO, pH, Fecal Coliform	2/1/96
VPDES PERMIT MODIFICATION w/ DAF = 6.25 MGD and an additional flow tier w/ DAF = 8.4 MGD (Jun-Nov), 16.0 MGD (Dec-May). Limits for: $CBOD_5$, NH_3-N, TSS, TRC, DO, pH, Fecal Coliform. Quarterly monitoring for TN and TP.	6/24/97
VPDES PERMIT REISSUACNE w/ DAF = 8.4 MGD (Jun-Nov), 16.0 MGD (Dec-May). Limits for: $CBOD_5$, NH_3-N, TSS, TRC, DO, pH, Fecal Coliform. Quarterly monitoring for TN and TP.	2/11/01
VPDES PERMIT REISSUANCE w/ DAF = 8.4 MGD and Seasonal (Dec-May) Flow Tier of 16.0 MGD. Expanded Flow Tiers w/ DAF = 10.4 MGD & 12.6 MGD. Limits for: BOD_5 (Jun-Nov), CBOD5 (Dec-May), NH_3-N, TSS, TRC, DO, pH, E. Coli, TN, TP.	Pending

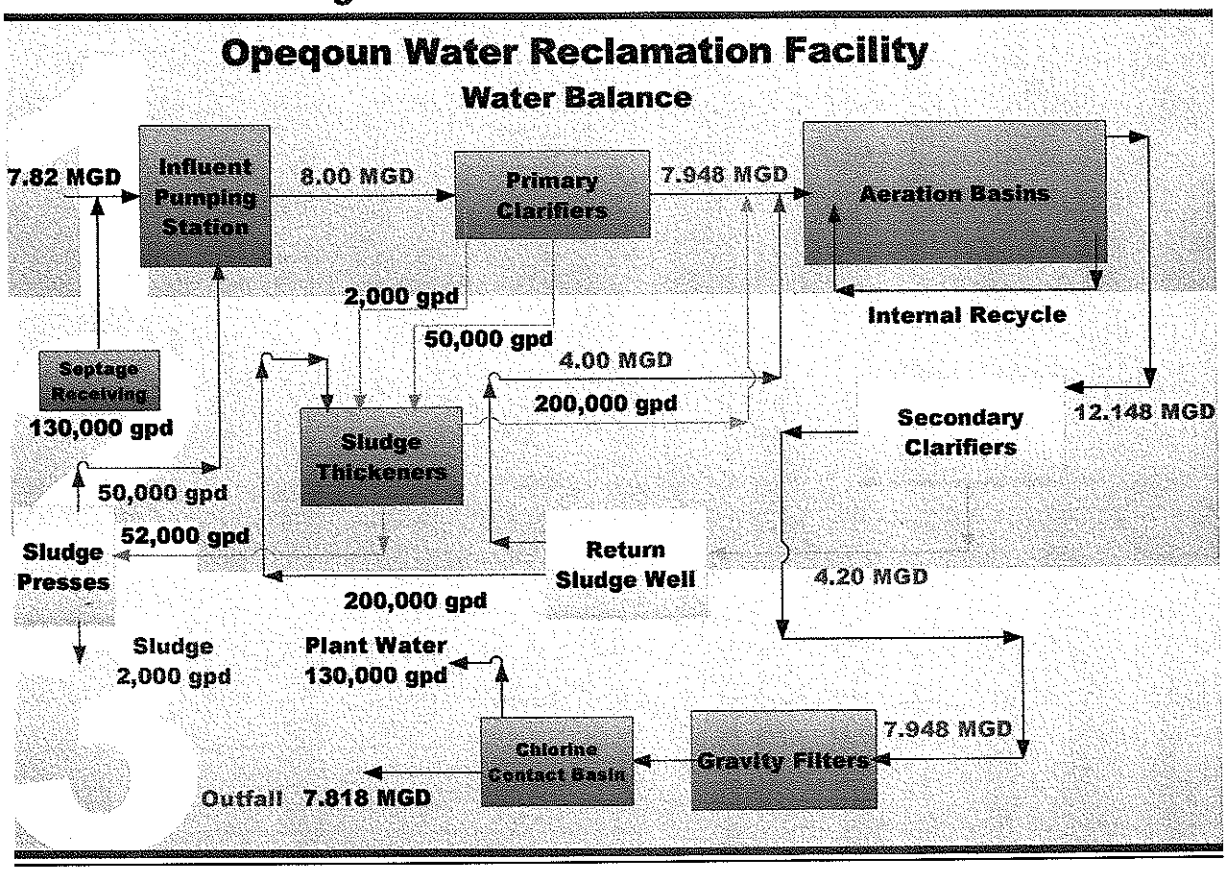
APPENDIX A

DESCRIPTION OF WASTEWATERS AND TREATMENT FACILITIES

The Opequon Water Reclamation Facility (OWRF) utilizes a conventional activated sludge system (designed for biological nutrient removal) to treat sewage from a variety of sources in Winchester and neighboring areas of Frederick County. These sources include domestic waste as well as commercial, industrial, and institutional facility wastes. The OWRF facilities are depicted in the process flow diagram included in this Appendix.

Current annual average daily flow rate = 7.8 MGD
Interim Flow Tier 1 – Design Capacity = 8.4 MGD (Jun – Nov), 16.0 MGD (Dec – May)
Final Flow Tier 1 – Design Capacity = 8.4 MGD
Flow Tier 2 – Design Capacity = 10.4 MGD
Flow Tier 3 – Design Capacity = 12.6 MGD

Process Flow Diagram



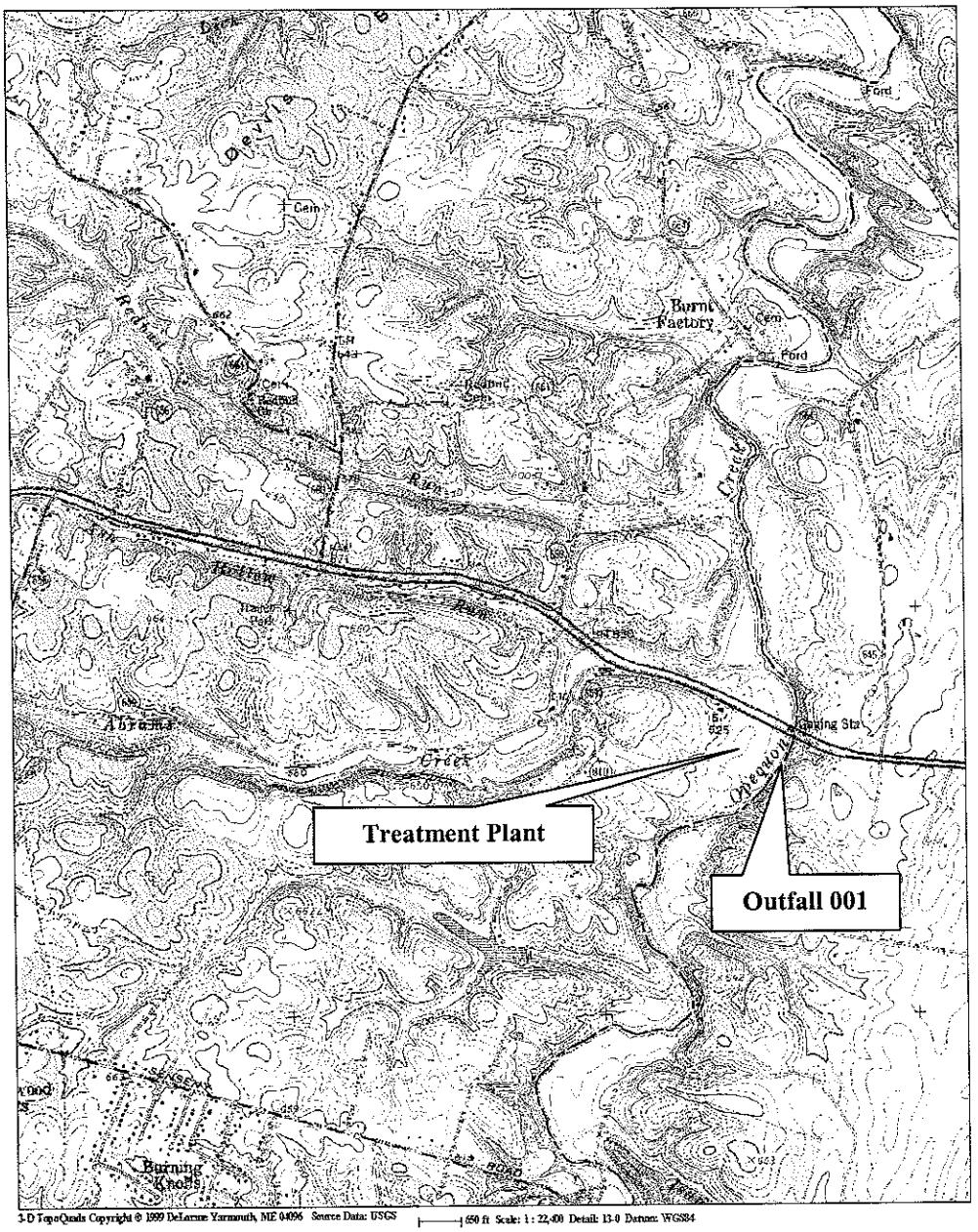
APPENDIX B

DISCHARGE LOCATION AND RECEIVING WATERS INFORMATION

OWRF discharges to Opequon Creek in Frederick County. The topographical maps below indicate the location of the treatment plant and Outfall 001.

Relevant points of interest within the watershed of the Potomac River and in the vicinity of the subject discharge are shown on the Water Quality Assessments TMDL Review for the Potomac River Basin and the corresponding map found in this Appendix.

A Flow Frequency Determination for Opequon Creek at the discharge point was provided by memo from Eric T. Aschenbach on March 18, 2005, and is also included in this Appendix.



MIXING ZONE ANALYSES

Mixing zone analyses were conducted at Outfall 001 for the annual and wet season stream flows using DEQ's mixing program (MIX.EXE). The results are used to determine the percentage of the total receiving stream flow available for mixing and dilution of the effluent. The results are as tabulated below:

Critical Annual Flow Mixing Conditions	Critical Annual Flow Mixing Conditions
Design Flow of 8.4 MGD	***Design Flow of 10.4 MGD***
Effluent Flow = 8.4 MGD Stream 7Q10 = 0.97 MGD Stream 30Q10 = 1.42 MGD Stream 1Q10 = 0.71 MGD Stream slope = 0.00114 ft/ft Stream width = 40 ft Bottom scale = 3 Channel scale = 1	Effluent Flow = 10.4 MGD Stream 7Q10 = 0.97 MGD Stream 30Q10 = 1.42 MGD Stream 1Q10 = 0.71 MGD Stream slope = 0.00114 ft/ft Stream width = 42 ft Bottom scale = 3 Channel scale = 1
Mixing Zone Predictions @ 7Q10 Depth = .8851 ft Length = 1643.41 ft Velocity = .4096 ft/sec Residence Time = .0464 days Recommendation: A complete mix assumption is appropriate for this situation and the entire 7Q10 may be used.	Mixing Zone Predictions @ 7Q10 Depth = .9661 ft Length = 1682.2 ft Velocity = .4338 ft/sec Residence Time = .0449 days Recommendation: A complete mix assumption is appropriate for this situation and the entire 7Q10 may be used.
Mixing Zone Predictions @ 30Q10 Depth = .9108 ft Length = 1603.14 ft Velocity = .4172 ft/sec Residence Time = .0445 days Recommendation: A complete mix assumption is appropriate for this situation and the entire 30Q10 may be used.	Mixing Zone Predictions @ 30Q10 Depth = .9893 ft Length = 1648.19 ft Velocity = .4404 ft/sec Residence Time = .0433 days Recommendation: A complete mix assumption is appropriate for this situation and the entire 30Q10 may be used.
Mixing Zone Predictions @ 1Q10 Depth = .8701 ft Length = 1667.69 ft Velocity = .4052 ft/sec Residence Time = 1.1433 hours Recommendation: A complete mix assumption is appropriate for this situation providing no more than 87.46% of the 1Q10 is used.	Mixing Zone Predictions @ 1Q10 Depth = .9526 ft Length = 1702.82 ft Velocity = .4299 ft/sec Residence Time = 1.1004 hours Recommendation: A complete mix assumption is appropriate for this situation providing no more than 90.88% of the 1Q10 is used.
Virginia DEQ Mixing Zone Analysis Version 2.1	

Critical Annual Flow Mixing Conditions

Design Flow of 12.6 MGD

Effluent Flow = 12.6 MGD
Stream 7Q10 = 0.97 MGD
Stream 30Q10 = 1.42 MGD
Stream 1Q10 = 0.71 MGD
Stream slope = 0.00114 ft/ft
Stream width = 45 ft
Bottom scale = 3
Channel scale = 1

Mixing Zone Predictions @ 7Q10
Depth = 1.0306 ft
Length = 1830.03 ft
Velocity = .4529 ft/sec
Residence Time = .0468 days

Recommendation: A complete mix assumption is appropriate for this situation and the entire 7Q10 may be used.

Mixing Zone Predictions @ 30Q10
Depth = 1.0514 ft
Length = 1798.83 ft
Velocity = .4587 ft/sec
Residence Time = .0454 days

Recommendation: A complete mix assumption is appropriate for this situation and the entire 30Q10 may be used.

Mixing Zone Predictions @ 1Q10
Depth = 1.0185 ft
Length = 1848.77 ft
Velocity = .4495 ft/sec
Residence Time = 1.1424 hours

Recommendation: A complete mix assumption is appropriate for this situation providing no more than 87.53% of the 1Q10 is used.

Virginia DEQ Mixing Zone Analysis Version 2.1

Critical Wet Season Flow Mixing Conditions	Critical Wet Season Flow Mixing Conditions
Design Flow of 8.4 MGD	***Design Flow of 10.4 MGD***
Effluent Flow = 8.4 MGD Stream 7Q10 = 2.65 MGD Stream 30Q10 = 4.33 MGD Stream 1Q10 = 2.0 MGD Stream slope = 0.00114 ft/ft Stream width = 41 ft Bottom scale = 3 Channel scale = 1	Effluent Flow = 10.4 MGD Stream 7Q10 = 2.65 MGD Stream 30Q10 = 4.33 MGD Stream 1Q10 = 2.0 MGD Stream slope = 0.00114 ft/ft Stream width = 44 ft Bottom scale = 3 Channel scale = 1
---------- Mixing Zone Predictions @ 7Q10 Depth = .9639 ft Length = 1605.14 ft Velocity = .4328 ft/sec Residence Time = .0429 days Recommendation: A complete mix assumption is appropriate for this situation and the entire 7Q10 may be used.	---------- Mixing Zone Predictions @ 7Q10 Depth = 1.0207 ft Length = 1763.18 ft Velocity = .4498 ft/sec Residence Time = .0454 days Recommendation: A complete mix assumption is appropriate for this situation and the entire 7Q10 may be used.
---------- Mixing Zone Predictions @ 30Q10 Depth = 1.051 ft Length = 1489.38 ft Velocity = .4573 ft/sec Residence Time = .0377 days Recommendation: A complete mix assumption is appropriate for this situation and the entire 30Q10 may be used.	---------- Mixing Zone Predictions @ 30Q10 Depth = 1.0991 ft Length = 1653.95 ft Velocity = .4715 ft/sec Residence Time = .0406 days Recommendation: A complete mix assumption is appropriate for this situation and the entire 30Q10 may be used.
---------- Mixing Zone Predictions @ 1Q10 Depth = .9288 ft Length = 1657.35 ft Velocity = .4227 ft/sec Residence Time = 1.0891 hours Recommendation: A complete mix assumption is appropriate for this situation providing no more than 91.82% of the 1Q10 is used.	---------- Mixing Zone Predictions @ 1Q10 Depth = .9893 ft Length = 1811.37 ft Velocity = .441 ft/sec Residence Time = 1.141 hours Recommendation: A complete mix assumption is appropriate for this situation providing no more than 87.64% of the 1Q10 is used.
Virginia DEQ Mixing Zone Analysis Version 2.1	

Critical Wet Season Flow Mixing Conditions	Critical Wet Season Flow Mixing Conditions
Design Flow of 12.6 MGD	***Design Flow of 16.0 MGD***
Effluent Flow = 12.6 MGD Stream 7Q10 = 2.65 MGD Stream 30Q10 = 4.33 MGD Stream 1Q10 = 2.0 MGD Stream slope = 0.00114 ft/ft Stream width = 47 ft Bottom scale = 3 Channel scale = 1	Effluent Flow = 16.0 MGD Stream 7Q10 = 2.65 MGD Stream 30Q10 = 4.33 MGD Stream 1Q10 = 2.00 MGD Stream slope = 0.00114 ft/ft Stream width = 50 ft Bottom scale = 3 Channel scale = 1
--- Mixing Zone Predictions @ 7Q10 Depth = 1.077 ft Length = 1924.49 ft Velocity = .4664 ft/sec Residence Time = .0478 days	--- Mixing Zone Predictions @ 7Q10 Depth = 1.1714 ft Length = 2029.43 ft Velocity = .4929 ft/sec Residence Time = .0477 days
Recommendation: A complete mix assumption is appropriate for this situation and the entire 7Q10 may be used.	Recommendation: A complete mix assumption is appropriate for this situation and the entire 7Q10 may be used.
--- Mixing Zone Predictions @ 30Q10 Depth = 1.148 ft Length = 1821.32 ft Velocity = .4857 ft/sec Residence Time = .0434 days	--- Mixing Zone Predictions @ 30Q10 Depth = 1.2348 ft Length = 1939.1 ft Velocity = .5097 ft/sec Residence Time = .044 days
Recommendation: A complete mix assumption is appropriate for this situation and the entire 30Q10 may be used.	Recommendation: A complete mix assumption is appropriate for this situation and the entire 30Q10 may be used.
--- Mixing Zone Predictions @ 1Q10 Depth = 1.0487 ft Length = 1969.12 ft Velocity = .4585 ft/sec Residence Time = 1.1929 hours	--- Mixing Zone Predictions @ 1Q10 Depth = 1.1463 ft Length = 2067.69 ft Velocity = .4862 ft/sec Residence Time = 1.1814 hours
Recommendation: A complete mix assumption is appropriate for this situation providing no more than 83.83% of the 1Q10 is used.	Recommendation: A complete mix assumption is appropriate for this situation providing no more than 84.65% of the 1Q10 is used.
Virginia DEQ Mixing Zone Analysis Version 2.1	

WATER QUALITY ASSESSMENTS TMDL REVIEW
POTOMAC-SHENANDOAH RIVER BASIN
6/20/2005

IMPAIRED SEGMENT:

SEGMENT ID	STREAM	SEGMENT START	SEGMENT END	LENGTH	PARAMETER
VAV-B08R-01	Opequon Creek	57.26	32.38	24.88 - Miles	Fecal Coli, Gen Std-Benthic
VAV-B09R-01	Abrams Creek	10.8	0	10.8 - Miles	Fecal Coli, Gen Std-Benthic
VAV-B09R-02	Opequon Creek	32.38	23.56	8.82 - Miles	Fecal Coli, Gen Std-Benthic
VAV-B09R-03	Lick Run	8.87	0	8.87 - Miles	Fecal Coliform
VAV-B09R-04	Redbud Run	8.07	0	8.07 - Miles	Fecal Coli, Gen Std-Benthic

PERMIT:	FACILITY:	STREAM:	MILE	LAT	LONG	WBID
VA0023116	I-81 Rest Area STP	Littlers Run(Hot Run)	3.22	391431	780617	VAV-B09R
VA0029653	County Court Reporters STP	Lick Run	0.8	391257	780456	VAV-B09R
VA0058025	Plumly, P.W.	Town Run	1.04	391055	780947	VAV-B09R
VA0062693	Shenandoah Mobile Court STP	Buffalo Lick Run X Trib	0.78	390728	780914	VAV-B08R
VA0065552	**Opequon WRF**	**Opequon Creek**	**32.66**	**391036**	**780429**	**VAV-B08R**
VA0075191	Parkins Mill STP	Opequon Creek	43.99	390627	780913	VAV-B08R
VA0087815	Fay Spring WTP	Redbud Run X-Trib	0.02	391218	780753	VAV-B09R
VA0088471	Frederick County Landfill	Opequon Creek	36.19	390837	780525	VAV-B08R
VA0089010	Franciscan Center	Opequon Creek X-Trib	0.23	390547	780815	VAV-B08R
VA0090808	APAC Virginia WWTP	Hot Run X-Trib	0.384	391426	780622	VAV-B09R

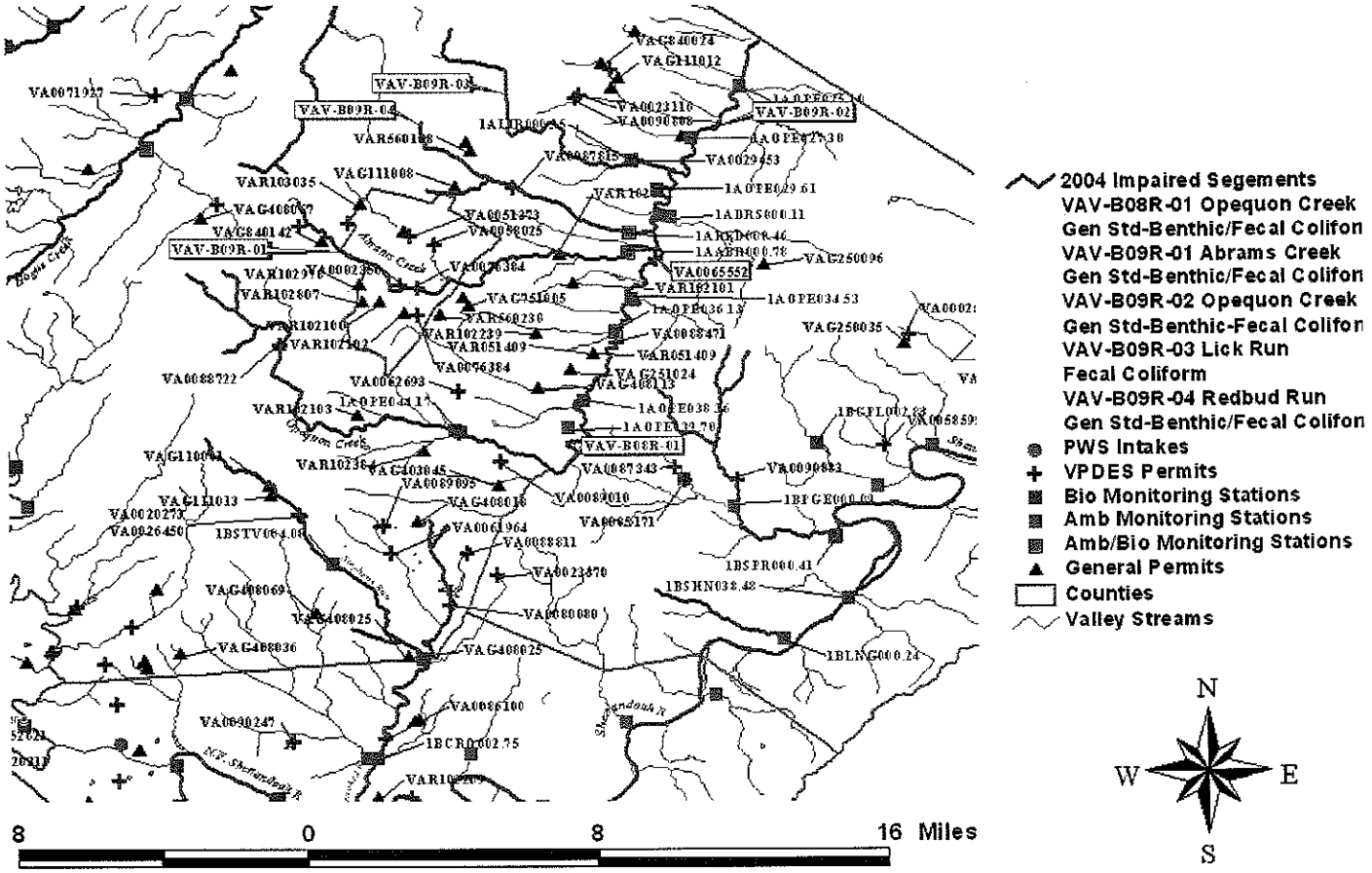
MONITORING STATIONS

STREAM	NAME	MILE	RECORD	LAT	LONG
Opequon Creek	1AOPE029.61	29.61	1984	391215	780427
Lick Run	1ALIR000.95	0.95	7/1/91	391255	780502
Opequon Creek	1AOPE025.10	25.1	4/25/79	391443	780227
Opequon Creek	1AOPE038.36	38.36	7/1/97	390713	780614
Opequon Creek	1AOPE044.17	44.17	8/1/01	390630	780921
Opequon Creek	1AOPE031.26	31.26	7/1/03	391136	780426
Opequon Creek	1AOPE027.30	27.3	7/1/03	391328	780337
Dry Marsh Run	1ADRS000.11	0.11	7/1/03	391135	780409
Opequon Creek	1AOPE044.01	44.01	3/12/01	390627	780912
Opequon Creek	1AOPE039.70	39.7	7/1/01	390633	780637
Abrams Creek	1AABR000.78	0.78	8/25/76	391043	780508
Opequon Creek	1AOPE036.13	36.13	7/1/91	390852	780526
Redbud Run	1ARED000.46	0.46	7/1/91	391113	780505

PUBLIC WATER SUPPLY INTAKES:

OWNER:	STREAM:	RIVER MILE:
None		

Opequon Water Reclamation Facility - TMDL Information
Potomac-Shenandoah Basin
June 20, 2005



MEMORANDUM

DEPARTMENT OF ENVIRONMENTAL QUALITY
VALLEY REGIONAL OFFICE

4411 Early Road – P.O. Box 3000 **Harrisonburg, VA 22801**

SUBJECT: Flow Frequency Determination
Opequon Water Reclamation Facility, VPDES Permit No. VA0065552, Frederick County

TO: Trevor Wallace → Permit Processing File

FROM: Eric Aschenbach

DATE: March 18, 2005

COPIES: File

This memo supersedes Paul Herman's flow frequency determination dated July 31, 2000.

The Opequon WRF discharges to Opequon Creek near Berryville, Virginia. While the period of record for the reference gage has not changed since the previous memo, additional stream flow frequencies that were not previously provided are required at this site for use by the permit writer in developing effluent limitations for the VPDES permit reissuance. In addition, actions have been taken to ensure this memorandum is consistent with the recent determination completed for the Parkins Mill STP modification.

The VDEQ operated a continuous record gage on Opequon Creek near Berryville, Virginia (#01615000) from 1943-1997. The gage is located downstream of the discharge point at the Route 7 bridge in Frederick County, Virginia. In July 1988, approximately 1000 feet upstream of the gage, the Opequon WRF began discharging from a 6.0 MGD facility to Opequon Creek. Therefore, the flow frequencies for the reference gage are based only on the period of record from 1943 to 1988. Since the Parkins Mill STP did not begin discharging to Opequon Creek until about September 1989, its flow did not impact the gage during the selected period of record. Due to the proximity of the gage to the Opequon WRF outfall, the values for the gage are applied directly to the discharge point. This analysis does not address any other discharges, withdrawals, or springs that may be located between the gage and the discharge point. The flow frequencies for the reference gage/discharge point are presented below.

Opequon Creek near Berryville, VA (#01615000):

Drainage Area = 57.4 mi^2

1Q10 =	1.1 cfs	(0.71 mgd)	High Flow 1Q10 =	3.1 cfs	(2.00 mgd)
7Q10 =	1.5 cfs	(0.97 mgd)	High Flow 7Q10 =	4.2 cfs	(2.65 mgd)
30Q10 =	2.2 cfs	(1.42 mgd)	High Flow 30Q10 =	6.2 cfs	(4.33 mgd)
30Q5 =	3.1 cfs	(2.00 mgd)	HM =	10.2 cfs	(6.59 mgd)
			Annual Average =	42.9 cfs	(27.7 mgd)

The high flow months are December through May.

APPENDIX C

EFFLUENT LIMITATIONS

A comparison of technology and water quality-based limits was performed, and the most stringent limits were selected. The selected limits are summarized in the table below.

Basis for Permit Limits

Flow Tier 1: Outfall 001 – Interim Limits Design Flow: 8.4 MGD (Jun-Nov), 16.0 MGD (Dec-May)

PARAMETER	BASIS FOR LIMITS	EFFLUENT LIMITATIONS		MONITORING REQUIREMENTS	
		Monthly Avg.	Weekly Avg.	Frequency	Sample Type
Flow (MGD)	4, 5	NL	NL	Continuous	T/I/R
TSS (Jun – Nov)	1, 8	30 mg/L	45 mg/L	1/Month	24 HC
		950 mg/L	1400 mg/L		
TSS (Dec – May)	1, 8	30 mg/L	45 mg/L	1/Month	24 HC
		1400 kg/d	2700 kg/d		
BOD_5 (Jun – Nov)	3, 6, 12	7.1 mg/L	11 mg/L	1/Day	24 HC
		206.99 kg/d	350 kg/d		
$CBOD_5$ (Dec – May)	3, 6	25 mg/L	40 mg/L	1/Week	24 HC
		1514 kg/d	2400 kg/d		
Ammonia-N (Jun – Nov)	3	2.1 mg/L	2.6 mg/L	1/Week	24 HC
Ammonia-N (Dec – May)	3	3.3 mg/L	4.1 mg/L	1/Day	24 HC
E. coli (geometric mean)	3, 8	126 N/100 mL	NA	3 Days/Week @ 48-Hour Intervals 10 a.m. – 4 p.m.	Grab
TRC, Effluent *	3	0.0087 mg/L	0.011 mg/L	1/Day	Grab
--------	--------	Minimum	Maximum	--------	--------
TRC, Chlorine Contact Tank *	2, 3	0.25 mg/L	NA	1/Hour	Grab
pH	3	6.5 S.U.	9.5 S.U.	1/Day	Grab
Dissolved Oxygen	3, 6	7.1 mg/L	NA	1/Day	Grab
Total Nitrogen	7	See page C5 for effluent nutrient limitations and monitoring requirements.			
Total Phosphorus	7	See page C5 for effluent nutrient limitations and monitoring requirements.			

NL = No Limitation, monitoring required
NA = Not Applicable
T/I/R = Totalizing, Indicating, and Recording equipment
24 HC = 24 Hour composite sample

* Applicable only if chlorination is used for disinfection.

NOTE: See page C6 for effluent limitations bases.

Flow Tier 1: Outfall 001 – Final Limits Design Flow: 8.4 MGD

PARAMETER	BASIS FOR LIMITS	EFFLUENT LIMITATIONS		MONITORING REQUIREMENTS	
		Monthly Avg.	Weekly Avg.	Frequency	Sample Type
Flow (MGD)	4, 5	NL	NL	Continuous	T/I/R
TSS	1, 8	30 mg/L	45 mg/L	1/Month	24 HC
		950 mg/L	1400 mg/L		
BOD_5 (Jun – Nov)	3, 6, 12	7.1 mg/L	11 mg/L	1/Day	24 HC
		206.99 kg/d	350 kg/d		
$CBOD_5$ (Dec – May)	3, 6	25 mg/L	40 mg/L	1/Week	24 HC
		790 kg/d	1300 kg/d		
Ammonia-N (Jun – Nov)	3	2.1 mg/L	2.6 mg/L	1/Day	24 HC
Ammonia-N (Dec – May)	3	3.8 mg/L	4.7 mg/L	1/Day	24 HC
E. coli (geometric mean)	3, 8	126 N/100 mL	NA	3 Days/Week @ 48-Hour Intervals 10 a.m. – 4 p.m.	Grab
TRC, Effluent *	3	0.0087 mg/L	0.011 mg/L	1/Day	Grab
--------	--------	Minimum	Maximum	--------	--------
Whole Effluent Toxicity	11	NA	1.61 TUc	1/Quarter	24 HC
TRC, Chlorine Contact Tank *	2, 3	0.25 mg/L	NA	1/Hour	Grab
pH	3	6.5 S.U.	9.5 S.U.	1/Day	Grab
Dissolved Oxygen	3, 6	7.1 mg/L	NA	1/Day	Grab
Total Nitrogen	7	See page C6 for effluent nutrient limitations and monitoring requirements.			
Total Phosphorus	7	See page C6 for effluent nutrient limitations and monitoring requirements.			

NL = No Limitation, monitoring required
NA = Not Applicable
T/I/R = Totalizing, Indicating, and Recording equipment
24 HC = 24 Hour composite sample

* Applicable only if chlorination is used for disinfection.

NOTE: See page C6 for effluent limitations bases.

Flow Tier 2: Outfall 001 – Final Limits Design Flow: 10.4 MGD

PARAMETER	BASIS FOR LIMITS	EFFLUENT LIMITATIONS		MONITORING REQUIREMENTS	
		Monthly Avg.	Weekly Avg.	Frequency	Sample Type
Flow (MGD)	4, 5	NL	NL	Continuous	T/I/R
TSS	1, 8	30 mg/L	45 mg/L	1/Month	24 HC
		1200 mg/L	1800 mg/L		
BOD_5 (Jun – Nov)	3, 6, 12	7.1 mg/L	11 mg/L	1/Day	24 HC
		206.99 kg/d	430 kg/d		
$CBOD_5$ (Dec – May)	3, 6	25 mg/L	40 mg/L	1/Week	24 HC
		980 kg/d	1600 kg/d		
Ammonia-N (Jun – Nov)	3	2.1 mg/L	2.6 mg/L	1/Day	24 HC
Ammonia-N (Dec – May)	3	3.6 mg/L	4.4 mg/L	1/Day	24 HC
E. coli (geometric mean)	3, 8	126 N/100 mL	NA	3 Days/Week @ 48-Hour Intervals 10 a.m. – 4 p.m.	Grab
TRC, Effluent *	3	0.0087 mg/L	0.011 mg/L	1/Day	Grab
---------	---------	Minimum	Maximum	---------	---------
Whole Effluent Toxicity	11	NA	1.59 TUc	1/Quarter	24 HC
TRC, Chlorine Contact Tank *	2, 3	0.25 mg/L	NA	1/Hour	Grab
pH	3	6.5 S.U.	9.5 S.U.	1/Day	Grab
Dissolved Oxygen	3, 6	7.1 mg/L	NA	1/Day	Grab
Total Nitrogen	7	See page C6 for effluent nutrient limitations and monitoring requirements.			
Total Phosphorus	7	See page C6 for effluent nutrient limitations and monitoring requirements.			

NL = No Limitation, monitoring required
NA = Not Applicable
T/I/R = Totalizing, Indicating, and Recording equipment
24 HC = 24 Hour composite sample

* Applicable only if chlorination is used for disinfection.

NOTE: See page C6 for effluent limitations bases.

Flow Tier 3: Outfall 001 – Final Limits Design Flow: 12.6 MGD

PARAMETER	BASIS FOR LIMITS	EFFLUENT LIMITATIONS		MONITORING REQUIREMENTS	
		Monthly Avg.	Weekly Avg.	Frequency	Sample Type
Flow (MGD)	4, 5	NL	NL	Continuous	T/I/R
TSS	1, 8	29 mg/L	44 mg/L	1/Month	24 HC
		1400 kg/d	2100 kg/d		
BOD_5 (Jun – Nov)	3, 6, 12	7.1 mg/L	11 mg/L	1/Day	24 HC
		206.99 kg/d	520 kg/d		
$CBOD_5$ (Dec – May)	3, 6	25 mg/L	40 mg/L	1/Week	24 HC
		1200 kg/d	1900 kg/d		
Ammonia-N (Jun – Nov)	3	2.0 mg/L	2.5 mg/L	1/Day	24 HC
Ammonia-N (Dec – May)	3	3.5 mg/L	4.3 mg/L	1/Day	24 HC
E. coli (geometric mean)	3, 8	122 N/100 mL	NA	3 Days/Week @ 48-Hour Intervals 10 a.m. – 4 p.m.	Grab
TRC, Effluent *	3	0.0087 mg/L	0.011 mg/L	1/Day	Grab
--------	--------	Minimum	Maximum	--------	--------
Whole Effluent Toxicity	11	NA	1.56 TUc	1/Quarter	24 HC
TRC, Chlorine Contact Tank *	2, 3	0.25 mg/L	NA	1/Hour	Grab
pH	3	6.5 S.U.	9.5 S.U.	1/Day	Grab
Dissolved Oxygen	3, 6	7.1 mg/L	NA	1/Day	Grab
Total Nitrogen	7	See page C6 for effluent nutrient limitations and monitoring requirements.			
Total Phosphorus	7	See page C6 for effluent nutrient limitations and monitoring requirements.			

NL = No Limitation, monitoring required
NA = Not Applicable
T/I/R = Totalizing, Indicating, and Recording equipment
24 HC = 24 Hour composite sample

* Applicable only if chlorination is used for disinfection.

NOTE: See page C6 for effluent limitations bases.

Bases for Permit Limits – Interim Limits (Nutrients) Outfall 001- Flow Tier: 1

PARAMETER	BASIS FOR LIMITS	EFFLUENT LIMITATIONS		MONITORING REQUIREMENTS	
		Monthly Average	Maximum	Frequency	Sample Type
Total Phosphorus	7	NL (mg/L)	NA	1/Week	24 HC
		NL (lb/d)			
Total Phosphorus - Monthly (kg/mo)	7	NA	NL	1/Month	Calculated
Orthophosphate	7	NL (mg/L)	NA	1/Week	24 HC
		NL (lb/d)			
Total Kjeldahl Nitrogen	7	NL (mg/L)	NA	1/Week	24 HC
		NL (lb/d)			
Nitrate plus Nitrite	7	NL (mg/L)	NA	1/Week	24 HC
		NL (lb/d)			
Total Nitrogen	7	NL (mg/L)	NA	1/Week	Calculated
		NL (lb/d)			
Total Nitrogen – Monthly (kg/mo)	7	NA	NL	1/Month	Calculated
--------	--------	Annual Average	Maximum	Frequency	Sample Type
Total Phosphorus – Year to Date	7	NL (mg/L)	NL (lb/yr)	1/Month	Calculated*
Total Phosphorus – Calendar Year	7	NL (mg/L)	NL (lb/yr)	1/Year	Calculated**
Total Nitrogen – Year to Date	7	NL (mg/L)	NL (lb/yr)	1/Month	Calculated*
Total Nitrogen – Calendar Year	7	NL (mg/L)	NL (lb/yr)	1/Year	Calculated**

NL = No Limitation, monitoring required
NA = Not Applicable

* To be reported on a monthly basis as the cumulative loading beginning with monitoring performed during the month of January each year and ending with the monitoring performed for the month of current reporting.

** To be reported on an annual basis as the total loading for the calendar year.

1) See page C6 for effluent limitations bases.

Bases for Permit Limits – Final Limits (Nutrients) Outfall 001- Flow Tiers: 1-3

PARAMETER	BASIS FOR LIMITS	EFFLUENT LIMITATIONS		MONITORING REQUIREMENTS	
		Monthly Average	Maximum	Frequency	Sample Type
Total Phosphorus	7	NL (mg/L) NL (lb/d)	NA	1/Week	24 HC
Total Phosphorus - Monthly (kg/mo)	7	NA	NL	1/Month	Calculated
Orthophosphate	7	NL (mg/L) NL (lb/d)	NA	1/Week	24 HC
Total Kjeldahl Nitrogen	7	NL (mg/L) NL (lb/d)	NA	1/Week	24 HC
Nitrate plus Nitrite	7	NL (mg/L) NL (lb/d)	NA	1/Week	24 HC
Total Nitrogen	7	NL (mg/L) NL (lb/d)	NA	1/Week	Calculated
Total Nitrogen – Monthly (kg/mo)	7	NA	NL	1/Month	Calculated
----------	---------	Annual Average	Maximum	Frequency	Sample Type
Total Phosphorus – Year to Date	7	NL (mg/L)	NL (lb/yr)	1/Month	Calculated**
Total Phosphorus – Calendar Year	7, 9, 10	0.3 mg/L*	7,675 lb/yr	1/Year	Calculated***
Total Nitrogen – Year to Date	7	NL (mg/L)	NL (lb/yr)	1/Month	Calculated**
Total Nitrogen – Calendar Year	7, 9, 10	3.0 mg/L*	102,336 lb/yr	1/Year	Calculated***

NL = No Limitation, monitoring required
NA = Not Applicable

* Limitation not applicable to Flow Tier 1.

** To be reported on a monthly basis as the average concentration and cumulative loading beginning with monitoring performed during the month of January each year and ending with the monitoring performed for the month of current reporting.

*** To be reported on an annual basis as the average concentration and total loading for the calendar year.

Bases for Effluent Limitations

1. Federal Effluent Guidelines and Standards – 40 CFR 133
2. Best Professional Judgement (BPJ)
3. Water Quality Standards
4. VPDES Permit Manual
5. VPDES Regulations
6. DO model presented in the Opequon Creek Capacity Study report dated March 2005 with all subsequent information and model runs (see attached).
7. Guidance Memo No. 05-2009 for facilities on the DEQ Chesapeake Bay Program's List of Significant Discharges.
8. Opequon Creek TMDL for bacteria and suspended solids. Approved 2/18/04.
9. Code of Virginia 62.1-44.19:12 – 19
10. Final Regulation (Rev. June 16, 2005) 9 VAC 25-720 *et seq.*
11. 11/29/05 TMP Evaluation
12. Water Quality Management Plan

The following potential limiting factors have been considered in developing this permit and fact sheet:

Water Quality Management Plan (WQMP)	**BOD, CBOD, TN, TP**
TMDL limits	**TSS, E. coli**
Federal Effluent Guidelines	**TSS, CBOD**
BPJ/Agency Guidance limits	**TRC (contact)**
Water Quality-based limits	**BOD, CBOD, DO, TRC (effluent), Ammonia-N, E. coli, pH**
Toxics Management Plan (TMP) analysis	**WET**
Storm Water limits	**Not Applicable**

EVALUATION OF EFFLUENT CONVENTIONAL POLLUTANTS

A site inspection was not performed at this reissuance, in lieu of the extensive field work performed by the owner's consultant as part of the Opequon Creek Capacity Study (OOCS) (included in this fact sheet) completed in March 2005. Opequon Creek was observed by the permit writer in February 2005. Based on the assessment from that time, the stream conditions presented in the OCCS report appear accurate.

The discharge from the current facility was first modeled in January 1997 by HydroQual, Inc using the proprietary flow model DIURNAL. The discharge was remodel by HydroQual in March 2005 and submitted as part of the OCCS report. DIURNAL was again used as the model base. The revised model encompasses the Parkins Mills WWTF (VA0075191) and Frederick County Landfill (VA0088471) discharges and continues approximately 14 miles downstream of the OWRF discharge, terminating at the confluence of Opequon Creek and Turkey Run in West Virginia. Ammonia-N limits were calculated as part of the 1997 model effort, but were not included in the 2005 report. As such, only (C)BOD and DO limits will be based on the 2005 model data, while ammonia-N limits will be determined per the DEQ toxics evaluation presented in this Appendix. The CBOD and D.O. concentration limits recommended by the model are included in the Effluent Limitation tables included in this appendix. In addition to the concentration based CBOD limits, the Water Quality Management Plan for Opequon Creek limits this discharge to 206.99 kg/d BOD_5 (Jun-Nov) and 1514 kg/d $CBOD_5$ (Dec-May). Because the WQMP specifies the dry season loading as BOD, and not CBOD, the concentration limit was also specified as BOD. The (C)BOD and DO limits applied to the permit at this reissuance were evaluated to be protective of downstream dissolved oxygen WQS's.

Based on the model, it was determined that no TKN limits were needed because the ammonia-N and total nitrogen (TN) limits imposed in this permit will control the effluent TKN.

TSS limits comply with secondary treatment limits and the facility's TSS wasteload allocation included in the Opequon Creek TMDL, approved February 18, 2004.

pH limits reflect the current Water Quality Standard for pH in the receiving stream and limits have been carried forward from the previous permit.

In accordance with current guidance and a change in the WQS, new E. coli limits and monitoring requirements have been imposed in the reissued permit to replace the existing fecal coliform limits. Per the previous permit, bacteria limitations and monitoring requirement are required by the current facility and continue to apply should an alternate to chlorine disinfection be used. These requirements were also applied to the expanded facilities. The 12.6 MGD E. coli limit was adjusted below the WQS of 126 cfu/100mL to comply with the TMDL bacteria loading requirements.

EVALUATION OF NUTRIENTS

Significant portions of the Chesapeake Bay and its tributaries are listed as impaired on Virginia's 303(d) list of impaired waters for not meeting the aquatic life use support goal, and the 2004 Virginia Water Quality Assessment 305(b)/303(d) Integrated Report indicates that 83% of the mainstem Bay does not fully support this use support goal under Virginia's water quality assessment guidelines. Nutrient enrichment is cited as one of the primary causes for impairment.

Guidance Memorandum (GM) 05-2009* implements DEQ's best professional judgment decision to limit nutrient loadings from facilities listed on the Chesapeake Bay Program Significant Discharger List and complies with the requirements set forth in 9 VAC 25-720 *et seq.* GM 05-2009 provides the basis for this decision and specifies the procedure for determining and applying annual nutrient loading limitations and monitoring requirements to SDL facilities. GM 05-2009 also establishes that discharges be required to: monitor and report nutrient effluent loads; submit a Basis of Design Report to construct and operate a range of nutrient removal technologies; and submit an Interim Optimization Plan for the removal with the existing facility. In accordance with the guidance memorandum, this permit contains special conditions requiring submittal of these reports.

This facility appears on the current DEQ Chesapeake Bay Program's Significant Discharger List. (see: http://www.deq.virginia.gov/bay/VASignificantListbyVPDES.pdf)

* Guidance Memo No. 05-2009, VPDES Nutrient Limitations for Significant Discharges to the Chesapeake Bay Watershed, May 24, 2005.

GM 05-2009 specifies that facilities that are included on the CBP SDL should, upon permit reissuance, contain a minimum level of nutrient monitoring and a four year schedule of compliance for meeting the annual nutrient loading limitation. As such, nutrient monitoring and limitations were applied to all permit flow tiers. A four schedule of compliance was allowed for the existing facility (Interim Flow Tier 1) to meet the TN and total phosphorus (TP) WLA's. Annual concentration based nutrient limitations as well as annual WLA's were applied to Flow Tiers 2, 3, and 4 in accordance with Code of Virginia 62.1-44.19:12 – 19. Where a facility expansion results in an annual discharge greater than the facilities allocated load, it is intended that the facility will be required to offset the additional load via a nutrient trading program. Any annual Total Nitrogen and/or Total Phosphorus loadings above and beyond those specified by the permit shall be offset subject to a DEQ-approved trading contract prepared in accordance with sections 62.1-44.19:12 - :19 of the law and any regulations.

The permit includes a general permit (GP) clause that will allow the permittee to obtain coverage under the future nutrient general permit. Per current planning, the GP will establish a formal nutrient trading program through which the OWRF may, if necessary, purchase nutrient credits and/or establish non-point source Best Management Practices sufficient to meet the GP requirements and the annual nutrient load allocations.

The Water Quality Management Plan (9 VAC 25-720), adopted by the State Water Control Board on September 26, 2005, lists nutrient loading limits for this facility in pounds per year. The draft permit will apply the nutrient loading limits in kilograms per year rounded to the nearest whole number using DEQ's guidance on rounding.

The final annual Total Nitrogen and Total Phosphorus load limitations for Opequon Water Reclamation Facility are 102,331 lb/yr (46,417 kg/yr) and 7,675 lb/yr (3,481 kg/yr) respectively.

EVALUATION OF EFFLUENT TOXIC POLLUTANTS

Data Input Form for WQS.WLA Spreadsheet

Discharge: Effluent pH and temperature values were obtained from the monthly Discharge Monitoring Reports (DMRs) submitted by the facility. The effluent hardness was obtained from data included in the permit application submitted for this reissuance.

Table 2. Effluent Data	
90% pH (SU) =	7.7
10% pH (SU) =	7.4
90% Annual Temp (°C) =	24.5
90% Wet Temp (°C) =	18.4
Mean Hardness (mg/L) =	326

Stream: The receiving stream pH, temperature, and hardness values were obtained from observations performed by the DEQ Water Quality Monitoring Program (WQMP) on Opequon Creek (Station ID 1AOPE036.13) at river mile 36.13. The Station ID is located approximately 3.5 miles upstream of outfall 001.

The 90th percentile annual pH was determined to be 8.5 S.U., while the 10th percentile annual pH was 7.8 S.U. The 90th percentile annual temperature was determined to be 21.9 °C and the 90th percentile wet season (December through May) temperature was 15.7 °C. The average hardness was found to be 234 mg/L $CaCO_3$.

Note: Interim Flow Tier 1 includes dry and wet season flow conditions. During the months of June-November, the facility operates at a design flow of 8.4 MGD. During the months of December-May, the design flow is set at 16.0 MGD to account for additional dilute influent flow caused by conveyance system I&I. As a result, WLA's for the 16.0 MGD flow condition were all based on the wet season stream and effluent characteristics.

PROTOCOL FOR EVALUATION OF EFFLUENT TOXIC POLLUTANTS

Toxic pollutants were evaluated in accordance with OWP Guidance Memo No. 00-2011 (8/24/00). Acute and Chronic Waste Load Allocations (WLA_a and WLA_c) were analyzed according to the protocol below using a statistical approach (STAT.exe) to determine the necessity and magnitude of limits. Human Health Waste Load Allocations (WLA_{hh}) were analyzed according to the same protocol through a simple comparison with the effluent data. If the WLA_{hh} exceeded the effluent datum or data mean, no limits were required. If the effluent datum or data mean exceeded the WLA_{hh}, the WLA_{hh} was imposed as the limit. Since there are no data available for any toxic pollutants immediately upstream of this discharge, all upstream (background) pollutant concentrations are assumed to be "0".

The steps used in evaluating the effluent data are as follows:

A. If all data are reported as "below detection" or < the required Quantification Level (QL), and at least one detection level is ≤ the required QL, then the pollutant is considered to be not significantly present in the discharge and no further monitoring is required.

B. If all data are reported as "below detection", and all detection levels are > the required QL, then an evaluation is performed in which the pollutant is assumed present at the lowest reported detection level.

B.1. If the evaluation indicates that no limits are needed, then the existing data set is adequate and no further monitoring is required.

B.2. If the evaluation indicates that limits are needed, then the existing data set is inadequate to make a determination and additional monitoring is required.

C. If any data value is reported as detectable at or above the required QL, then the data are adequate to determine whether effluent limits are needed.

C.1. If the evaluation indicates that no limits are needed, then no further monitoring is required.

C.2. If the evaluation indicates that limits are needed, then the limits and associated requirements are specified in the draft permit.

C.3. (Exception for Metals data only) If the evaluation indicates that limits are needed, but the data are reported as a form other than "Dissolved", then the existing data set is inadequate to make a determination and additional monitoring is required.

TOXLARGE – Flow Tier 1

Refer to the toxic pollutant tables below for the evaluation results for each of the toxic pollutants for which effluent data exists. Based on this evaluation, additional monitoring data is needed for several parameters. The existing data for selenium and cadmium were inadequate to demonstrate they are not present in the effluent in potentially toxic concentrations. Additionally, the effluent needs to be screened for several new WQS parameters within one year of the permit effective date. The permit Attachment A1 includes a list of those parameters for which sample data is required.

Parameter	CASRN	Type	QL (µg/L)	8.4 MGD (Jun-Nov), 16.0 MGD (Dec-May) Data (µg/L unless noted otherwise)	Source of Data	Data Eval
2,4 Dinitrophenol	51-28-5	A	---	<50, <50, <50	a	A
2,4,6-Trichlorophenol [c]	88-06-2	A	10	New data ≤to data previously evaluated. Evaluation not required.	---	---
2,4-Dichlorophenol	120-83-2	A	10	New data ≤to data previously evaluated. Evaluation not required.	---	---
2,4-Dimethylphenol	105-67-9	A	10	New data ≤to data previously evaluated. Evaluation not required.	---	---
2-Chlorophenol	95-57-8	A	10	New data ≤to data previously evaluated. Evaluation not required.	---	---
2-Methyl-4,6-Dinitrophenol	534-52-1	A	---	NEW REQUIREMENT. Needs to be sampled.	---	---
Pentachlorophenol [c]	87-86-5	A	50	New data ≤to data previously evaluated. Evaluation not required.	---	---
Phenol	108-95-2	A	10	New data ≤to data previously evaluated. Evaluation not required.	---	---
1,2,4-Trichlorobenzene	120-82-1	B	10	New data ≤to data previously evaluated. Evaluation not required.	---	---
1,2-Dichlorobenzene	95-50-1	B	10	New data ≤to data previously evaluated. Evaluation not required.	---	---
1,2-Diphenylhydrazine[c]	122-66-7	B	---	<10, <10, <10	a	A
1,3-Dichlorobenzene	541-73-1	B	10	New data ≤to data previously evaluated. Evaluation not required.	---	---
1,4-Dichlorobenzene	106-46-7	B	10	New data ≤to data previously evaluated. Evaluation not required.	---	---
2,4-Dinitrotoluene [c]	121-14-2	B	10	New data ≤to data previously evaluated. Evaluation not required.	---	---
2-Chloronaphthalene	91-58-7	B	---	<10, <10, <10	a	A
3,3-Dichlorobenzidine[c]	91-94-1	B	---	<20, <20, <20	a	A
Acenapthene	83-32-9	B	10	New data ≤to data previously evaluated. Evaluation not required.	---	---
Anthracene	120-12-7	B	10	New data ≤to data previously evaluated. Evaluation not required.	---	---
Benzidine[c]	92-87-5	B	---	<20, <20, <20	a	A
Benzo (a) anthracene [c]	56-55-3	B	10	New data ≤to data previously evaluated. Evaluation not required.	---	---
Benzo (a) pyrene [c]	50-32-8	B	10	New data ≤to data previously evaluated. Evaluation not required.	---	---
Benzo (b) fluoranthene [c]	205-99-2	B	10	New data ≤to data previously evaluated. Evaluation not required.	---	---
Benzo (k) fluoranthene [c]	207-08-9	B	10	New data ≤to data previously evaluated. Evaluation not required.	---	---
Bis2-Chloroethyl Ether	111-44-4	B	---	NEW REQUIREMENT. Needs to be sampled.	---	---
Bis2-Chloroisopropyl Ether	39638-32-9	B	---	<10, <10, <10	a	A
Butylbenzylphthalate	85-68-7	B	10	New data ≤to data previously evaluated. Evaluation not required.	---	---
Chrysene [c]	218-01-9	B	10	New data ≤to data previously evaluated. Evaluation not required.	---	---
Di-2-Ethylhexyl Phthalate [c]	117-81-7	B	10	New data ≤to data previously evaluated. Evaluation not required.	---	---
Dibenz(a,h)anthracene [c]	53-70-3	B	20	New data ≤to data previously evaluated. Evaluation not required.	---	---
Dibutyl phthalate (syn. = Di-n-Butyl Phthalate)	84-74-2	B	10	New data ≤to data previously evaluated. Evaluation not required.	---	---
Diethyl Phthalate	84-66-2	B	10	New data ≤to data previously evaluated. Evaluation not required.	---	---
Dimethyl Phthalate	131-11-3	B	---	<10, <10, <10	a	A
Fluoranthene	206-44-0	B	10	New data ≤to data previously evaluated. Evaluation not required.	---	---
Fluorene	86-73-7	B	10	Previously evaluated, no further monitoring required.	---	---
Hexachlorobenzene[c]	118-74-1	B	---	<10, <10, <10	a	A
Hexachlorobutadiene[c]	87-68-3	B	---	<10, <10, <10	a	A
Hexachlorocyclopentadiene	77-47-4	B	---	<10, <10, <10	a	A

Parameter	CASRN	Type	QL (µg/L)	8.4 MGD (Jun-Nov), 16.0 MGD (Dec-May) Data (µg/L unless noted otherwise)	Source of Data	Data Eval
Hexachloroethane[C]	67-72-1	B	---	<10, <10, <10	a	A
Indeno (1,2,3-cd) pyrene [C]	193-39-5	B	20	New data ≤to data previously evaluated. Evaluation not required.	---	---
Isophorone[C]	78-59-1	B	10	New data ≤to data previously evaluated. Evaluation not required.	---	---
Nitrobenzene	98-95-3	B	10	New data ≤to data previously evaluated. Evaluation not required.	---	---
N-Nitrosodimethylamine[C]	62-75-9	B	---	<10, <10, <10	a	A
N-Nitrosodi-n-propylamine[C]	621-64-7	B	---	<10, <10, <10	a	A
N-Nitrosodiphenylamine[C]	86-30-6	B	---	<10, <10, <10	a	A
Pyrene	129-00-0	B	10	New data ≤to data previously evaluated. Evaluation not required	---	---
Antimony	7440-36-0	M	0.2	<2, <2, <5	a	B.1
Arsenic	7440-38-2	M	1.0	New data ≤to data previously evaluated. Evaluation not required.	---	---
Barium	7440-39-3	M	---	Applicable to PWS waters only. Evaluation not required.	---	---
Cadmium	7440-43-9	M	0.3	<5, <5, <5	a	B.2
Chromium III	16065-83-1	M	0.5	Previously evaluated. Evaluation not required.	---	---
Chromium VI	18540-29-9	M	0.5	Previously evaluated. Evaluation not required.	---	---
Chromium, Total	7440-47-3	M	---	Applicable to PWS waters only. Evaluation not required.	---	---
Copper	7440-50-8	M	0.5	6, 7, 5	a	C.1
Iron	7439-89-6	M	1.0	Applicable to PWS waters only. Evaluation not required.	---	---
Lead	7439-92-1	M	0.5	New data ≤to data previously evaluated. Evaluation not required.	---	---
Manganese	7439-96-5	M	0.2	Applicable to PWS waters only. Evaluation not required.	---	---
Mercury	7439-97-6	M	1.0	<0.3, <0.3, <0.5	a	A
Nickel	7440-02-0	M	0.5	5, <5, <5	a	C.1
Selenium	7782-49-2	M	2.0	<10, <10, <10	a	B.2
Silver	7440-22-4	M	0.2	New data ≤to data previously evaluated. Evaluation not required.	---	---
Thallium	7440-28-0	M	---	<2, <2, <5	a	A
Zinc	7440-66-6	M	2.0	New data ≤to data previously evaluated. Evaluation not required.	---	---
2-(2,4,5-Trichlorophenoxy) propionic acid (synonym = Silvex)	93-72-1	P	---	Applicable to PWS waters only. Evaluation not required.	---	---
2,4-Dichlorophenoxy acetic acid (syn. = 2,4-D)	94-75-7	P	---	Applicable to PWS waters only. Evaluation not required.	---	---
Aldrin [C]	309-00-2	P	0.05	Previously evaluated, no further monitoring required.	---	---
Alpha-Endosulfan (I)	959-98-8	P	---	Previously evaluated, no further monitoring required.	---	---
Beta-Endosulfan (II)	33213-65-9	P	---	Previously evaluated, no further monitoring required.	---	---
Chlordane [C]	57-74-9	P	0.2	Previously evaluated, no further monitoring required.	---	---
Chlorpyrifos (synonym = Dursban)	2921-88-2	P	---	Previously evaluated, no further monitoring required.	---	---
DDD [C]	72-54-8	P	0.1	Previously evaluated, no further monitoring required.	---	---
DDE [C]	72-55-9	P	0.1	Previously evaluated, no further monitoring required.	---	---
DDT [C]	50-29-3	P	0.1	Previously evaluated, no further monitoring required.	---	---
Demeton	8065-48-3	P	---	Previously evaluated, no further monitoring required.	---	---
Dieldrin [C]	60-57-1	P	---	Previously evaluated, no further monitoring required.	---	---
Endosulfan Sulfate	1031-07-8	P	---	Previously evaluated, no further monitoring required.	---	---
Endrin	72-20-8	P	0.1	Previously evaluated, no further monitoring required.	---	---
Endrin Aldehyde	7421-93-4	P	---	NEW REQUIREMENT. Needs to be sampled.	---	---
Guthion	86-50-0	P	---	Previously evaluated, no further monitoring required.	---	---

Parameter	CASRN	Type	QL (µg/L)	8.4 MGD (Jun-Nov), 16.0 MGD (Dec-May) Data (µg/L unless noted otherwise)	Source of Data	Data Eval
Heptachlor [C]	76-44-8	P	0.05	Previously evaluated, no further monitoring required.	---	---
Heptachlor Epoxide[C]	1024-57-3	P	---	NEW REQUIREMENT. Needs to be sampled.	---	---
Hexachlorocyclohexane Alpha-BHC[C]	319-84-6	P	---	NEW REQUIREMENT. Needs to be sampled.	---	---
Hexachlorocyclohexane Beta-BHC[C]	319-85-7	P	---	NEW REQUIREMENT. Needs to be sampled.	---	---
Hexachlorocyclohexane Gamma-BHC[C] (syn. = Lindane)	58-89-9	P	---	Previously evaluated, no further monitoring required.	---	---
Kepone	143-50-0	P	---	<33	b	A
Malathion	121-75-5	P	---	Previously evaluated, no further monitoring required.	---	---
Methoxychlor	72-43-5	P	---	Previously evaluated, no further monitoring required	---	---
Mirex	2385-85-5	P	---	Previously evaluated, no further monitoring required	---	---
Parathion	56-38-2	P	---	Previously evaluated, no further monitoring required.	---	---
PCB Total[C]	1336-36-3	P	---	Previously evaluated, no further monitoring required.	---	---
PCB-1016	12674-11-2	P	1	Previously evaluated, no further monitoring required.	---	---
PCB-1221	11104-28-2	P	1	Previously evaluated, no further monitoring required.	---	---
PCB-1232	11141-16-5	P	1	Previously evaluated, no further monitoring required.	---	---
PCB-1242	53469-21-9	P	1	Previously evaluated, no further monitoring required.	---	---
PCB-1248	12672-29-6	P	1	Previously evaluated, no further monitoring required.	---	---
PCB-1254	11097-69-1	P	1	Previously evaluated, no further monitoring required.	---	---
PCB-1260	11096-82-5	P	1	Previously evaluated, no further monitoring required.	---	---
Toxaphene [C]	8001-35-2	P	5.0	Previously evaluated, no further monitoring required.	---	---
Beta Particle & Photon Activity (mrem/yr)		R	---	NEW REQUIREMENT. Needs to be sampled.	---	---
Gross Alpha Particle Activity (pCi/L)		R	---	NEW REQUIREMENT. Needs to be sampled.	---	---
Strontium-90 (pCi/L)		R	---	NEW REQUIREMENT. Needs to be sampled.	---	---
Tritium (pCi/L)		R	---	NEW REQUIREMENT. Needs to be sampled.	---	---
1,1,2,2-Tetrachloroethane[C]	79-34-5	V	---	<5, <5, <5	a	A
1,1,2-Trichloroethane[C]	79-00-5	V	---	<5, <5, <5	a	A
1,1-Dichloroethylene	75-35-4	V	10	New data ≤to data previously evaluated. Evaluation not required.	---	---
1,2-Dichloroethane [C]	107-06-2	V	10	New data ≤to data previously evaluated. Evaluation not required.	---	---
1,2-Dichloropropane[C]	78-87-5	V	---	<5, <5, <5	a	A
1,2-trans-dichloroethylene	156-60-5	V	---	<5, <5, <5	a	A
1,3-Dichloropropene	542-75-6	V	---	<5, <5, <5	a	A
Acrolein	107-02-8	V	---	<50, <50, <50	a	A
Acrylonitrile[C]	107-13-1	V	---	<50, <50, <50	a	A
Benzene [C]	71-43-2	V	10	New data ≤to data previously evaluated. Evaluation not required.	---	---
Bromoform [C]	75-25-2	V	10	<10, <10, <10	a	A
Carbon Tetrachloride [C]	56-23-5	V	10	New data ≤to data previously evaluated. Evaluation not required.	---	---
Chlorobenzene (synonym = Monochlorobenzene)	108-90-7	V	50	New data ≤to data previously evaluated. Evaluation not required.	---	---
Chlorodibromomethane[C]	124-48-1	V	10	New data ≤to data previously evaluated. Evaluation not required.	---	---
Chloroform [C]	67-66-3	V	10	New data ≤to data previously evaluated. Evaluation not required.	---	---
Dichlorobromomethane [C]	75-27-4	V	10	New data ≤to data previously evaluated. Evaluation not required.	---	---
Dichloromethane (syn. = Methylene Chloride) [C]	75-09-2	V	20	New data ≤to data previously evaluated. Evaluation not required.	---	---

Parameter	CASRN	Type	QL (µg/L)	8.4 MGD (Jun-Nov), 16.0 MGD (Dec-May) Data (µg/L unless noted otherwise)	Source of Data	Data Eval
Ethylbenzene	100-41-4	V	10	New data ≤to data previously evaluated. Evaluation not required.	---	---
Methyl Bromide	74-83-9	V	---	<10, <10, <10	a	A
Tetrachloroethylene[C]	127-18-4	V	10	New data ≤to data previously evaluated. Evaluation not required.	---	---
Toluene	10-88-3	V	10	New data ≤to data previously evaluated. Evaluation not required.	---	---
Trichloroethylene [C]	79-01-6	V	10	New data ≤to data previously evaluated. Evaluation not required.	---	---
Vinyl Chloride[C]	75-01-4	V	10	New data ≤to data previously evaluated. Evaluation not required.	---	---
Ammonia-N (mg/L) (Annual)	766-41-7	X	0.2 mg/L	Default = 9 mg/L	d	C.2
Ammonia-N (mg/L) (Wet Season)	766-41-7	X	0.2 mg/L	Default = 9 mg/L	d	C.2
Chloride (mg/L)	16887-00-6	X	---	See STAT.EXE RESULTS for data values	c	C.1
Cyanide	57-12-5	X	10	New data ≤to data previously evaluated. Evaluation not required.	---	---
Dioxin (2,3,7,8-tetrachlorodibenzo-p-dioxin) (ppq)	1746-01-6	X	0.00001	Applicable to Paper Mills & Oil Refineries only. Evaluation not required.	---	---
Foaming Agents		X	---	Applicable to PWS waters only. Evaluation not required.	---	---
Hydrogen Sulfide	7783-06-4	X	---	<100	b	A
Nitrate (as N)	14797-55-8	X	---	Applicable to PWS waters only. Evaluation not required.	---	---
Sulfate	14808-79-8	X	---	Applicable to PWS waters only. Evaluation not required.	---	---
Total dissolved solids		X	---	Applicable to PWS waters only. Evaluation not required.	---	---
TRC (mg/L)	7782-50-5	X	0.1 mg/L	Default = 20 mg/L	d	C.2
Tributyltin	60-10-5	X	---	Previously evaluated, no further monitoring required.	---	---

"Type" column indicates a category assigned to the referenced substance (see below):
A = Acid Extractable Organic Compounds
B = Base/Neutral Extractable Organic Compounds
M = Metals
p = PCBs
P = Pesticides
V = Volatile Organic Compounds
X = Miscellaneous Compounds and Parameters

The **superscript "C"** following the parameter name indicates that the substance is a known or suspected carcinogen; human health criteria at risk level 10^{-5}.

"Source of Data" codes:
a = Data from permittee monitoring on 4/13/05, 4/16/05, 4/15/05, 4/17/05 Metals are in the Total Recoverable form.
b = Data from permittee monitoring on 12/16/03
c = Data from DMR's and Daily Log Reports
d = Default effluent concentration

"Data Evaluation" codes:
See section titled "EVALUATION OF EFFLUENT TOXIC POLLUTANTS" (preceding the parameter table) for an explanation of the code used.

CASRN = Chemical Abstract Service Registry Number for each parameter is referenced in the current Water Quality Standards. A unique numeric identifier designating only one substance. The Chemical Abstract Service is a division of the American Chemical Society.

WQS – WLA Spreadsheet: 8.4 MGD Input

WATER QUALITY CRITERIA / WASTE LOAD ALLOCATION ANALYSIS

Facility Name:
Opequon Water Reclamation Facility
Receiving Stream:
Opequon Creek

Permit No.: VA0065552
Date: 12/1/2005

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

Stream Information	
Mean Hardness (as CaCO3) =	234 mg/L
90% Temperature (Annual) =	21.9 deg C
90% Temperature (Wet season) =	15.7 deg C
90% Maximum pH =	8.5 SU
10% Maximum pH =	7.8 SU
Tier Designation =	1
Public Water Supply (PWS) Y/N? =	N
V(alley) or P(iedmont)? =	V
Trout Present Y/N? =	N
Early Life Stages Present Y/N? =	Y

Stream Flows	
1Q10 (Annual) =	0.71 MGD
7Q10 (Annual) =	0.97 MGD
30Q10 (Annual) =	1.42 MGD
1Q10 (Wet season) =	2 MGD
30Q10 (Wet season) =	4.33 MGD
30Q5 =	2 MGD
Harmonic Mean =	6.59 MGD
Annual Average =	27.7 MGD

Mixing Information		
Annual	- 1Q10 Flow =	91.73 %
	- 7Q10 Flow =	100 %
	- 30Q10 Flow =	100 %
Wet Season	- 1Q10 Flow =	91.82 %
	- 30Q10 Flow =	100 %

Effluent Information	
Mean Hardness (as CaCO3) =	326 mg/L
90% Temp (Annual) =	24.5 deg C
90% Temp (Wet season) =	18.4 deg C
90% Maximum pH =	7.7 SU
10% Maximum pH =	7.4 SU
Current Discharge Flow =	8.400 MGD
Discharge Flow for Limit Analysis =	8.400 MGD

Footnotes:

1. All concentrations expressed as micrograms/liter (ug/l), unless noted otherwise.
2. All flow values are expressed as Million Gallons per Day (MGD).
3. Discharge volumes are highest monthly average or 2C maximum for Industries and design flows for Municipals.
4. Hardness expressed as mg/l CaCO3. Standards calculated using Hardness values in the range of 25-400 mg/l CaCO3.
5. "Public Water Supply" protects for fish & water consumption. "Other Surface Waters" protects for fish consumption only.
6. Carcinogen "Y" indicates carcinogenic parameter.
7. Ammonia WQSs selected from separate tables, based on pH and temperature.
8. Metals measured as Dissolved, unless specified otherwise.
9. WLA = Waste Load Allocation (based on standards).
10. WLA = Waste Load Allocation (based on standards).
11. WLAs are based on mass balances (less background, if data exist).
12. Acute - 1 hour avg. concentration not to be exceeded more than 1/3 years.
13. Chronic - 4 day avg. concentration (30 day avg. for Ammonia) not to be exceeded more than 1/3 years.
14. Mass balances employ 1Q10 for Acute, 30Q10 for Chronic Ammonia, 7Q10 for Other Chronic, 30Q5 for Non-carcinogens, Harmonic Mean for Carcinogens, and Annual Average for Dioxin. Actual flows employed are a function of the mixing analysis and may be less than the actual critical flows.
15. Effluent Limitations are calculated elsewhere using the minimum WLA and EPA's statistical approach (Technical Support Document).

WQS – WLA Spreadsheet: 8.4 MGD Output

Facility Name: Opequon Water Reclamation Facility	Permit No.: VA0065552	WATER QUALITY CRITERIA 8.400 MGD Discharge Flow - Mix per "Mixer"				NON-ANTIDEGRADATION WASTE LOAD ALLOCATIONS 8.400 MGD Discharge - Mix per "Mixer"		
Receiving Stream: Opequon Creek	Date: 12/1/2005			Human Health				
		Aquatic Protection		Public Water	Other Surface	Aquatic Protection		Human
Toxic Parameter and Form	Carcinogen?	Acute	Chronic	Supplies	Waters	Acute	Chronic	Health
Acrolein	N	None	None	3.2E+02	7.8E+02	N/A	N/A	9.7E+02
Acrylonitrile	Y	None	None	5.9E-01	6.6E+00	N/A	N/A	1.2E+01
Ammonia-N (Annual)	N	1.4E+01 mg/L	1.8E+00 mg/L	None	None	1.5E+01 mg/L	2.1E+00 mg/L	N/A
Ammonia-N (Wet season)	N	1.3E+01 mg/L	2.5E+00 mg/L	None	None	1.6E+01 mg/L	3.8E+00 mg/L	N/A
Antimony	N	None	None	1.4E+01	4.3E+03	N/A	N/A	5.3E+03
Benzidine	Y	None	None	1.2E-03	5.4E-03	N/A	N/A	9.6E-03
Bis2-Chloroethyl Ether	N	None	None	3.1E-01	1.4E+01	N/A	N/A	1.7E+01
Bis2-Chloroisopropyl Ether	N	None	None	1.4E+03	1.7E+05	N/A	N/A	2.1E+05
Bromoform	Y	None	None	4.4E+01	3.6E+03	N/A	N/A	6.4E+03
Cadmium	N	1.5E+01	2.8E+00	5.0E+00	None	1.6E+01	3.1E+00	N/A
Chloride	N	8.6E+02 mg/L	2.3E+02 mg/L	2.5E+02 mg/L	None	9.3E+02 mg/L	2.6E+02 mg/L	N/A
Chlorine, Total Residual	N	1.9E-02 mg/L	1.1E-02 mg/L	None	None	2.0E-02 mg/L	1.2E-02 mg/L	N/A
2-Chloronaphthalene	N	None	None	1.7E+03	4.3E+03	N/A	N/A	5.3E+03
Copper	N	4.0E+01	2.4E+01	1.3E+03	None	4.3E+01	2.7E+01	N/A
3,3-Dichlorobenzidine	Y	None	None	4.0E-01	7.7E-01	N/A	N/A	1.4E+00
1,2-trans-dichloroethylene	N	None	None	7.0E+01	1.4E+05	N/A	N/A	1.7E+05
1,2-Dichloropropane	Y	None	None	5.2E+00	3.9E+02	N/A	N/A	7.0E+02
1,3-Dichloropropene	N	None	None	1.0E+01	1.7E+03	N/A	N/A	2.1E+03
Dimethyl Phthalate	N	None	None	3.1E+05	2.9E+06	N/A	N/A	3.6E+06
2,4 Dinitrophenol	N	None	None	7.0E+01	1.4E+04	N/A	N/A	1.7E+04
2-Methyl-4,6-Dinitrophenol	N	None	None	1.3E+01	7.7E+02	N/A	N/A	9.5E+02
1,2-Diphenylhydrazine	Y	None	None	4.0E-01	5.4E+00	N/A	N/A	9.6E+00
Endrin Aldehyde	N	None	None	7.6E-01	8.1E-01	N/A	N/A	1.0E+00
Heptachlor Epoxide	Y	5.2E-01	3.8E-03	1.0E-03	1.1E-03	5.6E-01	4.2E-03	2.0E-03
Hexachlorobenzene	Y	None	None	7.5E-03	7.7E-03	N/A	N/A	1.4E-02
Hexachlorobutadiene	Y	None	None	4.4E+00	5.0E+02	N/A	N/A	8.9E+02
Hexachlorocyclohexane Alpha-BH(	Y	None	None	3.9E-02	1.3E-01	N/A	N/A	2.3E-01
Hexachlorocyclohexane Beta-BHC	Y	None	None	1.4E-01	4.6E-01	N/A	N/A	8.2E-01
Hexachlorocyclopentadiene	N	None	None	2.4E+02	1.7E+04	N/A	N/A	2.1E+04
Hexachloroethane	Y	None	None	1.9E+01	8.9E+01	N/A	N/A	1.6E+02
Hydrogen Sulfide	N	None	2.0E+00	None	None	N/A	2.2E+00	N/A
Kepone	N	None	Zero	None	None	N/A	Zero	N/A
Mercury	N	1.4E+00	7.7E-01	5.0E-02	5.1E-02	1.5E+00	8.6E-01	6.3E-02
Methyl Bromide	N	None	None	4.8E+01	4.0E+03	N/A	N/A	5.0E+03
Nickel	N	4.9E+02	5.4E+01	6.1E+02	4.6E+03	5.2E+02	6.0E+01	5.7E+03
N-Nitrosodimethylamine	Y	None	None	6.9E-03	8.1E+01	N/A	N/A	1.4E+02
N-Nitrosodiphenylamine	Y	None	None	5.0E+01	1.6E+02	N/A	N/A	2.9E+02
N-Nitrosodi-n-propylamine	Y	None	None	5.0E-02	1.4E+01	N/A	N/A	2.5E+01
RadNuc - Beta Part & Photon Act	N	None	None	4.0E+00 mrem	4.0E+00 mre	N/A	N/A	5.0E+00 mrem
RadNuc - Gross Alpha Part Act	N	None	None	1.5E+01 pCi/L	1.5E+01 pCi	N/A	N/A	1.9E+01 pCi/L
RadNuc - Strontium-90	N	None	None	8.0E+00 pCi/L	8.0E+00 pCi	N/A	N/A	9.9E+00 pCi/L
RadNuc - Tritium	N	None	None	2.0E+04 pCi/L	2.0E+04 pCi	N/A	N/A	2.5E+04 pCi/L
Selenium	N	2.0E+01	5.0E+00	1.7E+02	1.1E+04	2.2E+01	5.6E+00	1.4E+04
1,1,2,2-Tetrachloroethane	Y	None	None	1.7E+00	1.1E+02	N/A	N/A	2.0E+02
Thallium	N	None	None	1.7E+00	6.3E+00	N/A	N/A	7.8E+00
1,1,2-Trichloroethane	Y	None	None	6.0E+00	4.2E+02	N/A	N/A	7.5E+02

WQS – WLA Spreadsheet: 16.0 MGD (Dec-May) Input

WATER QUALITY CRITERIA / WASTE LOAD ALLOCATION ANALYSIS

Facility Name:
Opequon Water Reclamation Facility
Receiving Stream:
Opequon Creek

Permit No.: VA0065552
Date: 11/28/2005

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

Stream Information		Stream Flows		Mixing Information			Effluent Information	
Mean Hardness (as CaCO3) =	234 mg/L	1Q10 (Annual) =	2 MGD	Annual	- 1Q10 Flow =	84.65 %	Mean Hardness (as CaCO3) =	326 mg/L
90% Temperature (Annual) =	15.7 deg C	7Q10 (Annual) =	2.65 MGD		- 7Q10 Flow =	100 %	90% Temp (Annual) =	18.4 deg C
90% Temperature (Wet season) =	deg C	30Q10 (Annual) =	4.33 MGD		- 30Q10 Flow =	100 %	90% Temp (Wet season) =	deg C
90% Maximum pH =	8.5 SU	1Q10 (Wet season) =	MGD	Wet Season	- 1Q10 Flow =	%	90% Maximum pH =	7.7 SU
10% Maximum pH =	7.8 SU	30Q10 (Wet season) =	MGD		- 30Q10 Flow =	%	10% Maximum pH =	7.4 SU
Tier Designation =	1	30Q5 =	2 MGD				Current Discharge Flow =	16.000 MGD
Public Water Supply (PWS) Y/N? =	N	Harmonic Mean =	6.59 MGD				Discharge Flow for Limit Analysis =	16.000 MGD
V(alley) or P(iedmont)? =	V	Annual Average =	27.7 MGD					
Trout Present Y/N? =	N							
Early Life Stages Present Y/N? =	Y							

Footnotes:

1. All concentrations expressed as micrograms/liter (ug/l), unless noted otherwise.
2. All flow values are expressed as Million Gallons per Day (MGD).
3. Discharge volumes are highest monthly average or 2C maximum for Industries and design flows for Municipals.
4. Hardness expressed as mg/l CaCO3. Standards calculated using Hardness values in the range of 25-400 mg/l CaCO3.
5. "Public Water Supply" protects for fish & water consumption. "Other Surface Waters" protects for fish consumption only.
6. Carcinogen "Y" indicates carcinogenic parameter.
7. Ammonia WQSs selected from separate tables, based on pH and temperature.
8. Metals measured as Dissolved, unless specified otherwise.
9. WLA = Waste Load Allocaiton (based on standards).
10. WLA = Waste Load Allocation (based on standards).
11. WLAs are based on mass balances (less background, if data exist).
12. Acute - 1 hour avg. concentration not to be exceeded more than 1/3 years.
13. Chronic - 4 day avg. concentration (30 day avg. for Ammonia) not to be exceeded more than 1/3 years.
14. Mass balances employ 1Q10 for Acute, 30Q10 for Chronic Ammonia, 7Q10 for Other Chronic, 30Q5 for Non-carcinogens, Harmonic Mean for Carcinogens, and Annual Average for Dioxin. Actual flows employed are a function of the mixing analysis and may be less than the actual critical flows.
15. Effluent Limitations are calculated elsewhere using the minimum WLA and EPA's statistical approach (Technical Support Document).

WQS – WLA Spreadsheet: 16.0 MGD (Dec-May) Output

Facility Name: Opequon Water Reclamation Facility	Permit No.: VA0065552	WATER QUALITY CRITERIA 16.000 MGD Discharge Flow - Mix per "Mixer"				NON-ANTIDEGRADATION WASTE LOAD ALLOCATIONS 16.000 MGD Discharge - Mix per "Mixer"		
Receiving Stream: Opequon Creek	Date: 11/28/2005			Human Health				
		Aquatic Protection		Public Water	Other Surface	Aquatic Protection		Human
Toxic Parameter and Form	Carcinogen?	Acute	Chronic	Supplies	Waters	Acute	Chronic	Health
Acrolein	N	None	None	3.2E+02	7.8E+02	N/A	N/A	8.8E+02
Acrylonitrile	Y	None	None	5.9E-01	6.6E+00	N/A	N/A	9.3E+00
Ammonia-N (Annual)	N	1.4E+01 mg/L	2.6E+00 mg/L	None	None	1.5E+01 mg/L	3.3E+00 mg/L	N/A
Antimony	N	None	None	1.4E+01	4.3E+03	N/A	N/A	4.8E+03
Benzidine	Y	None	None	1.2E-03	5.4E-03	N/A	N/A	7.6E-03
Bis2-Chloroethyl Ether	N	None	None	3.1E-01	1.4E+01	N/A	N/A	1.6E+01
Bis2-Chloroisopropyl Ether	N	None	None	1.4E+03	1.7E+05	N/A	N/A	1.9E+05
Bromoform	Y	None	None	4.4E+01	3.6E+03	N/A	N/A	5.1E+03
Cadmium	N	1.4E+01	2.8E+00	5.0E+00	None	1.6E+01	3.2E+00	N/A
Chloride	N	8.6E+02 mg/L	2.3E+02 mg/L	2.5E+02 mg/L	None	9.5E+02 mg/L	2.7E+02 mg/L	N/A
Chlorine, Total Residual	N	1.9E-02 mg/L	1.1E-02 mg/L	None	None	2.1E-02 mg/L	1.3E-02 mg/L	N/A
2-Chloronaphthalene	N	None	None	1.7E+03	4.3E+03	N/A	N/A	4.8E+03
Copper	N	4.0E+01	2.4E+01	1.3E+03	None	4.4E+01	2.8E+01	N/A
3,3-Dichlorobenzidine	Y	None	None	4.0E-01	7.7E-01	N/A	N/A	1.1E+00
1,2-trans-dichloroethylene	N	None	None	7.0E+01	1.4E+05	N/A	N/A	1.6E+05
1,2-Dichloropropane	Y	None	None	5.2E+00	3.9E+02	N/A	N/A	5.5E+02
1,3-Dichloropropene	N	None	None	1.0E+01	1.7E+03	N/A	N/A	1.9E+03
Dimethyl Phthalate	N	None	None	3.1E+05	2.9E+06	N/A	N/A	3.3E+06
2,4 Dinitrophenol	N	None	None	7.0E+01	1.4E+04	N/A	N/A	1.6E+04
2-Methyl-4,6-Dinitrophenol	N	None	None	1.3E+01	7.7E+02	N/A	N/A	8.6E+02
1,2-Diphenylhydrazine	Y	None	None	4.0E-01	5.4E+00	N/A	N/A	7.6E+00
Endrin Aldehyde	N	None	None	7.6E-01	8.1E-01	N/A	N/A	9.1E-01
Heptachlor Epoxide	Y	5.2E-01	3.8E-03	1.0E-03	1.1E-03	5.8E-01	4.4E-03	1.6E-03
Hexachlorobenzene	Y	None	None	7.5E-03	7.7E-03	N/A	N/A	1.1E-02
Hexachlorobutadiene	Y	None	None	4.4E+00	5.0E+02	N/A	N/A	7.1E+02
Hexachlorocyclohexane Alpha-BH(	Y	None	None	3.9E-02	1.3E-01	N/A	N/A	1.8E-01
Hexachlorocyclohexane Beta-BHC	Y	None	None	1.4E-01	4.6E-01	N/A	N/A	6.5E-01
Hexachlorocyclopentadiene	N	None	None	2.4E+02	1.7E+04	N/A	N/A	1.9E+04
Hexachloroethane	Y	None	None	1.9E+01	8.9E+01	N/A	N/A	1.3E+02
Hydrogen Sulfide	N	None	2.0E+00	None	None	N/A	2.3E+00	N/A
Kepone	N	None	Zero	None	None	N/A	Zero	N/A
Mercury	N	1.4E+00	7.7E-01	5.0E-02	5.1E-02	1.5E+00	9.0E-01	5.7E-02
Methyl Bromide	N	None	None	4.8E+01	4.0E+03	N/A	N/A	4.5E+03
Nickel	N	4.8E+02	5.3E+01	6.1E+02	4.6E+03	5.4E+02	6.2E+01	5.2E+03
N-Nitrosodimethylamine	Y	None	None	6.9E-03	8.1E+01	N/A	N/A	1.1E+02
N-Nitrosodiphenylamine	Y	None	None	5.0E+01	1.6E+02	N/A	N/A	2.3E+02
N-Nitrosodi-n-propylamine	Y	None	None	5.0E-02	1.4E+01	N/A	N/A	2.0E+01
RadNuc - Beta Part & Photon Act	N	None	None	4.0E+00 mrem	4.0E+00 mre	N/A	N/A	4.5E+00
RadNuc - Gross Alpha Part Act	N	None	None	1.5E+01 pCi/L	1.5E+01 pCi	N/A	N/A	1.7E+01
RadNuc - Strontium-90	N	None	None	8.0E+00 pCi/L	8.0E+00 pCi	N/A	N/A	9.0E+00
RadNuc - Tritium	N	None	None	2.0E+04 pCi/L	2.0E+04 pCi	N/A	N/A	2.3E+04
Selenium	N	2.0E+01	5.0E+00	1.7E+02	1.1E+04	2.2E+01	5.8E+00	1.2E+04
1,1,2,2-Tetrachloroethane	Y	None	None	1.7E+00	1.1E+02	N/A	N/A	1.6E+02
Thallium	N	None	None	1.7E+00	6.3E+00	N/A	N/A	7.1E+00
1,1,2-Trichloroethane	Y	None	None	6.0E+00	4.2E+02	N/A	N/A	5.9E+02

STAT.EXE Results – Flow Tier 1 (Interim and Final)

Ammonia-N – 8.4 MGD (annual)

Chronic averaging period = 30
WLAa = 15
WLAc = 2.1
Q.L. = 0.2
# samples/mo. = 30
# samples/wk. = 7

Summary of Statistics:

observations = 1
Expected Value = 9
Variance = 29.16
C.V. = 0.6
97th percentile daily values = 21.9007
97th percentile 4 day average = 14.9741
97th percentile 30 day average= 10.8544
< Q.L. = 0
Model used = BPJ Assumptions, type 2 data

A limit is needed based on Chronic Toxicity
Maximum Daily Limit = 4.23710719617425
Average Weekly limit = 2.5876319004845
Average Monthly Limit = 2.1

The data are: 9

Ammonia-N – 8.4 MGD (wet season)

Chronic averaging period = 30
WLAa = 16
WLAc = 3.8
Q.L. = 0.2
# samples/mo. = 30
# samples/wk. = 7

Summary of Statistics:

observations = 1
Expected Value = 9
Variance = 29.16
C.V. = 0.6
97th percentile daily values = 21.9007
97th percentile 4 day average = 14.9741
97th percentile 30 day average= 10.8544
< Q.L. = 0
Model used = BPJ Assumptions, type 2 data

A limit is needed based on Chronic Toxicity
Maximum Daily Limit = 7.66714635498198
Average Weekly limit = 4.68238153421004
Average Monthly Limit = 3.8

The data are: 9

Ammonia-N – 16.0 MGD (wet season)

Chronic averaging period = 30
WLAa = 15
WLAc = 3.3
Q.L. = 0.2
# samples/mo. = 30
# samples/wk. = 7

Summary of Statistics:

observations = 1
Expected Value = 9
Variance = 29.16
C.V. = 0.6
97th percentile daily values = 21.9007
97th percentile 4 day average = 14.9741
97th percentile 30 day average= 10.8544
< Q.L. = 0
Model used = BPJ Assumptions, type 2 data

A limit is needed based on Chronic Toxicity
Maximum Daily Limit = 6.65831130827382
Average Weekly limit = 4.06627870076135
Average Monthly Limit = 3.3

The data are: 9

Total Residual Chlorine – 8.4 MGD

Chronic averaging period = 4
WLAa = 0.02
WLAc = 0.012
Q.L. = 0.1
# samples/mo. = 30
# samples/wk. = 7

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 = 1.75508974086388E-02
Average Weekly limit = 1.07184595324212E-02
Average Monthly Limit = 8.69859620059178E-03

The data are: 20

Chloride – 8.4 MGD

Chemical = Chloride
Chronic averaging period = 4
WLAa = 930
WLAc = 260
Q.L. = 1
# samples/mo. = 1
# samples/wk. = 1

Summary of Statistics:

observations = 67
Expected Value = 151.660
Variance = 1078.69
C.V. = 0.216558
97th percentile daily values = 221.720
97th percentile 4 day average = 184.730
97th percentile 30 day average= 162.939
< Q.L. = 0
Model used = lognormal

No Limit is required for this material

The data are:

200	150	230	140	170	180	150
195	100	150	190	160	155	140
190	180	150	190	220	155	80
100	130	110	150	120	160	140
150	90	120	140	160	170	140
90	190	140	150	160	130	110
170	190	133	130	150	145	110
120	130	110	170	150	200	
160	140	170	140	170	140	
150	160	180	170	180	155	

Copper – 8.4 MGD

Chronic averaging period = 4
WLAa = 43
WLAc = 27
Q.L. = 0.5
# samples/mo. = 1
# samples/wk. = 1

Summary of Statistics:

observations = 3
Expected Value = 6
Variance = 12.96
C.V. = 0.6
97th percentile daily values = 14.6005
97th percentile 4 day average = 9.98274
97th percentile 30 day average= 7.23631
< Q.L. = 0
Model used = BPJ Assumptions, type 2 data

No Limit is required for this material

The data are: 5, 6, 7

Cadmium – 8.4 MGD

Chronic averaging period = 4
WLAa = 16
WLAc = 3.1
Q.L. = 0.3
# samples/mo. = 1
# samples/wk. = 1

Summary of Statistics:

observations = 3
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 Chronic Toxicity
Maximum Daily Limit = 4.53398183056502
Average Weekly limit = 4.53398183056502
Average Monthly Limit = 4.53398183056502

The data are: 5, 5, 5

Selenium – 8.4 MGD

Chronic averaging period = 4
WLAa = 22
WLAc = 5.6
Q.L. = 2.0
# samples/mo. = 1
# samples/wk. = 1

Summary of Statistics:

observations = 3
Expected Value = 10
Variance = 36
C.V. = 0.6
97th percentile daily values = 24.3341
97th percentile 4 day average = 16.6379
97th percentile 30 day average= 12.0605
< Q.L. = 0
Model used = BPJ Assumptions, type 2 data

A limit is needed based on Chronic Toxicity
Maximum Daily Limit = 8.1904187906981
Average Weekly limit = 8.1904187906981
Average Monthly LImit = 8.1904187906981

The data are: 10, 10, 10

Nickel – 8.4 MGD

Chronic averaging period = 4
WLAa = 520
WLAc = 60
Q.L. = 0.5
# 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

TOXLARGE – Flow Tier 2

Refer to the toxic pollutant table below for the evaluation results for ammonia-N and TRC. Additional monitoring data is needed for all other WQS parameters for the 10.4 MGD facility. The permit Attachment A2 includes a list of those parameters for which sample data is required.

Parameter	CASRN	Type	QL (µg/L)	10.4 MGD Data (µg/L unless noted otherwise)	Source of Data	Data Eval
Ammonia-N (mg/L) (Annual)	766-41-7	X	0.2 mg/L	Default = 9 mg/L	a	C.2
Ammonia-N (mg/L) (Wet Season)	766-41-7	X	0.2 mg/L	Default = 9 mg/L	a	C.2
TRC (mg/L)	7782-50-5	X	0.1 mg/L	Default = 20 mg/L	a	C.2

"Type" column indicates a category assigned to the referenced substance (see below):
X = Miscellaneous Compounds and Parameters

The **superscript "C"** following the parameter name indicates that the substance is a known or suspected carcinogen; human health criteria at risk level 10^{-5}.

"Source of Data" codes:
a = Default effluent concentration

"Data Evaluation" codes:
See section titled "EVALUATION OF EFFLUENT TOXIC POLLUTANTS" (preceding the parameter table) for an explanation of the code used.

CASRN = Chemical Abstract Service Registry Number for each parameter is referenced in the current Water Quality Standards. A unique numeric identifier designating only one substance. The Chemical Abstract Service is a division of the American Chemical Society.

WQS-WLA Spreadsheet: Flow Tier 2 Input

WATER QUALITY CRITERIA / WASTE LOAD ALLOCATION ANALYSIS

Facility Name: Opequon Water Reclamation Facility
Receiving Stream: Opequon Creek
Permit No.: VA0065552
Date: 12/1/2005
Version: OWP Guidance Memo 00-2011 (8/24/00)

Stream Information		Stream Flows		Mixing Information			Effluent Information	
Mean Hardness (as CaCO3) =	234 mg/L	1Q10 (Annual) =	0.71 MGD	Annual	- 1Q10 Flow =	90.88 %	Mean Hardness (as CaCO3) =	326 mg/L
90% Temperature (Annual) =	21.9 deg C	7Q10 (Annual) =	0.97 MGD		- 7Q10 Flow =	100 %	90% Temp (Annual) =	24.5 deg C
90% Temperature (Wet season) =	15.7 deg C	30Q10 (Annual) =	1.42 MGD		- 30Q10 Flow =	100 %	90% Temp (Wet season) =	18.4 deg C
90% Maximum pH =	8.5 SU	1Q10 (Wet season) =	2 MGD	Wet Season	- 1Q10 Flow =	87.64 %	90% Maximum pH =	7.7 SU
10% Maximum pH =	7.8 SU	30Q10 (Wet season) =	4.33 MGD		- 30Q10 Flow =	100 %	10% Maximum pH =	7.4 SU
Tier Designation =	1	30Q5 =	2 MGD				Current Discharge Flow =	8.400 MGD
Public Water Supply (PWS) Y/N? =	N	Harmonic Mean =	6.59 MGD				Discharge Flow for Limit Analysis =	10.400 MGD
V(alley) or P(iedmont)? =	V	Annual Average =	27.7 MGD					
Trout Present Y/N? =	N							
Early Life Stages Present Y/N? =	Y							

Footnotes:
1. All concentrations expressed as micrograms/liter (ug/l), unless noted otherwise.
2. All flow values are expressed as Million Gallons per Day (MGD).
3. Discharge volumes are highest monthly average or 2C maximum for Industries and design flows for Municipals.
4. Hardness expressed as mg/l CaCO3. Standards calculated using Hardness values in the range of 25-400 mg/l CaCO3.
5. "Public Water Supply" protects for fish & water consumption. "Other Surface Waters" protects for fish consumption only.
6. Carcinogen "Y" indicates carcinogenic parameter.
7. Ammonia WQSs selected from separate tables, based on pH and temperature.
8. Metals measured as Dissolved, unless specified otherwise.
9. WLA = Waste Load Allocation (based on standards).
10. WLA = Waste Load Allocation (based on standards).
11. WLAs are based on mass balances (less background, if data exist).
12. Acute - 1 hour avg. concentration not to be exceeded more than 1/3 years.
13. Chronic - 4 day avg. concentration (30 day avg. for Ammonia) not to be exceeded more than 1/3 years.
14. Mass balances employ 1Q10 for Acute, 30Q10 for Chronic Ammonia, 7Q10 for Other Chronic, 30Q5 for Non-carcinogens, Harmonic Mean for Carcinogens, and Annual Average for Dioxin. Actual flows employed are a function of the mixing analysis and may be less than the actual critical flows.
15. Effluent Limitations are calculated elsewhere using the minimum WLA and EPA's statistical approach (Technical Support Document).

WQS-WLA Spreadsheet: Flow Tier 2 Output

Facility Name: Opequon Water Reclamation Facility	Permit No.: VA0065552	POST - EXPANSION WATER QUALITY CRITERIA 10.400 MGD Discharge Flow - Mix per "Mixer"				NON-ANTIDEGRADATION WASTE LOAD ALLOCATIONS 10.400 MGD Discharge - Mix per "Mixer"		
Receiving Stream: Opequon Creek	Date: 11/28/2005	Aquatic Protection		Human Health		Aquatic Protection		Human Health
Toxic Parameter and Form	Carcinogen?	Acute	Chronic	Public Water Supplies	Other Surface Waters	Acute	Chronic	
Ammonia-N (Annual)	N	1.4E+01 mg/L	1.8E+00 mg/L	None	None	1.5E+01 mg/L	2.1E+00 mg/L	N/A
Ammonia-N (Wet season)	N	1.3E+01 mg/L	2.5E+00 mg/L	None	None	1.5E+01 mg/L	3.6E+00 mg/L	N/A
Chlorine, Total Residual	N	1.9E-02 mg/L	1.1E-02 mg/L	None	None	2.0E-02 mg/L	1.2E-02 mg/L	N/A

STAT.EXE Results – Flow Tier 2

Ammonia-N – 10.4 MGD (annual)

Chronic averaging period = 30
WLAa = 15
WLAc = 2.1
Q.L. = 0.2
# samples/mo. = 30
# samples/wk. = 7

Summary of Statistics:

observations = 1
Expected Value = 9
Variance = 29.16
C.V. = 0.6
97th percentile daily values = 21.9007
97th percentile 4 day average = 14.9741
97th percentile 30 day average= 10.8544
< Q.L. = 0
Model used = BPJ Assumptions, type 2 data

A limit is needed based on Chronic Toxicity
Maximum Daily Limit = 4.23710719617425
Average Weekly limit = 2.5876319004845
Average Monthly Limit = 2.1

The data are: 9

Ammonia-N – 10.4 MGD (wet season)

Chronic averaging period = 30
WLAa = 15
WLAc = 3.6
Q.L. = 0.2
# samples/mo. = 30
# samples/wk. = 7

Summary of Statistics:

observations = 1
Expected Value = 9
Variance = 29.16
C.V. = 0.6
97th percentile daily values = 21.9007
97th percentile 4 day average = 14.9741
97th percentile 30 day average= 10.8544
< Q.L. = 0
Model used = BPJ Assumptions, type 2 data

A limit is needed based on Chronic Toxicity
Maximum Daily Limit = 7.26361233629872
Average Weekly limit = 4.43594040083056
Average Monthly Limit = 3.6

The data are: 9

Total Residual Chlorine – 10.4 MGD

Chronic averaging period = 4
WLAa = 0.02
WLAc = 0.012
Q.L. = 0.1
# samples/mo. = 30
# samples/wk. = 7

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 = 1.75508974086388E-02
Average Weekly limit = 1.07184595324212E-02
Average Monthly Limit = 8.69859620059178E-03

The data are: 20

TOXLARGE – Flow Tier 3

Refer to the toxic pollutant table below for the evaluation results for ammonia-N and TRC. Additional monitoring data is needed for all other WQS parameters for the 12.2 MGD facility. The permit Attachment A2 includes a list of those parameters for which sample data is required.

Parameter	CASRN	Type	QL (µg/L)	12.6 MGD Data (µg/L unless noted otherwise)	Source of Data	Data Eval
Ammonia-N (mg/L) (Annual)	766-41-7	X	0.2 mg/L	Default = 9 mg/L	a	C.2
Ammonia-N (mg/L) (Wet Season)	766-41-7	X	0.2 mg/L	Default = 9 mg/L	a	C.2
TRC (mg/L)	7782-50-5	X	0.1 mg/L	Default = 20 mg/L	a	C.2

"Type" column indicates a category assigned to the referenced substance (see below):
X = Miscellaneous Compounds and Parameters

The **superscript "C"** following the parameter name indicates that the substance is a known or suspected carcinogen; human health criteria at risk level 10^{-5}.

"Source of Data" codes:
a = Default effluent concentration

"Data Evaluation" codes:
See section titled "EVALUATION OF EFFLUENT TOXIC POLLUTANTS" (preceding the parameter table) for an explanation of the code used.

CASRN = Chemical Abstract Service Registry Number for each parameter is referenced in the current Water Quality Standards. A unique numeric identifier designating only one substance. The Chemical Abstract Service is a division of the American Chemical Society.

WQS-WLA Spreadsheet: Flow Tier 3 Input

WATER QUALITY CRITERIA / WASTE LOAD ALLOCATION ANALYSIS

Facility Name: Opequon Water Reclamation Facility
Receiving Stream: Opequon Creek
Permit No.: VA0065552
Date: 12/1/2005
Version: OWP Guidance Memo 00-2011 (8/24/00)

Stream Information		Stream Flows		Mixing Information			Effluent Information	
Mean Hardness (as CaCO3) =	234 mg/L	1Q10 (Annual) =	0.71 MGD	Annual	- 1Q10 Flow =	87.53 %	Mean Hardness (as CaCO3) =	326 mg/L
90% Temperature (Annual) =	21.9 deg C	7Q10 (Annual) =	0.97 MGD		- 7Q10 Flow =	100 %	90% Temp (Annual) =	24.5 deg C
90% Temperature (Wet season) =	15.7 deg C	30Q10 (Annual) =	1.42 MGD		- 30Q10 Flow =	100 %	90% Temp (Wet season) =	18.4 deg C
90% Maximum pH =	8.5 SU	1Q10 (Wet season) =	2 MGD	Wet Season	- 1Q10 Flow =	83.83 %	90% Maximum pH =	7.7 SU
10% Maximum pH =	7.8 SU	30Q10 (Wet season) =	4.33 MGD		- 30Q10 Flow =	100 %	10% Maximum pH =	7.4 SU
Tier Designation =	1	30Q5 =	2 MGD				Current Discharge Flow =	8.400 MGD
Public Water Supply (PWS) Y/N? =	N	Harmonic Mean =	6.59 MGD				Discharge Flow for Limit Analysis =	12.600 MGD
V(alley) or P(iedmont)? =	V	Annual Average =	27.7 MGD					
Trout Present Y/N? =	N							
Early Life Stages Present Y/N? =	Y							

Footnotes:
1. All concentrations expressed as micrograms/liter (ug/l), unless noted otherwise.
2. All flow values are expressed as Million Gallons per Day (MGD).
3. Discharge volumes are highest monthly average or 2C maximum for Industries and design flows for Municipals.
4. Hardness expressed as mg/l CaCO3. Standards calculated using Hardness values in the range of 25-400 mg/l CaCO3.
5. "Public Water Supply" protects for fish & water consumption. "Other Surface Waters" protects for fish consumption only.
6. Carcinogen "Y" indicates carcinogenic parameter.
7. Ammonia WQSs selected from separate tables, based on pH and temperature.
8. Metals measured as Dissolved, unless specified otherwise.
9. WLA = Waste Load Allocation (based on standards).
10. WLA = Waste Load Allocation (based on standards).
11. WLAs are based on mass balances (less background, if data exist).
12. Acute - 1 hour avg. concentration not to be exceeded more than 1/3 years.
13. Chronic - 4 day avg. concentration (30 day avg. for Ammonia) not to be exceeded more than 1/3 years.
14. Mass balances employ 1Q10 for Acute, 30Q10 for Chronic Ammonia, 7Q10 for Other Chronic, 30Q5 for Non-carcinogens, Harmonic Mean for Carcinogens, and Annual Average for Dioxin. Actual flows employed are a function of the mixing analysis and may be less than the actual critical flows.
15. Effluent Limitations are calculated elsewhere using the minimum WLA and EPA's statistical approach (Technical Support Document).

WQS-WLA Spreadsheet: Flow Tier 3 Input

Facility Name: Opequon Water Reclamation Facility	Permit No.: VA0065552	POST - EXPANSION WATER QUALITY CRITERIA 12.600 MGD Discharge Flow - Mix per "Mixer"				NON-ANTIDEGRADATION WASTE LOAD ALLOCATIONS 12.600 MGD Discharge - Mix per "Mixer"		
Receiving Stream: Opequon Creek	Date: 11/29/2005	Aquatic Protection		Human Health		Aquatic Protection		Human Health
Toxic Parameter and Form	Carcinogen?	Acute	Chronic	Public Water Supplies	Other Surface Waters	Acute	Chronic	
Ammonia-N (Annual)	N	1.4E+01 mg/L	1.8E+00 mg/L	None	None	1.5E+01 mg/L	2.0E+00 mg/L	N/A
Ammonia-N (Wet season)	N	1.3E+01 mg/L	2.6E+00 mg/L	None	None	1.5E+01 mg/L	3.5E+00 mg/L	N/A
Chlorine, Total Residual	N	1.9E-02 mg/L	1.1E-02 mg/L	None	None	2.0E-02 mg/L	1.2E-02 mg/L	N/A

STAT.EXE Results – Flow Tiers 3

Ammonia-N – 12.6 MGD (annual)

Chronic averaging period = 30
WLAa = 15
WLAc = 2
Q.L. = 0.2
# samples/mo. = 30
# samples/wk. = 7

Summary of Statistics:

observations = 1
Expected Value = 9
Variance = 29.16
C.V. = 0.6
97th percentile daily values = 21.9007
97th percentile 4 day average = 14.9741
97th percentile 30 day average= 10.8544
< Q.L. = 0
Model used = BPJ Assumptions, type 2 data

A limit is needed based on Chronic Toxicity
Maximum Daily Limit = 4.03534018683262
Average Weekly limit = 2.46441133379476
Average Monthly Limit = 2

The data are: 9

Ammonia-N – 12.6 MGD (wet season)

Chronic averaging period = 30
WLAa = 15
WLAc = 3.5
Q.L. = 0.2
# samples/mo. = 30
# samples/wk. = 7

Summary of Statistics:

observations = 1
Expected Value = 9
Variance = 29.16
C.V. = 0.6
97th percentile daily values = 21.9007
97th percentile 4 day average = 14.9741
97th percentile 30 day average= 10.8544
< Q.L. = 0
Model used = BPJ Assumptions, type 2 data

A limit is needed based on Chronic Toxicity
Maximum Daily Limit = 7.06184532695709
Average Weekly limit = 4.31271983414083
Average Monthly Limit = 3.5

The data are: 9

Total Residual Chlorine – 12.6 MGD

Chronic averaging period = 4
WLAa = 0.02
WLAc = 0.012
Q.L. = 0.1
# samples/mo. = 30
# samples/wk. = 7

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 = 1.75508974086388E-02
Average Weekly limit = 1.07184595324212E-02
Average Monthly Limit = 8.69859620059178E-03

The data are: 20

The following results were determined:

a. **Ammonia-N:** Per the STAT.EXE evaluation results, annual ammonia-N monthly average and maximum weekly average limits were applied to all flow tiers. Corresponding wet season limits were also applied since they were determined to be significantly greater than the annual limits. The change in the Interim Flow Tier 1 limits from the previous permit is the result of new stream data at this reissuance. Current guidance recommends that the frequency of monitoring be set the same as the frequency for (C)BOD since both parameters are operational factors relating to nitrification. The recommended baseline monitoring frequency for this facility is 1/Day.

b. **Total Residual Chlorine:** Per the STAT.EXE evaluation results, TRC monthly average and maximum weekly average limits were applied to all flow tiers. The limits are nearly identical to those required by the previous permit. The change in the limits is the result of new stream data at this reissuance. The chlorine contact tank TRC limit of 0.25 mg/L was demonstrated to be sufficient for disinfection during the 1991 permit reissuance. This limit was carried forward during the 1996 and 2001 permit reissuance and, because there is no data to indicate inadequate disinfection, this limit was again carried forward at this reissuance. The permit also contains bacteria limitations to ensure effective disinfection is continually achieved.

c. **Chloride**: Based on monitoring data submitted by the permittee during the last permit cycle, a chloride limit was determined not to be necessary. This determination is the result of new monitoring and stream data. No chloride limit would have been applied to the permit had this data been available during the previous chloride limit evaluation.

d. **Selenium & Cadmium:** New data provided by the permittee as part of the EPA Form 2A application was insufficient to determine if a limit is needed for these parameters. As such, additional monitoring for these constituents will be imposed in Attachment A1 of the permit.

There are no other pollutants of concern known to exist in this discharge.

REDUCED MONITORING FREQUENCY EVALUATION

The applicant requested reduced monitoring frequencies for CBOD, BOD, TSS, pH and DO be considered at this reissuance. Per the VPDES Permit Manual, to qualify for consideration of reduced monitoring requirements, the facility should not have been issued any Warning Letters, NOVs, or NULEs, or be under any Consent Orders, Consent Decrees, Executive Compliance Agreements, or related enforcement documents during the past three years. This evaluation applies only to the existing 8.4 MGD (Jun-Nov), 16.0 MGD (Dec-May) flow tier.

The facility received a Warning Letter for a BOD_5 (Jun-Nov) violation as well as an NOV for several NH_3-N (Dec-May) violations within the last three years from the date of this evaluation (11/14/05). As such neither of these parameters may be monitored at a reduced frequency.

The minimum DO concentration was violated during June 2004, but no compliance statement was issued by DEQ. Per the VPDES Permit Manual, where the post aeration system is passive (i.e. cascade steps), reduction of the monitoring frequency is to be considered on a case-by-case basis. The minimum monthly DO was reported to be within 0.5 mg/L (or less) of the limit on nine occasions from April 2004 to September 2005. Based on this evidence it does appear prudent to allow a reduction in the DO monitoring frequency.

The minimum pH for February 2005 was reported as 6.92 S.U., which is less than 0.5 S.U.'s above the minimum pH limit of 6.5 S.U. Per the VPDES Permit Manual, reduced monitoring should not be allowed where minimum or maximum pHs fall within 0.5 S.U.'s of the permit limits.

The long term average effluent $CBOD_5$ (Dec-May) values (monthly and maximum weekly average concentrations and quantities) are all less than 25% of the $CBOD_5$ (Dec-May) limit. As such the monitoring frequency was adjusted from 1/Day to 1/Week for this parameter at this reissuance.

The long term average effluent NH_3-N (Jun-Nov) values (monthly and maximum weekly average concentrations and quantities) are all less than 25% of the NH_3-N (Jun-Nov) limit. As such the monitoring frequency will be set at 1/Week. The previous permit required NH_3-N monitoring 1/Month. Current agency guidance recommends NH_3-N be monitored at the same frequency as BOD. The monitoring frequency for BOD (Jun-Nov) is 1/Day.

Per the VPDES Permit Manual, upgraded facilities should generate three years of data before being eligible for consideration for reduced monitoring. As such, reduced monitoring frequencies were not applied to the nutrient compliant and expanded facilities, expect for CBOD. Because the nutrient compliant and expanded facilities will be required to meet reduced and limit of technology annual TN and TP limits, respectively, monitoring for CBOD was reduced below the recommended frequency for a conventional wastewater treatment plant. A CBOD limit of 25 mg/L is not considered to be a permit limiting parameter for an ENR facility, and as such the monitoring frequency was set at 1/Week. This monitoring frequency should be sufficient to adequately gauge the treatment efficiency of the facility. The normal monitoring frequency of 1/Day may be reinstated should the facility fail to comply with the CBOD permit limitations.

OPEQUON CREEK CAPACITY STUDY

Notes:

Additional model runs included in the OCCS report attachments were submitted during the 2005 Parkins Mills WWTF (PMWWTF) VPDES permit (VA0075191) modification. These model runs include a range of effluent limits and flows for the PMWWTF as well as limits and flows for the Frederick County Landfill and OWRF discharges. Attachment 4 includes dry season model data for the expanded OWRF discharges of 10.4 and 12.6 MGD. Wet season CBOD and DO permit limits for the 10.4 and 12.6 MGD effluent flows are based on the 16.0 MGD discharge model runs included in Attachment 1.

Per the model developer (HydroQual):

1. All model report and data references to BOD are to be interpreted as CBOD. NBOD is evaluated based on Org-N and Ammonia-N.

2. The CBODu/BOD_5 ratio used for the original winter effluent BOD_5 levels (23 mg/L at PMMWTF and 25 mg/L at OWRF) was modified (from the model report) to reflect the variation in the ratio as a function of treatment level. The ratio increases with better treatment performance (lower BOD_5 levels) and decreases with lower treatment performance (higher BOD_5) levels). Therefore, for higher winter BOD_5 levels, a CBODu/BOD_5 ratio of 3 was used for the water quality projection. The summer ratio used was 5.14 for the PMWWTF and 4.77 for the OWRF.

3. DO values continue to increase to Turkey Run due to reducing CBOD and NH3 levels (less DO consumption) and atmospheric reaeration. When the DO levels are at or above saturation, this is due to algal photosynthesis (oxygen production). When the algal oxygen production exceeds the amount of oxygen that is lost to the atmosphere, DO levels can become super-saturated.

4. CBOD and NBOD from the point-sources within the model will continue to decrease in the downstream direction back to background conditions (downstream from the end of the model) due to continued decay of CBOD and NH3. Other inputs of CBOD and NH3 downstream will ultimately determine what CBOD and NH3 levels will be maintained downstream.

5. Output for the model is provided roughly every 0.5 miles. For the Alleghany County DIURNAL model (lower Jackson/James River) that was provided to VDEQ, an output frequency of between 0.2-1 miles was used and for the Mead-Westvaco DIURNAL model (Jackson River) an output frequency of 0.1-0.5 miles was used. Since for each model reach the model characteristics are the same (e.g., geometry, incremental flow and WQ, constants, temperature), the calculated variation in each reach is continuous (i.e., there will be no sudden changes in model output between the outputted mile points). Therefore, additional model output at 0.1 increments would not add any additional information to the report and intermediate model output can be closely estimated by interpolating between the current model outputs.

6. Estimates of the distance downstream where DO impacts are noticeable from the 3 point-sources (Parkins Mills WWTF, Frederick County Landfill, OWRF) are as follows: Roughly, the DO impact from the PMWWTTF extends about 6.5 miles below the outfall (until the FCL and OWRF discharges). The DO impact from the FCL extends about 5 miles below the outfall (until the OWRF discharge). The DO impact from the OWRF extends about 15 miles below the outfall (until the end of the model).

O'BRIEN & GERE

Landover, Maryland

OPEQUON CREEK CAPACITY STUDY (VIRGINIA)

Completed for the Frederick-Winchester Service Authority

March 2005

OBAG0110

HydroQual

Environmental

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EXECUTIVE SUMMARY

The primary objective of the Opequon Creek Capacity Study is to develop a technically defensible water quality model of Opequon Creek to support subsequent wastewater master planning by the Frederick-Winchester Service Authority (FWSA), County and City. As part of the Opequon Creek Capacity Study, field programs were designed and performed to gather current water quality information in the Opequon Creek watershed in addition to the development of an updated water quality model (DIURNAL) for the creek. This water quality model is similar to the USEPA supported QUAL2E model and has been applied for a number of point source permitting projects with the Virginia Department of Environmental Quality (VDEQ). HydroQual, Inc. (HQI), O'Brien & Gere Engineers, Inc. (OBG) and the Academy of Natural Sciences of Philadelphia (ANSP) conducted two, approximately 1-week long field surveys of Opequon Creek and major tributaries to the creek for the FWSA in the fall of 2004. Finally, the updated water quality model of the creek was used to determine the assimilative capacity of the creek to assist in point source permitting.

The following conclusions are the result of the field program and model development effort.

- The two field surveys of the creek gathered information relating to water quality including algal effects, geometry and travel time to support development of an updated water quality model of the creek. During these surveys, a number of spring fed tributaries were encountered (e.g., Dry Marsh Run) that have significant flow somewhat independent of runoff conditions in addition to being cooler than the creek with different water quality characteristics.
- The water quality data collected included measurements of dissolved oxygen (DO), BOD, suspended solids (SS), temperature, conductivity, pH, nitrogen, phosphorus and chlorophyll-a. DO levels during these surveys were all greater than 6 mg/L (above the daily average DO standard of 5 mg/L). Continuous data recorders were installed at six locations in the creek and indicated large daily diurnal DO swings (2-10 mg/L) with minimum levels always greater than 6 mg/L. TN levels were less than 7 mg/L, TP less than 0.8 mg/L and chlorophyll-a levels less than 2 mg/L. In general, all nutrient levels decreased in the downstream direction.
- Creek geometry and travel time information was also obtained throughout the creek, which provided a significant upgrade in the understanding of the creek's physical characteristics.
- The water quality model (DIURNAL) was chosen to represent Opequon Creek since it contains the necessary structure to simulate diurnal variation of DO in addition to the various parameters of concern (i.e., carbonaceous BOD and nitrogen). In addition, the DIURNAL model was used to complete water quality modeling for the Opequon Wastewater Reclamation Facility (OWRF) (HydroQual, 1997) and for permitting with

VDEQ. This upgraded model of the creek will be used for continued permitting of the Parkins Mills Wastewater Treatment Facility (PMWWTF) (permit reopening), the OWRF (permit reapplication) and the County Landfill.

- Using the data collected in 2004, the DIURNAL model was developed to represent Opequon Creek from just upstream of the PMWWTF to approximately 26 miles downstream. The model calibration is completed to develop a model that best represents the available data and was calibrated to the geometry data (depth, width,. cross-sectional area, velocity and flow) and then to the water quality data (organic, ammonia and nitrite plus nitrate nitrogen, conductivity, CBODu and DO).
- In general, the DIURNAL model output compares well with observed data for all parameters over the length of the creek analyzed and specifically, the model represents the measured CBODu and DO data very well. The model comparison to the observed data resulted in a successful calibrated model that can be used to assess the assimilative capacity of the creek.
- The calibrated water quality model of Opequon Creek provides a tool to determine the assimilative capacity of the creek for point source permitting of the PMWWTF, OWRF and County Landfill in addition to considering the new discharge from the Northern Wastewater Reclamation Facility (NWRF). The calibrated model was used for these water quality projection analyses with the creek flow set at the 7Q10 low-flow and at summer creek temperatures.
- For all of the discharge cases analyzed under both cloudy and sunny conditions, the daily average creek DO is always greater than the 5 mg/L State DO standard at the critical summer, low-flow creek conditions. Also, the daily minimum DO for both the cloudy and sunny conditions is always greater than the 4 mg/L State DO standard for all discharge cases. These water quality projections included discharges from the PMWWTF, County Landfill, OWRF and the potential new discharge from the NWRF.

SECTION 1

INTRODUCTION

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SECTION 1

INTRODUCTION

The primary objective of the Opequon Creek Capacity Study is to develop a technically defensible water quality model of Opequon Creek to support subsequent wastewater master planning by the Frederick-Winchester Service Authority (FWSA), County and City. Development of the water quality model was based on all available data with particular emphasis placed on the 2004 data because it best represents the current environmental conditions in the creek. The water quality modeling is intended to help answer the basic question of what is the assimilative capacity of Opequon Creek for receiving wastewater effluent at different treatment levels and locations in the watershed to optimize the assimilative capacity while maintaining water quality.

FWSA owns and the City of Winchester operates the Opequon Water Reclamation Facility (OWRF), which is currently required to achieve biological nutrient removal (BNR) with seasonal limits for other parameters. FWSA owns and Frederick County Sanitation Authority operates the Parkins Mills Wastewater Treatment Facility (PMWWTF), which is currently required to achieve Secondary Treatment – Nitrification. There are other point and nonpoint source discharges within the watershed not managed by the FWSA. These dischargers include the Frederick County Landfill point source discharge and various nonpoint source tributary and direct runoff loadings.

As part of the Opequon Creek Capacity Study, field programs were designed and performed to gather current water quality information in the Opequon Creek watershed in addition to the development of an updated water quality model for the creek. The updated water quality model includes the following parameters and associated transformation processes (kinetics): CBOD, DO, organic nitrogen, ammonia nitrogen, nitrite plus nitrate nitrogen and conductivity (conservative tracer). The steady-state creek model DIURNAL was used because it can represent all of these parameters and processes in addition to allowing for diurnal DO calculations to be performed. This water quality model is similar to the USEPA supported QUAL2E model and has been applied for a number of point source permitting projects in Virginia. The DIURNAL model was calibrated and applied to Jackson River from Covington to Clifton Forge for Mead-Westvaco and to the Jackson/James River from Clifton Forge to Eagle Rock for the County of Alleghany. Both of these projects were reviewed and approved by the Virginia Department of Environmental Quality (VDEQ) for the development of NPDES effluent permit limits at the Mead-Westvaco facility and for a proposed wastewater treatment plant for the Alleghany County Department of Public Works.

The field programs were specifically designed to support development of the updated water quality model for the creek. The remainder of this report presents the results from the field program, model development and various water quality projection analyses to investigate potential discharge options for the FWSA as part of NPDES permitting with the VDEQ.

SECTION 2

FIELD PROGRAM

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SECTION 2

FIELD PROGRAM

HydroQual, Inc. (HQI), O'Brien & Gere Engineers, Inc. (OBG) and the Academy of Natural Sciences of Philadelphia (ANSP) conducted two, approximately 1-week long field surveys of Opequon Creek and major tributaries to the creek for the FWSA. These surveys were designed to gather information relating to creek water quality including algal effects, geometry, travel time and atmospheric reaeration to support development of an updated water quality model of the creek. The first survey was conducted between October 12th and 14th for the collection of instream water quality and field parameters. The second survey was conducted between November 2nd and 7th for the collection of creek geometry, travel time, atmospheric reaeration information in addition to the deployment of continuous datasondes in the creek to assess algal effects on diurnal DO levels. While the field staff were conducting these surveys, a number of spring fed tributaries were encountered (e.g., Dry Marsh Run) that have significant flow somewhat independent of runoff conditions in addition to being cooler than the creek with different water quality characteristics.

During the second survey a significant rain event occurred on November 4th in which creek flows varied substantially. Although there was a rain event during the second survey, this survey was planned to collect other creek information and not water quality data to describe conditions in the creek. The installation of the continuous datasondes during the second survey actually provided valuable information regarding daily DO variation before, during and after the rain event. Due to a number of hurricanes passing through the area in September the creek surveys were delayed somewhat and ideal summer, low-flow conditions were not captured. In spite of the unusual hurricane season in September, the creek water quality survey was completed at relatively steady low-flow conditions. The hydrographs in Opequon Creek near the USGS Berryville gage (# 01615000) and Stephens City gage (# 01614830) are presented in Figures 1a (log-scale) and 1b (arithmetic-scale) for September through November that show the three hurricane events in September with the two survey periods indicated by the shaded areas.

In order to provide good coverage of the creek in the study area, 19 creek sampling stations and 7 tributary stations were sampled for a variety of water quality parameters. The study area ranged from just upstream of the PMWWTF near the Route 522 crossing of the creek to approximately 25 miles downstream near the Route 51 crossing of the creek by Middleway (WV). The station locations in the study area are presented in Figure 2 and tabulated in Table 1. In addition, 2 effluent samples were also collected from the PMWWTF and the OWRF. These field surveys were aimed at measuring ambient water quality in the creek and tributaries, atmospheric oxygen reaeration capacity, travel time through the creek and creek geometry. The data collected were used to develop a mathematical water quality model (DIURNAL) of Opequon Creek to assist

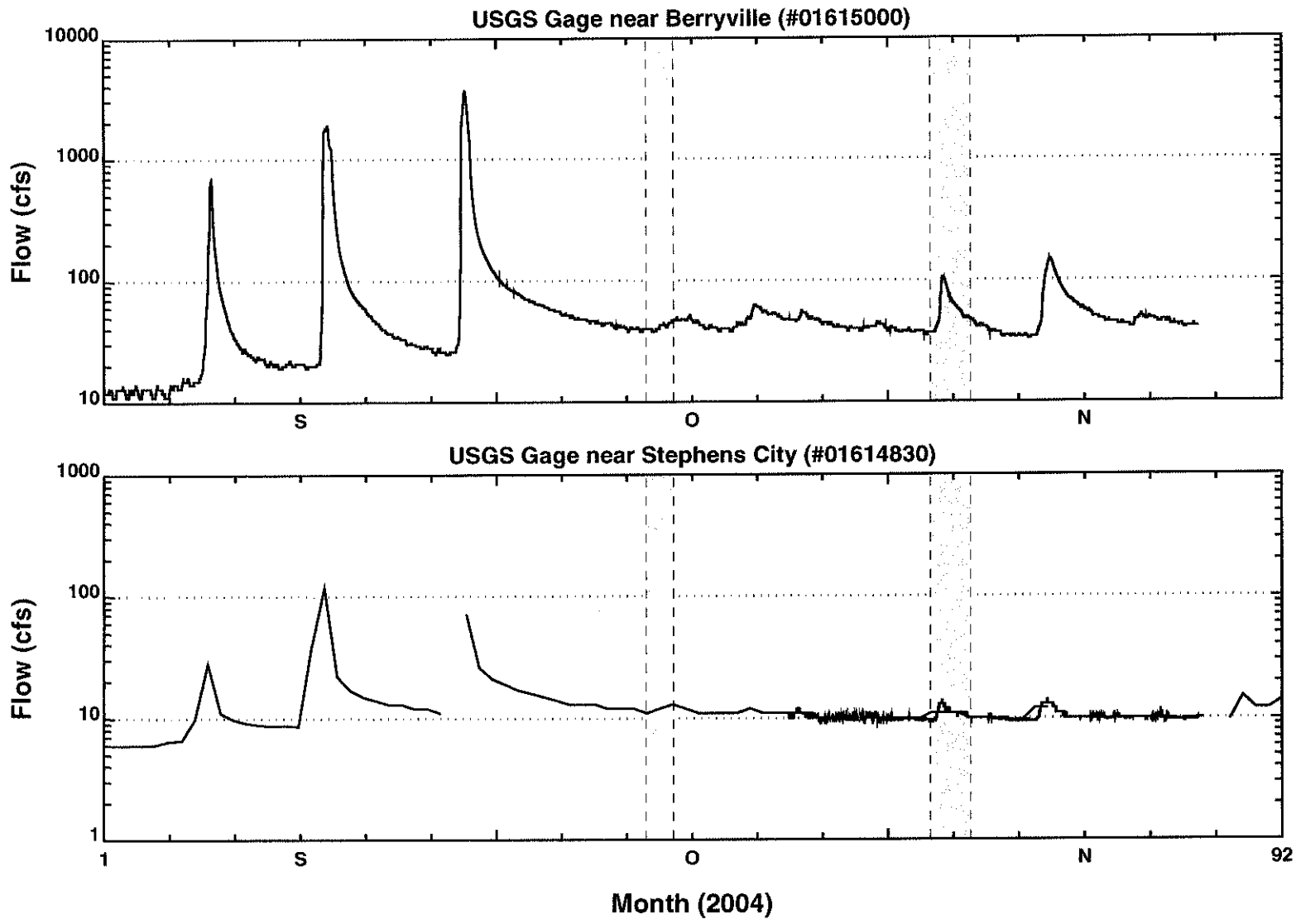

Figure 1a. Opequon Creek Survey USGS Stream Flows (9-11/2004) - Log-Scale

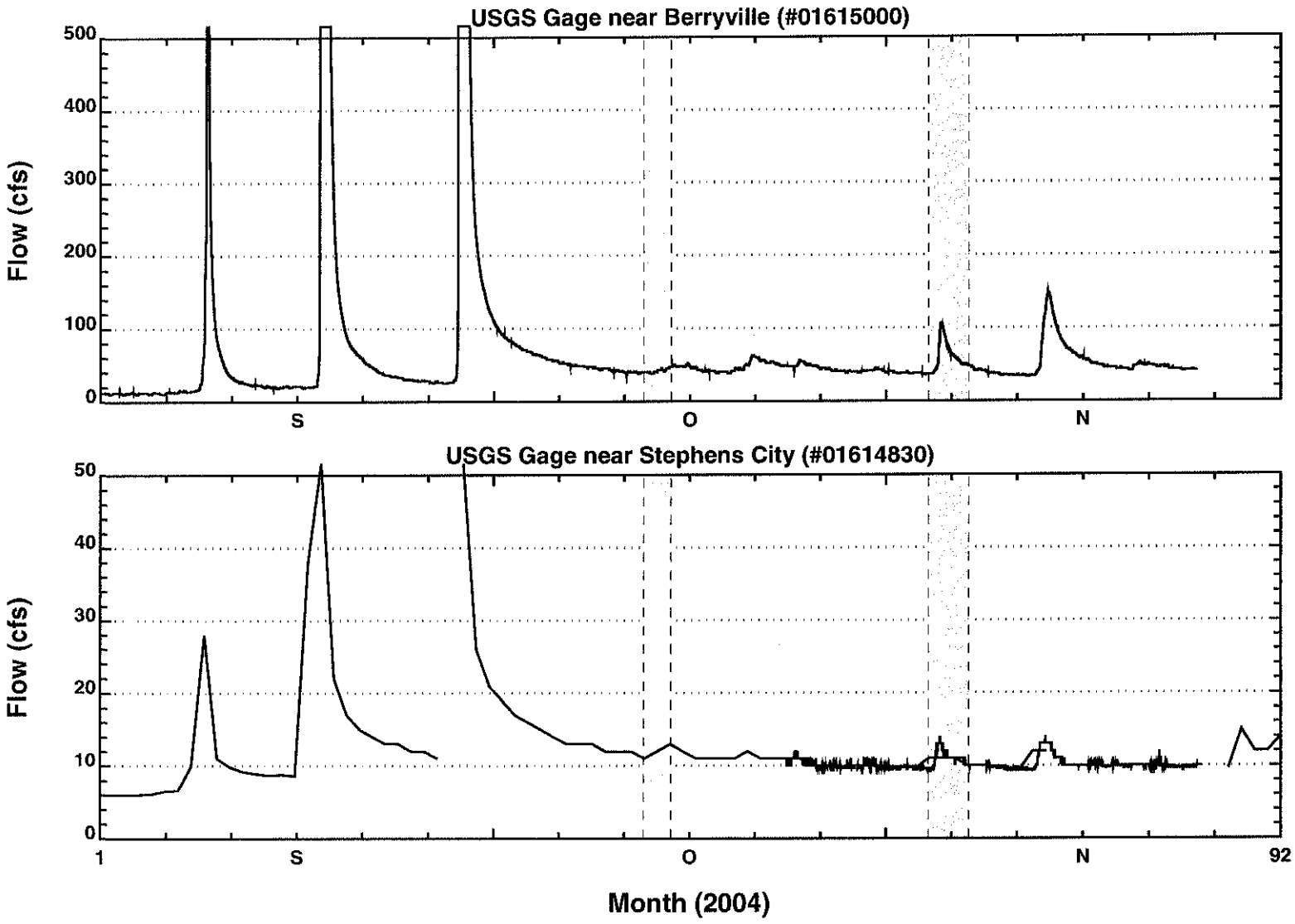

Figure 1b. Opequon Creek Survey USGS Stream Flows (9-11/2004) - Arithmetic-Scale

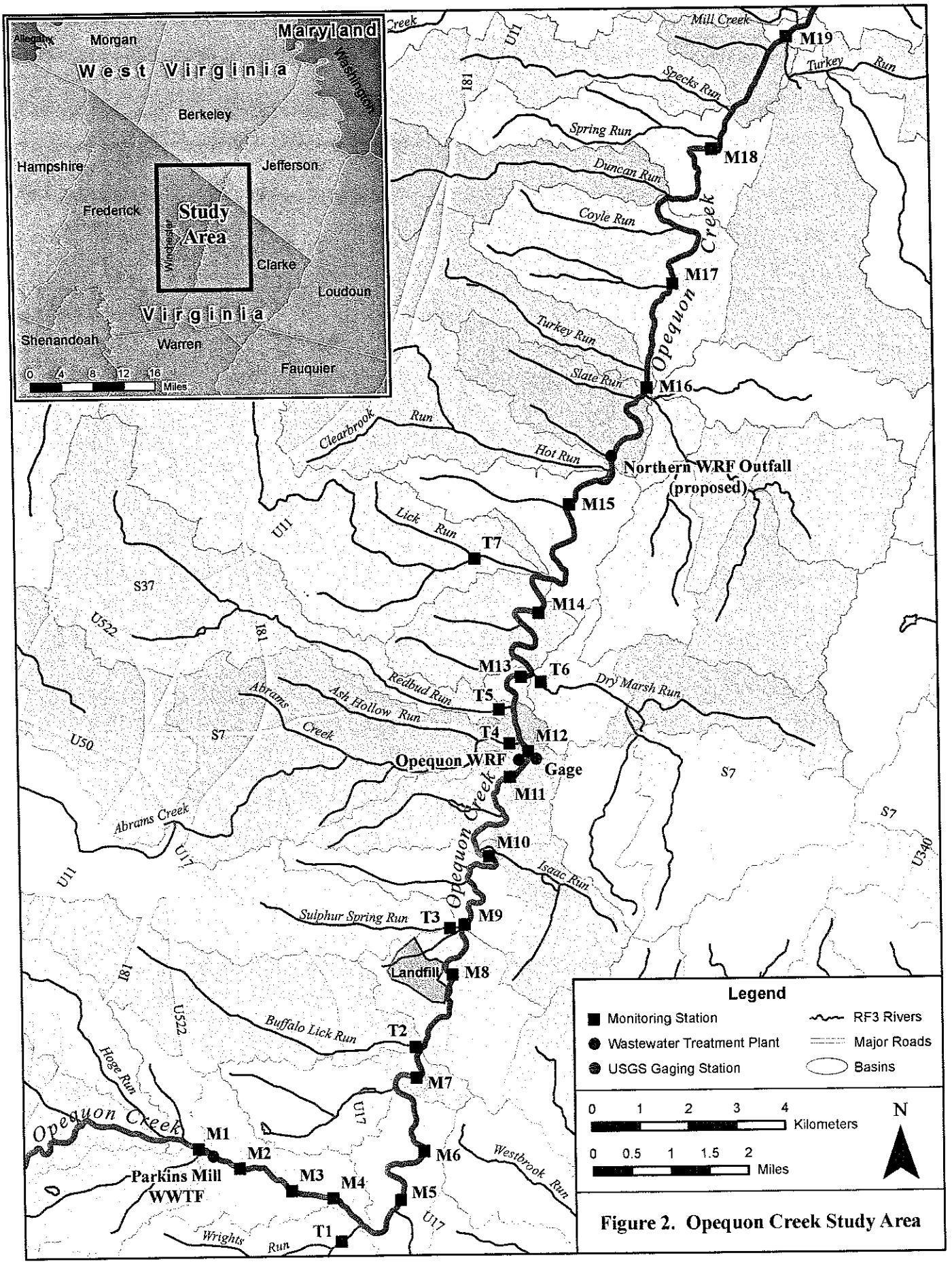

Figure 2. Opequon Creek Study Area

the FWSA in permitting of the PMWWTF and the OWRF with the VDEQ and also for overall watershed wastewater facilities planning in the Frederick-Winchester area.

Table 1. Monitoring Station Locations

Station	Description
M1	Above PMWWTF
M2	Route 522 crossing
M3	Private property access # 1
M4	Private property access # 2
M5	Route 50/17 crossing
M6	Route 644 crossing
M7	Route 723 crossing
M8	Near landfill (below discharge)
M9	Route 655 crossing
M10	Route 657 crossing
M11	Above OWRF
M12	Below OWRF (near Route 7 crossing)
M13	Route 664 crossing
M14	Route 660 crossing
M15	Route 761 crossing
M16	Route 672 crossing
M17	Route 667 crossing (Old Braddock Road - Carters Ford)
M18	Ford above Silver Spring Run
M19	Ford above Mill Creek near Middleway
T1	Wrights Run, Route 642 crossing
T2	Buffalo Lick Run, Route 723 crossing
T3	Sulphur Spring, road crossing off of Route 655
T4	Abrams Creek, Route 659 crossing
T5	Redbud Run, Route 659 crossing
T6	Dry Marsh Run, Route 645 crossing
T7	Lick Run, Route 664/761 crossing

The reaeration and time of travel study was conducted in three reaches of the creek and samples collected for sodium bromide (conservative tracer) and propane. Unfortunately when the propane samples were analyzed at the ANSP laboratory, upstream levels were lower than downstream levels (opposite of what should occur) and subsequent analyses at another laboratory were all reported at or less than the detection limit. Therefore, determination of creek atmospheric reaeration rates was not possible although the time of travel results using the bromide data were successful and used to determine creek velocities and flows. Although estimates of reaeration were

not possible, a widely used and accepted reaeration equation will be used (the Tsivoglou-Wallace formulation), which is applicable to shallow, fast moving streams. In addition, the Tsivoglou-Wallace formulation has been used on previous modeling studies of the creek. Since the datasondes were installed, the measured continuous DO data can be used to infer the reaeration rates in the creek. That is, the diurnal DO pattern measured is a function of the reaeration rate and will be used to verify the reaeration rates calculated with the Tsivoglou-Wallace reaeration formulation.

2.1 WATER QUALITY

The instream water quality surveys of the creek were completed on October 13th (PM) and October 14th (AM) by HQI, OBG and ANSP staff. Samples were collected in 4-liter containers either from bridge overpasses (if creek access was not possible) or directly in the creek and tributaries. The sampling was completed by three sampling teams to allow coverage of the creek study area in a relatively synoptic manner (i.e., sampling throughout the creek occurring roughly over the same period). The water samples collected were analyzed for total kjeldahl nitrogen (TKN), ammonia nitrogen (NH3), nitrite plus nitrate nitrogen (NO2+NO3), total phosphorus (TP), orthophosphate (PO4), total suspended solids (TSS), volatile suspended solids (VSS), chlorophyll-a, 5-day biochemical oxygen demand (BOD5) and long term BOD (LTBOD) at the ANSP laboratory. In addition, direct field measurement of creek and tributary dissolved oxygen (DO), temperature, conductivity and pH were completed using a portable field meter.

The water quality data collected are presented in Figures 3 and 4 as a function of stream length for DO, BOD5, ultimate CBOD (CBODu), VSS, TSS, temperature, conductivity, pH, TKN, NH3, NO2+NO3, TP, PO4 and chlorophyll-a. Milepoint 0 is where the PMWWTF discharges to the creek and milepoint 12 where the OWRF discharges to the creek. DO levels during these surveys were all greater than 6 mg/L (above the DO standard of 5 mg/L) with water temperatures between 12 and 15°C. The DO saturation level at these water temperatures ranges from 10.1 to 10.8 mg/L. Slight increases in temperature, conductivity and CBOD were present in the data below the PMWWTF and OWRF. Also a slight decrease and recovery in DO below the OWRF was present in the data. The nutrient data also show an increase in upstream levels below the PMWWTF and a decrease from upstream levels below the OWRF. TKN levels were less than 0.5 mg/L, NH3 levels less than 0.015 mg/L, NO2+NO3 levels less than 6 mg/L, TP less than 0.8 mg/L, PO4 less than 0.75 mg/L and chlorophyll-a levels less than 2 mg/L. In general, all nutrient levels decreased in the downstream direction, except for NH3, with relatively constant chlorophyll-a levels. The relatively constant NH3 levels in the creek may be a function of the low levels (<0.02 mg/L) or other sources to the creek. Tables of the water quality data collected on 10/13-14/2004 are presented in Appendix 1.

It is interesting to note that the tributary water quality varied throughout the creek. For example, the first two monitored tributaries (Wrights Run and Buffalo Lick Run) had different water quality than the remaining monitored tributaries (Sulphur Spring, Abrams Creek, Redbud Run, Dry

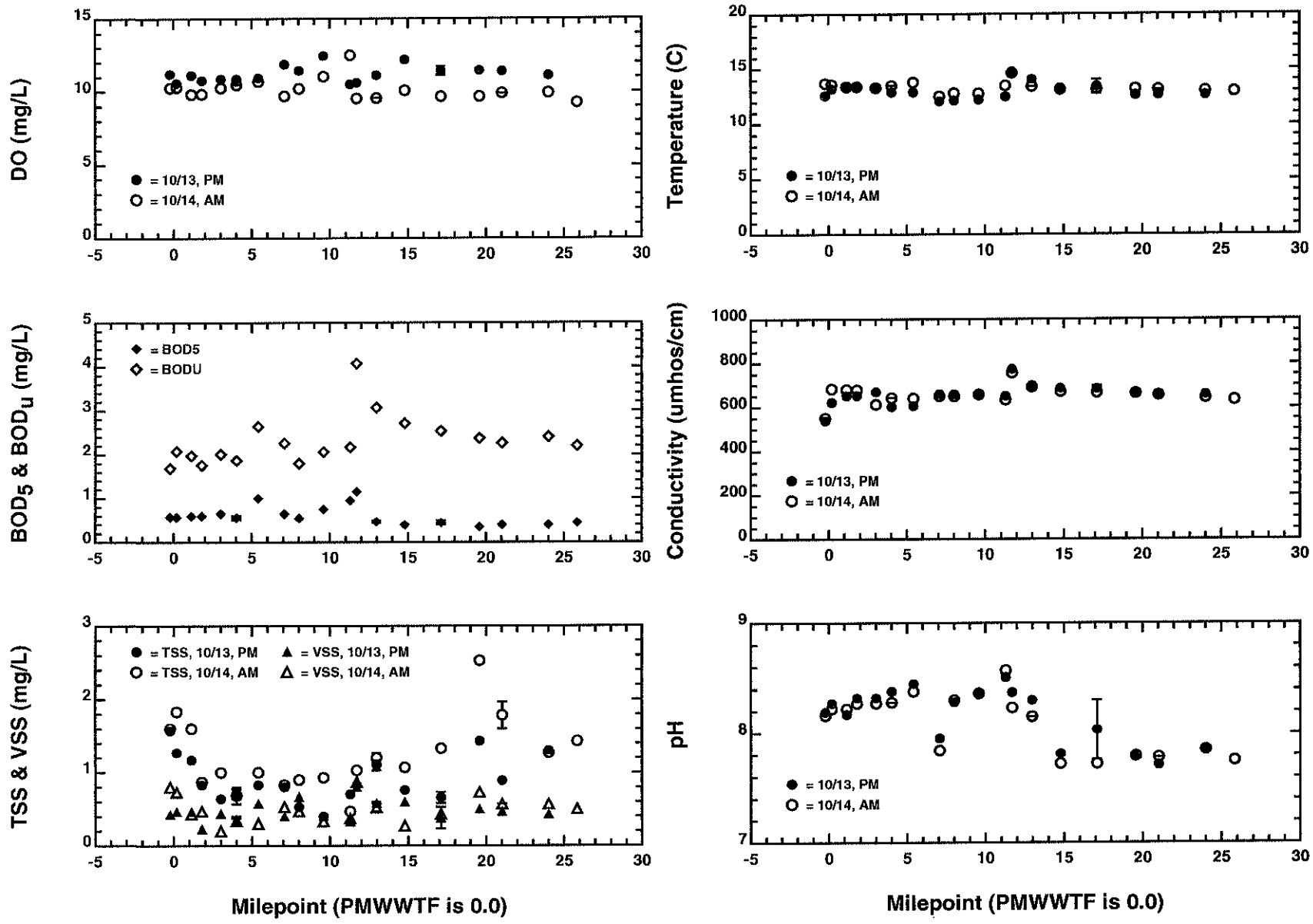

Figure 3. Opequon Creek Water Quality Data for the 10/13-14/2004 Survey

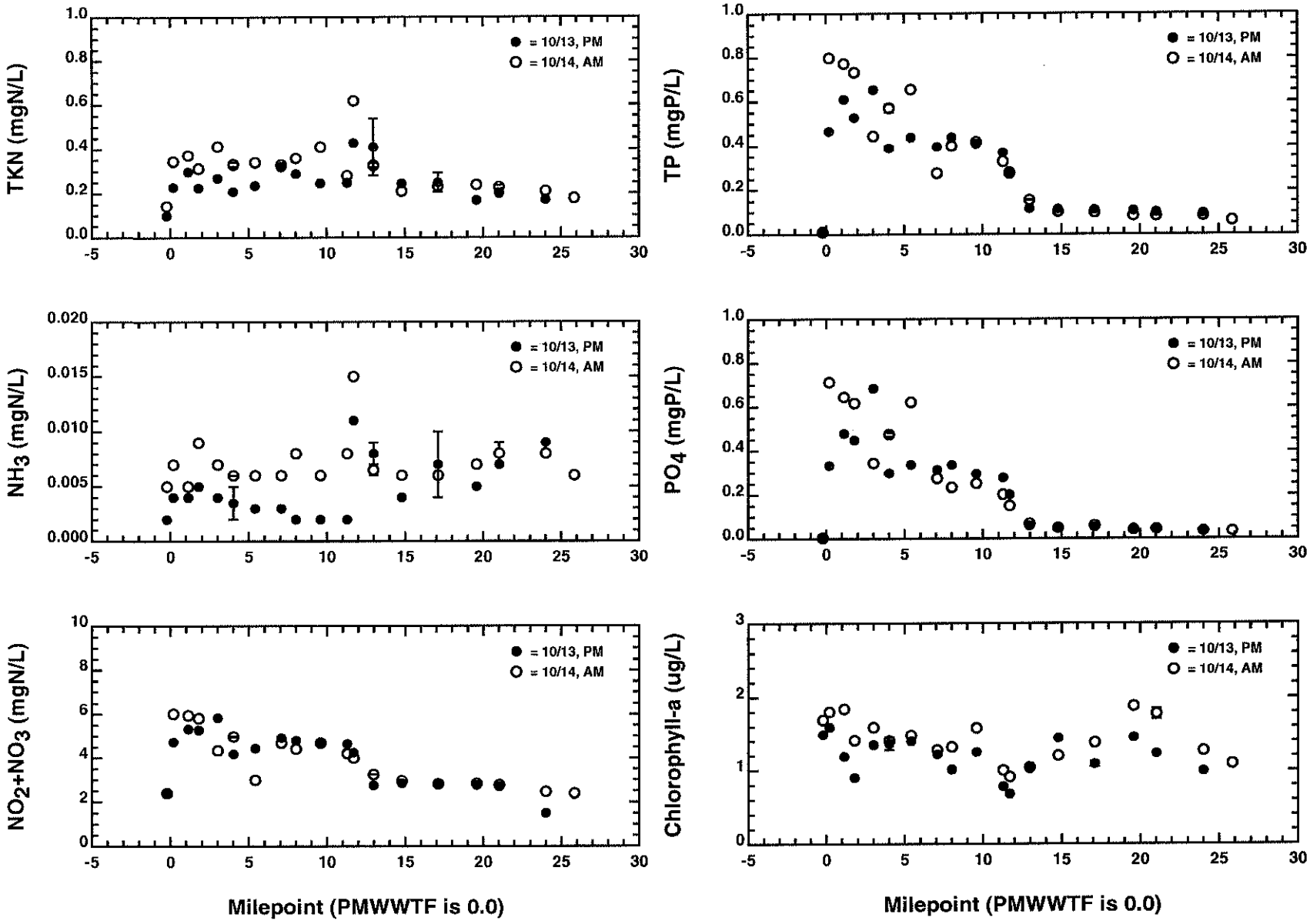

Figure 4. Opequon Creek Water Quality Data for the 10/13-14/2004 Survey

Marsh Run and Lick Run). The first two tributaries had lower conductivity levels than the remaining tributaries (529 vs. 606 mmhos/cm), higher DO (11.6 vs. 9.8 mg/L), and lower NO2+NO3 (0.1 vs. 1.8 mg/L) that may indicate that the first two tributaries may be more dominated by surface runoff and the remaining ones dominated by groundwater (spring fed).

2.2 LONG TERM BOD (LTBOD)

In order to determine the ultimate oxygen demand of a water sample, LTBOD studies were completed on the creek, tributary and effluent samples on October 13th. These studies involve incubating a water sample for an extended period of time (in this case 60 days) and monitoring the DO depletion in a BOD bottle throughout the test. The resulting DO data is then used to calculate BOD versus time and a non-linear regression is performed on the data to determine the ultimate CBOD (CBODu) and the bottle CBOD oxidation rate. It should be noted that the bottle CBOD oxidation rate is not necessarily the stream oxidation rate and depends on the size of the stream. In deep rivers the bottle rate may be a good representation of CBOD oxidation in the receiving water but in a shallow stream it is not. This is because the shallow stream has a large percentage of the water volume in contact with the stream bed where bacteria are more abundant than in the water column, which tends to act like a trickling filter in a WWTP resulting in higher instream CBOD oxidation rates. A trickling filter in a WWTP passes wastewater over a media with attached bacteria to allow greater water contact with the media similar to what is occurring in the shallow creek.

Figures 5 through 9 present the LTBOD data and resulting CBODu and bottle oxidation rate (Kd) determined from a non-linear regression of the data using the following equation:

$$BOD = BOD_u \left(1 - e^{-K_d \times time}\right) \qquad (1)$$

Since the DIURNAL model requires input of CBODu, the results from the LTBOD studies will be used to develop CBODu inputs for the model. Another piece of information that results from the LTBOD studies is the ratio of CBODu/BOD5. Based on the LTBOD data, the CBODu/BOD5 ratio for the creek samples averaged 4.11 (2.28-6.82), for the tributaries averaged 5.82 (2.88-8.25), for the PMWWTF was 5.14 and for the OWRF was 4.77. The ranges of these ratios are typical for the creek, PMWWTF and OWRF effluent. The previous effluent CBODu/BOD5 ratio used for the creek modeling was 3 and no based on LTBOD studies but rather general municipal effluent characteristics. These CBODu/BOD5 ratios will be used for water quality projections when converting model input CBODu to BOD5.

2.3 CONTINUOUS FIELD DATA

In order to define the DO concentrations in the creek throughout the day, a number of continuous datasonde recorders were installed at 6 locations in the creek between November 2nd and 7th. The installation stations were M3, M6, M8, M10, M13 and M15 and the datasondes

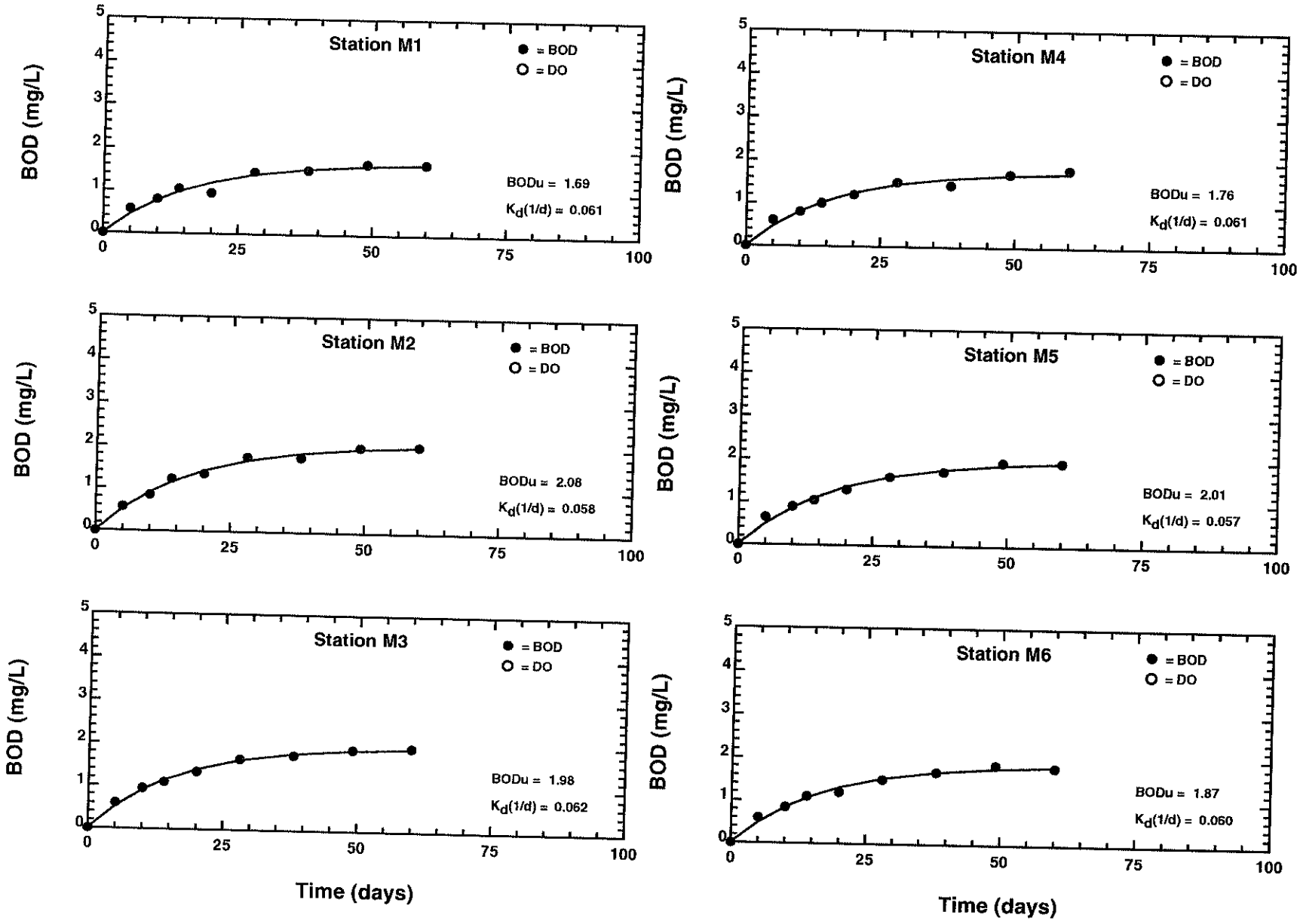

Figure 5. Opequon Creek LTBOD Data for the 10/13/2004 Survey

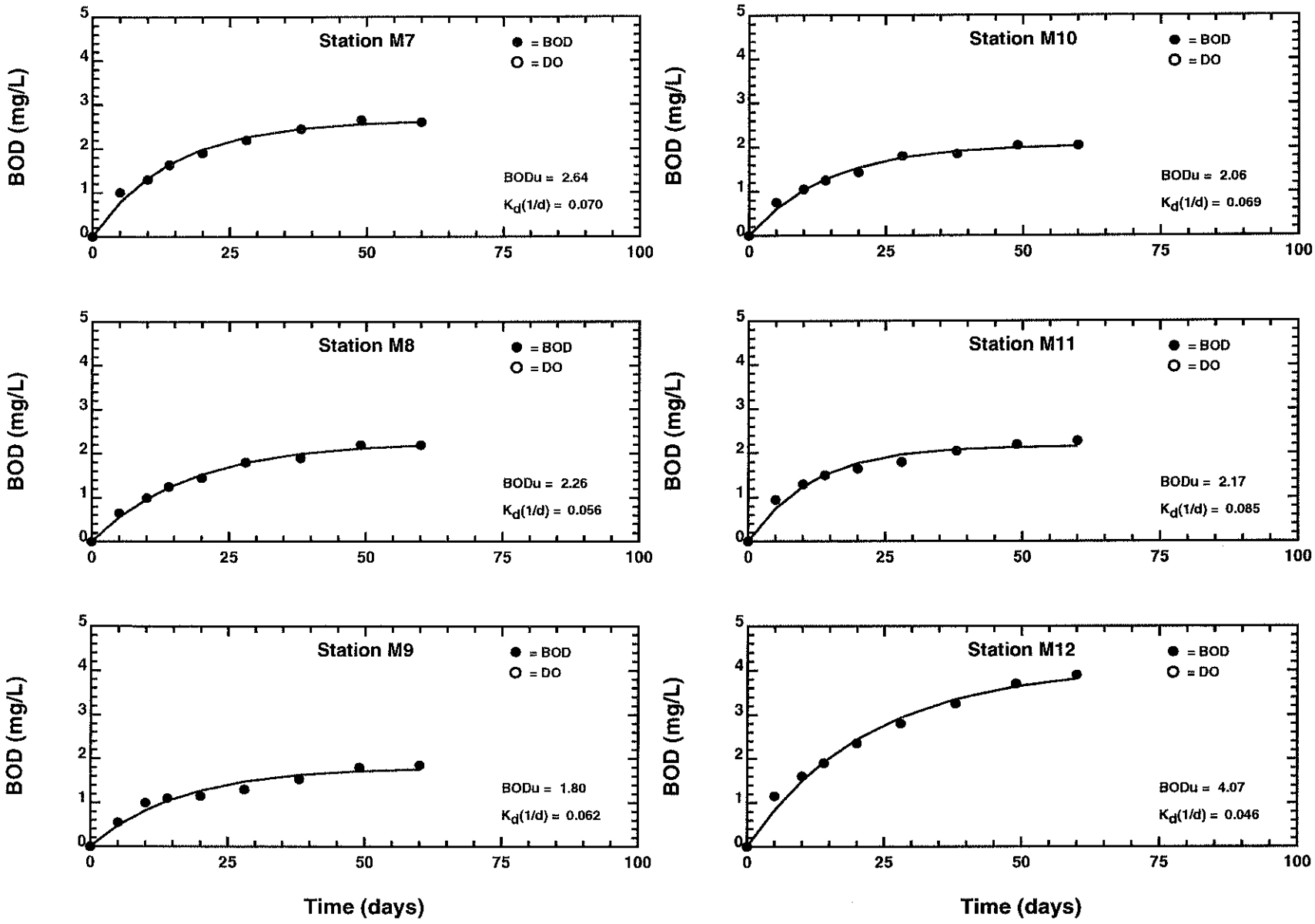

Figure 6. Opequon Creek LTBOD Data for the 10/13/2004 Survey

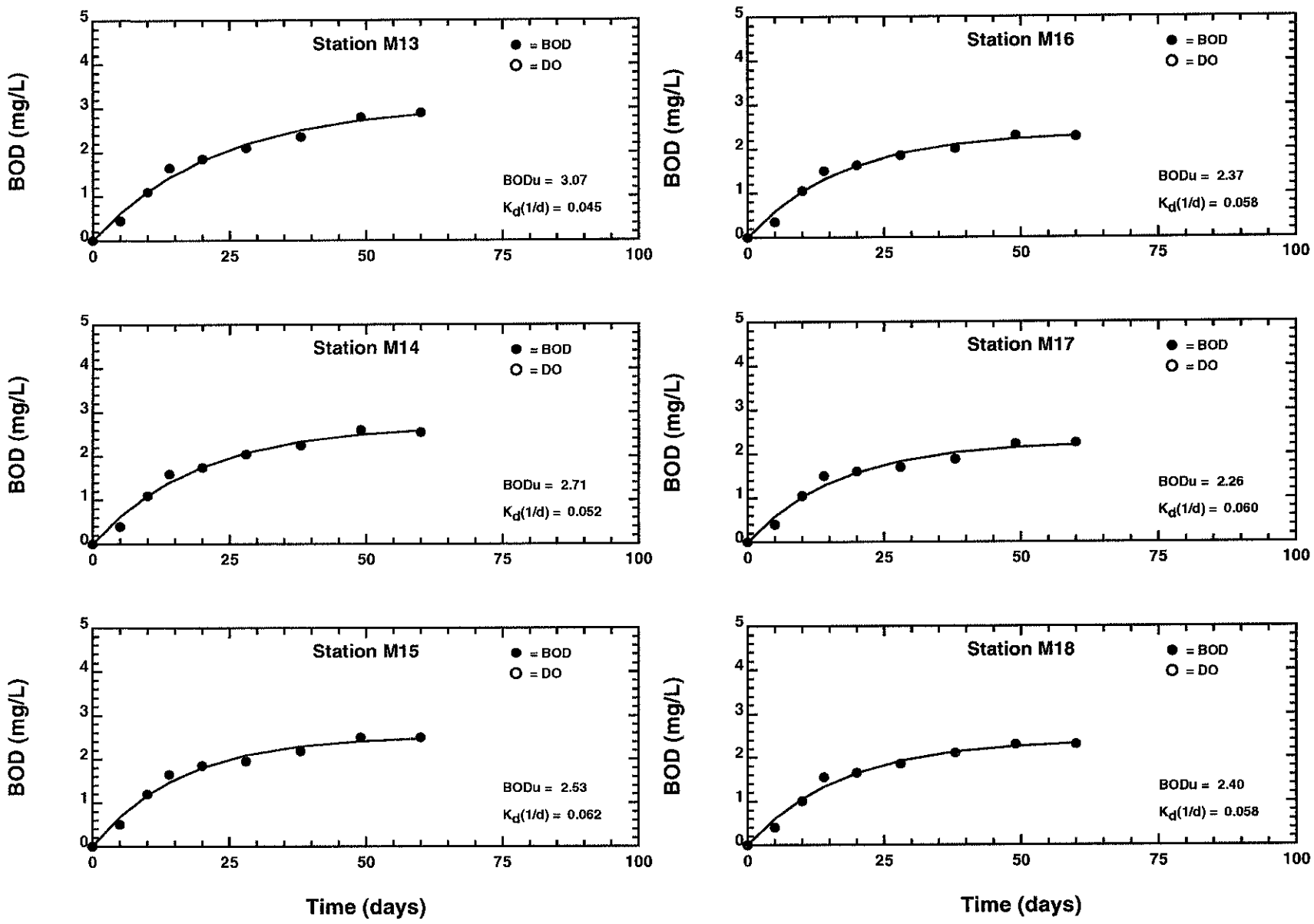

Figure 7. Opequon Creek LTBOD Data for the 10/13/2004 Survey

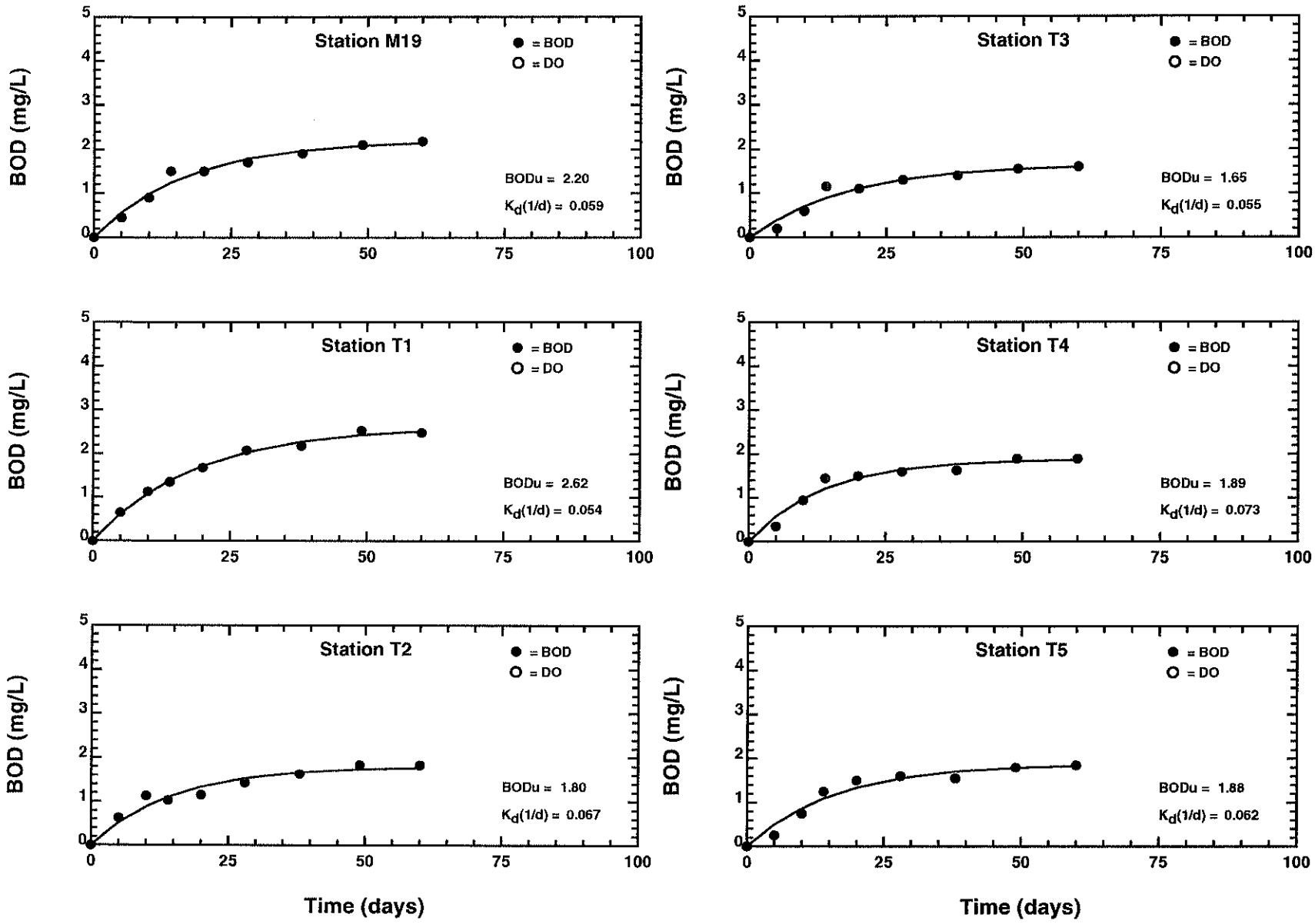

Figure 8. Opequon Creek LTBOD Data for the 10/13/2004 Survey

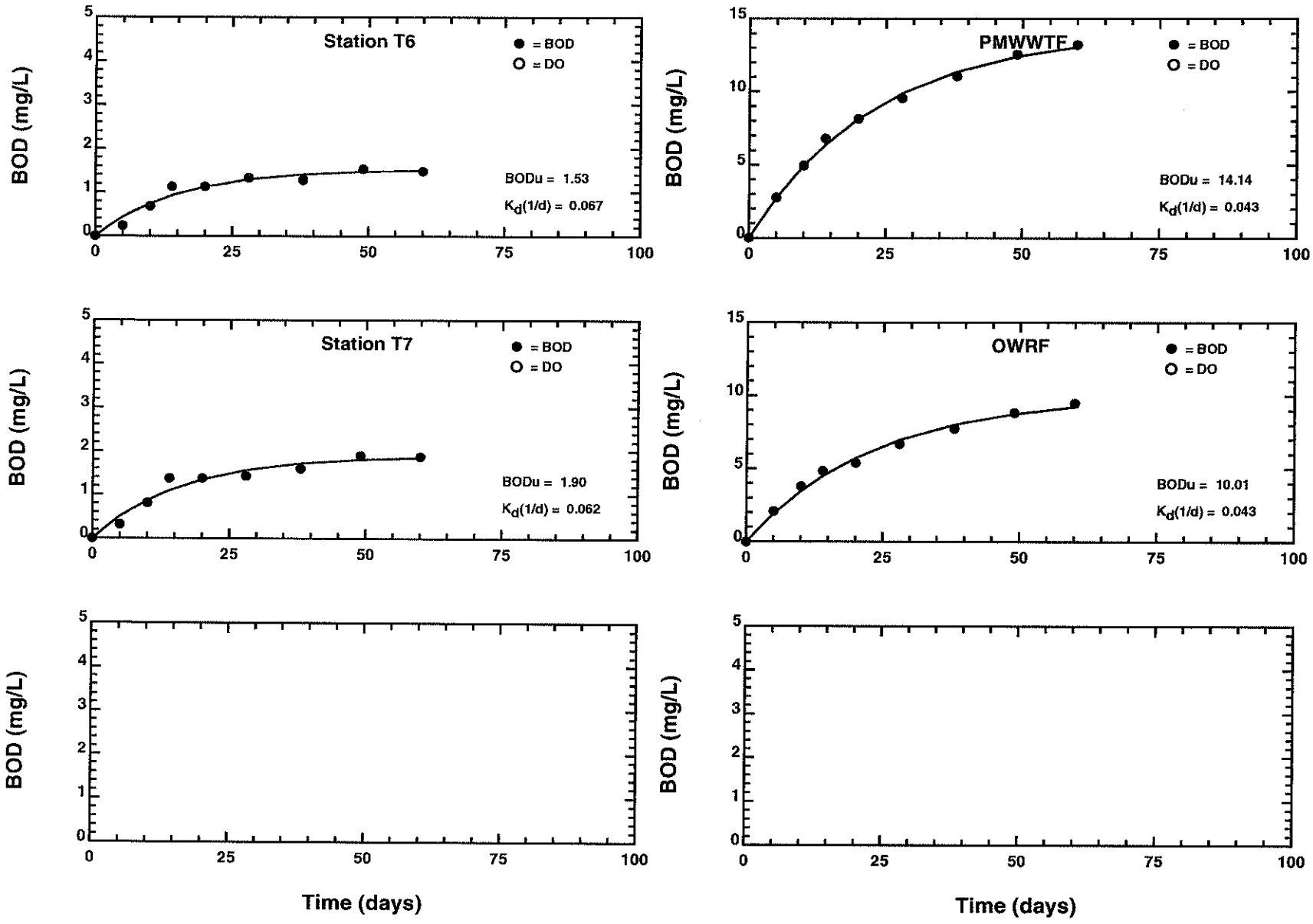

Figure 9. Opequon Creek LTBOD Data for the 10/13/2004 Survey

recorded DO, temperature, pH and conductivity approximately every 15-minutes. Figures 10 through 15 present the continuous data at each station and Figure 16 presents a summary of delta (maximum – minimum), minimum and average DO on each date at each station.

The minimum DO observed (6.7 mg/L) in this dataset occurred on November 3rd at station 10 as did the maximum DO (17.6 mg/L) and the largest delta DO (10.5 mg/L). Station 10 is upstream of the OWRF and downstream of Sulphur Spring Run. These large delta DO values are most likely due to attached algae (rooted aquatic plants or periphyton), as free-floating algae (phytoplankton) typically do not produce such large diurnal swings in DO. As can be seen in Figures 10-16, the rainfall and resulting overcast sky conditions (reduced light) that occurred on November 4th significantly reduced the diurnal DO swings observed at all stations with slight increases in the diurnal DO occurring after the rainfall. It should be noted that the minimum DO levels increased after the rainfall event (Figure 16) due to the decreased diurnal DO activity but daily average DO levels remained relatively constant (except for November 4th). This data highlights the effect that algal oxygen production and respiration have on creek DO levels. That is, average DO levels are relatively similar with or without algal diurnal effects but minimum DO levels are lower with increased algal effects.

2.4 CREEK GEOMETRY

Creek geometry measurements were completed to determine the width, depth and velocity at various cross-sections along the length of the creek. These measurements are used to define the creek geometry for development of the DIURNAL model. The creek cross-section measurements were completed by measuring water depth and velocity across the width of the creek at 1-2 foot increments. These measurements were completed at 29 cross-sections between November 3rd and 6th with velocity measurements taken at 19 of the 29 cross-sections for calculating creek flow. The creek cross-sections are presented in Figures 17 through 22 and as spatial profiles along the creek length in Figure 23.

The creek flow at the Berryville gage during the geometry measurements varied substantially especially on November 4th when the majority of measurements were completed. Creek flow ranged from a minimum of 35 cfs on November 3rd to a maximum of 106 cfs on November 4th. The creek flow increased significantly on November 4th due to a rain event and decreased during November 5th and 6th to a minimum of 48 cfs. The relatively steady creek flows before and after the rain event are approximately 3-4 times higher than average low-flow conditions of about 10 cfs. This unsteady flow during the geometry measurements complicates comparison of measured flows with the measured gage flows. The creek geometry measurements up to station M11 (up to mile 11) were completed roughly before the majority of rainfall occurred and from M13 downstream after the rainfall and increase in creek flow. In general, the calculated upstream flows near the PMWWTF compare well with the Stephens City flow gage but are slightly less than the measured flows at the Berryville flow gage. Given the highly variable flow conditions during the geometry survey, the

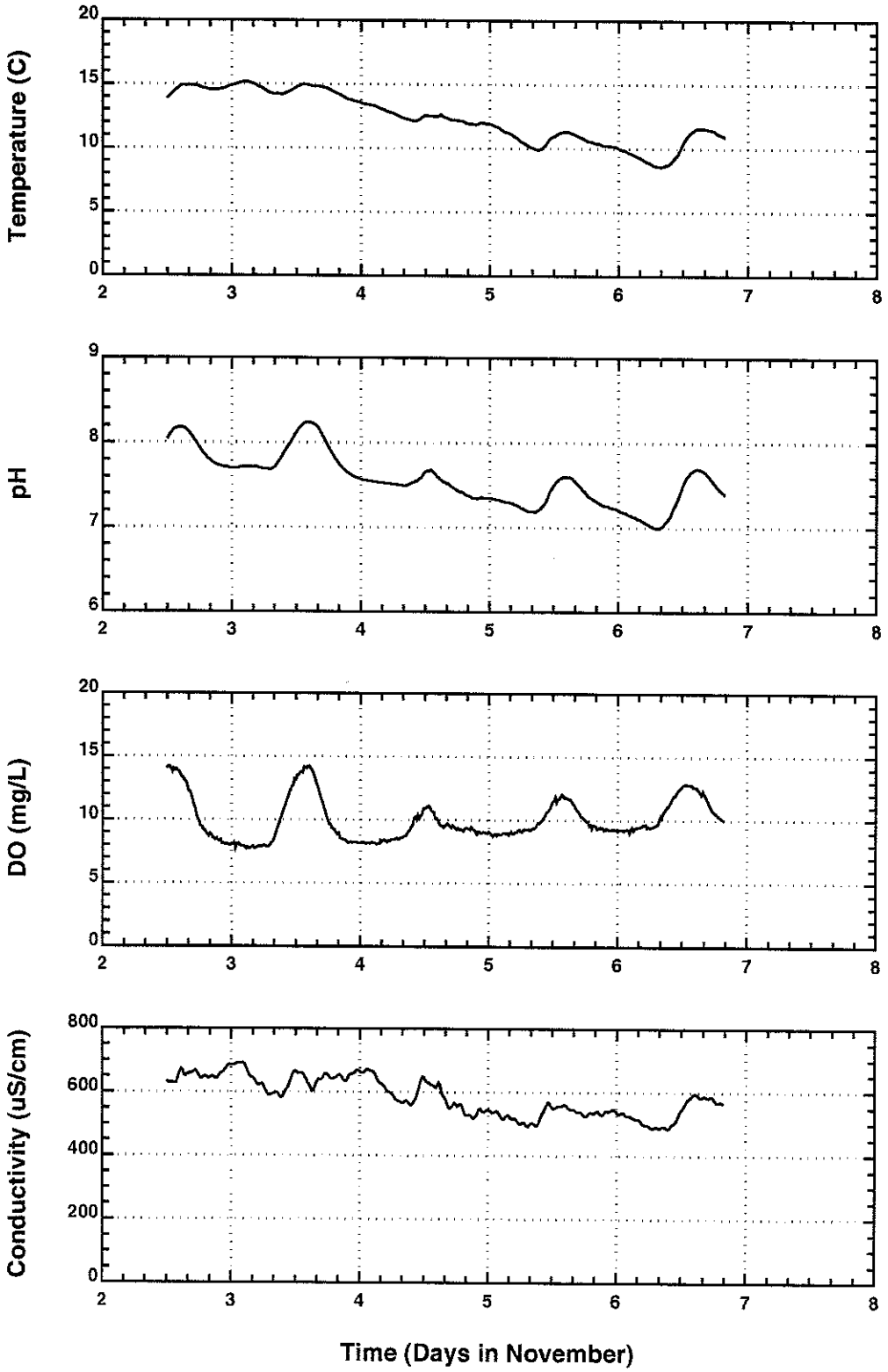

Figure 10. Opequon Creek Continuous Data at Station 3

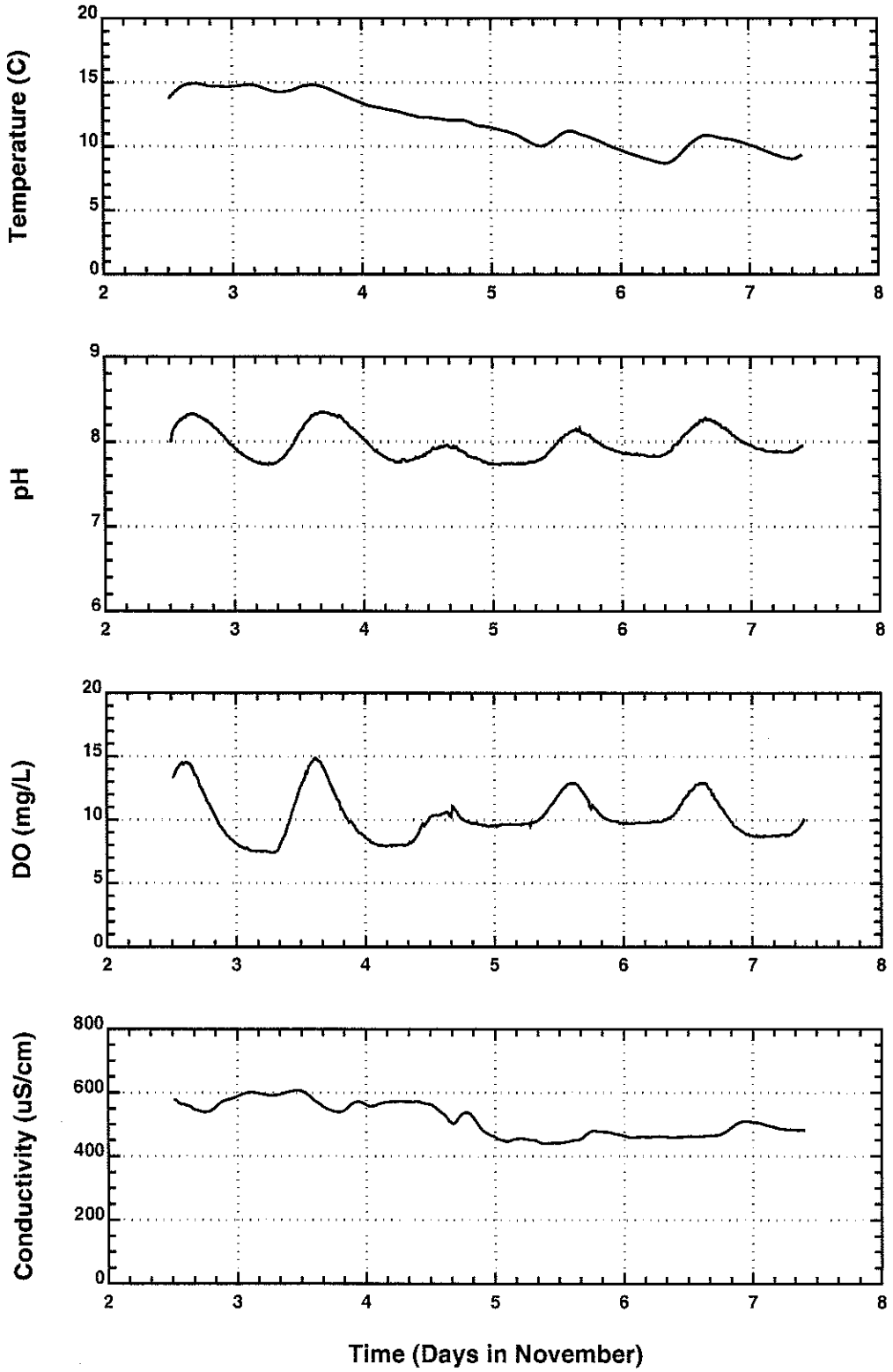

Figure 11. Opequon Creek Continuous Data at Station 6

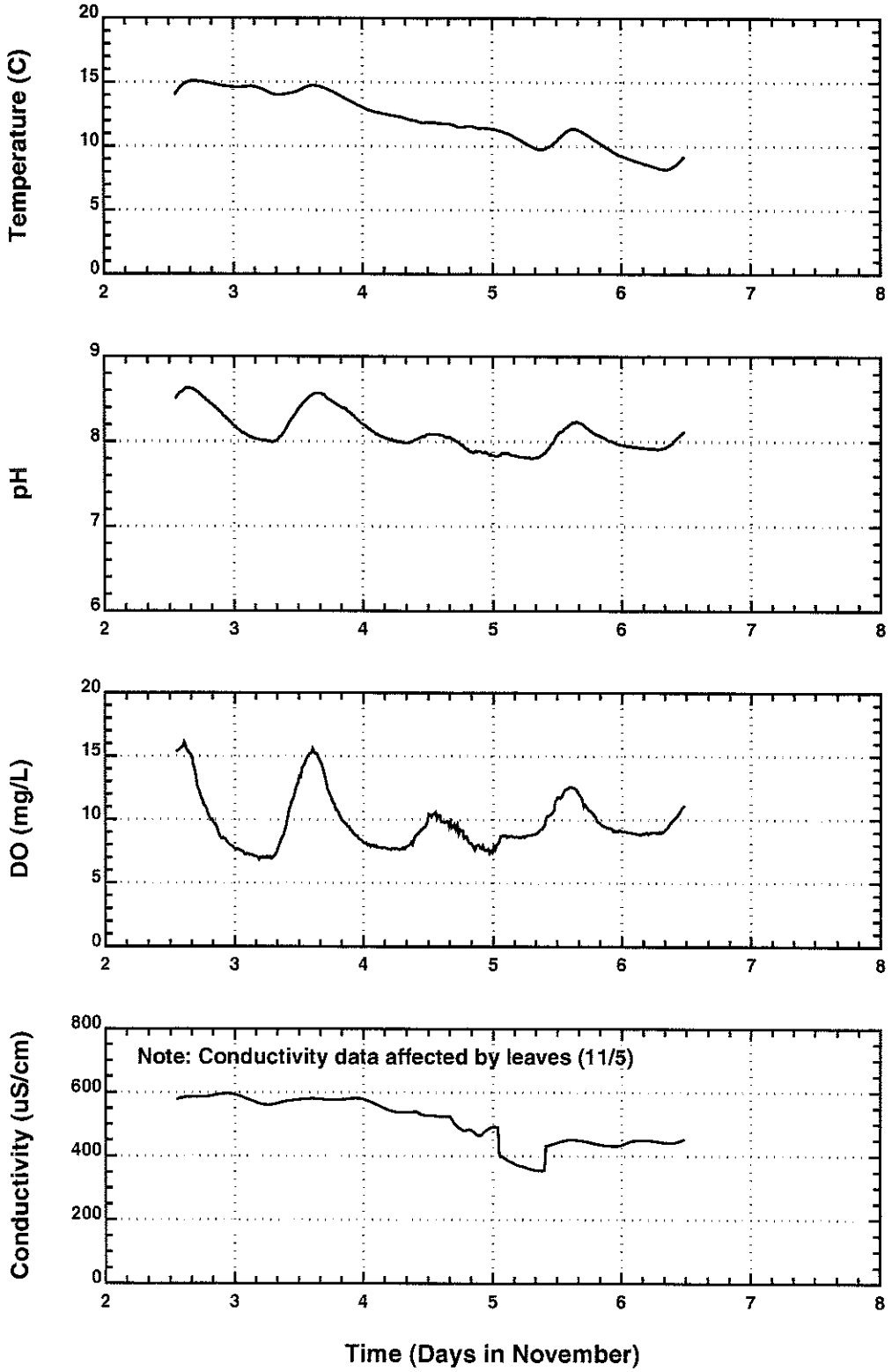

Figure 12. Opequon Creek Continuous Data at Station 8

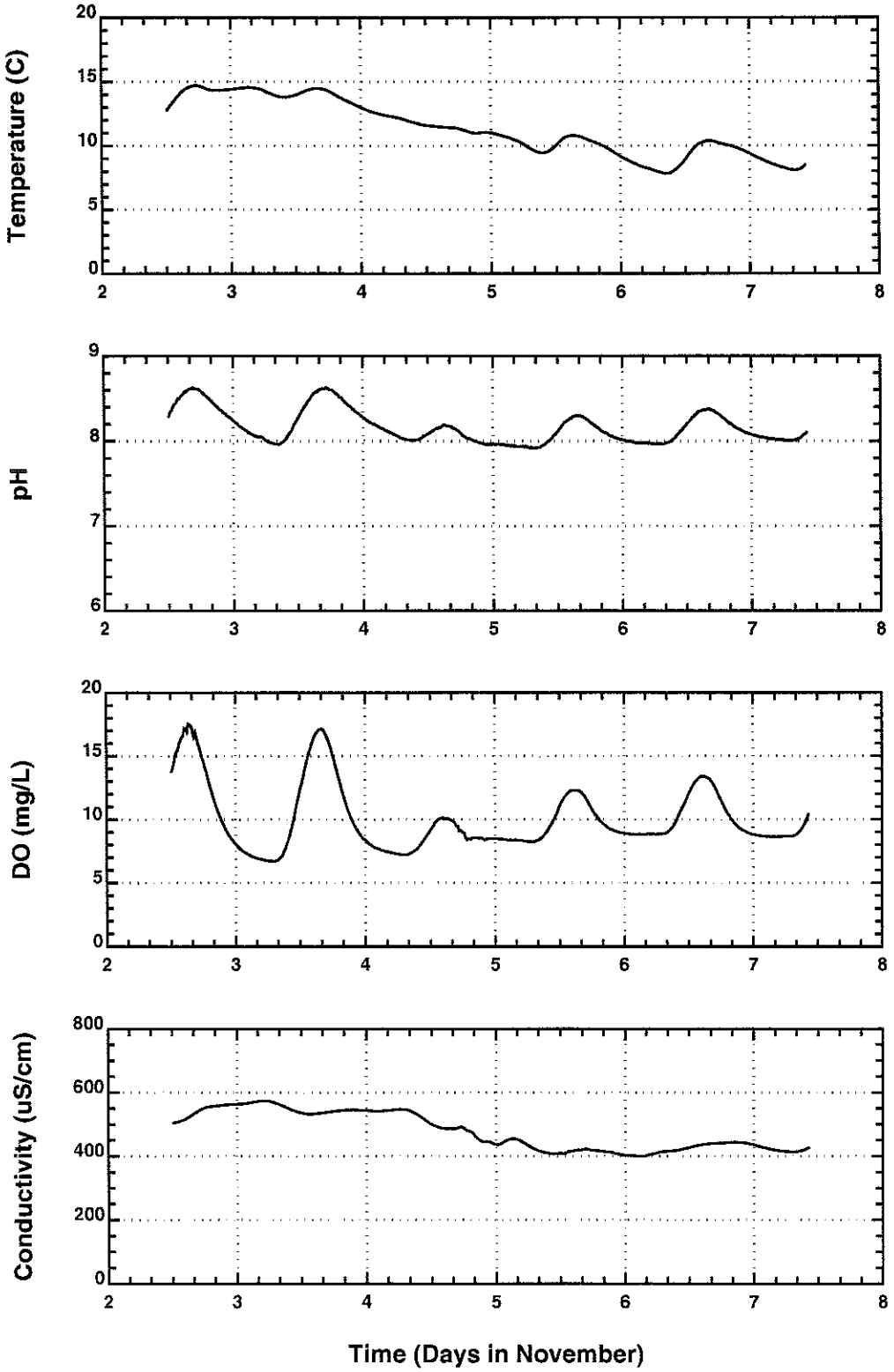

Figure 13. Opequon Creek Continuous Data at Station 10

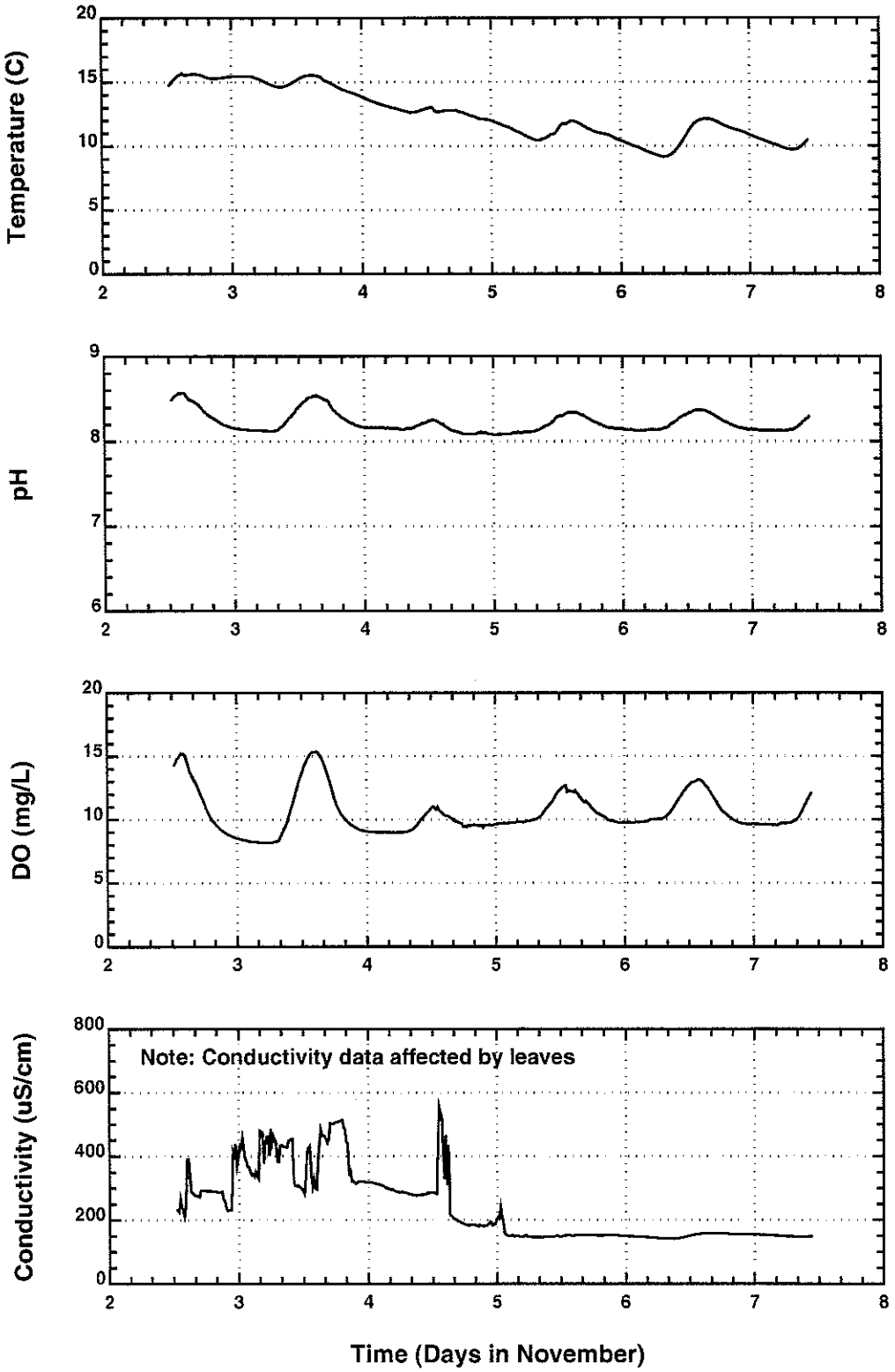

Figure 14. Opequon Creek Continuous Data at Station 13

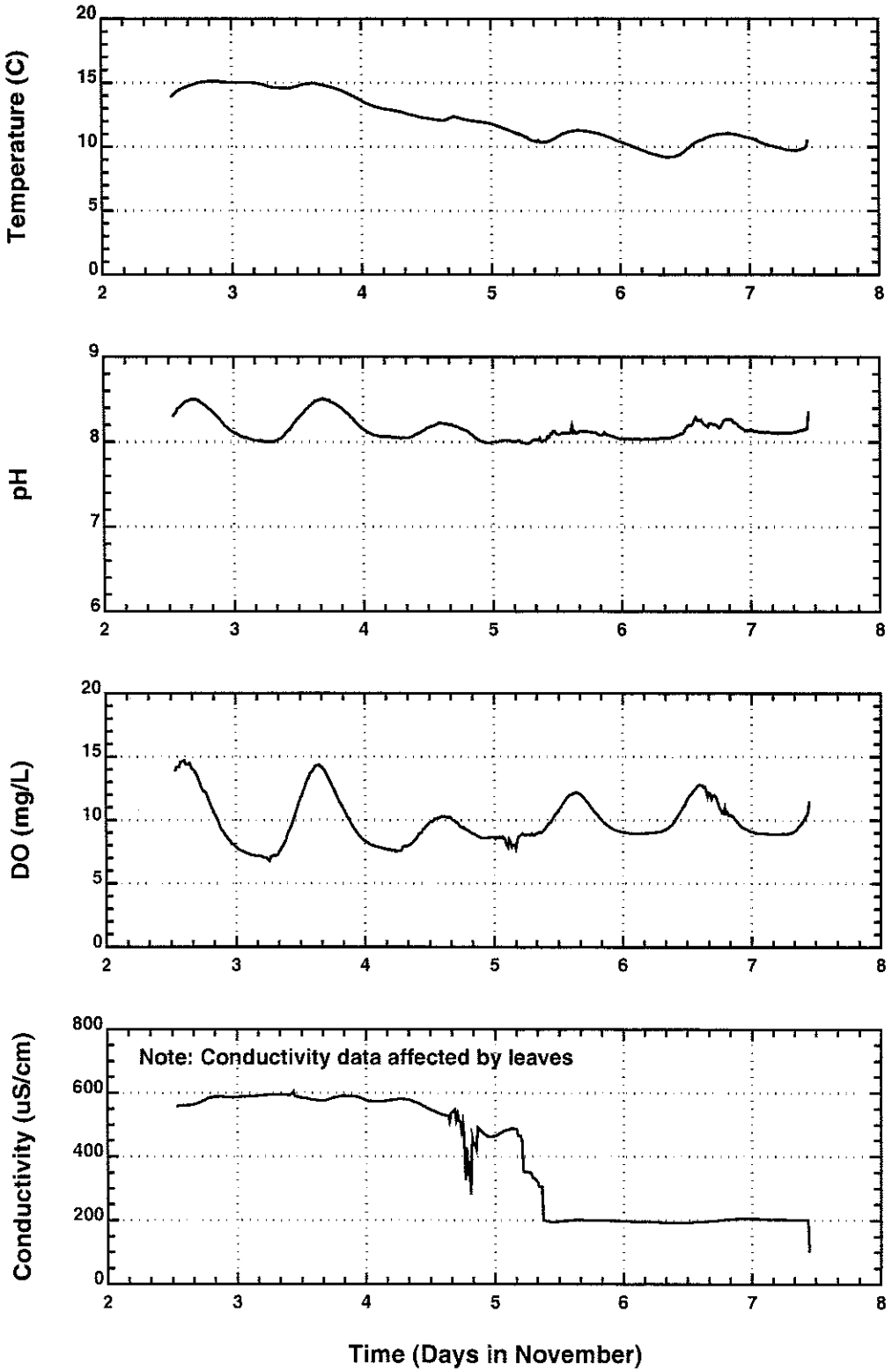

Figure 15. Opequon Creek Continuous Data at Station 15

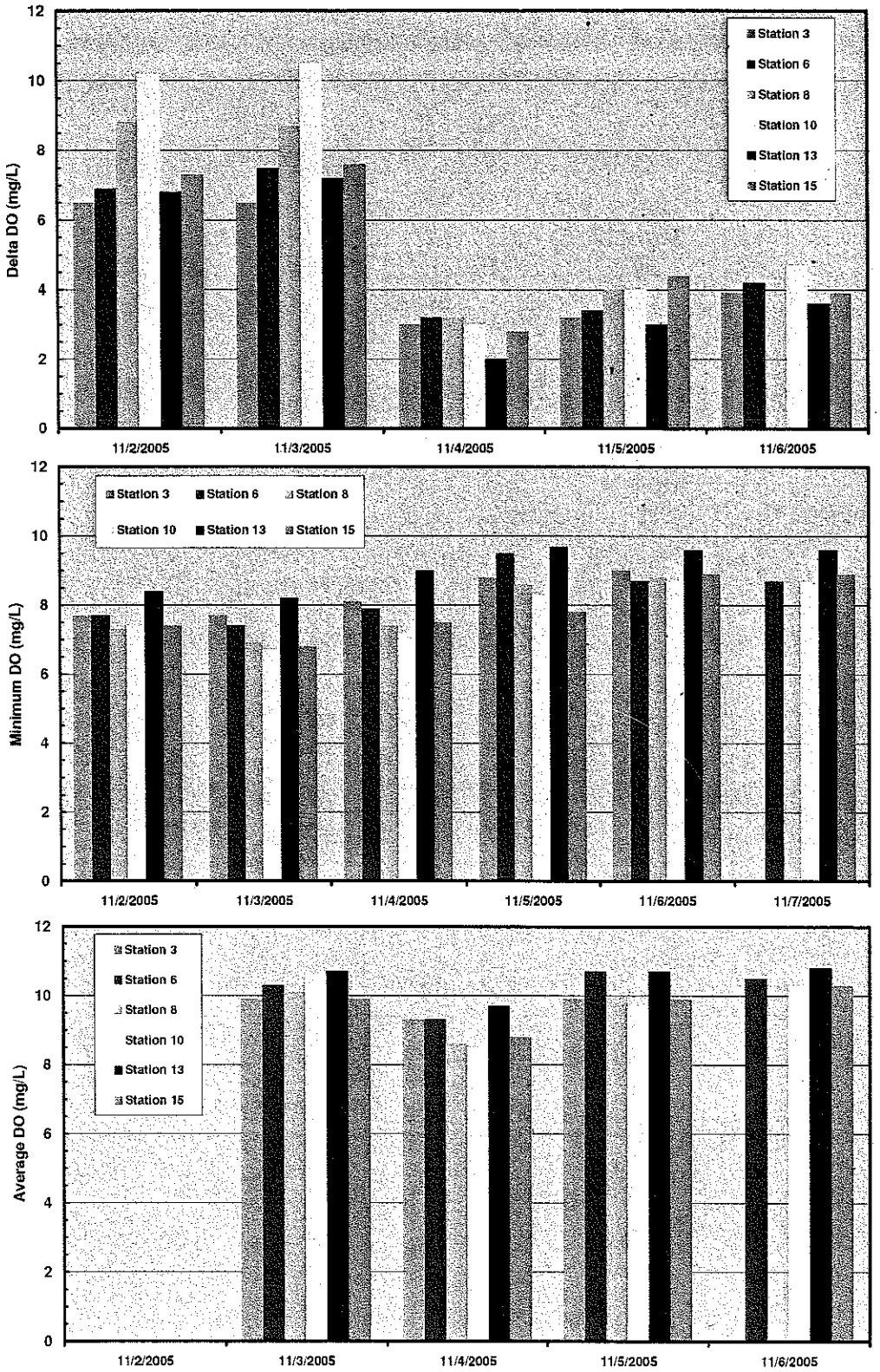

Figure 16. Opequon Creek Continuous DO Data Summary

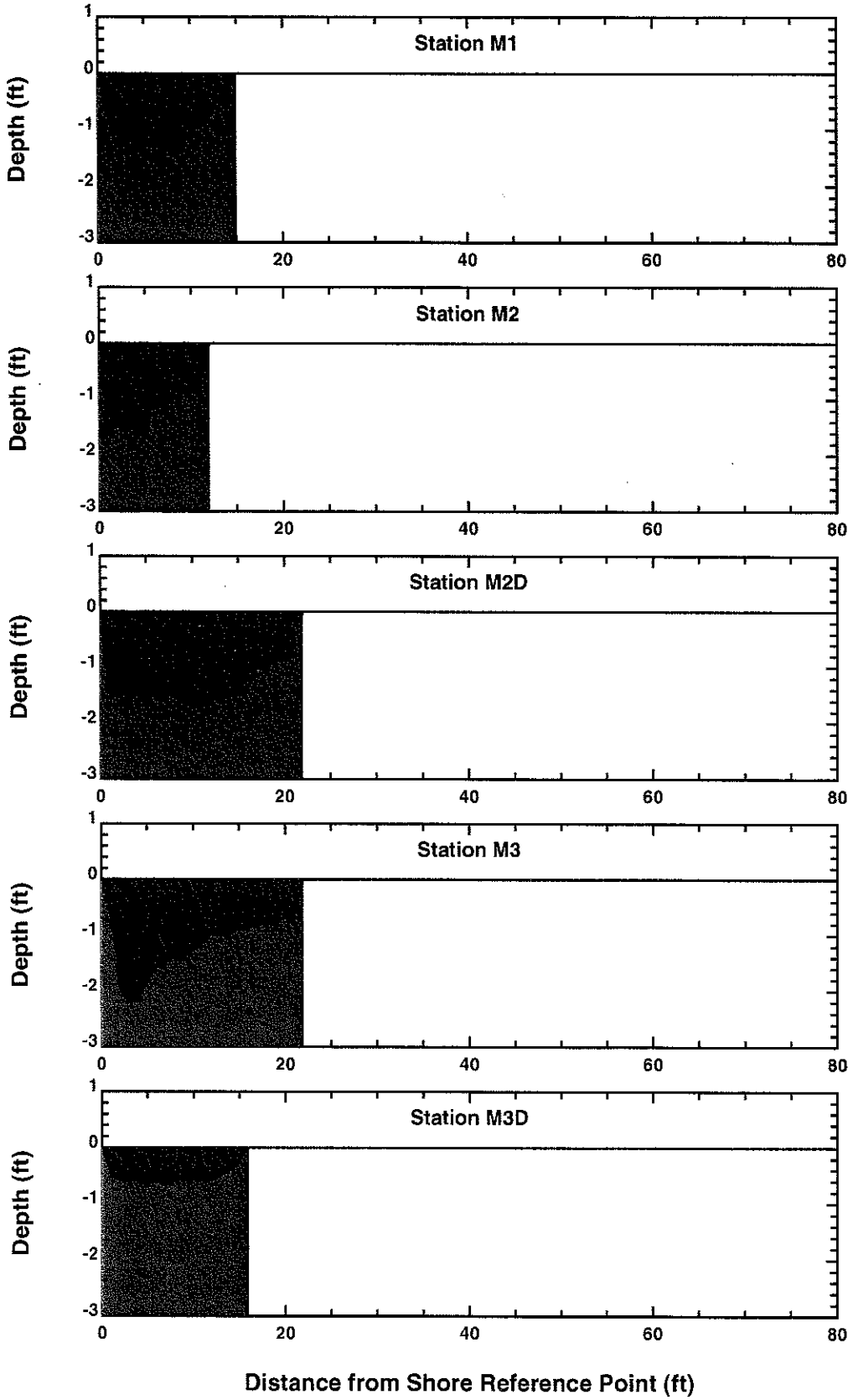

Figure 17. Opequon Creek Cross Section Data

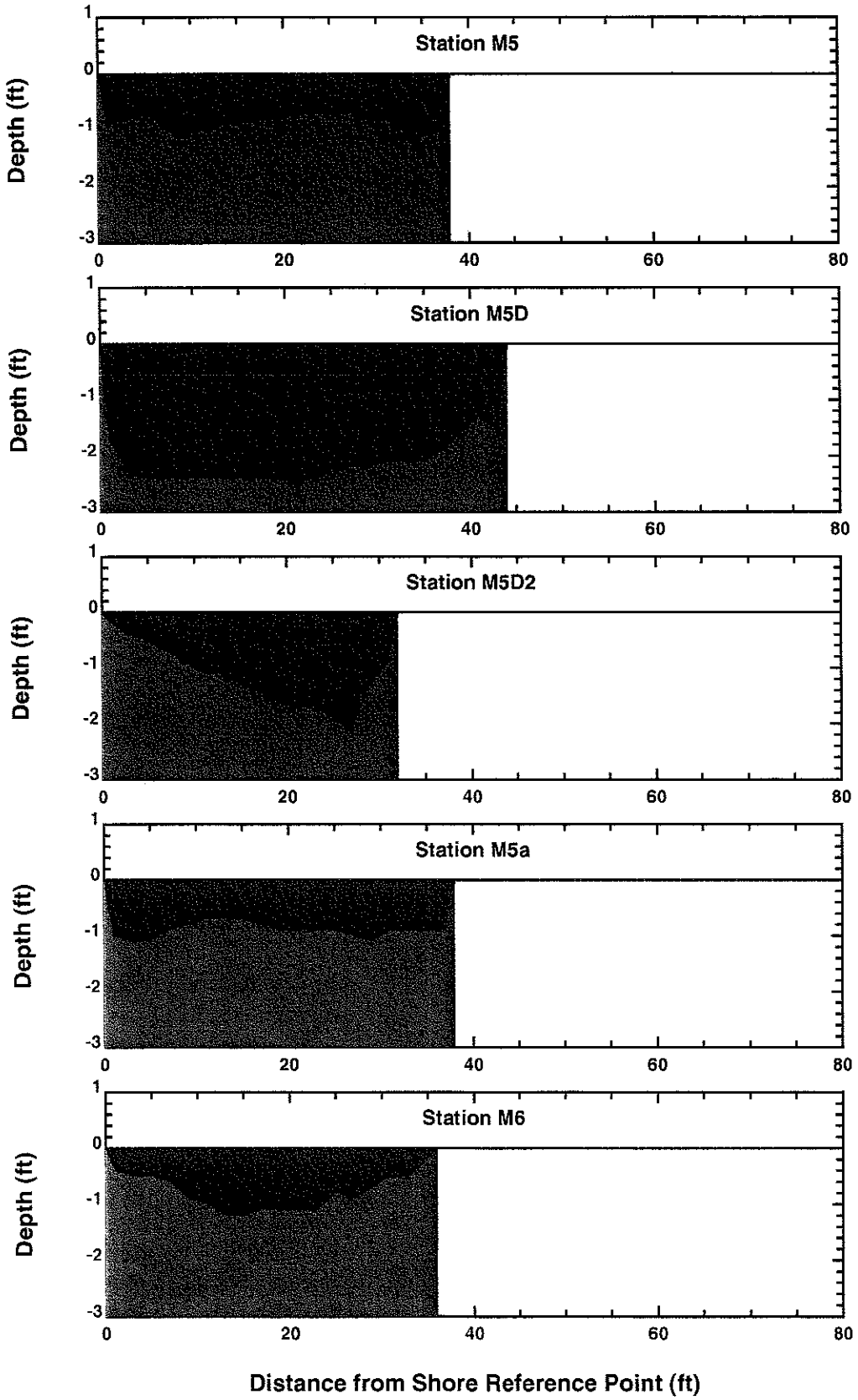

Figure 18. Opequon Creek Cross Section Data

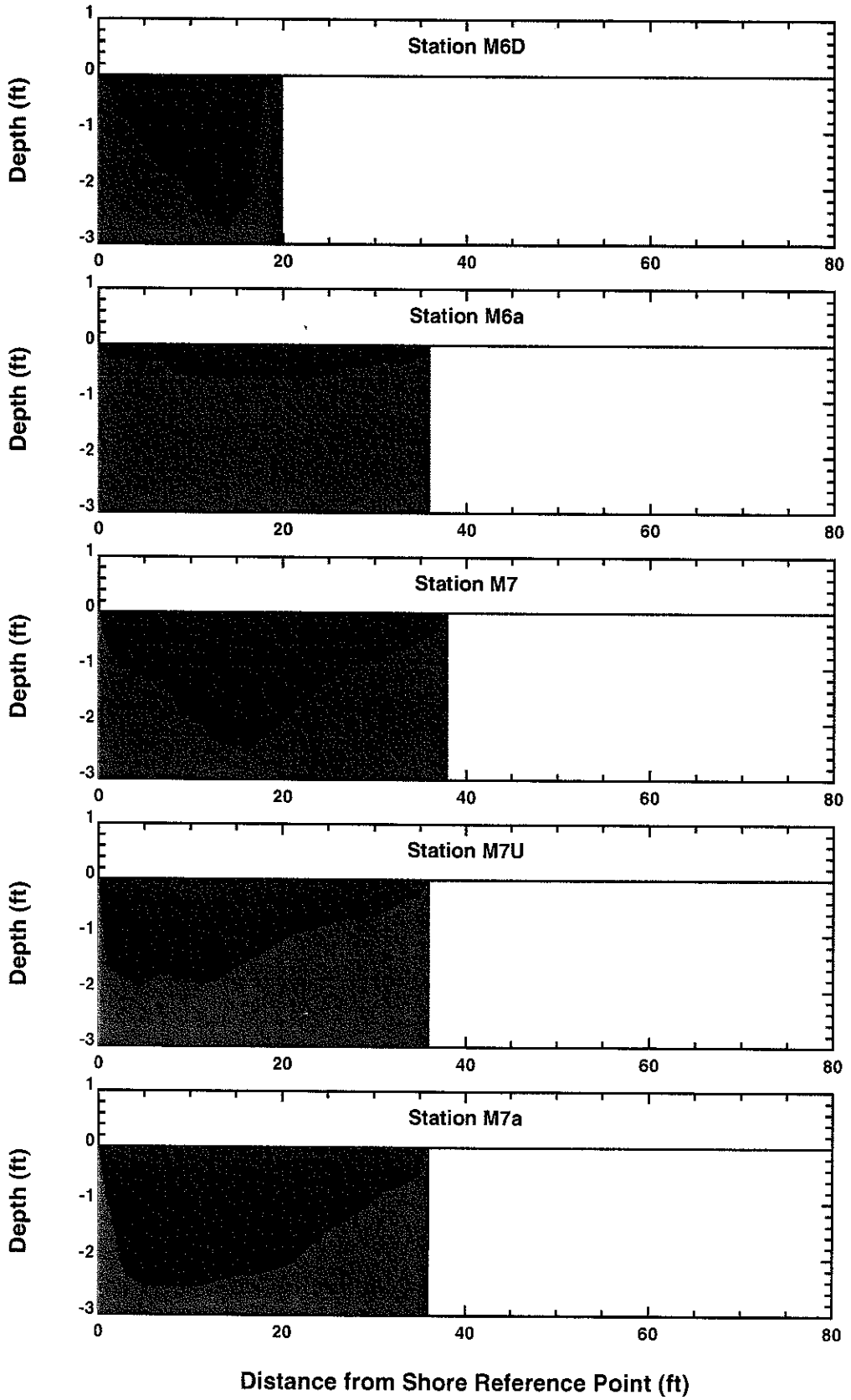

Figure 19. Opequon Creek Cross Section Data

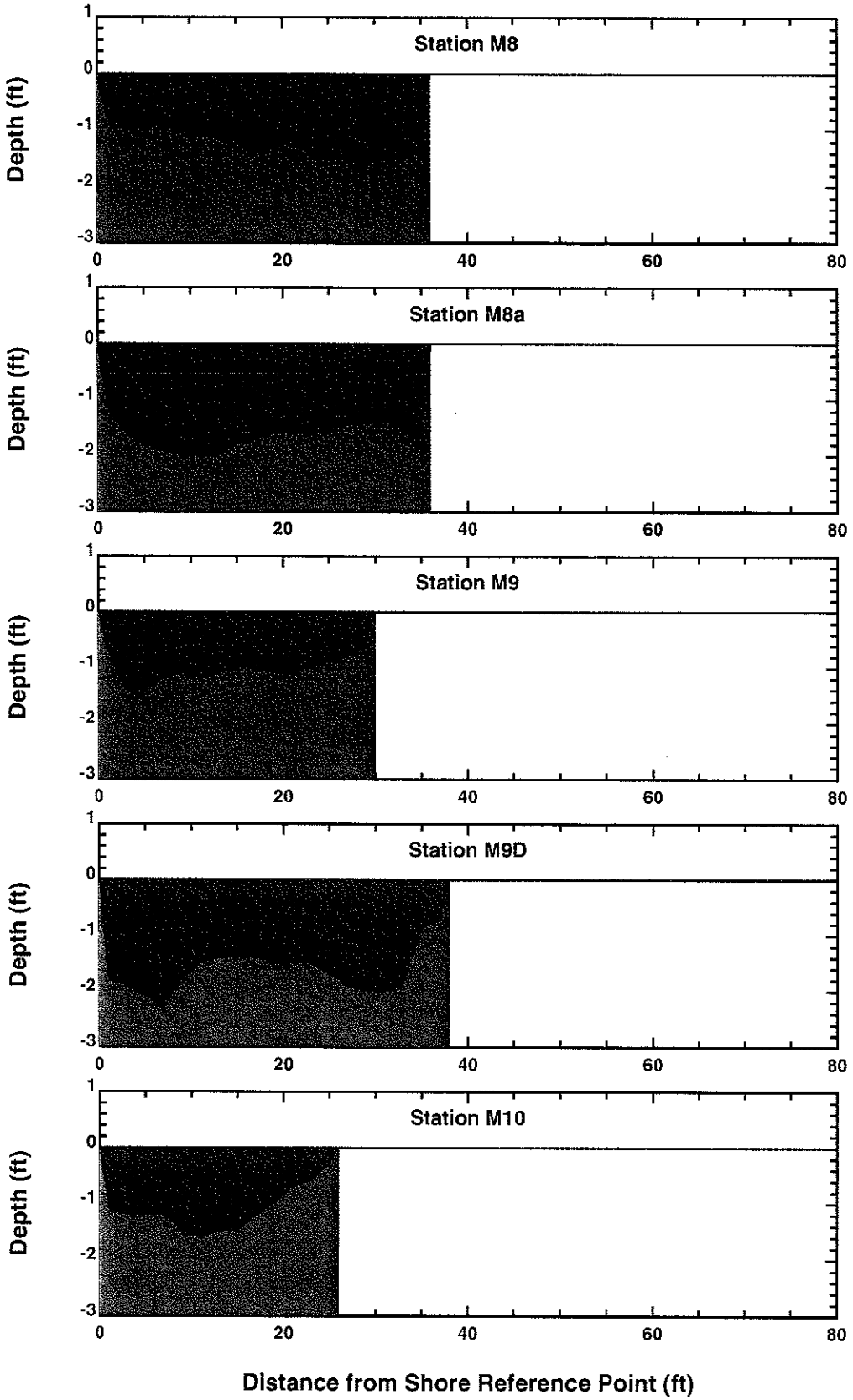

Figure 20. Opequon Creek Cross Section Data

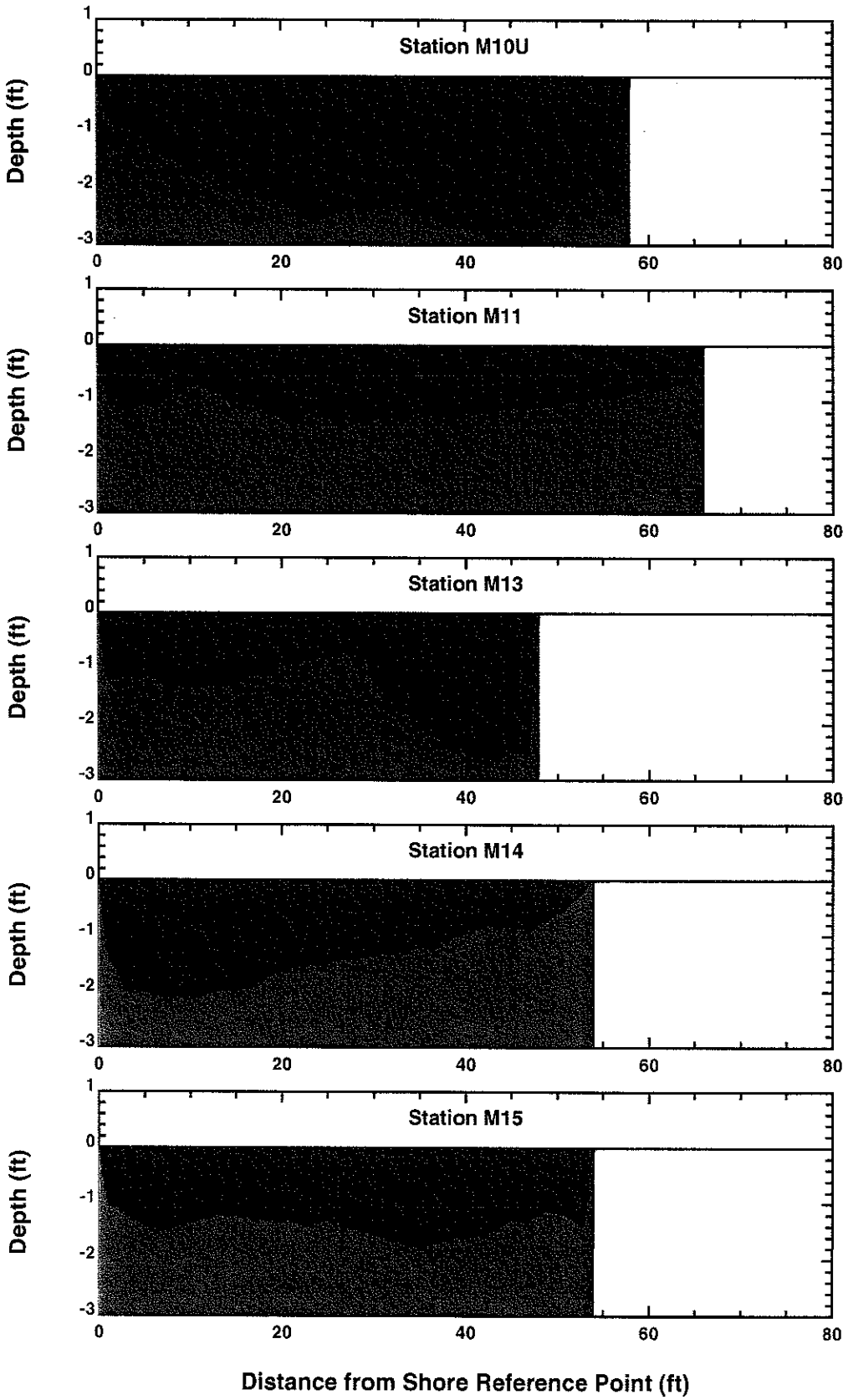

Figure 21. Opequon Creek Cross Section Data

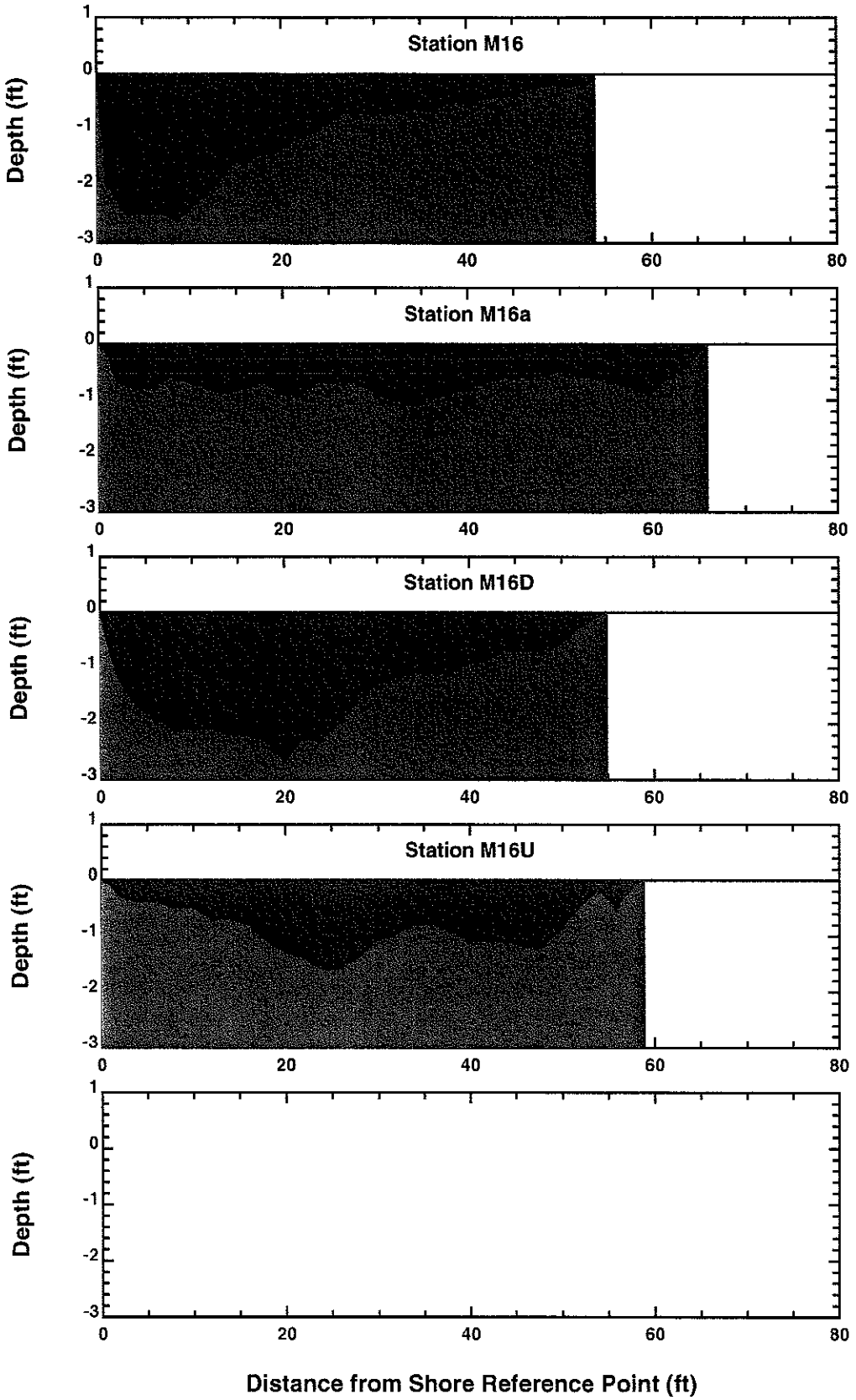

Figure 22. Opequon Creek Cross Section Data

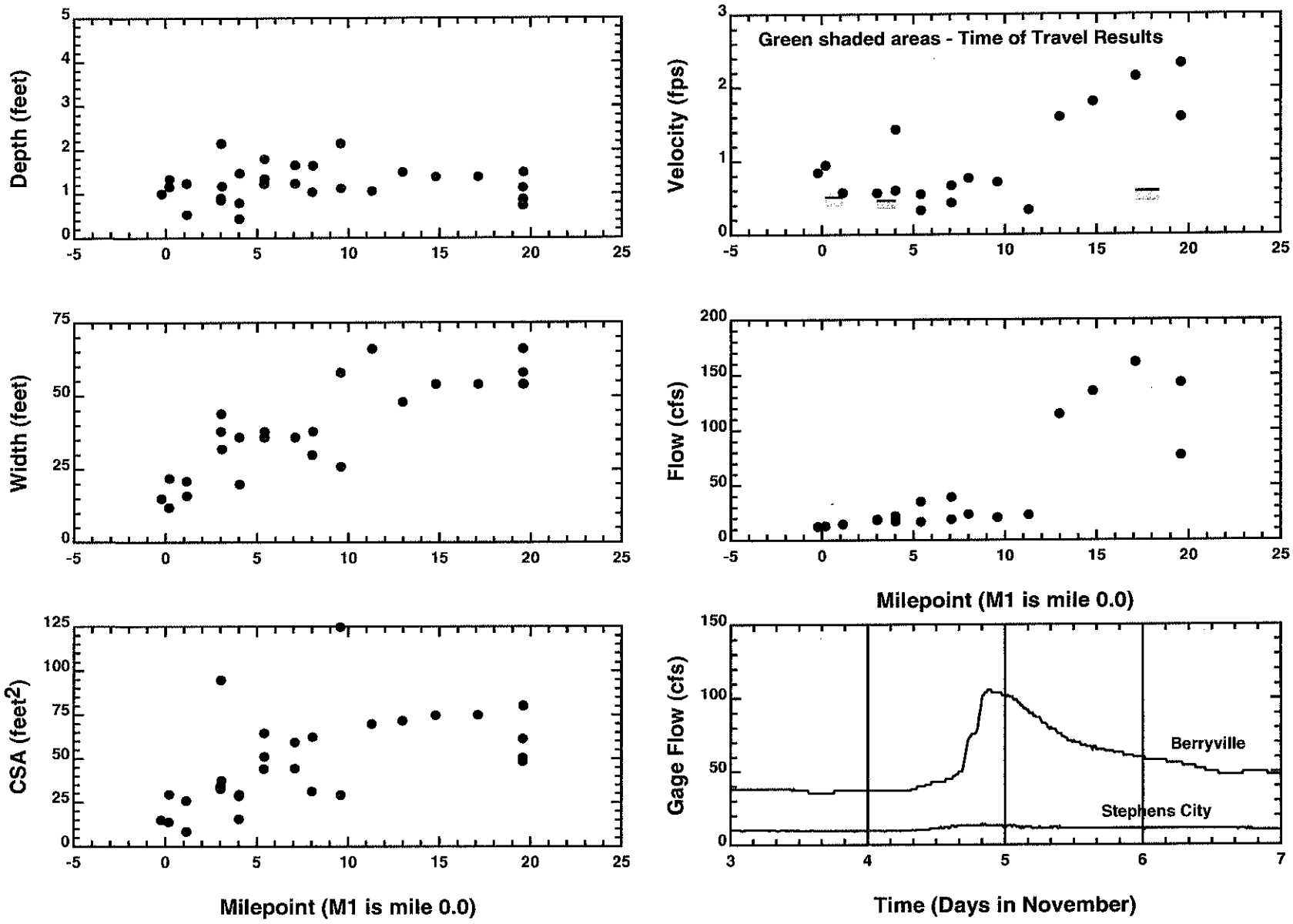

Figure 23. Opequon Creek Geometry Survey for 11/3-6/2004

measured flows at the USGS Berryville gage will be considered accurate with the calculated flows probably accurate to within +/-10-20%.

Measured creek depths during the geometry survey ranged from 0.4-2.2 feet with the shallower depths occurring upstream. Similarly, measured creek widths increased in the downstream direction and ranged from 12-66 feet. The measured cross-sectional area ranged from 8-80 square feet, velocities ranged from 0.3-2.3 feet/second (fps) and flows ranged from 12-162 cubic feet/second (cfs). In order to develop velocity and depth relationships to flow, data collected at the same station on different dates (i.e., different flows) were used to estimate the exponent in the flow relationships. These velocity and depth relationships to flow are represented with the following equations:

$$U = aQ^b \qquad H = cQ^d \qquad W = eQ^f \tag{2}$$

where:

Q = flow (cfs);

U = velocity (fps);

H = depth (ft);

W = width (ft); and

b + d + f = 1.

In a rectangular channel with depths much less than the width, the exponent for velocity can be shown to equal 0.4 and for depth 0.6 assuming a constant width. Based on the creek data collected, the velocity exponent was estimated to be 0.6. Assuming a width exponent of 0.1 and following the requirement that b + d + f = 1, the depth exponent will equal 0.3. These exponents were used to determine the velocity and depth constants (a and c) based on the data and then used to assign the geometry as a function of flow in the DIURNAL model.

2.5 TIME OF TRAVEL

The time of travel study was accomplished by injecting a conservative substance (sodium bromide) into the creek and then sampling at two downstream locations to determine instream sodium bromide profiles. By determining the center of mass in the two sodium bromide profiles, the travel time between these two points coupled with the distance between the two sampling locations were used to calculate the velocity between the two stations. Figure 24 presents the sodium bromide profiles for three reaches: M2+ to M3 (sampled 11/6 PM), M5+ to M6 (sampled 11/6 AM) and M15+ to M15a (sampled 11/3). The center of mass is presented in these figures as

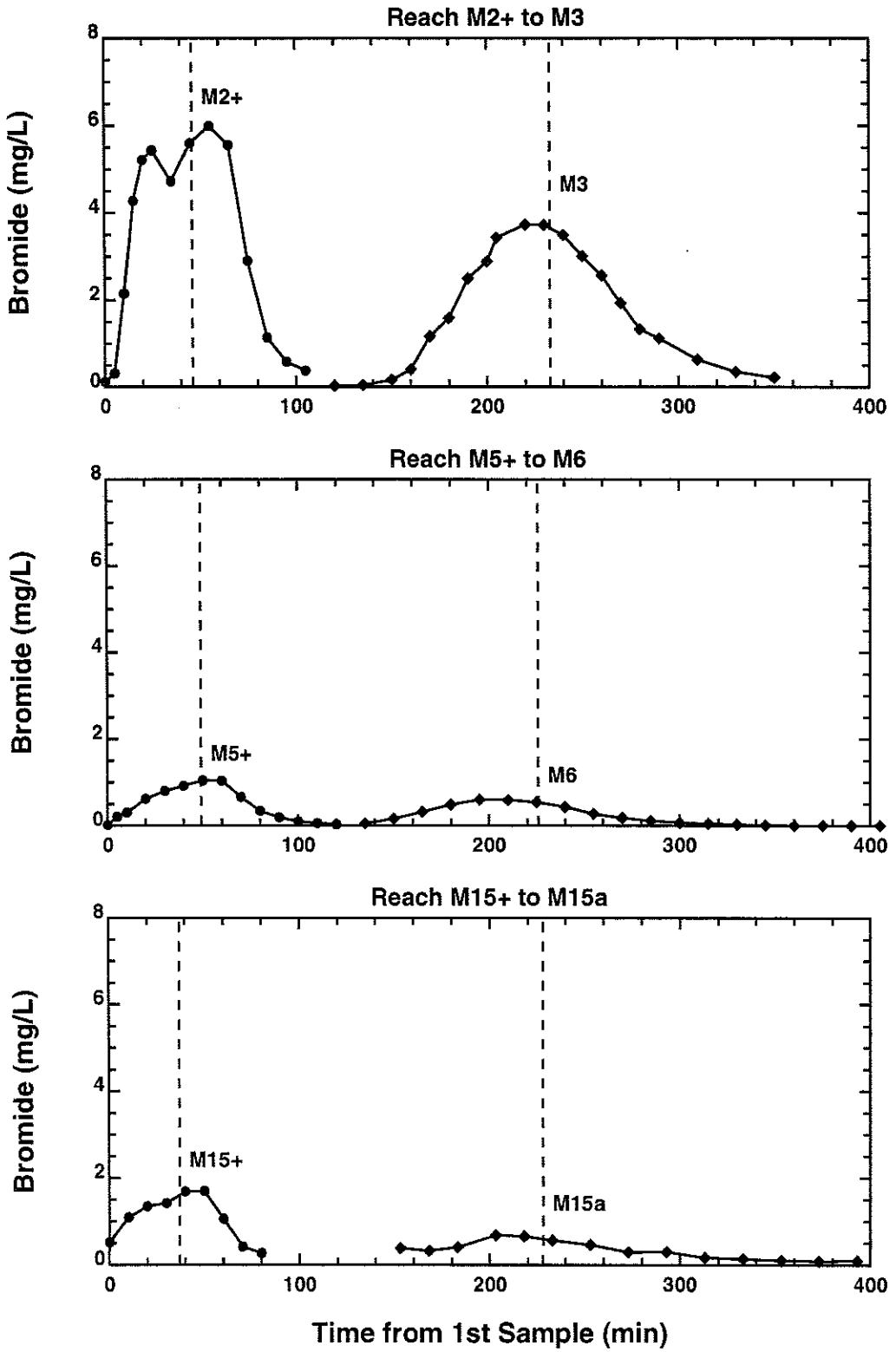

Figure 24. Time of Travel Study Bromide Profiles

the vertical dashed lines and the results in each reach are presented in Table 2 along with the creek flows as calculated from the total mass injected in the creek and the measured mass in the creek at each station. In addition, the velocities calculated from the sodium bromide data are presented in Figure 23 with the solid horizontal line representing the calculated velocity and the green shaded region representing +/- 25% of the calculated velocity.

The velocities calculated for the two upstream reaches (M2+ to M3 and M5+ to M6) based on the bromide data compare very well with the measured velocities in these areas since the creek flow conditions during each were similar. For the downstream reach (M15+ to M15a) the calculated velocity (from the bromide data) is less than the measured velocity but the flow was greater during the geometry survey when the velocities were measured and was highly variable due to the rain event. In general, the time of travel results compare well with the measured velocity data and will be used in conjunction with the geometry information to setup the DIURNAL model.

Table 2. Time of Travel Study Results

Station	Center of Mass (minutes)	Distance (miles)	Velocity (fps)	Calculated Flow (cfs)
M2+	46	1.09	0.51	17-23 (11/6/04 PM)
M3	233			
M5+	49	0.93	0.49	70-81 (11/6/04 AM)
M6	226			
M15+	37	1.28	0.57	59-91 (11/3/04)
M15a	228			

SECTION 3

DIURNAL MODEL

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SECTION 3

DIURNAL MODEL

The DIURNAL water quality model, a model developed by Hydroscience, Inc. and upgraded by HydroQual, was chosen to represent Opequon Creek since it contains the necessary structure to simulate diurnal variation of DO in addition to the various parameters of concern (i.e., CBOD and nitrogen). This model contains the physical and biochemical reactions required for the analysis of water quality in Opequon Creek and the following section describes the mathematical model DIURNAL. In addition, the DIURNAL model was used to complete water quality modeling for the OWRF (HydroQual, 1997) and for permitting with VDEQ. The calibrated DIURNAL model of Opequon Creek presented in this report will be a valuable tool for continued permitting of the PMWWTF (permit reopening) and the OWRF (permit reapplication). Besides being applicable for the PMWWTF and OWRF discharges, the model will also include the discharge from the County Landfill that enters the creek approximately 4 miles upstream from the OWRF. This will be useful to assist in determining water quality impacts associated with the County Landfill discharge as they are now permitted to discharge during low-flow creek conditions.

3.1 OVERVIEW

DIURNAL is a one-dimensional receiving water quality model. The model includes the physical processes of dilution and advection and simulates receiving water quality changes in DO and other water quality parameters. Coupled chemical reactions can be simulated, such as the interactions between DO and carbonaceous biochemical oxygen demand (CBOD), the nitrogen series and simple phosphorus kinetics. One of the unique functions of DIURNAL is the ability to simulate diurnal photosynthetic fluctuations in DO during periodic steady-state conditions.

The DIURNAL model can be applied to streams and rivers under one-dimensional, periodic steady-state conditions. It allows a stream length to be analyzed with any number of functional segments. The number of segments is dependent upon the frequency of changes of river characteristics, tributary and waste discharge locations and resolution desired. Sources and sinks of DO considered in the model include atmospheric reaeration, CBOD, nitrogenous biochemical oxygen demand (NBOD), benthic oxygen demand, photosynthesis and respiration. The water quality parameters that may be simulated are:

1. DO;
2. CBOD;
3. Organic nitrogen;
4. Ammonia nitrogen;

5. Nitrite plus nitrate nitrogen;
6. Phosphorus (simple 1st order kinetics); and
7. One conservative substance.

The solution analysis for DO is an extension of the technique based on the continuity equation, which includes the diurnal time-variable effect of photosynthetic oxygen production. The analysis considers temporal as well as spatial distributions. The periodic extension of the photosynthetic oxygen production is expressed as a Fourier series.

3.2 MODEL THEORY

In natural systems, the DO concentration of a river is dependent on the physical characteristics of the river, wasteload inputs (point and nonpoint source) into the river and instream biological and chemical activities. Dilution and advection reduce the concentration of pollutants and transport the pollutants downstream. Natural biological activity in the aquatic environment results in the reduction of organic carbonaceous and nitrogenous compounds to stable end products and, in the process, the DO of the river water is utilized. Alternatively, atmospheric reaeration and photosynthetic activity of aquatic plants raise the DO concentration in the river. After a wasteload is discharged to an aquatic system, biochemical oxidation generally proceeds in two stages: carbonaceous oxidation and nitrogenous oxidation. These reaction rates are approximated mathematically by first order kinetic equations in DIURNAL.

Aquatic plants such as phytoplankton, periphyton and rooted aquatic plants may serve as both sources and sinks of DO. During daylight hours, these plants utilize solar energy in the photosynthetic process, release DO to the water, and at the same time consume DO for respiration. During the night in the absence of sunlight, the photosynthetic process ceases. However, the plants continue to remove oxygen from the system for respiration. The activity of the plants is affected by factors such as sunlight intensity, depth of light penetration, availability of nutrients and water temperature. Bacterial oxidation of organic matter (carbonaceous and nitrogenous) typically produces a longitudinal distribution of DO deficit. Sources of the organic matter include natural background (plant material, etc.), nonpoint sources (runoff from farms, developed areas, etc.), and point source (wastewater treatment plants, etc.). Attached or unattached aquatic plants can cause a diurnal fluctuation of DO.

3.2.1 Dissolved Oxygen

In DIURNAL, the equation for the longitudinal distribution of DO is developed by a mass balance employing the continuity equation. The specific form of the equation for a given river is determined by the hydraulic and geomorphological characteristics of the river channel and drainage basin, and the various physical, chemical and biological characteristics of the aquatic environment

and wastewater discharges. Neglecting dispersions terms, the mass balance differential equation takes on the following form for the concentration of DO:

$$\frac{\partial c}{\partial t} = -\frac{Q}{A}\frac{\partial c}{\partial x} + K_a(c_s - c) - K_d\, L(x) - K_n\, N_2(x) + P(x,t) - R(x) - S(x) \tag{3}$$

The meanings of the various symbols are given in Table 3. Sources of DO, as shown above, include atmospheric reaeration, photosynthetic contribution from aquatic plants and incoming flow. Sinks include respiration by bacteria, rooted vegetation and algal respiration (phytoplankton and/or periphyton). Bacterial respiration (sediment oxygen demand, SOD) of the benthic community is assigned as a separate sink and respiration of the aquatic plants is combined as one term. DO saturation is calculated in DIURNAL as a function of the temperature and elevation above mean sea level using the saturation equation from Standard Methods for the Examination of Water and Wastewater.

Algal photosynthetic activity only takes place during daylight hours and varies with relation to light intensity. Therefore, the temporal form of photosynthesis is represented by a half-cycle sine wave:

$$\begin{aligned} P(t) &= P_m \sin\frac{\pi}{p}(t - t_s) \quad \textit{when } t_s \le t \le t_s + p \\ P(t) &= 0 \qquad\qquad\qquad\quad \textit{when } t_s + p \le t \le t_s + 1 \end{aligned} \tag{4}$$

This function is assumed to repeat periodically on a daily cycle as a function of the maximum photosynthesis (P_m) occurring during the course of the daylight period (p).

3.2.2 Water Quality Parameters

Steady state equations, similar to the DO equations, are also employed for modeling other water quality parameters. The differential equation defining the ultimate CBOD distribution in a river without dispersion is defined in Equation 5. Given the level of treatment wastewater typically receives today, the amount of particulate CBOD discharged is negligible and the amount of discharged CBOD lost to settling can be very small compared to oxidation. Therefore, the CBOD removal rate, K_r is assumed to equal the CBOD oxidation rate, K_d.

<u>Ultimate CBOD (CBODu)</u>

$$\frac{Q}{A}\frac{\partial L}{\partial x} = -K_r\, L \tag{5}$$

Nitrogen forms are influenced by bacterial oxidation, algal uptake, hydrolysis and volatilization. Equations 6 through 9 show the basic steady-state differential equations for organic, ammonia and nitrite plus nitrate nitrogen and phosphorus, which form the basis of the analytical solution equations used in DIURNAL.

Table 3. List of Symbols Used in Diurnal

Symbol	Description
C	Concentration of DO
c_s	DO Saturation value
K_a	Reaeration coefficient
K_d	Coefficient of CBOD oxidation
Q	River flow
A	River cross sectional area
X	Downstream distance
t	Time
L(x)	Distribution of CBOD concentration
K_n	Coefficient of nitrogenous oxidation (nitrification)
$N_2(x)$	Distribution of NBOD (ammonia)
P(x,t)	Photosynthetic oxygen source
R(x)	Aquatic vegetation respiration sink
S(x)	Benthic bacterial respiration sink (SOD)
P_m	The maximum rate of photosynthetic oxygen production
t_s	Time at which the source begins
p	Fraction of the day over which the source is active
K_r	Removal rate of CBOD
$N_1(x)$	Distribution of organic nitrogen concentration
K_s	Settling velocity
H	Depth of river
K_h	Hydrolysis rate of organic nitrogen to ammonia
K_v	Volatilization rate of ammonia
S_{N2}	Uptake of ammonia by benthic algae
ALG_{N2}	Uptake of ammonia by suspended algae
S_{N3}	Uptake of nitrite and nitrate by benthic algae
ALG_{N3}	Uptake of nitrite and nitrate by suspended algae

Organic Nitrogen (OrgN)

$$\frac{Q}{A}\frac{\partial N_1}{\partial x} = -\left(\frac{K_s}{H}\right)N_1 - K_h N_1 \tag{6}$$

Ammonia Nitrogen (NH_3)

$$\frac{Q}{A}\frac{\partial N_2}{\partial x} = K_h N_1 - K_n N_2 - K_v N_2 - S_{N_2} - ALG_{N_2} \tag{7}$$

Nitrite + Nitrate Nitrogen (NO_2+NO_3)

$$\frac{Q}{A}\frac{\partial N_3}{\partial x} = K_n N_2 - S_{N_3} - ALG_{N_3} \tag{8}$$

Phosphorus

$$\frac{Q}{A}\frac{\partial P}{\partial x} = -K_p P \tag{9}$$

A number of calculations are performed within DIURNAL to develop segment parameters, which are not directly associated with the equations previously described. These calculations are used to set site-specific parameters and coefficients. All reaction rates are input to DIURNAL at 20°C and the model then adjusts each rate to its site-specific rate using Equation 10.

$$K_{temp} = K_{20}\,\theta^{(T-20)} \tag{10}$$

where:

K_{temp} = temperature corrected rate;
K_{20} = rate at 20°C;
? = temperature correction factor; and
T = ambient temperature in river.

Correction factors for each reaction rate are listed in Table 4.

Table 4. Summary of Temperature Correction Factors

Reaction Rate	Symbol	T
Hydrolysis of organic nitrogen	K_h	1.08
Nitrification of ammonia	K_n	1.08
Volatilization of ammonia	K_v	1.00
Benthic uptake of ammonia	S_{N2}	1.065
Suspended algal uptake of ammonia	ALG_{N3}	1.04
Benthic uptake of NO_2+NO_3	S_{N3}	1.065
Suspended algal uptake of NO_2+NO_3	ALG_{N3}	1.04
Removal of CBOD	K_r	1.047
Oxidation of CBOD	K_d	1.047
Reaeration of dissolved oxygen	K_a	1.024
Sediment oxygen demand	S	1.065
Maximum photosynthetic oxygen production	P_m	1.065
Respiration of algae	R	1.045

3.2.3 Physical Parameters

The physical parameters of velocity and depth for each segment are calculated as a function of flow. The following equations are utilized by DIURNAL to determine stream velocity and depth:

$$U = aQ^b \qquad H = cQ^d \tag{11}$$

where:

Q = segment flow (cfs);
U = segment velocity (ft/sec); and
H = segment depth (ft).

The exponents and coefficients can be defined from available time of travel and field geometry data. The exponents and coefficients can be set as constants for a river with relatively uniform conditions or varied for changing river geometry. For uniform conditions, the exponents can be set to zero allowing the velocities and depths to be entered directly as the coefficients.

SECTION 4

MODEL DEVELOPMENT

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SECTION 4

MODEL DEVELOPMENT

Using the data collected in 2004, the DIURNAL model was developed to represent Opequon Creek from just upstream of the PMWWTF to approximately 26 miles downstream (ending at Mill Creek/Turkey Run near station M19). The DIURNAL model requires inputs for geometry, flow, boundary conditions (upstream and tributaries), point sources, temperature and constants. After the model inputs are assigned, model calibration is completed to develop a model that best represents the available data. This calibration process is completed in two steps. First the model is calibrated to the geometry data (depth, width, cross-sectional area, velocity and flow) based on the velocity and depth to flow relationships developed. After the geometry calibration is completed, the model is calibrated to water quality data (organic, ammonia and nitrite plus nitrate nitrogen, conductivity, CBODu and DO). The following sections describe this process and results.

4.1 GEOMETRY CALIBRATION

Using the geometry data collected, velocity and depth relationships to flow were developed for each model reach and are presented in Table 5. These relationships allow the creek geometry to change as a function of flow. In order to define incremental flow along the length of the creek and also tributary flow, the creek drainage area to each model reach and for each tributary was determined. The USGS gage near Berryville was used to prorate the measured gage flow for incremental runoff to the model reaches and for the tributaries based on the contributing drainage area. The drainage area at the USGS gage near Berryville is 57.3 square miles and the proration was completed as follows: $Q_{input} = Q_{gage} \times DA_{input}/DA_{gage}$. During this survey, the PMWWTF flow averaged 2.6 cfs (1.7 MGD) and the OWRF flow averaged 12.8 cfs (8.3 MGD). Since the geometry measurements were completed on November 4th during a rain event and an increasing hydrograph, the geometry calibration was completed at two creek flows. For the geometry measurements up to milepoint 12, a gage flow of 37 cfs was used and for the remainder of the creek a gage flow of 75 cfs was used. The resulting geometry calibration is presented in Figure 25 with the model output at 37 cfs represented as a black line and at 75 cfs as a blue line. The comparison between model output and measured data is very good and, therefore, the creek geometry is well represented in the DIURNAL model.

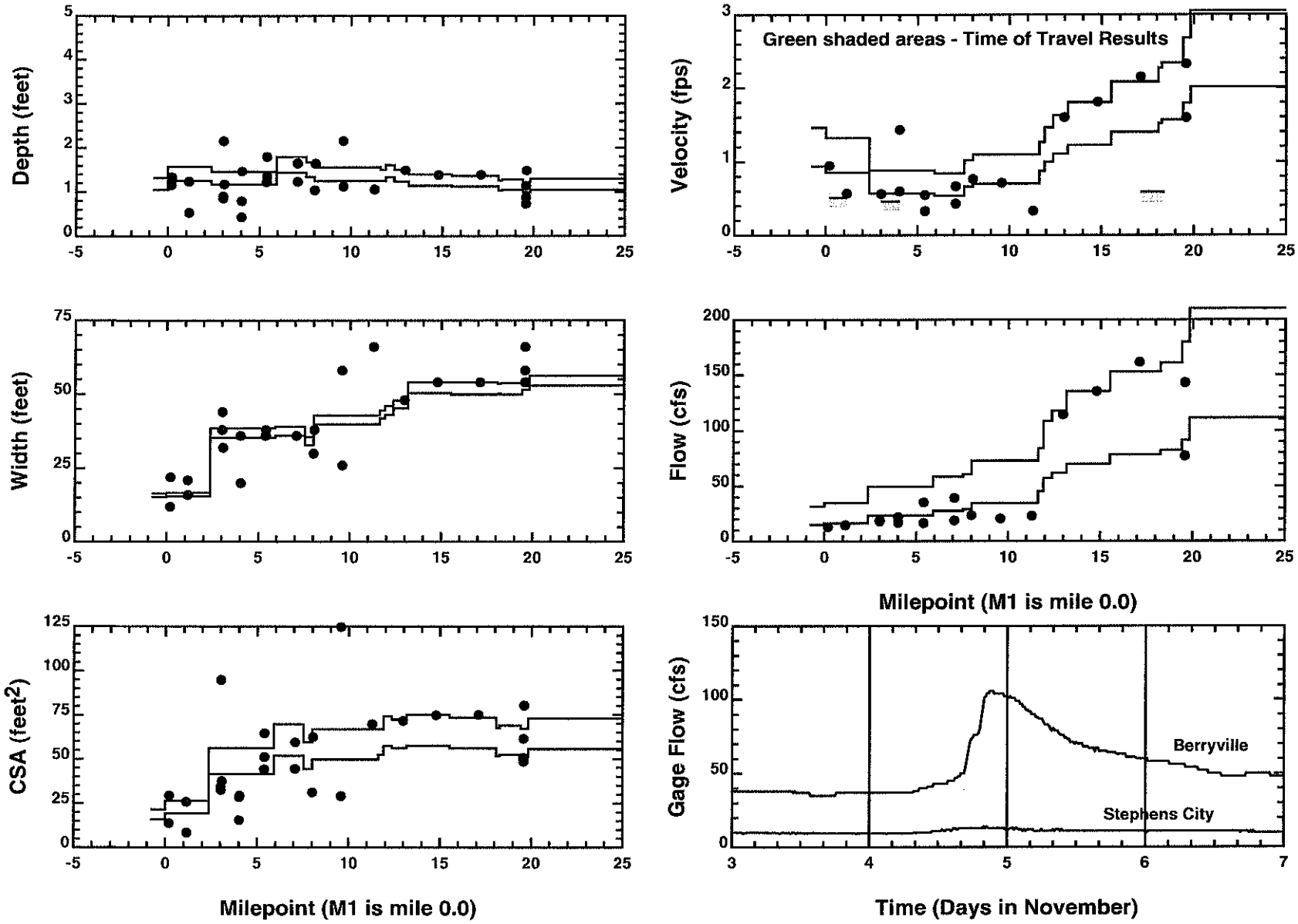

Figure 25. Opequon Creek Model Geometry Calibration for 11/3-6/2004

Table 5. Model Reach Geometry Inputs

Model Reach	Milepoints	U (fps) = a $Q^{0.6}$	H (ft) = c $Q^{0.3}$
1	-0.8 to 0.0	0.184	0.467
2	0.0 to 2.4	0.157	0.544
3	2.4 to 5.9	0.085	0.452
4	5.9 to 6.5	0.073	0.529
5	6.5 to 8.0	0.087	0.486
6	8.0 to 11.6	0.083	0.432
7	11.6 to 11.9	0.088	0.396
8	11.9 to 12.4	0.088	0.396
9	12.4 to 13.2	0.093	0.360
10	13.2 to 15.5	0.095	0.318
11	15.5 to 18.1	0.102	0.302
12	18.1 to 18.3	0.111	0.279
13	18.3 to 19.4	0.111	0.279
14	19.4 to 19.8	0.119	0.256
15	19.8 to 26.0	0.119	0.256

4.2 WATER QUALITY CALIBRATION

In order to calibrate the model to the observed water quality, inputs are required for the modeled parameters (DO, CBODu, conductivity, organic, ammonia and nitrite plus nitrate nitrogen) for the upstream boundary condition on the creek, tributaries, incremental runoff and point sources. The water quality data collected in the creek on October 13th (PM) and 14th (AM) included measurements in the tributaries and from the PMWWTF and OWRF. The PMWWTF enters the creek at MP0, the County Landfill at MP6.5 and the OWRF at MP11.6. No discharge information was available for the County Landfill so the following effluent characteristics were used based on their permitted discharge: flow of 0.23 cfs (0.15 MGD), CBODu of 75 mg/L, DO of 7 mg/L, OrgN of 5 mg/L, NH_3 of 0.001 mg/L, NO_2+NO_3 of 0.05 mg/L and conductivity of 1500 µmhos/cm. The resulting water quality model inputs are presented in Table 6 and the creek temperature averaged 13.2°C (55.8°F). During this survey, the PMWWTF flow averaged 2.1 cfs (1.4 MGD) and the OWRF flow averaged 10.3 cfs (6.6 MGD). The creek flow at the Berryville gage averaged 41 cfs

and upstream at the Stephens City gage averaged 12 cfs during the two surveys and the creek geometry was calculated in the model based on the drainage areas along the creek using the velocity and depth to flow relationships presented in the previous section.

Table 6. Water Quality Model Inputs

Input	DO (mg/L)	OrgN (mg/L)	NH_3 (mg/L)	NO_2+NO_3 (mg/L)	CBODu (mg/L)	Cond. (µmhos/cm)
Upstream	10.75	0.117	0.004	2.391	1.69	545
Incr. Flow (1-3)[1]	11.56	0.226	0.005	0.108	2.21	529
Incr. Flow (4-14)[2]	9.75	0.180	0.010	1.791	1.77	606
Wrights Run	10.37	0.271	0.005	0.042	2.62	552
Buffalo Lick	12.76	0.181	0.005	0.175	1.80	507
Sulphur Spring	10.13	0.476	0.030	1.490	1.65	614
Abrams Creek	10.59	0.137	0.004	1.991	1.89	647
Redbud Run	9.79	0.075	0.005	1.791	1.88	641
Dry Marsh Run	7.91	0.061	0.006	2.175	1.53	603
Lick Run	10.35	0.150	0.006	1.509	1.90	528
PMWWTF	7.00	1.650	0.027	35.635	14.14	1500
OWRF	7.00	1.398	0.035	3.892	10.01	1250

1 – Model Reaches 1 through 3
2 – Model Reaches 4 through 14

The reaction rates in the model were based on those used in previous modeling studies of Opequon Creek (HydroQual 1997, Donohue & Associates 1992, VDEQ 2004, SWCB 1978). These rates were based on model calibration to historical data and confirmed to be acceptable based on the current model calibration work presented in this report. The required reaction rates are: CBOD oxidation, organic nitrogen hydrolysis, ammonia nitrification, atmospheric reaeration, algal maximum photosynthesis and respiration rates. There are other rates available in the DIURNAL model but these were considered to be negligible in the overall water quality dynamics due to the shallow, fast moving characteristics of the creek that are not conducive to settling and any resulting sediment related dynamics such as SOD. These other rates are organic nitrogen settling, ammonia volatilization, ammonia and nitrite plus nitrate sediment flux, ammonia and nitrite plus nitrate algal uptake, and sediment oxygen demand (SOD). Atmospheric reaeration was calculated using the

Tsivoglou-Wallace reaeration equation (USEPA, 1986), which is a function of water velocity and creek slope as described with the following equation:

$$K_a = CUS \times 86400 \frac{\text{seconds}}{\text{day}} \tag{12}$$

where:

Ka = atmospheric reaeration rate at 20°C (1/d);
C = constant dependent on flow (1/ft);
U = water velocity (fps); and
S = creek slope (ft/ft).

The constant (C) varies from 0.11 at flows less than 1 cfs to 0.048 at a flow of 100 cfs and in the model is calculated as a function of flow and velocity given the slope of the creek. In order to verify the calculated reaeration rates, the continuous DO data for November 3rd (prior to the rain event with a large diurnal DO range) was used. As mentioned previously, the shape of the daily DO curve is related to the reaeration rate. Therefore, the model was run with the calculated reaeration rates with the maximum photosynthesis (Pmax) and respiration (R) rates adjusted to match the DO data. Figures 26 and 27 present the comparison of model and data over the day with the solid line representing the model and the dashed line the data. The hourly model results at stations M3, M6, M8, M10, M13 and M15 compare very well with the measured data, particularly the shape of the diurnal curve, which indicates that the calculated reaeration rates are represented well in the model.

The algal maximum photosynthesis (Pmax) and respiration (R) rates are required to properly calculate the observed diurnal range in DO. These rates are determined by calibrating the model to the observed daily DO data (R = 0.15Pmax) and are a function of the available sunlight or cloud cover. Along with these rates the time of sunrise and length of daylight are required, which were obtained from the US Naval Observatory website (http://aa.usno.navy.mil/data/docs/RS_OneYear.html). Tables 7 and 8 present the rates used for the model calibration. Higher Pmax and R rates were required to match the November 3rd data than the October 13th-14th data because the weather conditions during the latter survey were relatively overcast.

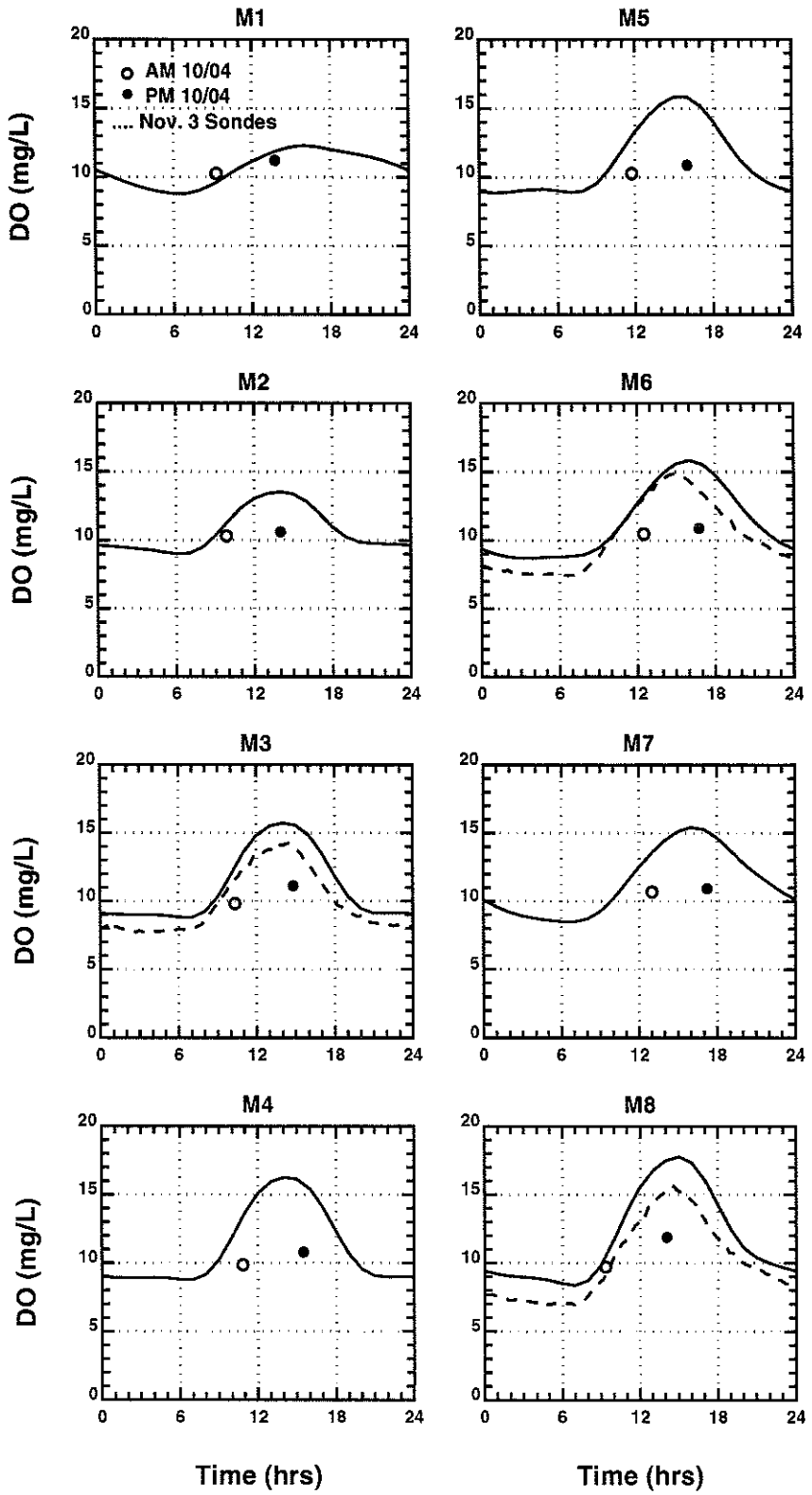

Figure 26. Opequon Creek Diurnal DO Calibration

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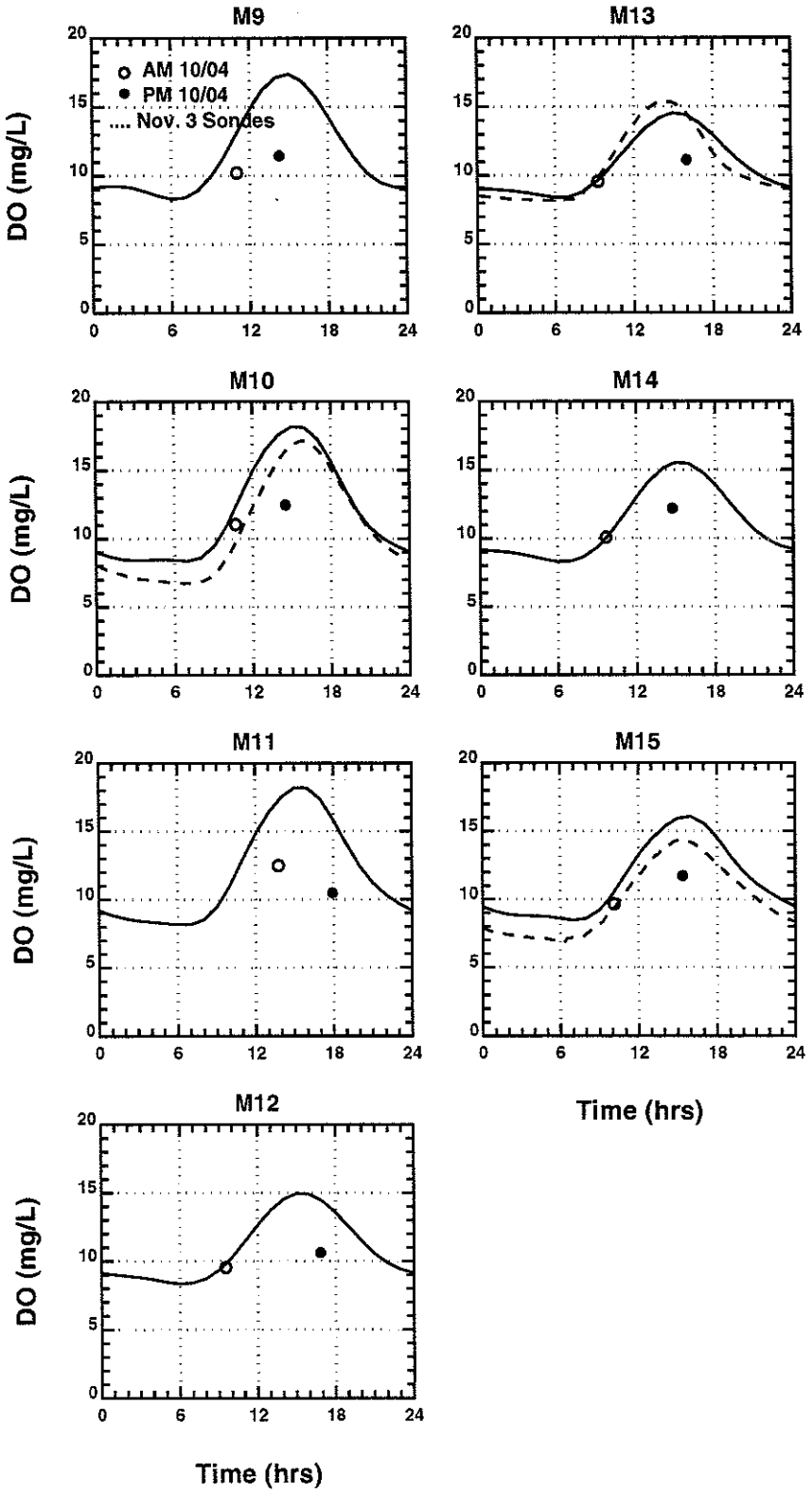

Figure 27. Opequon Creek Diurnal DO Calibration

DATE: 2/23/2005 TIME: 12:14:10

/usersm/obag0060/HEIDI/MODEL/WQ/pmodv8.gdp Run=15sPmvarB

Table 7. DIURNAL Model Calibration Rates

Reaction Rate	Rate at 20°C (1/d)
CBOD Oxidation	0.5
OrgN Hydrolysis	0.001
NH_3 Nitrification	0.5
Reaeration Rate	4.6 – 33.8
Time of Sunrise (hrs)	7.33
Length of Daylight (hrs)	11.25

Table 8. Model Calibration Pmax and R Rates

Model Reach	10/13-14/2004		11/3/2004	
	Pmax (mg/L/d)	R (mg/L/d)	Pmax (mg/L/d)	R (mg/L/d)
1	50	7.5	100	15
2	50	7.5	200	30
3	25	3.75	75	11.25
4	50	7.5	125	18.75
5	50	7.5	175	26.25
6	50	7.5	150	22.5
7	50	7.5	100	15
8	50	7.5	100	15
9	50	7.5	100	15
10	50	7.5	100	15
11	50	7.5	100	15
12	50	7.5	100	15
13	50	7.5	100	15
14	50	7.5	100	15
15	50	7.5	100	15

Figure 28 presents the DIURNAL model calibration to the observed data on October 13th and 14th for OrgN, NH_3, NO_2+NO_3, conductivity, CBODu and DO. The unique feature of the DIURNAL model is that it calculates DO over a daily cycle (hourly) unlike the QUAL2E model. The hourly DO output from the model is presented in Figures 29 and 30 for the stations in the creek. In both figures, the solid line represents the model output and the filled symbols represent the data. The dotted lines in Figure 28 in the DO panel represent the minimum and maximum calculated DO over the day. In general, the DIURNAL model output compares very well with observed data for all parameters over the length of the creek analyzed. For the nitrogen series, the model tends to be slightly greater than the data below the OWRF for OrgN and NH_3, which may be due to some nitrogen uptake below the outfall. Also the model NO_2+NO_3 is less than the data below the County Landfill, which may indicate a high NO_2+NO_3 groundwater source or higher than estimated load from the landfill. More importantly, the model represents the measured CBODu and DO data well over the length of the creek.

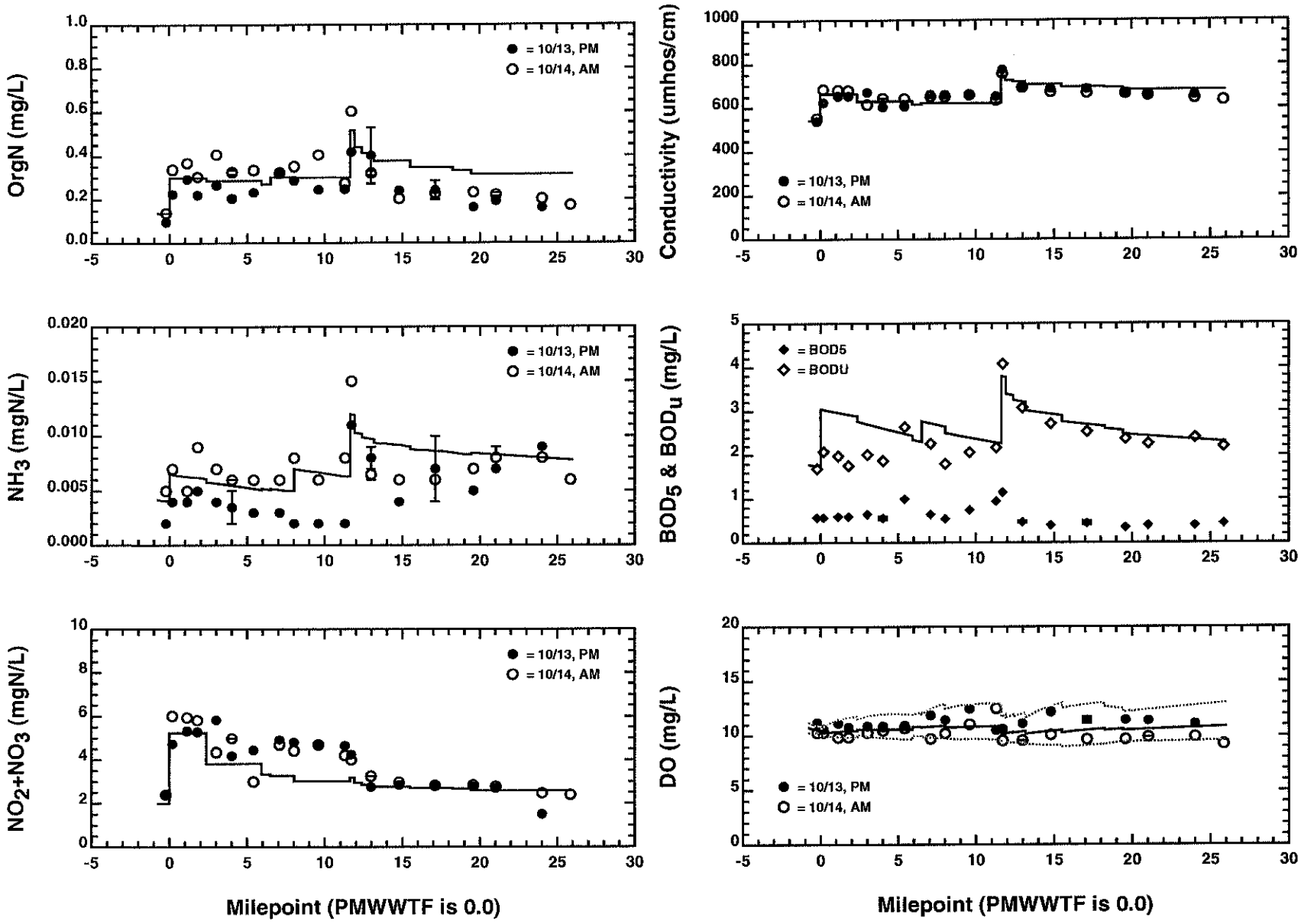

Figure 28. Opequon Creek Water Quality Data for the 10/13-14/2004 Survey

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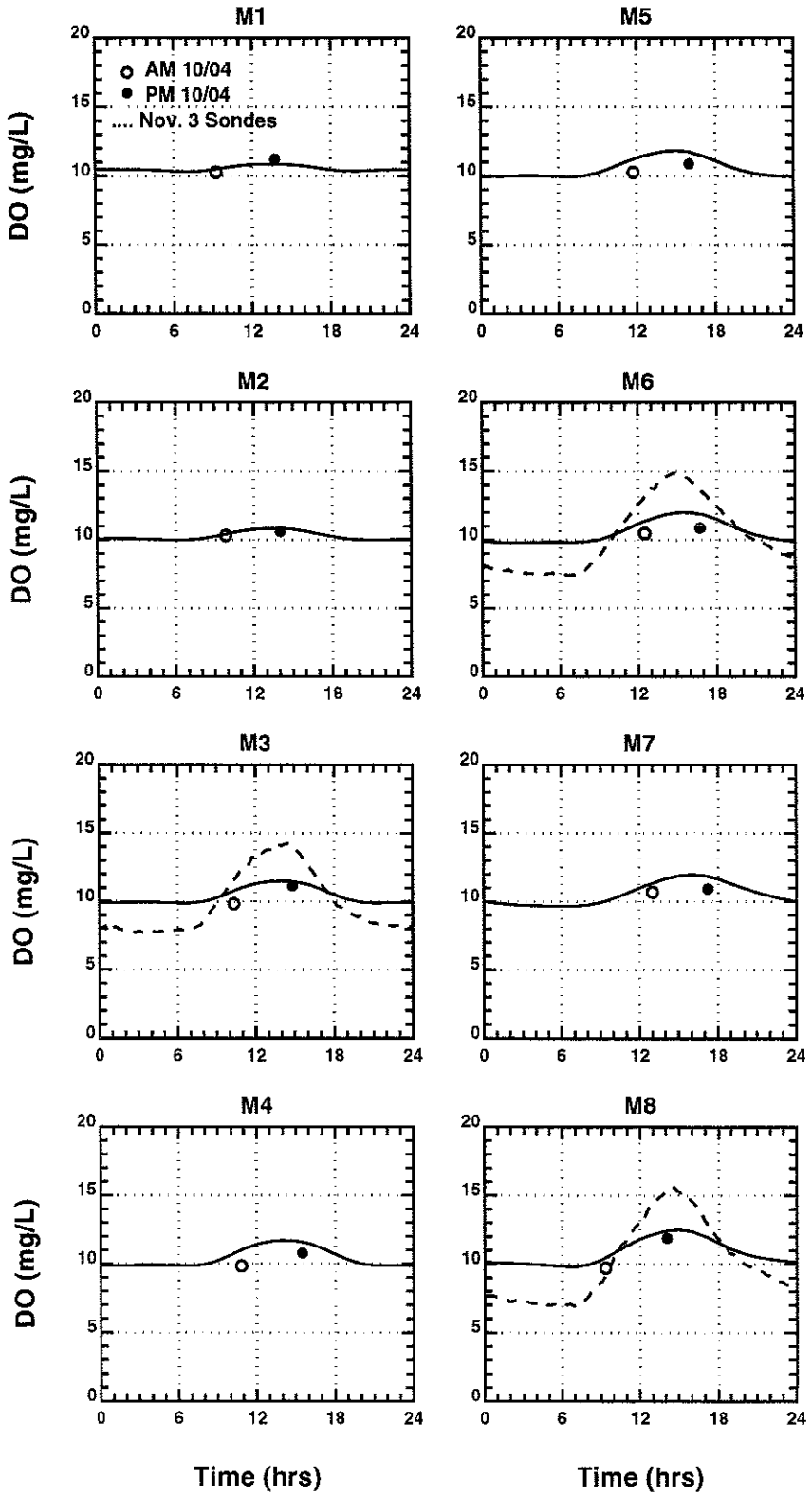

Figure 29. Opequon Creek Diurnal DO Calibration

DATE: 2/23/2005 TIME: 12:23:44

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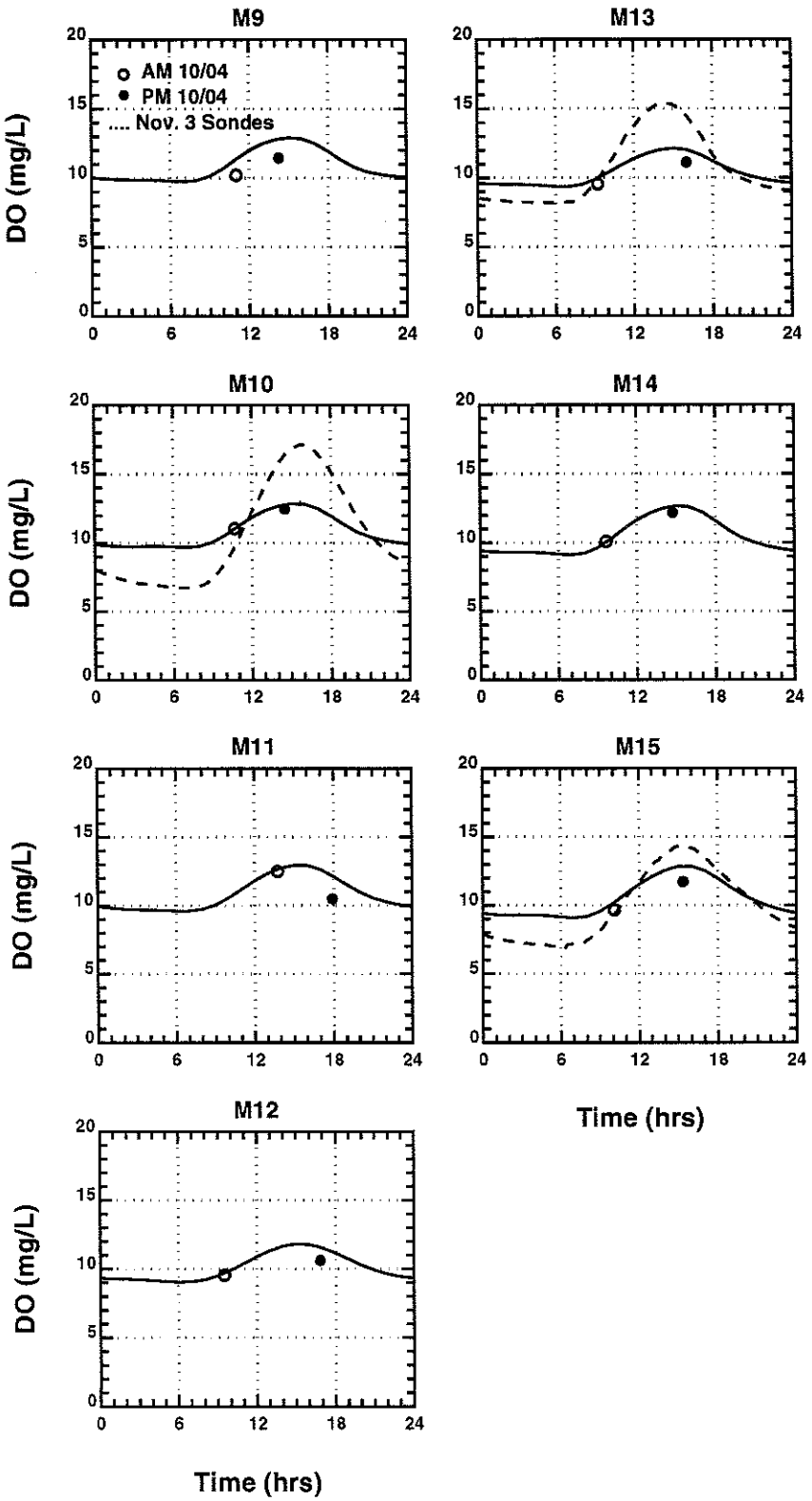

Figure 30. Opequon Creek Diurnal DO Calibration

DATE: 2/23/2005 TIME: 12:23:44

/usersm/obag0060/HEIDI/MODEL/WQ/pmodv8.gdp Run=3

SECTION 5

WATER QUALITY PROJECTIONS

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SECTION 5

WATER QUALITY PROJECTIONS

The ultimate goal of developing an updated water quality model of Opequon Creek is to provide a tool to determine the assimilative capacity of the creek for point source permitting of the PMWWTF and OWRF. In addition, the FWSA is also considering a new Northern Wastewater Reclamation Facility (NWRF) as part of its wastewater planning. The calibrated DIURNAL model is used for these water quality projection analyses with the creek flow set at the 7Q10 low-flow and at summer creek temperatures.

Figure 31 presents historical creek flow data from the two USGS gages on the creek from 1945 to 2005. The grey line in the top panel represents an estimate of the Stephens City flow based on a drainage area ratio to the Berryville gage flows. This data was used by VDEQ to determine a 7Q10 low-flow for the creek at the Berryville gage. The 7Q10 low-flow is the minimum 7-day average flow that occurs once in ten years and was estimated by VDEQ to equal 1.5 cfs (VDEQ, 2004). This estimated 7Q10 low-flow accounts for the start-up of the OWRF in July 1988 by only using the flow records prior to this date. This 7Q10 low-flow at the Berryville gage is used to develop flows along the length of the creek based on the incremental and tributary drainage areas as described in the geometry calibration section.

Creek temperature data was available in 2003 from OWRF staff sampling upstream from the discharge and is presented in Figure 32 along with the creek flow at the Berryville gage. This figure highlights the annual creek temperature variation, which ranges from 1 to 22°C, with the maximum temperatures occurring in the summer during low-flow conditions. In order to assign, an upper percentile creek temperature for the water quality model projections, a creek temperature of 23.6°C was assigned based on the critical condition creek modeling completed for the PMWWTF proposed expansion (Donohue & Associates, 1992).

The calibration rates presented in Tables 7 and 8 are used for the water quality projections and are corrected to the critical creek temperature of 23.6°C since these rates are assigned at 20°C. In order to investigate the DO impacts under different ambient light conditions (sunny vs. cloudy), the Pmax and R rates for both the 10/13-14 and 11/3 surveys were used to complete the water quality projections. In addition, the geometry is also adjusted as a function of creek flow as is the reaeration rate since it is a function of the creek velocity.

A number of water quality projections were completed for a range of effluent flow and quality scenarios at four flow tiers that included a combination of discharge conditions from the PMWWTF, OWRF, NWRF and the County Landfill. These conditions are presented in Tables 9 through 11 and resulted in a total of 20 water quality projection model runs.

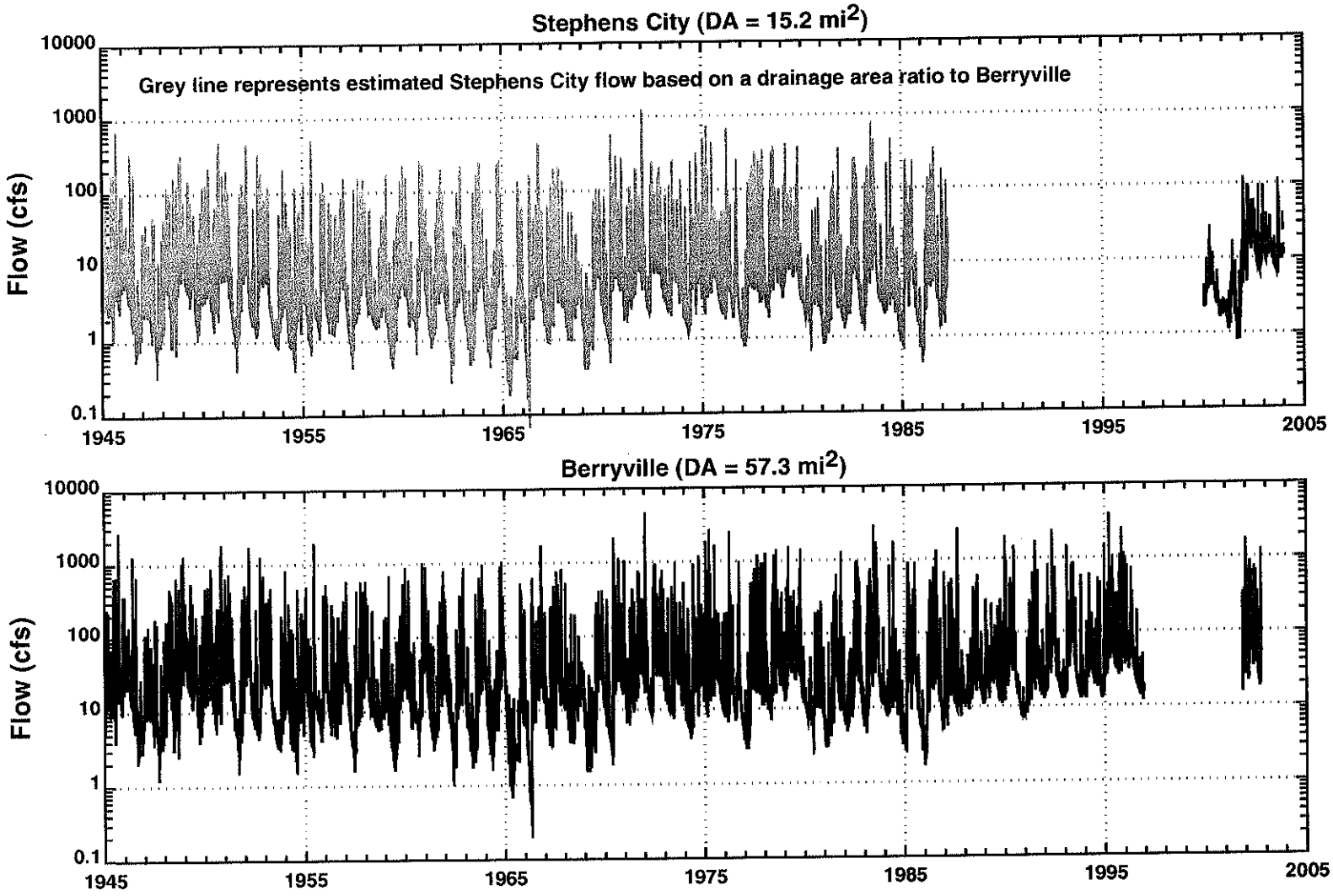

Figure 31. Opequon Creek USGS Gage Flows (1945-2004)

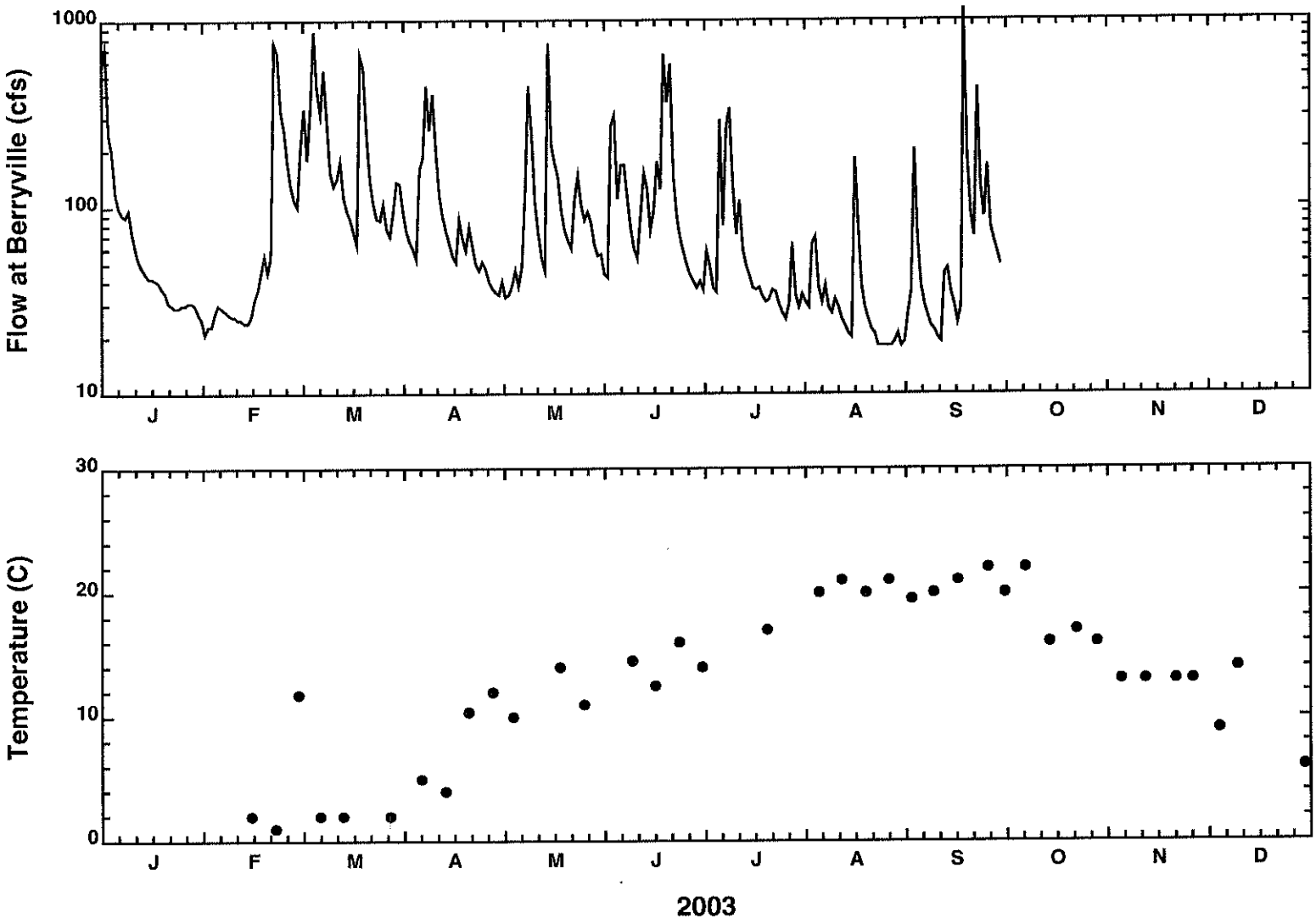

Figure 32. Opequon Creek Flow and Temperature Data for 2003
(Temperature Data from OWRF Staff Upstream of Discharge, Flow Data From USGS

Table 9. Discharge Flow Tiers for Projections

Flow Tier	PMWWTF Flow (MGD)	OWRF Flow (MGD)	NWRF Flow (MGD)	Landfill Flow (MGD)
1	2.0	6.4	0.0	0.15
2	3.0	8.0	2.0	0.15
3	4.0	12.0	4.0	0.15
4	5.0	16.0	6.0	0.15

Table 10. Discharge Quality Scenarios for Projections

Discharge Scenario	PMWWTF	OWRF	NWRF	Landfill
1	Current Permit	BNR	No Flow	Current Permit
2	Advanced BNR	ENR	No Flow	Future Permit
3	BNR	Advance BNR	No Flow	Future Permit
4	BNR	Advance BNR	BNR	Future Permit
5	ENR	ENR	ENR	Future Permit

BNR – Biological Nutrient Removal
Advanced BNR – Advanced Biological Nutrient Removal
ENR – Enhanced Nutrient Removal

Table 11. Discharge Effluent Quality for Projections

Parameter	Current PMWWTF Permit	Current OWRF/NWRF Permit	BNR	Advanced BNR	ENR	Landfill Current Permit	Landfill Future Permit
TN	20.0	8.0	8.0	5.0	3.0	20.5	8.1
OrgN	2.0	2.0	2.0	2.0	1.5	7.1	2.7
NH_3	1.6	1.6	1.6	1.0	1.0	12.9	4.9
NO_2+NO_3	16.4	4.4	4.4	2.0	0.5	0.5	0.5
TP	2.0	1.5	1.5	0.5	0.3	1.5	1.5
BOD_5	7.5	7.1	7.5/7.1[a]	7.5/7.1[a]	7.5/7.1[a]	25	9.5
CBODu	38.6	33.9	38.6/33.9[a]	38.6/33.9[a]	38.6/33.9[a]	75	28.5
DO	7.1	7.1	7.1	7.1	7.1	7.1	7.1

[a] – PMWWTF / OWRF or NWRF

These ranges of discharge conditions were evaluated with the calibrated DIURNAL model of Opequon Creek under 7Q10 low-flow and summer creek temperature conditions (critical summer low-flow). The resulting water quality model output is presented in the same format as Figure 28 for the two Pmax and R levels in the appendices as follows:

- Appendix 2 – Tier 1, Scenarios 1 to 5 – Cloudy Pmax & R Rates;
- Appendix 3 – Tier 2, Scenarios 1 to 5 – Cloudy Pmax & R Rates;
- Appendix 4 – Tier 3, Scenarios 1 to 5 – Cloudy Pmax & R Rates;
- Appendix 5 – Tier 4, Scenarios 1 to 5 – Cloudy Pmax & R Rates;
- Appendix 6 – Tier 1, Scenarios 1 to 5 – Sunny Pmax & R Rates;
- Appendix 7 – Tier 2, Scenarios 1 to 5 – Sunny Pmax & R Rates;
- Appendix 8 – Tier 3, Scenarios 1 to 5 – Sunny Pmax & R Rates; and
- Appendix 9 – Tier 4, Scenarios 1 to 5 – Sunny Pmax & R Rates.

In order to simplify the model output, Table 12 presents a summary of the model DO output (minimum daily average DO and minimum DO) for each ambient light condition (cloudy and sunny). For the cloudy condition, the daily average creek DO for all discharge cases is always greater than the 5 mg/L State DO standard and typically greater than 7 mg/L at the critical summer, low-flow creek conditions. The daily minimum DO for the cloudy condition is always greater than the 4 mg/L State DO standard and typically greater than 6 mg/L for all discharge cases. For the sunny condition, the daily average creek DO for all discharge cases is always greater than the 5 mg/L State DO standard and typically greater than 6 mg/L at the critical summer, low-flow creek conditions. The daily minimum DO for the summer condition is always greater than the 4 mg/L State DO standard for all discharge cases. The major difference between the cloudy and sunny conditions is that there are greater daily diurnal swings in DO with greater daily average DO and lower minimum DO levels for the sunny condition as opposed to the cloudy condition. It should be noted that for all discharge cases at critical summer, low-flow creek conditions during either cloudy or sunny conditions that State DO standards will be maintained throughout Opequon Creek from just upstream of the PMWWTF to approximately 26 miles downstream. This length of the creek includes discharges from the PMWWTF, County Landfill, OWRF and the potential new discharge from NWRF.

Table 12. Opequon Creek DO Water Quality Projection Results

Case	Cloudy Conditions		Sunny Conditions	
	Min Avg DO	Min DO	Min Avg DO	Min DO
Tier 1/Scen 1	7.15	5.84	6.00	4.16
Tier 1/Scen 2	7.34	6.07	6.19	4.55
Tier 1/Scen 3	7.28	6.05	6.13	4.46
Tier 1/Scen 4	7.28	6.05	6.13	4.46
Tier 1/Scen 5	7.34	6.07	6.19	4.55
Tier 2/Scen 1	7.12	6.05	5.96	4.12
Tier 2/Scen 2	7.29	6.23	6.13	4.42
Tier 2/Scen 3	7.22	6.05	6.07	4.27
Tier 2/Scen 4	7.22	6.05	6.08	4.27
Tier 2/Scen 5	7.29	6.23	6.14	4.42
Tier 3/Scen 1	7.06	6.15	5.90	4.55
Tier 3/Scen 2	7.22	6.32	6.05	4.71
Tier 3/Scen 3	7.15	6.24	5.98	4.55
Tier 3/Scen 4	7.16	6.24	6.02	4.55
Tier 3/Scen 5	7.23	6.32	6.08	4.71
Tier 4/Scen 1	7.23	6.43	6.09	4.83
Tier 4/Scen 2	7.36	6.59	6.23	4.97
Tier 4/Scen 3	7.30	6.43	6.16	4.83
Tier 4/Scen 4	7.32	6.43	6.20	4.83
Tier 4/Scen 5	7.38	6.59	6.27	4.97

SECTION 6

REFERENCES

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SECTION 6

REFERENCES

Donohue & Associates, 1992. A Wasteload Allocation Study for the Proposed Expansion of the Parkins Mills Wastewater Treatment Plant.

HydroQual, Inc., 1997. Evaluation of Water Quality Based Effluent Limits for an Expanded Opequon Water Reclamation Facility.

State Water Control Board, Valley Regional Office, 1978. Modeling Report Opequon Creek Basin, Proposed Frederick-Winchester Service Authority Facility.

USEPA, 1986. Memorandum: Guidelines for Using the Tsivoglou Reaeration Equation to Adjust Measured Reaeration Rates for Low Flow Conditions.

Virginia Department of Environmental Quality, 2004. Personal communication from Larry Hough (Fax dated 3/30/2004).

Virginia Department of Environmental Quality, 2004. Memorandum – Department of Environmental Quality, Valley Regional Office from Eric Aschenbach to Trevor Wallace (Flow Frequency Determination, Parkins Mill STP – VPDES Permit No. VA0075191, Frederick County (9/16/2004).

APPENDIX 1

2004 OPEQUON CREEK LABORATORY AND FIELD DATA

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Opequon Creek Water Quality Survey - 10/13/2004 (PM)

Station	MP	NO2+NO3 (mgN/L)	NH3 (mgN/L)	TKN (mgN/L)	PO4 (mgP/L)	TP (mgP/L)	TSS mg/L	VSS mg/L	Chla ug/L	BOD5 mg/L
M1	-0.221	2.382	0.002	0.098	0.004	0.007	1.57	0.43	1.49	0.575
M2	0.190	4.728	0.004	0.228	0.334	0.466	1.27	0.47	1.59	0.575
M3	1.141	5.328	0.004	0.297	0.479	0.610	1.17	0.47	1.19	0.600
M4	1.803	5.281	0.005	0.225	0.449	0.527	0.83	0.23	0.90	0.600
M5	3.015	5.831	0.004	0.269	0.684	0.653	0.64	0.44	1.35	0.650
M6	4.022	4.169	0.005	0.214	0.294	0.397	0.64	0.30	1.28	0.600
M7	5.408	4.440	0.003	0.235	0.337	0.438	0.83	0.58	1.40	1.000
M8	7.081	4.922	0.003	0.319	0.314	0.396	0.80	0.40	1.22	0.650
T1		0.032	0.004	0.251	0.003	0.010	1.30	0.43	2.02	0.650
T2		0.200	0.003	0.167	0.003	0.007	0.80	0.37	1.96	0.625
M6 Dup	4.022	4.191	0.002	0.203	0.303	0.381	0.77	0.37	1.45	0.525
M9	8.019	4.806	0.002	0.288	0.336	0.438	0.53	0.67	1.01	0.550
M10	9.587	4.728	0.002	0.246	0.295	0.408	0.40	0.40	1.25	0.750
M11	11.291	4.647	0.002	0.248	0.278	0.368	0.70	0.33	0.78	0.950
M12	11.705	4.244	0.011	0.428	0.201	0.284	0.83	0.80	0.68	1.150
M13	12.973	2.746	0.007	0.279	0.062	0.112	1.03	0.57	1.01	0.450
T3		2.228	0.003	0.218	0.004	0.008	0.17	0.17	0.46	0.200
T4		1.939	0.003	0.128	0.003	0.008	2.57	0.50	2.03	0.350
T5		1.655	0.003	0.092	0.002	0.006	4.02	0.77	1.10	0.250
T6		2.698	0.002	0.085	0.003	0.008	1.42	0.40	0.57	0.225
M14	14.792	2.849	0.004	0.244	0.054	0.113	0.76	0.60	1.44	0.400
M15	17.113	2.812	0.004	0.204	0.052	0.113	0.58	0.53	1.05	0.500
M16	19.581	2.763	0.005	0.168	0.048	0.106	1.43	0.50	1.45	0.350
M17	21.036	2.695	0.007	0.199	0.041	0.100	0.89	0.47	1.23	0.400
M18	24.019	1.508	0.009	0.171	0.041	0.095	1.30	0.43	0.99	0.400
M19	25.843									
T7		1.500	0.006	0.166	0.003	0.009	1.00	0.40	0.82	0.325
M13 FDup	12.973	2.760	0.009	0.538	0.056	0.120	1.17	0.60	1.03	0.500
M15 FDup	17.113	2.809	0.010	0.292	0.052	0.108	0.73	0.23	1.12	0.400
PMWWTF		35.468	0.035	1.115	6.784	6.527	0.73	0.67	0.59	NM
OWRF		4.845	0.034	1.492	0.019	0.190	4.00	3.15	0.17	NM
Field Duplicates										
M6	4.022	4.169	0.005	0.214	0.294	0.397	0.64	0.30	1.28	
M6 Dup	4.022	4.191	0.002	0.203	0.303	0.381	0.77	0.37	1.45	
RPD		0.526	85.714	5.276	3.015	4.113	18.53	20.96	12.89	
M13	12.973	2.746	0.007	0.279	0.062	0.112	1.03	0.57	1.01	
M13 FDup	12.973	2.760	0.009	0.538	0.056	0.120	1.17	0.60	1.03	
RPD		0.509	25.000	63.403	10.169	6.897	12.12	5.71	2.24	
M15	17.113	2.812	0.004	0.204	0.052	0.113	0.58	0.53	1.05	
M15 FDup	17.113	2.809	0.010	0.292	0.052	0.108	0.73	0.23	1.12	
RPD		0.107	85.714	35.484	0.000	4.525	23.73	78.26	6.32	

Opequon Creek Water Quality Survey - 10/14/2004 (AM)

Station	MP	NO2+NO3 (mgN/L)	NH3 (mgN/L)	TKN (mgN/L)	PO4 (mgP/L)	TP (mgP/L)	TSS mg/L	VSS mg/L	Chla ug/L	BOD5 mg/L
M1	-0.221	2.399	0.005	0.143	0.005	0.011	1.60	0.80	1.69	NM
M2	0.190	6.013	0.007	0.344	0.712	0.799	1.83	0.73	1.80	NM
M3	1.141	5.941	0.005	0.372	0.645	0.773	1.60	0.43	1.84	NM
M4	1.803	5.812	0.009	0.312	0.617	0.733	0.87	0.47	1.41	NM
M5	3.015	4.342	0.007	0.413	0.344	0.444	1.00	0.20	1.59	NM
M6	4.022	5.003	0.006	0.321	0.466	0.588	0.80	0.40	1.36	NM
M6 Fdup	4.022	4.961	0.006	0.340	0.484	0.553	0.57	0.27	1.45	NM
M7	5.408	2.991	0.006	0.340	0.621	0.655	1.00	0.30	1.48	NM
M8	7.081	4.686	0.006	0.328	0.275	0.276	0.83	0.53	1.28	NM
T1		0.051	0.005	0.300	0.004	0.010	1.53	0.50	1.87	NM
T2		0.150	0.007	0.204	0.003	0.006	0.70	0.37	1.92	NM
M9	8.019	4.415	0.008	0.358	0.234	0.399	0.90	0.47	1.32	NM
M10	9.587	4.688	0.006	0.410	0.252	0.417	0.93	0.33	1.58	NM
M11	11.291	4.202	0.008	0.280	0.202	0.328	0.47	0.37	1.00	NM
M12	11.705	3.995	0.015	0.618	0.151	0.276	1.03	0.87	0.91	NM
M13	12.973	3.248	0.006	0.335	0.071	0.156	1.13	0.57	1.02	NM
M13 FDup	12.973	3.240	0.007	0.316	0.067	0.153	1.27	0.47	1.06	NM
T3		0.752	0.056	0.793	0.004	0.064	2.25	1.75	1.19	NM
T4		2.042	0.005	0.154	0.002	0.009	1.25	0.75	1.68	NM
T5		1.927	0.006	0.067	0.002	0.005	4.40	0.83	1.26	NM
T6		1.652	0.009	0.047	0.004	0.009	1.67	0.70	0.64	NM
M14	14.792	2.962	0.006	0.209	0.049	0.102	1.07	0.27	1.20	NM
M15	17.113	2.820	0.006	0.231	0.061	0.098	1.33	0.43	1.38	NM
M16	19.581	2.840	0.007	0.238	0.041	0.084	2.53	0.73	1.88	NM
M17	21.036	2.775	0.007	0.220	0.043	0.082	1.97	0.57	1.85	NM
M17 Fdup	21.036	2.775	0.009	0.237	0.045	0.084	1.60	0.57	1.70	NM
M18	24.019	2.465	0.008	0.210	0.036	0.084	1.27	0.57	1.27	NM
M19	25.843	2.390	0.006	0.178	0.035	0.063	1.43	0.50	1.09	0.45
T7		1.517	0.005	0.145	0.003	0.009	1.10	0.30	1.11	NM
PMWWTF		35.801	0.018	2.237	7.840	6.677	12.90	10.55	1.07	2.75
OWRF		2.939	0.035	1.372	0.019	0.178	3.05	3.05	1.35	2.10
Field Duplicates										
M6	4.022	5.003	0.006	0.321	0.466	0.588	0.80	0.40	1.36	
M6 Fdup	4.022	4.961	0.006	0.340	0.484	0.553	0.57	0.27	1.45	
RPD		0.843	0.000	5.749	3.789	6.135	34.15	40.00	6.24	
M13	12.973	3.248	0.006	0.335	0.071	0.156	1.13	0.57	1.02	
M13 FDup	12.973	3.240	0.007	0.316	0.067	0.153	1.27	0.47	1.06	
RPD		0.247	15.385	5.837	5.797	1.942	11.11	19.35	3.89	
M17	21.036	2.775	0.007	0.220	0.043	0.082	1.97	0.57	1.85	
M17 Fdup	21.036	2.775	0.009	0.237	0.045	0.084	1.60	0.57	1.70	
RPD		0.000	25.000	7.440	4.545	2.410	20.56	0.00	8.43	

Opequon Creek Water Quality Survey - 10/13-14/2004 (AM/PM)

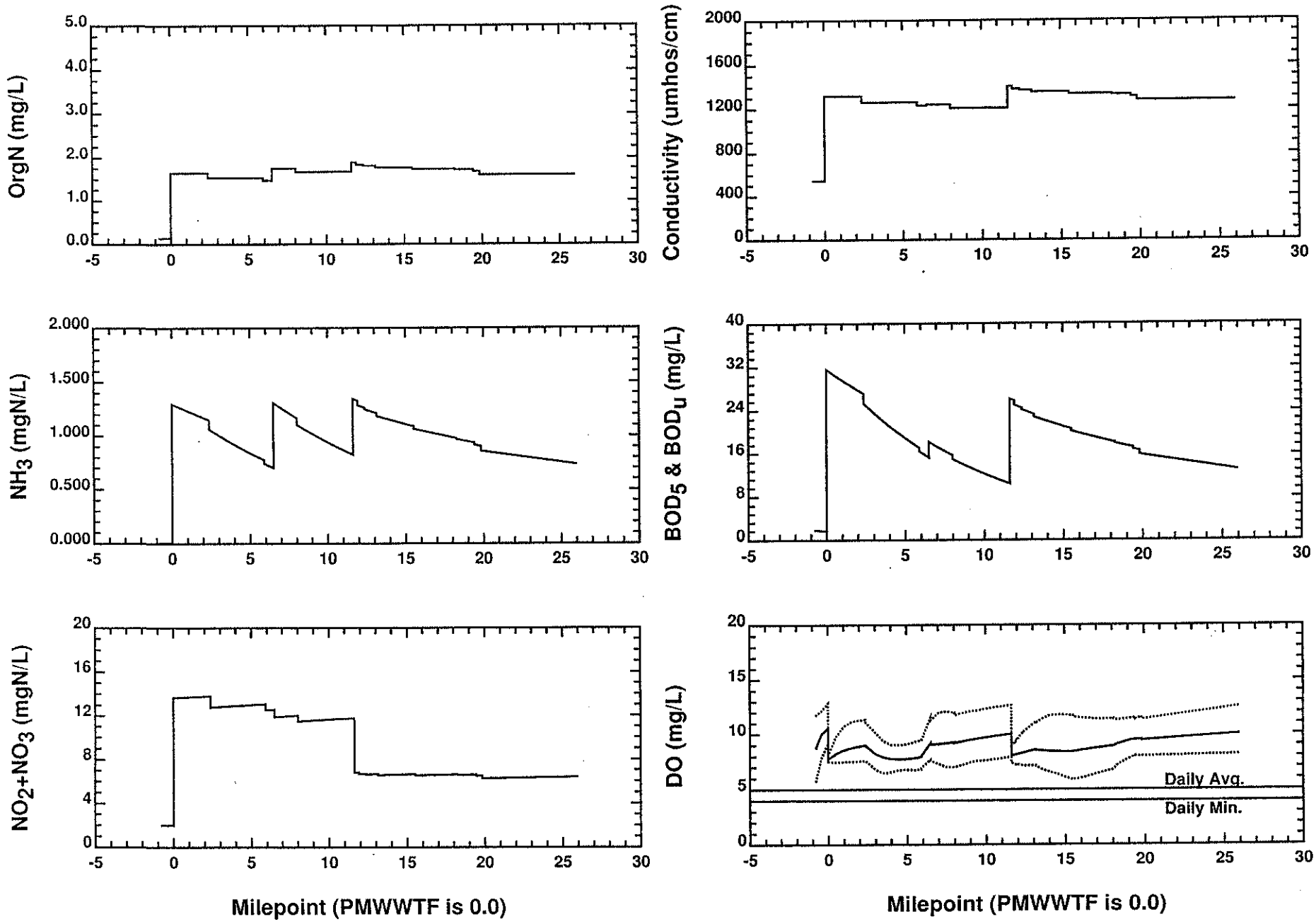
Date	Time	MP	Station ID	DO (mg/L)	DO (% Sat)	Conductivity (umhos/cm)	pH	Temperature (C)
10/13/2004	13:45	-0.221	M1	11.22	105.6	538	8.19	12.60
10/13/2004	14:00	0.190	M2	10.60	101.3	623	8.27	13.20
10/13/2004	14:50	1.141	M3	11.14	106.7	653	8.17	13.30
10/13/2004	15:30	1.803	M4	10.78	103.3	653	8.32	13.40
10/13/2004	16:00	3.015	M5	10.88	104.4	670	8.32	13.40
10/13/2004	16:45	4.022	M6	10.87	103.1	603	8.38	12.90
10/13/2004	17:15	5.408	M7	10.94	103.7	606	8.45	12.90
10/13/2004	14:05	7.081	M8	11.88	110.5	660	7.95	12.08
10/13/2004	16:20		T1	10.39	99.5	550	8.17	13.30
10/13/2004	17:00		T2	11.82	110.2	512	8.37	12.10
10/13/2004	16:45	4.022	M6 Dup	10.87	103.1	603	8.38	12.90
10/13/2004	14:15	8.019	M9	11.45	106.7	659	8.28	12.16
10/13/2004	14:30	9.587	M10	12.46	116.0	657	8.37	12.22
10/13/2004	17:55	11.291	M11	10.50 5:55	98.7	651	8.51	12.48
10/13/2004	16:50	11.705	M12	10.61	105.0	773	8.37	14.75
10/13/2004	16:00	12.973	M13	11.12	108.3	699	8.30	14.06
10/13/2004	13:56		T3	10.94	98.8	583	7.90	10.81
10/13/2004	15:05		T4	10.84	105.0	653	8.27	13.89
10/13/2004	16:25		T5	9.70	92.9	638	8.19	13.36
10/13/2004	15:45		T6	8.15	77.1	604	7.79	12.85
10/13/2004	14:45	14.792	M14	12.19	116.8	686	7.81	13.27
10/13/2004	15:22	17.113	M15	11.74	111.2	670	7.76	12.79
10/13/2004	15:42	19.581	M16	11.45	108.0	662	7.80	12.63
10/13/2004	16:04	21.036	M17	11.40	107.4	660	7.71	12.63
10/13/2004	16:44	24.019	M18	11.11	104.5	658	7.84	12.62
10/13/2004	15:07		T7	10.78	100.6	526	7.80	12.18
10/13/2004	16:00	12.973	M13 FDup	11.12	108.3	699	8.30	14.06
10/13/2004	16:05	17.113	M15 FDup	11.12	108.3	699	8.30	14.06
10/13/2004			PMWWTF					
10/13/2004	14:25		OWRF					
10/14/2004	9:15	-0.221	M1	10.27	96.9	551	8.16	13.70
10/14/2004	9:50	0.190	M2	10.30	99.2	684	8.22	13.60
10/14/2004	10:20	1.141	M3	9.83	94.2	681	8.22	13.40
10/14/2004	10:50	1.803	M4	9.85	94.5	679	8.27	13.40
10/14/2004	11:45	3.015	M5	10.27	98.2	614	8.27	13.30
10/14/2004	12:30	4.022	M6	10.46	100.5	643	8.28	13.50
10/14/2004	12:30	4.022	M6 Fdup	10.46	100.5	643	8.28	13.50
10/14/2004	13:00	5.408	M7	10.69	103.2	641	8.38	13.80
10/14/2004	9:20	7.081	M8	9.71	91.5	651	7.84	12.52
10/14/2004	12:05		T1	10.34	98.0	553	8.14	12.90
10/14/2004	13:20		T2	13.69	131.5	501	8.49	13.50
10/14/2004	11:00	8.019	M9	10.21	96.9	650	8.30	12.81
10/14/2004	10:40	9.587	M10	11.04	104.4	658	8.36	12.77
10/14/2004	13:45	11.291	M11	12.50 1:45	120.3	634	8.57	13.48
10/14/2004	9:30	11.705	M12	9.54	94.2	756	8.23	14.63
10/14/2004	9:15	12.973	M13	9.56	91.7	692	8.15	13.40
10/14/2004	9:20	12.973	M13 FDup	9.56	91.7	692	8.15	13.40
10/14/2004	11:15		T3	9.31	86.6	645	8.13	11.98
10/14/2004	10:15		T4	10.34	99.7	640	8.19	13.72
10/14/2004	10:00		T5	9.88	93.4	643	8.19	12.84
10/14/2004	8:55		T6	7.66	72.4	601	7.88	12.76
10/14/2004	9:40	14.792	M14	10.08	95.7	671	7.72	13.12
10/14/2004	10:07	17.113	M15	9.66	92.4	667	7.72	13.17
10/14/2004	10:33	19.581	M16	9.67	92.4	664	7.79	13.19
10/14/2004	10:50	21.036	M17	9.89	94.3	656	7.78	13.13
10/14/2004	10:50	21.036	M17 Fdup	9.89	94.3	656	7.78	13.13
10/14/2004	11:20	24.019	M18	9.92	94.4	644	7.85	13.02
10/14/2004	11:49	25.843	M19	9.25	87.8	634	7.75	12.95
10/14/2004	9:53		T7	9.91	93.4	529	7.76	12.58
10/14/2004	14:25		PMWWTF					
10/14/2004			OWRF					

APPENDIX 2

TIER 1, SCENARIOS 1-5
CLOUDY CONDITIONS

HydroQual

Environmental
Engineers & Scientists



Tier 1 - Scenario 1

Figure . Opequon Creek Water Quality Projections

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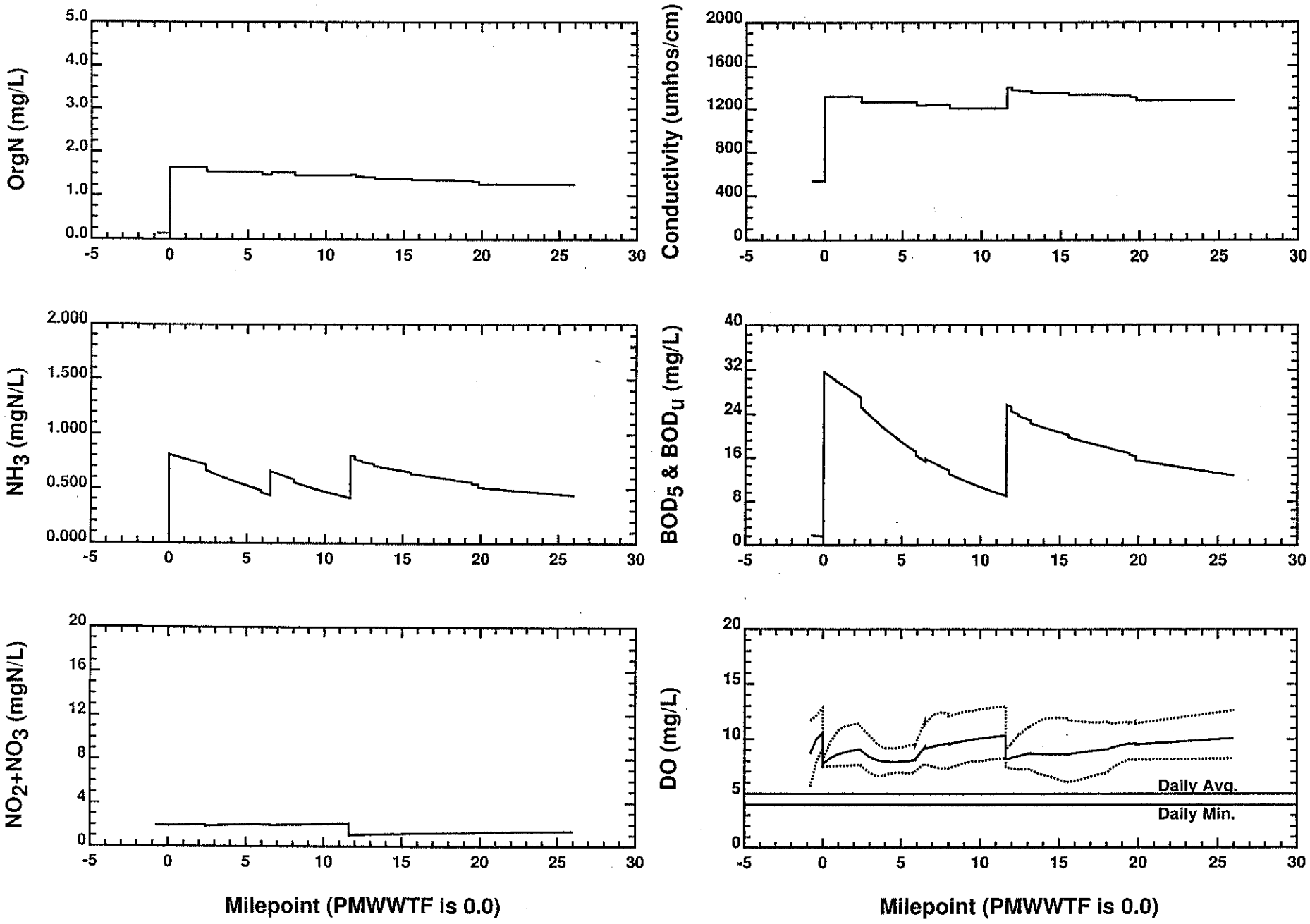
DATE: 2/23/2005 TIME: 11: 1:53



Tier 1 - Scenario 2

Figure . Opequon Creek Water Quality Projections-Cloudy Day

DATE: 2/23/2005 TIME: 11:22: 3

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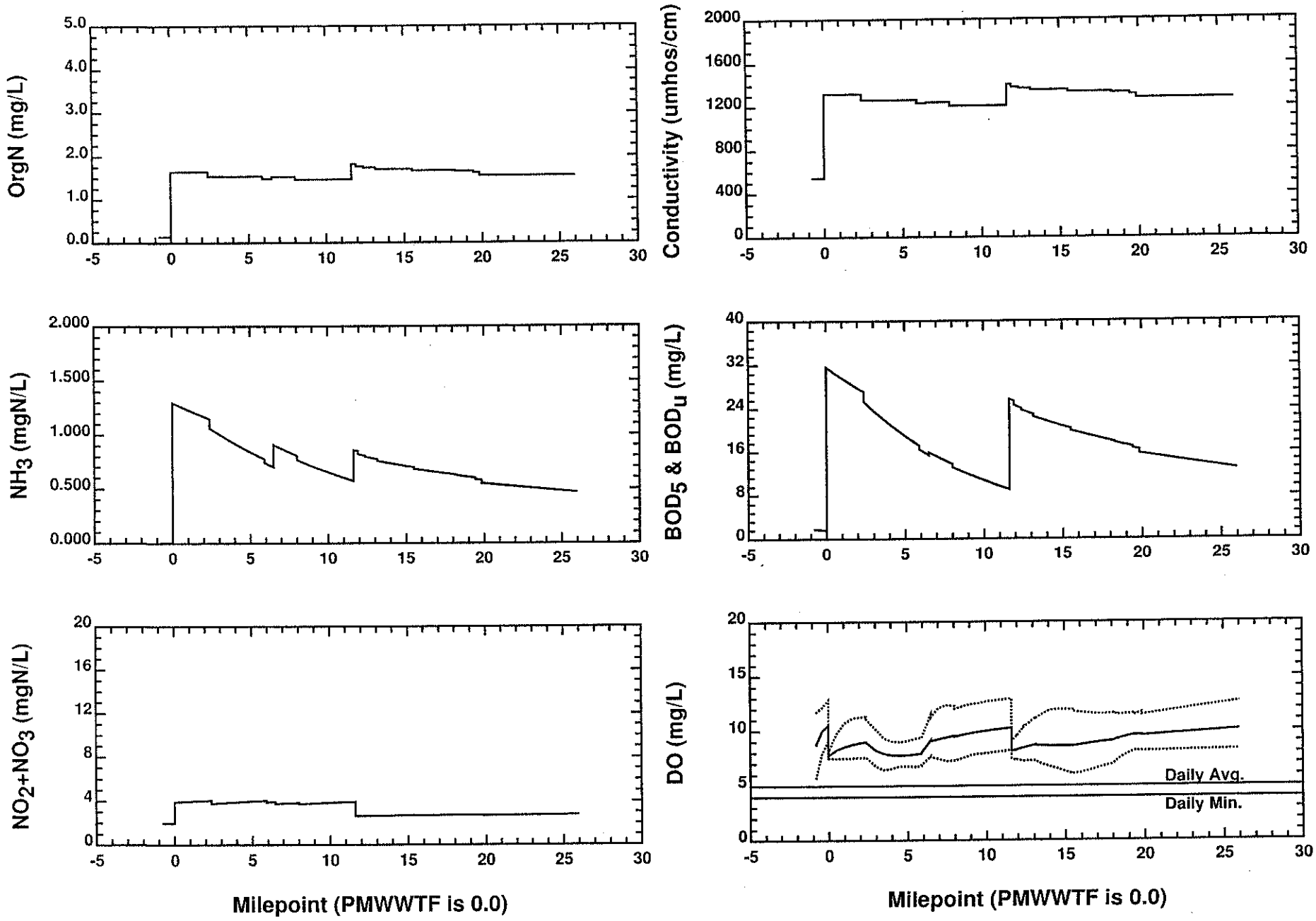

Tier 1 - Scenario 3

Figure . Opequon Creek Water Quality Projections - Cloudy Day

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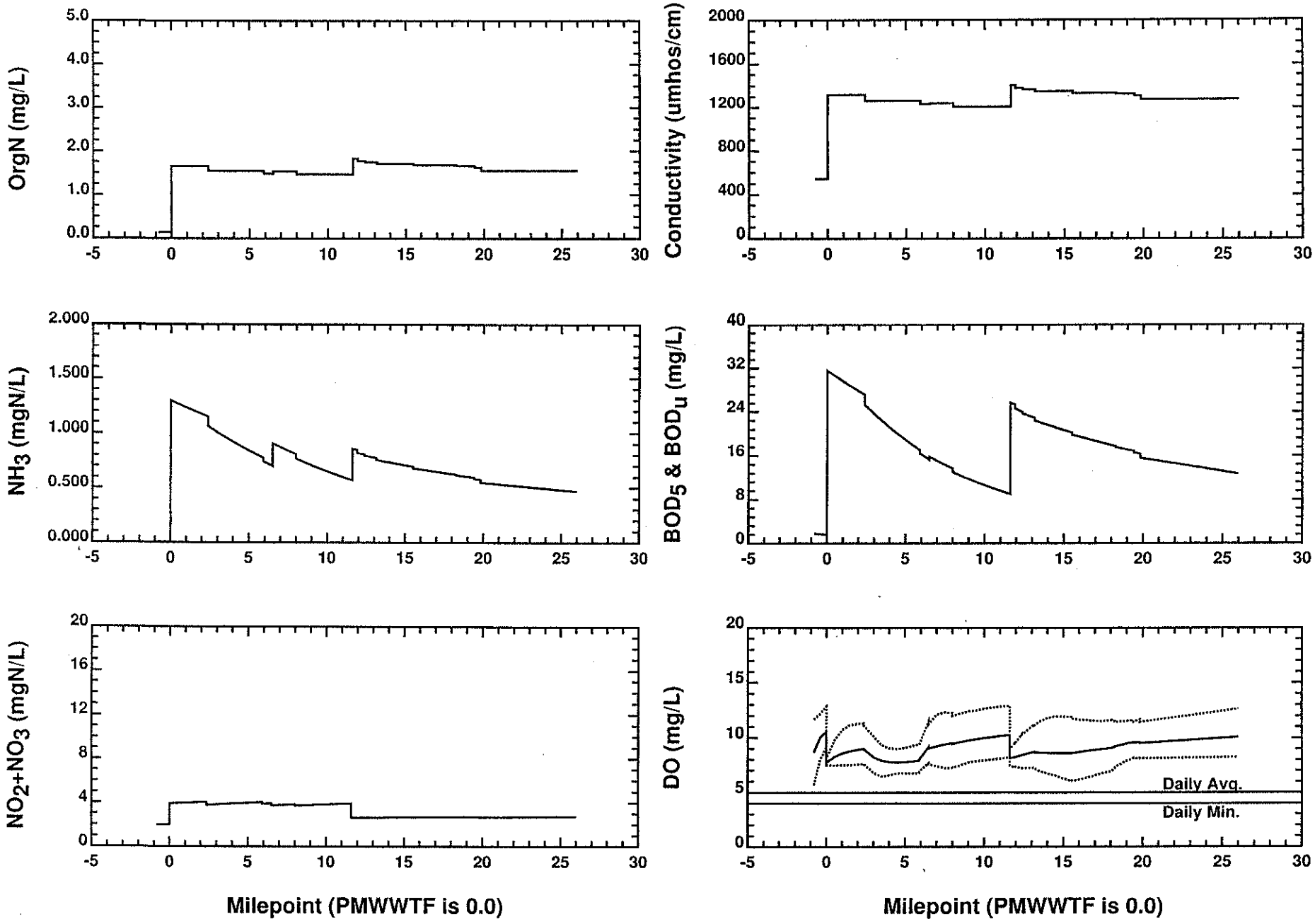
DATE: 2/23/2005 TIME: 12:40:36



Tier 1 - Scenario 4

Figure . Opequon Creek Water Quality Projections - Cloudy Day

DATE: 2/23/2005 TIME: 12:45:51

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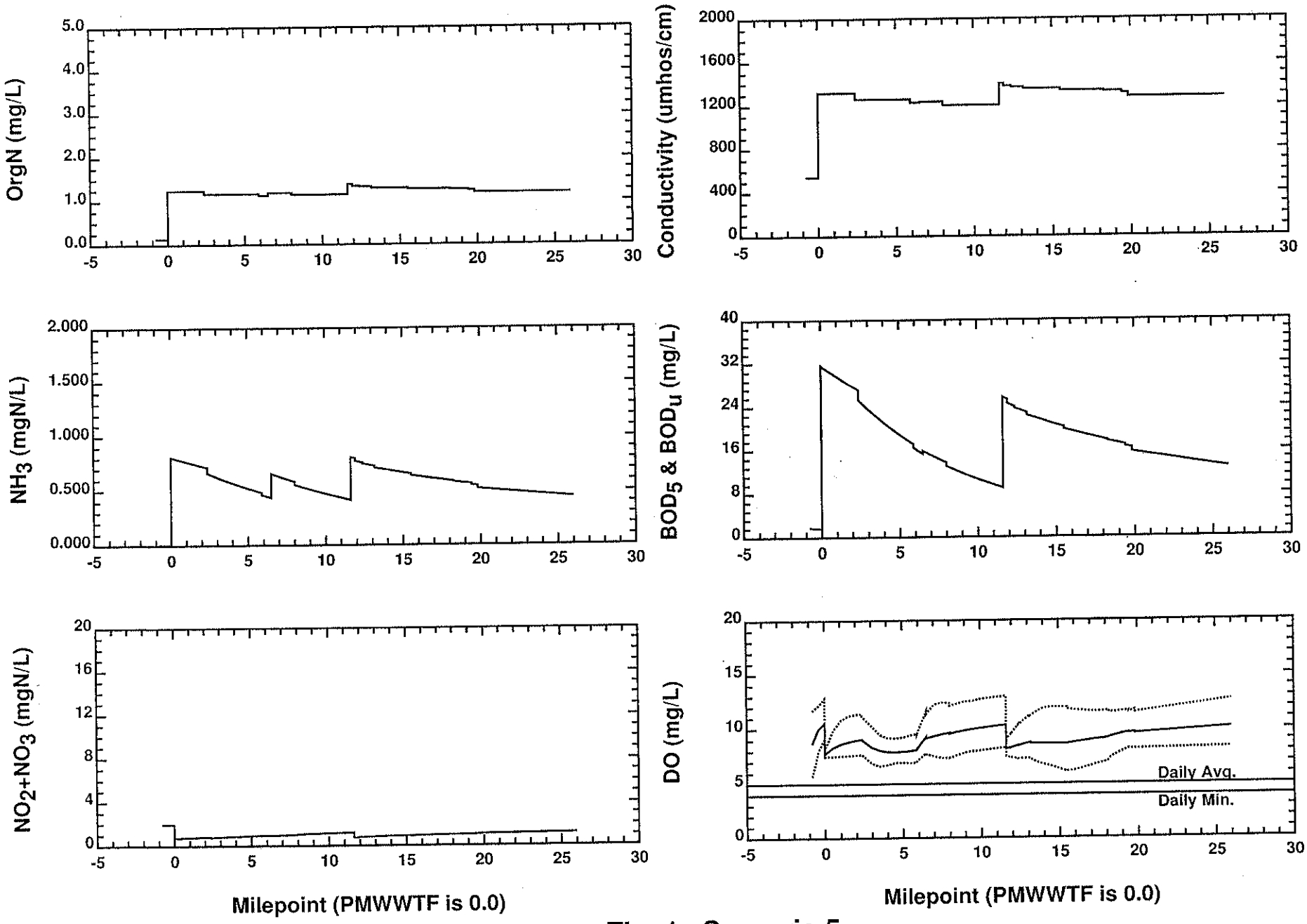


Tier 1 - Scenario 5

Figure . Opequon Creek Water Quality Projections - Cloudy Day

/usersm/obag0060/HEIDI/MODEL/PROJECTION/TIER1/CLOUDY/t1s5.gdp

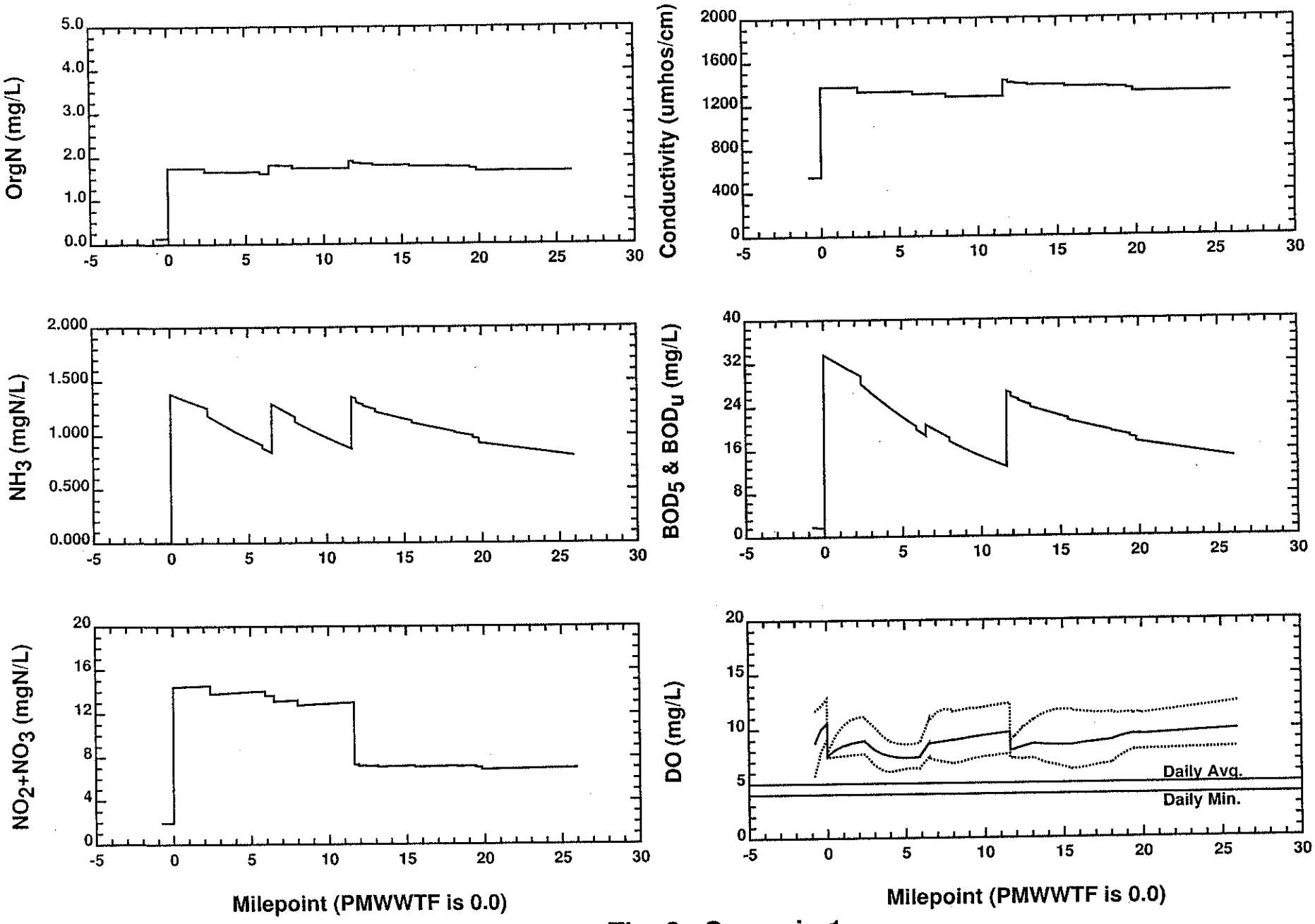
DATE: 2/23/2005 TIME: 12:51:39

APPENDIX 3

TIER 2, SCENARIOS 1-5
CLOUDY CONDITIONS

HydroQual

Environmental
Engineers & Scientists



Tier 2 - Scenario 1

Figure . Opequon Creek Water Quality Projections

DATE: 2/23/2005 TIME: 13:33:43

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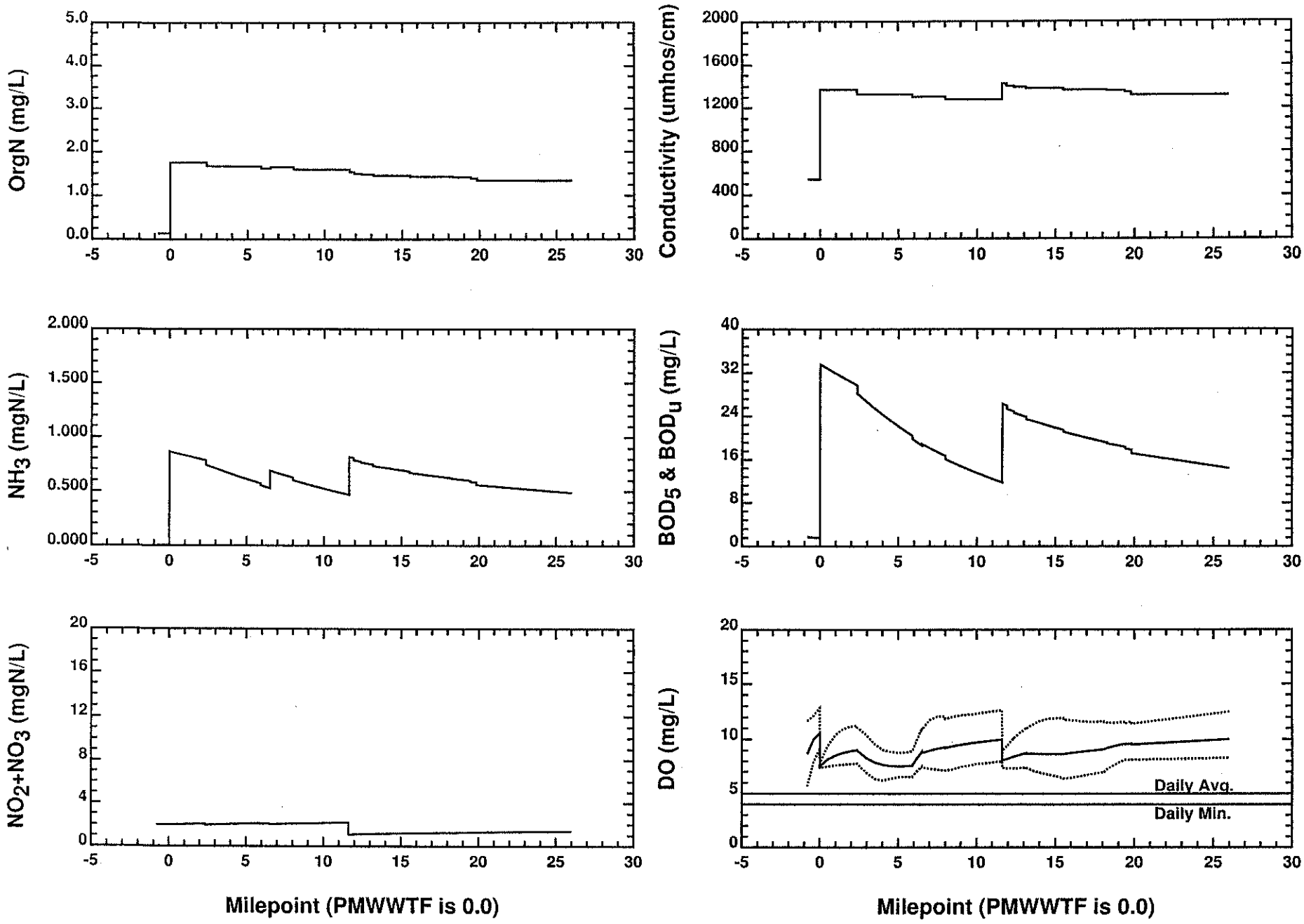

Tier 2 - Scenario 2

Figure . Opequon Creek Water Quality Projections

DATE: 2/23/2005 TIME: 13:33:45

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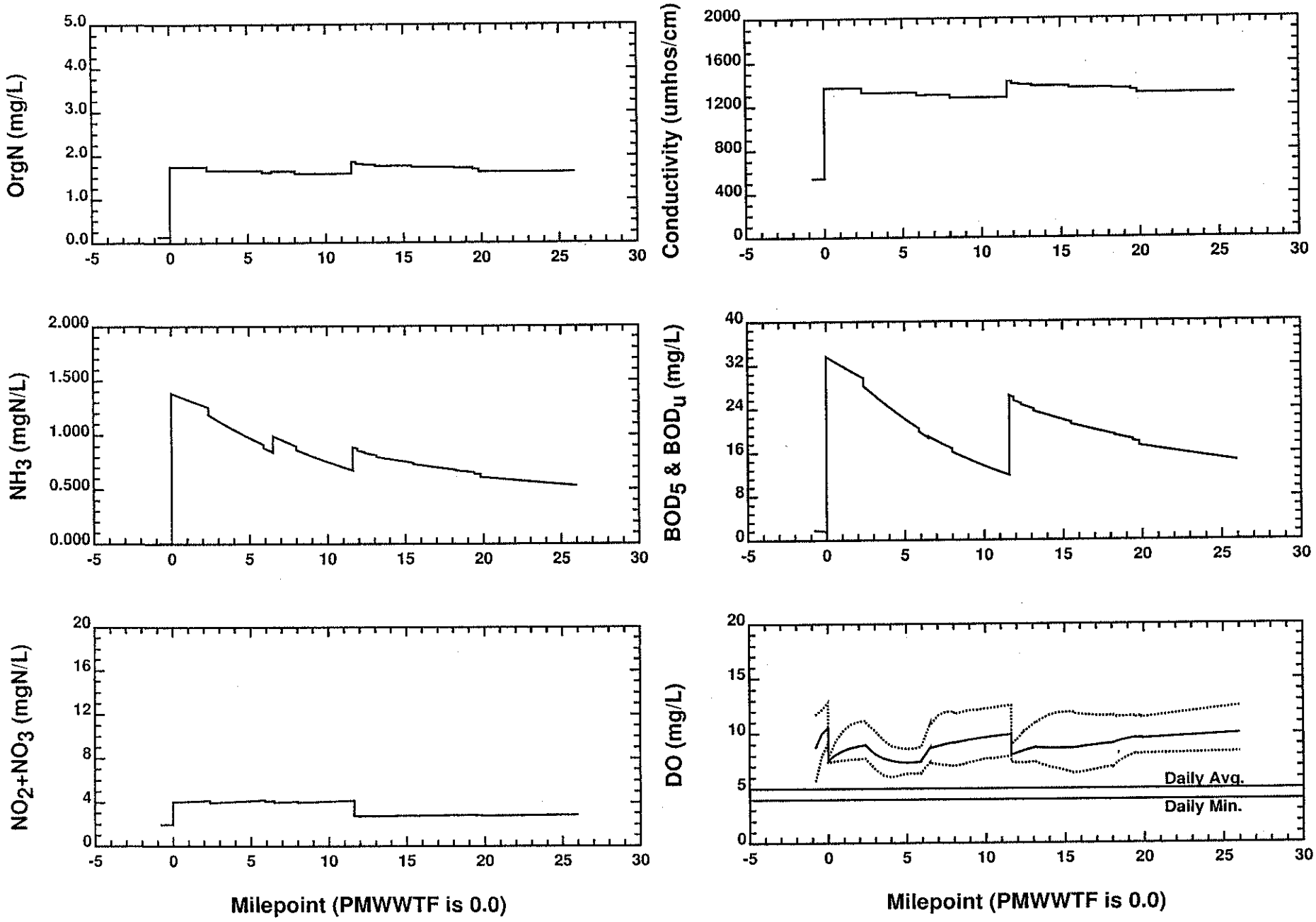

Tier 2 - Scenario 3

Figure . Opequon Creek Water Quality Projections

DATE: 2/23/2005 TIME: 13:33:48

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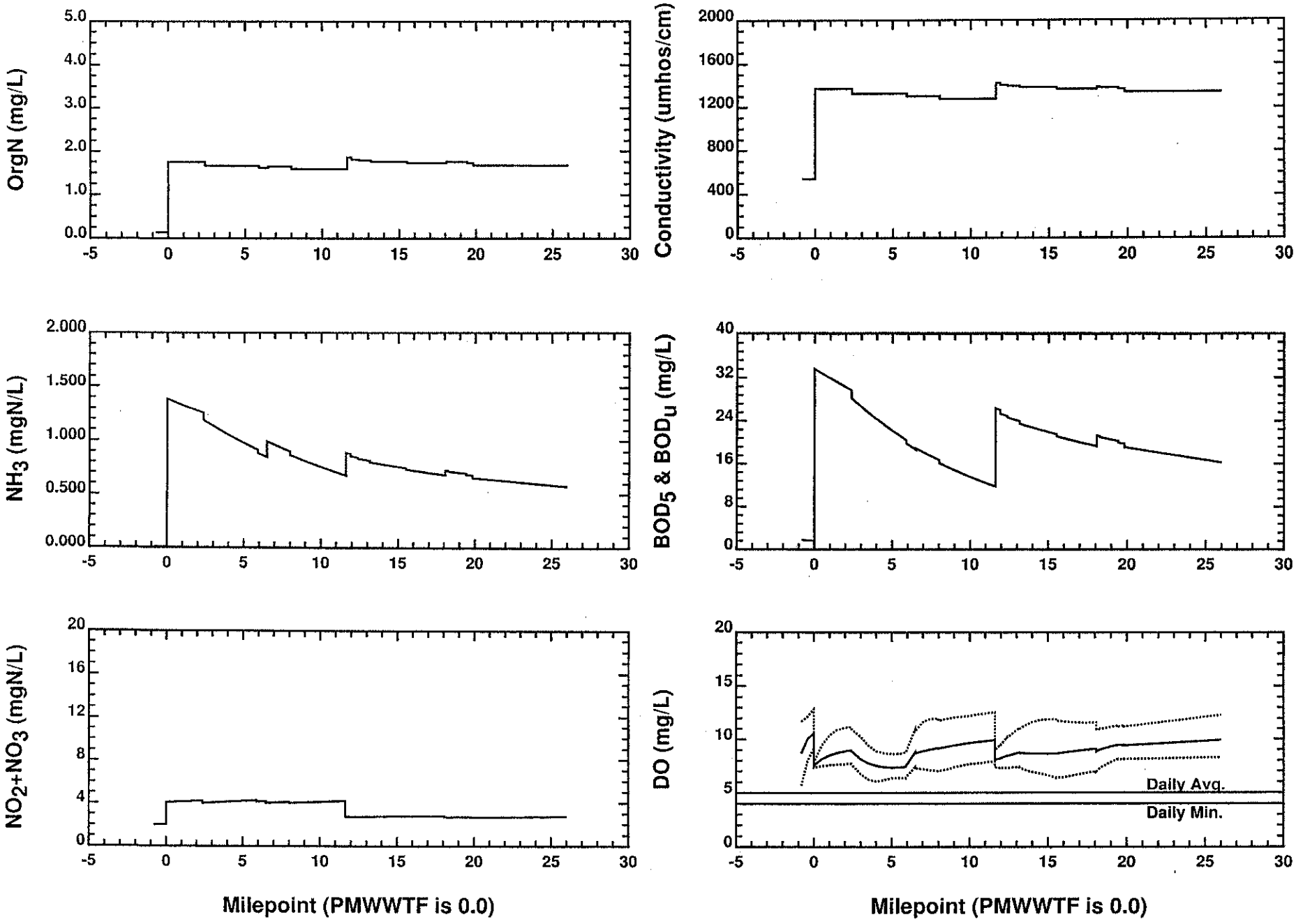

Tier 2 - Scenario 4

Figure . Opequon Creek Water Quality Projections

DATE: 2/23/2005 TIME: 13:33:51

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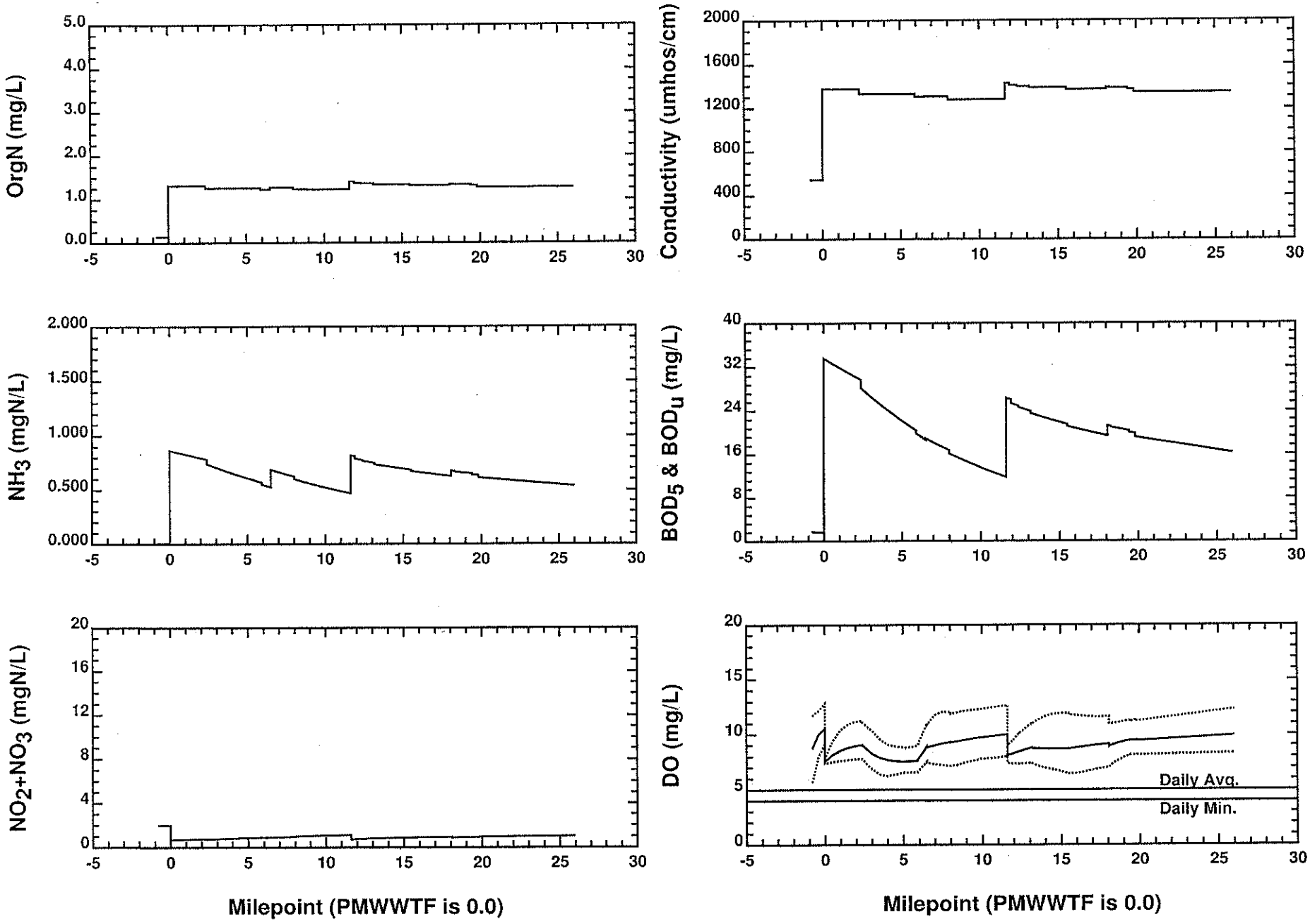


Tier 2 - Scenario 5

Figure . Opequon Creek Water Quality Projections

DATE: 2/23/2005 TIME: 13:33:53

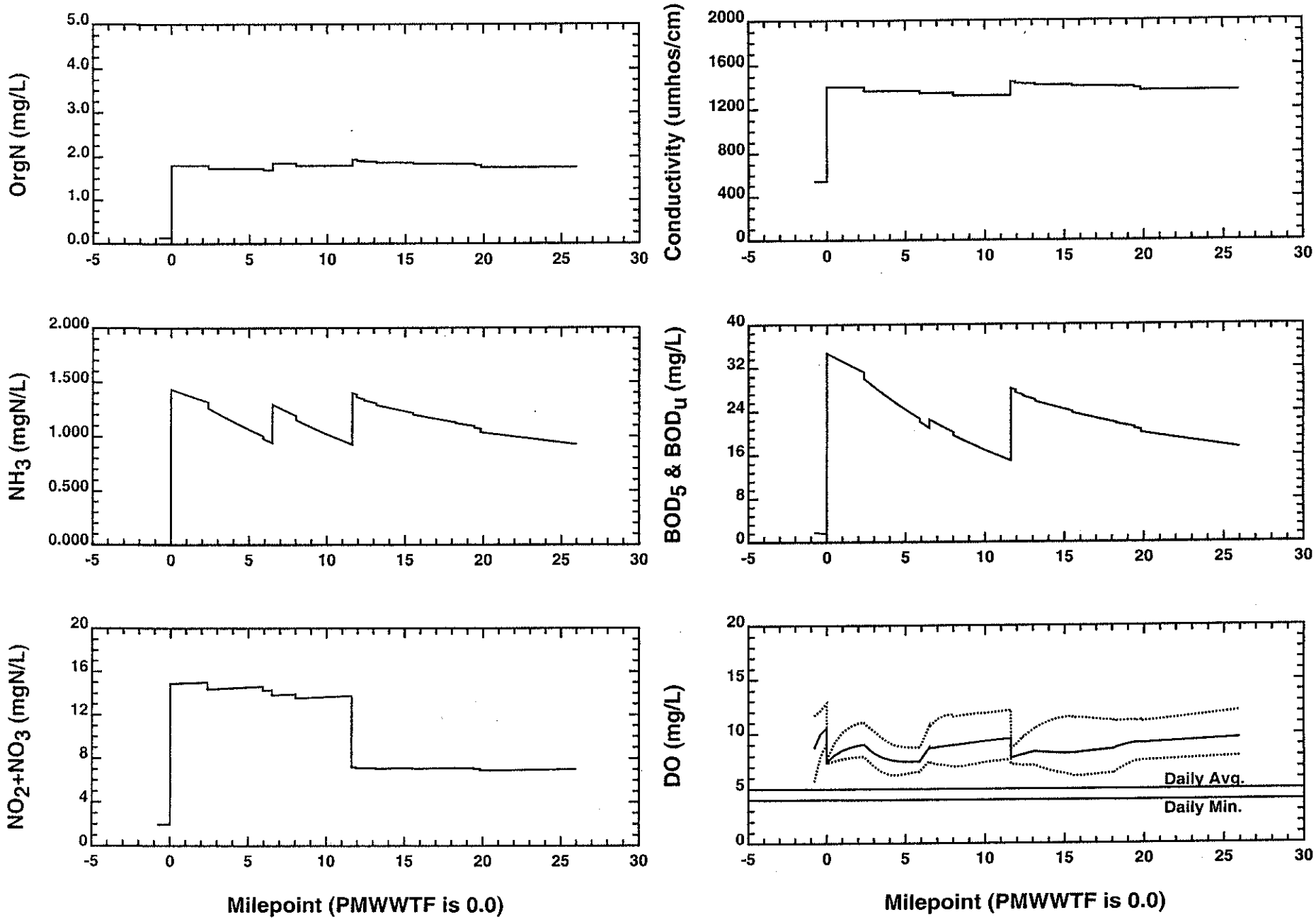
/usersm/obag0060/HEIDI/MODEL/PROJECTION/TIER2/t2s5.gdp

APPENDIX 4

TIER 3, SCENARIOS 1-5
CLOUDY CONDITIONS

HydroQual

Environmental
Engineers & Scientists



Tier 3 - Scenario 1

Figure . Opequon Creek Water Quality Projections

DATE: 3/14/2005 TIME: 9:24:38

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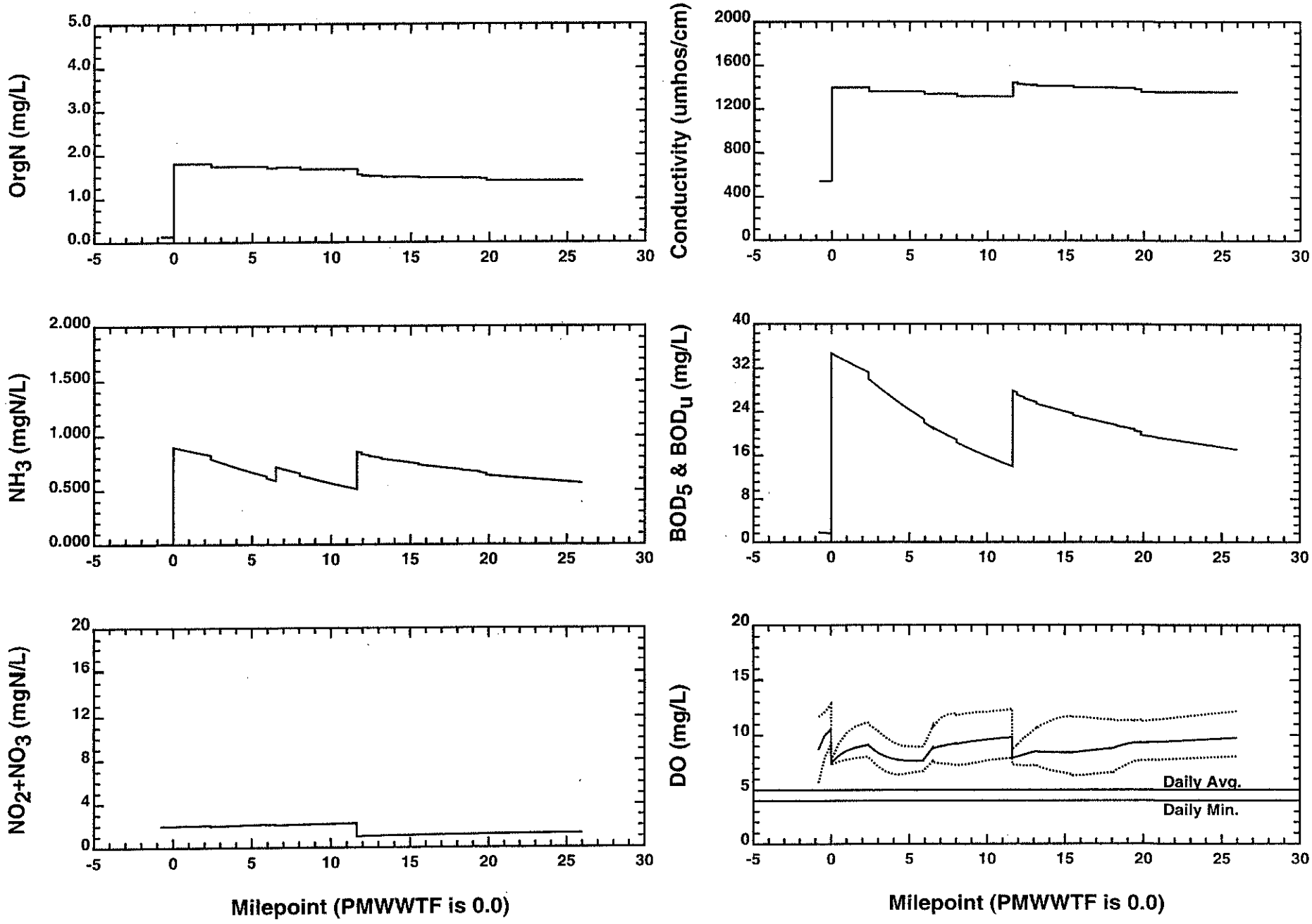

Tier 3 - Scenario 2

Figure . Opequon Creek Water Quality Projections

DATE: 3/14/2005 TIME: 9:25:10

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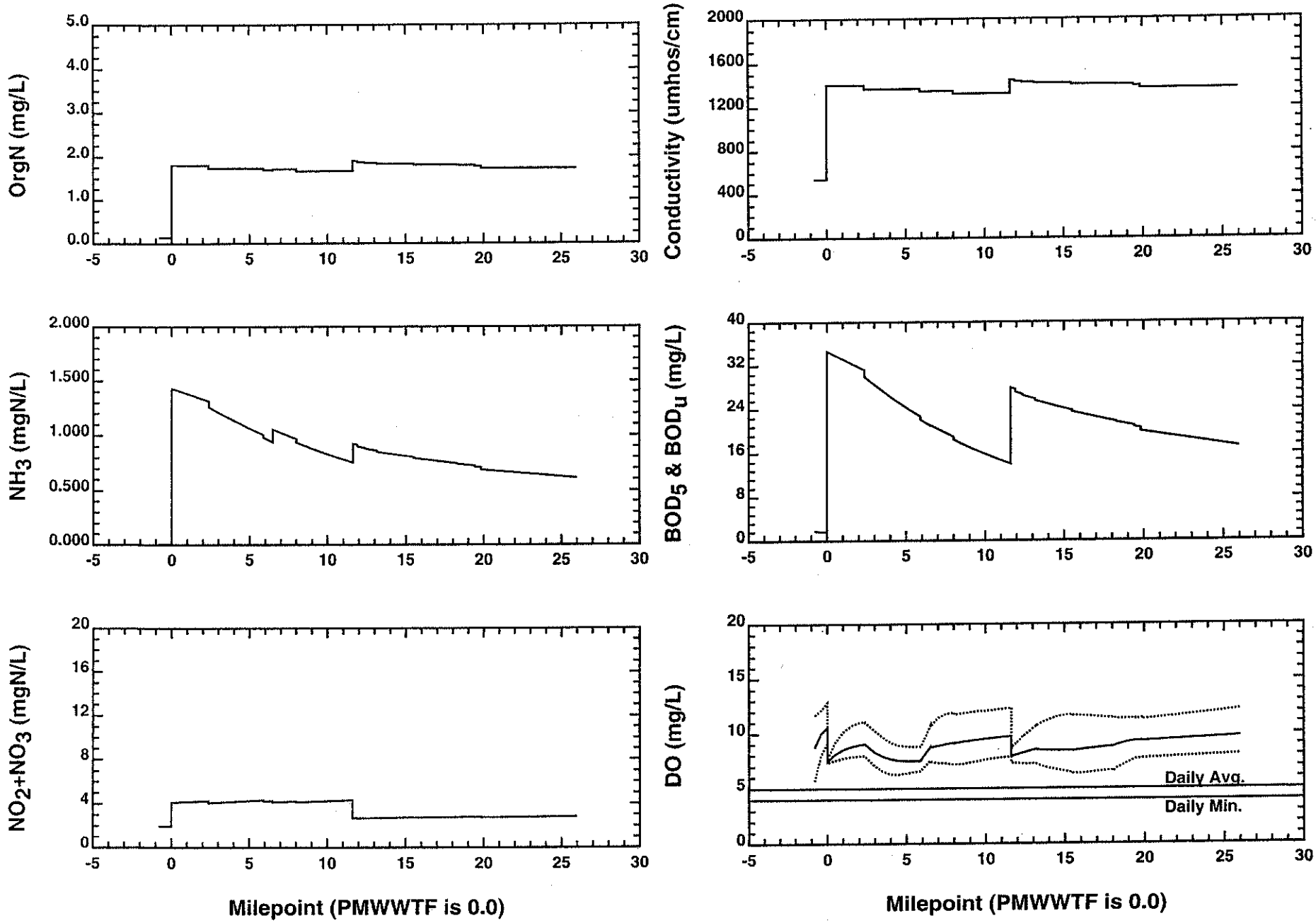

Tier 3 - Scenario 3

Figure . Opequon Creek Water Quality Projections

DATE: 3/14/2005 TIME: 9:25:12

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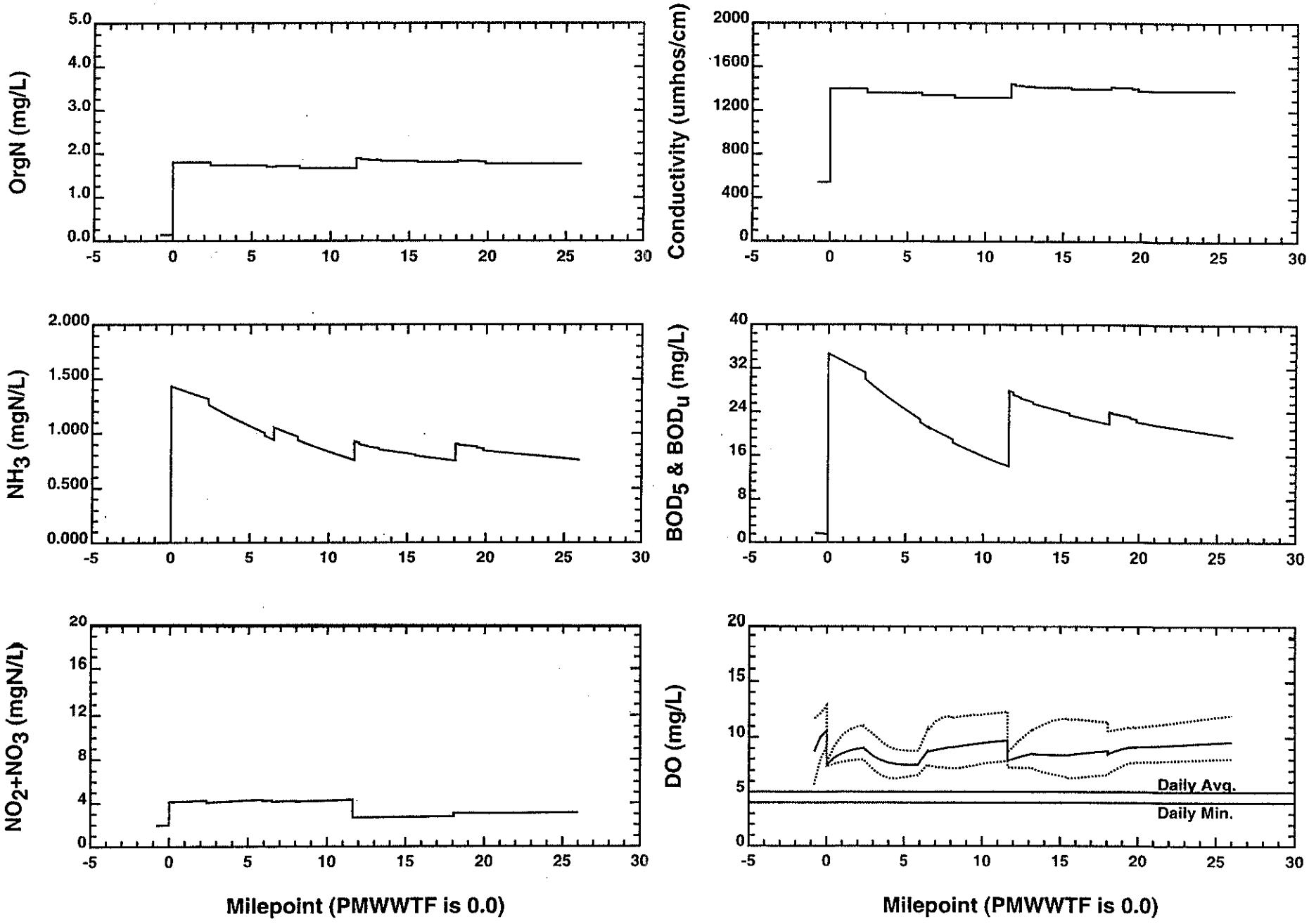

Tier 3 - Scenario 4

Figure . Opequon Creek Water Quality Projections

DATE: 3/14/2005 TIME: 9:25:15

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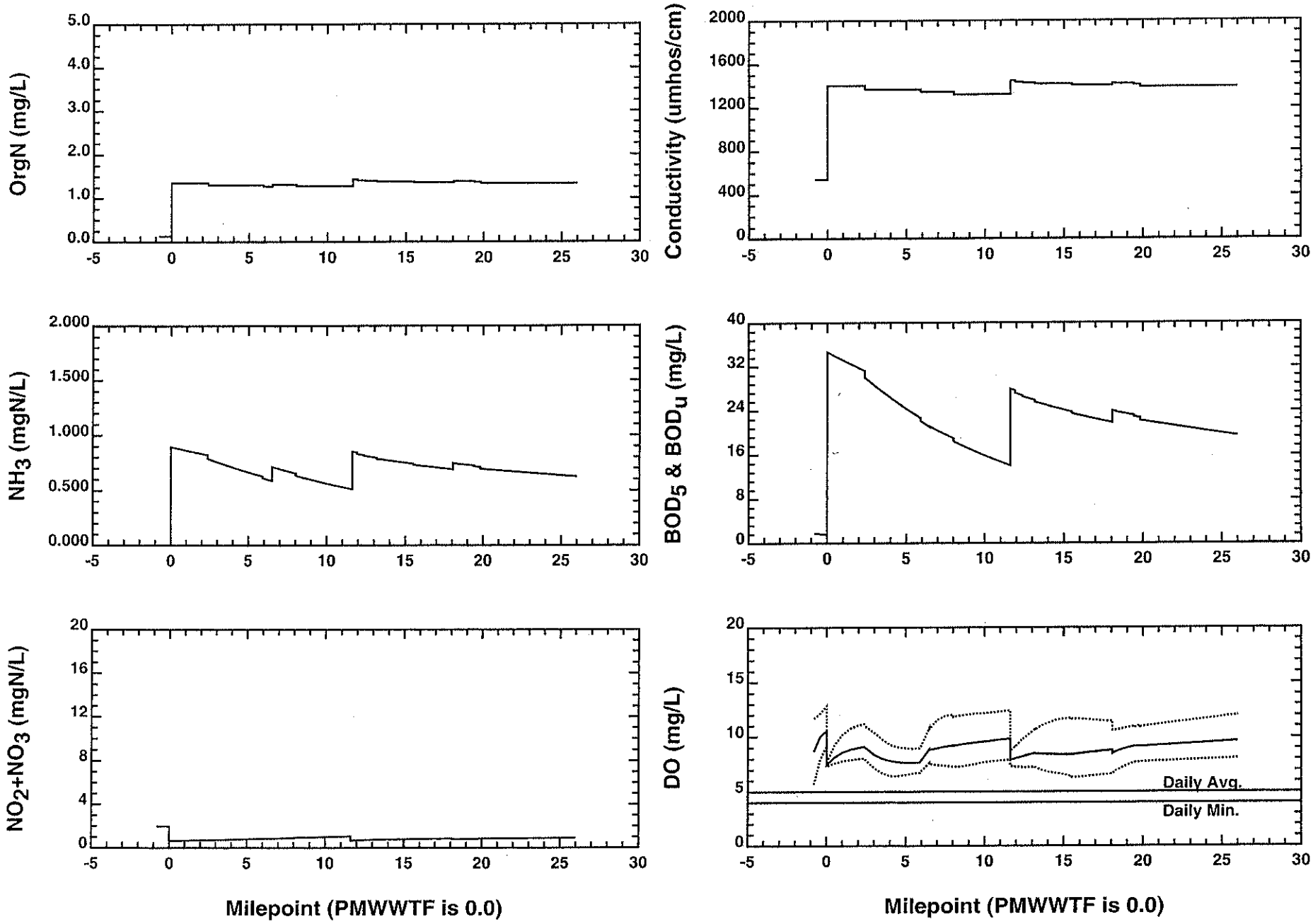


Tier 3 - Scenario 5

Figure . Opequon Creek Water Quality Projections

DATE: 3/14/2005 TIME: 9:25:16

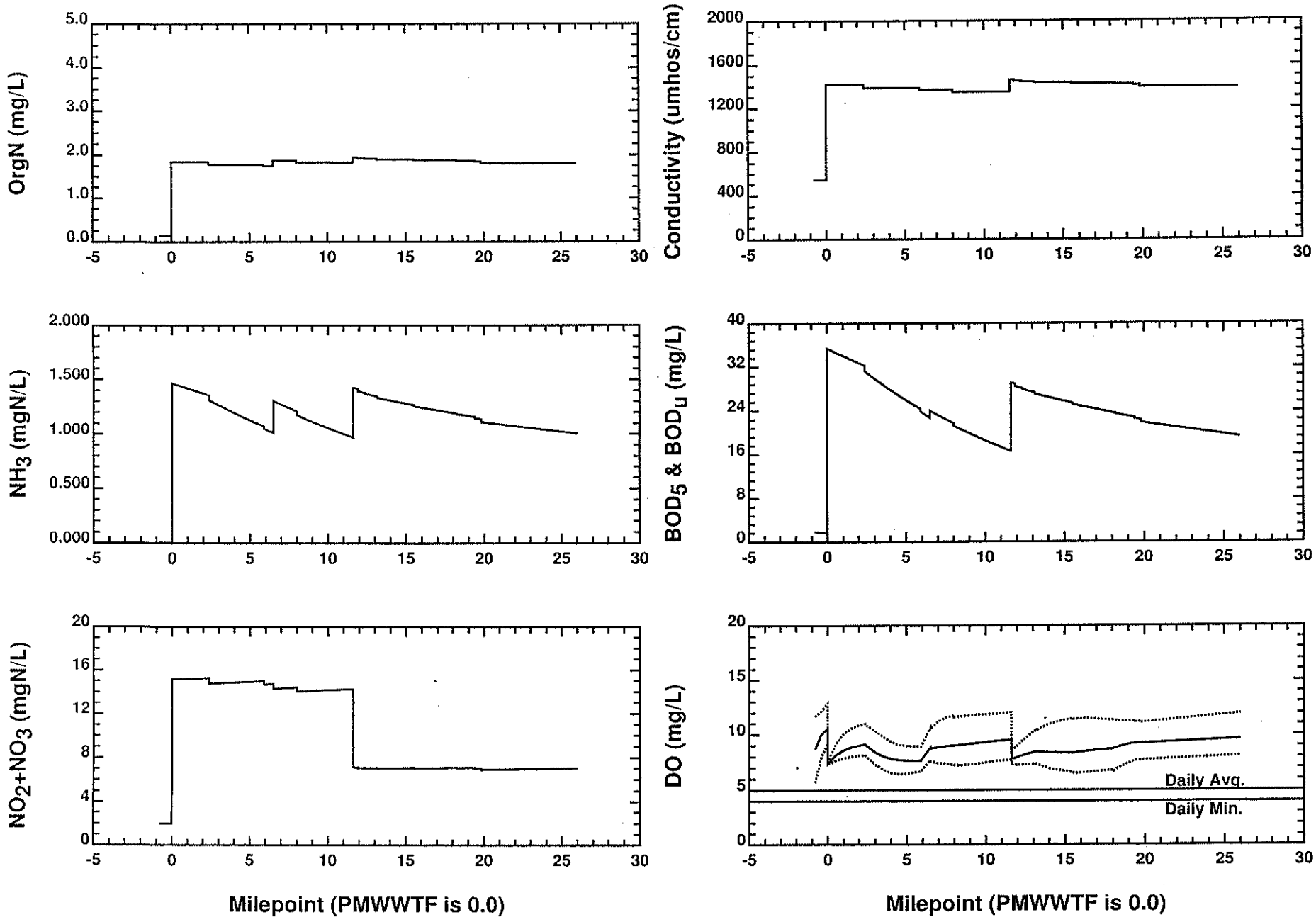
/usersm/obag0060/HEIDI/MODEL/PROJECTION/TIER3/t3s5.gdp

APPENDIX 5

TIER 4, SCENARIOS 1-5
CLOUDY CONDITIONS

HydroQual

Environmental
Engineers & Scientists

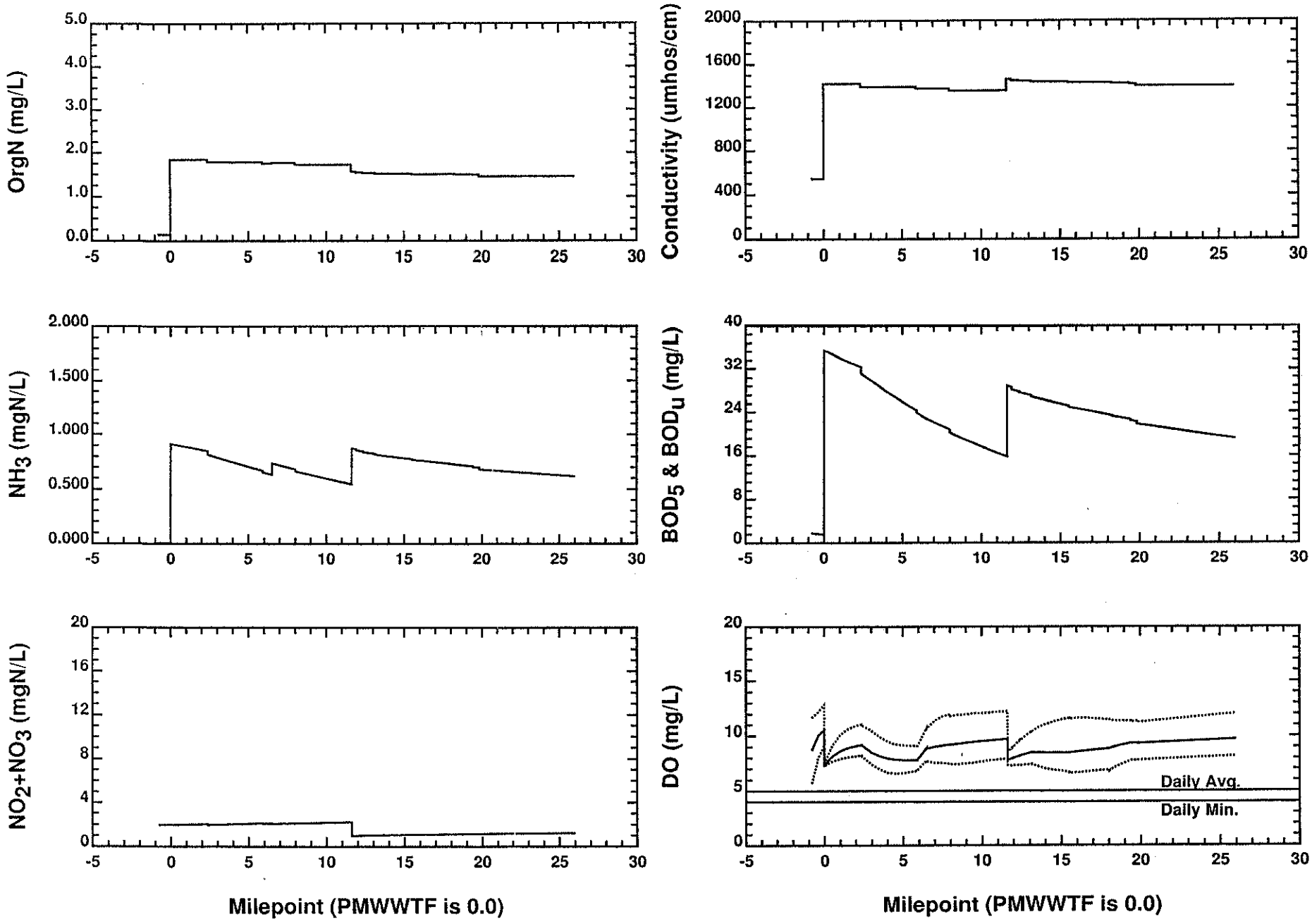


Tier 4 - Scenario 1 - Cloudy Day

Figure . Opequon Creek Water Quality Projections

DATE: 2/23/2005 TIME: 15:40:36

/usersm/obag0060/HEIDI/MODEL/PROJECTION/TIER4/CLOUDY/t

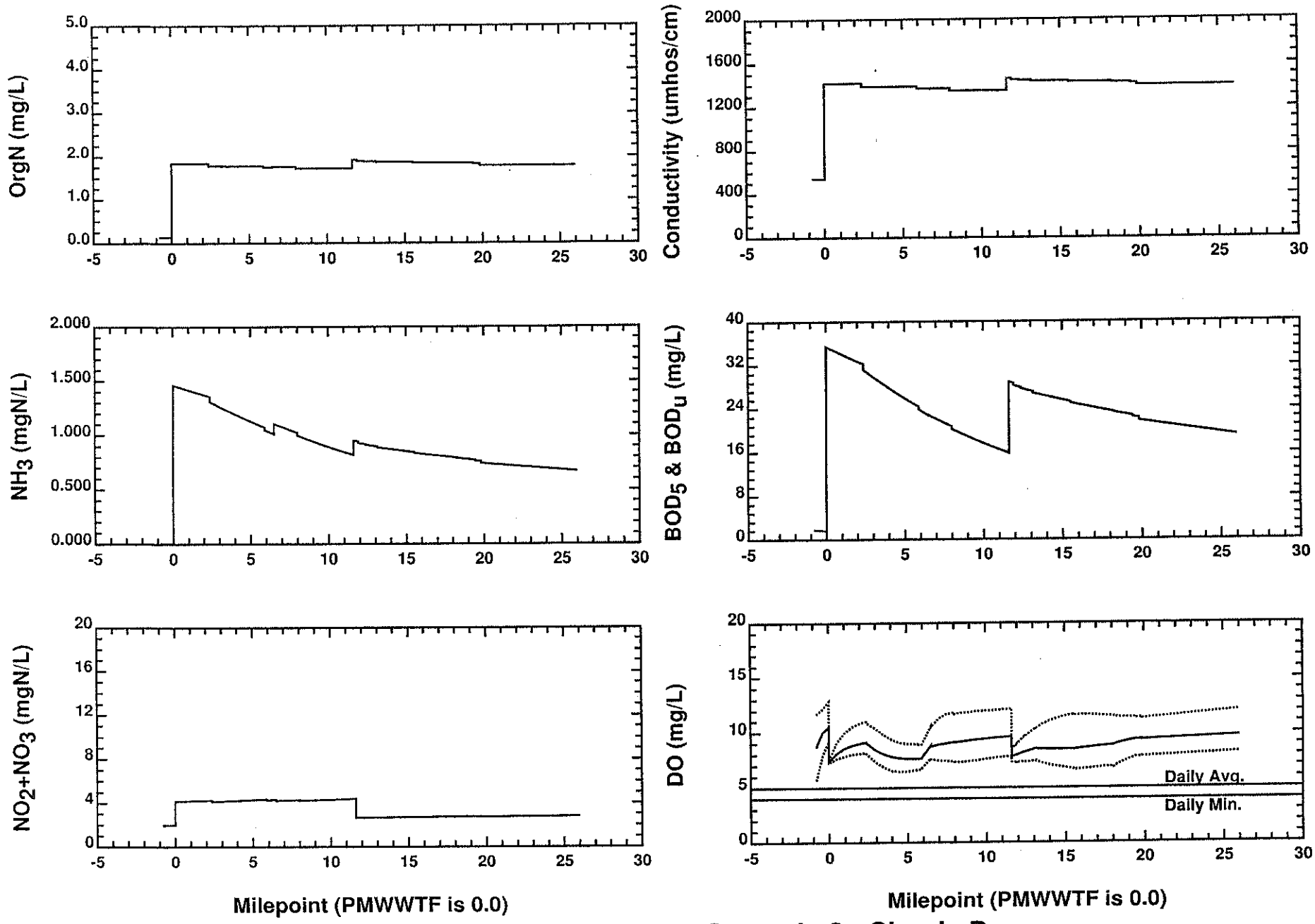


Tier 4 - Scenario 2 - Cloudy Day

Figure . Opequon Creek Water Quality Projections

DATE: 2/23/2005 TIME: 15:40:40

/usersm/obag0060/HEIDI/MODEL/PROJECTION/TIER4/CLOUDY/

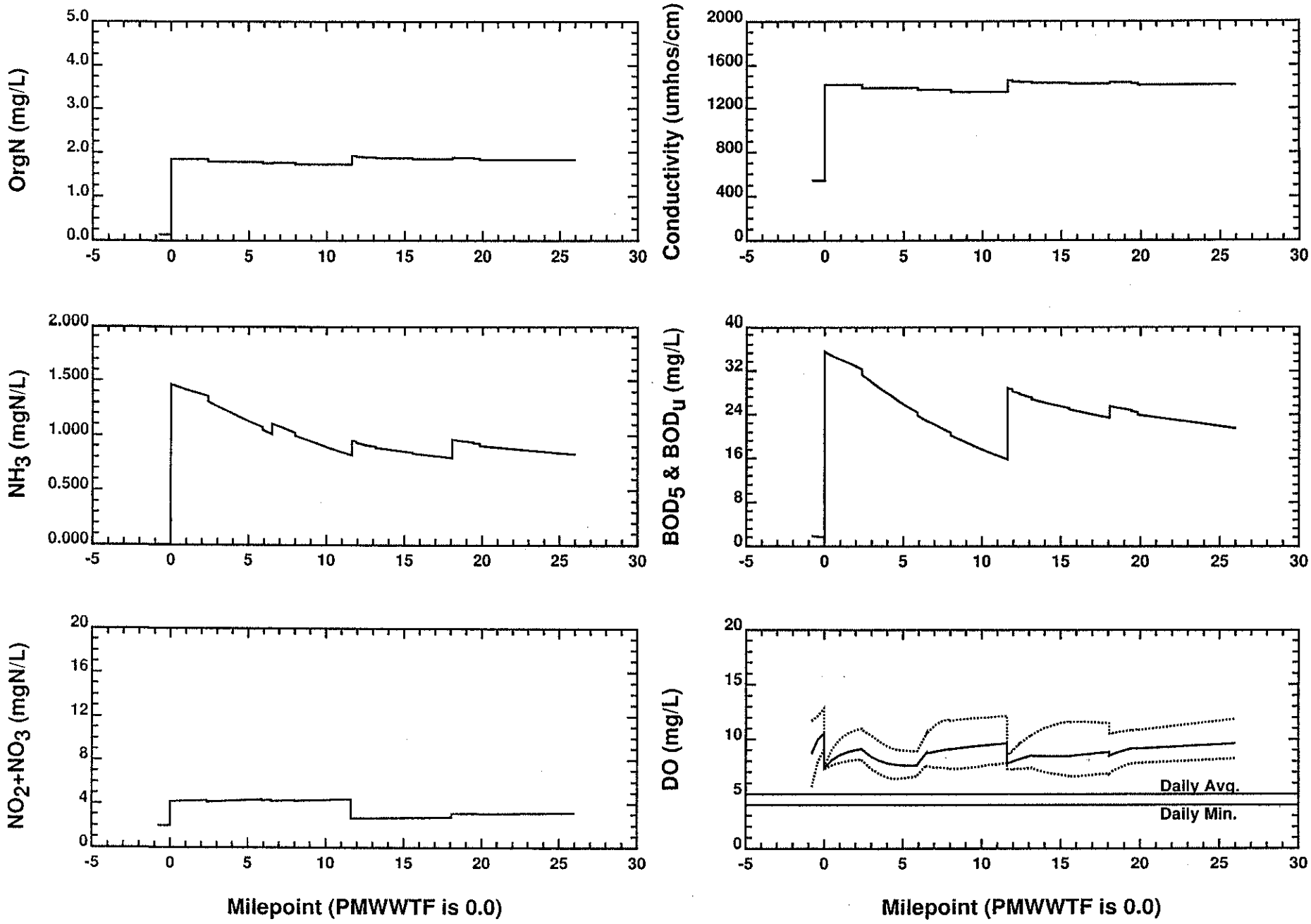


Tier 4 - Scenario 3 - Cloudy Day

Figure . Opequon Creek Water Quality Projections

DATE: 2/23/2005 TIME: 15:40:42

/usersm/obag0060/HEIDI/MODEL/PROJECTION/TIER4/CLOUDY/t

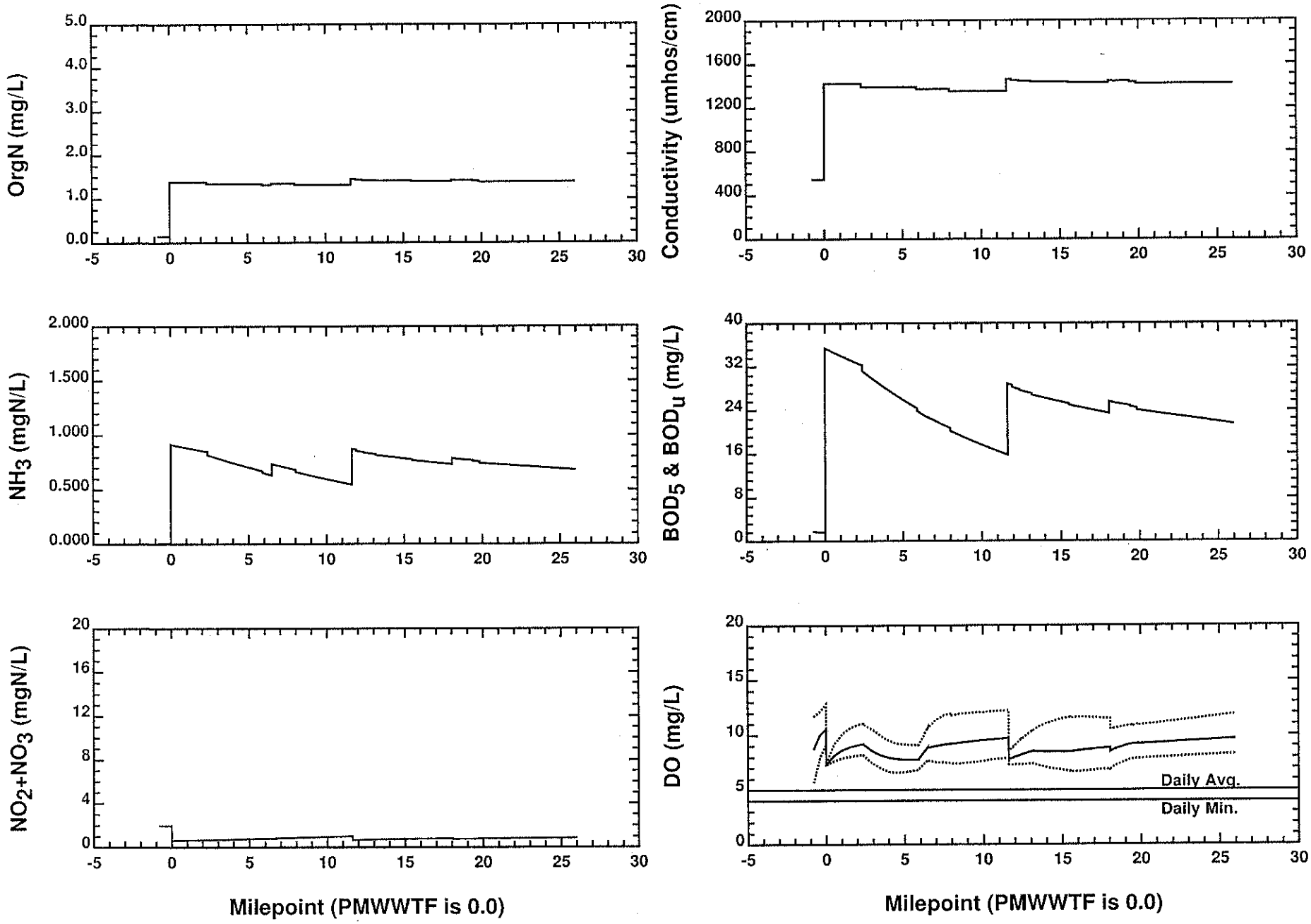


Tier 4 - Scenario 4 - Cloudy Day

Figure . Opequon Creek Water Quality Projections

DATE: 2/23/2005 TIME: 15:40:45

/usersm/obag0060/HEIDI/MODEL/PROJECTION/TIER4/CLOUDY/t



Tier 4 - Scenario 5 - Cloudy Day

Figure . Opequon Creek Water Quality Projections

DATE: 2/23/2005 TIME: 15:40:48

/usersm/obag0060/HEIDI/MODEL/PROJECTION/TIER4/CLOUDY/t

APPENDIX 6

TIER 1, SCENARIOS 1-5
SUNNY CONDITIONS

HydroQual

Environmental
Engineers & Scientists

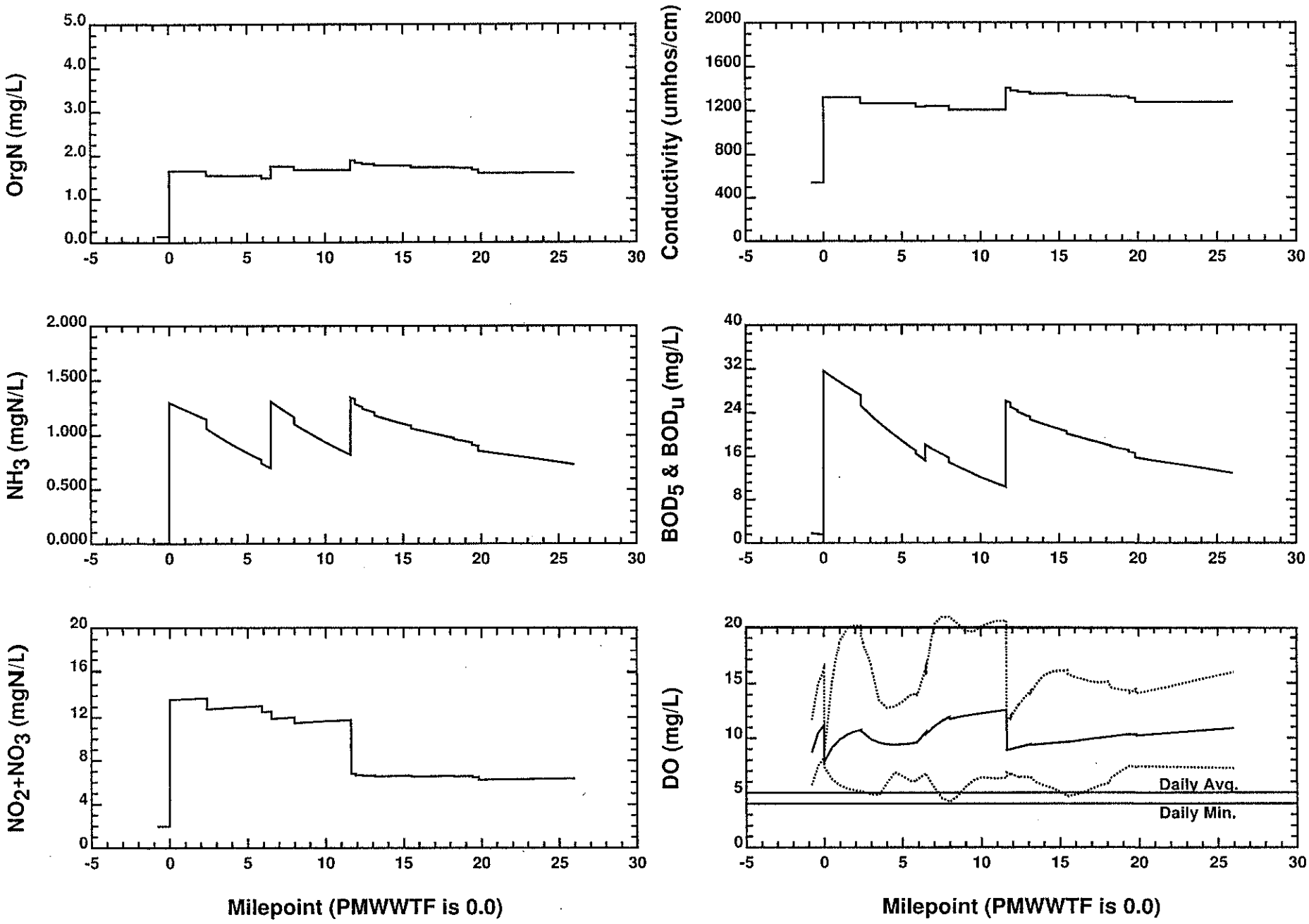


Figure . Opequon Creek Water Quality Projections Tier 1 - Scenario 1
Change Pmax in seg 4 and 5

DATE: 2/23/2005 TIME: 9:38:45

/usersm/obag0060/HEIDI/MODEL/PROJECTION/TIER1/t1s1.gdp

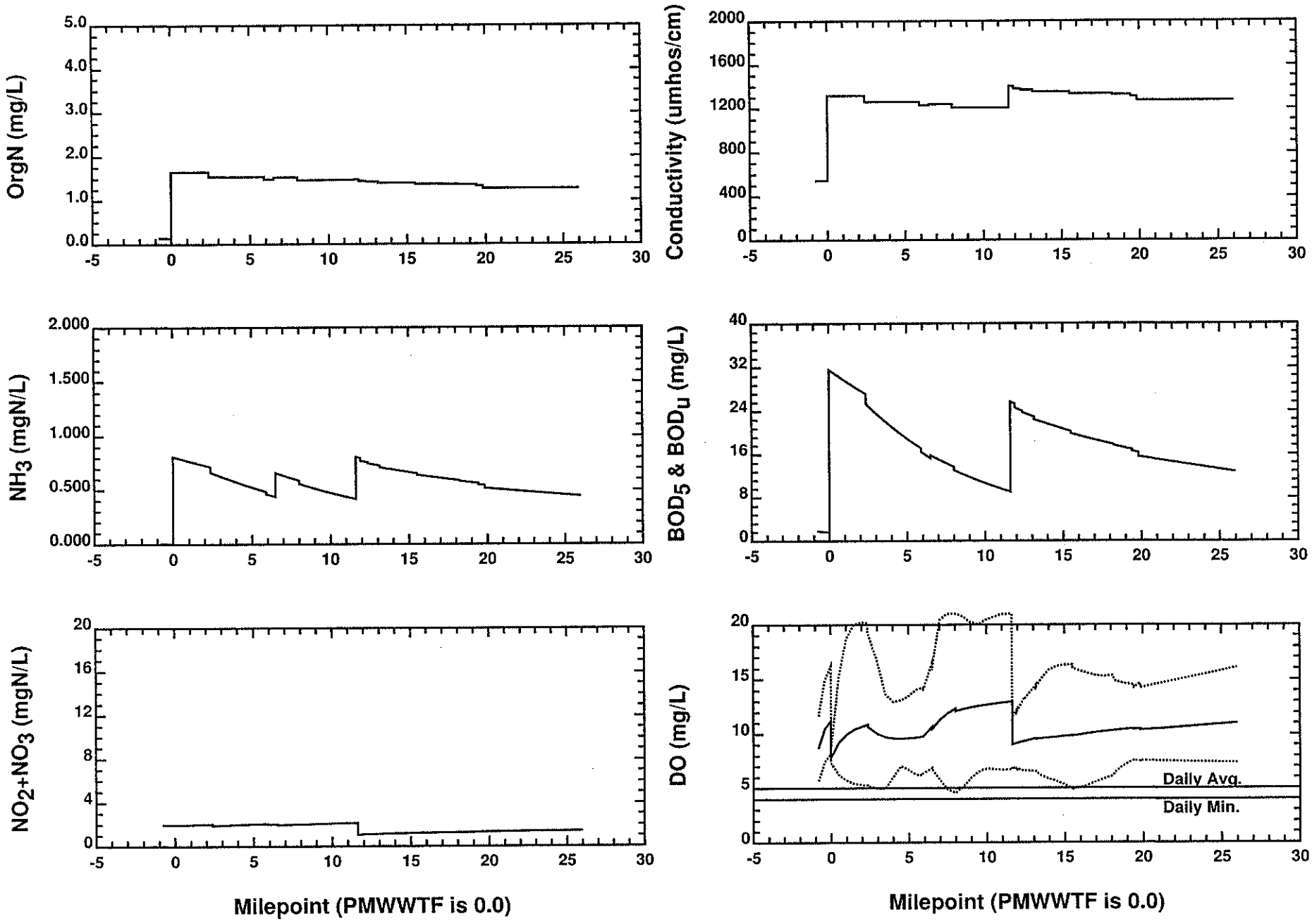


Figure Proposed Segment Water Quality Projections Tier 1 - Scenario 2

DATE: 2/23/2005 TIME: 9:38:48

/usersm/obag0060/HEIDI/MODEL/PROJECTION/TIER1/t1s2.gdp

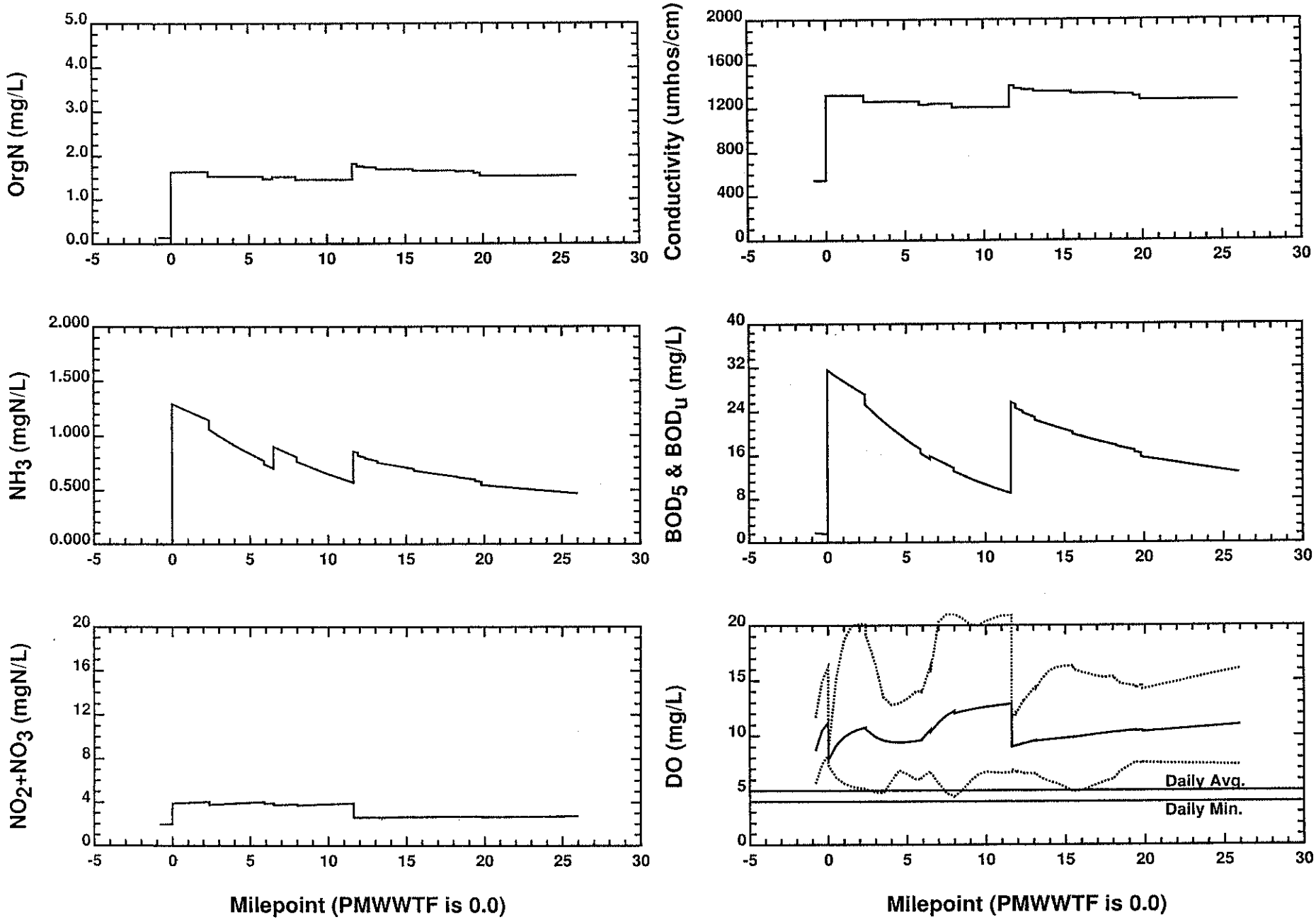


Figure . Opequon Creek Water Quality Projections Tier 1 - Scenario 3
Change Pmax in Seg 4 and 5

DATE: 2/23/2005 TIME: 9:38:53

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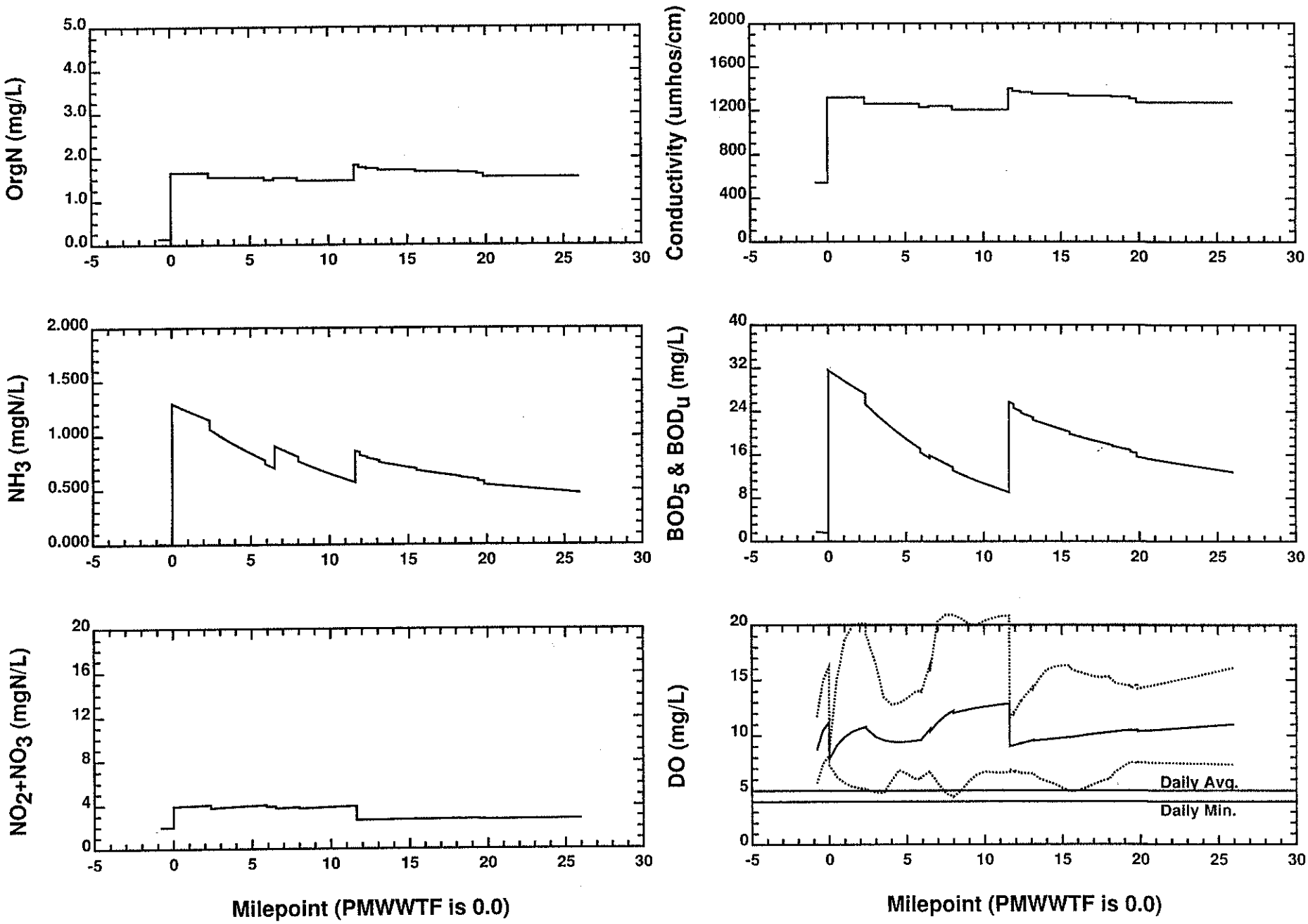


Figure . Opequon Creek Water Quality Projections Tier 1 - Scenario 4
Change Pmax in Seg 4 and 5

DATE: 2/23/2005 TIME: 9:32: 5

/usersm/obag0060/HEIDI/MODEL/PROJECTION/TIER1/t1s4.gdp

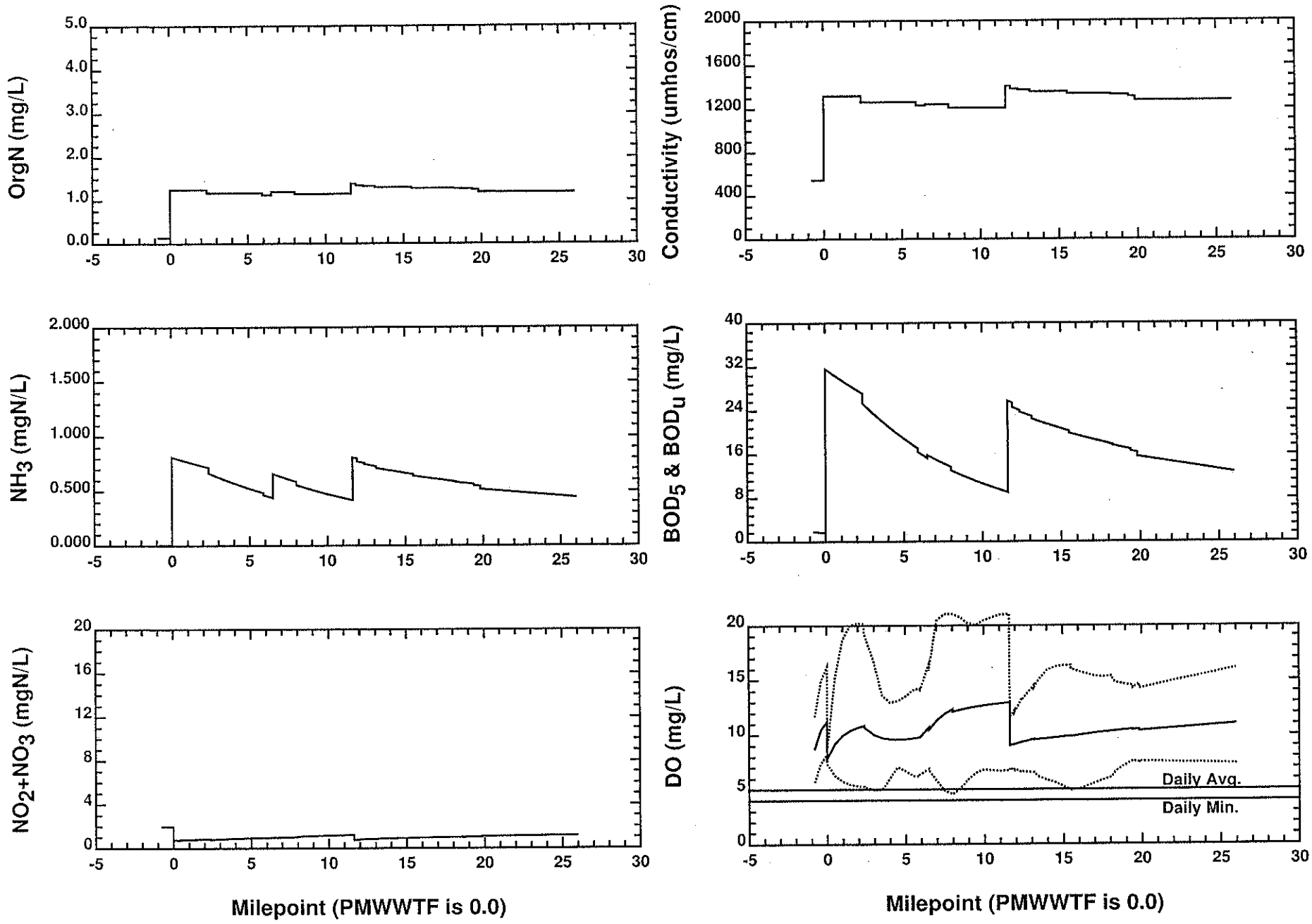


Figure . Opequon Creek Water Quality Projections Tier 1 - Scenario 5
Change Pmax in Seg 4 and 5

DATE: 2/23/2005 TIME: 9:38:27

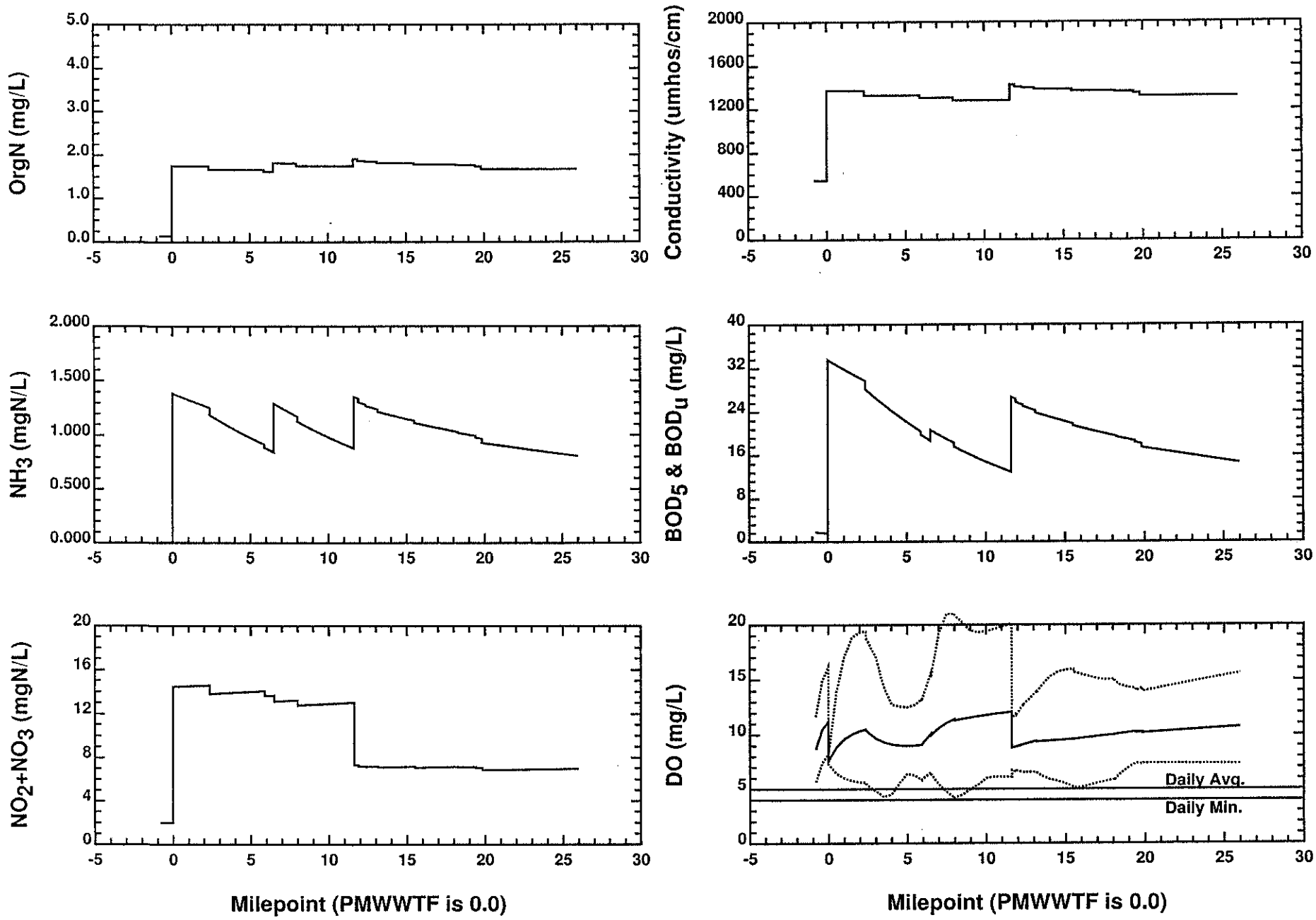
/usersm/obag0060/HEIDI/MODEL/PROJECTION/TIER1/t1s5.gdp

APPENDIX 7

TIER 2, SCENARIOS 1-5
SUNNY CONDITIONS

HydroQual

Environmental
Engineers & Scientists

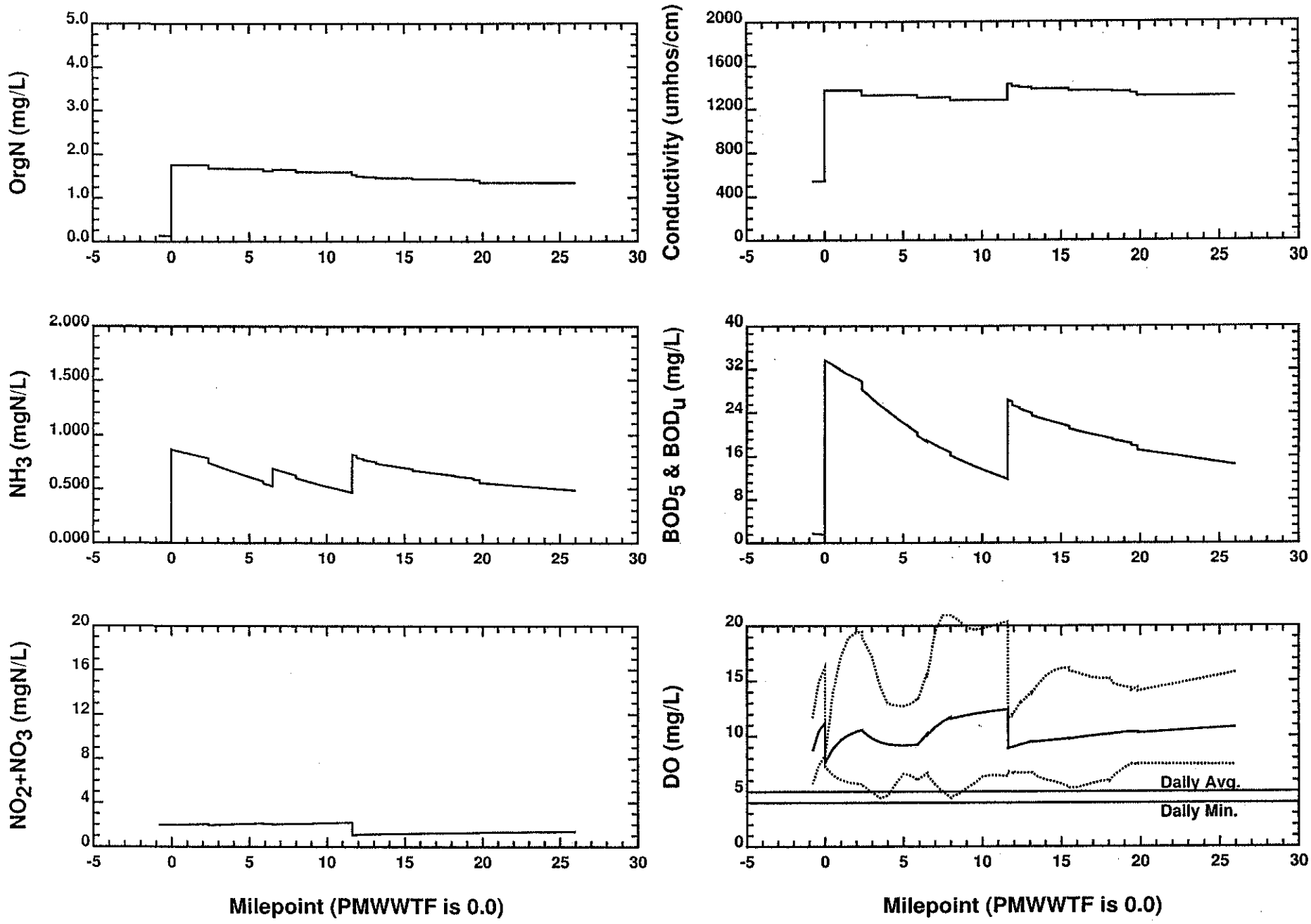


Tier 2 - Scenario 1 - Sunny Day

Figure . Opequon Creek Water Quality Projections

DATE: 2/23/2005 TIME: 14: 2:42

/usersm/obag0060/HEIDI/MODEL/PROJECTION/TIER2/SUNNYB/t

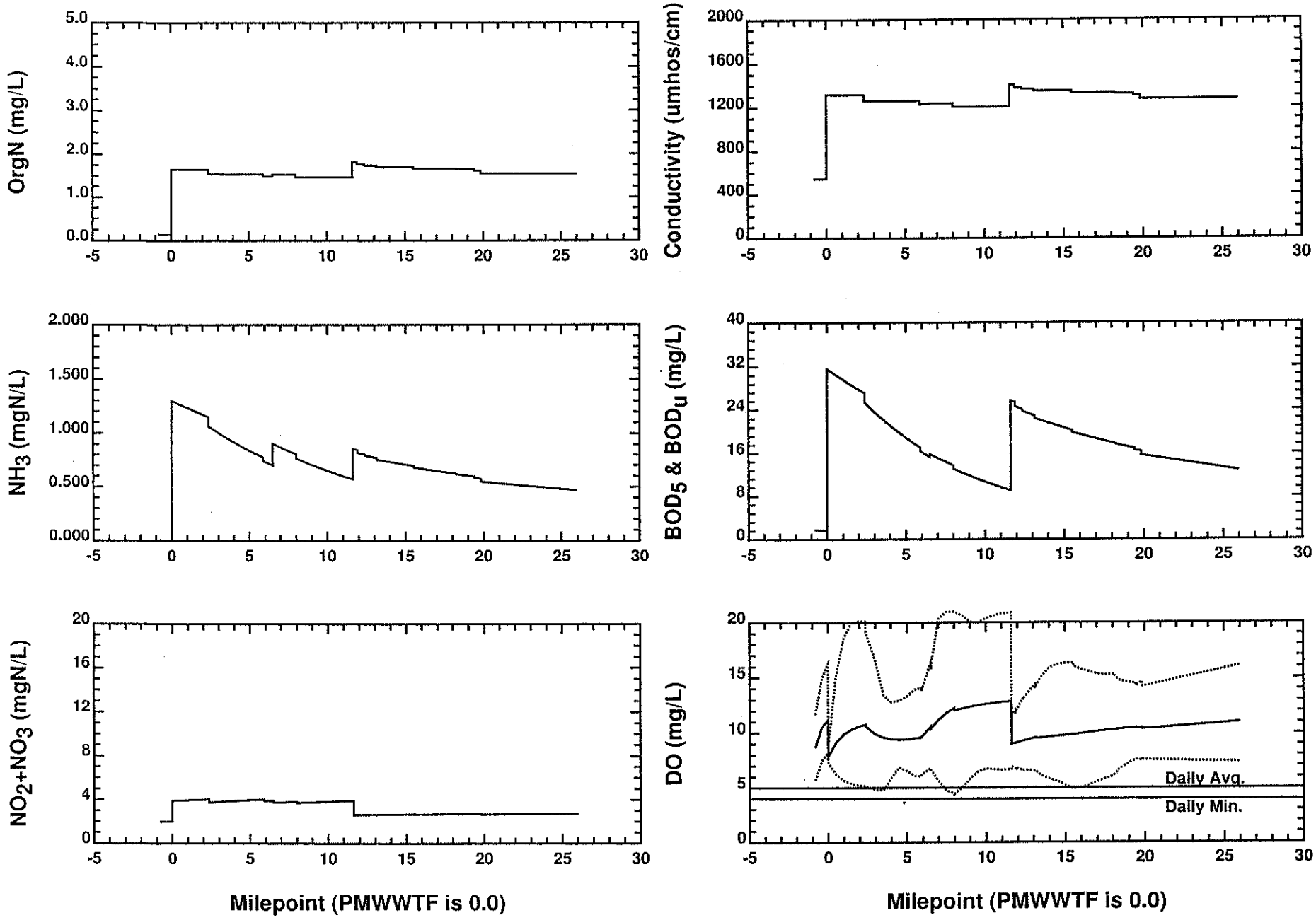


Tier 2 - Scenario 2 - Sunny Day

Figure . Opequon Creek Water Quality Projections

DATE: 2/23/2005 TIME: 14: 2:45

/usersm/ohao0060/HEIDI/MODEL/PROJECTION/TIER2/SUNNYR/t

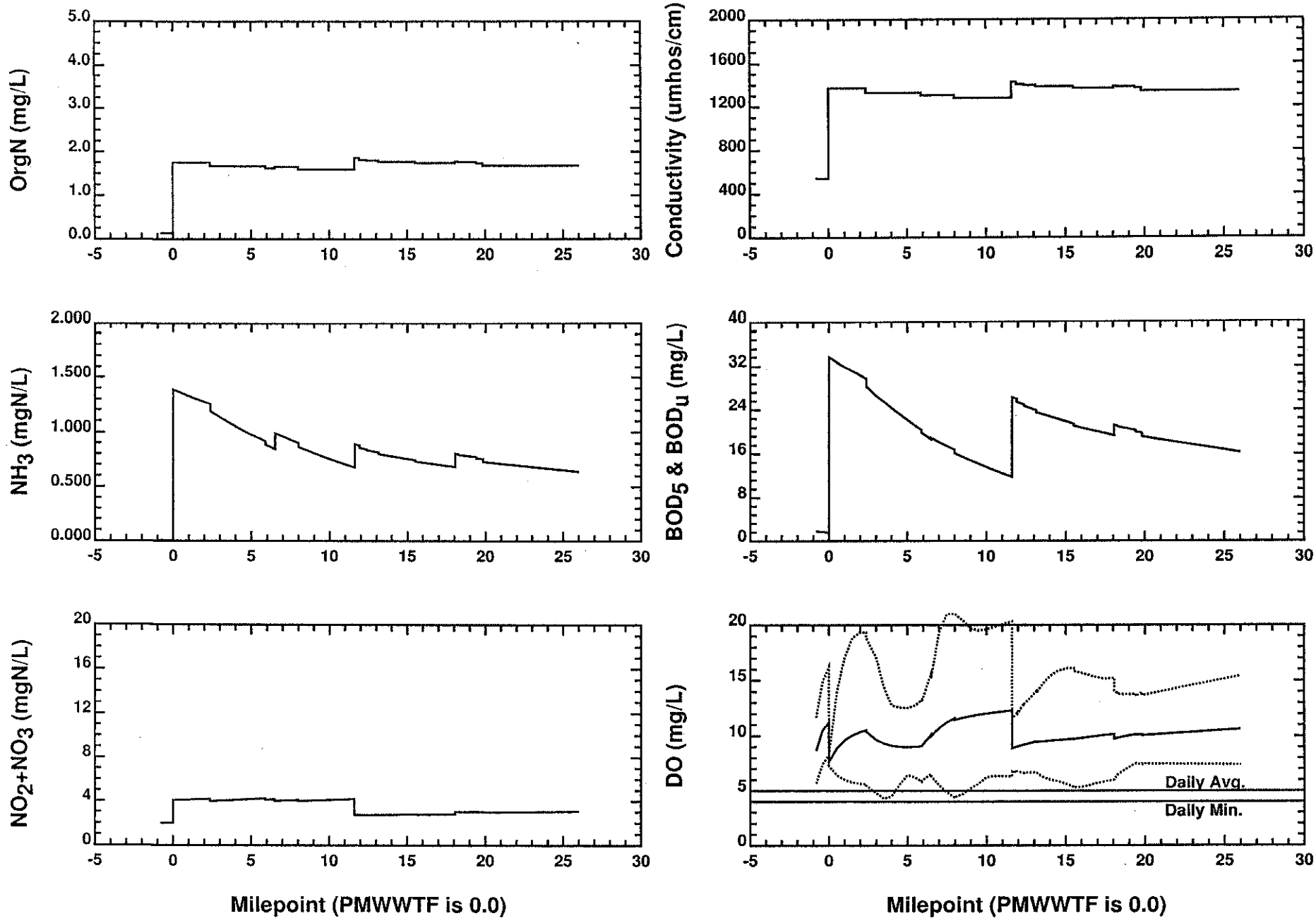


Tier 2 - Scenario 3 - Sunny Day

Figure . Opequon Creek Water Quality Projections

DATE: 2/23/2005 TIME: 14: 2:47

/usersm/obag0060/HEIDI/MODEL/PROJECTION/TIER2/SUNNYB/t

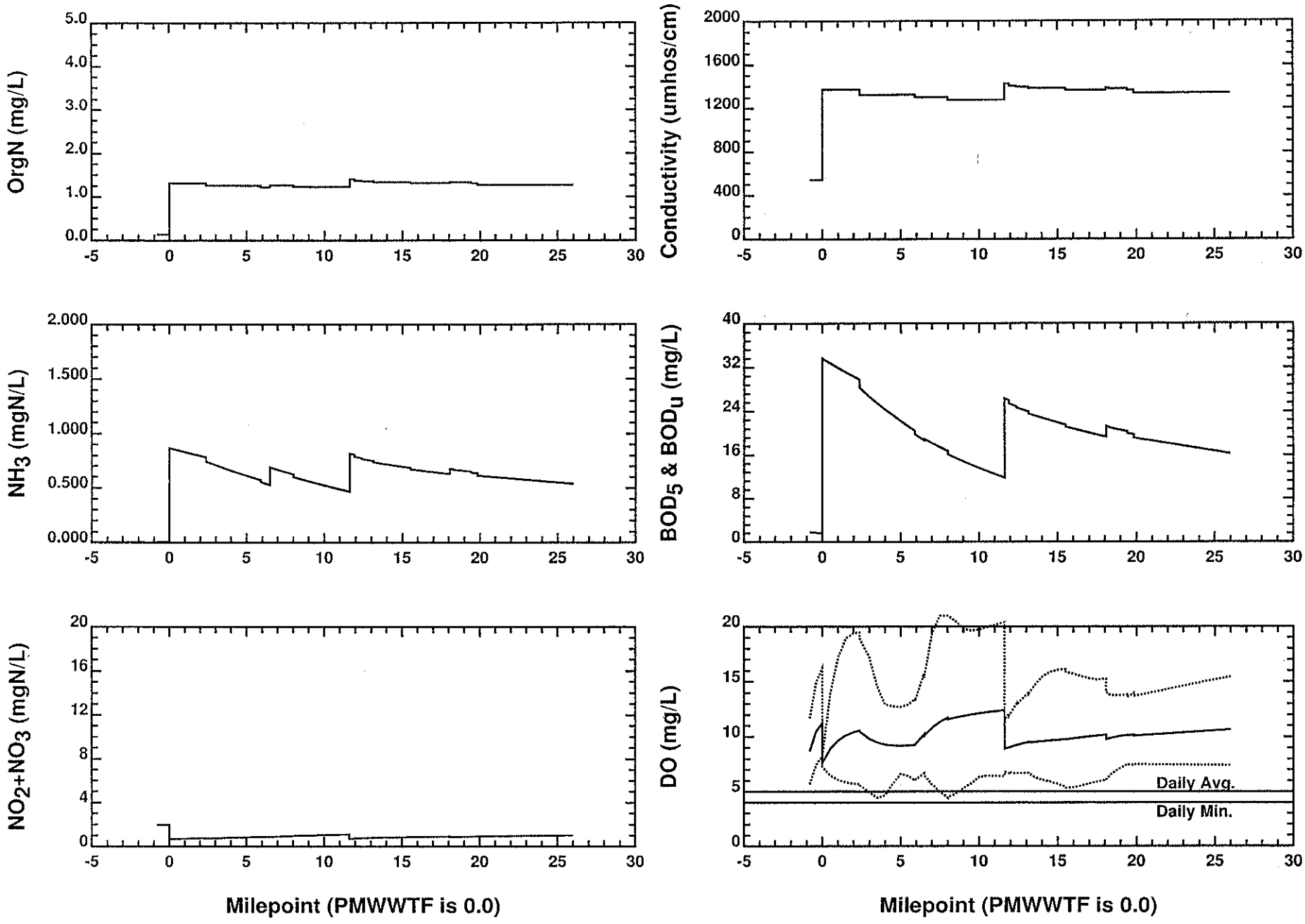


Tier 2 - Scenario 4 - Sunny Day

Figure . Opequon Creek Water Quality Projections

DATE: 2/23/2005 TIME: 14: 2:50

/usersm/pbap0060/HEIDI/MODEL/PROJECTION/TIER2/SUNNYB/t



Tier 2 - Scenario 5 - Sunny Day

Figure . Opequon Creek Water Quality Projections

DATE: 2/23/2005 TIME: 14: 2:53

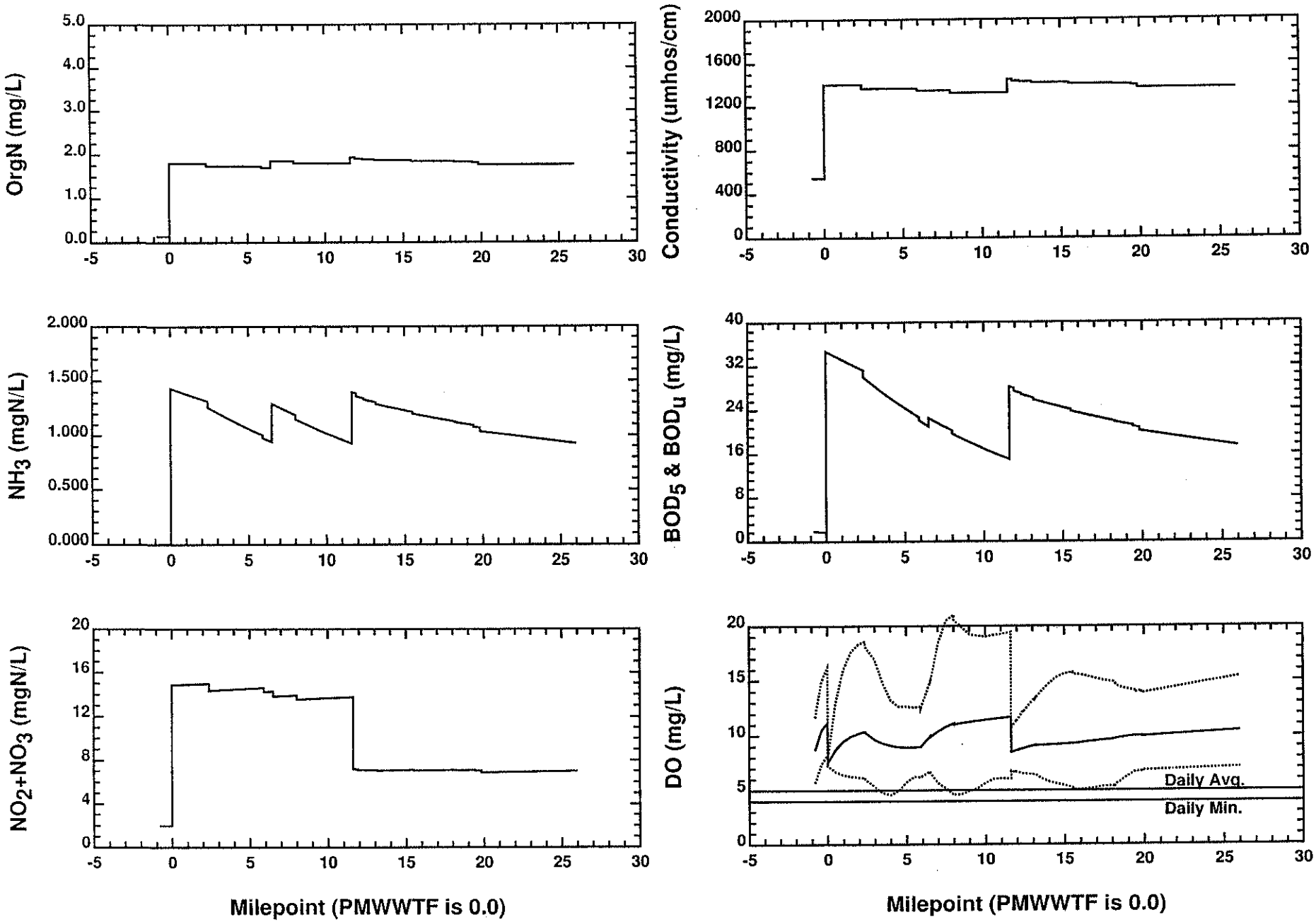
/usersm/obag0060/HEIDI/MODEL/PROJECTION/TIER2/SUNNY_B/

APPENDIX 8

TIER 3, SCENARIOS 1-5
SUNNY CONDITIONS

HydroQual

Environmental
Engineers & Scientists

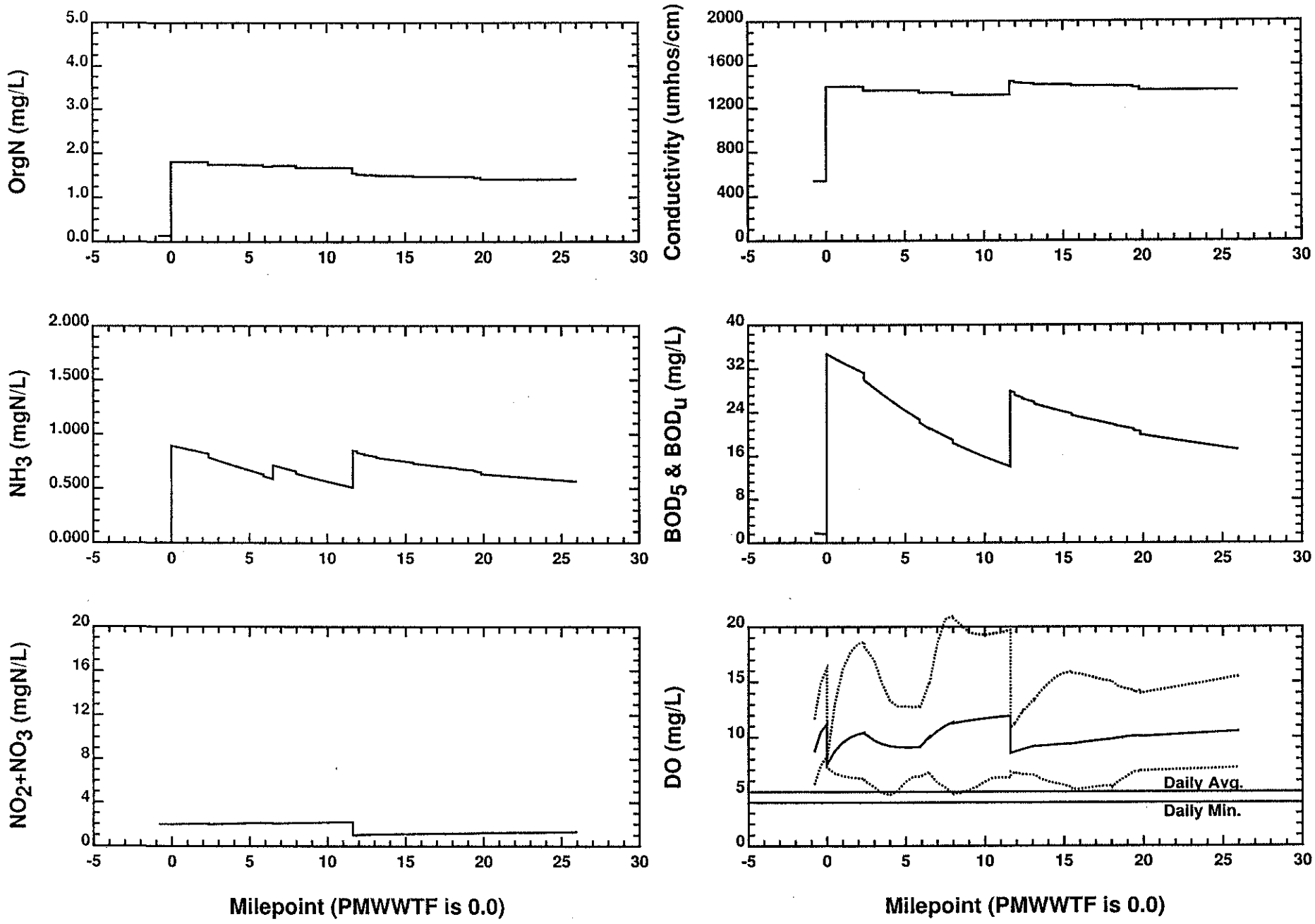


Tier 3 - Scenario 1 - Sunny Day

Figure . Opequon Creek Water Quality Projections

DATE: 2/23/2005 TIME: 14:50:32

/usersm/obag0060/HEIDI/MODEL/PROJECTION/TIER3/SUNNYB/t:



Tier 3 - Scenario 2 - Sunny Day

Figure . Opequon Creek Water Quality Projections

DATE: 2/23/2005 TIME: 14:50:35

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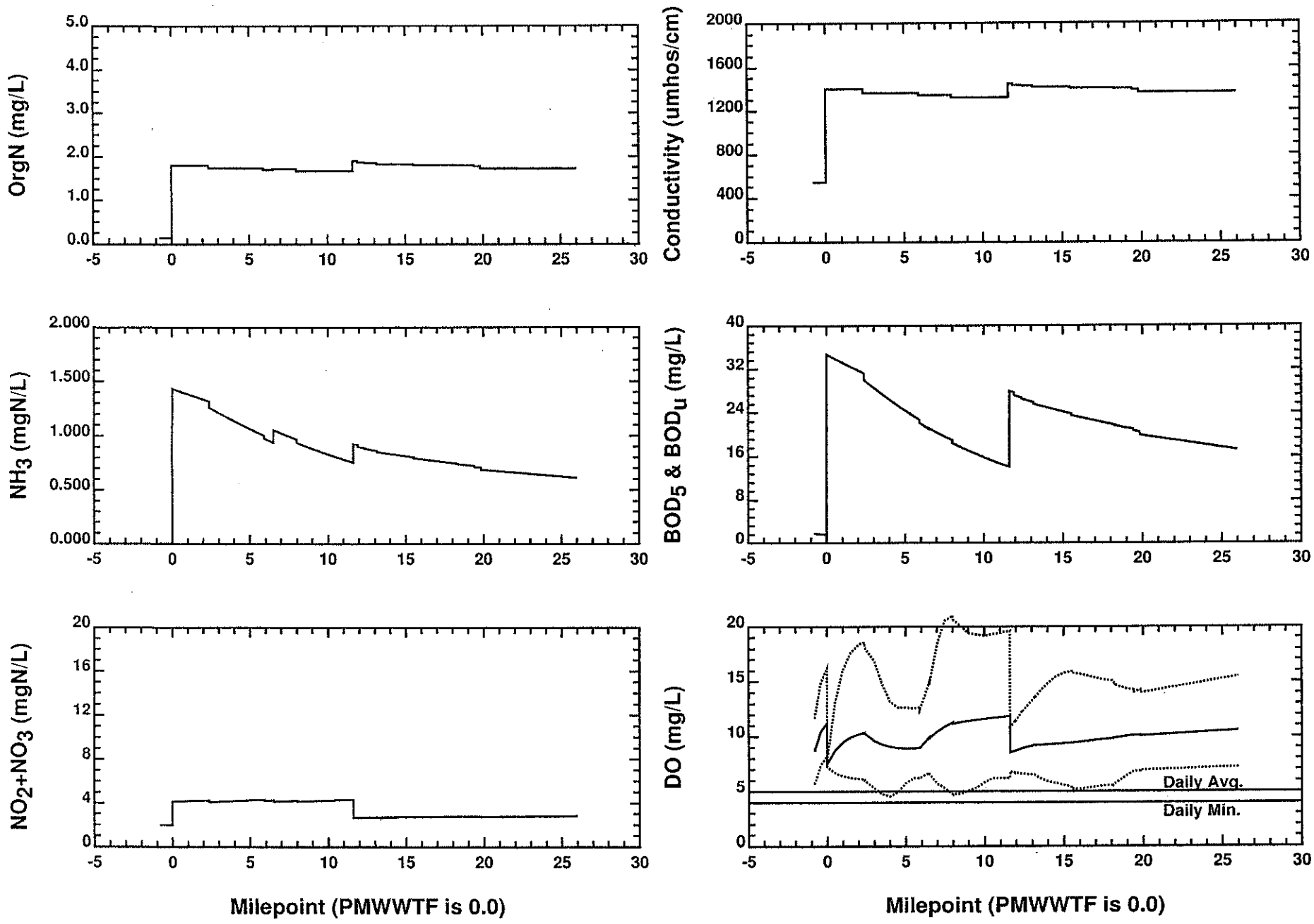
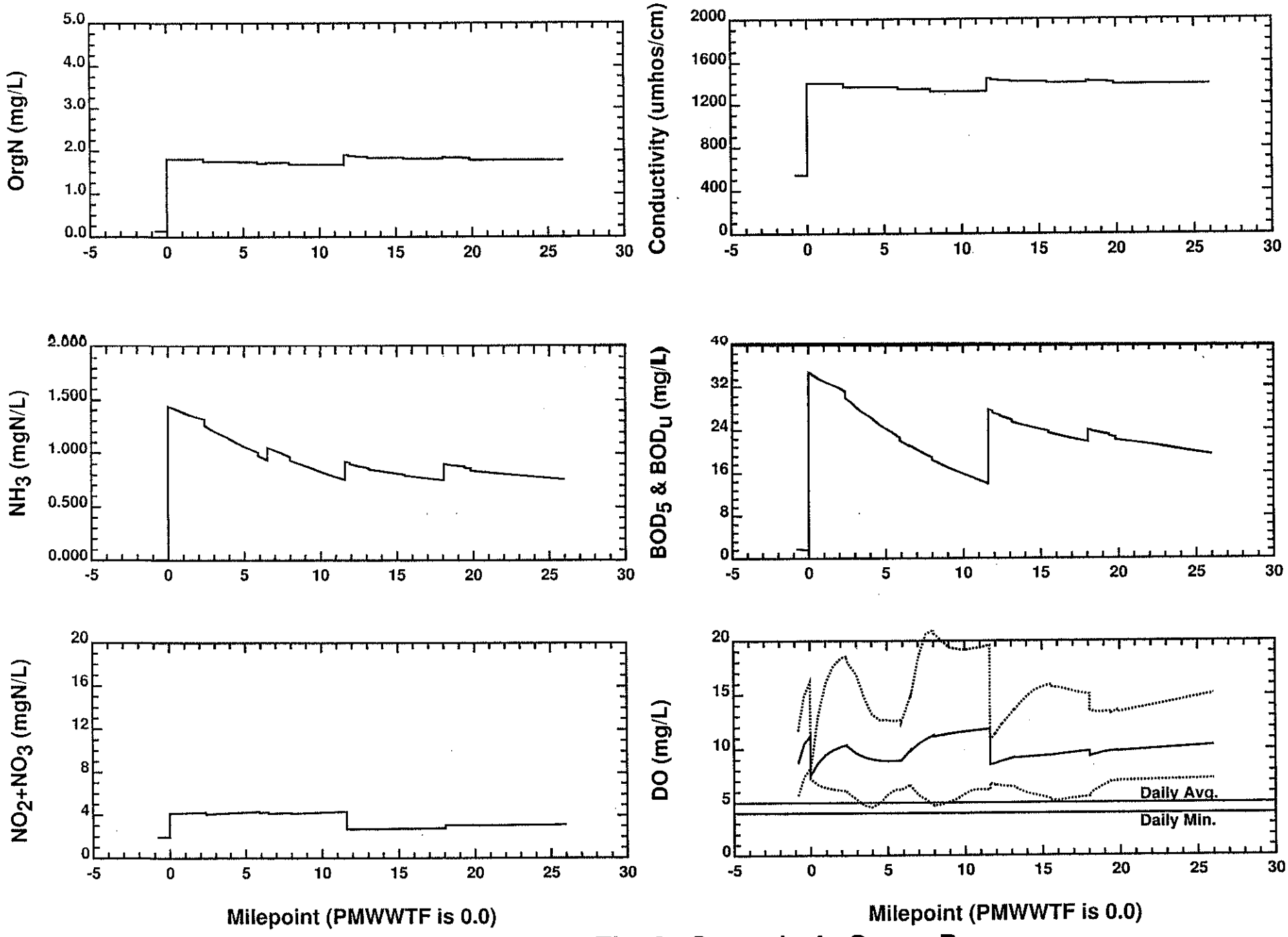


Tier 3 - Scenario 3 - Sunny Day

Figure . Opequon Creek Water Quality Projections

DATE: 2/23/2005 TIME: 14:50:37

/usersm/obag0060/HEIDI/MODEL/PROJECTION/TIER3/SUNNYB/t

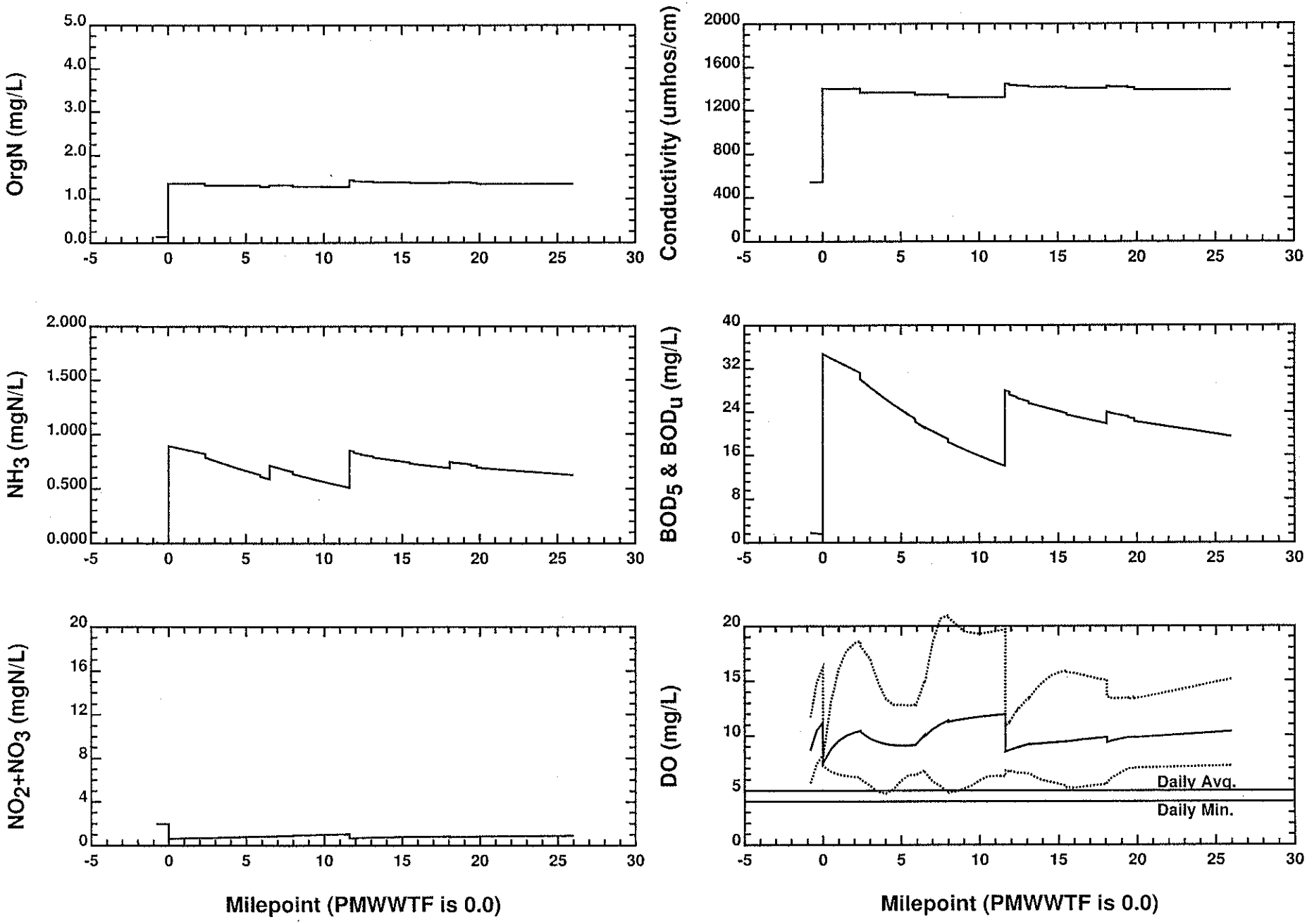


Tier 3 - Scenario 4 - Sunny Day

Figure . Opequon Creek Water Quality Projections

DATE: 2/23/2005 TIME: 14:50:40

/usersm/obao0060/HEIDI/MODEL/PROJECTION/TIER3/SUNNYB/



Tier 3 - Scenario 5 - Sunny Day

Figure . Opequon Creek Water Quality Projections

DATE: 2/23/2005 TIME: 14:50:43

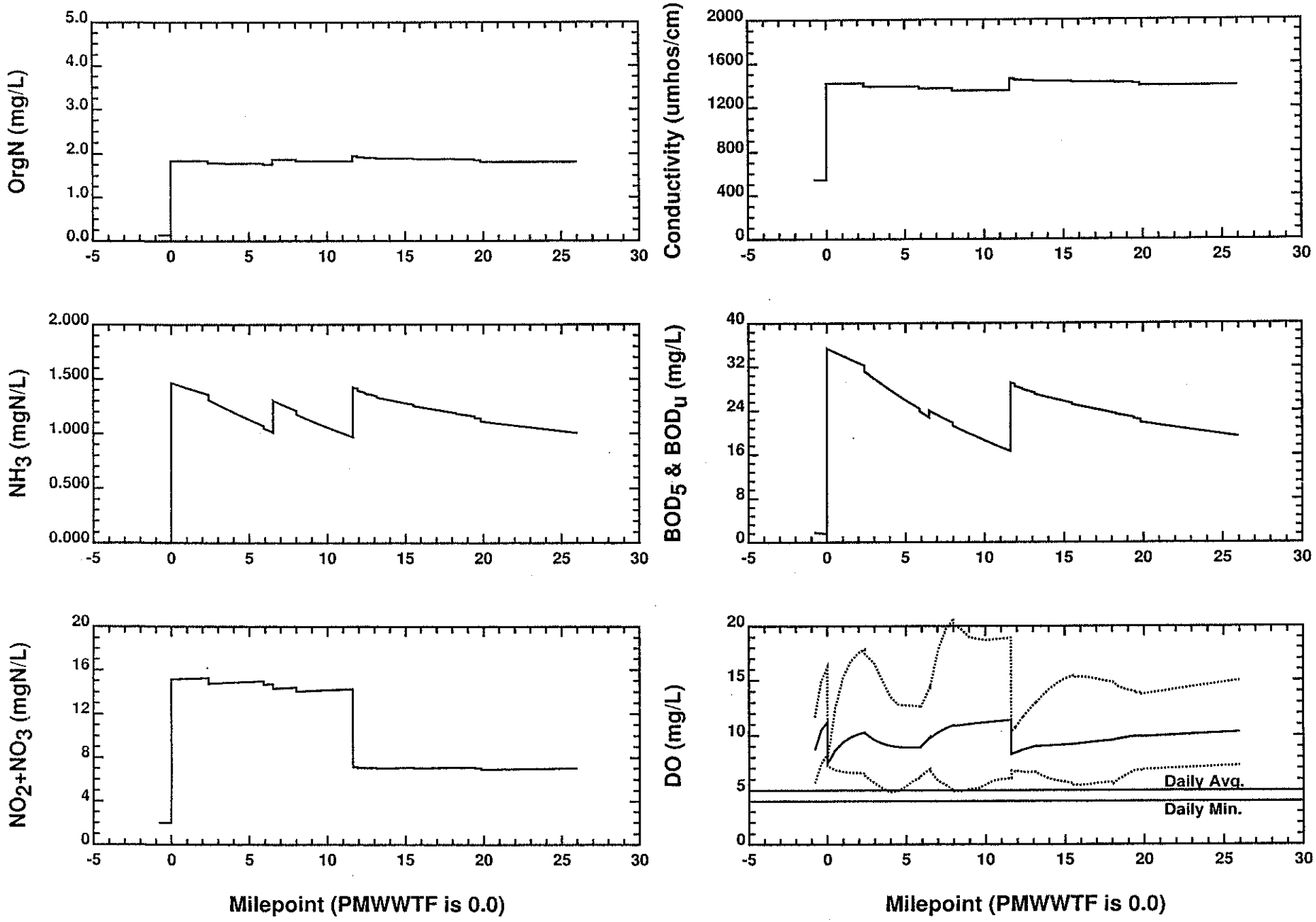
/usersm/obag0060/HEIDI/MODEL/PROJECTION/TIER3/SUNNY_B/

APPENDIX 9

TIER 4, SCENARIOS 1-5
SUNNY CONDITIONS

HydroQual

Environmental
Engineers & Scientists

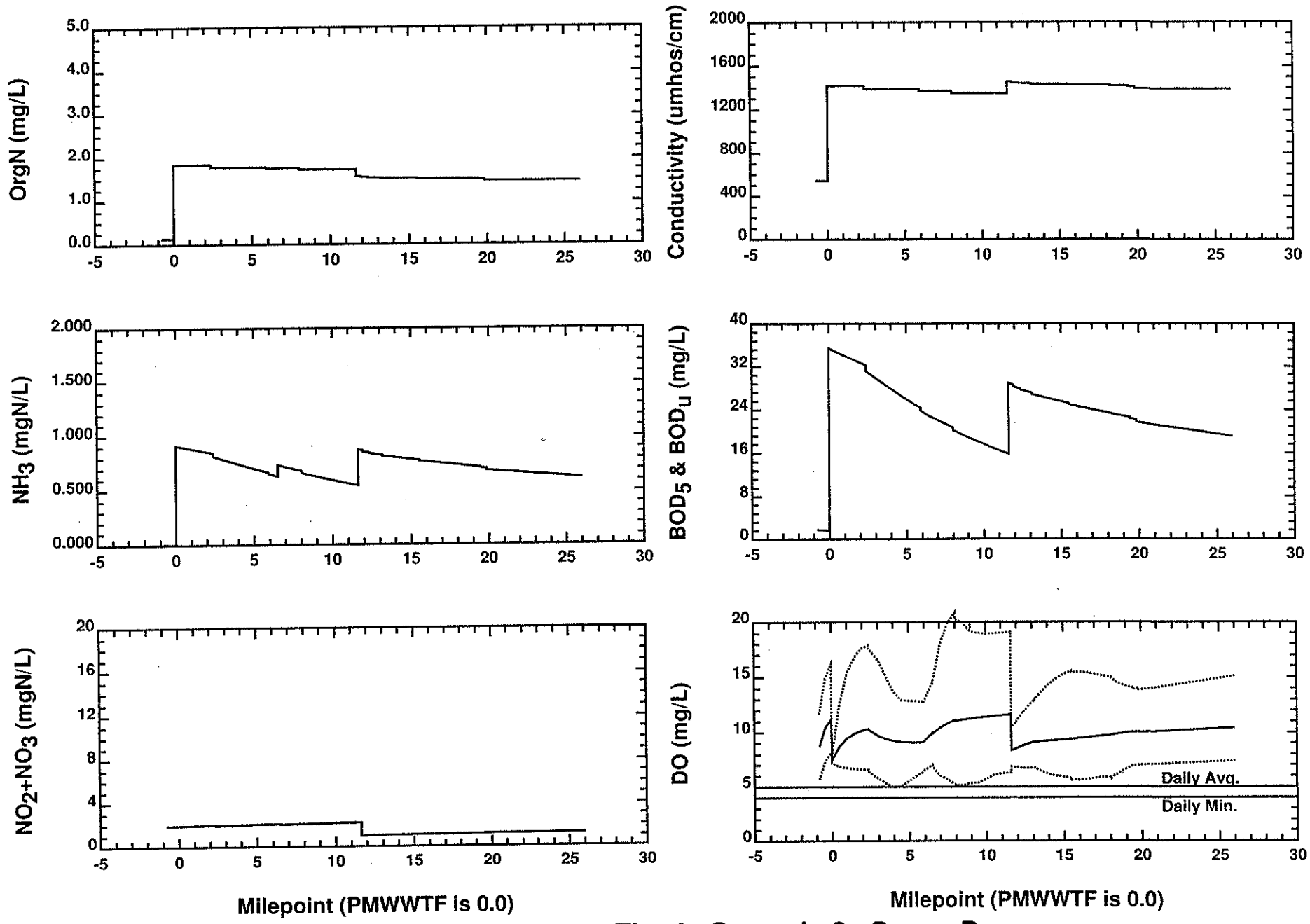


Tier 4 - Scenario 1 - Sunny Day

Figure . Opequon Creek Water Quality Projections

DATE: 2/23/2005 TIME: 15:32:44

/usersm/obag0060/HEIDI/MODEL/PROJECTION/TIER4/SUNNYB/t

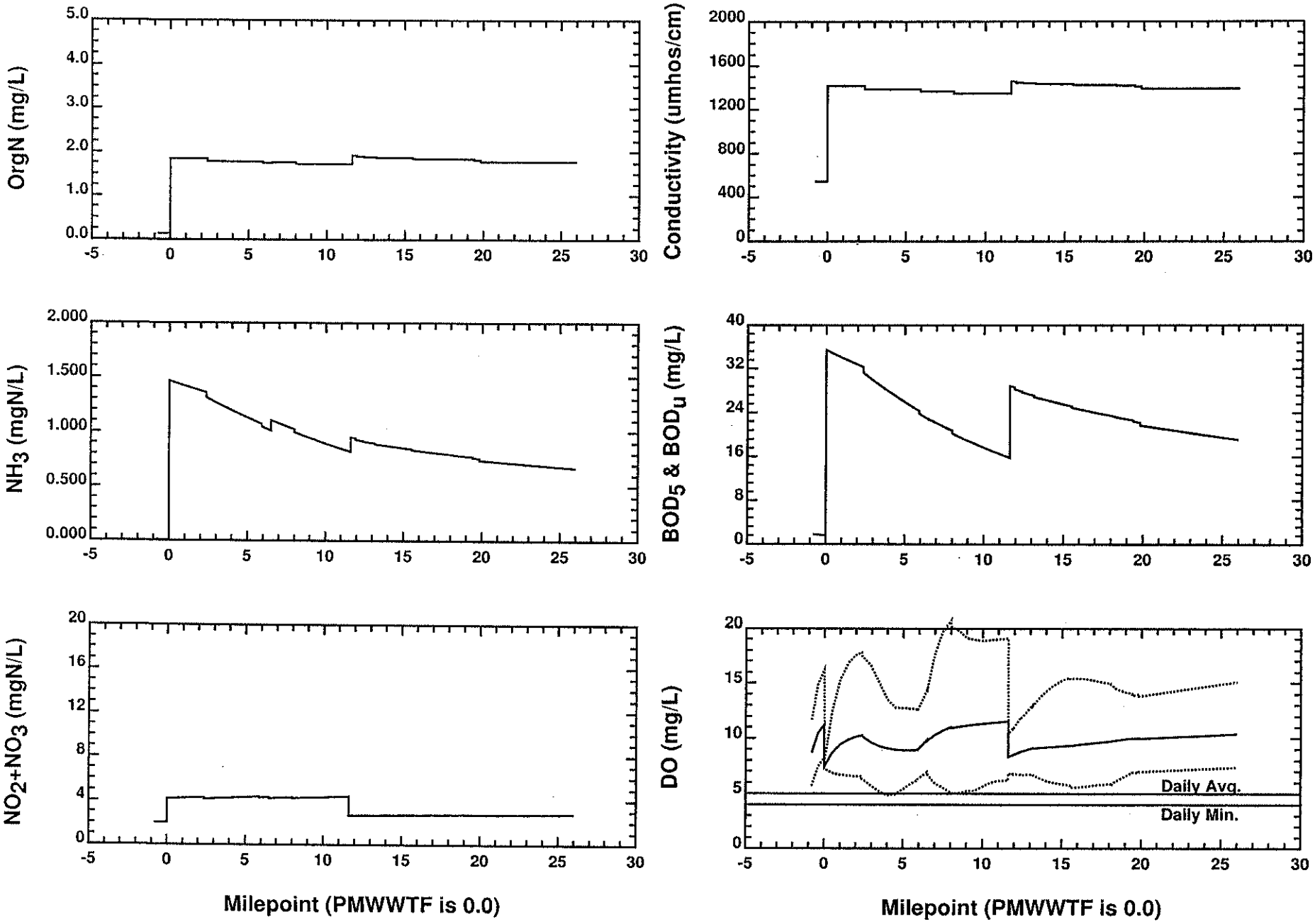


Tier 4 - Scenario 2 - Sunny Day

Figure . Opequon Creek Water Quality Projections

DATE: 2/23/2005 TIME: 15:32:47

/usersm/obag0060/HEIDI/MODEL/PROJECTION/TIER4/SUNNYB/t

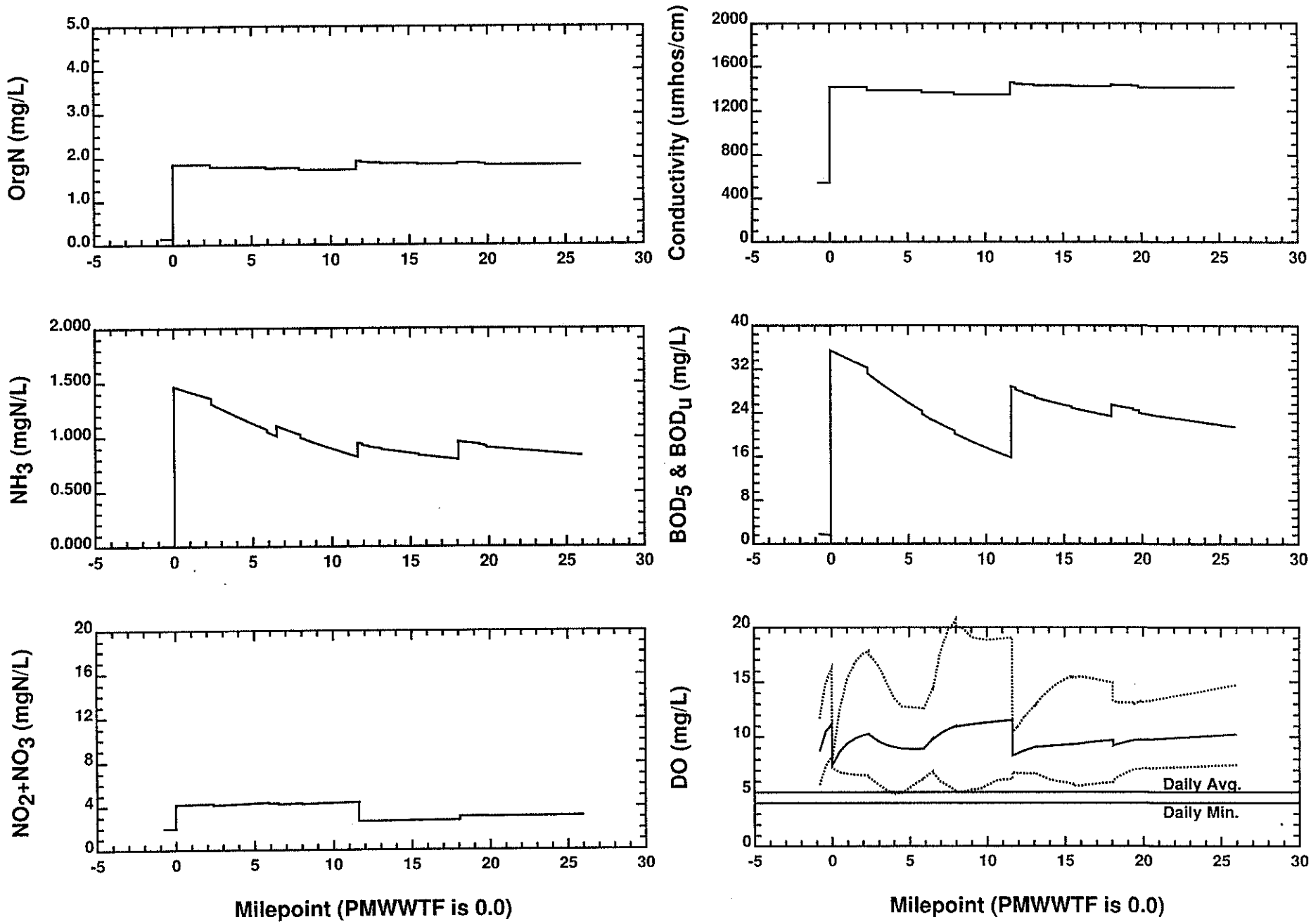


Tier 4 - Scenario 3 - Sunny Day

Figure . Opequon Creek Water Quality Projections

DATE: 2/23/2005 TIME: 15:32:50

/usersm/obag0060/HEIDI/MODEL/PROJECTION/TIER4/SUNNYB/t

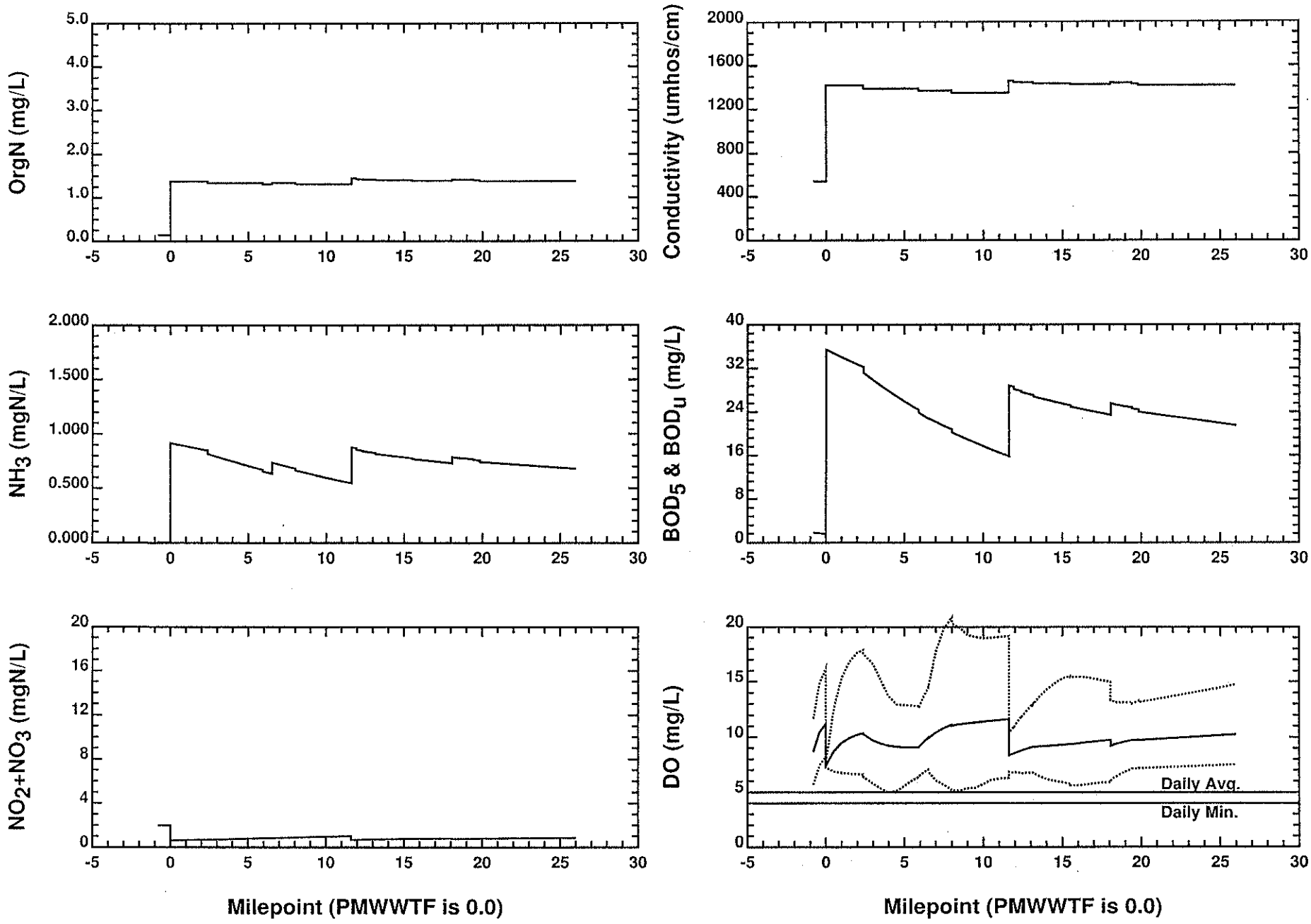


Tier 4 - Scenario 4 - Sunny Day

Figure . Opequon Creek Water Quality Projections

DATE: 2/23/2005 TIME: 15:32:52

/usersm/obag0060/HEIDI/MODEL/PROJECTION/TIER4/SUNNYB/t



Tier 4 - Scenario 5 - Sunny Day

Figure . Opequon Creek Water Quality Projections

DATE: 2/23/2005 TIME: 15:32:55

/usersm/obag0060/HEIDI/MODEL/PROJECTION/TIER4/SUNNY_B/

ATTACHMENT 1
TABULATED MODEL OUTPUT

2mgd_sunny

	Model Reach	Output MP	OrgN (mg/L)	NH4 (mg/L)	NBODu (mg/L) - calc	NO2+NO3 (mg/L)	CBODu (mg/L)	Daily Minimum DO (mg/L)	Daily Average DO (mg/L)	Daily Maximum DO (mg/L)	DO Saturation (mg/L)	Conductivity (umhos/cm)
Upstream	1	-0.8	0.1367	0.0042	0.0192	1.9785	1.784	5.6785	8.6785	11.6785	8.2953	542.11
	1	-0.4	0.1366	0.0036	0.0165	1.9787	1.6123	7.5256	8.6876	10.0815	8.2953	542.11
	1	0	0.1365	0.003	0.0137	1.9789	1.4571	7.7243	8.6979	10.4275	8.2953	542.11
PMWWTF	2	0	3.11	1.542	7.0469	13.6454	31.5813	7.2397	7.4119	7.7139	8.3026	1318.96
	2	0.5	3.1093	1.4559	6.6535	13.7315	29.9782	5.9968	7.2209	9.5924	8.3026	1318.96
	2	1	3.1086	1.3746	6.2819	13.8128	28.4745	5.6205	7.2135	10.2592	8.3026	1318.96
	2	1.5	3.1079	1.2978	5.9309	13.8896	27.0462	5.5301	7.2718	10.4886	8.3026	1318.96
	2	2	3.1073	1.2254	5.6001	13.9621	25.6896	5.5582	7.3518	10.5525	8.3026	1318.96
	2	2.37	3.1067	1.1744	5.3670	14.0131	24.7297	5.6037	7.4148	10.5982	8.3026	1318.96
Wrights Run	3	2.37	2.8957	1.088	4.9722	12.9826	23.0824	5.7836	7.5144	10.5162	8.3109	1261.52
	3	3	2.8942	0.9577	4.3767	13.113	20.5878	4.4371	6.2176	8.8388	8.3109	1261.52
	3	3.5	2.8929	0.8655	3.9553	13.2053	18.8013	4.0433	5.8661	7.8837	8.3109	1261.52
	3	4	2.8917	0.7822	3.5747	13.2886	17.1698	4.2223	5.8167	7.6808	8.3109	1261.52
	3	4.5	2.8905	0.707	3.2310	13.364	15.6799	4.5239	5.924	7.7765	8.3109	1261.52
	3	5	2.8892	0.6391	2.9207	13.432	14.3193	4.6711	6.1072	7.9894	8.3109	1261.52
	3	5.5	2.888	0.5777	2.6401	13.4936	13.0768	4.8276	6.3221	8.2653	8.3109	1261.52
	3	5.91	2.887	0.5318	2.4303	13.5396	12.1387	4.9992	6.5049	8.4645	8.3109	1261.52
falo Lick Run	4	5.91	2.7693	0.5089	2.3257	12.9723	11.6889	5.2115	6.6457	8.5139	8.3164	1229.54
	4	6.5	2.7679	0.4447	2.0323	13.0367	10.3522	6.2707	7.7492	10.1447	8.3164	1229.54
FCL	5	6.5	2.8392	0.6656	3.0418	12.3142	12.783	5.922	7.3593	9.6601	8.3199	1238.11
	5	7	2.8381	0.6066	2.7722	12.3732	11.7615	5.3654	7.7406	11.7113	8.3199	1238.11
	5	7.5	2.8371	0.553	2.5272	12.427	10.8216	5.1039	8.0024	12.5184	8.3199	1238.11
	5	8.01	2.836	0.5031	2.2992	12.477	9.9403	5.1214	8.203	12.5798	8.3199	1238.11
ır Spring Run	6	8.01	2.7025	0.4776	2.1826	11.9101	9.509	5.2021	8.1829	12.3218	8.3272	1205.1
	6	8.5	2.7014	0.4357	1.9911	11.9522	8.7531	5.5455	8.2738	11.9585	8.3272	1205.1
	6	9	2.7004	0.3966	1.8125	11.9913	8.0437	5.794	8.3737	11.8955	8.3272	1205.1
	6	9.5	2.6993	0.3611	1.6502	12.0269	7.3918	5.9909	8.4722	11.9776	8.3272	1205.1
	6	10	2.6982	0.3289	1.5031	12.0594	6.7927	6.0814	8.5659	12.1111	8.3272	1205.1
	6	10.5	2.6972	0.2995	1.3687	12.0889	6.2422	6.1559	8.6534	12.2117	8.3272	1205.1
	6	11	2.6961	0.2728	1.2467	12.1157	5.7363	6.2236	8.7343	12.3017	8.3272	1205.1
	6	11.62	2.6948	0.243	1.1105	12.1457	5.1655	6.3142	8.8259	12.3912	8.3272	1205.1
OWRF	7	11.62	4.0805	1.7418	7.9600	6.4901	26.0778	6.8858	7.5671	8.526	8.3327	1419.37
	7	11.91	4.0802	1.7013	7.7749	6.5306	25.5337	6.3773	7.2294	8.4738	8.3327	1419.37
brams Creek	8	11.91	3.9725	1.6549	7.5629	6.4065	24.8878	6.4436	7.2686	8.4754	8.3336	1398.24
	8	12.38	3.9719	1.594	7.2846	6.4675	24.0652	6.045	7.0108	8.5555	8.3336	1398.24
edbud Creek	9	12.38	3.9303	1.577	7.2069	6.4176	23.8282	6.0575	7.0203	8.5557	8.3351	1390.13
	9	13.16	3.9295	1.4874	6.7974	6.5073	22.6108	5.8208	6.8747	8.6838	8.3351	1390.13
Marsh Creek	10	13.16	3.857	1.4595	6.6699	6.4243	22.2145	5.8124	6.8698	8.6729	8.3375	1375.31
	10	13.5	3.8566	1.424	6.5077	6.4599	21.7284	5.4038	6.6522	8.7895	8.3375	1375.31
	10	14	3.8561	1.3732	6.2755	6.5107	21.0329	4.9697	6.4143	8.8492	8.3375	1375.31
	10	14.5	3.8555	1.3243	6.0521	6.5597	20.3596	4.6779	6.2545	8.894	8.3375	1375.31
	10	15	3.855	1.2771	5.8363	6.607	19.7078	4.4339	6.1552	8.8927	8.3375	1375.31
	10	15.51	3.8544	1.2308	5.6248	6.6534	19.0645	4.2522	6.102	8.8732	8.3375	1375.31
Lick Run	11	15.51	3.785	1.2078	5.5196	6.558	18.7423	4.3003	6.14	8.8495	8.3408	1359.7
	11	16	3.7845	1.1689	5.3419	6.5969	18.2	4.4913	6.2778	8.8313	8.3408	1359.7
	11	16.5	3.784	1.1305	5.1664	6.6354	17.6628	4.6685	6.4011	8.7942	8.3408	1359.7
	11	17	3.7835	1.0934	4.9968	6.6726	17.1415	4.8436	6.5111	8.7847	8.3408	1359.7
	11	17.5	3.783	1.0575	4.8328	6.7086	16.6355	4.9857	6.6104	8.8349	8.3408	1359.7
	11	18.07	3.7824	1.0181	4.6527	6.7481	16.0769	5.1149	6.7137	8.9401	8.3408	1359.7
NWRF	12	18.07	3.7813	1.0178	4.6513	6.7466	16.0725	5.1122	6.714	8.9276	8.3429	1359.46
	12	18.26	3.7811	1.006	4.5974	6.7584	15.9052	5.4945	6.9184	8.9122	8.3429	1359.46
ɜarbrook Run	13	18.26	3.7504	0.9975	4.5586	6.7124	15.7854	5.5236	6.929	8.8855	8.3446	1352.86
	13	18.5	3.7502	0.983	4.4923	6.7269	15.5793	5.7904	7.0804	8.9055	8.3446	1352.86
	13	19	3.7497	0.9535	4.3575	6.7565	15.1584	6.1846	7.3093	8.9477	8.3446	1352.86
	13	19.42	3.7493	0.9293	4.2469	6.7807	14.8137	6.4124	7.4398	8.999	8.3446	1352.86
Slate Run	14	19.42	3.6794	0.9113	4.1646	6.6819	14.5586	6.4243	7.4478	9.0081	8.3464	1338.19
	14	19.83	3.6791	0.8906	4.0700	6.7027	14.2603	6.3784	7.4621	9.1666	8.3464	1338.19
Turkey Run	15	19.83	3.5299	0.8531	3.8987	6.4934	13.7281	6.4428	7.4764	9.1043	8.3517	1307
	15	26	3.5247	0.6088	2.7822	6.7385	10.1349	6.5935	7.8524	9.8284	8.3517	1307

3mgd_sunny

	Model Reach	Output MP	OrgN (mg/L)	NH4 (mg/L)	NBODu (mg/L) - calc	NO2+NO3 (mg/L)	CBODu (mg/L)	Daily Minimum DO (mg/L)	Daily Average DO (mg/L)	Daily Maximum DO (mg/L)	DO Saturation (mg/L)	Conductivity (umhos/cm)
Upstream	1	-0.8	0.1367	0.0042	0.0192	1.9785	1.784	5.6785	8.6785	11.6785	8.2953	542.11
	1	-0.4	0.1366	0.0036	0.0165	1.9787	1.6123	7.5256	8.6876	10.0815	8.2953	542.11
	1	0	0.1365	0.003	0.0137	1.9789	1.4571	7.7243	8.6979	10.4275	8.2953	542.11
PMWWTF	2	0	1.3182	0.8663	3.9590	0.6754	33.5826	7.1993	7.3217	7.5363	8.3026	1371.32
	2	0.5	1.3179	0.8266	3.7776	0.715	32.2036	6.2507	7.2949	9.3172	8.3026	1371.32
	2	1	1.3177	0.7887	3.6044	0.7527	30.8813	5.9319	7.3268	10.0499	8.3026	1371.32
	2	1.5	1.3175	0.7526	3.4394	0.7888	29.6132	5.833	7.3812	10.3121	8.3026	1371.32
	2	2	1.3173	0.7181	3.2817	0.8232	28.3972	5.8316	7.4433	10.4152	8.3026	1371.32
	2	2.37	1.3171	0.6936	3.1698	0.8476	27.5297	5.8585	7.4905	10.4525	8.3026	1371.32
Wrights Run	3	2.37	1.2599	0.6566	3.0007	0.8059	26.183	5.9648	7.5588	10.4114	8.3109	1326.79
	3	3	1.2594	0.5908	2.7000	0.8715	23.8243	4.7438	6.3829	9.0059	8.3109	1326.79
	3	3.5	1.2589	0.5433	2.4829	0.9188	22.1045	4.2797	5.9997	8.1331	8.3109	1326.79
	3	4	1.2585	0.4997	2.2836	0.9623	20.5089	4.2285	5.8819	7.75	8.3109	1326.79
	3	4.5	1.2581	0.4595	2.0999	1.0023	19.0284	4.4337	5.9139	7.7758	8.3109	1326.79
	3	5	1.2577	0.4226	1.9313	1.0391	17.6548	4.6596	6.0274	7.8722	8.3109	1326.79
	3	5.5	1.2573	0.3886	1.7759	1.0729	16.3804	4.7935	6.1825	8.0429	8.3109	1326.79
	3	5.91	1.2569	0.3628	1.6580	1.0986	15.4043	4.9005	6.3241	8.2153	8.3109	1326.79
falo Lick Run	4	5.91	1.2225	0.3514	1.6059	1.0793	14.9692	5.0609	6.4333	8.2584	8.3164	1301.2
	4	6.5	1.222	0.3139	1.4345	1.1166	13.5318	6.1433	7.5278	9.7651	8.3164	1301.2
FCL	5	6.5	1.3427	0.4845	2.2142	1.0975	15.2079	5.8717	7.2464	9.4403	8.3199	1304.47
	5	7	1.3423	0.4481	2.0478	1.1338	14.1812	5.394	7.5807	11.2964	8.3199	1304.47
	5	7.5	1.3419	0.4145	1.8943	1.1674	13.2239	5.1712	7.8163	12.106	8.3199	1304.47
	5	8.01	1.3415	0.3827	1.7489	1.199	12.314	5.1317	7.9993	12.3271	8.3199	1304.47
ır Spring Run	6	8.01	1.2998	0.3682	1.6827	1.218	11.8934	5.169	7.9922	12.1222	8.3272	1276.86
	6	8.5	1.2994	0.3405	1.5561	1.2456	11.0886	5.4121	8.074	11.8016	8.3272	1276.86
	6	9	1.299	0.3144	1.4368	1.2716	10.3234	5.6423	8.1645	11.6363	8.3272	1276.86
	6	9.5	1.2986	0.2902	1.3262	1.2956	9.6111	5.8147	8.2553	11.6993	8.3272	1276.86
	6	10	1.2982	0.268	1.2248	1.3178	8.9479	5.96	8.3431	11.7889	8.3272	1276.86
	6	10.5	1.2978	0.2474	1.1306	1.3382	8.3304	6.0404	8.4264	11.8916	8.3272	1276.86
	6	11	1.2973	0.2284	1.0438	1.3571	7.7556	6.1082	8.5047	11.9793	8.3272	1276.86
	6	11.62	1.2968	0.2069	0.9455	1.3785	7.0976	6.188	8.5949	12.0778	8.3272	1276.86
OWRF	7	11.62	3.5105	1.6101	7.3582	3.4048	25.0408	6.7935	7.5918	8.7305	8.3327	1425.81
	7	11.91	3.5102	1.5745	7.1955	3.4404	24.5436	6.375	7.3031	8.6587	8.3327	1425.81
brams Creek	8	11.91	3.4252	1.5349	7.0145	3.4039	23.9729	6.437	7.3374	8.6546	8.3336	1406.17
	8	12.38	3.4248	1.481	6.7682	3.4578	23.2176	6.1331	7.1223	8.6773	8.3336	1406.17
edbud Creek	9	12.38	3.3918	1.4665	6.7019	3.4413	23.0073	6.1452	7.1299	8.675	8.3351	1398.61
	9	13.16	3.3911	1.3869	6.3381	3.521	21.8857	5.9753	7.0111	8.7624	8.3351	1398.61
Marsh Creek	10	13.16	3.3335	1.3629	6.2285	3.4962	21.5321	5.9639	7.0042	8.7497	8.3375	1384.76
	10	13.5	3.3332	1.3312	6.0836	3.528	21.0825	5.5894	6.8089	8.8729	8.3375	1384.76
	10	14	3.3327	1.2859	5.8766	3.5733	20.4383	5.1934	6.5948	8.9489	8.3375	1384.76
	10	14.5	3.3323	1.2421	5.6764	3.6171	19.8138	4.9265	6.4503	9.0029	8.3375	1384.76
	10	15	3.3318	1.1999	5.4835	3.6594	19.2084	4.7138	6.3599	9.0201	8.3375	1384.76
	10	15.51	3.3314	1.1583	5.2934	3.7011	18.6099	4.5423	6.3105	9.0188	8.3375	1384.76
Lick Run	11	15.51	3.2763	1.1383	5.2020	3.664	18.3195	4.5773	6.3421	8.9983	8.3408	1370.15
	11	16	3.2759	1.1033	5.0421	3.6991	17.8132	4.7497	6.4656	8.9797	8.3408	1370.15
	11	16.5	3.2754	1.0686	4.8835	3.7337	17.311	4.9125	6.576	8.9391	8.3408	1370.15
	11	17	3.275	1.0351	4.7304	3.7673	16.8229	5.0685	6.6741	8.9185	8.3408	1370.15
	11	17.5	3.2746	1.0026	4.5819	3.7998	16.3486	5.1957	6.7627	8.9505	8.3408	1370.15
	11	18.07	3.2741	0.9668	4.4183	3.8357	15.8241	5.3084	6.8547	9.0369	8.3408	1370.15
NWRF	12	18.07	3.2732	0.9666	4.4174	3.8351	15.8201	5.2915	6.8549	9.0273	8.3429	1369.93
	12	18.26	3.2731	0.9559	4.3685	3.8458	15.6629	5.6501	7.041	8.996	8.3429	1369.93
earbrook Run	13	18.26	3.2487	0.9484	4.3342	3.8262	15.5538	5.6763	7.0499	8.9699	8.3446	1363.74
	13	18.5	3.2485	0.9352	4.2739	3.8394	15.3598	5.9264	7.1875	8.9759	8.3446	1363.74
	13	19	3.2481	0.9083	4.1509	3.8663	14.9633	6.3032	7.3954	8.9958	8.3446	1363.74
	13	19.42	3.2478	0.8864	4.0508	3.8883	14.6382	6.5167	7.5138	9.0404	8.3446	1363.74
Slate Run	14	19.42	3.1921	0.8705	3.9782	3.8492	14.4048	6.5236	7.5198	9.0475	8.3464	1349.93
	14	19.83	3.1918	0.8515	3.8914	3.8683	14.1226	6.4794	7.5317	9.1953	8.3464	1349.93
Turkey Run	15	19.83	3.0724	0.8181	3.7387	3.7859	13.6329	6.5361	7.5423	9.1354	8.3517	1320.45
	15	26	3.068	0.5921	2.7059	4.0125	10.195	6.6653	7.8793	9.8133	8.3517	1320.45

4mgd_sunny

	Model Reach	Output MP	OrgN (mg/L)	NH4 (mg/L)	NBODu (mg/L) - calc	NO2+NO3 (mg/L)	CBODu (mg/L)	Daily Minimum DO (mg/L)	Daily Average DO (mg/L)	Daily Maximum DO (mg/L)	DO Saturation (mg/L)	Conductivity (umhos/cm)
Upstream	1	-0.8	0.1367	0.0042	0.0192	1.9785	1.784	5.6785	8.6785	11.6785	8.2953	542.11
	1	-0.4	0.1366	0.0036	0.0165	1.9787	1.6123	7.5256	8.6876	10.0815	8.2953	542.11
	1	0	0.1365	0.003	0.0137	1.9789	1.4571	7.7243	8.6979	10.4275	8.2953	542.11
PMWWTF	2	0	1.359	0.8963	4.0961	0.636	34.697	7.177	7.272	7.4385	8.3026	1400.19
	2	0.5	1.3588	0.8609	3.9343	0.6713	33.4701	6.4292	7.3265	9.0623	8.3026	1400.19
	2	1	1.3586	0.8269	3.7789	0.7052	32.2866	6.1783	7.382	9.7513	8.3026	1400.19
	2	1.5	1.3584	0.7943	3.6300	0.7378	31.1449	6.1043	7.4369	10.0041	8.3026	1400.19
	2	2	1.3582	0.7629	3.4865	0.769	30.0436	6.1015	7.4903	10.0988	8.3026	1400.19
	2	2.37	1.358	0.7405	3.3841	0.7914	29.2537	6.1217	7.5288	10.1424	8.3026	1400.19
Wrights Run	3	2.37	1.3114	0.7095	3.2424	0.761	28.1238	6.1866	7.5808	10.1469	8.3109	1364.01
	3	3	1.3109	0.6476	2.9595	0.8227	25.9188	5.0158	6.4636	8.9542	8.3109	1364.01
	3	3.5	1.3106	0.6023	2.7525	0.8679	24.2925	4.5657	6.0816	8.1809	8.3109	1364.01
	3	4	1.3102	0.5602	2.5601	0.9099	22.7682	4.4256	5.9451	7.8179	8.3109	1364.01
	3	4.5	1.3098	0.5211	2.3814	0.9489	21.3396	4.5072	5.9488	7.7682	8.3109	1364.01
	3	5	1.3095	0.4847	2.2151	0.9852	20.0006	4.6844	6.0304	7.8514	8.3109	1364.01
	3	5.5	1.3091	0.4508	2.0602	1.0189	18.7457	4.8564	6.1533	7.9616	8.3109	1364.01
	3	5.91	1.3088	0.4248	1.9413	1.0448	17.7756	4.965	6.2695	8.0824	8.3109	1364.01
lalo Lick Run	4	5.91	1.2803	0.4142	1.8929	1.0309	17.3717	5.0899	6.3572	8.1168	8.3164	1342.84
	4	6.5	1.2799	0.3756	1.7165	1.0694	15.9135	6.1796	7.4247	9.46	8.3164	1342.84
FCL	5	6.5	1.3742	0.5095	2.3284	1.0558	17.1678	5.9499	7.2038	9.2203	8.3199	1344
	5	7	1.3738	0.4759	2.1749	1.0893	16.1513	5.5275	7.4859	10.8902	8.3199	1344
	5	7.5	1.3735	0.4445	2.0314	1.1206	15.195	5.3553	7.6858	11.634	8.3199	1344
	5	8.01	1.3731	0.4147	1.8952	1.1504	14.2779	5.2854	7.8421	11.9046	8.3199	1344
ır Spring Run	6	8.01	1.3386	0.402	1.8371	1.1672	13.8769	5.3122	7.8414	11.741	8.3272	1320.53
	6	8.5	1.3382	0.3753	1.7151	1.1938	13.0493	5.5096	7.9098	11.497	8.3272	1320.53
	6	9	1.3379	0.3499	1.5990	1.2191	12.2557	5.6928	7.9885	11.2989	8.3272	1320.53
	6	9.5	1.3375	0.3262	1.4907	1.2427	11.5104	5.8135	8.0691	11.3462	8.3272	1320.53
	6	10	1.3371	0.3041	1.3897	1.2647	10.8104	5.9555	8.1481	11.4104	8.3272	1320.53
	6	10.5	1.3368	0.2836	1.2961	1.2852	10.153	6.0456	8.2239	11.4984	8.3272	1320.53
	6	11	1.3364	0.2644	1.2083	1.3042	9.5356	6.1174	8.296	11.5748	8.3272	1320.53
	6	11.62	1.336	0.2424	1.1078	1.3261	8.8218	6.193	8.3798	11.6652	8.3272	1320.53
OWRF	7	11.62	3.3614	1.5197	6.9450	3.235	24.3647	6.7406	7.5847	8.8202	8.3327	1431.3
	7	11.91	3.3611	1.4875	6.7979	3.2671	23.9025	6.3819	7.3366	8.7703	8.3327	1431.3
brams Creek	8	11.91	3.2858	1.4528	6.6393	3.2372	23.3881	6.4401	7.3677	8.763	8.3336	1412.95
	8	12.38	3.2854	1.4041	6.4167	3.2861	22.6832	6.1999	7.1906	8.7592	8.3336	1412.95
edbud Creek	9	12.38	3.2561	1.3913	6.3582	3.2724	22.4928	6.2117	7.197	8.7551	8.3351	1405.87
	9	13.16	3.2554	1.319	6.0278	3.3447	21.443	6.0885	7.1036	8.8151	8.3351	1405.87
Marsh Creek	10	13.16	3.2041	1.2978	5.9309	3.3246	21.1215	6.0752	7.0957	8.8012	8.3375	1392.88
	10	13.5	3.2038	1.2688	5.7984	3.3535	20.6992	5.7254	6.917	8.9262	8.3375	1392.88
	10	14	3.2034	1.2275	5.6097	3.3949	20.0934	5.3593	6.7207	9.0146	8.3375	1392.88
	10	14.5	3.203	1.1875	5.4269	3.4349	19.5054	5.109	6.5877	9.0666	8.3375	1392.88
	10	15	3.2026	1.1488	5.2500	3.4737	18.9346	4.9182	6.5038	9.0956	8.3375	1392.88
	10	15.51	3.2021	1.1106	5.0754	3.5119	18.3696	4.7569	6.4573	9.1063	8.3375	1392.88
Lick Run	11	15.51	3.153	1.0928	4.9941	3.4804	18.1033	4.7808	6.4843	9.0892	8.3408	1379.15
	11	16	3.1526	1.0606	4.8469	3.5127	17.6237	4.9415	6.5977	9.0721	8.3408	1379.15
	11	16.5	3.1522	1.0287	4.7012	3.5446	17.1475	5.0952	6.6987	9.0308	8.3408	1379.15
	11	17	3.1518	0.9977	4.5595	3.5756	16.6842	5.2382	6.7884	9.0034	8.3408	1379.15
	11	17.5	3.1514	0.9677	4.4224	3.6057	16.2333	5.3557	6.8691	9.0217	8.3408	1379.15
	11	18.07	3.151	0.9346	4.2711	3.6388	15.7342	5.4576	6.9528	9.0923	8.3408	1379.15
NWRF	12	18.07	3.1502	0.9344	4.2702	3.6383	15.7305	5.4293	6.953	9.085	8.3429	1378.95
	12	18.26	3.15	0.9245	4.2250	3.6482	15.5807	5.7696	7.1262	9.0432	8.3429	1378.95
;arbrook Run	13	18.26	3.1282	0.9177	4.1939	3.6315	15.4798	5.7935	7.1339	9.018	8.3446	1373.11
	13	18.5	3.1281	0.9055	4.1381	3.6437	15.2947	6.0308	7.2617	9.0142	8.3446	1373.11
	13	19	3.1277	0.8806	4.0243	3.6687	14.9162	6.3944	7.4548	9.0261	8.3446	1373.11
	13	19.42	3.1274	0.8601	3.9307	3.6891	14.6056	6.5965	7.5645	9.0598	8.3446	1373.11
Slate Run	14	19.42	3.0775	0.8457	3.8648	3.6561	14.3885	6.5991	7.5692	9.0654	8.3464	1360.08
	14	19.83	3.0772	0.8281	3.7844	3.6738	14.1181	6.5562	7.5792	9.2038	8.3464	1360.08
Turkey Run	15	19.83	2.9699	0.7977	3.6455	3.604	13.6604	6.6071	7.5872	9.1468	8.3517	1332.14
	15	26	2.9659	0.5847	2.6721	3.8174	10.3339	6.7214	7.8936	9.7868	8.3517	1332.14

5mgd_sunny

	Model Reach	Output MP	OrgN (mg/L)	NH4 (mg/L)	NBODu (mg/L) - calc	NO2+NO3 (mg/L)	CBODu (mg/L)	Daily Minimum DO (mg/L)	Daily Average DO (mg/L)	Daily Maximum DO (mg/L)	DO Saturation (mg/L)	Conductivity (umhos/cm)
Upstream	1	-0.8	0.1367	0.0042	0.0192	1.9785	1.784	5.6785	8.6785	11.6785	8.2953	542.11
	1	-0.4	0.1366	0.0036	0.0165	1.9787	1.6123	7.5256	8.6876	10.0815	8.2953	542.11
	1	0	0.1365	0.003	0.0137	1.9789	1.4571	7.7243	8.6979	10.4275	8.2953	542.11
PMWWTF	2	0	1.3848	0.9153	4.1829	0.6111	35.403	7.1629	7.2405	7.3764	8.3026	1418.48
	2	0.5	1.3846	0.8832	4.0362	0.6431	34.292	6.5629	7.3575	8.8928	8.3026	1418.48
	2	1	1.3845	0.8523	3.8950	0.674	33.2159	6.3616	7.4326	9.544	8.3026	1418.48
	2	1.5	1.3843	0.8224	3.7584	0.7038	32.1736	6.3058	7.4894	9.8003	8.3026	1418.48
	2	2	1.3841	0.7936	3.6268	0.7325	31.1639	6.3046	7.5378	9.8952	8.3026	1418.48
	2	2.37	1.384	0.7729	3.5322	0.7531	30.4372	6.3207	7.5707	9.9292	8.3026	1418.48
Wrights Run	3	2.37	1.3447	0.7463	3.4106	0.7294	29.4661	6.3599	7.6121	9.9733	8.3109	1388.07
	3	3	1.3443	0.688	3.1442	0.7875	27.4013	5.2448	6.5553	8.8843	8.3109	1388.07
	3	3.5	1.344	0.6451	2.9481	0.8304	25.8661	4.8378	6.1823	8.236	8.3109	1388.07
	3	4	1.3437	0.6048	2.7639	0.8705	24.4169	4.6576	6.037	7.8902	8.3109	1388.07
	3	4.5	1.3433	0.567	2.5912	0.9082	23.0489	4.6726	6.0226	7.793	8.3109	1388.07
	3	5	1.343	0.5316	2.4294	0.9435	21.7575	4.7879	6.0821	7.848	8.3109	1388.07
	3	5.5	1.3427	0.4985	2.2781	0.9766	20.5385	4.9398	6.1816	7.9437	8.3109	1388.07
	3	5.91	1.3424	0.4728	2.1607	1.0021	19.5901	5.0558	6.2788	8.0345	8.3109	1388.07
falo Lick Run	4	5.91	1.3181	0.463	2.1159	0.9915	19.2182	5.1522	6.3512	8.0632	8.3164	1370.06
	4	6.5	1.3177	0.4243	1.9391	1.0302	17.7722	6.2378	7.3793	9.2617	8.3164	1370.06
FCL	5	6.5	1.3951	0.5343	2.4418	1.02	18.7617	6.0418	7.1968	9.0714	8.3199	1370.23
	5	7	1.3948	0.5026	2.2969	1.0515	17.7639	5.6542	7.4382	10.5837	8.3199	1370.23
	5	7.5	1.3945	0.4729	2.1612	1.0812	16.8192	5.5082	7.6103	11.2965	8.3199	1370.23
	5	8.01	1.3941	0.4443	2.0305	1.1097	15.9072	5.4311	7.7459	11.5401	8.3199	1370.23
ır Spring Run	6	8.01	1.3647	0.4329	1.9784	1.1249	15.5283	5.4463	7.7479	11.4891	8.3272	1349.9
	6	8.5	1.3644	0.407	1.8600	1.1507	14.6939	5.6213	7.8058	11.2344	8.3272	1349.9
	6	9	1.3641	0.3822	1.7467	1.1754	13.8886	5.7679	7.8748	11.0334	8.3272	1349.9
	6	9.5	1.3637	0.3589	1.6402	1.1987	13.1275	5.8658	7.9468	11.0555	8.3272	1349.9
	6	10	1.3634	0.337	1.5401	1.2205	12.4081	5.9842	8.0183	11.1135	8.3272	1349.9
	6	10.5	1.3631	0.3164	1.4459	1.2409	11.7281	6.0792	8.0876	11.1842	8.3272	1349.9
	6	11	1.3628	0.2971	1.3577	1.2602	11.0854	6.1475	8.1538	11.2569	8.3272	1349.9
	6	11.62	1.3624	0.2748	1.2558	1.2824	10.3371	6.2207	8.2315	11.3359	8.3272	1349.9
OWRF	7	11.62	3.2329	1.4453	6.6050	3.085	23.9316	6.7076	7.5771	8.8944	8.3327	1436.04
	7	11.91	3.2327	1.416	6.4711	3.1143	23.4964	6.3948	7.3606	8.849	8.3327	1436.04
brams Creek	8	11.91	3.1652	1.3852	6.3304	3.0897	23.0255	6.4495	7.3891	8.8398	8.3336	1418.82
	8	12.38	3.1649	1.3406	6.1265	3.1344	22.3596	6.2577	7.242	8.8176	8.3336	1418.82
edbud Creek	9	12.38	3.1385	1.3292	6.0744	3.1229	22.1847	6.2692	7.2476	8.8121	8.3351	1412.17
	9	13.16	3.1379	1.2629	5.7715	3.1893	21.1905	6.1794	7.1741	8.8505	8.3351	1412.17
Marsh Creek	10	13.16	3.0917	1.2439	5.6846	3.1728	20.8939	6.1668	7.1657	8.8359	8.3375	1399.93
	10	13.5	3.0915	1.2172	5.5626	3.1995	20.4927	5.8365	6.9997	8.9605	8.3375	1399.93
	10	14	3.0911	1.1791	5.3885	3.2376	19.9167	5.4944	6.817	9.0566	8.3375	1399.93
	10	14.5	3.0907	1.1422	5.2199	3.2746	19.3568	5.2561	6.6927	9.104	8.3375	1399.93
	10	15	3.0904	1.1065	5.0567	3.3103	18.8127	5.0814	6.6138	9.1414	8.3375	1399.93
	10	15.51	3.09	1.0711	4.8949	3.3457	18.2735	4.9293	6.5693	9.1606	8.3375	1399.93
Lick Run	11	15.51	3.0457	1.0551	4.8218	3.3188	18.0259	4.9436	6.5929	9.1465	8.3408	1386.99
	11	16	3.0453	1.0252	4.6852	3.3487	17.567	5.0954	6.6984	9.132	8.3408	1386.99
	11	16.5	3.045	0.9955	4.5494	3.3784	17.1108	5.2426	6.7921	9.0919	8.3408	1386.99
	11	17	3.0446	0.9667	4.4178	3.4072	16.6664	5.3756	6.8751	9.0604	8.3408	1386.99
	11	17.5	3.0443	0.9388	4.2903	3.4352	16.2336	5.4849	6.9497	9.0685	8.3408	1386.99
	11	18.07	3.0438	0.9079	4.1491	3.4661	15.7538	5.5759	7.0268	9.1257	8.3408	1386.99
NWRF	12	18.07	3.0431	0.9077	4.1482	3.4657	15.7503	5.5429	7.027	9.1207	8.3429	1386.79
	12	18.26	3.043	0.8985	4.1061	3.4749	15.6063	5.8682	7.1904	9.0707	8.3429	1386.79
ɜarbrook Run	13	18.26	3.0233	0.8923	4.0778	3.4605	15.5117	5.8901	7.1971	9.0548	8.3446	1381.28
	13	18.5	3.0232	0.8809	4.0257	3.4719	15.3334	6.1167	7.3175	9.0446	8.3446	1381.28
	13	19	3.0228	0.8576	3.9192	3.4952	14.9687	6.469	7.4991	9.0438	8.3446	1381.28
	13	19.42	3.0226	0.8385	3.8319	3.5144	14.669	6.6621	7.6022	9.0674	8.3446	1381.28
Slate Run	14	19.42	2.9775	0.8253	3.7716	3.4862	14.4646	6.661	7.6061	9.0718	8.3464	1368.95
	14	19.83	2.9773	0.8087	3.6958	3.5028	14.2032	6.619	7.6143	9.202	8.3464	1368.95
Turkey Run	15	19.83	2.8799	0.7809	3.5687	3.4432	13.7706	6.6652	7.6206	9.1479	8.3517	1342.41
	15	26	2.8762	0.579	2.6460	3.6455	10.5258	6.3862	7.7701	9.8804	8.3517	1342.41

2mgd_cloudy

	Model Reach	Output MP	OrgN (mg/L)	NH4 (mg/L)	NBODu (mg/L) - calc	NO2+NO3 (mg/L)	CBODu (mg/L)	Daily Minimum DO (mg/L)	Daily Average DO (mg/L)	Daily Maximum DO (mg/L)	DO Saturation (mg/L)	Conductivity (umhos/cm)
Upstream	1	-0.8	0.1367	0.0042	0.0192	1.9785	1.784	8.2035	8.6785	9.1535	8.2953	542.11
	1	-0.4	0.1366	0.0036	0.0165	1.9787	1.6123	7.822	8.6876	10.3319	8.2953	542.11
	1	0	0.1365	0.003	0.0137	1.9789	1.4571	7.6395	8.6979	10.5612	8.2953	542.11
PMWWTF	2	0	3.11	1.542	7.0469	13.6454	31.5613	7.225	7.4119	7.7368	8.3026	1318.96
	2	0.5	3.1093	1.4559	6.6535	13.7315	29.9782	6.3159	6.966	8.1866	8.3026	1318.96
	2	1	3.1086	1.3746	6.2819	13.8128	28.4745	6.0523	6.8626	8.3911	8.3026	1318.96
	2	1.5	3.1079	1.2978	5.9309	13.8896	27.0462	6.0091	6.8848	8.4905	8.3026	1318.96
	2	2	3.1073	1.2254	5.6001	13.9621	25.6896	6.0533	6.9512	8.5496	8.3026	1318.96
	2	2.37	3.1067	1.1744	5.3670	14.0131	24.7297	6.1044	7.0099	8.6006	8.3026	1318.96
Wrights Run	3	2.37	2.8957	1.088	4.9722	12.9826	23.0824	6.2741	7.1395	8.6394	8.3109	1261.52
	3	3	2.8942	0.9577	4.3767	13.113	20.5878	4.8149	5.879	7.4678	8.3109	1261.52
	3	3.5	2.8929	0.8655	3.9553	13.2053	18.8013	4.3886	5.5424	6.928	8.3109	1261.52
	3	4	2.8917	0.7822	3.5747	13.2886	17.1698	4.4217	5.5014	6.786	8.3109	1261.52
	3	4.5	2.8905	0.707	3.2310	13.364	15.6799	4.6375	5.6133	6.87	8.3109	1261.52
	3	5	2.8892	0.6391	2.9207	13.432	14.3193	4.8303	5.7992	7.0582	8.3109	1261.52
	3	5.5	2.888	0.5777	2.6401	13.4936	13.0768	5.0251	6.0156	7.3008	8.3109	1261.52
	3	5.91	2.887	0.5318	2.4303	13.5396	12.1387	5.2001	6.1991	7.4975	8.3109	1261.52
falo Lick Run	4	5.91	2.7693	0.5089	2.3257	12.9723	11.6889	5.4017	6.3532	7.591	8.3164	1229.54
	4	6.5	2.7679	0.4447	2.0323	13.0367	10.3522	6.4067	7.5687	9.5054	8.3164	1229.54
FCL	5	6.5	2.8392	0.6656	3.0418	12.3142	12.783	6.0591	7.1894	9.0492	8.3199	1238.11
	5	7	2.8381	0.6066	2.7722	12.3732	11.7615	5.8176	7.3108	9.7544	8.3199	1238.11
	5	7.5	2.8371	0.553	2.5272	12.427	10.8216	5.7274	7.4454	9.997	8.3199	1238.11
	5	8.01	2.836	0.5031	2.2992	12.477	9.9403	5.81	7.5829	10.0482	8.3199	1238.11
ır Spring Run	6	8.01	2.7025	0.4776	2.1826	11.9101	9.509	5.8942	7.5953	9.9266	8.3272	1205.1
	6	8.5	2.7014	0.4357	1.9911	11.9522	8.7531	6.0827	7.7648	10.1143	8.3272	1205.1
	6	9	2.7004	0.3966	1.8125	11.9913	8.0437	6.2306	7.9027	10.2834	8.3272	1205.1
	6	9.5	2.6993	0.3611	1.6502	12.0269	7.3918	6.3592	8.0192	10.3868	8.3272	1205.1
	6	10	2.6982	0.3289	1.5031	12.0594	6.7927	6.4457	8.1214	10.4984	8.3272	1205.1
	6	10.5	2.6972	0.2995	1.3687	12.0889	6.2422	6.5397	8.2128	10.5883	8.3272	1205.1
	6	11	2.6961	0.2728	1.2467	12.1157	5.7363	6.6222	8.2957	10.6717	8.3272	1205.1
	6	11.62	2.6948	0.243	1.1105	12.1457	5.1655	6.715	8.3882	10.7633	8.3272	1205.1
OWRF	7	11.62	4.0805	1.7418	7.9600	6.4901	26.0778	6.995	7.4488	8.0876	8.3327	1419.37
	7	11.91	4.0802	1.7013	7.7749	6.5306	25.5337	6.4558	7.1365	8.1662	8.3327	1419.37
brams Creek	8	11.91	3.9725	1.6549	7.5629	6.4065	24.8878	6.5198	7.1783	8.1762	8.3336	1398.24
	8	12.38	3.9719	1.594	7.2846	6.4675	24.0652	6.0804	6.9551	8.4183	8.3336	1398.24
edbud Creek	9	12.38	3.9303	1.577	7.2069	6.4176	23.8282	6.0925	6.9651	8.4256	8.3351	1390.13
	9	13.16	3.9295	1.4874	6.7974	6.5073	22.6108	5.8324	6.8491	8.6645	8.3351	1390.13
Marsh Creek	10	13.16	3.857	1.4595	6.6699	6.4243	22.2145	5.8199	6.8447	8.6539	8.3375	1375.31
	10	13.5	3.8566	1.424	6.5077	6.4599	21.7284	5.4069	6.6308	8.7871	8.3375	1375.31
	10	14	3.8561	1.3732	6.2755	6.5107	21.0329	4.9711	6.3975	8.8532	8.3375	1375.31
	10	14.5	3.8555	1.3243	6.0521	6.5597	20.3596	4.6746	6.2413	8.903	8.3375	1375.31
	10	15	3.855	1.2771	5.8363	6.607	19.7078	4.42	6.1449	8.9022	8.3375	1375.31
	10	15.51	3.8544	1.2308	5.6248	6.6534	19.0645	4.2344	6.0939	8.8803	8.3375	1375.31
Lick Run	11	15.51	3.785	1.2078	5.5196	6.558	18.7423	4.2828	6.1321	8.8565	8.3408	1359.7
	11	16	3.7845	1.1689	5.3419	6.5969	18.2	4.4738	6.2719	8.8355	8.3408	1359.7
	11	16.5	3.784	1.1305	5.1664	6.6354	17.6628	4.6551	6.3968	8.7964	8.3408	1359.7
	11	17	3.7835	1.0934	4.9968	6.6726	17.1415	4.832	6.5078	8.7857	8.3408	1359.7
	11	17.5	3.783	1.0575	4.8328	6.7088	16.6355	4.9768	6.6081	8.8352	8.3408	1359.7
	11	18.07	3.7824	1.0181	4.6527	6.7481	16.0769	5.1093	6.712	8.9397	8.3408	1359.7
NWRF	12	18.07	3.7813	1.0178	4.6513	6.7466	16.0725	5.1076	6.7123	8.9273	8.3429	1359.46
	12	18.26	3.7811	1.006	4.5974	6.7584	15.9052	5.4911	6.917	8.9117	8.3429	1359.46
ɜarbrook Run	13	18.26	3.7504	0.9975	4.5586	6.7124	15.7854	5.5204	6.9277	8.885	8.3446	1352.86
	13	18.5	3.7502	0.983	4.4923	6.7269	15.5793	5.7882	7.0793	8.9048	8.3446	1352.86
	13	19	3.7497	0.9535	4.3575	6.7565	15.1584	6.1834	7.3087	8.9469	8.3446	1352.86
	13	19.42	3.7493	0.9293	4.2469	6.7807	14.8137	6.4119	7.4394	8.998	8.3446	1352.86
Slate Run	14	19.42	3.6794	0.9113	4.1646	6.6819	14.5586	6.4241	7.4473	9.0071	8.3464	1338.19
	14	19.83	3.6791	0.8906	4.0700	6.7027	14.2603	6.3784	7.4618	9.1657	8.3464	1338.19
Turkey Run	15	19.83	3.5299	0.8531	3.8987	6.4934	13.7281	6.4428	7.4761	9.1034	8.3517	1307
	15	26	3.5247	0.6088	2.7822	6.7385	10.1349	6.5935	7.8524	9.8284	8.3517	1307

3mgd_cloudy

	Model Reach	Output MP	OrgN (mg/L)	NH4 (mg/L)	NBODu (mg/L) - calc	NO2+NO3 (mg/L)	CBODu (mg/L)	Daily Minimum DO (mg/L)	Daily Average DO (mg/L)	Daily Maximum DO (mg/L)	DO Saturation (mg/L)	Conductivity (umhos/cm)
Upstream	1	-0.8	0.1367	0.0042	0.0192	1.9785	1.784	8.2035	8.6785	9.1535	8.2953	542.11
	1	-0.4	0.1366	0.0036	0.0165	1.9787	1.6123	7.822	8.6876	10.3319	8.2953	542.11
	1	0	0.1365	0.003	0.0137	1.9789	1.4571	7.6395	8.6979	10.5612	8.2953	542.11
PMWWTF	2	0	1.3182	0.8663	3.9590	0.6754	33.5826	7.1888	7.3217	7.5526	8.3026	1371.32
	2	0.5	1.3179	0.8266	3.7776	0.715	32.2036	6.5264	7.0785	8.1221	8.3026	1371.32
	2	1	1.3177	0.7887	3.6044	0.7527	30.8813	6.3113	7.0207	8.3859	8.3026	1371.32
	2	1.5	1.3175	0.7526	3.4394	0.7888	29.6132	6.2591	7.038	8.5033	8.3026	1371.32
	2	2	1.3173	0.7181	3.2817	0.8232	28.3972	6.2771	7.0847	8.5693	8.3026	1371.32
	2	2.37	1.3171	0.6936	3.1698	0.8476	27.5297	6.3099	7.1266	8.6066	8.3026	1371.32
Wrights Run	3	2.37	1.2599	0.6566	3.0007	0.8059	26.183	6.4168	7.2144	8.6398	8.3109	1326.79
	3	3	1.2594	0.5908	2.7000	0.8715	23.8243	5.1041	6.07	7.6526	8.3109	1326.79
	3	3.5	1.2589	0.5433	2.4829	0.9188	22.1045	4.6271	5.7006	7.1162	8.3109	1326.79
	3	4	1.2585	0.4997	2.2836	0.9623	20.5089	4.5157	5.591	6.8849	8.3109	1326.79
	3	4.5	1.2581	0.4595	2.0999	1.0023	19.0284	4.6186	5.6279	6.8957	8.3109	1326.79
	3	5	1.2577	0.4226	1.9313	1.0391	17.6548	4.8014	5.7443	6.9899	8.3109	1326.79
	3	5.5	1.2573	0.3886	1.7759	1.0729	16.3804	4.9639	5.9011	7.1466	8.3109	1326.79
	3	5.91	1.2569	0.3628	1.6580	1.0986	15.4043	5.0956	6.0435	7.3005	8.3109	1326.79
lalo Lick Run	4	5.91	1.2225	0.3514	1.6059	1.0793	14.9692	5.2479	6.1617	7.3747	8.3164	1301.2
	4	6.5	1.222	0.3139	1.4345	1.1166	13.5318	6.2813	7.3564	9.1497	8.3164	1301.2
FCL	5	6.5	1.3427	0.4845	2.2142	1.0975	15.2079	6.0108	7.0824	8.8409	8.3199	1304.47
	5	7	1.3423	0.4481	2.0478	1.1338	14.1812	5.8064	7.1944	9.5043	8.3199	1304.47
	5	7.5	1.3419	0.4145	1.8943	1.1674	13.2239	5.7347	7.3133	9.7787	8.3199	1304.47
	5	8.01	1.3415	0.3827	1.7489	1.199	12.314	5.7649	7.4341	9.8712	8.3199	1304.47
ır Spring Run	6	8.01	1.2998	0.3682	1.6827	1.218	11.8934	5.8128	7.4494	9.775	8.3272	1276.86
	6	8.5	1.2994	0.3405	1.5561	1.2456	11.0886	5.9511	7.5956	9.927	8.3272	1276.86
	6	9	1.299	0.3144	1.4368	1.2716	10.3234	6.1047	7.7197	10.0408	8.3272	1276.86
	6	9.5	1.2986	0.2902	1.3262	1.2956	9.6111	6.2206	7.8276	10.1528	8.3272	1276.86
	6	10	1.2982	0.268	1.2248	1.3178	8.9479	6.3253	7.924	10.2383	8.3272	1276.86
	6	10.5	1.2978	0.2474	1.1306	1.3382	8.3304	6.407	8.0117	10.3306	8.3272	1276.86
	6	11	1.2973	0.2284	1.0438	1.3571	7.7556	6.4887	8.0923	10.4116	8.3272	1276.86
	6	11.62	1.2968	0.2069	0.9455	1.3785	7.0976	6.5796	8.1838	10.5042	8.3272	1276.86
OWRF	7	11.62	3.5105	1.6101	7.3582	3.4048	25.0408	6.9249	7.4567	8.2154	8.3327	1425.81
	7	11.91	3.5102	1.5745	7.1955	3.4404	24.5436	6.4712	7.197	8.2901	8.3327	1425.81
brams Creek	8	11.91	3.4252	1.5349	7.0145	3.4039	23.9729	6.5308	7.234	8.2952	8.3336	1406.17
	8	12.38	3.4248	1.481	6.7682	3.4578	23.2176	6.1789	7.0585	8.5066	8.3336	1406.17
edbud Creek	9	12.38	3.3918	1.4665	6.7019	3.4413	23.0073	6.1905	7.0667	8.5059	8.3351	1398.61
	9	13.16	3.3911	1.3869	6.3381	3.521	21.8857	5.9895	6.9817	8.7331	8.3351	1398.61
Marsh Creek	10	13.16	3.3335	1.3629	6.2285	3.4962	21.5321	5.9757	6.9753	8.7209	8.3375	1384.76
	10	13.5	3.3332	1.3312	6.0836	3.528	21.0825	5.5962	6.7843	8.8648	8.3375	1384.76
	10	14	3.3327	1.2859	5.8766	3.5733	20.4383	5.1979	6.5755	8.9572	8.3375	1384.76
	10	14.5	3.3323	1.2421	5.6764	3.6171	19.8138	4.9258	6.4352	9.0113	8.3375	1384.76
	10	15	3.3318	1.1999	5.4835	3.6594	19.2084	4.7019	6.348	9.0309	8.3375	1384.76
	10	15.51	3.3314	1.1583	5.2934	3.7011	18.6099	4.5253	6.3012	9.0278	8.3375	1384.76
Lick Run	11	15.51	3.2763	1.1383	5.2020	3.664	18.3195	4.5606	6.333	9.0072	8.3408	1370.15
	11	16	3.2759	1.1033	5.0421	3.6991	17.8132	4.7319	6.4588	8.9855	8.3408	1370.15
	11	16.5	3.2754	1.0686	4.8835	3.7337	17.311	4.8989	6.5709	8.9425	8.3408	1370.15
	11	17	3.275	1.0351	4.7304	3.7673	16.8229	5.0559	6.6704	8.9203	8.3408	1370.15
	11	17.5	3.2746	1.0026	4.5819	3.7998	16.3486	5.1853	6.76	8.9514	8.3408	1370.15
	11	18.07	3.2741	0.9668	4.4183	3.8357	15.8241	5.3011	6.8527	9.0371	8.3408	1370.15
NWRF	12	18.07	3.2732	0.9666	4.4174	3.8351	15.8201	5.2849	6.853	9.0275	8.3429	1369.93
	12	18.26	3.2731	0.9559	4.3685	3.8458	15.6629	5.6452	7.0394	8.9959	8.3429	1369.93
earbrook Run	13	18.26	3.2487	0.9484	4.3342	3.8262	15.5538	5.6714	7.0483	8.9699	8.3446	1363.74
	13	18.5	3.2485	0.9352	4.2739	3.8394	15.3598	5.9231	7.1863	8.9757	8.3446	1363.74
	13	19	3.2481	0.9083	4.1509	3.8663	14.9633	6.3011	7.3947	8.9953	8.3446	1363.74
	13	19.42	3.2478	0.8864	4.0508	3.8883	14.6382	6.5157	7.5133	9.0396	8.3446	1363.74
Slate Run	14	19.42	3.1921	0.8705	3.9782	3.8492	14.4048	6.523	7.5193	9.0467	8.3464	1349.93
	14	19.83	3.1918	0.8515	3.8914	3.8683	14.1226	6.4792	7.5314	9.1944	8.3464	1349.93
Turkey Run	15	19.83	3.0724	0.8181	3.7387	3.7859	13.6329	6.5359	7.5419	9.1346	8.3517	1320.45
	15	26	3.068	0.5921	2.7059	4.0125	10.195	6.6653	7.8793	9.8133	8.3517	1320.45

4mgd_cloudy

	Model Reach	Output MP	OrgN (mg/L)	NH4 (mg/L)	NBODu (mg/L) - calc	NO2+NO3 (mg/L)	CBODu (mg/L)	Daily Minimum DO (mg/L)	Daily Average DO (mg/L)	Daily Maximum DO (mg/L)	DO Saturation (mg/L)	Conductivity (umhos/cm)
Upstream	1	-0.8	0.1367	0.0042	0.0192	1.9785	1.784	8.2035	8.6785	9.1535	8.2953	542.11
	1	-0.4	0.1366	0.0036	0.0165	1.9787	1.6123	7.822	8.6876	10.3319	8.2953	542.11
	1	0	0.1365	0.003	0.0137	1.9789	1.4571	7.6395	8.6979	10.5612	8.2953	542.11
PMWWTF	2	0	1.359	0.8963	4.0961	0.636	34.697	7.1689	7.272	7.4511	8.3026	1400.19
	2	0.5	1.3588	0.8609	3.9343	0.6713	33.4701	6.6687	7.1407	8.0361	8.3026	1400.19
	2	1	1.3586	0.8269	3.7789	0.7052	32.2866	6.508	7.1193	8.3089	8.3026	1400.19
	2	1.5	1.3584	0.7943	3.6300	0.7378	31.1449	6.4721	7.1422	8.4252	8.3026	1400.19
	2	2	1.3582	0.7629	3.4865	0.769	30.0436	6.4865	7.1824	8.4861	8.3026	1400.19
	2	2.37	1.358	0.7405	3.3841	0.7914	29.2537	6.5121	7.2164	8.5226	8.3026	1400.19
Wrights Run	3	2.37	1.3114	0.7095	3.2424	0.761	28.1238	6.5839	7.2815	8.5639	8.3109	1364.01
	3	3	1.3109	0.6476	2.9595	0.8227	25.9188	5.341	6.1923	7.6681	8.3109	1364.01
	3	3.5	1.3106	0.6023	2.7525	0.8679	24.2925	4.8792	5.8225	7.2058	8.3109	1364.01
	3	4	1.3102	0.5602	2.5601	0.9099	22.7682	4.7185	5.6932	6.9765	8.3109	1364.01
	3	4.5	1.3098	0.5211	2.3814	0.9489	21.3396	4.7452	5.7012	6.9393	8.3109	1364.01
	3	5	1.3095	0.4847	2.2151	0.9852	20.0006	4.8711	5.7854	7.0128	8.3109	1364.01
	3	5.5	1.3091	0.4508	2.0602	1.0189	18.7457	5.0285	5.9098	7.1239	8.3109	1364.01
	3	5.91	1.3088	0.4248	1.9413	1.0448	17.7756	5.149	6.0268	7.2397	8.3109	1364.01
falo Lick Run	4	5.91	1.2803	0.4142	1.8929	1.0309	17.3717	5.27	6.1206	7.2979	8.3164	1342.84
	4	6.5	1.2799	0.3756	1.7165	1.0694	15.9135	6.3105	7.2757	8.8962	8.3164	1342.84
FCL	5	6.5	1.3742	0.5095	2.3284	1.0558	17.1678	6.0867	7.0599	8.6657	8.3199	1344
	5	7	1.3738	0.4759	2.1749	1.0893	16.1513	5.9009	7.1483	9.2752	8.3199	1344
	5	7.5	1.3735	0.4445	2.0314	1.1206	15.195	5.8557	7.2463	9.5232	8.3199	1344
	5	8.01	1.3731	0.4147	1.8952	1.1504	14.2779	5.8578	7.3484	9.6492	8.3199	1344
ır Spring Run	6	8.01	1.3386	0.402	1.8371	1.1672	13.8769	5.8895	7.3635	9.5719	8.3272	1320.53
	6	8.5	1.3382	0.3753	1.7151	1.1938	13.0493	5.9985	7.4892	9.7102	8.3272	1320.53
	6	9	1.3379	0.3499	1.5990	1.2191	12.2557	6.1266	7.5978	9.7861	8.3272	1320.53
	6	9.5	1.3375	0.3262	1.4907	1.2427	11.5104	6.218	7.6935	9.898	8.3272	1320.53
	6	10	1.3371	0.3041	1.3897	1.2647	10.8104	6.3226	7.7803	9.9695	8.3272	1320.53
	6	10.5	1.3368	0.2836	1.2961	1.2852	10.153	6.4004	7.86	10.0503	8.3272	1320.53
	6	11	1.3364	0.2644	1.2083	1.3042	9.5356	6.4747	7.9341	10.1239	8.3272	1320.53
	6	11.62	1.336	0.2424	1.1078	1.3261	8.8218	6.5593	8.019	10.2102	8.3272	1320.53
OWRF	7	11.62	3.3614	1.5197	6.9450	3.235	24.3647	6.8851	7.4483	8.2722	8.3327	1431.3
	7	11.91	3.3611	1.4875	6.7979	3.2671	23.9025	6.4902	7.2294	8.3661	8.3327	1431.3
brams Creek	8	11.91	3.2858	1.4528	6.6393	3.2372	23.3881	6.5459	7.263	8.3683	8.3336	1412.95
	8	12.38	3.2854	1.4041	6.4167	3.2861	22.6832	6.2546	7.126	8.5642	8.3336	1412.95
edbud Creek	9	12.38	3.2561	1.3913	6.3582	3.2724	22.4928	6.2659	7.133	8.5619	8.3351	1405.87
	9	13.16	3.2554	1.319	6.0278	3.3447	21.443	6.1057	7.0738	8.7755	8.3351	1405.87
Marsh Creek	10	13.16	3.2041	1.2978	5.9309	3.3246	21.1215	6.0921	7.0664	8.7623	8.3375	1392.88
	10	13.5	3.2038	1.2688	5.7984	3.3535	20.6992	5.7372	6.8921	8.911	8.3375	1392.88
	10	14	3.2034	1.2275	5.6097	3.3949	20.0934	5.3679	6.7011	9.0196	8.3375	1392.88
	10	14.5	3.203	1.1875	5.4269	3.4349	19.5054	5.1125	6.5723	9.0724	8.3375	1392.88
	10	15	3.2026	1.1488	5.2500	3.4737	18.9346	4.9109	6.4917	9.1062	8.3375	1392.88
	10	15.51	3.2021	1.1106	5.0754	3.5119	18.3696	4.7438	6.4478	9.1162	8.3375	1392.88
Lick Run	11	15.51	3.153	1.0928	4.9941	3.4804	18.1033	4.7679	6.475	9.099	8.3408	1379.15
	11	16	3.1526	1.0606	4.8469	3.5127	17.6237	4.9262	6.5908	9.0791	8.3408	1379.15
	11	16.5	3.1522	1.0287	4.7012	3.5446	17.1475	5.0835	6.6936	9.0353	8.3408	1379.15
	11	17	3.1518	0.9977	4.5595	3.5756	16.6842	5.2265	6.7846	9.006	8.3408	1379.15
	11	17.5	3.1514	0.9677	4.4224	3.6057	16.2333	5.3453	6.8663	9.0233	8.3408	1379.15
	11	18.07	3.151	0.9346	4.2711	3.6388	15.7342	5.4496	6.9508	9.0931	8.3408	1379.15
NWRF	12	18.07	3.1502	0.9344	4.2702	3.6383	15.7305	5.4215	6.9511	9.0857	8.3429	1378.95
	12	18.26	3.15	0.9245	4.2250	3.6482	15.5807	5.7637	7.1246	9.0437	8.3429	1378.95
ɜarbrook Run	13	18.26	3.1282	0.9177	4.1939	3.6315	15.4798	5.7875	7.1323	9.0185	8.3446	1373.11
	13	18.5	3.1281	0.9055	4.1381	3.6437	15.2947	6.0264	7.2605	9.0144	8.3446	1373.11
	13	19	3.1277	0.8806	4.0243	3.6687	14.9162	6.3918	7.454	9.0257	8.3446	1373.11
	13	19.42	3.1274	0.8601	3.9307	3.6891	14.6056	6.595	7.564	9.0593	8.3446	1373.11
Slate Run	14	19.42	3.0775	0.8457	3.8648	3.6561	14.3885	6.5981	7.5688	9.0649	8.3464	1360.08
	14	19.83	3.0772	0.8281	3.7844	3.6738	14.1181	6.5557	7.5788	9.2032	8.3464	1360.08
Turkey Run	15	19.83	2.9699	0.7977	3.6455	3.604	13.6604	6.6066	7.5869	9.1462	8.3517	1332.14
	15	26	2.9659	0.5847	2.6721	3.8174	10.3339	6.7214	7.8936	9.7868	8.3517	1332.14

5mgd_cloudy

	Model Reach	Output MP	OrgN (mg/L)	NH4 (mg/L)	NBODu (mg/L) - calc	NO2+NO3 (mg/L)	CBODu (mg/L)	Daily Minimum DO (mg/L)	Daily Average DO (mg/L)	Daily Maximum DO (mg/L)	DO Saturation (mg/L)	Conductivity (umhos/cm)
Upstream	1	-0.8	0.1367	0.0042	0.0192	1.9785	1.784	8.2035	8.6785	9.1535	8.2953	542.11
	1	-0.4	0.1366	0.0036	0.0165	1.9787	1.6123	7.822	8.6876	10.3319	8.2953	542.11
	1	0	0.1365	0.003	0.0137	1.9789	1.4571	7.6395	8.6979	10.5612	8.2953	542.11
PMWWTF	2	0	1.3848	0.9153	4.1829	0.6111	35.403	7.1563	7.2405	7.3868	8.3026	1418.48
	2	0.5	1.3846	0.8832	4.0362	0.6431	34.292	6.7766	7.193	7.9843	8.3026	1418.48
	2	1	1.3845	0.8523	3.8950	0.674	33.2159	6.6566	7.1999	8.2609	8.3026	1418.48
	2	1.5	1.3843	0.8224	3.7584	0.7038	32.1736	6.6335	7.2284	8.384	8.3026	1418.48
	2	2	1.3841	0.7936	3.6268	0.7325	31.1639	6.6472	7.2651	8.4431	8.3026	1418.48
	2	2.37	1.384	0.7729	3.5322	0.7531	30.4372	6.6684	7.2941	8.4728	8.3026	1418.48
Wrights Run	3	2.37	1.3447	0.7463	3.4106	0.7294	29.4661	6.7184	7.345	8.5251	8.3109	1388.07
	3	3	1.3443	0.688	3.1442	0.7875	27.4013	5.5439	6.3135	7.6797	8.3109	1388.07
	3	3.5	1.344	0.6451	2.9481	0.8304	25.8661	5.1141	5.9515	7.2782	8.3109	1388.07
	3	4	1.3437	0.6048	2.7639	0.8705	24.4169	4.9288	5.8127	7.0674	8.3109	1388.07
	3	4.5	1.3433	0.567	2.5912	0.9082	23.0489	4.9185	5.8023	7.0051	8.3109	1388.07
	3	5	1.343	0.5316	2.4294	0.9435	21.7575	4.9979	5.8641	7.0539	8.3109	1388.07
	3	5.5	1.3427	0.4985	2.2781	0.9766	20.5385	5.1254	5.965	7.1468	8.3109	1388.07
	3	5.91	1.3424	0.4728	2.1607	1.0021	19.5901	5.2375	6.0629	7.2384	8.3109	1388.07
falo Lick Run	4	5.91	1.3181	0.463	2.1159	0.9915	19.2182	5.3312	6.1398	7.2861	8.3164	1370.06
	4	6.5	1.3177	0.4243	1.9391	1.0302	17.7722	6.3627	7.2462	8.7379	8.3164	1370.06
FCL	5	6.5	1.3951	0.5343	2.4418	1.02	18.7617	6.1724	7.0676	8.5534	8.3199	1370.23
	5	7	1.3948	0.5026	2.2969	1.0515	17.7639	5.9974	7.1356	9.1178	8.3199	1370.23
	5	7.5	1.3945	0.4729	2.1612	1.0812	16.8192	5.9625	7.2167	9.3519	8.3199	1370.23
	5	8.01	1.3941	0.4443	2.0305	1.1097	15.9072	5.9524	7.3038	9.4652	8.3199	1370.23
ır Spring Run	6	8.01	1.3647	0.4329	1.9784	1.1249	15.5283	5.9745	7.3176	9.4358	8.3272	1349.9
	6	8.5	1.3644	0.407	1.8600	1.1507	14.6939	6.0682	7.4274	9.5385	8.3272	1349.9
	6	9	1.3641	0.3822	1.7467	1.1754	13.8886	6.1707	7.5236	9.5928	8.3272	1349.9
	6	9.5	1.3637	0.3589	1.6402	1.1987	13.1275	6.2483	7.6094	9.6923	8.3272	1349.9
	6	10	1.3634	0.337	1.5401	1.2205	12.4081	6.3422	7.6878	9.7636	8.3272	1349.9
	6	10.5	1.3631	0.3164	1.4459	1.2409	11.7281	6.417	7.7606	9.8315	8.3272	1349.9
	6	11	1.3628	0.2971	1.3577	1.2602	11.0854	6.4852	7.8287	9.9007	8.3272	1349.9
	6	11.62	1.3624	0.2748	1.2558	1.2824	10.3371	6.5645	7.9075	9.9785	8.3272	1349.9
OWRF	7	11.62	3.2329	1.4453	6.6050	3.085	23.9316	6.86	7.4406	8.3194	8.3327	1436.04
	7	11.91	3.2327	1.416	6.4711	3.1143	23.4964	6.5106	7.2535	8.4191	8.3327	1436.04
brams Creek	8	11.91	3.1652	1.3852	6.3304	3.0897	23.0255	6.5628	7.2843	8.4193	8.3336	1418.82
	8	12.38	3.1649	1.3406	6.1265	3.1344	22.3596	6.3183	7.1773	8.6034	8.3336	1418.82
edbud Creek	9	12.38	3.1385	1.3292	6.0744	3.1229	22.1847	6.3293	7.1834	8.5998	8.3351	1412.17
	9	13.16	3.1379	1.2629	5.7715	3.1893	21.1905	6.2003	7.1443	8.8015	8.3351	1412.17
Marsh Creek	10	13.16	3.0917	1.2439	5.6846	3.1728	20.8939	6.1873	7.1363	8.7877	8.3375	1399.93
	10	13.5	3.0915	1.2172	5.5626	3.1995	20.4927	5.8518	6.9748	8.9381	8.3375	1399.93
	10	14	3.0911	1.1791	5.3885	3.2376	19.9167	5.5061	6.7974	9.0575	8.3375	1399.93
	10	14.5	3.0907	1.1422	5.2199	3.2746	19.3568	5.2629	6.6773	9.1064	8.3375	1399.93
	10	15	3.0904	1.1065	5.0567	3.3103	18.8127	5.0784	6.6017	9.1508	8.3375	1399.93
	10	15.51	3.09	1.0711	4.8949	3.3457	18.2735	4.9201	6.5598	9.1707	8.3375	1399.93
Lick Run	11	15.51	3.0457	1.0551	4.8218	3.3188	18.0259	4.9346	6.5836	9.1565	8.3408	1386.99
	11	16	3.0453	1.0252	4.6852	3.3487	17.567	5.0832	6.6915	9.1397	8.3408	1386.99
	11	16.5	3.045	0.9955	4.5494	3.3784	17.1108	5.2332	6.787	9.0971	8.3408	1386.99
	11	17	3.0446	0.9667	4.4178	3.4072	16.6664	5.3654	6.8713	9.0637	8.3408	1386.99
	11	17.5	3.0443	0.9388	4.2903	3.4352	16.2336	5.4736	6.9469	9.0706	8.3408	1386.99
	11	18.07	3.0438	0.9079	4.1491	3.4661	15.7538	5.5675	7.0248	9.1268	8.3408	1386.99
NWRF	12	18.07	3.0431	0.9077	4.1482	3.4657	15.7503	5.5345	7.025	9.1216	8.3429	1386.79
	12	18.26	3.043	0.8985	4.1061	3.4749	15.6063	5.8615	7.1888	9.0716	8.3429	1386.79
ɜarbrook Run	13	18.26	3.0233	0.8923	4.0778	3.4605	15.5117	5.8835	7.1956	9.0554	8.3446	1381.28
	13	18.5	3.0232	0.8809	4.0257	3.4719	15.3334	6.1117	7.3163	9.045	8.3446	1381.28
	13	19	3.0228	0.8576	3.9192	3.4952	14.9687	6.4663	7.4984	9.0437	8.3446	1381.28
	13	19.42	3.0226	0.8385	3.8319	3.5144	14.669	6.6603	7.6017	9.0672	8.3446	1381.28
Slate Run	14	19.42	2.9775	0.8253	3.7716	3.4862	14.4646	6.6596	7.6056	9.0716	8.3464	1368.95
	14	19.83	2.9773	0.8087	3.6958	3.5028	14.2032	6.6182	7.6139	9.2017	8.3464	1368.95
Turkey Run	15	19.83	2.8799	0.7809	3.5687	3.4432	13.7706	6.6644	7.6203	9.1476	8.3517	1342.41
	15	26	2.8762	0.579	2.6460	3.6455	10.5258	6.3862	7.7701	9.8804	8.3517	1342.41

Winter Notes

Sheet	Description
2mgd_cloudy_winter	Winter wet, 2MGD, cloudy conditions, temp=15.7C
3mgd_cloudy_winter	Winter wet, 3MGD, cloudy conditions, temp=15.7C
43mgd_cloudy_winter	Winter wet, 4.3MGD, cloudy conditions, temp=15.7C
63mgd_cloudy_winter	Winter wet, 6.3MGD, cloudy conditions, temp=15.7C
76mgd_cloudy_winter	Winter wet, 7.6MGD, cloudy conditions, temp=15.7C
2mgd_cloudyT_winter	Winter wet, 2MGD, cloudy conditions, temp=14C
3mgd_cloudyT_winter	Winter wet, 3MGD, cloudy conditions, temp=14C
43mgd_cloudyT_winter	Winter wet, 4.3MGD, cloudy conditions, temp=14C
63mgd_cloudyT_winter	Winter wet, 6.3MGD, cloudy conditions, temp=14C
76mgd_cloudyT_winter	Winter wet, 7.6MGD, cloudy conditions, temp=14C
2mgd_cloudyB_winter	Winter wet, 2MGD, cloudy conditions, temp=15.7C, BOD5=7.5
3mgd_cloudyB_winter	Winter wet, 3MGD, cloudy conditions, temp=15.7C, BOD5=7.5
43mgd_cloudyB_winter	Winter wet, 4.3MGD, cloudy conditions, temp=15.7C, BOD5=7.5
63mgd_cloudyB_winter	Winter wet, 6.3MGD, cloudy conditions, temp=15.7C, BOD5=7.5
76mgd_cloudyB_winter	Winter wet, 7.6MGD, cloudy conditions, temp=15.7C, BOD5=7.5
2mgd_cloudyE_winter	Winter wet, 2MGD w/ ENR, cloudy conditions, temp=15.7C
3mgd_cloudyE_winter	Winter wet, 3MGD w/ ENR, cloudy conditions, temp=15.7C
43mgd_cloudyE_winter	Winter wet, 4.3MGD w/ ENR, cloudy conditions, temp=15.7C
63mgd_cloudyE_winter	Winter wet, 6.3MGD w/ ENR, cloudy conditions, temp=15.7C
76mgd_cloudyE_winter	Winter wet, 7.6MGD w/ ENR, cloudy conditions, temp=15.7C

2mgd_cloudy_winter

	Model Reach	Output MP	OrgN (mg/L)	NH4 (mg/L)	NBODu (mg/L) - calc	NO2+NO3 (mg/L)	CBODu (mg/L)	Daily Minimum DO (mg/L)	Daily Average DO (mg/L)	Daily Maximum DO (mg/L)	DO Saturation (mg/L)	Conductivity (umhos/cm)
Upstream	1	-0.8	0.1367	0.0042	0.0192	1.9781	1.784	8.2035	8.6785	9.1535	9.7154	542.11
	1	-0.4	0.1367	0.004	0.0183	1.9782	1.7167	9.0293	9.5294	10.6016	9.7154	542.11
	1	0	0.1366	0.0038	0.0174	1.9782	1.6518	9.1891	9.781	11.2141	9.7154	542.11
PMWWTF	2	0	4.3352	2.141	9.7844	10.7277	42.8399	7.8735	8.1249	8.6142	9.7239	1127.18
	2	0.5	4.3346	2.0851	9.5289	10.7835	41.5651	7.455	8.0219	9.3614	9.7239	1127.18
	2	1	4.334	2.0307	9.2803	10.8378	40.3281	7.3028	8.0039	9.6942	9.7239	1127.18
	2	1.5	4.3334	1.9778	9.0385	10.8907	39.128	7.2445	8.0259	9.8402	9.7239	1127.18
	2	2	4.3329	1.9262	8.8027	10.9423	37.9636	7.2453	8.0662	9.8734	9.7239	1127.18
	2	2.37	4.3324	1.8889	8.6323	10.9795	37.1243	7.265	8.1016	9.8929	9.7239	1127.18
Wrights Run	3	2.37	3.7569	1.6232	7.4180	9.441	32.2331	7.3812	8.1947	9.6787	9.7337	1044.62
	3	3	3.7557	1.5346	7.0131	9.5295	30.2294	6.2623	7.1627	8.8184	9.7337	1044.62
	3	3.5	3.7548	1.4677	6.7074	9.5963	28.7282	5.7426	6.7452	8.201	9.7337	1044.62
	3	4	3.7538	1.4038	6.4154	9.6602	27.3015	5.4853	6.5452	7.8402	9.7337	1044.62
	3	4.5	3.7529	1.3427	6.1361	9.7212	25.9457	5.4996	6.483	7.7774	9.7337	1044.62
	3	5	3.7519	1.2842	5.8688	9.7797	24.6573	5.5974	6.5071	7.7661	9.7337	1044.62
	3	5.5	3.751	1.2283	5.6133	9.8356	23.4328	5.7122	6.5841	7.8345	9.7337	1044.62
	3	5.91	3.7502	1.1843	5.4123	9.8796	22.4742	5.7896	6.6713	7.9455	9.7337	1044.62
falo Lick Run	4	5.91	3.464	1.0898	4.9804	9.1272	20.8161	6.0689	6.9173	8.0423	9.74	1003.06
	4	6.5	3.463	1.0282	4.6989	9.1887	19.4756	7.2097	8.1885	10.1573	9.74	1003.06
FCL	5	6.5	3.4863	1.1451	5.2331	8.7797	20.5922	6.8291	7.9028	9.6915	9.7442	1014.03
	5	7	3.4856	1.1001	5.0275	8.8247	19.6681	6.7519	8.0437	10.4941	9.7442	1014.03
	5	7.5	3.4848	1.0568	4.8296	8.8679	18.7854	6.7686	8.1647	10.7981	9.7442	1014.03
	5	8.01	3.4841	1.0144	4.6358	8.9102	17.9259	6.7191	8.2743	10.8143	9.7442	1014.03
ır Spring Run	6	8.01	3.1869	0.9216	4.2117	8.2367	16.4173	6.7208	8.2321	10.4622	9.7527	976.33
	6	8.5	3.1862	0.8865	4.0513	8.2718	15.7031	6.9355	8.448	10.7739	9.7527	976.33
	6	9	3.1855	0.852	3.8936	8.3062	15.0063	7.1492	8.6037	11.0228	9.7527	976.33
	6	9.5	3.1848	0.8189	3.7424	8.3393	14.3404	7.2357	8.7207	11.1175	9.7527	976.33
	6	10	3.1841	0.7871	3.5970	8.3711	13.7041	7.3415	8.8145	11.1896	9.7527	976.33
	6	10.5	3.1834	0.7565	3.4572	8.4017	13.096	7.4345	8.8938	11.28	9.7527	976.33
	6	11	3.1827	0.7271	3.3228	8.431	12.5149	7.488	8.9638	11.3443	9.7527	976.33
	6	11.62	3.1818	0.6923	3.1638	8.4659	11.83	7.5698	9.0419	11.426	9.7527	976.33
OWRF	7	11.62	5.1881	2.3871	10.9090	5.3319	60.3382	7.1835	7.5482	8.0767	9.7592	1377.99
	7	11.91	5.1879	2.3657	10.8112	5.3532	59.7208	6.7657	7.2796	8.1247	9.7592	1377.99
brams Creek	8	11.91	4.9823	2.2695	10.3716	5.2162	57.3662	6.8232	7.336	8.1184	9.7602	1348.19
	8	12.38	4.982	2.2375	10.2254	5.2483	56.441	6.4993	7.1758	8.4209	9.7602	1348.19
edbud Creek	9	12.38	4.9043	2.2021	10.0636	5.1935	55.5764	6.4735	7.1872	8.3913	9.762	1336.96
	9	13.16	4.9038	2.1539	9.8433	5.2416	54.1885	6.2396	7.0839	8.7736	9.762	1336.96
Marsh Creek	10	13.16	4.7701	2.0944	9.5714	5.1546	52.7292	6.1901	7.0709	8.6629	9.7647	1316.61
	10	13.5	4.7699	2.075	9.4828	5.1739	52.1726	5.7848	6.8065	8.7274	9.7647	1316.61
	10	14	4.7696	2.0469	9.3543	5.202	51.3648	5.328	6.4772	8.7805	9.7647	1316.61
	10	14.5	4.7692	2.0192	9.2277	5.2297	50.5694	4.9581	6.2094	8.7703	9.7647	1316.61
	10	15	4.7689	1.9918	9.1025	5.2571	49.7864	4.6951	5.9939	8.714	9.7647	1316.61
	10	15.51	4.7686	1.9643	8.9769	5.2846	49.0003	4.4214	5.8197	8.6297	9.7647	1316.61
Lick Run	11	15.51	4.6427	1.9109	8.7328	5.1831	47.7145	4.396	5.8828	8.516	9.7686	1295.5
	11	16	4.6424	1.8876	8.6263	5.2063	47.0507	4.4866	5.9601	8.5429	9.7686	1295.5
	11	16.5	4.6421	1.8642	8.5194	5.2298	46.3829	4.5717	6.0347	8.5631	9.7686	1295.5
	11	17	4.6418	1.841	8.4134	5.2529	45.7246	4.6843	6.1058	8.568	9.7686	1295.5
	11	17.5	4.6415	1.8182	8.3092	5.2758	45.0756	4.7944	6.1737	8.5727	9.7686	1295.5
	11	18.07	4.6412	1.7924	8.1913	5.3015	44.347	4.8666	6.2478	8.5999	9.7686	1295.5
NWRF	12	18.07	4.6391	1.7916	8.1876	5.2998	44.327	4.6987	6.2486	8.5079	9.7711	1295.17
	12	18.26	4.639	1.7838	8.1520	5.3076	44.1063	5.0857	6.5298	8.6117	9.7711	1295.17
ɜarbrook Run	13	18.26	4.5836	1.7617	8.0510	5.2587	43.581	5.1283	6.5502	8.6037	9.7731	1286.36
	13	18.5	4.5835	1.7521	8.0071	5.2683	43.3092	5.4242	6.7708	8.6947	9.7731	1286.36
	13	19	4.5832	1.7323	7.9166	5.2881	42.7484	5.9518	7.1377	8.9066	9.7731	1286.36
	13	19.42	4.583	1.7158	7.8412	5.3046	42.2829	6.2848	7.3706	9.0702	9.7731	1286.36
Slate Run	14	19.42	4.4589	1.6677	7.6214	5.204	41.1411	6.2806	7.384	8.9846	9.7752	1267.12
	14	19.83	4.4587	1.6534	7.5560	5.2183	40.7399	6.2983	7.4193	9.1155	9.7752	1267.12
Turkey Run	15	19.83	4.2012	1.5545	7.1041	5.012	38.3946	6.3875	7.442	9.0099	9.7814	1227.34
	15	26	4.1982	1.373	6.2746	5.1935	33.3093	6.8692	7.9379	9.9776	9.7814	1227.34

3mgd_cloudy_winter

	Model Reach	Output MP	OrgN (mg/L)	NH4 (mg/L)	NBODu (mg/L) - calc	NO2+NO3 (mg/L)	CBODu (mg/L)	Daily Minimum DO (mg/L)	Daily Average DO (mg/L)	Daily Maximum DO (mg/L)	DO Saturation (mg/L)	Conductivity (umhos/cm)
Upstream	1	-0.8	0.1367	0.0042	0.0192	1.9781	1.784	8.2035	8.6785	9.1535	9.7154	542.11
	1	-0.4	0.1367	0.004	0.0183	1.9782	1.7167	9.0293	9.5294	10.6016	9.7154	542.11
	1	0	0.1366	0.0038	0.0174	1.9782	1.6518	9.1891	9.781	11.2141	9.7154	542.11
PMWWTF	2	0	4.9606	2.4599	11.2417	12.0588	48.9789	7.692	7.8844	8.2589	9.7239	1214.67
	2	0.5	4.96	2.4051	10.9913	12.1135	47.7347	7.4342	7.9083	9.046	9.7239	1214.67
	2	1	4.9595	2.3516	10.7468	12.167	46.5221	7.3512	7.9462	9.4216	9.7239	1214.67
	2	1.5	4.9589	2.2993	10.5078	12.2193	45.3403	7.3263	7.9902	9.5811	9.7239	1214.67
	2	2	4.9584	2.2481	10.2738	12.2705	44.1885	7.3372	8.0364	9.6553	9.7239	1214.67
	2	2.37	4.958	2.211	10.1043	12.3076	43.355	7.3581	8.071	9.6828	9.7239	1214.67
Wrights Run	3	2.37	4.4326	1.9647	8.9787	10.9415	38.7879	7.4177	8.1481	9.5232	9.7337	1139.56
	3	3	4.4314	1.8712	8.5514	11.035	36.6836	6.2037	7.0171	8.6029	9.7337	1139.56
	3	3.5	4.4305	1.8001	8.2265	11.106	35.0951	5.6518	6.5446	8.016	9.7337	1139.56
	3	4	4.4296	1.7318	7.9143	11.1743	33.5753	5.3499	6.3034	7.6119	9.7337	1139.56
	3	4.5	4.4286	1.666	7.6136	11.24	32.1214	5.2606	6.2096	7.4847	9.7337	1139.56
	3	5	4.4277	1.6028	7.3248	11.3032	30.7304	5.3153	6.2091	7.4782	9.7337	1139.56
	3	5.5	4.4268	1.542	7.0469	11.3641	29.3997	5.4169	6.2665	7.5101	9.7337	1139.56
	3	5.91	4.426	1.4938	6.8267	11.4122	28.3516	5.5116	6.3406	7.5781	9.7337	1139.56
falo Lick Run	4	5.91	4.152	1.3978	6.3879	10.7076	26.6374	5.7486	6.5599	7.6761	9.74	1099.98
	4	6.5	4.151	1.3282	6.0699	10.7772	25.1254	7.0285	7.9201	9.7116	9.74	1099.98
FCL	5	6.5	4.1423	1.4112	6.4492	10.381	25.8064	6.7124	7.6986	9.3462	9.7442	1105.01
	5	7	4.1416	1.3621	6.2248	10.4301	24.781	6.6094	7.8014	10.0955	9.7442	1105.01
	5	7.5	4.1409	1.3147	6.0082	10.4775	23.7963	6.6531	7.8992	10.376	9.7442	1105.01
	5	8.01	4.1401	1.268	5.7948	10.5242	22.8323	6.6175	7.9945	10.456	9.7442	1105.01
ır Spring Run	6	8.01	3.8437	1.1717	5.3547	9.8427	21.2064	6.5985	7.9811	10.1593	9.7527	1066.81
	6	8.5	3.843	1.1318	5.1723	9.8826	20.3811	6.7853	8.1749	10.4209	9.7527	1066.81
	6	9	3.8423	1.0925	4.9927	9.922	19.5721	6.9849	8.3185	10.6245	9.7527	1066.81
	6	9.5	3.8416	1.0545	4.8191	9.9599	18.7952	7.0593	8.4297	10.7493	9.7527	1066.81
	6	10	3.8408	1.0179	4.6518	9.9966	18.0491	7.1467	8.5212	10.8011	9.7527	1066.81
	6	10.5	3.8401	0.9825	4.4900	10.0319	17.3326	7.2499	8.6005	10.8899	9.7527	1066.81
	6	11	3.8394	0.9484	4.3342	10.0661	16.6446	7.3191	8.6717	10.9586	9.7527	1066.81
	6	11.62	3.8385	0.9077	4.1482	10.1067	15.8292	7.3948	8.7524	11.036	9.7527	1066.81
OWRF	7	11.62	5.2705	2.3665	10.8149	5.9114	59.1746	7.1473	7.5399	8.1239	9.7592	1383.59
	7	11.91	5.2703	2.3459	10.7208	5.932	58.5858	6.7668	7.3003	8.1893	9.7592	1383.59
brams Creek	8	11.91	5.0705	2.2548	10.3044	5.7785	56.3793	6.8218	7.3535	8.1802	9.7602	1354.89
	8	12.38	5.0702	2.2238	10.1628	5.8095	55.494	6.5417	7.2242	8.4743	9.7602	1354.89
edbud Creek	9	12.38	4.9945	2.1901	10.0088	5.7486	54.6813	6.5164	7.2344	8.4447	9.762	1344.04
	9	13.16	4.994	2.1435	9.7958	5.7952	53.3512	6.3217	7.1595	8.8259	9.762	1344.04
Marsh Creek	10	13.16	4.8636	2.0867	9.5362	5.6971	51.9758	6.2709	7.145	8.7172	9.7647	1324.36
	10	13.5	4.8634	2.0679	9.4503	5.7159	51.4412	5.885	6.8944	8.7843	9.7647	1324.36
	10	14	4.8631	2.0406	9.3255	5.7432	50.6649	5.4519	6.5822	8.8449	9.7647	1324.36
	10	14.5	4.8627	2.0137	9.2026	5.7701	49.9003	5.0945	6.3281	8.8463	9.7647	1324.36
	10	15	4.8624	1.9871	9.0810	5.7967	49.1473	4.8424	6.1235	8.8035	9.7647	1324.36
	10	15.51	4.8621	1.9603	8.9586	5.8235	48.3909	4.5939	5.958	8.7238	9.7647	1324.36
Lick Run	11	15.51	4.739	1.9092	8.7250	5.712	47.174	4.5501	6.0149	8.6069	9.7686	1303.91
	11	16	4.7387	1.8866	8.6218	5.7347	46.534	4.6405	6.0906	8.6395	9.7686	1303.91
	11	16.5	4.7384	1.8637	8.5171	5.7575	45.8899	4.7257	6.1634	8.6643	9.7686	1303.91
	11	17	4.7381	1.8411	8.4138	5.7801	45.2546	4.8357	6.2324	8.6723	9.7686	1303.91
	11	17.5	4.7378	1.8188	8.3119	5.8024	44.6282	4.9453	6.298	8.6773	9.7686	1303.91
	11	18.07	4.7375	1.7937	8.1972	5.8275	43.9247	5.0142	6.3694	8.701	9.7686	1303.91
NWRF	12	18.07	4.7354	1.7929	8.1936	5.8257	43.9057	4.8557	6.37	8.6115	9.7711	1303.6
	12	18.26	4.7353	1.7853	8.1588	5.8333	43.6925	5.2302	6.6415	8.7064	9.7711	1303.6
ɜarbrook Run	13	18.26	4.6811	1.7641	8.0619	5.78	43.1935	5.2696	6.6597	8.6977	9.7731	1295.05
	13	18.5	4.6809	1.7547	8.0190	5.7894	42.9307	5.5556	6.8726	8.7807	9.7731	1295.05
	13	19	4.6806	1.7354	7.9308	5.8088	42.3884	6.0648	7.2265	8.9821	9.7731	1295.05
	13	19.42	4.6804	1.7192	7.8567	5.8249	41.9381	6.3894	7.451	9.1347	9.7731	1295.05
Slate Run	14	19.42	4.5586	1.6729	7.6452	5.7142	40.8509	6.38	7.4617	9.0494	9.7752	1276.33
	14	19.83	4.5584	1.659	7.5816	5.7281	40.462	6.395	7.4951	9.1741	9.7752	1276.33
Turkey Run	15	19.83	4.3047	1.5635	7.1452	5.5	38.2201	6.4757	7.5126	9.0686	9.7814	1237.5
	15	26	4.3018	1.3848	6.3285	5.6787	33.2642	6.9353	7.9826	10.0023	9.7814	1237.5

3mgd_cloudy_winter_tw

	Model Reach	Output MP	OrgN (mg/L)	NH4 (mg/L)	NBODu (mg/L) - calc	NO2+NO3 (mg/L)	CBODu (mg/L)	Daily Minimum DO (mg/L)	Daily Average DO (mg/L)	Daily Maximum DO (mg/L)	DO Saturation (mg/L)	Conductivity (umhos/cm)
Upstream	1	-0.8	0.1367	0.0042	0.0192	1.9781	1.784	8.2035	8.6785	9.1535	9.7154	542.11
	1	-0.4	0.1367	0.004	0.0183	1.9782	1.7167	9.0293	9.5294	10.6016	9.7154	542.11
	1	0	0.1366	0.0038	0.0174	1.9782	1.6518	9.1891	9.781	11.2141	9.7154	542.11
PMWWTF	2	0	4.2581	2.1086	9.6363	13.1126	48.9789	7.692	7.8844	8.2589	9.7239	1214.67
	2	0.5	4.2576	2.0617	9.4220	13.1595	47.7347	7.4595	7.9337	9.0713	9.7239	1214.67
	2	1	4.2571	2.0158	9.2122	13.2053	46.5221	7.3882	7.9832	9.4585	9.7239	1214.67
	2	1.5	4.2567	1.9709	9.0070	13.2501	45.3403	7.3683	8.0322	9.6231	9.7239	1214.67
	2	2	4.2562	1.9271	8.8068	13.294	44.1885	7.3811	8.0804	9.6992	9.7239	1214.67
	2	2.37	4.2558	1.8952	8.6611	13.3258	43.355	7.4024	8.1153	9.7271	9.7239	1214.67
Wrights Run	3	2.37	3.8088	1.6842	7.6968	11.846	38.7879	7.4571	8.1875	9.5626	9.7337	1139.56
	3	3	3.8078	1.604	7.3303	11.9261	36.6836	6.2735	7.0869	8.6728	9.7337	1139.56
	3	3.5	3.807	1.5431	7.0520	11.987	35.0951	5.7348	6.6276	8.0991	9.7337	1139.56
	3	4	3.8062	1.4845	6.7842	12.0455	33.5753	5.4401	6.3935	7.7021	9.7337	1139.56
	3	4.5	3.8055	1.4281	6.5264	12.1019	32.1214	5.354	6.303	7.5781	9.7337	1139.56
	3	5	3.8047	1.3739	6.2787	12.156	30.7304	5.4095	6.3033	7.5724	9.7337	1139.56
	3	5.5	3.8039	1.3218	6.0406	12.2082	29.3997	5.5103	6.3599	7.6035	9.7337	1139.56
	3	5.91	3.8032	1.2805	5.8519	12.2494	28.3516	5.6037	6.4327	7.6701	9.7337	1139.56
falo Lick Run	4	5.91	3.5694	1.1982	5.4758	11.4908	26.6374	5.8347	6.6461	7.7623	9.74	1099.98
	4	6.5	3.5685	1.1386	5.2034	11.5504	25.1254	7.082	7.9736	9.7651	9.74	1099.98
FCL	5	6.5	3.5832	1.2292	5.6174	11.1232	25.8064	6.7638	7.75	9.3976	9.7442	1105.01
	5	7	3.5826	1.1864	5.4218	11.166	24.781	6.662	7.8539	10.148	9.7442	1105.01
	5	7.5	3.5819	1.1451	5.2331	11.2073	23.7963	6.7056	7.9517	10.4285	9.7442	1105.01
	5	8.01	3.5813	1.1044	5.0471	11.2479	22.8323	6.6691	8.0461	10.5077	9.7442	1105.01
r Spring Run	6	8.01	3.3279	1.0207	4.6646	10.5107	21.2064	6.6462	8.0288	10.2069	9.7527	1066.81
	6	8.5	3.3273	0.9859	4.5056	10.5454	20.3811	6.8309	8.2204	10.4665	9.7527	1066.81
	6	9	3.3267	0.9516	4.3488	10.5797	19.5721	7.0286	8.3622	10.6682	9.7527	1066.81
	6	9.5	3.3261	0.9186	4.1980	10.6128	18.7952	7.1014	8.4717	10.7913	9.7527	1066.81
	6	10	3.3254	0.8866	4.0518	10.6447	18.0491	7.1872	8.5617	10.8416	9.7527	1066.81
	6	10.5	3.3248	0.8558	3.9110	10.6755	17.3326	7.2889	8.6395	10.9289	9.7527	1066.81
	6	11	3.3242	0.8261	3.7753	10.7052	16.6446	7.3567	8.7093	10.9962	9.7527	1066.81
	6	11.62	3.3234	0.7906	3.6130	10.7406	15.8292	7.4308	8.7884	11.072	9.7527	1066.81
OWRF	7	11.62	5.1337	2.3354	10.6728	6.0797	59.1746	7.1569	7.5494	8.1335	9.7592	1383.59
	7	11.91	5.1335	2.3151	10.5800	6.1	58.5858	6.7761	7.3096	8.1986	9.7592	1383.59
brams Creek	8	11.91	4.9391	2.2251	10.1687	5.94	56.3793	6.8307	7.3624	8.1892	9.7602	1354.89
	8	12.38	4.9388	2.1946	10.0293	5.9706	55.494	6.5498	7.2323	8.4824	9.7602	1354.89
edbud Creek	9	12.38	4.8651	2.1614	9.8776	5.9072	54.6813	6.5244	7.2424	8.4526	9.762	1344.04
	9	13.16	4.8646	2.1153	9.6669	5.9533	53.3512	6.3287	7.1666	8.8329	9.762	1344.04
Marsh Creek	10	13.16	4.7376	2.0593	9.4110	5.851	51.9758	6.2777	7.1519	8.724	9.7647	1324.36
	10	13.5	4.7374	2.0408	9.3265	5.8695	51.4412	5.8922	6.9016	8.7915	9.7647	1324.36
	10	14	4.7371	2.0138	9.2031	5.8964	50.6649	5.4595	6.5899	8.8526	9.7647	1324.36
	10	14.5	4.7368	1.9872	9.0815	5.923	49.9003	5.1026	6.3362	8.8543	9.7647	1324.36
	10	15	4.7364	1.961	8.9618	5.9493	49.1473	4.8507	6.1319	8.8119	9.7647	1324.36
	10	15.51	4.7361	1.9346	8.8411	5.9757	48.3909	4.6025	5.9666	8.7324	9.7647	1324.36
Lick Run	11	15.51	4.6163	1.8841	8.6103	5.8602	47.174	4.5584	6.0233	8.6153	9.7686	1303.91
	11	16	4.616	1.8618	8.5084	5.8826	46.534	4.6486	6.0988	8.6476	9.7686	1303.91
	11	16.5	4.6157	1.8392	8.4051	5.9051	45.8899	4.7336	6.1713	8.6722	9.7686	1303.91
	11	17	4.6154	1.8169	8.3032	5.9274	45.2546	4.8434	6.2401	8.68	9.7686	1303.91
	11	17.5	4.6152	1.7949	8.2027	5.9494	44.6282	4.9528	6.3055	8.6848	9.7686	1303.91
	11	18.07	4.6148	1.7702	8.0898	5.9742	43.9247	5.0215	6.3768	8.7083	9.7686	1303.91
NWRF	12	18.07	4.6128	1.7694	8.0862	5.9723	43.9057	4.863	6.3774	8.6189	9.7711	1303.6
	12	18.26	4.6127	1.7619	8.0519	5.9798	43.6925	5.237	6.6483	8.7132	9.7711	1303.6
:arbrook Run	13	18.26	4.56	1.7409	7.9559	5.9248	43.1935	5.2763	6.6664	8.7044	9.7731	1295.05
	13	18.5	4.5598	1.7317	7.9139	5.9341	42.9307	5.5618	6.8788	8.787	9.7731	1295.05
	13	19	4.5596	1.7125	7.8261	5.9532	42.3884	6.0702	7.232	8.9875	9.7731	1295.05
	13	19.42	4.5593	1.6966	7.7535	5.9691	41.9381	6.3944	7.456	9.1397	9.7731	1295.05
Slate Run	14	19.42	4.4408	1.651	7.5451	5.8545	40.8509	6.3849	7.4665	9.0542	9.7752	1276.33
	14	19.83	4.4406	1.6372	7.4820	5.8682	40.462	6.3998	7.4999	9.1789	9.7752	1276.33
Turkey Run	15	19.83	4.1937	1.5429	7.0511	5.632	38.2201	6.4802	7.5171	9.0732	9.7814	1237.5
	15	26	4.1909	1.3666	6.2454	5.8083	33.2642	6.9393	7.9866	10.0063	9.7814	1237.5

43mgd_cloudy_winter

	Model Reach	Output MP	OrgN (mg/L)	NH4 (mg/L)	NBODu (mg/L) - calc	NO2+NO3 (mg/L)	CBODu (mg/L)	Daily Minimum DO (mg/L)	Daily Average DO (mg/L)	Daily Maximum DO (mg/L)	DO Saturation (mg/L)	Conductivity (umhos/cm)
Upstream	1	-0.8	0.1367	0.0042	0.0192	1.9781	1.784	8.2035	8.6785	9.1535	9.7154	542.11
	1	-0.4	0.1367	0.004	0.0183	1.9782	1.7167	9.0293	9.5294	10.6016	9.7154	542.11
	1	0	0.1366	0.0038	0.0174	1.9782	1.6518	9.1891	9.781	11.2141	9.7154	542.11
PMWWTF	2	0	1.1909	0.7728	3.5317	0.7983	53.6501	7.5539	7.7014	7.9885	9.7239	1281.24
	2	0.5	1.1908	0.7581	3.4645	0.813	52.4859	7.5863	7.9873	8.9507	9.7239	1281.24
	2	1	1.1907	0.7436	3.3983	0.8273	51.3469	7.6345	8.1439	9.4229	9.7239	1281.24
	2	1.5	1.1906	0.7294	3.3334	0.8414	50.2326	7.671	8.2377	9.6322	9.7239	1281.24
	2	2	1.1905	0.7155	3.2698	0.8552	49.1425	7.7037	8.301	9.7214	9.7239	1281.24
	2	2.37	1.1904	0.7054	3.2237	0.8653	48.3511	7.7284	8.3375	9.7633	9.7239	1281.24
Wrights Run	3	2.37	1.1079	0.6438	2.9422	0.7955	44.3168	7.7213	8.3748	9.6235	9.7337	1216.26
	3	3	1.1076	0.6171	2.8201	0.822	42.2264	6.6398	7.3739	8.8431	9.7337	1216.26
	3	3.5	1.1075	0.5967	2.7269	0.8423	40.6377	6.1522	6.947	8.3805	9.7337	1216.26
	3	4	1.1073	0.5769	2.6364	0.8619	39.1088	5.8921	6.7205	8.037	9.7337	1216.26
	3	4.5	1.1071	0.5578	2.5491	0.8809	37.6375	5.7669	6.6225	7.862	9.7337	1216.26
	3	5	1.1069	0.5394	2.4651	0.8992	36.2215	5.7641	6.6061	7.8449	9.7337	1216.26
	3	5.5	1.1067	0.5215	2.3833	0.9169	34.8587	5.8282	6.6408	7.8715	9.7337	1216.26
	3	5.91	1.1065	0.5073	2.3184	0.931	33.7796	5.9021	6.6936	7.9111	9.7337	1216.26
falo Lick Run	4	5.91	1.0588	0.4815	2.2005	0.9086	32.1318	6.0624	6.8505	7.9633	9.74	1180.72
	4	6.5	1.0586	0.4604	2.1040	0.9295	30.5328	7.2465	8.0584	9.6844	9.74	1180.72
FCL	5	6.5	1.1514	0.5552	2.5373	0.9285	30.9064	6.9788	7.8757	9.386	9.7442	1182.16
	5	7	1.1513	0.5381	2.4591	0.9454	29.8258	6.704	7.8449	10.0585	9.7442	1182.16
	5	7.5	1.1511	0.5215	2.3833	0.9619	28.783	6.6569	7.8576	10.3451	9.7442	1182.16
	5	8.01	1.1509	0.5052	2.3088	0.9781	27.7568	6.5702	7.8976	10.4214	9.7442	1182.16
ır Spring Run	6	8.01	1.0969	0.4745	2.1685	1.0221	26.1187	6.5211	7.8928	10.1491	9.7527	1146.1
	6	8.5	1.0967	0.4601	2.1027	1.0364	25.2163	6.6295	8.0294	10.3373	9.7527	1146.1
	6	9	1.0965	0.4458	2.0373	1.0505	24.3277	6.7937	8.1426	10.4762	9.7527	1146.1
	6	9.5	1.0963	0.432	1.9742	1.0642	23.4703	6.8395	8.2384	10.5968	9.7527	1146.1
	6	10	1.0962	0.4186	1.9130	1.0775	22.6432	6.9096	8.3227	10.6376	9.7527	1146.1
	6	10.5	1.096	0.4056	1.8536	1.0904	21.8452	7.0024	8.399	10.7031	9.7527	1146.1
	6	11	1.0958	0.393	1.7960	1.1028	21.0753	7.0977	8.4696	10.7795	9.7527	1146.1
	6	11.62	1.0956	0.378	1.7275	1.1177	20.1583	7.1737	8.5511	10.8529	9.7527	1146.1
OWRF	7	11.62	4.3486	2.1221	9.6980	3.3892	58.0686	7.0871	7.5462	8.2256	9.7592	1390.13
	7	11.91	4.3484	2.1042	9.6162	3.4071	57.5104	6.7606	7.3434	8.2903	9.7592	1390.13
brams Creek	8	11.91	4.1934	2.0269	9.2629	3.3549	55.4628	6.8175	7.3921	8.2774	9.7602	1362.73
	8	12.38	4.1931	1.9999	9.1395	3.3818	54.6203	6.5967	7.3016	8.5551	9.7602	1362.73
edbud Creek	9	12.38	4.1341	1.9713	9.0088	3.359	53.8635	6.5752	7.3102	8.5163	9.762	1352.36
	9	13.16	4.1337	1.9306	8.8228	3.3996	52.5951	6.4347	7.2709	8.9011	9.762	1352.36
Marsh Creek	10	13.16	4.0317	1.8822	8.6017	3.3669	51.3103	6.3841	7.2544	8.7945	9.7647	1333.49
	10	13.5	4.0315	1.8658	8.5267	3.3833	50.799	6.0238	7.0228	8.8662	9.7647	1333.49
	10	14	4.0313	1.8419	8.4175	3.4072	50.0564	5.623	6.7343	8.9382	9.7647	1333.49
	10	14.5	4.031	1.8183	8.3096	3.4307	49.3246	5.2856	6.4994	8.9561	9.7647	1333.49
	10	15	4.0308	1.795	8.2032	3.454	48.6036	5.0498	6.3102	8.9322	9.7647	1333.49
	10	15.51	4.0305	1.7716	8.0962	3.4774	47.879	4.8408	6.157	8.8742	9.7647	1333.49
Lick Run	11	15.51	3.9343	1.7278	7.8960	3.4299	46.7364	4.7693	6.2061	8.7503	9.7686	1313.85
	11	16	3.934	1.7079	7.8051	3.4497	46.1217	4.8597	6.2799	8.7793	9.7686	1313.85
	11	16.5	3.9338	1.6878	7.7132	3.4698	45.5028	4.9446	6.3503	8.8105	9.7686	1313.85
	11	17	3.9336	1.668	7.6228	3.4896	44.8921	5.0512	6.4165	8.8235	9.7686	1313.85
	11	17.5	3.9333	1.6484	7.5332	3.5092	44.2897	5.1596	6.4793	8.8301	9.7686	1313.85
	11	18.07	3.9331	1.6263	7.4322	3.5312	43.6128	5.2282	6.5472	8.8507	9.7686	1313.85
NWRF	12	18.07	3.9315	1.6257	7.4294	3.5305	43.5948	5.0783	6.5477	8.7643	9.7711	1313.55
	12	18.26	3.9314	1.619	7.3988	3.5371	43.3897	5.4355	6.805	8.8467	9.7711	1313.55
earbrook Run	13	18.26	3.889	1.6007	7.3152	3.5126	42.9191	5.4707	6.8204	8.8368	9.7731	1305.31
	13	18.5	3.8889	1.5924	7.2773	3.5209	42.6659	5.7431	7.0222	8.9091	9.7731	1305.31
	13	19	3.8886	1.5754	7.1996	3.5379	42.1432	6.227	7.3575	9.096	9.7731	1305.31
	13	19.42	3.8885	1.5612	7.1347	3.5521	41.709	6.5393	7.5701	9.2338	9.7731	1305.31
Slate Run	14	19.42	3.793	1.5212	6.9519	3.5054	40.6807	6.5238	7.5772	9.1484	9.7752	1287.24
	14	19.83	3.7928	1.5089	6.8957	3.5176	40.3049	6.5354	7.6083	9.2657	9.7752	1287.24
Turkey Run	15	19.83	3.5931	1.4261	6.5173	3.4222	38.175	6.6052	7.6187	9.1596	9.7814	1249.6
	15	26	3.5908	1.2673	5.7916	3.5808	33.3541	7.0358	8.0569	10.0516	9.7814	1249.6

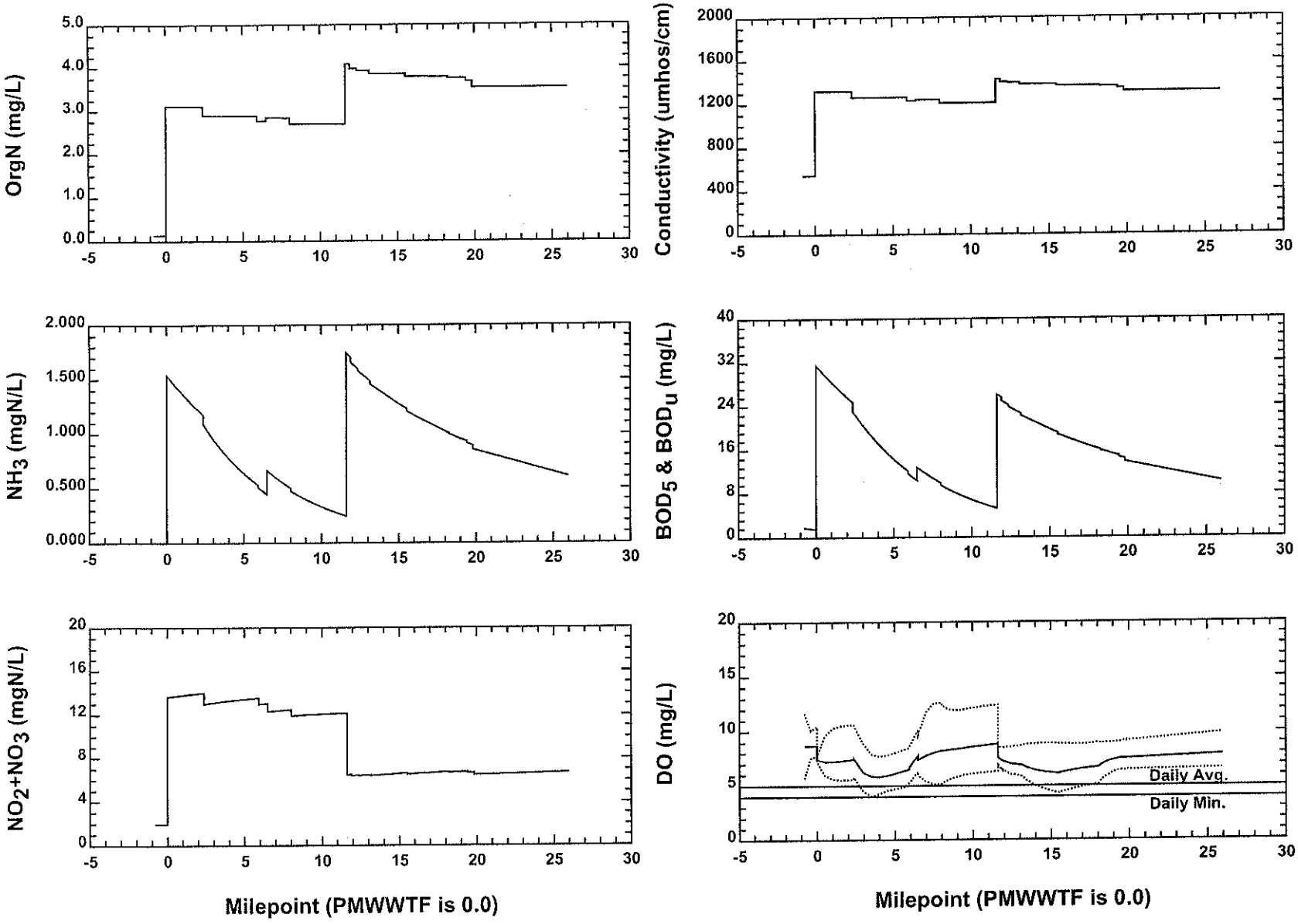
63mgd_cloudy_winter

	Model Reach	Output MP	OrgN (mg/L)	NH4 (mg/L)	NBODu (mg/L) - calc	NO2+NO3 (mg/L)	CBODu (mg/L)	Daily Minimum DO (mg/L)	Daily Average DO (mg/L)	Daily Maximum DO (mg/L)	DO Saturation (mg/L)	Conductivity (umhos/cm)
Upstream	1	-0.8	0.1367	0.0042	0.0192	1.9781	1.784	8.2035	8.6785	9.1535	9.7154	542.11
	1	-0.4	0.1367	0.004	0.0183	1.9782	1.7167	9.0293	9.5294	10.6016	9.7154	542.11
	1	0	0.1366	0.0038	0.0174	1.9782	1.6518	9.1891	9.781	11.2141	9.7154	542.11
PMWWTF	2	0	1.2727	0.8329	3.8064	0.7194	57.712	7.4338	7.5422	7.7534	9.7239	1339.13
	2	0.5	1.2726	0.8197	3.7460	0.7325	56.6686	7.4977	7.8448	8.6777	9.7239	1339.13
	2	1	1.2725	0.8067	3.6866	0.7455	55.644	7.5587	8.0201	9.1817	9.7239	1339.13
	2	1.5	1.2724	0.7939	3.6281	0.7582	54.638	7.605	8.1276	9.4417	9.7239	1339.13
	2	2	1.2723	0.7813	3.5705	0.7707	53.6502	7.6402	8.1988	9.565	9.7239	1339.13
	2	2.37	1.2723	0.7721	3.5285	0.7799	52.9307	7.664	8.2383	9.6109	9.7239	1339.13
Wrights Run	3	2.37	1.2047	0.7213	3.2963	0.733	49.5904	7.6347	8.273	9.5152	9.7337	1286.38
	3	3	1.2045	0.696	3.1807	0.7581	47.6101	6.548	7.2687	8.7331	9.7337	1286.38
	3	3.5	1.2044	0.6765	3.0916	0.7775	46.0948	6.0328	6.7968	8.2474	9.7337	1286.38
	3	4	1.2042	0.6576	3.0052	0.7963	44.6278	5.7143	6.5143	7.8841	9.7337	1286.38
	3	4.5	1.204	0.6392	2.9211	0.8146	43.2075	5.5316	6.3609	7.6302	9.7337	1286.38
	3	5	1.2039	0.6213	2.8393	0.8324	41.8323	5.4553	6.2949	7.5224	9.7337	1286.38
	3	5.5	1.2037	0.6039	2.7598	0.8496	40.501	5.4618	6.2879	7.5179	9.7337	1286.38
	3	5.91	1.2036	0.59	2.6963	0.8634	39.4409	5.5058	6.3122	7.5386	9.7337	1286.38
falo Lick Run	4	5.91	1.1634	0.5671	2.5916	0.849	37.9619	5.6249	6.4469	7.5775	9.74	1256.52
	4	6.5	1.1632	0.5459	2.4948	0.87	36.3502	6.8502	7.6656	9.2172	9.74	1256.52
FCL	5	6.5	1.2319	0.6166	2.8179	0.8707	36.493	6.6518	7.5349	8.9893	9.7442	1255.75
	5	7	1.2317	0.6004	2.7438	0.8868	35.4008	6.541	7.5944	9.6071	9.7442	1255.75
	5	7.5	1.2316	0.5846	2.6716	0.9025	34.3412	6.5721	7.6595	9.9289	9.7442	1255.75
	5	8.01	1.2314	0.5689	2.5999	0.9181	33.2931	6.5768	7.7287	10.0592	9.7442	1255.75
ır Spring Run	6	8.01	1.1854	0.5418	2.4760	0.9553	31.7439	6.501	7.7332	9.8517	9.7527	1224.02
	6	8.5	1.1852	0.5276	2.4111	0.9694	30.7969	6.6241	7.8681	10.0486	9.7527	1224.02
	6	9	1.185	0.5135	2.3467	0.9834	29.8597	6.7886	7.9775	10.1812	9.7527	1224.02
	6	9.5	1.1849	0.4998	2.2841	0.9971	28.951	6.8482	8.0686	10.2847	9.7527	1224.02
	6	10	1.1847	0.4864	2.2228	1.0103	28.0699	6.8948	8.1477	10.3338	9.7527	1224.02
	6	10.5	1.1846	0.4734	2.1634	1.0233	27.2157	6.9689	8.2188	10.3837	9.7527	1224.02
	6	11	1.1844	0.4607	2.1054	1.0358	26.3874	7.0473	8.2842	10.4574	9.7527	1224.02
	6	11.62	1.1842	0.4455	2.0359	1.0509	25.3953	7.1357	8.3598	10.5285	9.7527	1224.02
OWRF	7	11.62	4.1214	2.0075	9.1743	3.184	56.943	7.0663	7.557	8.3143	9.7592	1398.89
	7	11.91	4.1212	1.9914	9.1007	3.2001	56.4221	6.7886	7.3916	8.3987	9.7592	1398.89
brams Creek	8	11.91	3.9859	1.9239	8.7922	3.1589	54.5691	6.8401	7.4349	8.3822	9.7602	1373.3
	8	12.38	3.9856	1.8995	8.6807	3.1833	53.7788	6.6761	7.3832	8.6507	9.7602	1373.3
edbud Creek	9	12.38	3.9338	1.8744	8.5660	3.1648	53.0907	6.655	7.39	8.6061	9.762	1363.57
	9	13.16	3.9335	1.8375	8.3974	3.2017	51.8977	6.565	7.3857	8.9791	9.762	1363.57
Marsh Creek	10	13.16	3.8437	1.7948	8.2022	3.176	50.7245	6.513	7.3677	8.8764	9.7647	1345.85
	10	13.5	3.8436	1.7798	8.1337	3.191	50.2418	6.1808	7.1549	8.9487	9.7647	1345.85
	10	14	3.8433	1.7581	8.0345	3.2127	49.5403	5.8088	6.8897	9.0271	9.7647	1345.85
	10	14.5	3.8431	1.7366	7.9363	3.2342	48.8486	5.4943	6.6735	9.0575	9.7647	1345.85
	10	15	3.8429	1.7154	7.8394	3.2554	48.1666	5.2718	6.499	9.0498	9.7647	1345.85
	10	15.51	3.8426	1.694	7.7416	3.2767	47.4807	5.0948	6.3576	9.012	9.7647	1345.85
Lick Run	11	15.51	3.7577	1.6551	7.5638	3.2373	46.4302	5.0003	6.3985	8.8921	9.7686	1327.35
	11	16	3.7575	1.6369	7.4806	3.2555	45.8463	5.0884	6.4694	8.9191	9.7686	1327.35
	11	16.5	3.7573	1.6185	7.3965	3.2738	45.258	5.1745	6.5367	8.9405	9.7686	1327.35
	11	17	3.7571	1.6003	7.3134	3.292	44.6773	5.275	6.5995	8.9591	9.7686	1327.35
	11	17.5	3.7569	1.5823	7.2311	3.31	44.104	5.3806	6.6587	8.9679	9.7686	1327.35
	11	18.07	3.7566	1.5621	7.1388	3.3302	43.4595	5.4537	6.7223	8.9852	9.7686	1327.35
NWRF	12	18.07	3.7552	1.5615	7.1361	3.3296	43.4429	5.311	6.7227	8.9027	9.7711	1327.06
	12	18.26	3.7551	1.5553	7.1077	3.3357	43.2475	5.6503	6.9658	8.9733	9.7711	1327.06
ɜarbrook Run	13	18.26	3.7176	1.539	7.0332	3.3151	42.8122	5.6811	6.9784	8.9629	9.7731	1319.27
	13	18.5	3.7175	1.5315	6.9990	3.3227	42.5706	5.9395	7.169	9.0328	9.7731	1319.27
	13	19	3.7173	1.5157	6.9267	3.3383	42.0717	6.397	7.4854	9.199	9.7731	1319.27
	13	19.42	3.7172	1.5027	6.8673	3.3514	41.6571	6.6967	7.6859	9.3204	9.7731	1319.27
Slate Run	14	19.42	3.6325	1.4669	6.7037	3.3127	40.702	6.675	7.6897	9.2367	9.7752	1302.13
	14	19.83	3.6323	1.4556	6.6521	3.3241	40.3419	6.6834	7.7178	9.3439	9.7752	1302.13
Turkey Run	15	19.83	3.4542	1.381	6.3112	3.245	38.3515	6.7405	7.7219	9.24	9.7814	1266.22
	15	26	3.452	1.233	5.6348	3.3927	33.6914	7.1374	8.1212	10.0787	9.7814	1266.22

76mgd_cloudy_winter

	Model Reach	Output MP	OrgN (mg/L)	NH4 (mg/L)	NBODu (mg/L) - calc	NO2+NO3 (mg/L)	CBODu (mg/L)	Daily Minimum DO (mg/L)	Daily Average DO (mg/L)	Daily Maximum DO (mg/L)	DO Saturation (mg/L)	Conductivity (umhos/cm)
Upstream	1	-0.8	0.1367	0.0042	0.0192	1.9781	1.784	8.2035	8.6785	9.1535	9.7154	542.11
	1	-0.4	0.1367	0.004	0.0183	1.9782	1.7167	9.0293	9.5294	10.6016	9.7154	542.11
	1	0	0.1366	0.0038	0.0174	1.9782	1.6518	9.1891	9.781	11.2141	9.7154	542.11
PMWWTF	2	0	1.306	0.8574	3.9183	0.6872	59.3651	7.3849	7.4775	7.6577	9.7239	1362.69
	2	0.5	1.3059	0.845	3.8617	0.6996	58.3883	7.5401	7.8537	8.6063	9.7239	1362.69
	2	1	1.3058	0.8328	3.8059	0.7117	57.4275	7.6452	8.066	9.1245	9.7239	1362.69
	2	1.5	1.3057	0.8208	3.7511	0.7237	56.4826	7.7146	8.191	9.3977	9.7239	1362.69
	2	2	1.3056	0.8089	3.6967	0.7355	55.5532	7.7607	8.2695	9.5349	9.7239	1362.69
	2	2.37	1.3056	0.8002	3.6569	0.7441	54.8753	7.7876	8.3107	9.5889	9.7239	1362.69
Wrights Run	3	2.37	1.2455	0.7549	3.4499	0.7057	51.8854	7.7424	8.3365	9.5029	9.7337	1315.88
	3	3	1.2453	0.7306	3.3388	0.7298	49.9869	6.6961	7.3672	8.7602	9.7337	1315.88
	3	3.5	1.2451	0.7119	3.2534	0.7484	48.5297	6.2039	6.9075	8.2922	9.7337	1315.88
	3	4	1.245	0.6936	3.1698	0.7666	47.115	5.888	6.6284	7.967	9.7337	1315.88
	3	4.5	1.2448	0.6759	3.0889	0.7842	45.7416	5.7202	6.4725	7.7311	9.7337	1315.88
	3	5	1.2447	0.6585	3.0093	0.8014	44.4081	5.6218	6.4004	7.6024	9.7337	1315.88
	3	5.5	1.2445	0.6417	2.9326	0.8182	43.1136	5.6097	6.3848	7.5784	9.7337	1315.88
	3	5.91	1.2444	0.6282	2.8709	0.8316	42.0803	5.637	6.401	7.5965	9.7337	1315.88
falo Lick Run	4	5.91	1.2082	0.607	2.7740	0.8202	40.7087	5.7177	6.5147	7.6235	9.74	1289
	4	6.5	1.208	0.5861	2.6785	0.8409	39.1198	6.9152	7.6893	9.1605	9.74	1289
FCL	5	6.5	1.2668	0.6468	2.9559	0.8421	39.1843	6.735	7.5751	8.959	9.7442	1287.63
	5	7	1.2667	0.6311	2.8841	0.8577	38.1046	6.6305	7.6177	9.52	9.7442	1287.63
	5	7.5	1.2665	0.6158	2.8142	0.8729	37.0546	6.6439	7.6697	9.8261	9.7442	1287.63
	5	8.01	1.2664	0.6006	2.7447	0.888	36.0134	6.6631	7.7281	9.9727	9.7442	1287.63
ır Spring Run	6	8.01	1.2245	0.5756	2.6305	0.9219	34.5409	6.5703	7.7321	9.7842	9.7527	1258.49
	6	8.5	1.2244	0.5616	2.5665	0.9357	33.5887	6.6849	7.8509	9.9699	9.7527	1258.49
	6	9	1.2242	0.5477	2.5030	0.9495	32.644	6.8344	7.9484	10.0844	9.7527	1258.49
	6	9.5	1.2241	0.5342	2.4413	0.9629	31.7259	6.9026	8.0305	10.1822	9.7527	1258.49
	6	10	1.224	0.521	2.3810	0.9761	30.8336	6.9384	8.1026	10.2281	9.7527	1258.49
	6	10.5	1.2238	0.5081	2.3220	0.9888	29.9665	6.9938	8.1679	10.2719	9.7527	1258.49
	6	11	1.2237	0.4956	2.2649	1.0013	29.1237	7.067	8.2284	10.3376	9.7527	1258.49
	6	11.62	1.2235	0.4804	2.1954	1.0163	28.1115	7.1493	8.2987	10.4097	9.7527	1258.49
OWRF	7	11.62	3.9925	1.9445	8.8864	3.0656	56.4612	7.069	7.5724	8.3727	9.7592	1403.86
	7	11.91	3.9923	1.9294	8.8174	3.0807	55.96	6.8154	7.4253	8.4607	9.7592	1403.86
brams Creek	8	11.91	3.8676	1.8671	8.5326	3.0453	54.2102	6.8633	7.4654	8.4425	9.7602	1379.33
	8	12.38	3.8674	1.8441	8.4275	3.0683	53.4475	6.727	7.432	8.7046	9.7602	1379.33
edbud Creek	9	12.38	3.8195	1.8208	8.3211	3.0522	52.7958	6.7061	7.4378	8.6587	9.762	1369.98
	9	13.16	3.8192	1.786	8.1620	3.087	51.6429	6.6403	7.4498	9.0215	9.762	1369.98
Marsh Creek	10	13.16	3.7361	1.7464	7.9810	3.065	50.5292	6.5878	7.4312	8.9213	9.7647	1352.92
	10	13.5	3.7359	1.7323	7.9166	3.0792	50.0617	6.2705	7.228	8.9929	9.7647	1352.92
	10	14	3.7357	1.7117	7.8225	3.0997	49.382	5.9113	6.9746	9.0732	9.7647	1352.92
	10	14.5	3.7355	1.6913	7.7292	3.1201	48.7115	5.6111	6.7678	9.1091	9.7647	1352.92
	10	15	3.7353	1.6712	7.6374	3.1401	48.0502	5.3951	6.6009	9.1089	9.7647	1352.92
	10	15.51	3.7351	1.6509	7.5446	3.1604	47.3849	5.2255	6.4653	9.0808	9.7647	1352.92
Lick Run	11	15.51	3.6563	1.6148	7.3796	3.1253	46.3836	5.128	6.502	8.9637	9.7686	1335.1
	11	16	3.6561	1.5975	7.3006	3.1425	45.816	5.2141	6.5711	8.9945	9.7686	1335.1
	11	16.5	3.6559	1.58	7.2206	3.16	45.2441	5.3009	6.6364	9.0041	9.7686	1335.1
	11	17	3.6557	1.5627	7.1415	3.1772	44.6792	5.3973	6.6972	9.0258	9.7686	1335.1
	11	17.5	3.6555	1.5457	7.0638	3.1943	44.1214	5.5005	6.7542	9.0361	9.7686	1335.1
	11	18.07	3.6553	1.5264	6.9756	3.2135	43.494	5.5778	6.8154	9.0522	9.7686	1335.1
NWRF	12	18.07	3.654	1.5258	6.9729	3.213	43.4782	5.4375	6.8158	8.9718	9.7711	1334.82
	12	18.26	3.6539	1.52	6.9464	3.2188	43.2879	5.7671	7.0513	9.0371	9.7711	1334.82
ɔarbrook Run	13	18.26	3.6191	1.5048	6.8769	3.2002	42.8715	5.7956	7.0625	9.026	9.7731	1327.3
	13	18.5	3.619	1.4976	6.8440	3.2075	42.6361	6.0465	7.247	9.0975	9.7731	1327.3
	13	19	3.6188	1.4826	6.7755	3.2224	42.1497	6.4897	7.5533	9.2512	9.7731	1327.3
	13	19.42	3.6187	1.4702	6.7188	3.2348	41.7455	6.7827	7.7472	9.3638	9.7731	1327.3
Slate Run	14	19.42	3.5399	1.4367	6.5657	3.2005	40.8298	6.7558	7.7494	9.2814	9.7752	1310.72
	14	19.83	3.5397	1.4259	6.5164	3.2113	40.4781	6.7648	7.7759	9.3827	9.7752	1310.72
Turkey Run	15	19.83	3.3735	1.3558	6.1960	3.141	38.5631	6.8133	7.7769	9.2807	9.7814	1275.87
	15	26	3.3715	1.214	5.5480	3.2827	33.987	7.1931	8.1544	10.0886	9.7814	1275.87

ATTACHMENT 2
GRAPHICAL MODEL OUTPUT



PMWWTF Water Quality Projections - 2 MGD, Summer Dry Creek Flow, Sunny

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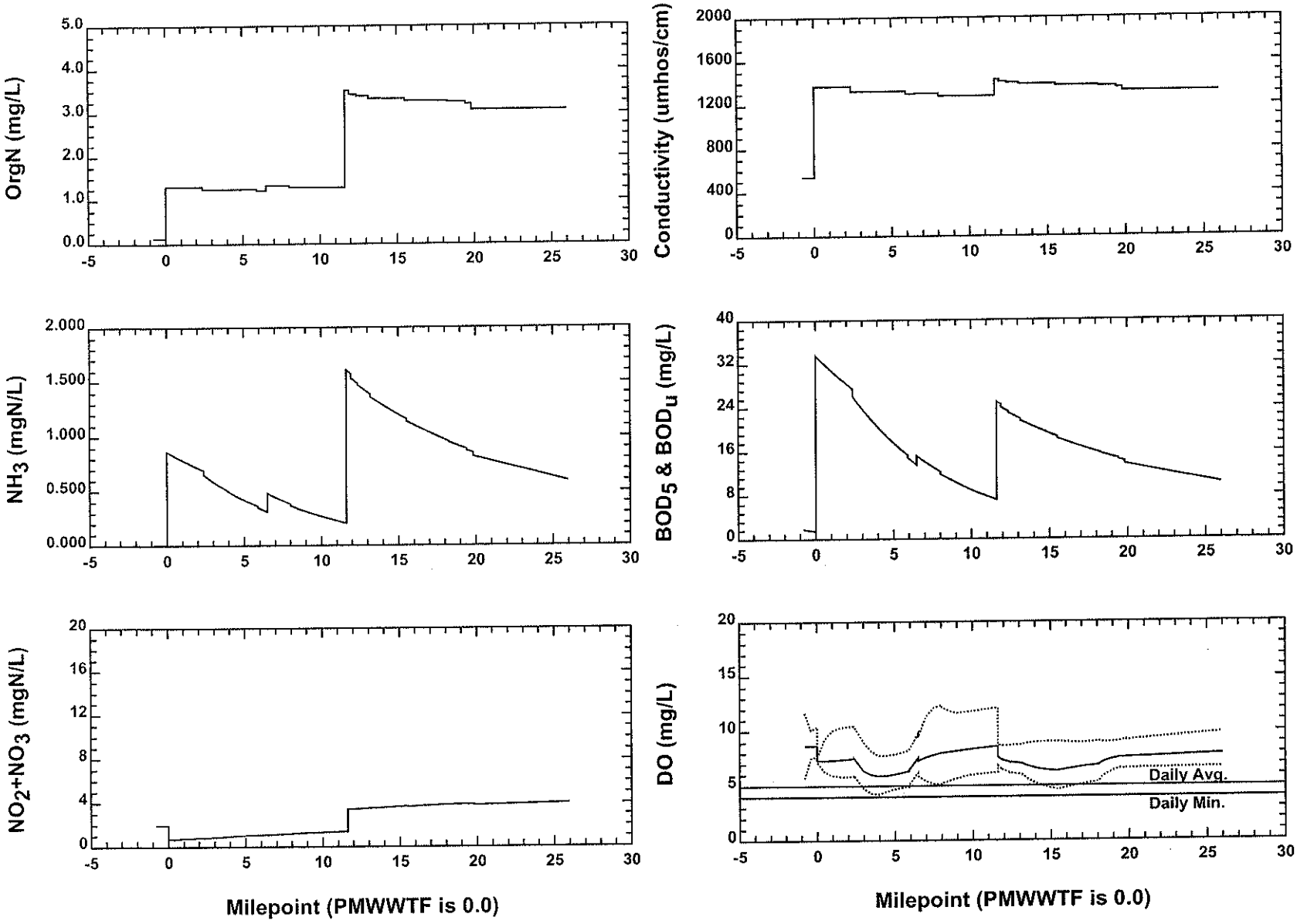

PMWWTF Water Quality Projections - 3 MGD, Summer Dry Creek Flow, Sunny

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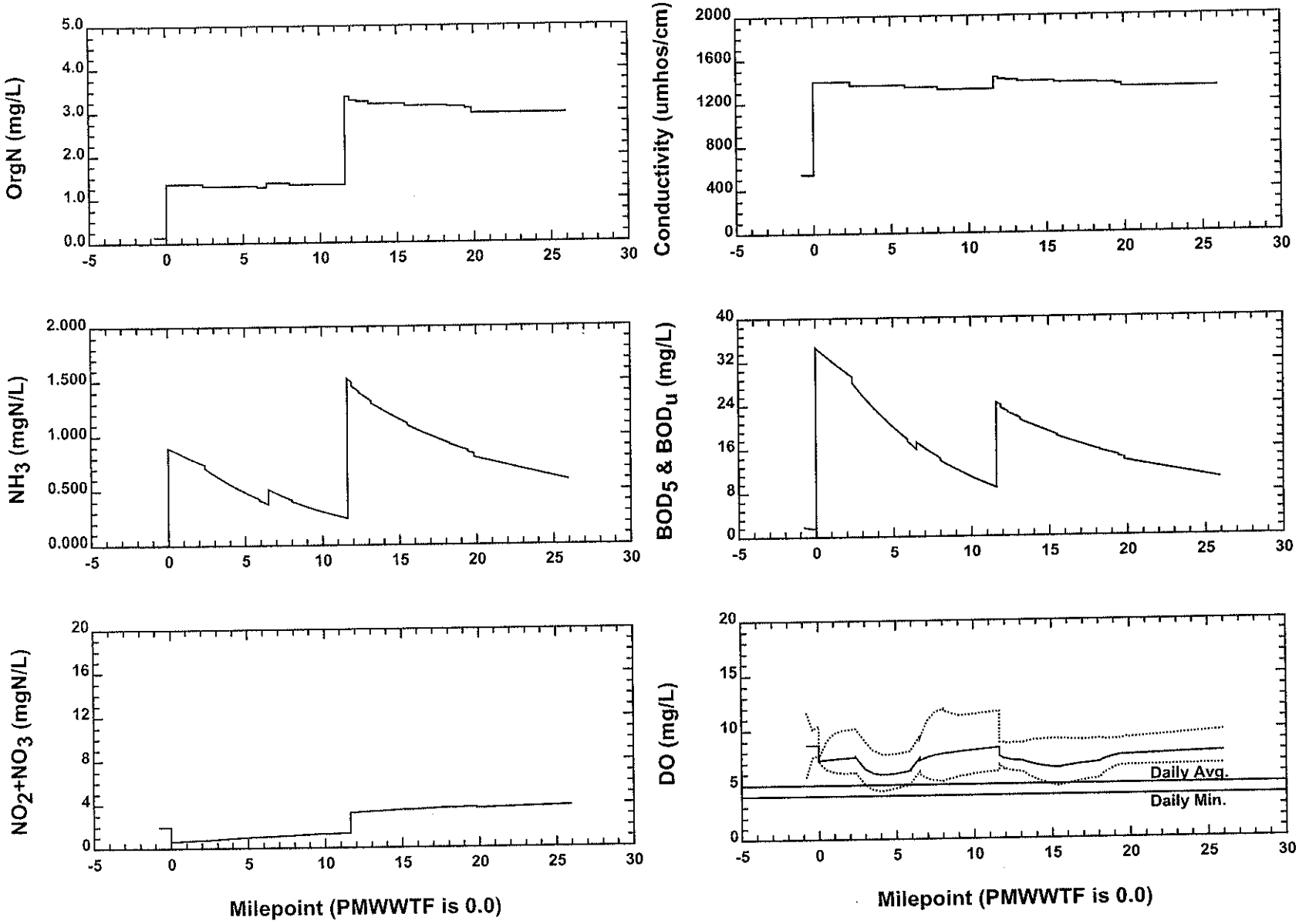

PMWWTF Water Quality Projections - 4 MGD, Summer Dry Creek Flow, Sunny

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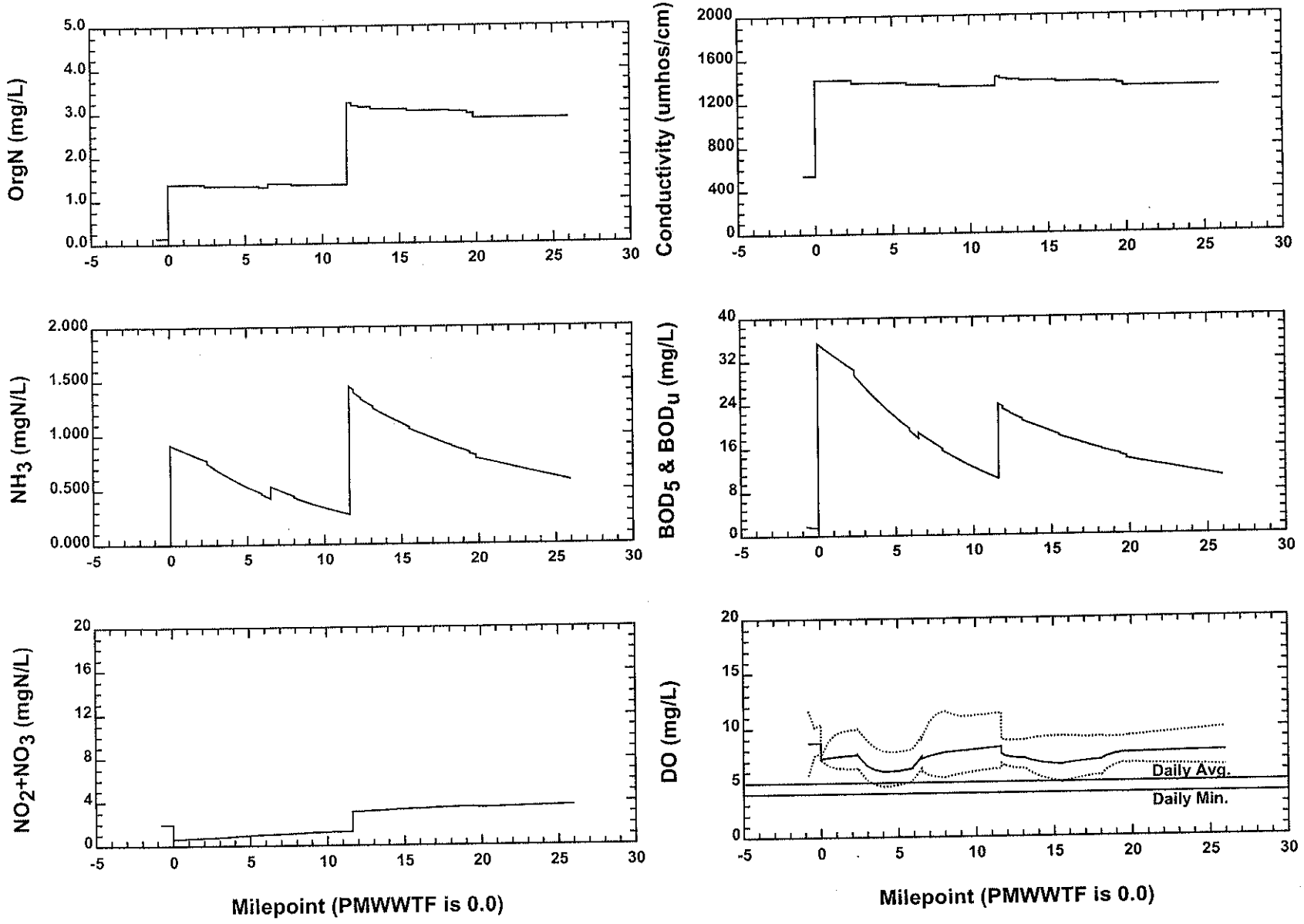

PMWWTF Water Quality Projections - 5 MGD, Summer Dry Creek Flow, Sunny

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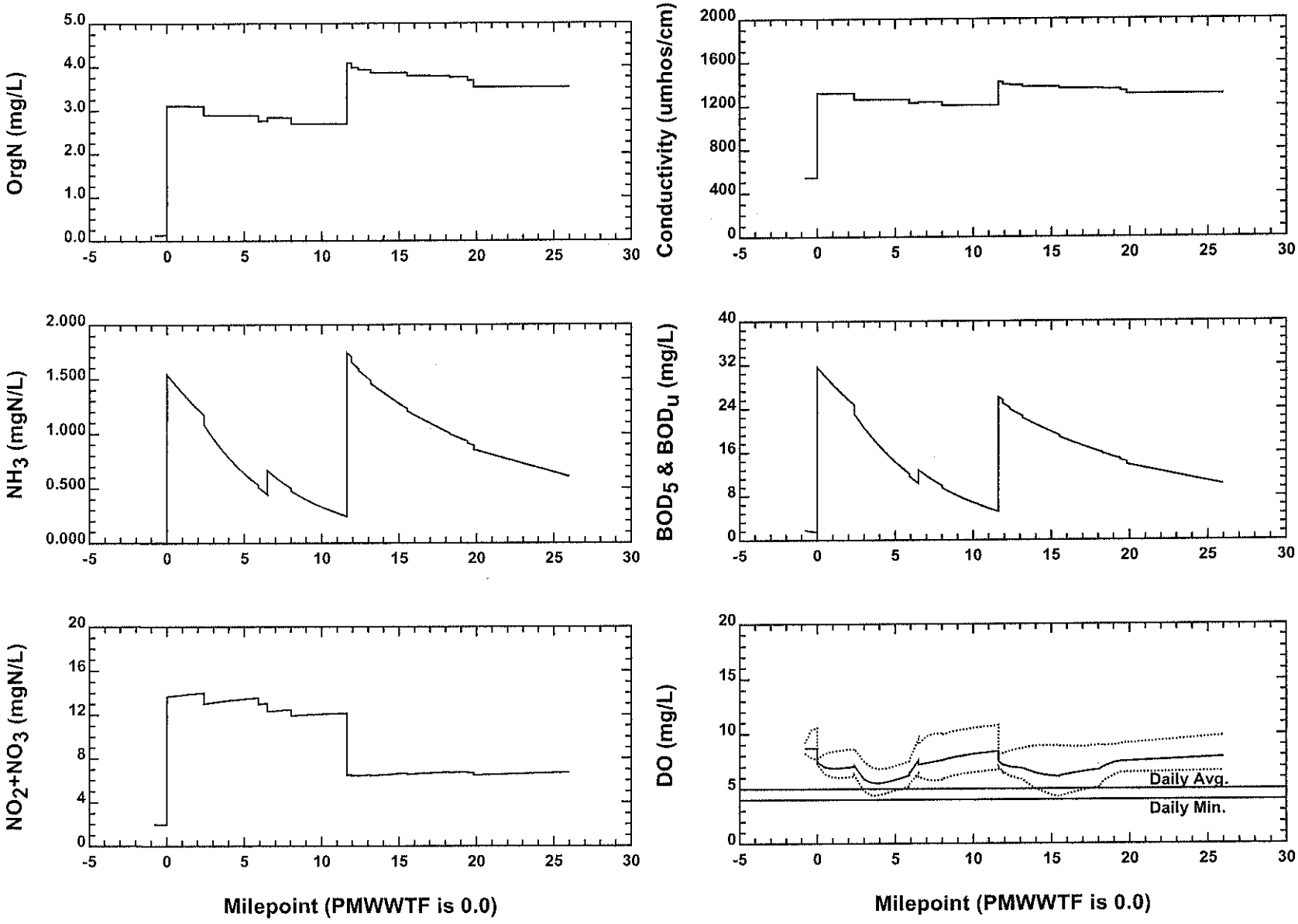

PMWWTF Water Quality Projections - 2 MGD, Summer Dry Creek Flow, Cloudy

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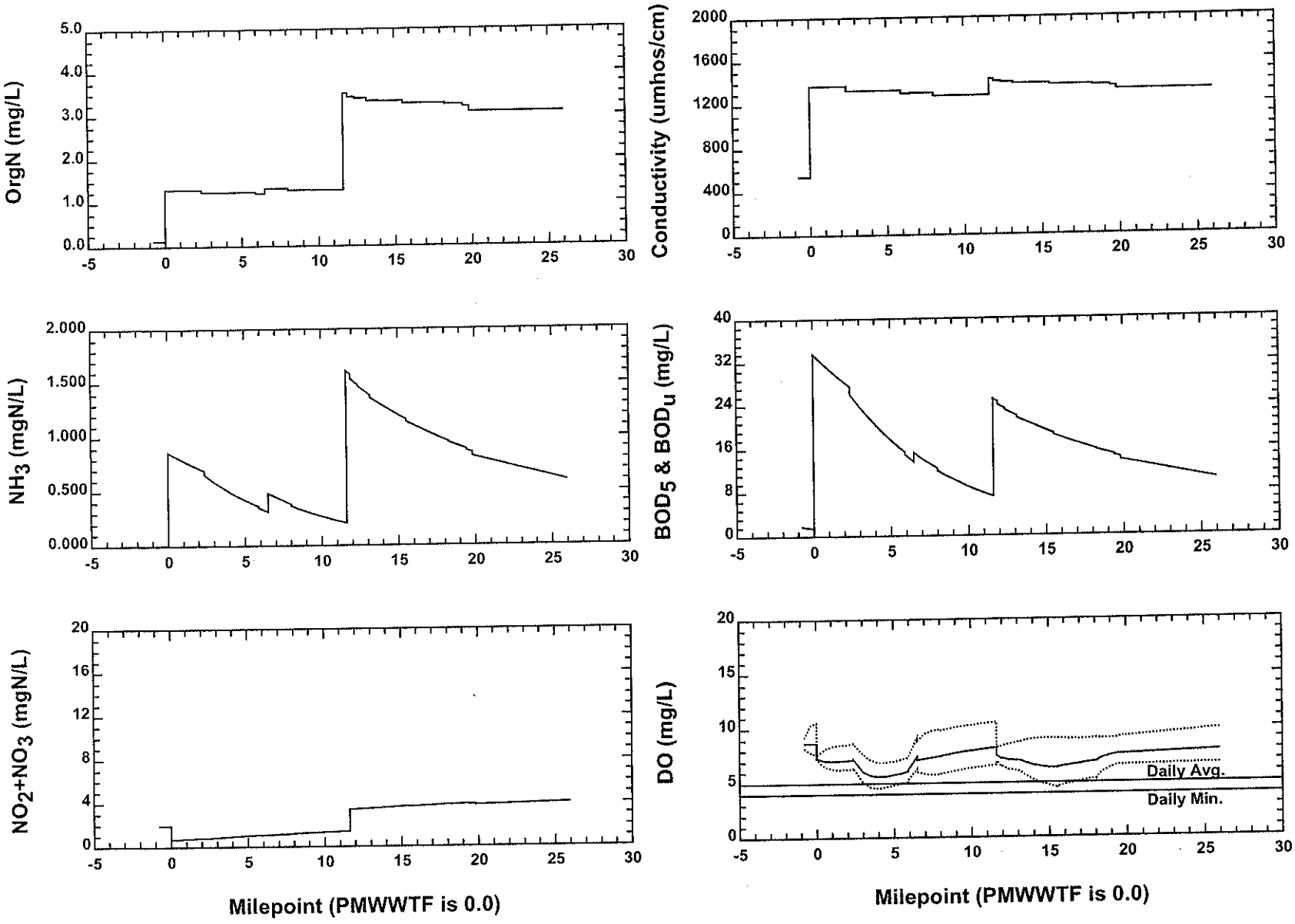

PMWWTF Water Quality Projections - 3 MGD, Summer Dry Creek Flow, Cloudy

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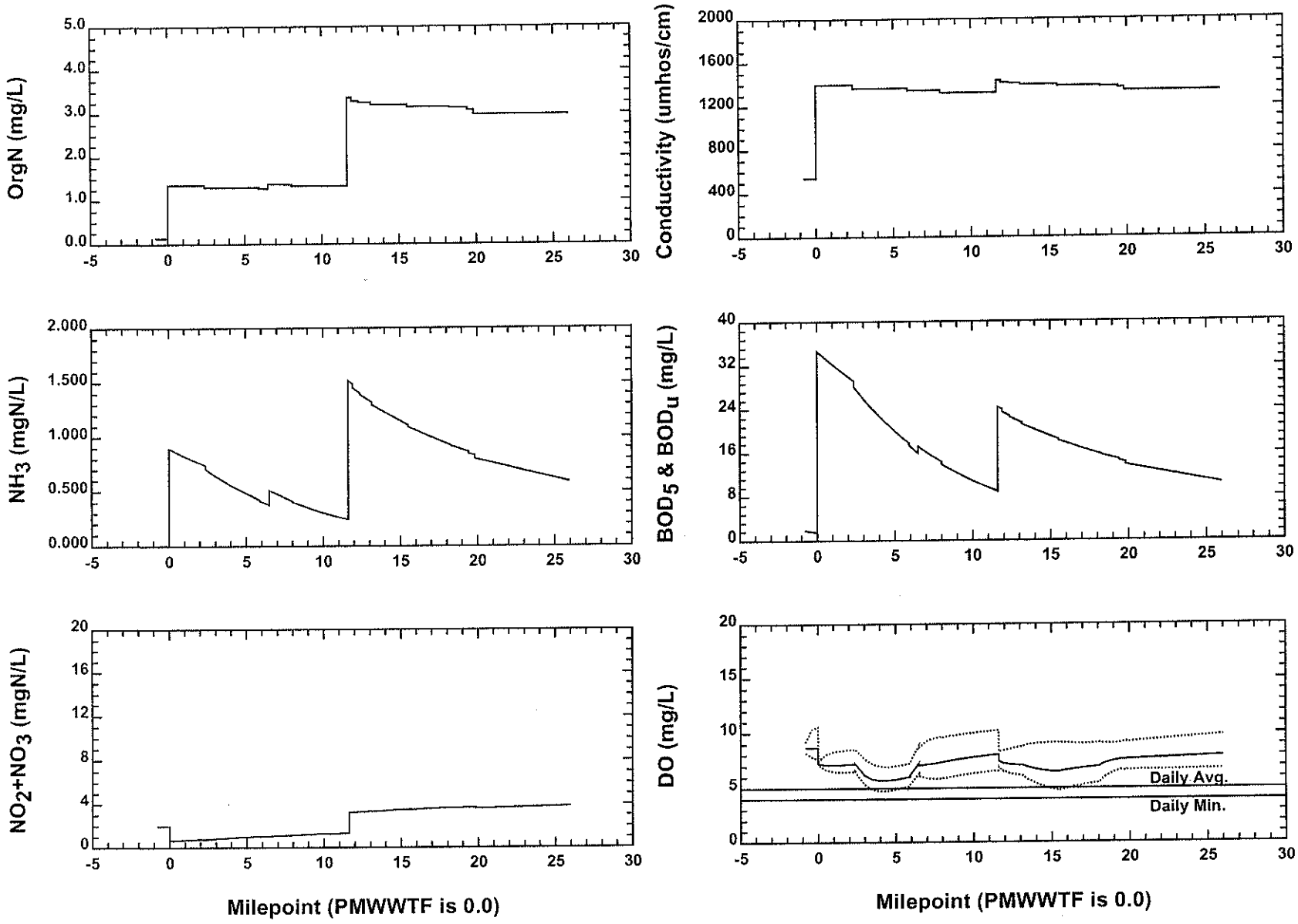

PMWWTF Water Quality Projections - 4 MGD, Summer Dry Creek Flow, Cloudy

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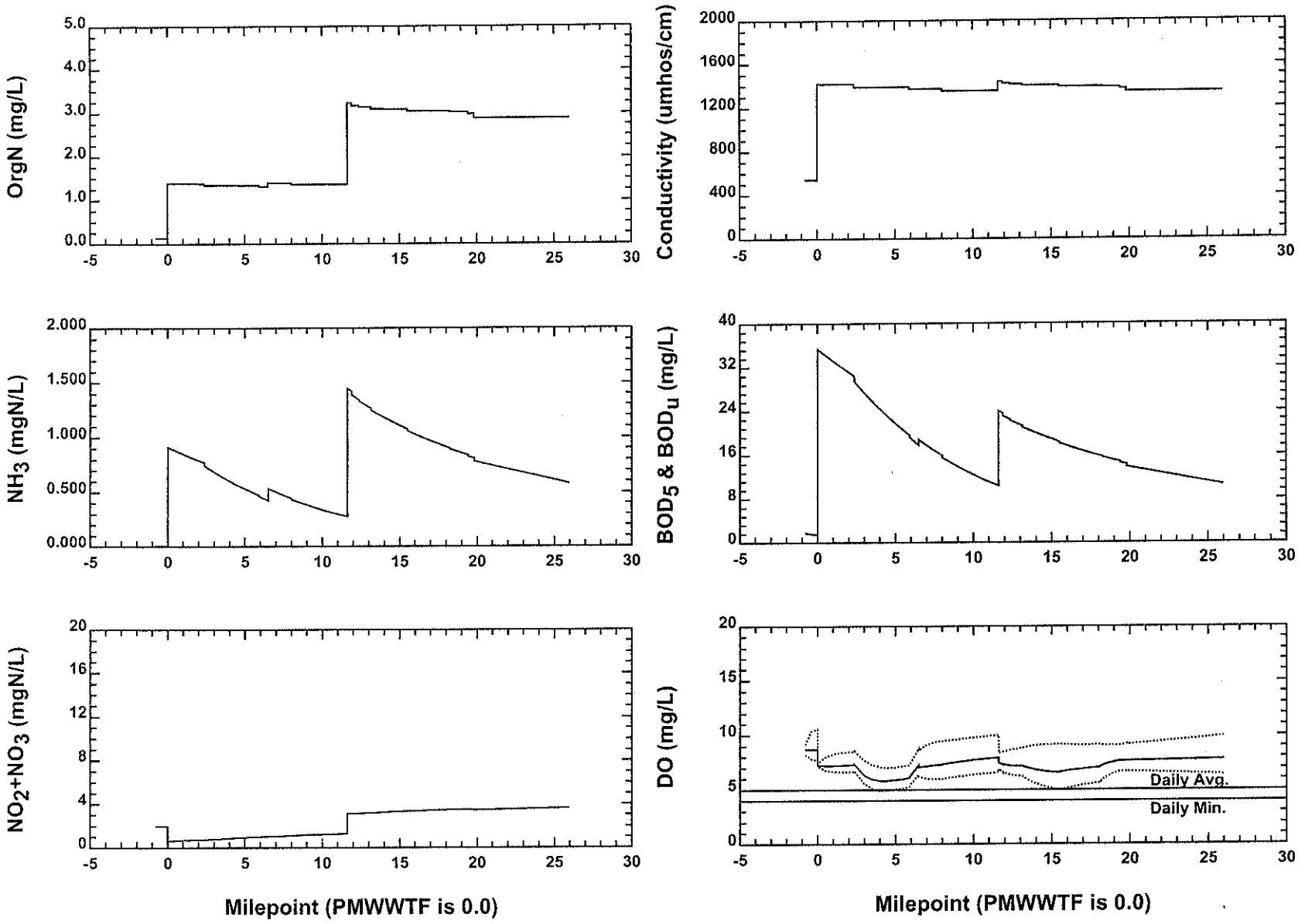

PMWWTF Water Quality Projections - 5 MGD, Summer Dry Creek Flow, Cloudy

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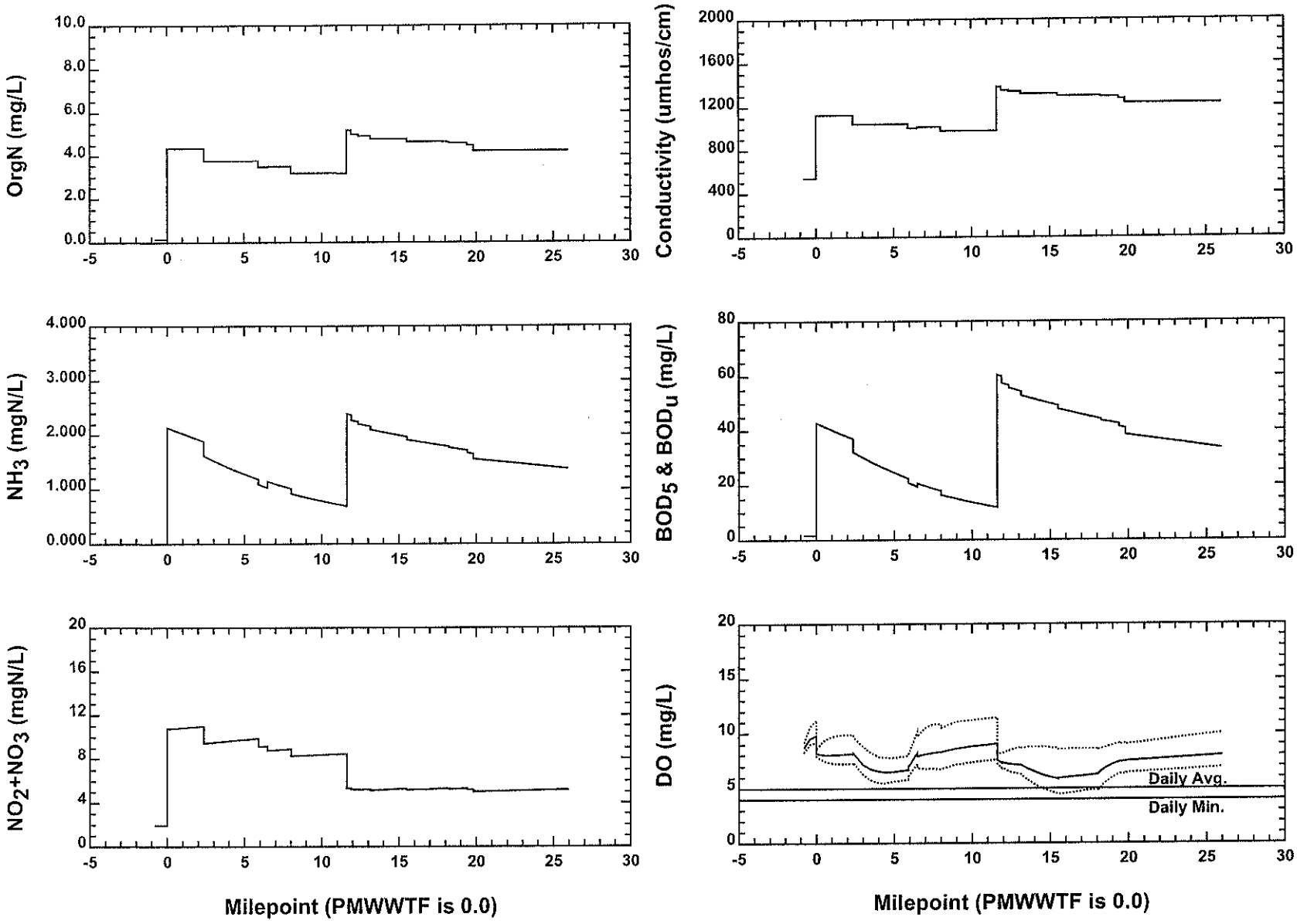
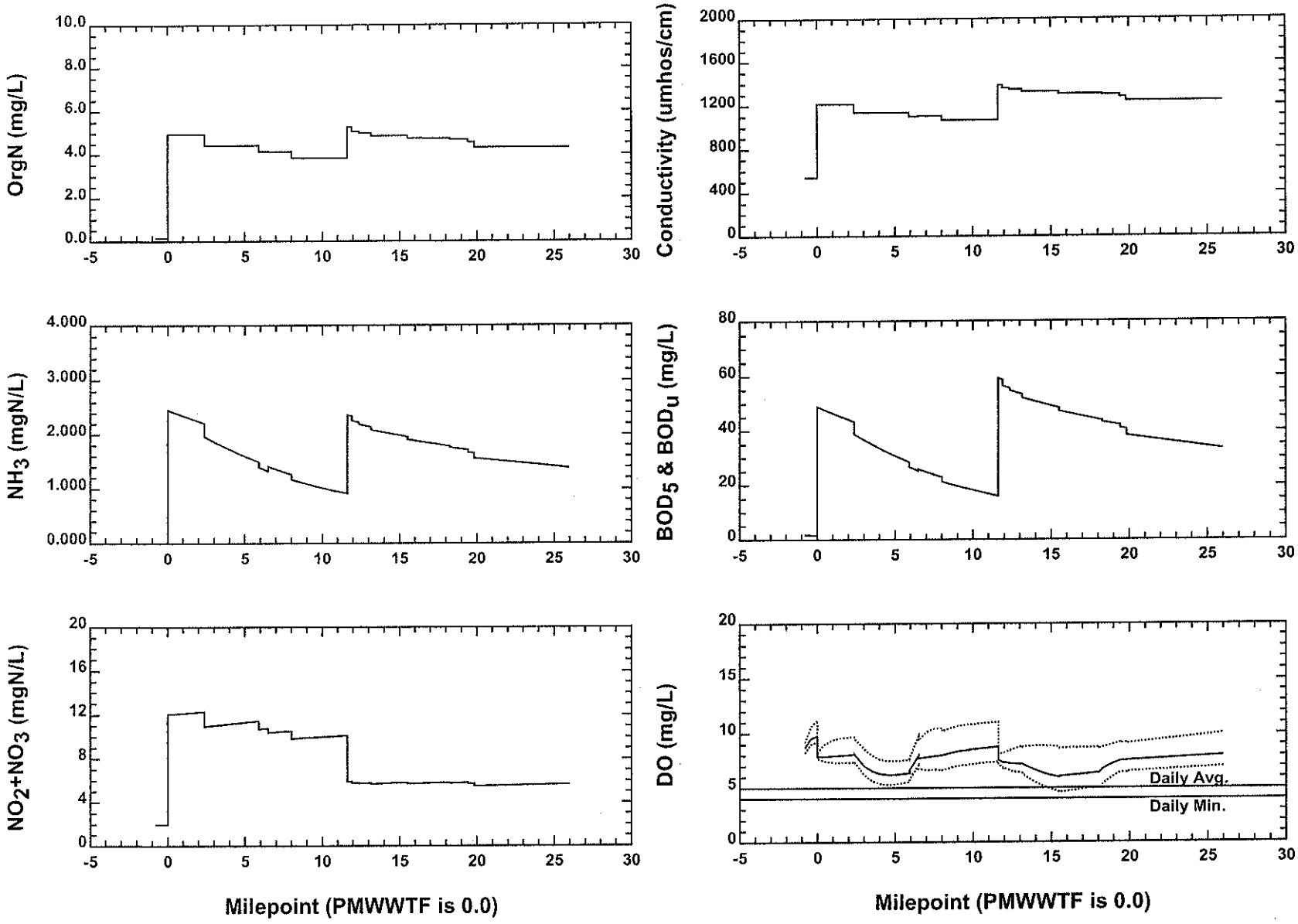


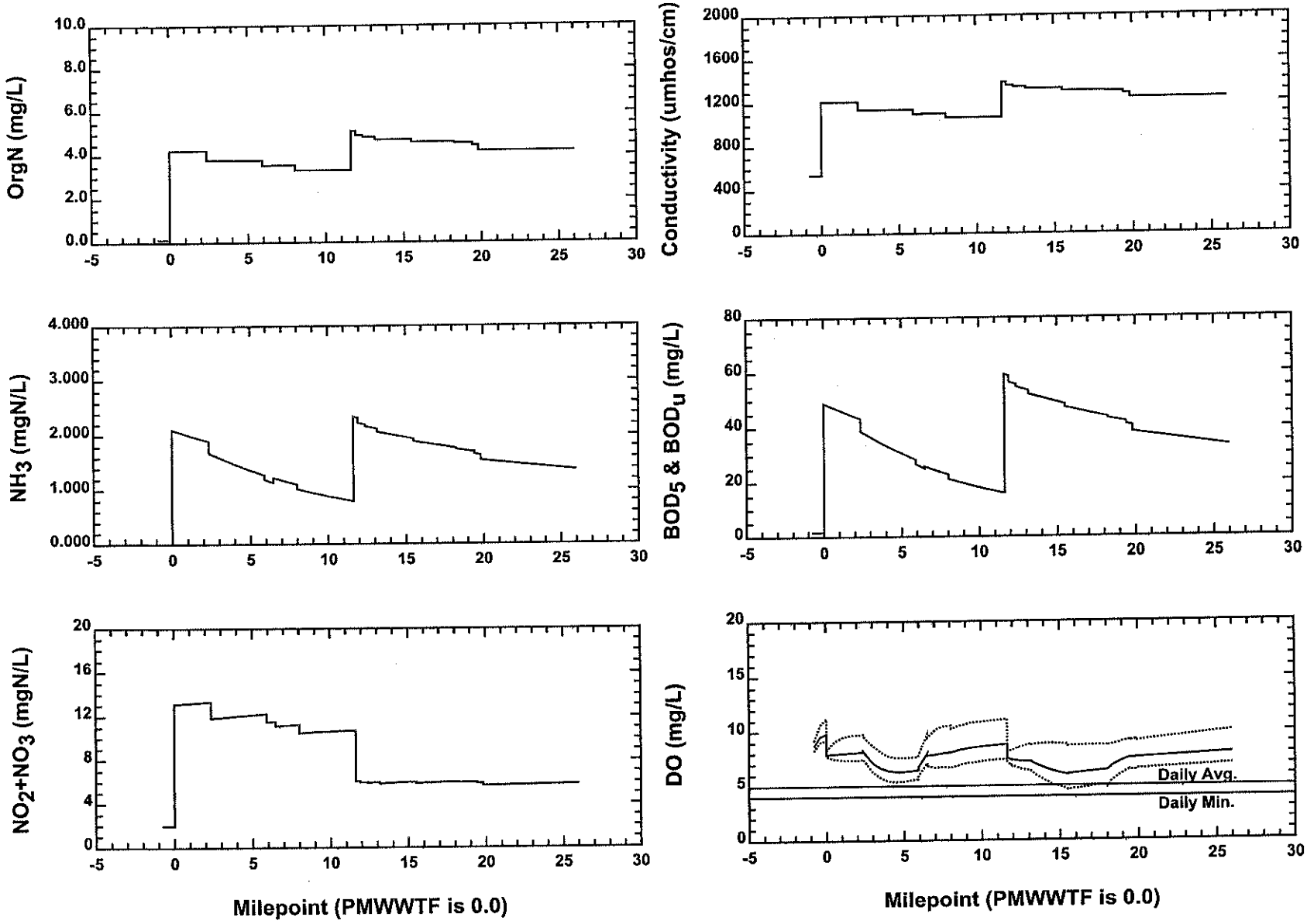
PMWWTF Water Quality Projections - 2 MGD, Winter Dry Creek Flow, Cloudy

DATE: 7/03/2005 TIME: 18:34:47 /usersm/obag0060/HEIDI/MODEL/PROJECTION/WET_LOW_FLOW/CLOUDY/2mgd_cl.gdp



PMWWTF Water Quality Projections - 3 MGD, Winter Dry Creek Flow, Cloudy

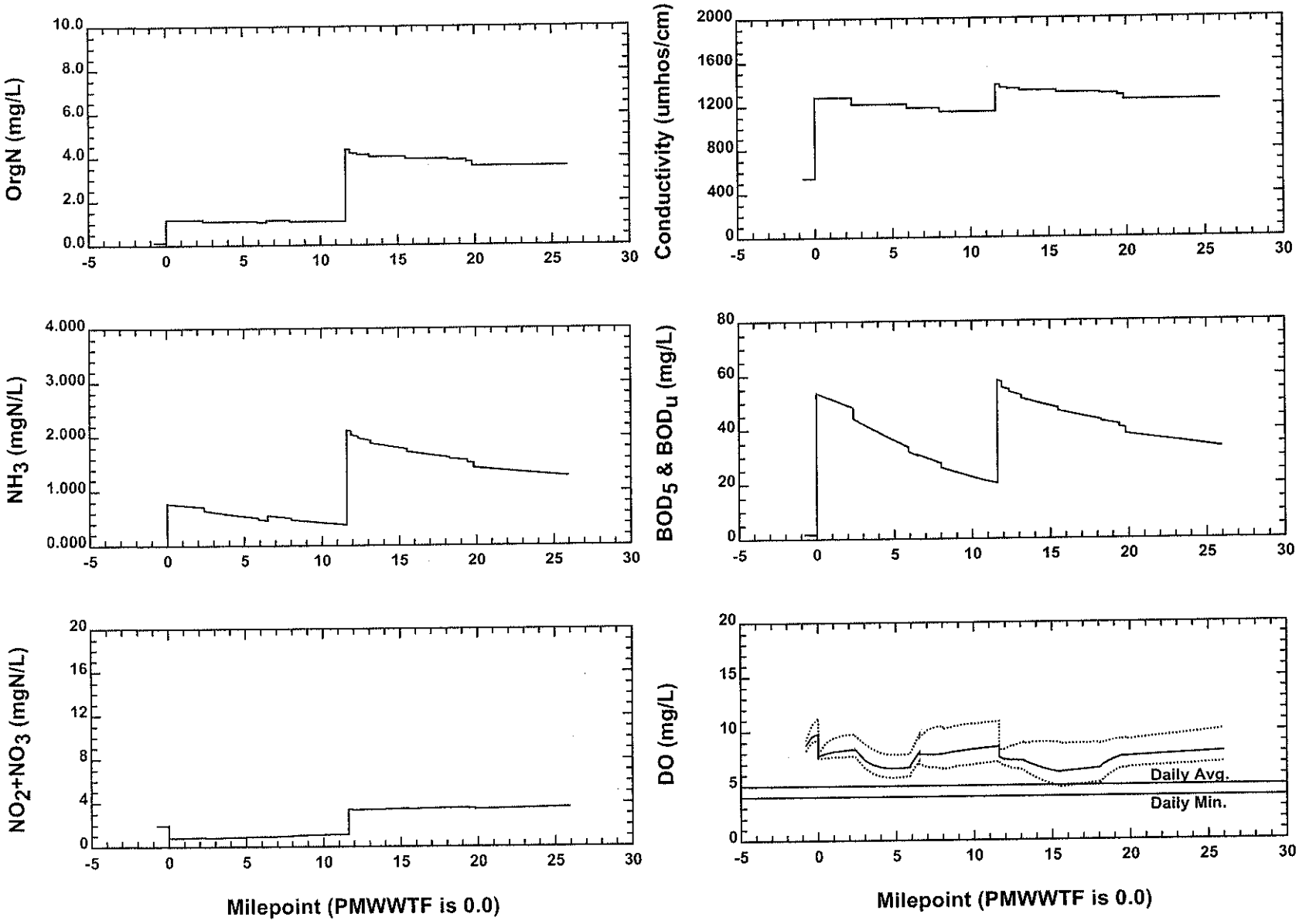
DATE: 7/03/2005 TIME: 18:34:54 /usersm/obag0060/HEIDI/MODEL/PROJECTION/WET_LOW_FLOW/CLOUDY/3mgd_cl.gdp



PMWWTF Water Quality Projections - 3 MGD, Winter Dry Creek Flow, Cloudy

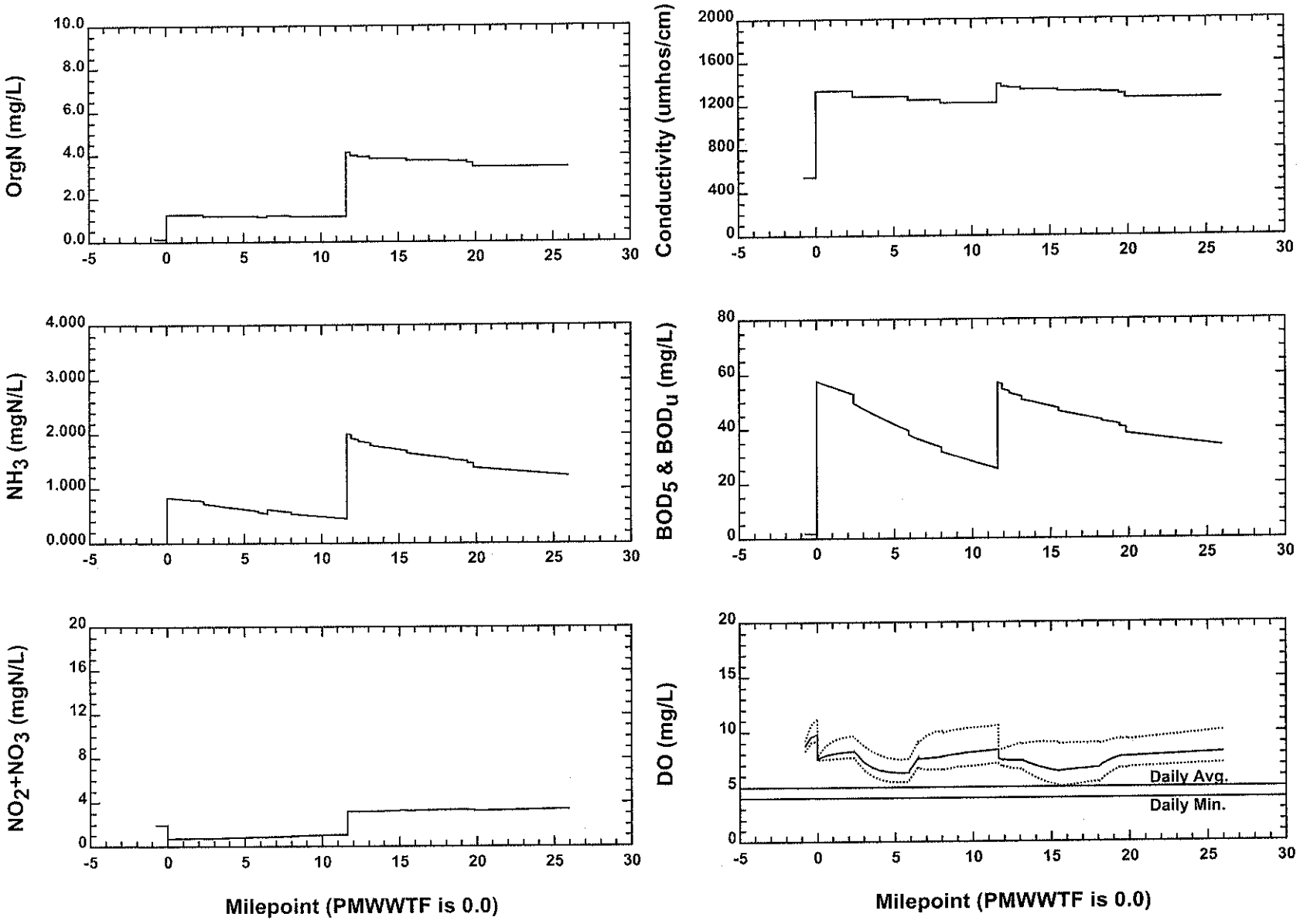
PMWWTF at Current Discharge (BOD5=23 mg/L, TN=26.9 mg/L, OrgN=6 mg/L, NH3=3 mg/L)

DATE: 9/13/2005 TIME: 11:28:17 /usersm/obag0060/HEIDI/MODEL/PROJECTION/WET_LOW_FLOW/CLOUDY/3mgd_cl_tw.gdp



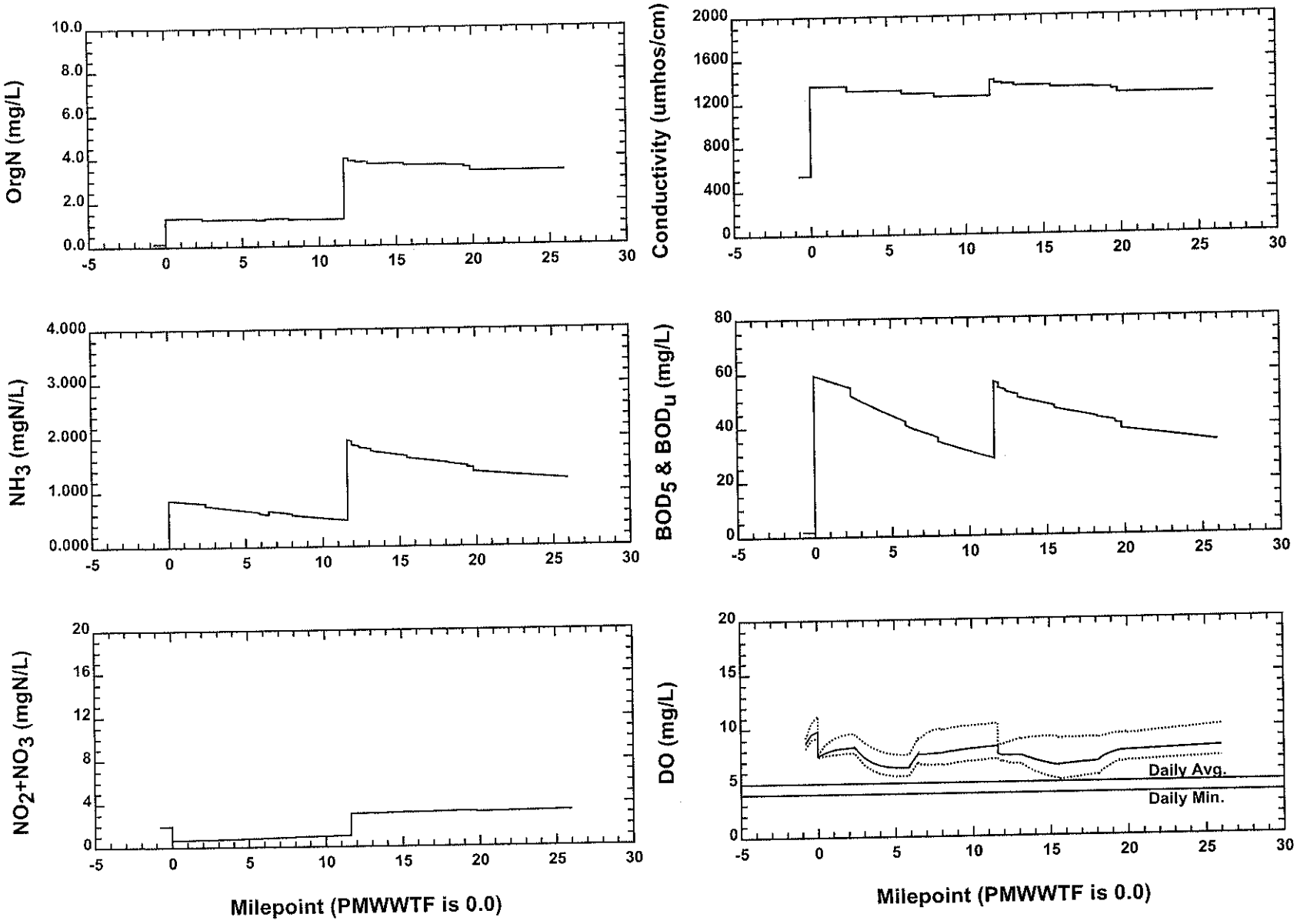
PMWWTF Water Quality Projections - 4.3 MGD, Winter Dry Creek Flow, Cloudy

DATE: 7/03/2005 TIME: 18:34:59 /usersm/obag0060/HEIDI/MODEL/PROJECTION/WET_LOW_FLOW/CLOUDY/43mgd_cl.gdp



PMWWTF Water Quality Projections - 6.3 MGD, Winter Dry Creek Flow, Cloudy

DATE: 7/03/2005 TIME: 18:35: 3 /usersm/obag0060/HEIDI/MODEL/PROJECTION/WET_LOW_FLOW/CLOUDY/63mgd_cl.gdp



PMWWTF Water Quality Projections - 7.6 MGD, Winter Dry Creek Flow, Cloudy

DATE: 7/03/2005 TIME: 18:35: 8 /usersm/obag0060/HEIDI/MODEL/PROJECTION/WET_LOW_FLOW/CLOUDY/76mgd_cl.gdp

ATTACHMENT 3
EFFLUENT DISCHARGE CONDITIONS

DRY WEATHER CONDITIONS (~~MAY~~ JUN-NOV)

	PMWWTF (current)	PMWWTF (ENR)	PMWWTF (ENR)	PMWWTF (ENR)	USE FOR INPUT * FCL (before 9/17/08)	FCL (after 9/17/08)	USE FOR INPUT OWRF (current)	* OWRF (ENR)
Flow (MGD)	2.0	3.0	4.0	5.0	0.15	0.15	8.4	16.0
TN (mg/L)	22.1	3.0	3.0	3.0	10.0	10.0	11.3	3.0
OrgN (mg/L)	3.8	1.5	1.5	1.5	4.6	4.6	4.6	1.5
NH3 (mg/L)	1.9	1.0	1.0	1.0	4.9	4.9	2.3	1.0
NO2+NO3 (mg/L)	16.4	0.5	0.5	0.5	0.5	0.5	4.4	0.5
TP (mg/L)	2.0	0.3	0.3	0.3	1.5	1.5	1.5	0.3
BOD5 (mg/L)	7.5	7.5	7.5	7.5	20.0	9.5	7.1	7.1
CBODu (mg/L)	38.6	38.6	38.6	38.6	60.0	28.5	33.9	33.9
DO (mg/L)	7.1	7.1	7.1	7.1	0.0	0.0	7.1	7.1
TN (lb/d)	369	75	100	125	13	13	792	400
OrgN (lb/d)	63	38	50	63	6	6	322	200
NH3 (lb/d)	32	25	33	42	6	6	161	133
NO2+NO3 (lb/d)	274	13	17	21	1	1	308	67
TP (lb/d)	33	8	10	13	2	2	105	40
BOD5 (lb/d)	125	188	250	313	25	12	497	947
CBODu (lb/d)	643	965	1286	1608	75	36	2373	4519
DO (lb/d)	118	178	237	296	0	0	497	947

CREEK CONDITIONS

7Q10 low flow (cfs) = 1.5 at the Berryville Gage (minus PMWWTF and FCL effluent flow)

Dry/Summer Temp (C) = 23.6

WET WEATHER CONDITIONS (DEC-~~APR~~ MAY)

	PMWWTF (current)	PMWWTF (ENR)	PMWWTF (ENR)	PMWWTF (ENR)	PMWWTF (ENR)	USE FOR INPUT * FCL (before 9/17/08)	FCL (after 9/17/08)	USE FOR INPUT OWRF (current)	* OWRF (ENR)
Flow (MGD)	2.0	3.0	4.3	6.3	7.6	0.15	0.15	16.0	16.0
TN (mg/L)	26.9	3.0	3.0	3.0	3.0	11.0	11.0	13.1	3.0
OrgN (mg/L)	7.0	1.5	1.5	1.5	1.5	5.6	5.6	5.8	1.5
NH3 (mg/L)	3.5	1.0	1.0	1.0	1.0	4.9	4.9	2.9	1.0
NO2+NO3 (mg/L)	16.4	0.5	0.5	0.5	0.5	0.5	0.5	4.4	0.5
TP (mg/L)	2.0	0.3	0.3	0.3	0.3	1.5	1.5	1.5	0.3
BOD5 (mg/L)	23.0	7.5	7.5	7.5	7.5	20.0	8.9	25.0	25.0
CBODu (mg/L)	69.0	38.6	38.6	38.6	38.6	60.0	26.7	75.0	75.0
DO (mg/L)	7.1	7.1	7.1	7.1	7.1	0.0	0.0	7.1	7.1
TN (lb/d)	449	75	108	158	190	14	14	1748	400
OrgN (lb/d)	117	38	54	79	95	7	7	774	200
NH3 (lb/d)	58	25	36	53	63	6	6	387	133
NO2+NO3 (lb/d)	274	13	18	26	32	1	1	587	67
TP (lb/d)	33	8	11	16	19	2	2	200	40
BOD5 (lb/d)	384	188	269	394	475	25	11	3336	3336
CBODu (lb/d)	1151	965	1382	2025	2443	75	33	10008	10008
DO (lb/d)	118	178	255	373	450	0	0	947	947

CREEK CONDITIONS

7Q10 low flow (cfs) = 4.1 at the Berryville Gage (minus PMWWTF and FCL effluent flow)

Wet/Winter Temp (C) = 15.7

Winter Notes

Sheet	Description
3mgd_cloudy_winter_tw	Winter wet, 3MGD, cloudy conditions, temp=15.7C (PMWWTF at current discharge conditions)

	PMWWTF (current)
Flow (MGD)	3.0
TN (mg/L)	26.9
OrgN (mg/L)	6.0
NH3 (mg/L)	3.0
NO2+NO3 (mg/L)	17.9
TP (mg/L)	2.0
BOD5 (mg/L)	23.0
CBODu (mg/L)	69.0
DO (mg/L)	7.1
TN (lb/d)	673
OrgN (lb/d)	150
NH3 (lb/d)	75
NO2+NO3 (lb/d)	448
TP (lb/d)	50
BOD5 (lb/d)	575
CBODu (lb/d)	1726
DO (lb/d)	178

CREEK CONDITIONS

7Q10 low flow (cfs) =	4.1	at the Berryville Gage (minus PMWWTF and FCL effluent flow)
Wet/Winter Temp (C) =	15.7	

ATTACHMENT 4
ADDITIONAL MODEL RUNS FOR OWRF WITH ANNUAL DISCHARGE FLOWS OF 10.4 MGD AND 12.6 MGD

DISCHARGE CONDITIONS ANALYZED FOR OWRF CASES

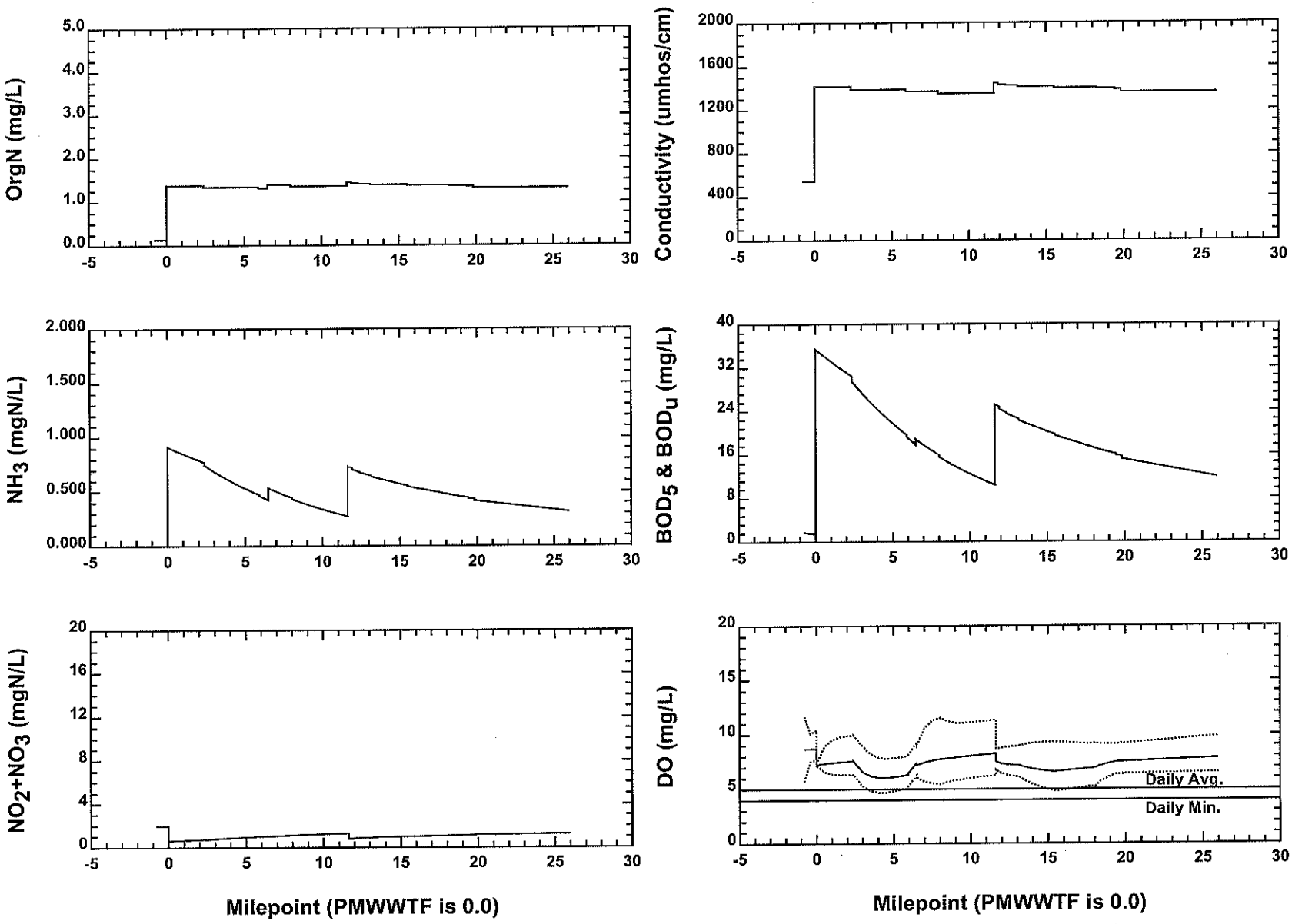
	Flow (MGD)	DO (mg/L)	OrgN (mg/L)	NH3 (mg/L)	NO2+NO3 (mg/L)	CBODu (mg/L)	TN (mg/L)	TP (mg/L)	CBOD5 (mg/L)
PMWWTF (at ENR)	5.00	7.10	1.50	1.00	0.50	38.55	3.00	0.30	7.50
FCL	0.15	0.00	4.60	4.90	0.50	60.00	10.00	1.50	20.00
OWRF (at ENR)	variable	7.10	1.50	1.00	0.50	33.87	3.00	0.30	7.10

	OWRF Dry Flow (MGD)
Case 1	10.4
Case 2	12.6

Note: Used PMWWTF flow of 5 MGD and ENR since this will be the PMWWTF discharge conditions for the OWRF cases analyzed

10.4 MGD Summer_Sunny

	Model Reach	Output MP	OrgN (mg/L)	NH4 (mg/L)	NO2+NO3 (mg/L)	CBODu (mg/L)	Daily Minimum DO (mg/L)	Daily Average DO (mg/L)	Daily Maximum DO (mg/L)	DO Saturation (mg/L)	Conductivity (umhos/cm)	NBODu (mg/L) - calc
Upstream	1	-0.8	0.1367	0.00421	1.97851	1.78405	5.67858	8.678511	11.67858	8.2953542	542.11	0.0192
	1	-0.4	0.1366	0.00361	1.97871	1.61237	7.52568	8.68761	10.08158	8.2953542	542.11	0.0165
	1	0	0.1365	0.00301	1.97891	1.45717	7.72438	8.69791	10.42758	8.2953542	542.11	0.0138
PMWWTF	2	0	1.3848	0.9153	0.611135	35.40307	7.16297	7.24057	7.37648	8.30261418	1418.48	4.1829
	2	0.5	1.3846	0.8832	0.643134	34.29206	6.56297	7.35758	8.89288	8.30261418	1418.48	4.0362
	2	1	1.3845	0.8523	0.674033	33.21596	6.36167	7.43269	9.54408	8.30261418	1418.48	3.8950
	2	1.5	1.3843	0.8224	0.703832	32.17366	6.30587	7.48949	9.80038	8.30261418	1418.48	3.7584
	2	2	1.3841	0.7936	0.732531	31.16396	6.30467	7.53789	9.89528	8.30261418	1418.48	3.6268
	2	2.37	1.384	0.7729	0.75313	30.43726	6.32077	7.57079	9.92928	8.30261418	1418.48	3.5322
Wrights Run	3	2.37	1.3447	0.7463	0.729429	29.46616	6.35997	7.61219	9.97338	8.31091388	1388.07	3.4106
	3	3	1.3443	0.688	0.787527	27.40135	5.24486	6.55538	8.88438	8.31091388	1388.07	3.1442
	3	3.5	1.344	0.6451	0.830425	25.86614	4.83786	6.18238	8.23608	8.31091388	1388.07	2.9481
	3	4	1.3437	0.6048	0.870524	24.41694	4.65766	6.03707	7.89028	8.31091388	1388.07	2.7639
	3	4.5	1.3433	0.567	0.908223	23.04894	4.67266	6.02267	7.79308	8.31091388	1388.07	2.5912
	3	5	1.343	0.5316	0.943521	21.75754	4.78796	6.08217	7.84808	8.31091388	1388.07	2.4294
	3	5.5	1.3427	0.4985	0.97662	20.53854	4.93986	6.18167	7.94378	8.31091388	1388.07	2.2781
	3	5.91	1.3424	0.47281	1.002119	19.59015	5.05586	6.27888	8.03458	8.31091388	1388.07	2.1607
falo Lick Run	4	5.91	1.3181	0.463	0.991519	19.21825	5.15226	6.35128	8.06328	8.3164137	1370.06	2.1159
	4	6.5	1.3177	0.42431	1.030217	17.77226	6.23787	7.37939	9.26178	8.3164137	1370.06	1.9391
FCL	5	6.5	1.3951	0.53431	1.020018	18.76176	6.04187	7.19689	9.07148	8.3199137	1370.23	2.4418
	5	7	1.3948	0.50261	1.051517	17.76395	5.65427	7.43821	10.58378	8.3199137	1370.23	2.2969
	5	7.5	1.3945	0.47291	1.081216	16.81925	5.50827	7.610311	11.29658	8.3199137	1370.23	2.1612
	5	8.01	1.3941	0.44431	1.109715	15.90725	5.43117	7.745911	11.54018	8.3199137	1370.23	2.0305
r Spring Run	6	8.01	1.3647	0.43291	1.124915	15.52835	5.44637	7.747911	11.48918	8.32721349	1349.9	1.9784
	6	8.5	1.3644	0.40701	1.150714	14.69395	5.62137	7.805811	11.23448	8.32721349	1349.9	1.8600
	6	9	1.3641	0.38221	1.175413	13.88865	5.76797	7.874811	11.03348	8.32721349	1349.9	1.7467
	6	9.5	1.3637	0.35891	1.198713	13.12755	5.86587	7.946811	11.05558	8.32721349	1349.9	1.6402
	6	10	1.3634	0.33701	1.220512	12.40815	5.98428	8.018311	11.11358	8.32721349	1349.9	1.5401
	6	10.5	1.3631	0.31641	1.240911	11.72816	6.07928	8.087611	11.18428	8.32721349	1349.9	1.4460
	6	11	1.3628	0.29711	1.260211	11.08546	6.14758	8.153811	11.25698	8.32721349	1349.9	1.3578
	6	11.62	1.3624	0.27481	1.28241	10.33716	6.22078	8.231511	11.33598	8.32721349	1349.9	1.2559
OWRF	7	11.62	1.4481	0.7309	0.790525	25.13526	6.75527	7.51938	8.67708	8.33271443	1443.79	3.3402
	7	11.91	1.448	0.7171	0.804224	24.71206	6.43827	7.33928	8.73178	8.33271443	1443.79	3.2771
brams Creek	8	11.91	1.4228	0.7035	0.826924	24.27376	6.48677	7.36468	8.72468	8.33361428	1428.47	3.2150
	8	12.38	1.4227	0.6824	0.848023	23.62236	6.23237	7.22758	8.82628	8.33361428	1428.47	3.1186
edbud Creek	9	12.38	1.4125	0.6773	0.855123	23.45856	6.24397	7.23268	8.82008	8.33511422	1422.52	3.0953
	9	13.16	1.4123	0.6458	0.886422	22.48186	6.06697	7.14388	8.95548	8.33511422	1422.52	2.9513
Marsh Creek	10	13.16	1.3946	0.6373	0.902722	22.20256	6.05677	7.13688	8.94168	8.33751411	1411.58	2.9125
	10	13.5	1.3945	0.6246	0.915321	21.80645	5.74426	6.98879	9.07938	8.33751411	1411.58	2.8544
	10	14	1.3943	0.6064	0.933521	21.23675	5.40086	6.81699	9.19028	8.33751411	1411.58	2.7712
	10	14.5	1.3941	0.5887	0.95112	20.68195	5.14456	6.69079	9.26948	8.33751411	1411.58	2.6904
	10	15	1.394	0.5715	0.96832	20.14164	4.95886	6.60189	9.30898	8.33751411	1411.58	2.6118
	10	15.51	1.3938	0.5545	0.985219	19.60504	4.77566	6.54259	9.32028	8.33751411	1411.58	2.5341
Lick Run	11	15.51	1.3773	0.5472	0.992919	19.36804	4.77856	6.56379	9.31498	8.34081399	1399.96	2.5007
	11	16	1.3771	0.53271	1.007418	18.90934	4.86526	6.63369	9.29058	8.34081399	1399.96	2.4345
	11	16.5	1.377	0.51841	1.021718	18.45244	4.96016	6.70159	9.23438	8.34081399	1399.96	2.3691
	11	17	1.3768	0.50441	1.035618	18.00665	5.06076	6.76649	9.17588	8.34081399	1399.96	2.3052
	11	17.5	1.3767	0.49081	1.049217	17.57165	5.15516	6.82859	9.14968	8.34081399	1399.96	2.2430
	11	18.07	1.3765	0.47571	1.064217	17.08845	5.24066	6.89649	9.17378	8.34081399	1399.96	2.1740
NWRF	12	18.07	1.3763	0.47561	1.064417	17.08505	5.20696	6.89669	9.17588	8.34291399	1399.79	2.1735
	12	18.26	1.3762	0.47111	1.068916	16.93985	5.50387	7.04299	9.13178	8.34291399	1399.79	2.1530
arbrook Run	13	18.26	1.369	0.46831	1.070716	16.84785	5.52607	7.04979	9.10878	8.34461394	1394.82	2.1402
	13	18.5	1.3689	0.46271	1.076316	16.66775	5.74617	7.16359	9.09758	8.34461394	1394.82	2.1146
	13	19	1.3688	0.45131	1.087716	16.29876	6.09917	7.34729	9.09138	8.34461394	1394.82	2.0625
	13	19.42	1.3687	0.44191	1.097015	15.99506	6.31677	7.46019	9.09838	8.34461394	1394.82	2.0195
Slate Run	14	19.42	1.3519	0.43581	1.106015	15.79506	6.33637	7.46559	9.08958	8.34641383	1383.69	1.9917
	14	19.83	1.3518	0.42761	1.114215	15.52916	6.32367	7.48549	9.21208	8.34641383	1383.69	1.9542
Turkey Run	15	19.83	1.3155	0.41471	1.135215	15.10256	6.37507	7.49509	9.16258	8.35171359	1359.58	1.8952
	15	26	1.314	0.31341	1.236111	11.75326	6.52217	7.81879	9.83928	8.35171359	1359.58	1.4323

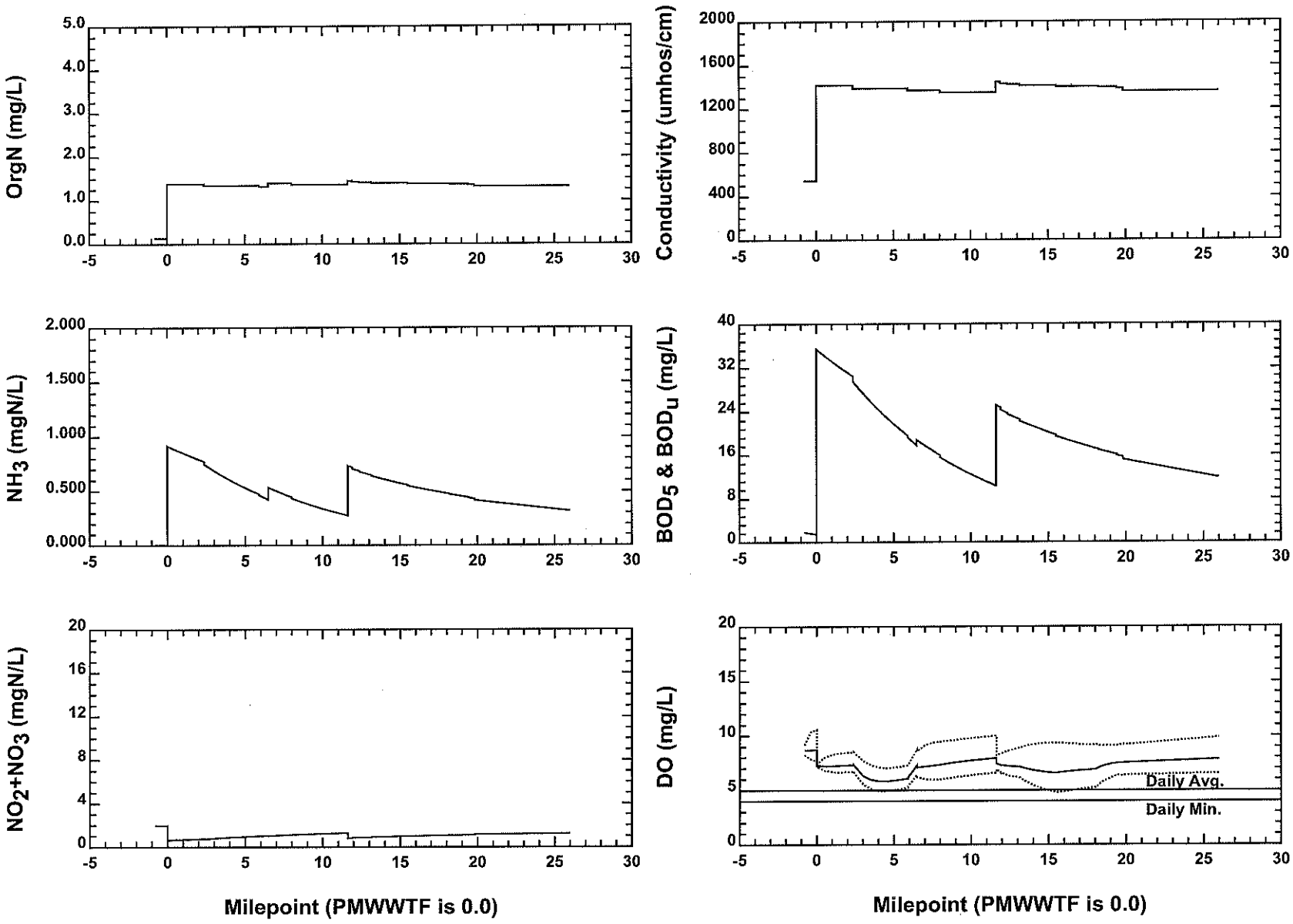


OWRF Water Quality Projections - 10.4 MGD, Summer Dry Creek Flow, Sunny

DATE: 11/09/2005 TIME: 11:44:56 /usersm/obag0060/HEIDI/MODEL/PROJECTION/OWRF/pmodel.gdp

10.4 MGD Summer_Cloudy

	Model Reach	Output MP	OrgN (mg/L)	NH4 (mg/L)	NO2+NO3 (mg/L)	CBODu (mg/L)	Daily Minimum DO (mg/L)	Daily Average DO (mg/L)	Daily Maximum DO (mg/L)	DO Saturation (mg/L)	Conductivity (umhos/cm)	NBODu (mg/L) - calc
Upstream	1	-0.8	0.1367	0.00421	1.97851	1.78408	8.20358	8.67859	9.15358	8.2953542	542.11	0.0192
	1	-0.4	0.1366	0.00361	1.97871	1.61237	7.82208	8.68761	10.33198	8.2953542	542.11	0.0165
	1	0	0.1365	0.00301	1.97891	1.45717	7.63958	8.69791	10.56128	8.2953542	542.11	0.0138
PMWWTF	2	0	1.3848	0.9153	0.611135	35.40307	7.15637	7.24057	7.38688	8.30261418	1418.48	4.1829
	2	0.5	1.3846	0.8832	0.643134	34.29206	6.77667	7.19307	7.98438	8.30261418	1418.48	4.0362
	2	1	1.3845	0.8523	0.674033	33.21596	6.65667	7.19998	8.26098	8.30261418	1418.48	3.8950
	2	1.5	1.3843	0.8224	0.703832	32.17366	6.63357	7.22848	8.38408	8.30261418	1418.48	3.7584
	2	2	1.3841	0.7936	0.732531	31.16396	6.64727	7.26518	8.44318	8.30261418	1418.48	3.6268
	2	2.37	1.384	0.7729	0.75313	30.43726	6.66847	7.29418	8.47288	8.30261418	1418.48	3.5322
Wrights Run	3	2.37	1.3447	0.7463	0.729429	29.46616	6.71847	7.34508	8.52518	8.31091388	1388.07	3.4106
	3	3	1.3443	0.688	0.787527	27.40135	5.54396	6.31357	7.67978	8.31091388	1388.07	3.1442
	3	3.5	1.344	0.6451	0.830425	25.86615	5.11415	5.95157	7.27828	8.31091388	1388.07	2.9481
	3	4	1.3437	0.6048	0.870524	24.41694	4.92885	5.81277	7.06748	8.31091388	1388.07	2.7639
	3	4.5	1.3433	0.567	0.908223	23.04894	4.91855	5.80237	7.00518	8.31091388	1388.07	2.5912
	3	5	1.343	0.5316	0.943521	21.75754	4.99795	5.86417	7.05398	8.31091388	1388.07	2.4294
	3	5.5	1.3427	0.4985	0.97662	20.53855	5.12545	5.96507	7.14688	8.31091388	1388.07	2.2781
	3	5.91	1.3424	0.47281	1.002119	19.59015	5.23756	6.06297	7.23848	8.31091388	1388.07	2.1607
falo Lick Run	4	5.91	1.3181	0.463	0.991519	19.21825	5.33126	6.13987	7.28618	8.3164137	1370.06	2.1159
	4	6.5	1.3177	0.42431	1.030217	17.77226	6.36277	7.24628	8.73798	8.3164137	1370.06	1.9391
FCL	5	6.5	1.3951	0.53431	1.020018	18.76176	6.17247	7.06768	8.55348	8.3199137	1370.23	2.4418
	5	7	1.3948	0.50261	1.051517	17.76395	5.99747	7.13569	9.11788	8.3199137	1370.23	2.2969
	5	7.5	1.3945	0.47291	1.081216	16.81925	5.96257	7.21679	9.35198	8.3199137	1370.23	2.1612
	5	8.01	1.3941	0.44431	1.109715	15.90725	5.95247	7.30389	9.46528	8.3199137	1370.23	2.0305
r Spring Run	6	8.01	1.3647	0.43291	1.124915	15.52835	5.97457	7.31769	9.43588	8.32721349	1349.9	1.9784
	6	8.5	1.3644	0.40701	1.150714	14.69396	6.06827	7.42749	9.53858	8.32721349	1349.9	1.8600
	6	9	1.3641	0.38221	1.175413	13.88866	6.17077	7.52369	9.59288	8.32721349	1349.9	1.7467
	6	9.5	1.3637	0.35891	1.198713	13.12756	6.24837	7.60949	9.69238	8.32721349	1349.9	1.6402
	6	10	1.3634	0.33701	1.220512	12.40816	6.34227	7.68789	9.76368	8.32721349	1349.9	1.5401
	6	10.5	1.3631	0.31641	1.240911	11.72816	6.41707	7.76069	9.83158	8.32721349	1349.9	1.4460
	6	11	1.3628	0.29711	1.260211	11.08546	6.48527	7.82879	9.90078	8.32721349	1349.9	1.3578
	6	11.62	1.3624	0.27481	1.28241	10.33716	6.56457	7.90759	9.97858	8.32721349	1349.9	1.2559
OWRF	7	11.62	1.4481	0.7309	0.790525	25.13526	6.88917	7.39938	8.17178	8.33271443	1443.79	3.3402
	7	11.91	1.448	0.7171	0.804224	24.71206	6.54567	7.24018	8.33238	8.33271443	1443.79	3.2771
brams Creek	8	11.91	1.4228	0.7035	0.826924	24.27376	6.59217	7.26758	8.33298	8.33361428	1428.47	3.2150
	8	12.38	1.4227	0.6824	0.848023	23.62236	6.29567	7.16138	8.59998	8.33361428	1428.47	3.1186
edbud Creek	9	12.38	1.4125	0.6773	0.855123	23.45856	6.30687	7.16688	8.59558	8.33511422	1422.52	3.0953
	9	13.16	1.4123	0.6458	0.886422	22.48186	6.09307	7.10808	8.88718	8.33511422	1422.52	2.9513
Marsh Creek	10	13.16	1.3946	0.6373	0.902722	22.20256	6.08257	7.10148	8.87428	8.33751411	1411.58	2.9125
	10	13.5	1.3945	0.6246	0.915321	21.80645	5.76436	6.95779	9.04188	8.33751411	1411.58	2.8544
	10	14	1.3943	0.6064	0.933521	21.23675	5.41736	6.79129	9.18348	8.33751411	1411.58	2.7712
	10	14.5	1.3941	0.5887	0.95112	20.68195	5.15556	6.66959	9.26508	8.33751411	1411.58	2.6904
	10	15	1.394	0.5715	0.96832	20.14164	4.96096	6.58449	9.31778	8.33751411	1411.58	2.6118
	10	15.51	1.3938	0.5545	0.985219	19.60504	4.76796	6.52819	9.33388	8.33751411	1411.58	2.5341
Lick Run	11	15.51	1.3773	0.5472	0.992919	19.36804	4.77096	6.54959	9.32838	8.34081399	1399.96	2.5007
	11	16	1.3771	0.53271	1.007418	18.90934	4.85186	6.62249	9.30298	8.34081399	1399.96	2.4345
	11	16.5	1.377	0.51841	1.021718	18.45244	4.94966	6.69279	9.24408	8.34081399	1399.96	2.3691
	11	17	1.3768	0.50441	1.035618	18.00665	5.04706	6.75949	9.18278	8.34081399	1399.96	2.3052
	11	17.5	1.3767	0.49081	1.049217	17.57165	5.13986	6.82309	9.15428	8.34081399	1399.96	2.2430
	11	18.07	1.3765	0.47571	1.064217	17.08845	5.22566	6.89239	9.17668	8.34081399	1399.96	2.1740
NWRF	12	18.07	1.3763	0.47561	1.064417	17.08505	5.18986	6.89259	9.17888	8.34291399	1399.79	2.1735
	12	18.26	1.3762	0.47111	1.068916	16.93985	5.48927	7.03949	9.13418	8.34291399	1399.79	2.1530
arbrook Run	13	18.26	1.369	0.46831	1.070716	16.84785	5.51167	7.04639	9.11108	8.34461394	1394.82	2.1402
	13	18.5	1.3689	0.46271	1.076316	16.66775	5.73397	7.16079	9.09938	8.34461394	1394.82	2.1146
	13	19	1.3688	0.45131	1.087716	16.29876	6.09107	7.34529	9.09238	8.34461394	1394.82	2.0625
	13	19.42	1.3687	0.44191	1.097015	15.99506	6.31107	7.45879	9.09898	8.34461394	1394.82	2.0195
Slate Run	14	19.42	1.3519	0.43581	1.106015	15.79506	6.33117	7.46429	9.08978	8.34641383	1383.69	1.9917
	14	19.83	1.3518	0.42761	1.114215	15.52916	6.31997	7.48439	9.21198	8.34641383	1383.69	1.9542
Turkey Run	15	19.83	1.3155	0.41471	1.135215	15.10256	6.37147	7.49409	9.16238	8.35171359	1359.58	1.8952
	15	26	1.314	0.31341	1.236111	11.75326	6.52217	7.81879	9.83908	8.35171359	1359.58	1.4323

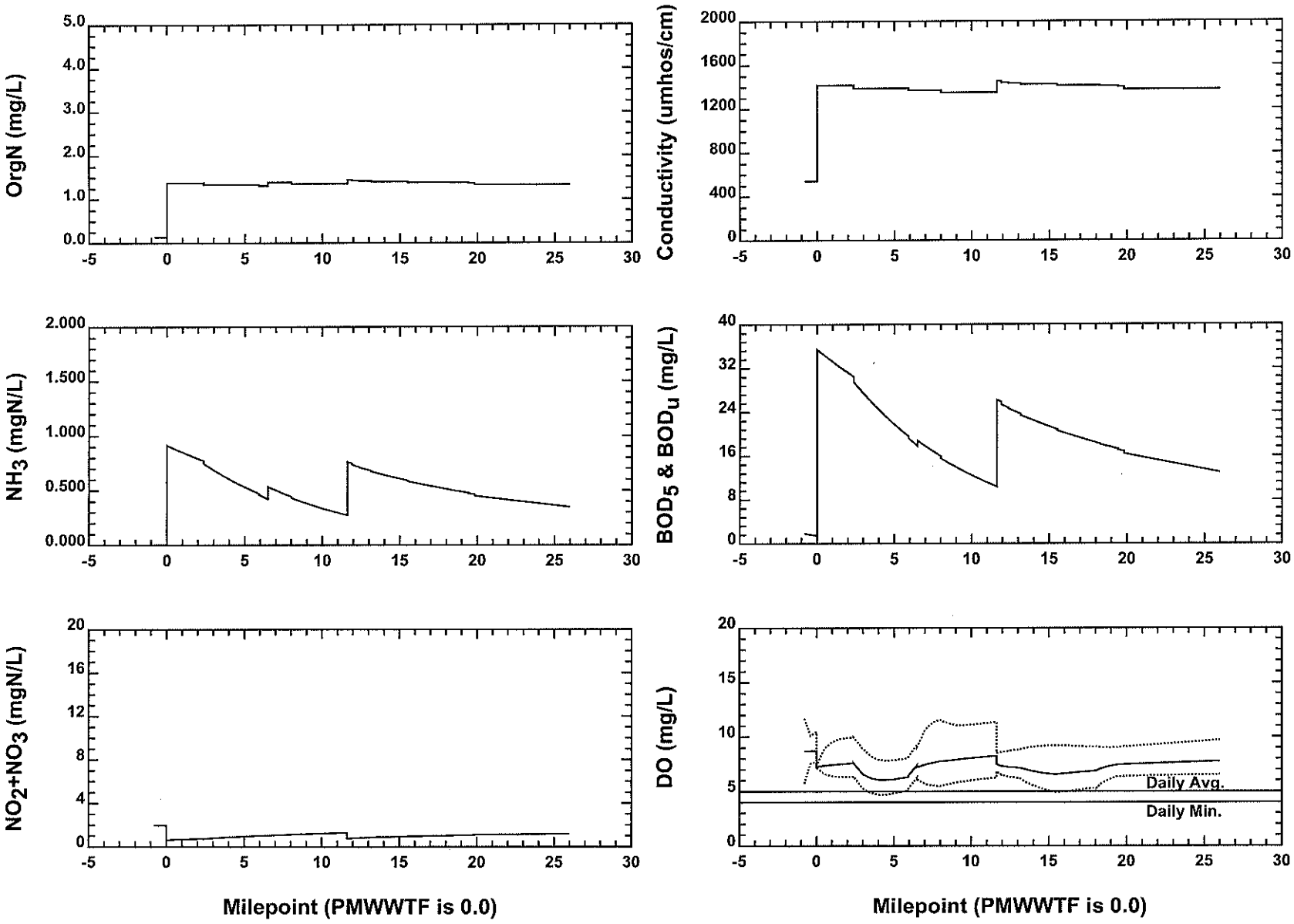


OWRF Water Quality Projections - 10.4 MGD, Summer Dry Creek Flow, Cloudy

DATE: 11/09/2005 TIME: 11:48:36 /usersm/obag0060/HEIDI/MODEL/PROJECTION/OWRF/pmodel.gdp

12.6 MGD Summer_Sunny

	Model Reach	Output MP	OrgN (mg/L)	NH4 (mg/L)	NO2+NO3 (mg/L)	CBODu (mg/L)	Daily Minimum DO (mg/L)	Daily Average DO (mg/L)	Daily Maximum DO (mg/L)	DO Saturation (mg/L)	Conductivity (umhos/cm)	NBODu (mg/L) - calc
Upstream	1	-0.8	0.1367	0.00421	1.97851	1.78405	5.67858	8.678511	11.67858	8.2953542	542.11	0.0192
	1	-0.4	0.1366	0.00361	1.97871	1.61237	7.52568	8.68761	10.08158	8.2953542	542.11	0.0165
	1	0	0.1365	0.00301	1.97891	1.45717	7.72438	8.69791	10.42758	8.2953542	542.11	0.0138
PMWWTF	2	0	1.3848	0.9153	0.611135	35.40307	7.16297	7.24057	7.37648	8.30261418	1418.48	4.1829
	2	0.5	1.3846	0.8832	0.643134	34.29206	6.56297	7.35758	8.89288	8.30261418	1418.48	4.0362
	2	1	1.3845	0.8523	0.674033	33.21596	6.36167	7.43269	9.54408	8.30261418	1418.48	3.8950
	2	1.5	1.3843	0.8224	0.703832	32.17366	6.30587	7.48949	9.80038	8.30261418	1418.48	3.7584
	2	2	1.3841	0.7936	0.732531	31.16396	6.30467	7.53789	9.89528	8.30261418	1418.48	3.6268
	2	2.37	1.384	0.7729	0.75313	30.43726	6.32077	7.57079	9.92928	8.30261418	1418.48	3.5322
Wrights Run	3	2.37	1.3447	0.7463	0.729429	29.46616	6.35997	7.61219	9.97338	8.31091388	1388.07	3.4106
	3	3	1.3443	0.688	0.787527	27.40135	5.24486	6.55538	8.88438	8.31091388	1388.07	3.1442
	3	3.5	1.344	0.6451	0.830425	25.86614	4.83786	6.18238	8.23608	8.31091388	1388.07	2.9481
	3	4	1.3437	0.6048	0.870524	24.41694	4.65766	6.03707	7.89028	8.31091388	1388.07	2.7639
	3	4.5	1.3433	0.567	0.908223	23.04894	4.67266	6.02267	7.79308	8.31091388	1388.07	2.5912
	3	5	1.343	0.5316	0.943521	21.75754	4.78796	6.08217	7.84808	8.31091388	1388.07	2.4294
	3	5.5	1.3427	0.4985	0.97662	20.53854	4.93986	6.18167	7.94378	8.31091388	1388.07	2.2781
	3	5.91	1.3424	0.47281	1.002119	19.59015	5.05586	6.27888	8.03458	8.31091388	1388.07	2.1607
falo Lick Run	4	5.91	1.3181	0.463	0.991519	19.21825	5.15226	6.35128	8.06328	8.3164137	1370.06	2.1159
	4	6.5	1.3177	0.42431	1.030217	17.77226	6.23787	7.37939	9.26178	8.3164137	1370.06	1.9391
FCL	5	6.5	1.3951	0.53431	1.020018	18.76176	6.04187	7.19689	9.07148	8.3199137	1370.23	2.4418
	5	7	1.3948	0.50261	1.051517	17.76395	5.65427	7.43821	10.58378	8.3199137	1370.23	2.2969
	5	7.5	1.3945	0.47291	1.081216	16.81925	5.50827	7.610311	11.29658	8.3199137	1370.23	2.1612
	5	8.01	1.3941	0.44431	1.109715	15.90725	5.43117	7.745911	11.54018	8.3199137	1370.23	2.0305
r Spring Run	6	8.01	1.3647	0.43291	1.124915	15.52835	5.44637	7.747911	11.48918	8.32721349	1349.9	1.9784
	6	8.5	1.3644	0.40701	1.150714	14.69395	5.62137	7.805811	11.23448	8.32721349	1349.9	1.8600
	6	9	1.3641	0.38221	1.175413	13.88865	5.76797	7.874811	11.03348	8.32721349	1349.9	1.7467
	6	9.5	1.3637	0.35891	1.198713	13.12755	5.86587	7.946811	11.05558	8.32721349	1349.9	1.6402
	6	10	1.3634	0.33701	1.220512	12.40815	5.98428	8.018311	11.11358	8.32721349	1349.9	1.5401
	6	10.5	1.3631	0.31641	1.240911	11.72816	6.07928	8.087611	11.18428	8.32721349	1349.9	1.4460
	6	11	1.3628	0.29711	1.260211	11.08546	6.14758	8.153811	11.25698	8.32721349	1349.9	1.3578
	6	11.62	1.3624	0.27481	1.28241	10.33716	6.22078	8.231511	11.33598	8.32721349	1349.9	1.2559
OWRF	7	11.62	1.4542	0.7625	0.756426	26.15936	6.79567	7.47018	8.49218	8.3327145	1450.38	3.4846
	7	11.91	1.4541	0.7491	0.769725	25.75046	6.49577	7.30478	8.55938	8.3327145	1450.38	3.4234
brams Creek	8	11.91	1.4317	0.7365	0.790425	25.34506	6.53877	7.32788	8.55498	8.33361436	1436.71	3.3658
	8	12.38	1.4316	0.716	0.810924	24.71246	6.29657	7.20768	8.68218	8.33361436	1436.71	3.2721
edbud Creek	9	12.38	1.4226	0.7112	0.817424	24.56016	6.30817	7.21228	8.67598	8.33511431	1431.4	3.2502
	9	13.16	1.4223	0.6805	0.848123	23.60816	6.13457	7.13608	8.84258	8.33511431	1431.4	3.1099
Marsh Creek	10	13.16	1.4065	0.6725	0.863023	23.34706	6.12687	7.12988	8.82958	8.33751421	1421.58	3.0733
	10	13.5	1.4064	0.66	0.875422	22.95925	5.82206	6.98238	8.96338	8.33751421	1421.58	3.0162
	10	14	1.4062	0.6421	0.893322	22.40065	5.49126	6.80989	9.08148	8.33751421	1421.58	2.9344
	10	14.5	1.4061	0.6246	0.910721	21.85565	5.23416	6.68179	9.13428	8.33751421	1421.58	2.8544
	10	15	1.4059	0.6077	0.927621	21.32385	5.05176	6.59009	9.18668	8.33751421	1421.58	2.7772
	10	15.51	1.4058	0.5908	0.94442	20.79484	4.88046	6.52699	9.20878	8.33751421	1421.58	2.7000
Lick Run	11	15.51	1.391	0.5839	0.95172	20.57014	4.86996	6.54609	9.20778	8.34081411	1411.15	2.6684
	11	16	1.3908	0.5695	0.96612	20.11614	4.94906	6.61269	9.20038	8.34081411	1411.15	2.6026
	11	16.5	1.3907	0.5552	0.980419	19.66305	5.04256	6.67709	9.15858	8.34081411	1411.15	2.5373
	11	17	1.3906	0.5412	0.994319	19.22025	5.13166	6.73819	9.10698	8.34081411	1411.15	2.4733
	11	17.5	1.3904	0.52761	1.007818	18.78745	5.21756	6.79669	9.07628	8.34081411	1411.15	2.4112
	11	18.07	1.3903	0.51251	1.022918	18.30585	5.28996	6.86049	9.08528	8.34081411	1411.15	2.3422
NWRF	12	18.07	1.39	0.51241	1.023018	18.30265	5.24596	6.86059	9.08788	8.3429141	1410.99	2.3417
	12	18.26	1.39	0.50791	1.027618	18.15765	5.53557	7.00879	9.04708	8.3429141	1410.99	2.3211
:arbrook Run	13	18.26	1.3835	0.50521	1.029418	18.06925	5.55557	7.01509	9.02628	8.34461406	1406.52	2.3088
	13	18.5	1.3834	0.49961	1.035017	17.88925	5.76957	7.12969	9.01418	8.34461406	1406.52	2.2832
	13	19	1.3833	0.48811	1.046517	17.51996	6.12637	7.31409	9.00478	8.34461406	1406.52	2.2307
	13	19.42	1.3832	0.47861	1.056017	17.21566	6.33677	7.42709	9.00848	8.34461406	1406.52	2.1872
Slate Run	14	19.42	1.3681	0.47271	1.064517	17.02226	6.34637	7.43229	9.01248	8.34641396	1396.46	2.1603
	14	19.83	1.368	0.46441	1.072816	16.75486	6.33317	7.44899	9.12098	8.34641396	1396.46	2.1224
Turkey Run	15	19.83	1.3351	0.45181	1.092616	16.33986	6.37977	7.45859	9.07828	8.35171374	1374.57	2.0648
	15	26	1.3337	0.34781	1.196312	12.92676	6.52917	7.75249	9.70378	8.35171374	1374.57	1.5895

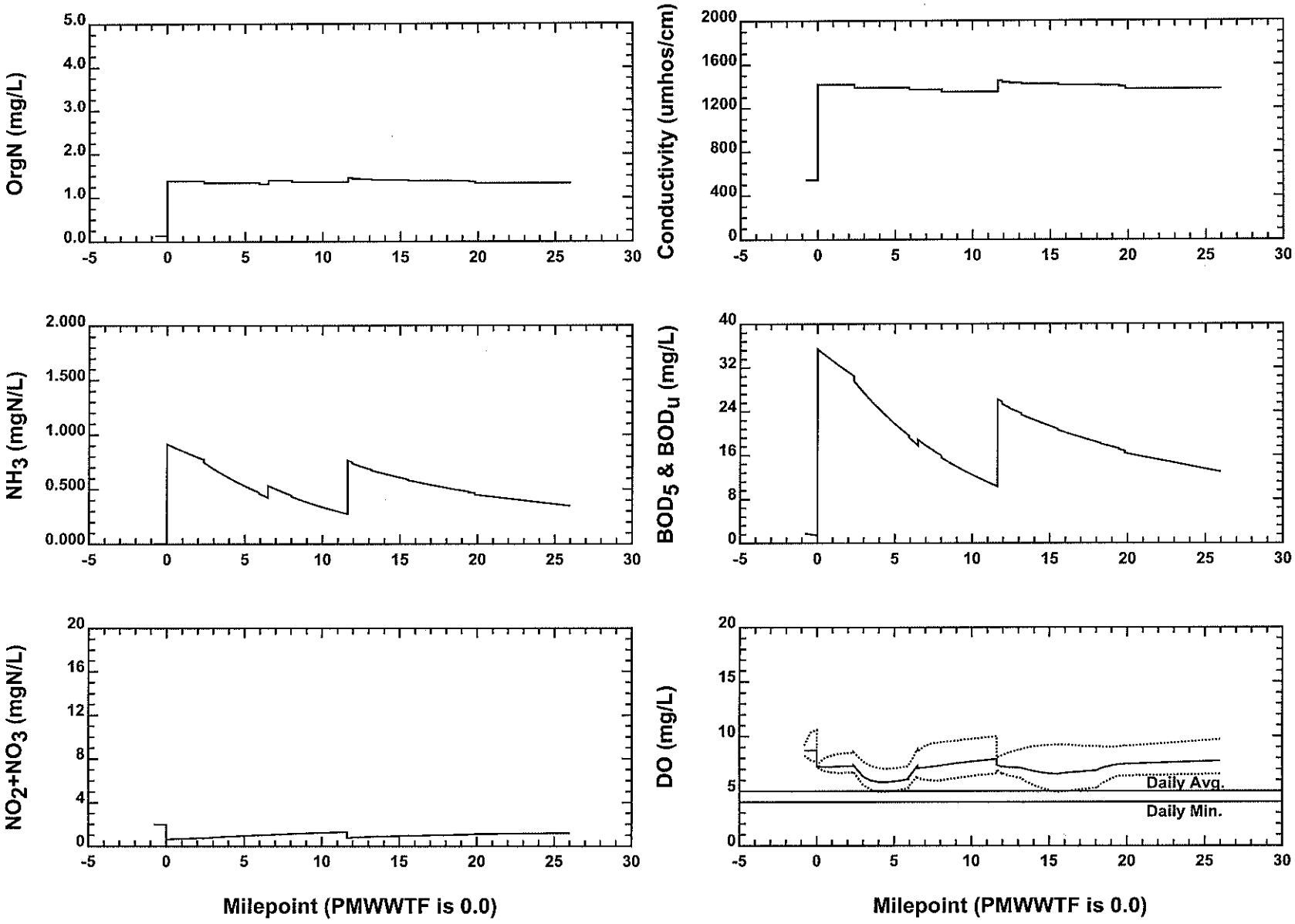


OWRF Water Quality Projections - 12.6 MGD, Summer Dry Creek Flow, Sunny

DATE: 11/09/2005 TIME: 11:45: 8 /usersm/obag0060/HEIDI/MODEL/PROJECTION/OWRF/pmodel.gdp

12.6 MGD Summer_Cloudy

	Model Reach	Output MP	OrgN (mg/L)	NH4 (mg/L)	NO2+NO3 (mg/L)	CBODu (mg/L)	Daily Minimum DO (mg/L)	Daily Average DO (mg/L)	Daily Maximum DO (mg/L)	DO Saturation (mg/L)	Conductivity (umhos/cm)	NBODu (mg/L) - calc
Upstream	1	-0.8	0.1367	0.00421	1.97851	1.78408	8.20358	8.67859	9.15358	8.2953542	542.11	0.0192
	1	-0.4	0.1366	0.00361	1.97871	1.61237	7.82208	8.68761	10.33198	8.2953542	542.11	0.0165
	1	0	0.1365	0.00301	1.97891	1.45717	7.63958	8.69791	10.56128	8.2953542	542.11	0.0138
PMWWTF	2	0	1.3848	0.9153	0.611135	35.40307	7.15637	7.24057	7.38688	8.30261418	1418.48	4.1829
	2	0.5	1.3846	0.8832	0.643134	34.29206	6.77667	7.19307	7.98438	8.30261418	1418.48	4.0362
	2	1	1.3845	0.8523	0.674033	33.21596	6.65667	7.19998	8.26098	8.30261418	1418.48	3.8950
	2	1.5	1.3843	0.8224	0.703832	32.17366	6.63357	7.22848	8.38408	8.30261418	1418.48	3.7584
	2	2	1.3841	0.7936	0.732531	31.16396	6.64727	7.26518	8.44318	8.30261418	1418.48	3.6268
	2	2.37	1.384	0.7729	0.75313	30.43726	6.66847	7.29418	8.47288	8.30261418	1418.48	3.5322
Wrights Run	3	2.37	1.3447	0.7463	0.729429	29.46616	6.71847	7.34508	8.52518	8.31091388	1388.07	3.4106
	3	3	1.3443	0.688	0.787527	27.40135	5.54396	6.31357	7.67978	8.31091388	1388.07	3.1442
	3	3.5	1.344	0.6451	0.830425	25.86615	5.11415	5.95157	7.27828	8.31091388	1388.07	2.9481
	3	4	1.3437	0.6048	0.870524	24.41694	4.92885	5.81277	7.06748	8.31091388	1388.07	2.7639
	3	4.5	1.3433	0.567	0.908223	23.04894	4.91855	5.80237	7.00518	8.31091388	1388.07	2.5912
	3	5	1.343	0.5316	0.943521	21.75754	4.99795	5.86417	7.05398	8.31091388	1388.07	2.4294
	3	5.5	1.3427	0.4985	0.97662	20.53855	5.12545	5.96507	7.14688	8.31091388	1388.07	2.2781
	3	5.91	1.3424	0.47281	1.002119	19.59015	5.23756	6.06297	7.23848	8.31091388	1388.07	2.1607
falo Lick Run	4	5.91	1.3181	0.463	0.991519	19.21825	5.33126	6.13987	7.28618	8.3164137	1370.06	2.1159
	4	6.5	1.3177	0.42431	1.030217	17.77226	6.36277	7.24628	8.73798	8.3164137	1370.06	1.9391
FCL	5	6.5	1.3951	0.53431	1.020018	18.76176	6.17247	7.06768	8.55348	8.3199137	1370.23	2.4418
	5	7	1.3948	0.50261	1.051517	17.76395	5.99747	7.13569	9.11788	8.3199137	1370.23	2.2969
	5	7.5	1.3945	0.47291	1.081216	16.81925	5.96257	7.21679	9.35198	8.3199137	1370.23	2.1612
	5	8.01	1.3941	0.44431	1.109715	15.90725	5.95247	7.30389	9.46528	8.3199137	1370.23	2.0305
r Spring Run	6	8.01	1.3647	0.43291	1.124915	15.52835	5.97457	7.31769	9.43588	8.32721349	1349.9	1.9784
	6	8.5	1.3644	0.40701	1.150714	14.69396	6.06827	7.42749	9.53858	8.32721349	1349.9	1.8600
	6	9	1.3641	0.38221	1.175413	13.88866	6.17077	7.52369	9.59288	8.32721349	1349.9	1.7467
	6	9.5	1.3637	0.35891	1.198713	13.12756	6.24837	7.60949	9.69238	8.32721349	1349.9	1.6402
	6	10	1.3634	0.33701	1.220512	12.40816	6.34227	7.68789	9.76368	8.32721349	1349.9	1.5401
	6	10.5	1.3631	0.31641	1.240911	11.72816	6.41707	7.76069	9.83158	8.32721349	1349.9	1.4460
	6	11	1.3628	0.29711	1.260211	11.08546	6.48527	7.82879	9.90078	8.32721349	1349.9	1.3578
	6	11.62	1.3624	0.27481	1.28241	10.33716	6.56457	7.90759	9.97858	8.32721349	1349.9	1.2559
OWRF	7	11.62	1.4542	0.7625	0.756426	26.15936	6.91387	7.36428	8.04608	8.3327145	1450.38	3.4846
	7	11.91	1.4541	0.7491	0.769725	25.75046	6.59097	7.21738	8.20518	8.3327145	1450.38	3.4234
brams Creek	8	11.91	1.4317	0.7365	0.790425	25.34506	6.63177	7.24198	8.20688	8.33361436	1436.71	3.3658
	8	12.38	1.4316	0.716	0.810924	24.71246	6.35367	7.14908	8.47678	8.33361436	1436.71	3.2721
edbud Creek	9	12.38	1.4226	0.7112	0.817424	24.56016	6.36487	7.15408	8.48578	8.33511431	1431.4	3.2502
	9	13.16	1.4223	0.6805	0.848123	23.60816	6.15867	7.10438	8.77448	8.33511431	1431.4	3.1099
Marsh Creek	10	13.16	1.4065	0.6725	0.863023	23.34706	6.15067	7.09858	8.76228	8.33751421	1421.58	3.0733
	10	13.5	1.4064	0.66	0.875422	22.95925	5.84086	6.95478	8.92228	8.33751421	1421.58	3.0162
	10	14	1.4062	0.6421	0.893322	22.40065	5.50636	6.78709	9.06838	8.33751421	1421.58	2.9344
	10	14.5	1.4061	0.6246	0.910721	21.85565	5.24496	6.66299	9.13158	8.33751421	1421.58	2.8544
	10	15	1.4059	0.6077	0.927621	21.32385	5.05836	6.57449	9.18958	8.33751421	1421.58	2.7772
	10	15.51	1.4058	0.5908	0.94442	20.79484	4.87776	6.51419	9.21818	8.33751421	1421.58	2.7000
Lick Run	11	15.51	1.391	0.5839	0.95172	20.57014	4.86726	6.53339	9.21708	8.34081411	1411.15	2.6684
	11	16	1.3908	0.5695	0.96612	20.11614	4.94186	6.60269	9.21048	8.34081411	1411.15	2.6026
	11	16.5	1.3907	0.5552	0.980419	19.66305	5.03726	6.66919	9.16728	8.34081411	1411.15	2.5373
	11	17	1.3906	0.5412	0.994319	19.22025	5.12346	6.73209	9.11368	8.34081411	1411.15	2.4733
	11	17.5	1.3904	0.52761	1.007818	18.78745	5.20746	6.79179	9.08098	8.34081411	1411.15	2.4112
	11	18.07	1.3903	0.51251	1.022918	18.30585	5.27656	6.85679	9.08838	8.34081411	1411.15	2.3422
NWRF	12	18.07	1.39	0.51241	1.023018	18.30265	5.23246	6.85689	9.09088	8.3429141	1410.99	2.3417
	12	18.26	1.39	0.50791	1.027618	18.15765	5.52377	7.00569	9.04948	8.3429141	1410.99	2.3211
arbrook Run	13	18.26	1.3835	0.50521	1.029418	18.06925	5.54387	7.01199	9.02868	8.34461406	1406.52	2.3088
	13	18.5	1.3834	0.49961	1.035017	17.88925	5.75937	7.12709	9.01608	8.34461406	1406.52	2.2832
	13	19	1.3833	0.48811	1.046517	17.51996	6.11907	7.31239	9.00588	8.34461406	1406.52	2.2307
	13	19.42	1.3832	0.47861	1.056017	17.21566	6.33167	7.42589	9.00918	8.34461406	1406.52	2.1872
Slate Run	14	19.42	1.3681	0.47271	1.064517	17.02226	6.34137	7.43109	9.01298	8.34641396	1396.46	2.1603
	14	19.83	1.368	0.46441	1.072816	16.75486	6.32917	7.44799	9.12118	8.34641396	1396.46	2.1224
Turkey Run	15	19.83	1.3351	0.45181	1.092616	16.33986	6.37597	7.45769	9.07848	8.35171374	1374.57	2.0648
	15	26	1.3337	0.34781	1.196312	12.92676	6.52927	7.75249	9.70358	8.35171374	1374.57	1.5895



OWRF Water Quality Projections - 12.6 MGD, Summer Dry Creek Flow, Cloudy

DATE: 11/09/2005 TIME: 11:48:46 /usersm/obag0060/HEIDI/MODEL/PROJECTION/OWRF/pmodel.gdp

APPENDIX D

TOXICS MANAGEMENT PROGRAM INFORMATION

Rationale for Toxics Management Program in Permit (VA0065552) – November 29, 2005

Outfall 001: This discharge qualifies as being subject to Toxics Management Program (TMP) monitoring, because it is a municipal sewage treatment plant with a design flow greater than 1 MGD and it has a pretreatment program (TMP Guidance 00-2012, Parts IV.2.A and IV.2.B, respectively).

The results from nine semi-annual monitoring tests were evaluated using the procedures outlined in the TMP Guidance. This involves expressing the results of the toxicity tests as Toxicity Units (TU) and entering them separately by species into the Agency's STAT.exe program. The acute and chronic Wasteload Allocations (WLAs) generated from the WETLimit10.xls spreadsheet are also needed to run STAT.exe. These calculations were completed at the current design flow (8.4 MGD) for the chronic test data (calculations on following page). Based on the evaluation of data, a chronic WET limit (TU_c) will be required. Although the results met the initial permit criteria, the WETLimit10.xls spreadsheet explains that if the mean of the data exceed a TU_c of 1.0, a limit may result during the statistical analysis using STAT.exe. This constraint is due to the high Instream Waste Concentration (IWC). The TU_c is considered a maximum and is how the results are to be reported on the DMR. The permittee will have until December 31, 2009 to meet the WET limit at the 8.4 MGD flow tier. Testing will be required on a quarterly basis. There was no need to perform the same calculations with STAT.exe for the acute data since all the NOAECs were 100% (i.e. the mean of the data does not exceed a TU_a of 1.0). No acute WET limit is required at this time, nor will acute monitoring be required. Since the future chronic test data can be assessed to some degree for the presence of acute toxicity, the permit can be modified to include acute monitoring or an acute WET limit if it is deemed necessary. Should further information clearly indicate the cause of toxicity for this discharge, a pollutant specific effluent limitation can be used in lieu of a WET limit.

The permittee has also requested that three higher flow tiers be included in the permit, in addition to the current flow tier. The issuance of a Certificate to Operate (CTO) for any higher flow tier will supersede the 2009 deadline, and the permittee will be required to complete their first quarterly test within the calendar quarter that is six months from the date of issuance of the CTO. The chronic WET limit for each flow tier is listed below, along with the recommended dilution series:

Flow Tier (MGD)	WET Limit (TUc)	NOEC	Recommended Dilution Series	Limits effective
8.4	1.61	≥ 62%	100, 78.7, **62**, 48.8, 38.4%	December 31, 2009
10.4	1.59	≥ 63%	100, 79.4, **63**, 50, 39.7%	Upon issuance of CTO
12.6	1.56	≥ 64%	100, 80, **64**, 51.2, 41%	Upon issuance of CTO

A most-sensitive species will not be selected. As per the TMP Guidance and the "published rule" (EPA Form 2A application requirements), testing will require both species (*Ceriodaphnia dubia* and *Pimephales promelas*) for the chronic tests.

STAT.exe Results:

Chemical = TUc - Minnow Chronic averaging period = 4 WLAa,c = 3.2217736 WLAc = 1.1154762 Q.L. = 1 # samples/mo. = 1 # samples/wk. = 1 Summary of Statistics: # observations = 9 Expected Value = 1.19888 Variance = .517440 C.V. = 0.6 97th percentile daily values = 2.91739 97th percentile 4 day average = 1.99469 97th percentile 30 day average= 1.44592 # < Q.L. = 0 Model used = BPJ Assumptions, type 2 data A limit is needed based on Chronic Toxicity Maximum Daily Limit = 1.63146736233152 Average Weekly Limit = 1.63146736233152 Average Monthly Limit = 1.63146736233152 The data are: 1 1 1 1 1.23 2.56 1 1 1	Chemical = TUc - Flea Chronic averaging period = 4 WLAa,c = 3.2217736 WLAc = 1.1154762 Q.L. = 1 # samples/mo. = 1 # samples/wk. = 1 Summary of Statistics: # observations = 9 Expected Value = 1.06777 Variance = .410453 C.V. = 0.6 97th percentile daily values = 2.59834 97th percentile 4 day average = 1.77655 97th percentile 30 day average= 1.28779 # < Q.L. = 0 Model used = BPJ Assumptions, type 2 data A limit is needed based on Chronic Toxicity Maximum Daily Limit = 1.63146736233152 Average Weekly Limit = 1.63146736233152 Average Monthly Limit = 1.63146736233152 The data are: 1 1.61 1 1 1 1 1 1 1

8.4 MGD Flow Tier:

Spreadsheet for determination of WET test endpoints or WET limits

Excel 97
Revision Date: 01/10/05
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	0.3221774	Note: Inform the permittee that if the mean of the data exceeds this TUa: 1.0 a limit may result using WLA.EXE				

Chronic Endpoint/Permit Limit — Use as NOEC in Special Condition, as TUc on DMR

CHRONIC	1.63146724 TU_c	NOEC =	62 %	Use as	1.61	TU_c
BOTH*	3.22177365 TU_c	NOEC =	32 %	Use as	3.12	TU_c
AML	1.63146724 TU_c	NOEC =	62 %	Use as	1.61	TU_c

ACUTE WLAa,c	3.2217736	Note: Inform the permittee that if the mean of the data exceeds this TUc: 1.0 a limit may result using WLA.EXE
CHRONIC WLAc	1.1154762	

* Both means acute expressed as chronic

Enter data in the cells with blue type:

Entry Date:	11/16/05
Facility Name:	
VPDES Number:	VA0065552
Outfall Number:	001

		% Flow to be used from MIX.EXE	Difuser /modeling study?	
Plant Flow:	8.4 MGD		Enter Y/N	N
Acute 1Q10:	0.71 MGD	87.46 %	Acute	1 :1
Chronic 7Q10:	0.97 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	93.11641348 %	Plant flow/plant flow + 1Q10
IWC_c	89.64781217 %	Plant flow/plant flow + 7Q10

NOTE: If the IWCa is >33%, specify the NOAEC = 100% test/endpoint for use

Dilution, acute	1.073924524	100/IWCa
Dilution, chronic	1.11547619	100/IWCc

WLA_a	0.322177357	Instream criterion (0.3 TUa) X's Dilution, acute
WLA_c	1.11547619	Instream criterion (1.0 TUc) X's Dilution, chronic
$WLA_{a,c}$	3.221773571	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.

						Rounded NOEC's	%
$LTA_{a,c}$	1.323970774	WLAa,c X's eA					
LTA_c	0.670442798	WLAc X's eB					
MDL** with $LTA_{a,c}$	3.22177365	TU_c	NOEC =	31.038804	(Protects from acute/chronic toxicity)	NOEC =	32 %
MDL** with LTA_c	1.631467237	TU_c	NOEC =	61.294519	(Protects from chronic toxicity)	NOEC =	62 %
AML with lowest LTA	1.631467237	TU_c	NOEC =	61.294519	Lowest LTA X's eD	NOEC =	62

IF ONLY ACUTE ENDPOINT/LIMIT IS NEEDED, CONVERT MDL FROM TU_c to TU_a

						Rounded LC50's	%
MDL with $LTA_{a,c}$	0.322177365	TU_a	LC50 =	310.388037 %	Use NOAEC=100%	LC50 = NA	%
MDL with LTA_c	0.163146724	TU_a	LC50 =	612.945193 %	Use NOAEC=100%	LC50 = NA	

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			62	1.6129032
Dilution factor to recommend:	0.5		0.7874008	
Dilution series to recommend:	100.0	1.00	100.0	1.00
	50.0	2.00	78.7	1.27
	25.0	4.00	62.0	1.61
	12.5	8.00	48.8	2.05
	6.25	16.00	38.4	2.60
Extra dilutions if needed	3.12	32.05	30.3	3.30
	1.56	64.10	23.8	4.20

10.4 MGD Flow Tier:

Spreadsheet for determination of WET test endpoints or WET limits

Excel 97
Revision Date: 01/10/05
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	0.3186129	Note: Inform the permittee that if the mean of the data exceeds this TUa: 1.0 a limit may result using WLA.EXE				

Chronic Endpoint/Permit Limit — Use as NOEC in Special Condition, as TUc on DMR

CHRONIC	1.5989879	TU_c	NOEC =	63 %	Use as 1.58	TU_c
BOTH*	3.18612931	TU_c	NOEC =	32 %	Use as 3.12	TU_c
AML	1.5989879	TU_c	NOEC =	63 %	Use as 1.58	TU_c

ACUTE WLAa,c	3.1861292
CHRONIC WLAc	1.0932692

* 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 WLA.EXE

Enter data in the cells with blue type:

Entry Date:	11/16/05
Facility Name:	
VPDES Number:	VA0065552
Outfall Number:	001

		% Flow to be used from MIX.EXE
Plant Flow:	10.4 MGD	
Acute 1Q10:	0.71 MGD	90.88 %
Chronic 7Q10:	0.97 MGD	100 %

Difuser /modeling study?
Enter Y/N N
Acute 1 :1
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	94.15813932 %	Plant flow/plant flow + 1Q10
IWC_c	91.46877748 %	Plant flow/plant flow + 7Q10

NOTE: If the IWCa is >33%, specify the NOAEC = 100% test/endpoint for use

Dilution, acute	1.062043077	100/IWCa
Dilution, chronic	1.093269231	100/IWCc

WLA_a	0.318612923	Instream criterion (0.3 TUa) X's Dilution, acute
WLA_c	1.093269231	Instream criterion (1.0 TUc) X's Dilution, chronic
$WLA_{a,c}$	3.186129231	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 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.

						Rounded NOEC's	%
$LTA_{a,c}$	1.309322921	WLAa,c X's eA					
LTA_c	0.657095587	WLAc X's eB					
MDL** with $LTA_{a,c}$	3.186129309	TU_c	NOEC =	31.386046	(Protects from acute/chronic toxicity)	NOEC =	32 %
MDL** with LTA_c	1.5989879	TU_c	NOEC =	62.539560	(Protects from chronic toxicity)	NOEC =	63 %
AML with lowest LTA	1.5989879	TU_c	NOEC =	62.539560	Lowest LTA X's eD	NOEC =	63

IF ONLY ACUTE ENDPOINT/LIMIT IS NEEDED, CONVERT MDL FROM TU_c to TU_a

						Rounded LC50's	%
MDL with $LTA_{a,c}$	0.318612931	TU_a	LC50 =	313.860457 %	Use NOAEC=100%	LC50 = NA	%
MDL with LTA_c	0.15989879	TU_a	LC50 =	625.395602 %	Use NOAEC=100%	LC50 = NA	

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			63	1.5873016
Dilution factor to recommend:	0.5		0.7937254	
Dilution series to recommend:	100.0	1.00	100.0	1.00
	50.0	2.00	79.4	1.26
	25.0	4.00	63.0	1.59
	12.5	8.00	50.0	2.00
	6.25	16.00	39.7	2.52
Extra dilutions if needed	3.12	32.05	31.5	3.17
	1.56	64.10	25.0	4.00

12.6 MGD Flow Tier:

Spreadsheet for determination of WET test endpoints or WET limits

Excel 97
Revision Date: 01/10/05
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	0.3147967	Note: Inform the permittee that if the mean of the data exceeds this TUa:	1.0	a limit may result using WLA.EXE		

Chronic Endpoint/Permit Limit — Use as NOEC in Special Condition, as TUc on DMR

CHRONIC	1.57516972 TU_c	NOEC =	64 %	Use as	1.56	TU_c
BOTH*	3.14796746 TU_c	NOEC =	32 %	Use as	3.12	TU_c
AML	1.57516972 TU_c	NOEC =	64 %	Use as	1.56	TU_c

ACUTE WLAa.c	3.1479674	Note: Inform the permittee that if the mean of the data exceeds this TUc: 1.0 a limit may result using WLA.EXE
CHRONIC WLAc	1.0769841	

* Both means acute expressed as chronic

Enter data in the cells with blue type:

Entry Date:	11/16/05
Facility Name:	
VPDES Number:	VA0065552
Outfall Number:	001

		% Flow to be used from MIX.EXE
Plant Flow:	12.6 MGD	
Acute 1Q10:	0.71 MGD	87.53 %
Chronic 7Q10:	0.97 MGD	100 %

Difuser /modeling study?
Enter Y/N N
Acute 1 :1
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	95.29958977 %	Plant flow/plant flow + 1Q10
IWC_c	92.85187915 %	Plant flow/plant flow + 7Q10

NOTE: If the IWCa is >33%, specify the NOAEC = 100% test/endpoint for use

Dilution, acute	1.04932246	100/IWCa
Dilution, chronic	1.076984127	100/IWCc

WLA_a	0.314796738	Instream criterion (0.3 TUa) X's Dilution, acute
WLA_c	1.076984127	Instream criterion (1.0 TUc) X's Dilution, chronic
$WLA_{a,c}$	3.147967381	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.

						Rounded NOEC's	%
$LTA_{a,c}$	1.293640511	WLAa,c X's eA					
LTA_c	0.647307632	WLAc X's eB					
MDL** with $LTA_{a,c}$	3.147967458	TU_c	NOEC =	31.766529	(Protects from acute/chronic toxicity)	NOEC =	32 %
MDL** with LTA_c	1.575169719	TU_c	NOEC =	63.485222	(Protects from chronic toxicity)	NOEC =	64 %
AML with lowest LTA	1.575169719	TU_c	NOEC =	63.485222	Lowest LTA X's eD	NOEC =	64

IF ONLY ACUTE ENDPOINT/LIMIT IS NEEDED, CONVERT MDL FROM TU_c to TU_a

						Rounded LC50's	%
MDL with $LTA_{a,c}$	0.314796746	TU_a	LC50 =	317.665291 %	Use NOAEC=100%	LC50 = NA	%
MDL with LTA_c	0.157516972	TU_a	LC50 =	634.852224 %	Use NOAEC=100%	LC50 = NA	

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			64	1.5625
Dilution factor to recommend:	0.5		0.8	
Dilution series to recommend:	100.0	1.00	100.0	1.00
	50.0	2.00	80.0	1.25
	25.0	4.00	64.0	1.56
	12.5	8.00	51.2	1.95
	6.25	16.00	41.0	2.44
Extra dilutions if needed	3.12	32.05	32.8	3.05
	1.56	64.10	26.2	3.81

APPENDIX E

PERMIT CHANGES AND BASES FOR SPECIAL CONDITIONS

Tabulated below are the sections of the permit, with any changes and the reasons for the changes identified. Also provided is the basis for each of the permit special conditions.

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- Content and format as prescribed by the VPDES Permit Manual.
- The permit term is less than 5 years because the expiration date was set to the end of the last full month of the permit term.
- Facility Location revised to only include 911address.

Part I.A.1. **Interim Effluent Limitations and Monitoring Requirements:** Bases for effluent limits provided in previous pages of this fact sheet. Monitoring requirements as prescribed by the VPDES Permit Manual.

Updates Part I.A.1. of the previous permit with the following:

- Slight changes were made to the format and introductory language.
- TRC and NH_3-N limits were made less stringent per new information and the WQS_WLA / STAT evaluation at this reissuance.
- NH_3-N (Jun-Nov) monitoring frequency was reduced to 1/Week per the standard reduced monitoring evaluation.
- Limits for BOD, CBOD, TSS, and TRC were revised per new significant figures guidance.
- The monthly average BOD_5 loading limit was revised to 206.99 kg/day to match the approved WQMP allocation for this discharge
- Monitoring frequency for $CBOD_5$ was reduced to 1/Week (Dec-May) per the standard reduced monitoring evaluation.
- Fecal coliform limits replaced with E. coli limits.
- Chlorides limits removed.
- WET limit added w/ reference to Schedule of Compliance footnote.
- Monitoring for Orthophosphate, TKN, Nitrate, and Nitrite were added.
- Total Nitrogen and Total Phosphorous monitoring frequency and reporting requirements were adjusted per GM No. 05 – 2009 with reference to Schedule of Compliance footnote for meeting TN and TP WLAs added.
- Flow footnote was revised to include reference to Part I.G.1. ('95% Capacity Reopener')
- Footnote was added to indicate Federal Secondary Treatment requirement for CBOD and TSS removal.

Part I.A.2. **Final Effluent Limitations and Monitoring Requirements:** *New Requirement.* Includes effluent limits and monitoring requirements for a nutrient compliant facility with an annual discharge flow of 8.4 MGD. Bases for effluent limits provided in previous pages of this fact sheet. Monitoring frequency for $CBOD_5$ was reduced to 1/Week (Dec-May) per BPJ; all other monitoring requirements are as recommended by the VPDES Permit Manual.

Part I.A.3 **Final Effluent Limitations and Monitoring Requirements:** *New Requirement.* Includes effluent limits and monitoring requirements for an expanded discharge of 10.4 MGD. Bases for effluent limits provided in previous pages of this fact sheet. Monitoring frequency for $CBOD_5$ was reduced to 1/Week (Dec-May) per BPJ; all other monitoring requirements are as recommended by the VPDES Permit Manual.

Part I.A.4 **Final Effluent Limitations and Monitoring Requirements:** *New Requirement.* Includes effluent limits and monitoring requirements for an expanded discharge of 12.6 MGD. Bases for effluent limits provided in previous pages of this fact sheet. Monitoring frequency for $CBOD_5$ was reduced to 1/Week (Dec-May) per BPJ; all other monitoring requirements are as recommended by the VPDES Permit Manual.

Part I.B. **TRC Effluent Limitations and Monitoring Requirements:** *Updates Part I.B. of the previous permit.* Specifies both disinfection and effluent limits and monitoring requirements for the chlorine contact tank , as well as limitations and monitoring requirements should the permittee elect to switch to an alternative to chlorine disinfection. Required by Sewage Collection and Treatment (SCAT) Regulations and 9 VAC 25-260-170, Bacteria; other waters. Also, 40 CFR 122.41(e) requires the permittee, at all times, to properly operate and maintain all facilities and systems of treatment in order to comply with the permit. This ensures proper operation of chlorination equipment to maintain adequate disinfection.

Part I.C. **Schedule of Compliance:** *New Requirement.* The Schedule of Compliance applies only to Total Nitrogen, Total Phosphorous, and Whole Effluent Toxicity limitations. 9 VAC 25-31-250 allows for schedules of compliance, when appropriate, which will lead to compliance with the Clean Water Act, the State Water Control Law and regulations promulgated under them.

Part I.D. **Effluent Limitations and Monitoring Requirements – Additional Instructions:** *Updates Part I.C. of the previous permit.* Authorized by VPDES Permit Regulation, 9 VAC 25-31-190.J.4 and 220.I. This condition is necessary when a maximum level of quantification and/or a specific analytical method is required in order to assess compliance with a permit limit or to compare effluent quality with a numeric criterion. The condition also establishes protocols for calculation of reported values.

Part I.E. **Pretreatment Program Requirements:** *Updates Part I.E. of the previous permit.* VPDES Permit Regulation, 9 VAC 25-31-730 through 900, and 40 CFR part 403 require certain existing and new sources of pollution to meet specified regulations.

Part I.F. **Toxics Management Program Requirements:** *Updates Part I.F. of the previous permit.* VPDES Permit Regulation, 9 VAC 25-31-210 and 220 I, requires monitoring in the permit to provide for and assure compliance with all applicable requirements of the State Water Control Law and the Clean Water Act.

Part I.G.1. **95% Capacity Reopener:** *Identical to Part I.G.1. of the previous permit.* Required by VPDES Permit Regulation, 9 VAC 25-31-200 B.4 for all STP permits.

Part I.G.2. **Indirect Dischargers:** *Identical to Part I.E.2. of the previous permit.* Required by VPDES Permit Regulation, 9 VAC 25-31-200.B.1 for all sewage treatment plants that receive waste from someone other than the owner of the treatment works.

Part I.G.3. **Materials Handling/Storage:** *New Requirement.* 9 VAC 25-31-280.B.2. requires that the types and quantities of "wastes, fluids, or pollutants which are … treated, stored, etc." be addressed for all permitted facilities.

Part I.G.4. **CTC/CTO Requirement:** *Updates Part I.G.3. of the previous permit.* Required by Code of Virginia §62.1-44.19, SCAT Regulations, 9 VAC 25-790.

Part I.G.5. **O&M Manual Requirement:** *Updates Part I.G.3. of the previous permit.* Required by Code of Virginia §62.1-44.19; SCAT Regulations, 9 VAC 25-790; and VPDES Permit Regulation, 9 VAC 25-31-190.E for all sewage treatment plants. Added requirement to describe procedures for handling, storage and disposal of materials that will prevent pollutants from reaching State waters.

Part I.G.6. **Sludge Reopener:** *Updates Part I.G.4. of the previous permit.* Required by the VPDES Permit Regulation, 9 VAC 25-31-220.C for all permits issued to sewage treatment plants.

Part I.G.7. **SMP Requirement:** *Updates Part I.G.5. of the previous permit.* VPDES Permit Regulation 9 VAC 25-31-100.J, 220.B.2, and 420 through 720, and 40 CFR Part 503 require all sewage treatment plants to submit information on their sludge use and disposal practices and to meet specified standards for sludge use and disposal. Technical requirements are derived from the Department of Health's Biosolids Use Regulations, 12 VAC 5-585-10 et seq.

Part I.G.8. **Licensed Operator Requirement:** *Updates Part I.G.6. of the previous permit.* The VPDES Permit Regulation 9 VAC 25-31-200 C, the Code of Virginia 54.1-2300 et seq., and Rules and Regulations for Waterworks and Wastewater Works Operators 18 VAC 160-20-10 et seq., require licensure of operators. A class I license is indicated for this facility.

Part I.G.9. **Reliability Class:** *Identical to Part I.G.7. of the previous permit.* Required by SCAT Regulations, 9 VAC 25-790. Class II status was assigned to this facility on February 7, 1985.

Part I.G.10. **Water Quality Criteria Monitoring:** *Updates Part I.G.8. of the previous permit.* State Water Control Law at 62.1-44.21 authorizes the Board to request information needed to determine the discharge's impact on State waters. States are required to review data on discharges to identify actual or potential toxicity problems, or the attainment of water quality goals, according to 40 CFR Part 131, Water Quality Standards, subpart 131.11. To ensure that water quality criteria are maintained, the permittee is required to analyze the facility's effluent for the substances noted in Attachment A of this VPDES permit.

Part I.G.11. Special condition added to allow for nutrient trading.

Part I.G.12 **Chesapeake Bay Nutrients Reopener:** *New requirement.* Policy for Nutrient Enriched Waters 9 VAC 25-40-10 et seq. allows reopening of permits for discharges into waters designated as nutrient enriched if total phosphorus and total nitrogen in a discharge potentially exceed specified concentrations. The policy anticipates that future total phosphorus and total nitrogen limits may be needed to control aquatic plants.

Part I.G.13 **General Permit Controls:** *New requirement.* The Virginia General Assembly, in their 2005 session, enacted a new Article 4.02 (Chesapeake Bay Watershed Nutrient Credit Exchange Program) to the Code of Virginia to address nutrient loads to the Bay. Section 62.1-44.19:14 of the law requires the development of a watershed general permit that authorizes point source discharges of total nitrogen and total phosphorus and provides for the control of those nutrients in lieu of the individual VPDES permits, unless the individual permits contain more restrictive limits that are necessary to protect local water quality. That section of the law also sets forth various items to be contained within the general permit. Section 62.1-44.19:15 sets forth the requirements for new and expanded dischargers which are captured by the requirements of the law.

Part I.G.14 and 15 **Basis of Design Report and Interim Optimization Plan for Nutrient Removal:** *New requirement.* Significant portions of the Chesapeake Bay and its tributaries are listed as impaired on Virginia's 303(d) list of impaired waters for not meeting the aquatic life use support goal, and the 2004 Virginia Water Quality Assessment 305(b)/303(d) Integrated Report indicates that 83% of the mainstem Bay does not fully support this use support goal under Virginia's water quality assessment guidelines. Nutrient enrichment is cited as one of the primary causes for impairment. Guidance Memorandum 05-2009 implements DEQ's best professional judgment decision to limit nutrient loadings from facilities listed on the Chesapeake Bay Program Significant Discharger List. Guidance Memorandum 05-2009 provides the basis for this decision and specifies the procedure for determining annual effluent limitations for these parameters for each affected facility. The guidance memorandum also establishes that dischargers be required to: monitor and report effluent nutrient loads; submit a Basis of Design Report to construct and operate a range of nutrient removal technologies; and submit an Interim Optimization Plan for the removal of nutrients with the existing facility.

Part I.G.16.	**Treatment Works Closure Plan:** *New requirement.* Requirement for all sewage treatment facilities, per State Water Control Law at 62.1-44.19. This condition is used to notify the owner of the need for a closure plan where a treatment works is being replaced or is expected to close.
Part II	**Conditions Applicable to All VPDES Permits:** VPDES Permit Regulation 9 VAC 25-31-190 requires all VPDES permits to contain or specifically cite the conditions listed.
Additional Notes	Previous permit Part I.D. was replaced with a new Schedule of Compliance, and previous permit Part I.G.9 was removed because the facility has been assigned a WLA for TSS per the approved Opequon Creek TMDL.