Appomattox River TMDL Development and Source Assessment

5/21/03

Presentation Outline

- Project background
- Dissolved oxygen & pH impairments
- Bacteria TMDLs methodology
- Benthic TMDL methodology

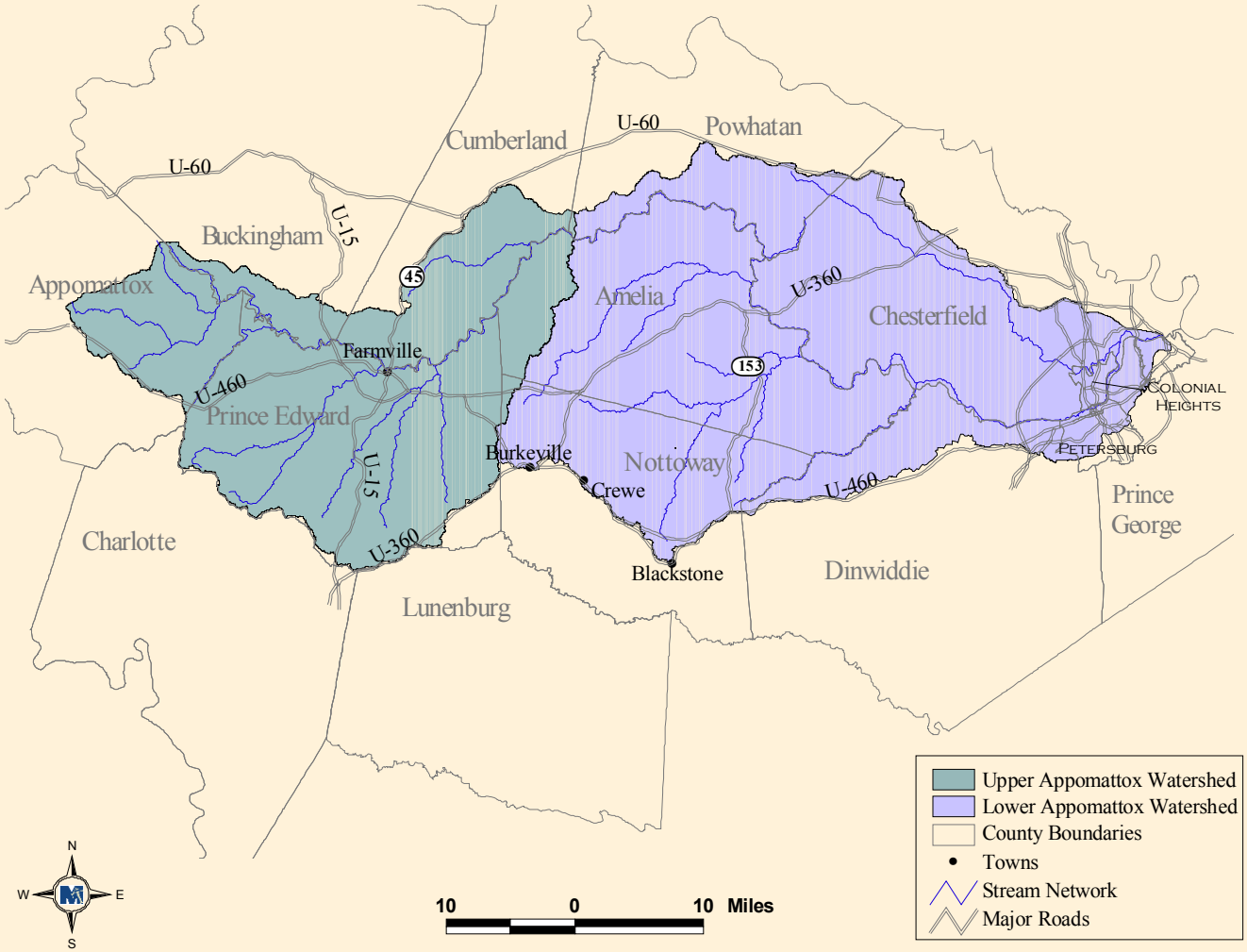
Project Background

- Teamed with Virginia Tech (Dr. David Kibler)
- 18-month project
- 19 bacteria TMDLs
- 1 benthic TMDL
- 9 dissolved oxygen & 4 pH source assessments
- Final report due to EPA by May 1, 2004

Appomattox River Background

- 10 counties, 3 cities
- 1,025,500 acres
- Appomattox basin divided between Upper & Lower
  - Drainage to Amelia, Cumberland, Powhatan borders

Appomattox River Watershed



County Coverage: Upper Appomattox River

County	Acres	% of County
Amelia	26,500	12 (100)
Appomattox	64,000	30
Buckingham	22,700	6
Cumberland	68,500	36
Nottoway	2,000	1 (52)
Powhatan	500	0.3 (30)
Prince Edward	216,500	96 (96.2)

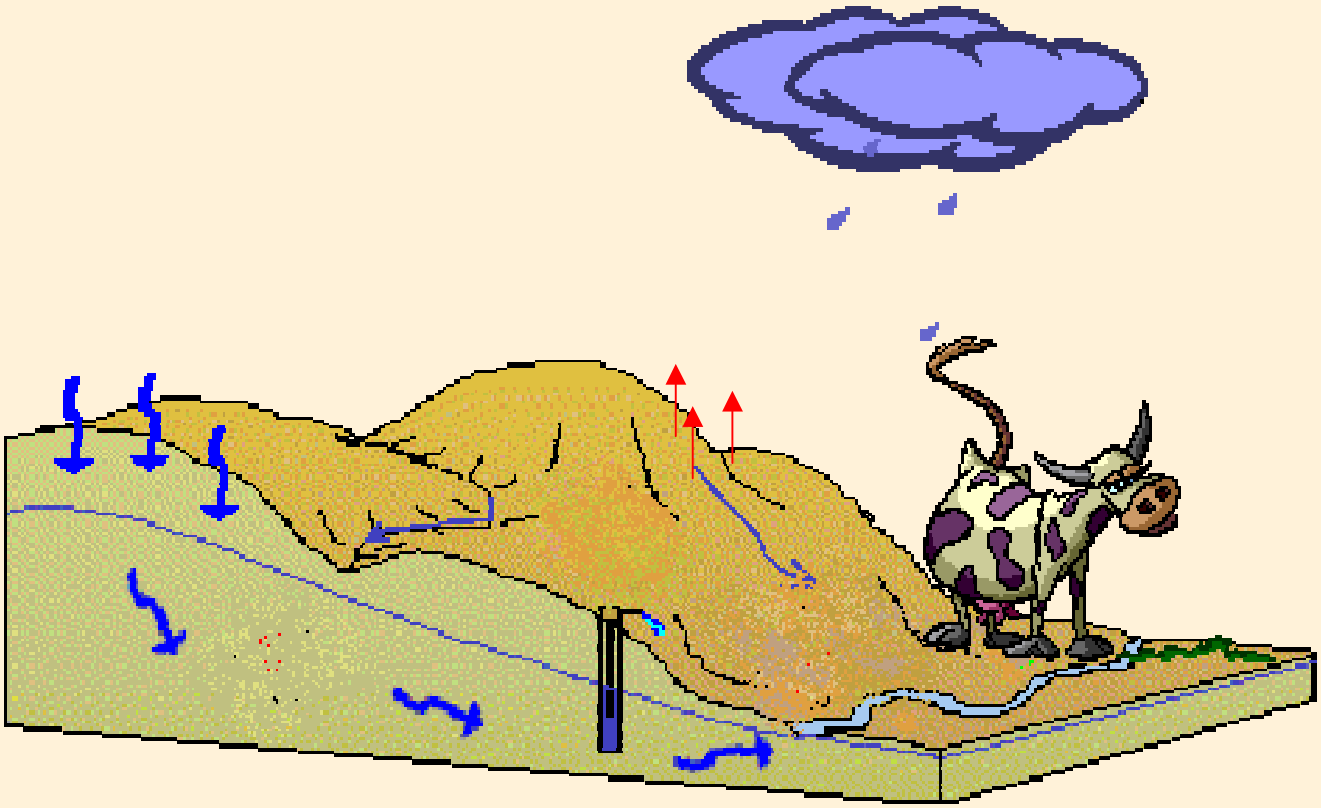
County Coverage: Lower Appomattox River

County/City	Acres	% of County
Amelia	203,100	88 (100)
Chesterfield	191,100	68
Colonial Heights	5,000	100
Dinwiddie	51,900	15
Hopewell	2,400	34
Nottoway	105,000	51 (52)
Petersburg	9,800	66
Powhatan	48,700	29.7 (30)
Prince Edward	500	0.2 (96.2)
Prince George	6,300	4

pH and DO Impairments

- Literature review of interactions, processes, and sources/sinks
- Spatial analysis
  - Land use characterization
- Compile historical water quality data
- Natural or anthropogenic

Modeling

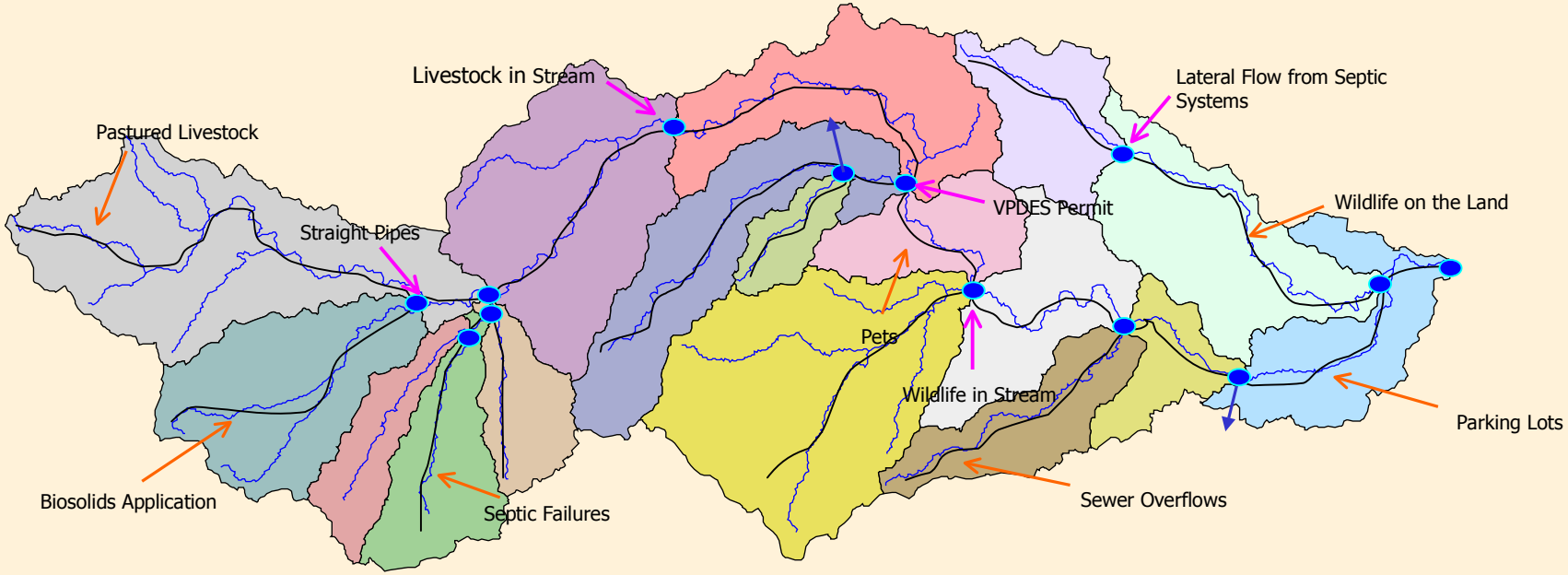


Models

- Non-tidal
  - Hydrologic Simulation Program – Fortran (HSPF)
    - Watershed-based
    - Continuous time interval
    - Land-applied, direct loads
- Tidal
  - Hydrologic Simulation Program – Fortran (HSPF)
  - Water Quality Analysis Simulation Program (WASP) / Link-Node Tidal Hydrodynamic Model (DYNHYD)

Conceptual Model

- Mathematical Representation
- Overland
- Direct discharges
- Withdrawal



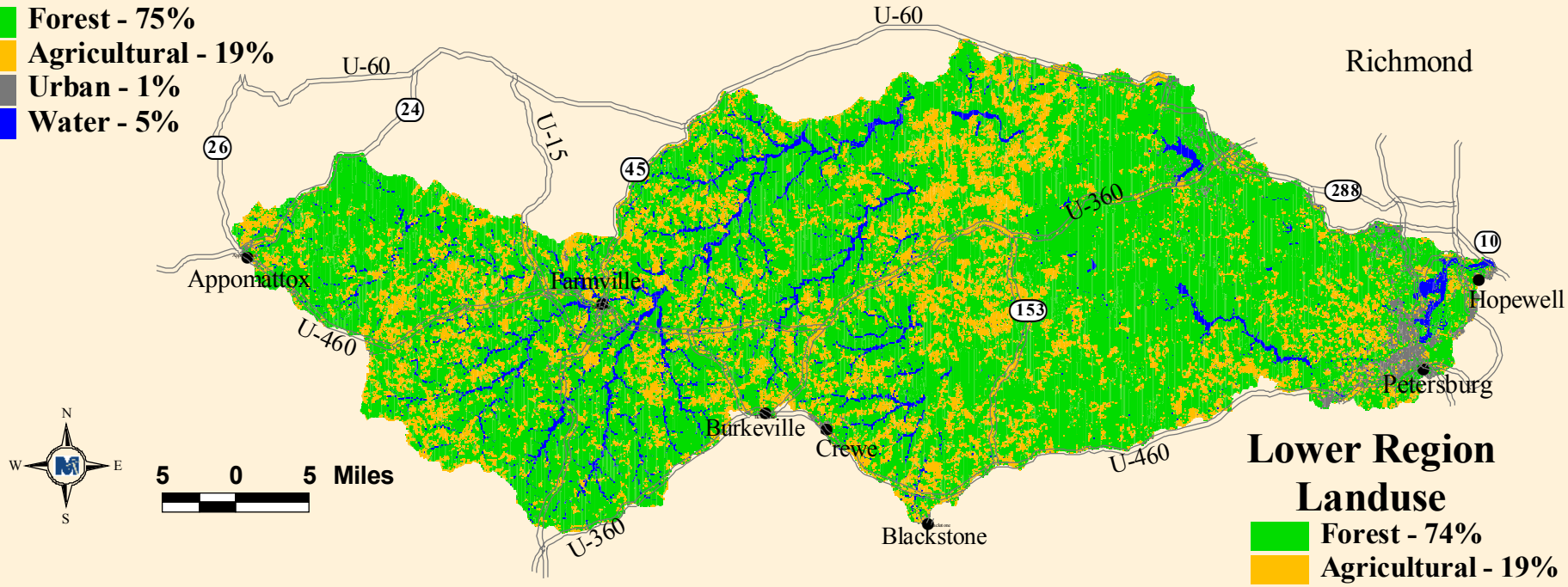
Hydrologic Modeling Components

- Climatic data
- Land use
- Topography
- Soils
- Stream channel characteristics
- Point source discharge/withdrawal
- Flow data

Land use

Upper Region Landuse

- Forest - 75%
- Agricultural - 19%
- Urban - 1%
- Water - 5%



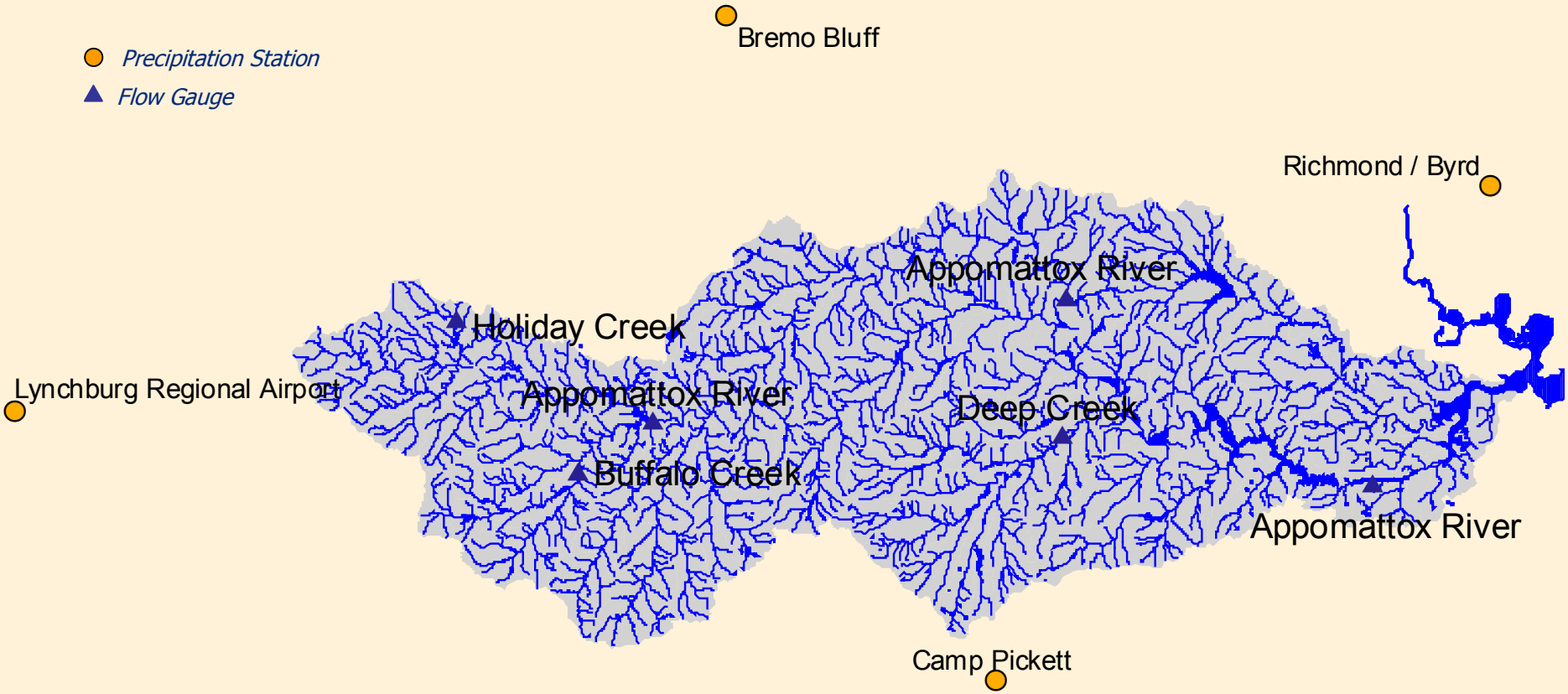
Lower Region Landuse

- Forest - 74%
- Agricultural - 19%
- Urban - 3%
- Water - 3%

Land use

Impairment	Acres	Forest (%)	Agricultural (%)	Urban (%)	Water (%)
Appomattox River (1)	64,900	75	20	0	5
Appomattox River (2)	10,400	52	19	28	1
App. River – Tidal	19,800	48	11	29	12
Deep Creek	11,600	77	22	0	1
Deep Creek UT	1,900	62	21	14	3
Flat Creek	8,200	55	45	0	0
Nibbs Creek	7,000	57	42	1	0
Swift Creek (1)	1,400	84	7	1	8
Swift Creek (2)	5,700	79	15	5	1
Swift Creek (3)	1,700	56	9	30	5
West Creek	11,200	64	34	0	2
Outside Impairments	480,000	77	18	2	3
TOTAL	**623,800**				

Hydrologic Calibration



Water Quality Modeling Components

- Sources
  - Fecal production
  - FC densities
  - FC distribution
- Delivery Mechanisms
  - Direct
  - Land-applied
- Temporal Variation

Source Assessment

- Permitted discharges
  - Wastewater treatment facilities
- Human
  - Biosolids
- Pets
- Livestock
- Wildlife

Permitted Discharges

- Chlorine $\rightarrow$ fecal coliform translator
- Historical averages (DMR) for calibration period
- Design values for allocations
- Direct application

Permitted Discharges

Receiving Water	Permit ID	Facility
Deep Creek UT	VA0020303	Town of Crewe WWTP
Appomattox River	VA0083135	Town of Farmville WWTP
UT to Appomattox River	VAG402047	Residence
UT to Dry Creek	VAG404002	Residence
UT to Dry Creek	VAG404161	Residence
UT to Appomattox River	VAG407199	Residence
Briery Creek	VAG404092	PRJ Land Trust
Dry Creek	VAG404107	Residence
UT to Dry Creek	VAG404129	Landing View Golf Club
Dry Creek	VAG404140	Residence
Tanyard Branch	VAG407198	Residence

Permitted Discharges

Receiving Stream	Permit No	Facility Name
Appomattox River	VA0025437	South Central Wastewater Authority WWTF
Ashton Creek, UT	VAG404094	Residence
Cattail Run	VAG404133	Residence
Church Branch, UT	VA0027561	Childrens Home of VA Baptists Lagoon
Deep Creek	VA0020303	Crewe WWTP
Fighting Creek	VA0089206	Fighting Creek WWTF
Flat Creek, UT	VAG404032	Residence
Harrison Branch	VA0028258	Red Hill Mobile Home Park WWTP
Nibbs Creek	VA0086681	Amelia County Sanitary District
Piney Branch	VA0020206	Thomas Dale West STP
Sappony Creek	VA0020222	Chesterfield Co Schools Grange Elem WWTP
South Fork Appomattox River, UT	VA0020257	Appomattox Town - Lagoon
Swift Creek	VA0090344	New Matoaca High School
Swift Creek	VAG404202	Residence
Swift Creek, UT	VA0023426	DOC Pocahontas Correctional Unit 13
Whipponock Creek, UT	VA0023540	DOC Dinwiddie Field Unit 27 WWTP

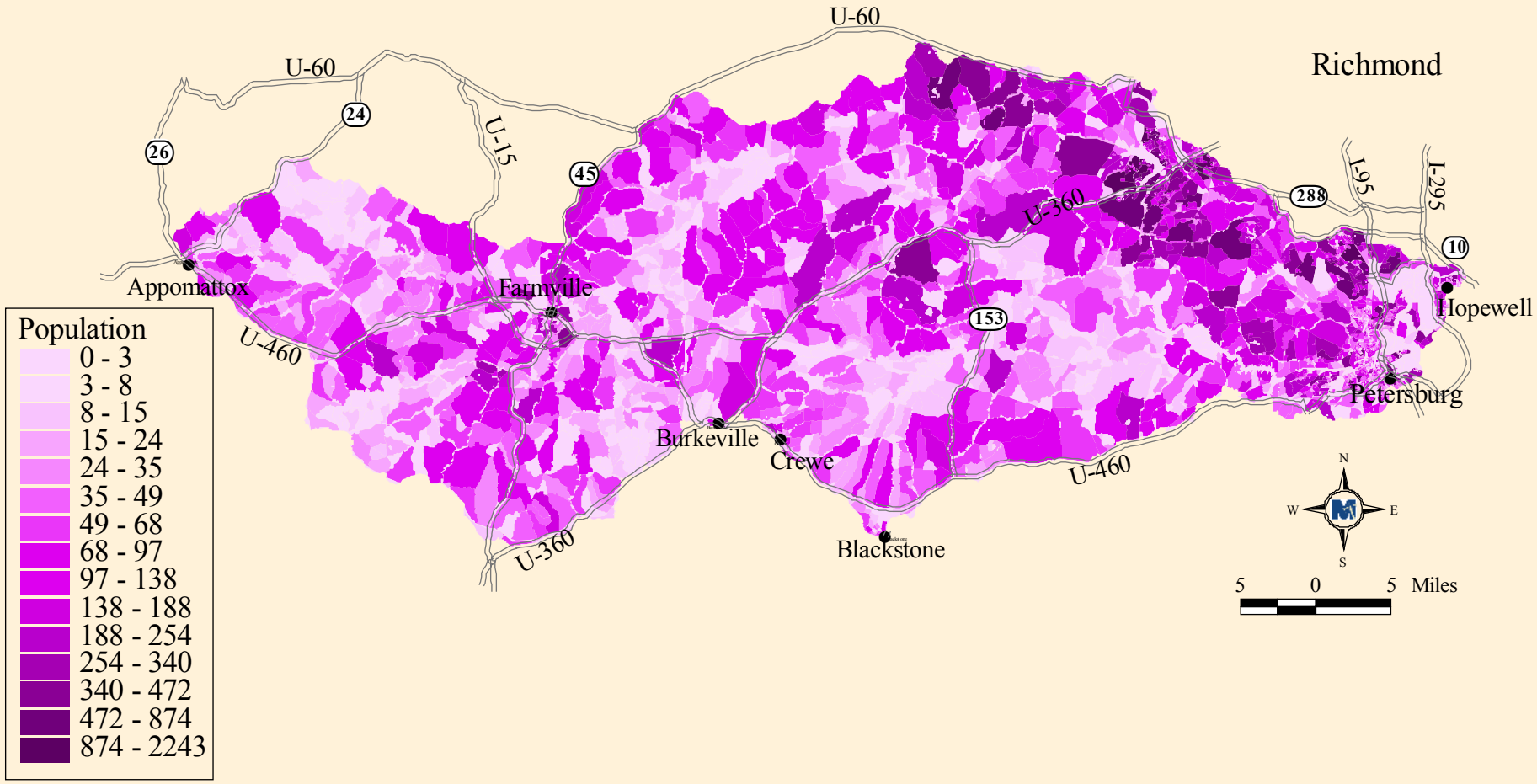
Human Source

- Population, housing units, and onsite treatment system based on U.S. Census
- Sanitary Sewer
  - Loading rates
    - Exfiltration
    - Overflows
  - Land-applied / direct deposition
    - Loading type
    - Proximity to stream

Human Source

- Septic Systems
  - Failure to soil surface throughout year
  - Lateral movement continuously to stream
- Straight Pipes
  - Direct continuous input into stream
- Biosolids
  - Land-applied

Human Source



Human Source (2003)

Impairment	Population	Housing Units (HU)	HU with Sewer	HU with Septic	HU with Other
Appomattox River (1)	3,875	1,450	37	1,365	48
Appomattox River (2)	17,489	7,909	7,309	571	29
App. River – Tidal	30,607	14,241	13,660	523	57
Deep Creek	495	184	5	169	10
Deep Creek UT	1,289	584	461	114	9
Flat Creek	760	299	18	267	14
Nibbs Creek	833	318	81	217	20
Swift Creek (1)	106	37	11	26	0
Swift Creek (2)	1,485	536	136	397	3
Swift Creek (3)	3,962	1,726	1,663	62	1
West Creek	659	260	6	237	17
Outside Impairments	110,642	42,784	24,616	17,488	680
TOTAL	172,202	70,328	48,003	21,436	888

Pet Source

- Population/household based on literature values, veterinarians, and animal control
- Translated to housing units based on U.S. Census
- Land-applied

Pet Source (2003)

Impairment	Dogs	Cats
Appomattox River (1)	2,464	3,189
Appomattox River (2)	13,446	17,401
App. River – Tidal	24,216	31,339
Deep Creek	313	405
Flat Creek	508	657
Nibbs Creek	540	699
Swift Creek (1)	63	82
Swift Creek (2)	911	1179
Swift Creek (3)	2,935	3,798
West Creek	443	573
Outside Impairments	72,733	94,126
TOTAL	**118,572**	**153,448**

Livestock Source

- Population
  - Virginia Agricultural Statistics
  - Consultation with SWCD, NRCS, VADCR, and VCE
  - Watershed visits
- Distribution of waste
  - Pastured
  - Confined, waste collected, spread
  - Direct deposition to the stream
- Seasonal varying applications

Livestock Population

Impairment	Beef	Dairy	Horse	Poultry	Swine	Other
Appomattox River (1)	1,480	850	110	144,000	0	0
Appomattox River (2)	0	0	19	0	0	0
App. River – Tidal	0	0	13	0	0	0
Deep Creek	630	300	6	312,000	0	0
Deep Creek UT	80	0	2	0	0	0
Flat Creek	380	0	8	0	0	0
Nibbs Creek	100	400	7	0	0	0
Swift Creek (1)	0	0	2	0	0	0
Swift Creek (2)	40	0	11	0	0	0
Swift Creek (3)	0	0	3	0	0	0
West Creek	280	0	9	0	0	300
Outside Impairments	9,580	4,220	608	2,590,000	0	150
TOTAL	**12,570**	**5,770**	**798**	**3,046,000**	**0**	**450**

Wildlife Source

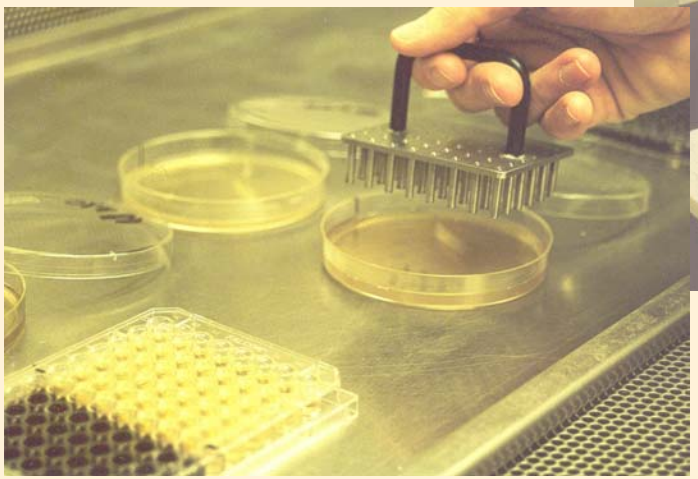
- Population
  - Animal densities from VDGIF biologists
  - Habitat from literature values
- Distribution of waste based on habitat
  - Land-applied
  - Direct deposition to the stream
- Seasonal variations based on migration patterns and food sources

Wildlife Population

Impairment	Deer	Turkey	Goose	Duck	Muskrat	Raccoon	Beaver
Appomattox River (1)	2,397	598	477	294	3,038	912	230
Appomattox River (2)	129	39	146	125	576	161	76
App. River – Tidal	171	15	277	238	4,397	307	909
Deep Creek	378	105	69	35	605	203	55
Deep Creek UT	48	11	11	6	129	32	9
Flat Creek	319	68	49	25	484	115	33
Nibbs Creek	267	59	42	21	461	111	31
Swift Creek (1)	32	8	20	17	432	31	6
Swift Creek (2)	126	29	79	68	218	106	60
Swift Creek (3)	11	2	24	21	302	48	46
West Creek	422	106	67	34	1,310	233	67
Outside Impairments	13,682	3,622	4,604	3,379	33,737	6,574	2,751
TOTAL	**17,982**	**4,622**	**5,865**	**4,263**	**45,689**	**8,833**	**4,273**

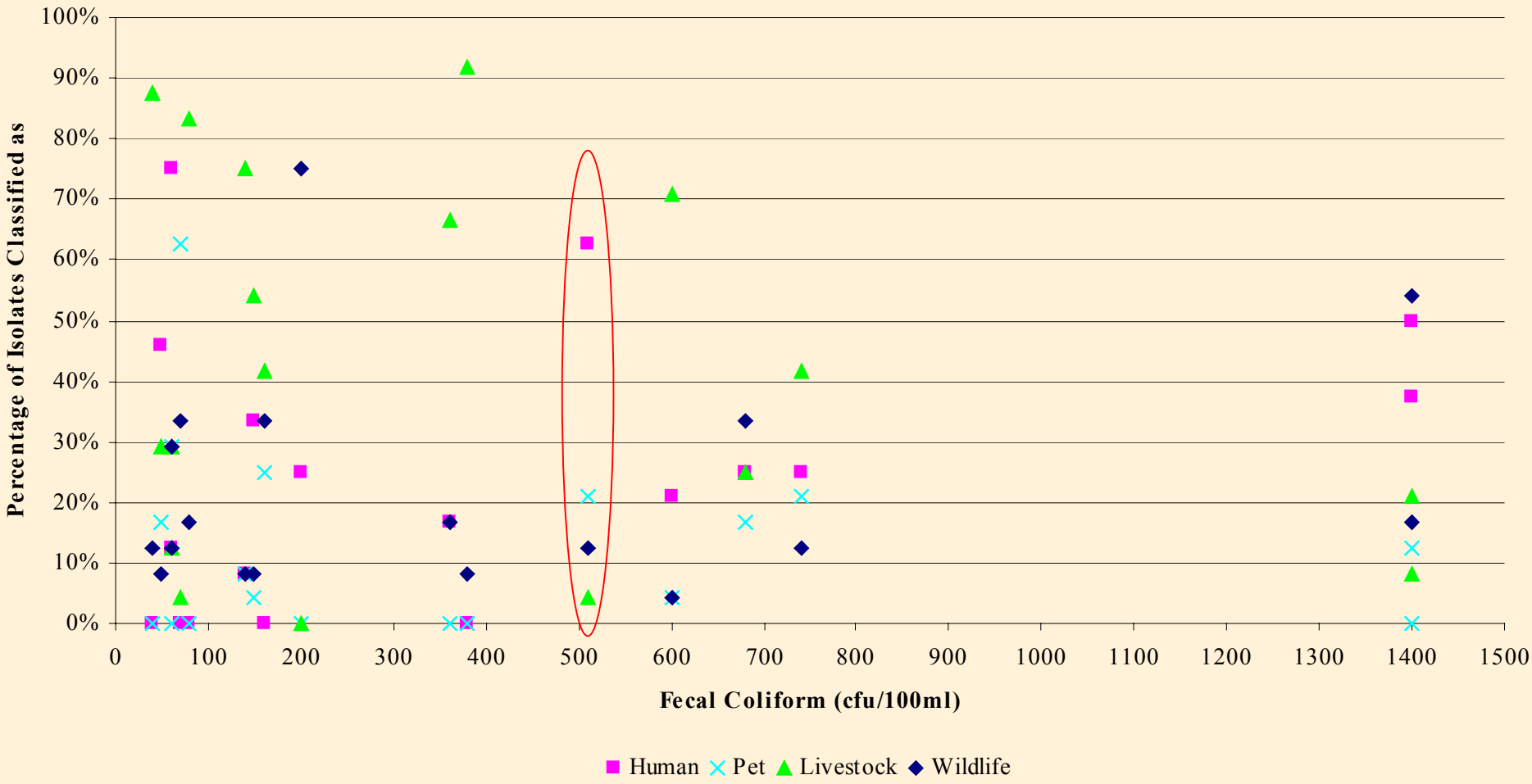
Bacterial Source Tracking

- Antibiotic Resistance Analysis (ARA)
  - Differentiates the sources of bacteria based on bacterial resistance to antibiotics



Bacterial Source Tracking

Lower Appomattox River Stations



Bacterial Source Tracking Results

Waterbody	Station	Human (%)	Pet (%)	Livestock (%)	Wildlife (%)
Appomattox River	2APP050.23	33	10	45	13
	2APP068.93	40	5	17	38
	2APP012.79	27	15	34	25
	2APP001.53	20	16	37	27
Deep Creek	2DPC005.20	17	16	47	20
Flat Creek	2FLA001.95	8	7	68	16
Nibbs Creek	2NBB001.54	3	6	64	27
	2NBB003.65	9	0	68	23
Swift Creek	2SFT004.92	29	22	26	23
	2SFT019.15	15	10	34	41
	2SFT036.00	26	11	6	56
West Creek	2WET004.96	10	4	81	5

Benthic TMDL Development

- Stressor analysis
- Endpoints
- Reference watershed selection
- Source assessment
- Model similar to bacteria impairments

Stressor Analysis

- Identify potential stressors
  - Streamwalks
  - Toxic pollutant analysis
  - Toxicity studies
  - Comparison with candidate reference watersheds
- Analyze data for each potential stressor
- Determine most probable stressor(s) for basis of TMDL

Stressor Analysis

Potential Stressors

- Sediment
- Toxics
- Dissolved Oxygen (DO)
- Nutrients
- pH
- Metals
- Temperature
- Organic matter

Reference Watershed Selection

- Identify candidate based on:
  - Stream order
  - Eco-region
  - Non-impairment status
- Compare various watershed characteristics
  - Land use
  - Level of identified stressor(s)
- Select most comparable watershed

And then:

- Public Meeting 2 (Date?)
- Public Meeting 3 (Date?)
- Public Review
- Submit to EPA
- State Approval
- Implementation Plan Development
- Implementation