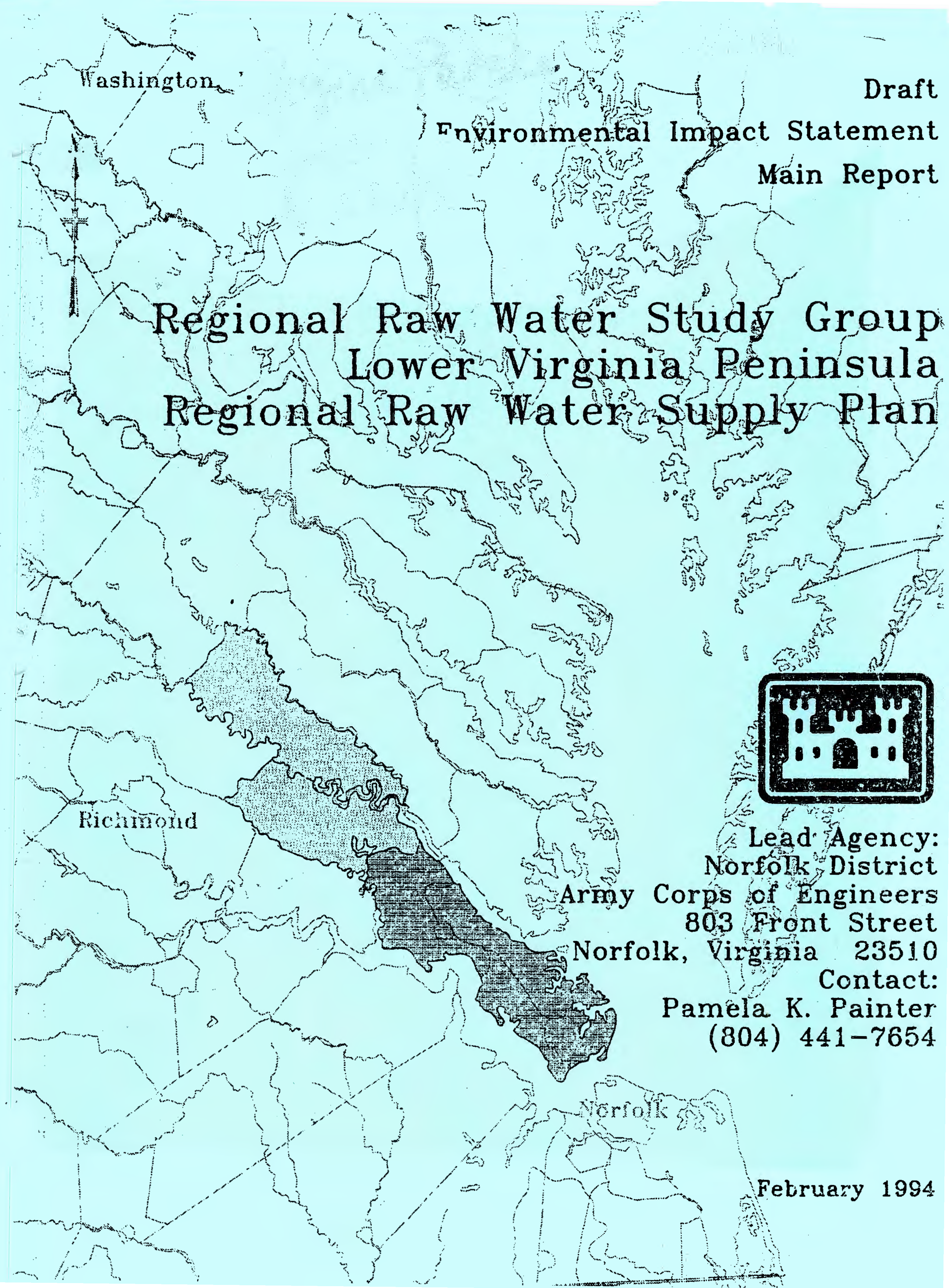
Draft

Environmental Impact Statement

Main Report

Regional Raw Water Study Group
Lower Virginia Peninsula
Regional Raw Water Supply Plan



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February 1994

LOWER VIRGINIA PENINSULA
REGIONAL RAW WATER SUPPLY PLAN
1990 - 2040

DRAFT ENVIRONMENTAL IMPACT STATEMENT

Regional Raw Water Study Group:

Newport News Waterworks
City of Williamsburg
York County

Local Jurisdictions in Study Area:

Cities of Newport News, Hampton, Poquoson and Williamsburg
Counties of York and James City

Federal Installations in Study Area:

Fort Monroe, Langley AFB, NASA Langley Research Center, Fort Eustis
Yorktown Naval Weapons Station, Camp Peary, Cheatham Annex
and Yorktown Coast Guard Reserve Training Center

FEBRUARY 1994

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LIST OF APPENDIX REPORTS

ABBREVIATIONS

ADD	-	Average day demand
AF	-	Acre-feet
AFD	-	Agricultural/Forestal District
ARWA	-	Appomattox River Water Authority
ASR	-	Aquifer storage and recovery
AWT	-	Advanced wastewater treatment
BDL	-	Below Detection Limit
BG	-	Billion gallons
BOCA	-	Building Officials and Code Administrators
BOD	-	Biological Oxygen Demand
BOVA	-	Biota of Virginia
CBNERRS	-	Chesapeake Bay National Estuarine Research Reserve System
CBPA	-	Chesapeake Bay Preservation Act
CBPA	-	Chesapeake Bay Preservation Area
CDM	-	Camp, Dresser & McKee
CDWR	-	California Department of Water Resources
CEQ	-	Council on Environmental Quality
CFR	-	Code of Federal Regulations
COD	-	Chemical oxygen demand
CSO	-	Combined sewer overflow
CWA	-	Clean Water Act
EDR	-	Electrodialysis reversal
EIS	-	Environmental Impact Statement

ERC	-	Equivalent residential connection
EVGMA	-	Eastern Virginia Groundwater Management Area
FHA	-	Federal Highway Administration
fps	-	Feet per second
GAC	-	Granular activated carbon
gal/min	-	Gallons per minute
gpcpd	-	Gallons per capita per day
gpf	-	Gallons per flush
gpm	-	gallons per minute
HEP	-	Habitat Evaluation Procedures
HRSD	-	Hampton Roads Sanitation District
HSI	-	Habitat Suitability Index
HU	-	Habitat Unit
HUD	-	United States Department of Housing and Urban Development
JCC	-	James City County
JCSA	-	James City Service Authority
JTU	-	Jackson turbidity unit
KWC	-	King William County
KWCPD	-	King William County Planning Department
LG&E	-	Louisville Gas & Electric
MDD	-	Maximum day demand
MED	-	Multiple effect distillation
MG	-	Million gallons
mgd	-	Million gallons per day
mg/l	-	Milligrams per liter

MHD	-	Maximum hourly demand
MHI	-	Median household income
MIF	-	Minimum in-stream flow
MRCE	-	Mueser Rutledge Consulting Engineers
MW	-	Megawatt
MWH	-	Megawatt hour
MWDSC	-	Metropolitan Water District of Southern California
MWRA	-	Massachusetts Water Resources Authority
NAPP	-	National Aerial Photography Program
NEPA	-	National Environmental Policy Act
NFA	-	No Federal Action
NHAP	-	National High Altitude Photography
NKC	-	New Kent County
NMFS	-	National Marine Fisheries Service
NPS	-	National Park Service
NTU	-	Nephelometric turbidity unit
NWF	-	National Wildlife Federation
NWI	-	National Wetlands Inventory
ODEC	-	Old Dominion Electric Cooperative
PACC	-	Powhatan, Amelia, Cumberland, and Chesterfield Counties
ppt	-	parts per thousand
RCO	-	Reasonable conservation objective
RMA	-	Resource Management Area
RO	-	Reverse osmosis
ROW	-	Right-of-way

RPA	-	Resource Protection Area
RRPDC	-	Richmond Regional Planning District Commission
RRWSG	-	Regional Raw Water Study Group
SAV	-	Submerged aquatic vegetation
SCC	-	State Corporation Commission
SCR	-	Summer conservation rate
SDC	-	System development charge
SDN	-	Smith Demer Normann
SDWA	-	Safe Drinking Water Act
SELC	-	Southern Environmental Law Center
STP	-	Sewage Treatment Plant
SWCB	-	Virginia State Water Control Board
SWMA	-	Surface Water Management Area
TDS	-	Total dissolved solids
THM	-	Trihalomethane
TKN	-	Total Kjeldahl nitrogen
TOC	-	Total organic carbon
UAW	-	Unaccounted-for water
ULF	-	Ultra-low-flow
ULV	-	Ultra-low-volume
UOSA	-	Upper Occoquan Sewage Authority
USBC	-	Uniform Statewide Building Code
USC	-	United States Code
USCOE	-	United States Army Corps of Engineers
USDC	-	United States Department of Commerce

USEPA	-	United States Environmental Protection Agency
USFWS	-	United States Fish and Wildlife Service
USGS	-	United States Geological Survey
VCOE	-	Virginia Council on the Environment
VDACS	-	Virginia Department of Agriculture and Consumer Services
VDC	-	Virginia Department of Corrections
VDCR	-	Virginia Department of Conservation and Recreation
VDEQ	-	Virginia Department of Environmental Quality
VDGIF	-	Virginia Department of Game and Inland Fisheries
VDH	-	Virginia Department of Health
VDHR	-	Virginia Department of Historic Resources
VDOT	-	Virginia Department of Transportation
VDMR	-	Virginia Department of Mineral Resources
VDWM	-	Virginia Department of Waste Management
VEC	-	Virginia Employment Commission
VGA	-	Virginia Groundwater Act
VIMS	-	Virginia Institute of Marine Science
VIP	-	Virginia Initiative Plant
VMRC	-	Virginia Marine Resources Commission
VPDES	-	Virginia Pollutant Discharge Elimination System
VRA	-	Virginia Resources Authority
VSRS	-	Virginia Scenic Rivers System
VWA	-	Virginia Wetlands Act
VWPP	-	Virginia Water Protection Permit
WET	-	Wetland Evaluation Technique

WTP - Water treatment plant

WWTP - Wastewater treatment plant

1.0 SUMMARY

1.1 PURPOSE

The Regional Raw Water Study Group (RRWSG) was created in the Fall of 1987 to examine the water supply needs of the Lower Peninsula area of southeast Virginia and to develop a plan for obtaining a new source of supply for meeting the region's future water needs. Current members of the RRWSG include the City of Newport News (representing Newport News Waterworks and its service area), the City of Williamsburg and York County.

The RRWSG is acknowledged by the participating jurisdictions as an appropriate regional entity to pursue the necessary engineering and environmental studies to search for the least environmentally damaging, practicable alternative(s) to meet the future water supply needs of the study area[1]. Only after a full public interest review will the U.S. Army Corps of Engineers (USCOE) determine what is/are the least environmentally damaging, practicable alternatives. This determination will be published in the Norfolk District's Record of Decision on this Environmental Impact Statement (EIS). To this end, the purpose and goal of the RRWSG is:

To provide a dependable, long-term public water supply for the Lower Virginia Peninsula, in a manner which is not contrary to the overall public interest.

Estimated delivery capacities of the five public water supply systems on the Lower Peninsula are presented below for the Year 1990.

Water System	Raw Water Source Safe Yield (mgd)	Treated Water Delivery Capacity (mgd)
Newport News Waterworks	57.0	51.9
Williamsburg	4.15	3.8
York County	0.12	0.12
James City Service Authority	3.1	3.1
U. S. Army (Big Bethel)	2.0	1.9
Lower Peninsula Total	66.4	60.8

Total regional treated water pumped to distribution in the base Year 1990 was 55.2 million gallons per day (mgd). Lower Peninsula water supply system demands are projected to grow through the Year 2040. Projections of growth and the impact on future demands within the service area of each Lower Peninsula water purveyors have been estimated based on data from previous studies and system operating records.

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[1] Local jurisdictions in the study area: Cities of Newport News, Hampton, Poquoson and Williamsburg, and Counties of York and James City. Federal installations in study area: Fort Monroe, Langley AFB, NASA Langley Research Center, Fort Eustis, Yorktown Naval Weapons Station, Camp Peary, Cheatham Annex and Yorktown Cost Guard Reserve Training Center.

Based on estimated population projections for the region and other applicable factors, water demand projections through the Year 2040 have been made for five categories of demand. Base Year 1990 demands and a summary of projections through the 50-year planning horizon are presented below as total regional average daily demands.

Demand Category	1990	2000	2010	2020	2030	2040
Residential	26.78	29.80	32.55	34.82	37.46	40.19
Commercial, Institutional, Light Industrial	10.89	11.69	12.59	13.36	14.28	15.24
Heavy Industrial	10.28	12.81	17.31	19.00	20.92	22.38
Federal Installations	4.12	4.82	5.45	5.48	5.51	5.52
Unaccounted-for Water	3.13	4.31	5.58	6.66	7.92	9.26
Lower Peninsula Total (mgd)	55.21	63.43	73.49	79.32	86.09	92.59

Comparing treated water delivery capacities with demand projections results in the following treated water delivery capacity deficit projections over the planning period:

	1990	2000	2010	2020	2030	2040
Regional Demands	55.2	63.4	73.5	79.3	86.1	92.6
Regional Treated Water Delivery Capacity	60.8	62.5	64.3	62.4	62.4	62.4
Treated Water Delivery Capacity Deficits (mgd)	-5.6	0.9	9.2	16.9	23.7	30.2

Based on these deficit projections, a regional deficit could occur by the Year 1998. Some individual water purveyors, such as Newport News Waterworks, are expected to be in deficit situations before the Year 1998. Based on an estimate of the average time required to implement a large water resource project, an interim supply of up to 5 mgd may be necessary to augment supplies until a large, long-term project can be implemented.

A new raw water supply system which can increase the regional treated water delivery capacity by 30.2 mgd is required to satisfy projected demands through the Year 2040. This estimate assumes that reasonable conservation objectives will be achieved for each category of demand throughout the planning period.

1.2 DESCRIPTION OF THE PROPOSED PROJECT

Based on detailed practicability and environmental analyses of 31 alternatives, three water supply alternatives are deemed by the RRWSG to represent the least damaging combination of practicable alternatives. These three alternatives are proposed as long-term components of an overall 30.2-mgd water supply plan to meet the water supply needs of the Lower Peninsula through the Year 2040. The RRWSG's preferred project components are:

- Use Restrictions (1.5 mgd treated water safe yield benefit)
- Fresh Groundwater Development (4.4 mgd treated water safe yield benefit)
- King William Reservoir with Pumpover from Mattaponi River (26.4 mgd treated water safe yield benefit)

Assuming a 10-year time to completion for King William Reservoir, interim groundwater supplies yielding between 3 and 4 mgd would be required to satisfy projected interim water supply deficits within the region before the new reservoir becomes operational. This estimate also assumes implementation of use restrictions capable of reducing short-term demands by at least 1.5 mgd.

Brief descriptions of alternatives considered are presented in Section 1.3 of this Summary.

Approximately 479 acres of wetlands would be directly affected by construction of the proposed King William Reservoir. No impacts to wetlands are anticipated as a result of the Fresh Groundwater Development or Use Restrictions project components.

No known endangered or threatened species populations would be directly impacted by intake construction and operation on the Mattaponi River or construction of the proposed King William Reservoir. An existing Bald Eagle nest may be temporarily affected by noise and disruption occurring during reservoir construction. No impacts to threatened or endangered species are anticipated as a result of the Fresh Groundwater Development or Use Restrictions project components.

Based on the results of a Phase IA Cultural Resource Survey of the proposed reservoir area, it is anticipated that there would be a relatively large number of prehistoric sites within the impoundment area that would be inundated. Cultural resources may also be located in other project areas associated with the preferred alternative.

1.3 ALTERNATIVES

1.3.1 Alternatives Considered

A practicability analysis was conducted for 31 water supply alternatives. This analysis included evaluation of the alternatives with respect to practicability criteria including availability, cost, technological reliability, and logistics. Summary descriptions of the 31 alternatives evaluated, including the preferred project components, are presented below.

1. Lake Genito: New dam across the Appomattox River near Genito, Virginia on the Amelia County/Powhatan County border. Controlled releases would be made from Lake Genito to Lake Chesdin. A new intake on Lake Chesdin would be required to pump water to Diascund Creek Reservoir where new pump station would be needed to pump to Little Creek Reservoir. 48.5 miles of new pipelines required.

2. Lake Chesdin: New intake structure on Lake Chesdin to pump water to Diascund Creek Reservoir where a new pump station would be needed to pump to Little Creek Reservoir. 48.5 miles of new pipelines required.

3. Lake Anna: New intake structure on Lake Anna in Louisa County to pump water to Diascund Creek Reservoir where a new pump station would be needed to pump to Little Creek Reservoir. 71.5 miles of new pipelines required.

4. Lake Gaston: New intake structure on Lake Gaston in Brunswick County to pump water to Diascund Creek Reservoir where a new pump station would be needed to pump to Little Creek Reservoir. 91.5 miles of new pipelines required.

5. Rappahannock River (above Fredericksburg): New intake structure on Rappahannock River in Spotsylvania County to pump water to Diascund Creek Reservoir where a new pump station would be needed to pump to Little Creek Reservoir. 94.5 miles of new pipelines required.

6. James River (above Richmond) without New Off-Stream Storage: New intake structure on James River in Chesterfield County to pump water to Diascund Creek Reservoir where a new pump station would be needed to pump to Little Creek Reservoir. 55.5 miles of new pipeline required.

7. City of Richmond Surplus Raw Water: New intake structure at Richmond Water Treatment Plant to pump to Diascund Creek Reservoir where a new pump station would be needed to pump to Little Creek Reservoir. 39.5 miles of new pipeline required.

8. City of Richmond Surplus Treated Water: Treated water pumped from Richmond Water Treatment Plant to Newport News Waterworks' northern distribution zone in James City County. 64 miles of new pipeline required.

9. James River (between Richmond and Hopewell): New pump station on James River in Henrico County to pump water to Diascund Creek Reservoir where a new pump station would be needed to pump to Little Creek Reservoir. 30.5 miles of new pipeline required.

10. Ware Creek Reservoir: New 50-foot dam across Ware Creek on New Kent County/James City County border; 6.87-billion gallon lake draining 17.4 square miles and covering 1,238 acres at pool elevation of 35 feet. Water pumped from new 20 mgd intake structure to Newport News Waterworks raw water

mains through new 3.6-mile, 30-inch pipeline. New 1.5-mile, 30-inch pipeline from Waterworks raw water mains to Ware Creek Reservoir also required.

* 11. Ware Creek Reservoir & Pamunkey, Mattaponi, and/or Chickahominy River Pumpovers: Similar to (10) with 40 mgd pump station and 36-mile, 42-inch pipeline from Ware Creek Reservoir to Waterworks' raw water mains. New 120 mgd intake structure on Pamunkey River (11.4 miles of 66-inch pipeline and 6.2 miles of 54-inch pipeline), 45 mgd pump station on Mattaponi River (16.8-mile, 48-inch pipeline), and/or expansion of pump station on Chickahominy River to 61 or 81 mgd (new 1.5-mile, 42-inch pipeline). Pamunkey and Mattaponi options also would require 40 mgd pump station on Diascund Creek Reservoir to pump 4.9 miles (42-inch pipeline) to Ware Creek Reservoir.

12. Ware Creek Reservoir & James River Pumpover (above Richmond): Similar to (10) with pump station on Ware Creek Reservoir to pump to Waterworks raw water mains. Pump station on James River in Chesterfield County to pump to Diascund Creek Reservoir where a new pump station would be needed to pump to Ware Creek Reservoir. 58.5 miles of new pipeline required.

* 13. Black Creek Reservoir & Pamunkey River Pumpover: Two dams across the southern and eastern branches of Black Creek in New Kent County; 8.4-billion gallon interconnected lake draining 5.5 square miles and covering 1,146 acres at pool elevation of 100 feet; supplemented with water pumped from new 120 mgd pump station on Pamunkey River in New Kent County through new 5-mile, 66-inch pipeline. Water pumped from new 40 mgd reservoir intake structure to Diascund Creek Reservoir through new 7.5-mile, 42-inch pipeline. New 40 mgd pump station and 5.5-mile, 42-inch pipeline from Diascund Creek Reservoir to Little Creek Reservoir also required. 18 miles of new pipeline required.

14. Black Creek Reservoir & James River Pumpover (above Richmond): Similar to (13), but supplemented with new 75 mgd pump station on James River in Chesterfield County. 43-mile pipeline to Black Creek Reservoir required.

* 15. King William Reservoir & Mattaponi River Pumpover: New 90-foot dam across Cohoke Mill Creek in King William County; 21.7-billion gallon lake draining 13.2 square miles and covering 2,234 acres at 90 foot pool elevation; supplemented with water from new 75 mgd pump station on Mattaponi River in King William County through new 1.5-mile, 54-inch pipeline. Water delivered to Diascund Creek Reservoir through new 9.9-mile, 42- and 60-inch gravity-flow pipelines (40 mgd capacity). Also includes new 40 mgd pump station and 5.5-mile, 42-inch pipeline from Diascund Creek Reservoir to Little Creek Reservoir.

16. King William Reservoir & Pamunkey River Pumpover: Same as (15) but supplemented with water pumped from Pamunkey River in King William

County (100 mgd pump station). 5.7-mile pipeline to King William Reservoir required.

17. Chickahominy River Pumping Capacity Increase: Increase pumping capacity of existing Waterworks Chickahominy River pump station in New Kent County to 61 mgd.

18. Chickahominy River Pumping Capacity Increase and Raise Diascund and Little Creek Dams: Same as (17) but also modifying Waterworks' Diascund Creek and Little Creek dams to increase normal pool elevations by 2 feet.

19. Aquifer Storage and Recovery, Constrained by Number of Wells: Withdraw water from Chickahominy River at full capacity when streamflow is high and demand is low; treat and store underground for later use. Treated water injected through new well system (12 wells on Waterworks property) when raw water source exceeds demand. Water recovered from same wells.

20. Aquifer Storage and Recovery, Unconstrained by Number of Wells: Same as (19) limited only by the Chickahominy River withdrawal capacity and amount of surplus streamflow available.

21. Fresh Groundwater Development: New well fields in western James City County and/or eastern New Kent County; used to augment Diascund Creek and Little Creek Reservoirs when system reservoir storage is below 75 percent of total capacity.

22. Groundwater Desalination as the Single Long-Term Alternative: Large-scale withdrawals from wells located throughout the Lower Peninsula drilled into deep, brackish aquifers, treated in four or five new desalination plants.

23. Groundwater Desalination in Newport News Waterworks Distribution Area: Small-scale withdrawals from new wells located adjacent to Waterworks distribution facilities and drilled into deep, brackish aquifers, treated in new desalination plant(s).

24. James River Desalination: New off-shore intake, with subaqueous pipeline and pump station on James River in James City County; Pumped to a reverse osmosis desalination plant near Waller Mill Reservoir. Requires a 26-mgd capacity outfall for concentrate disposal and 29 miles of new pipeline.

25. Pamunkey River Desalination: New intake on Pamunkey River in New Kent County to pump water to new desalination plant near Waller Mill Reservoir. Requires a 21-mgd capacity outfall for concentrate disposal and 33.2 miles of new pipeline.

26. York River Desalination: New intake on York River in New Kent County to pump to a new reverse osmosis desalination plant near Waller Mill Reservoir. Requires a 41-mgd capacity outfall for concentrate disposal and 33.6 miles of new pipeline.

27. Cogeneration: Purchase drinking water produced through distillation process powered by excess steam from privately-owned cogeneration facility. Private initiative required.

28. Wastewater Reuse as a Source of Potable Water: Blending highly treated wastewater with potable raw water supplies, using advanced wastewater reclamation plant adjacent to existing HRSD York River WWTP.

29. Wastewater Reuse for Non-Potable Uses: One to four systems, each located adjacent to an existing HRSD WWTP, and each providing advanced treatment of WWTP effluent to produce non-potable water suitable for industrial cooling and industrial process use.

* 30. Use Restrictions: Contingency measures beyond normal conservation measures, employed to produce short-term reductions in water demand during water supply emergencies.

31. No Action: Do nothing to provide additional raw water supply or curtail water use on the Lower Peninsula.

Six of the above-listed alternatives were deemed practicable in terms of availability, cost, technological reliability, and logistics. These alternatives are noted above with asterisks.

1.3.2 RRWSG's Preferred Alternative

The preferred alternative of the RRWSG includes three practicable alternatives as long-term components of an overall 30.2 mgd plan to meet the water supply needs of the Lower Peninsula through the Year 2040. These project components are:

- Use Restrictions (Alternative 30)
- Fresh Groundwater Development (Alternative 21)
- King William Reservoir with Pumpover from Mattaponi River (Alternative 15)

1.4 ISSUES/AREAS OF CONTROVERSY

1.4.1 Wetlands

Approximately 479 acres of non-tidal, palustrine forested wetlands would be inundated by the proposed King William Reservoir. An additional 55 acres of vegetated wetlands may be indirectly affected downstream of the proposed dam site. The existing Cohoke Millpond already provides a substantial degree of flow moderation in the lower reaches of Cohoke Mill Creek. Consequently, flow reductions due to the proposed reservoir should not cause dramatic changes in average Millpond water levels or floodplain hydrology in vegetated wetland areas below the dam site. Minimal salinity changes in the Mattaponi River are also anticipated from freshwater withdrawal for the proposed reservoir. However, studies conducted by VIMS indicate that the salinity effects should not cause any changes in tidal freshwater wetland communities along the Mattaponi River. A conceptual mitigation plan has been developed to mitigate for wetlands impacted as a result of the proposed project and is presented in Section 3.7.4.

1.4.2 Endangered/Threatened Species

No known populations of endangered or threatened species would be directly impacted by construction of the preferred alternative. However, an existing Bald Eagle nest is located approximately 375 feet downstream of the toe of the proposed dam. This nest may be temporarily affected by noise and disruption occurring during construction. Field surveys conducted for the Small Whorled Pogonia resulted in the identification of one individual of the species near the reservoir project area. If reservoir construction proceeds, the individual would be located within a watershed protection area which would not be harvested. Management techniques would be implemented to minimize potential impacts to the Bald Eagle nest and the known individual of Small Whorled Pogonia near the project area.

1.4.3 Water Quality/Hydrology

The water quality characteristic of the Mattaponi River which is of greatest concern relative to the proposed withdrawal is salinity. An analysis was conducted to estimate the impact of the proposed withdrawal on existing salinity concentrations in the Mattaponi River. Minute incremental salinity changes resulting from the proposed withdrawal, and other existing and projected consumptive Mattaponi River basin water use, are not expected to measurably impact existing tidal freshwater communities.

A cumulative streamflow analysis was also conducted to estimate the impact of future streamflow reductions on streamflow in the Mattaponi River. It is estimated that by the Year 2040, with all currently identified potential uses taken into account, and an estimated average withdrawal of 35 mgd for the RRWSG's preferred alternative, average Mattaponi River streamflow would be reduced by 6.9 percent from historical levels.

1.4.4 Cultural Resources

Based on the results of a Phase IA Cultural Resource Survey of the proposed King William Reservoir site, it is anticipated that there would be a relatively large number of prehistoric sites within the impoundment area that would be inundated. Sites identified in the reservoir area during the survey included an earthen dam, an ice house, and a total of six prehistoric sites. Additional sites are likely to be identified in other project areas for the preferred alternative. A site survey of these areas would be required prior to construction to identify additional cultural resources.

1.5 REQUIRED MAJOR FEDERAL, STATE, AND LOCAL PERMITS

1.5.1 Federal

Pursuant to Section 404 of the Clean Water Act, a U.S. Army Corps of Engineers (USCOE) permit is required for the discharge of dredged or fill material into waters of the United States. Construction of the proposed river intake structure, dam, and pipelines would involve the discharge of dredged or fill material into jurisdictional wetlands.

Pursuant to Section 10 of the Rivers and Harbors Act, the USCOE reviews applications for Department of the Army permits for certain structures or work in or affecting navigable waters of the United States. Construction of the proposed Mattaponi River intake structure would take place in navigable waters of the United States.

1.5.2 State

Virginia Department of Environmental Quality - Water Division

Pursuant to the State Water Control Law, the Virginia Department of Environmental Quality - Water Division (Water Division) will assess the impacts of the proposed project on beneficial uses of State waters and issue a Virginia Water Protection Permit.

Until recently, pursuant to Section 401 of the Clean Water Act, the State would issue a Water Quality Certificate to assure that a project would not violate Virginia Water Quality Standards. This program is now administered through the Virginia Water Protection Permit Program. A Virginia Water Protection Permit is now issued by the Water Division which, in most cases, incorporates the 401 Water Quality Certificate.

Pursuant to the Virginia Ground Water Management Act, any person or group wishing to install a well to withdraw 300,000 gallons or more of groundwater a month within a designated Groundwater Management Area (GMA) must obtain a Groundwater Withdrawal Permit. The Eastern Virginia GMA includes the area east of I-95 and south of the Mattaponi and York Rivers. Permits are issued by the Water Division.

In addition, the Water Division will also require a Virginia Pollution Discharge Elimination System (VPDES) permit to be issued for the discharge of untreated water from the groundwater withdrawal system to Diascund Creek and Little Creek Reservoirs. VPDES permit decisions are based on the nature of both the discharge and the receiving water.

Virginia Marine Resources Commission

Pursuant to the Virginia Wetlands Act, the Virginia Marine Resources Commission (VMRC) assesses potential impacts of any project which requires building in or disturbing any waterway or wetland area in the Commonwealth of Virginia. Any person or entity wishing to conduct these activities must submit a permit to the VMRC.

Virginia Department of Health

Virginia has been granted primacy under the Federal Safe Drinking Water Act, with the effect that the Virginia Department of Health (VDH) is responsible for administering both state and federal laws applicable to waterworks operations (subject to certain oversight by the USEPA with respect to federal requirements). The VDH is responsible for issuing permits required for waterworks operations. The permit would indicate the approved capacity of the system. In addition, the VDH requires that waterworks expansion be planned when demands for three consecutive months are 80 percent or more of the rated capacity of the waterworks.

Virginia Department of Conservation and Recreation

Pursuant to the Virginia Dam Safety Act, the Virginia Department of Conservation and Recreation (VDCR) must issue construction permits to provide for the proper and safe design, construction, operation and maintenance of impounding structures to protect public safety. Construction of the proposed King William Dam would require approval from the VDCR in the form of a construction permit.

1.5.3 Local

Erosion and Sediment Control

The Virginia Erosion and Sediment Control Law specifies minimum standards for control of soil erosion, sediment deposition, and non-agricultural runoff. This law is administered by the VDCR. Localities must adopt the State plan or create their own using the minimum standards. The RRWSG will be required to submit a sediment and erosion control plan for approval by the counties in which work is conducted.

Chesapeake Bay Preservation Act

The Chesapeake Bay Preservation Act requires localities within Virginia to implement land use controls to improve the condition of Chesapeake Bay waters. This law is administered by the Chesapeake Bay Local Assistance Department. Localities designate Chesapeake Bay Preservation Areas (CBPAs) within their respective jurisdictions. All project activities occurring within the CBPAs would be required to comply with the appropriate land use controls.

Zoning Requirements

The proposed reservoir site is currently zoned as Agricultural-Rural Residence. As described in the ***King William Reservoir Project Development Agreement*** (King William County and City of Newport News, 1990), King William County would acquire and lease to the City of Newport News sufficient land to create the reservoir and its associated buffer area.

Storm Water Management

The Virginia Storm Water Management Act enables local governments to establish management plans and adopt ordinances which require control and treatment of storm water runoff to prevent flooding and contamination of local waterways. This law is administered by the VDCR. Local programs must meet or exceed the minimum standards contained in the VDCR regulations.

1.6 DOCUMENT ORGANIZATION

The remainder of this document is organized as described below.

- Purpose and Need for Action (Section 2) describes the formation and members of the RRWSG, their objectives, current supplies, water supply concerns, historical and projected demands, projected deficits, and political/institutional considerations.

- Evaluation of Alternatives (Section 3) explains the evaluation methodology used, the alternatives considered, and a summary of the practicability and environmental analyses. Also, the RRWSG's preferred project alternative is identified.

- Affected Environment (Section 4) reviews the physical, biological, cultural, and socioeconomic resources affected by candidate alternatives.

- Environmental Consequences (Section 5) details the potential impacts of candidate alternatives on physical, biological, cultural, and socioeconomic resources, as well as other environmental concerns.

- List of Preparers (Section 6) provides a brief description of the experience and background of individuals who helped collect and prepare the information in this document and its appendices.

- Public Involvement (Section 7) provides information on the public's involvement and interaction in the alternatives selection process.

2.0 PURPOSE AND NEED FOR ACTION

2.1 INTRODUCTION

This section outlines the basis for the study area boundaries, and summarizes the water supplies, demands, and deficit projections applicable to this region. A more detailed review of these topics is contained in ***Water Supply, Demand and Deficit Projections*** (Report B) (Malcolm Pirnie, 1993). Report B is incorporated herein by reference and is an appendix to this document.

2.2 REGIONAL RAW WATER STUDY GROUP

The Regional Raw Water Study Group (RRWSG) was created in the Fall of 1987 to examine the long-term water supply needs of the Lower Peninsula area of southeast Virginia and to develop a plan for meeting those needs. Jurisdictions included in the regional study area are the Cities of Newport News, Williamsburg, Hampton, and Poquoson, and the counties of York and James City.

The RRWSG is acknowledged by the currently participating jurisdictions (i.e., Newport News (representing Newport News Waterworks and its service area), Williamsburg, and York County) to be an appropriate regional entity to pursue the necessary engineering and environmental studies to search for the least environmentally damaging, practicable alternative(s) to meet the future water supply needs of the study area. To this end, the purpose and goal of the RRWSG has been:

> ***To provide a dependable, long-term public water supply for the Lower Virginia Peninsula, in a manner which is not contrary to the overall public interest.***

The study area encompasses approximately 521 square miles in which more than 400,000 persons currently reside. It is bounded by the James River on the south, the York River on the north, the Chesapeake Bay on the east, and New Kent and Charles City counties on the west. Each of the RRWSG members has responsibility to provide water to its citizens. In addition, Newport News is responsible for serving the cities of Hampton and Poquoson, as well as portions of York and James City counties where most of these jurisdictions' water demands currently exist. Existing water supplies and future demands within the region have been combined and are addressed as a regional unit in this study.

The original concept for a regional raw water supply study was to issue a final Phase I Report which would identify the RRWSG's preferred alternative for meeting the region's water supply deficits over the planning horizon. The preparation of an environmental assessment and the submittal of a permit application for the RRWSG's preferred project to the USCOE would then follow during Phase II. As the Phase I planning process evolved, it became apparent that this original concept, planning period, and procedural strategy would need to change.

The USCOE required that the federal advisory agencies be involved in the identification of practicable alternatives and, further, with the evaluation of practicable alternatives relative to environmental impact. Only through detailed environmental analysis of all practicable alternatives, as part of an EIS, could the USCOE and federal advisory agencies determine which of the candidate projects would be least environmentally damaging and, therefore, most acceptable. Originally, the USCOE intended to have the EIS prepared in two tiers. However, the USCOE and federal advisory agencies were unable to agree on procedural arrangements for conducting a tiered EIS. As a result, the USCOE decided to complete the remainder of this NEPA process using the format of a conventional EIS.

Throughout the process, there has been an active exchange of information and ideas between involved federal, state, and local regulatory agencies, environmental organizations, and the RRWSG. This exchange included single and multi-agency briefing meetings, distribution of project briefing materials and many written and oral communications.

2.2.1 Regional Approach to Water Supply Management

It was recognized in the late 1980s that the continuing growth projected for the Lower Peninsula of Southeast Virginia would result in water demands which would soon exceed the capacity of existing water supply sources. Realizing that additional raw water supply for the Lower Peninsula would likely originate from outside the Newport News Waterworks service area, the City of Newport News initiated an effort to enlist the participation of surrounding communities to join in a regional approach to water supply planning.

Regional cooperation promotes the concept of more effective sharing and the preservation of existing resources, reduces the competition for remaining supplies and provides the economic benefits of single large scale water supply development projects. Most importantly, combining the resources of several jurisdictions with a common need provides the opportunity of considering many more water supply development alternatives, which, in combination, can result in the selection of a plan which has the greatest cumulative benefits and least overall impacts within the region.

The City invited participation from communities within a geographic range which would facilitate cooperation in regional water supply management. Jurisdictions were invited to participate from the Lower Peninsula, Middle Peninsula, and Richmond Planning Districts, and included the Counties of Hanover, New Kent, York, James City, Charles City, King William and Gloucester, and the Cities of Newport News and Williamsburg.

Several organizational meetings were held with potential participants to discuss formation of the group. The first organizational meeting was held on March 18, 1987. It was chaired by then City of Newport News Mayor Jessie Rattley. The following jurisdictions were represented at the meeting: the Counties of Hanover, Henrico, James City, King William, New Kent and York, and the Cities of Newport News, Richmond and Williamsburg. Representatives of the State Water Control Board (SWCB), U.S. Army Corps of Engineers (USCOE), the U.S. Geological Survey (USGS) and the Peninsula Planning District Commission were also in attendance. Subsequent meetings were held in May, June, and August of 1987. An official response regarding participation in the regional study was requested by the City of Newport News by September 15, 1987. A list of the localities requested to participate in the planning effort and their responses are summarized in Table 2-1. These locations on the Lower Peninsula are shown in Figure 2-1.

TABLE 2-1

LIST OF POTENTIAL PARTICIPANTS AND RESPONSES TO PARTICIPATION IN THE REGIONAL RAW WATER STUDY GROUP

Jurisdiction	Response	
Charles City County	No -	Board of Supervisors voted not to participate financially in the study but expressed interest in the efforts of the study group.
Chesterfield County	No -	The County indicated that, at the time, they were part of a four county study group with Amelia, Cumberland, and Powhatan Counties. They were unable to participate, but suggested that both groups maintain contact.
City of Richmond	No -	Richmond showed an overall decrease in water demand, therefore they chose not to participate.
City of Williamsburg	Yes -	The City accepted participation and agreed to contribute financially.
Gloucester County	No -	Gloucester County declined participation.
Hanover County	No -	Hanover County responded through the Pamunkey River Water Study Committee which is composed of Hanover, James City, King William, and New Kent Counties. The committee stated that they would not proceed as an entity in the study.
Henrico County	No -	Henrico County determined it was not in their best interest to participate in the study.
James City County	Yes -	James City decided to participate, and agreed to contribute financial support.
King William County	No -	King William declined participation.
New Kent County	No -	New Kent declined participation
York County	Yes -	The County accepted inclusion in the study and agreed to contribute financially to the project.

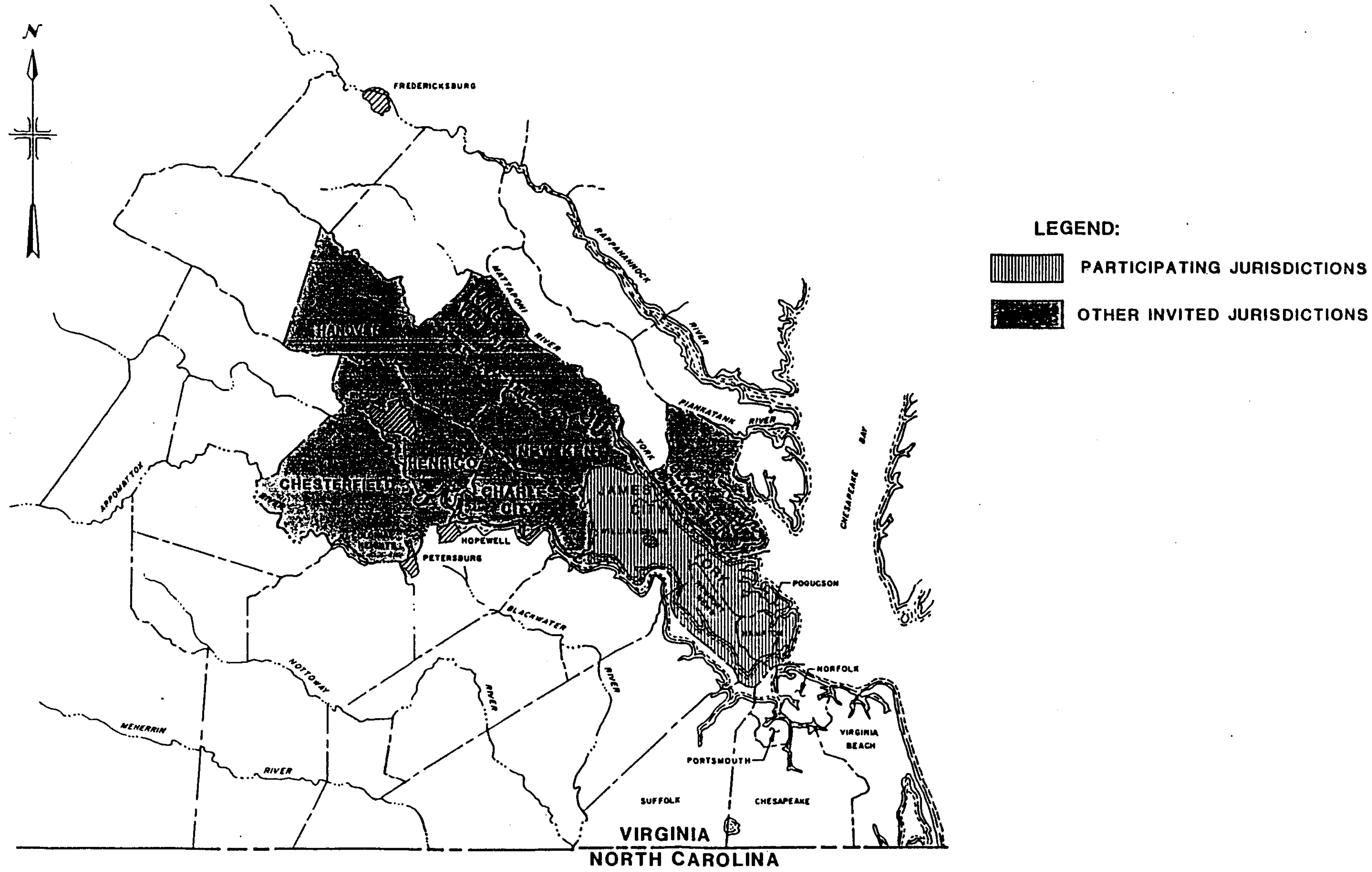


FIGURE 2-1

MALCOLM PIRNIE

LOWER PENINSULA STUDY AREA

MALCOLM PIRNIE, INC.

NOVEMBER 1991

2.3 CURRENT SUPPLIES

The Lower Peninsula is supplied by five principal public water supply systems: Newport News Waterworks, Williamsburg, York County, James City Service Authority, and the federally-owned Big Bethel Reservoir System. Figure 2-2 illustrates the geographic locations of these systems. A schematic of the Lower Peninsula water supply systems is presented in Figure 2-3.

2.3.1 Newport News Waterworks

The City of Newport News operates a regional water supply system serving approximately 340,000 people in the cities of Newport News, Hampton, Poquoson, and portions of York County and James City County. The system consists of a raw water intake on the Chickahominy River, three western storage reservoirs, two terminal reservoirs, two water treatment plants (WTP), and a distribution system with 12 finished water storage tanks. The average daily water production was 48.25 mgd in 1990.

Chickahominy River Withdrawal

The Chickahominy River is the principal raw water source for the Newport News Waterworks system. Raw water from the Chickahominy River can be pumped by a 41 mgd pump station to either terminal reservoir (Lee Hall and/or Harwood's Mill), Little Creek Reservoir, Skiffes Creek Reservoir, Waller Mill Reservoir (owned and operated by the City of Williamsburg), or Big Bethel Reservoir (owned and operated by the U.S. Army). The Chickahominy River raw water intake is located above Walker's Dam, a tidal exclusion dam in New Kent County. The drainage area to the Chickahominy River above Walker's Dam is 301 square miles. The estimated average daily river flow at the intake is 206.3 mgd based on 48 years of record.

A minimum of 10 cubic feet per second (cfs) flow downstream from Walker's Dam must be maintained at all times according to current withdrawal permit requirements. In addition, when the water surface elevation upstream of the dam is less than or equal to 3 feet msl, pumping to Little Creek Reservoir is not allowed according to the Little Creek Reservoir USCOE Permit to Construct. However, water may still be pumped to the other reservoirs as long as the minimum flow-by requirement is met. Newport News also voluntarily stops pumping when chloride levels exceed 100 mg/l at the Walker's Dam intake in accordance with recommended procedures in their current Chloride Action Plan. The City may also stop pumping as a precautionary measure if chloride levels are between 70 and 100 mg/l for a week.

Western Reservoir Operations

Little Creek Reservoir is the largest of the five reservoirs in the Newport News system. A December 1989 report prepared for the City indicates the total storage in Little Creek Reservoir is 7.48 billion gallons (BG) (CDM, 1989). Due to the small reservoir drainage area (4.6 square miles), pumpover from the Chickahominy River and the Diascund Creek Reservoir is required to maintain levels in the Little Creek Reservoir. The Little Creek pump station capacity is 40.4 mgd.

Little Creek Reservoir becomes drawn down when low flows in the Chickahominy River cause a curtailment of pumpover operations. Water from the Little Creek Reservoir can be pumped to five other impoundments: Skiffes Creek Reservoir, Lee Hall Reservoir, Harwood's Mill Reservoir, Waller Mill Reservoir, or Big Bethel Reservoir.

The Diascund Creek Reservoir has the largest drainage area, 44.6 square miles. The reservoir provides 3.49 BG total storage. The pump station can pump 30.3 mgd.

Skiffes Creek Reservoir is the smallest reservoir in the Newport News system with a drainage area of 6.25 square miles and 0.23 BG of storage. This source is supplemented by a 20-inch interconnection to the main raw water transmission system from the Chickahominy River pump station. Skiffes Creek has a 3 mgd pump station that can only pump to the Lee Hall Reservoir.

Terminal Reservoir Operations

The Lee Hall Reservoir is a terminal reservoir used for on-site storage for the Lee Hall WTP. The impoundment has 0.88 BG of total storage, has a drainage area of 14.6 square miles, and receives water from the Chickahominy River, Diascund Creek Reservoir, Little Creek Reservoir, and Skiffes Creek Reservoir.

The Harwood's Mill Reservoir is also a terminal reservoir used for on-site storage for the Harwood's Mill Water Treatment Plant. The impoundment has 0.85 BG of total storage, a drainage area of 8.6 square miles, and receives raw water from the Chickahominy River, Little Creek Reservoir, and Diascund Creek Reservoir.

Raw Water Transmission System

Newport News Waterworks is completing a final pipeline segment in the transmission system that will increase the maximum rate of flow from the western reservoirs that can be delivered to the terminal reservoirs to 92 mgd, up from the 67 mgd available with the current transmission system. However, since the current transmission capacity already exceeds the safe yield of the reservoirs from which water is withdrawn, these improvements will not safely increase current supply.

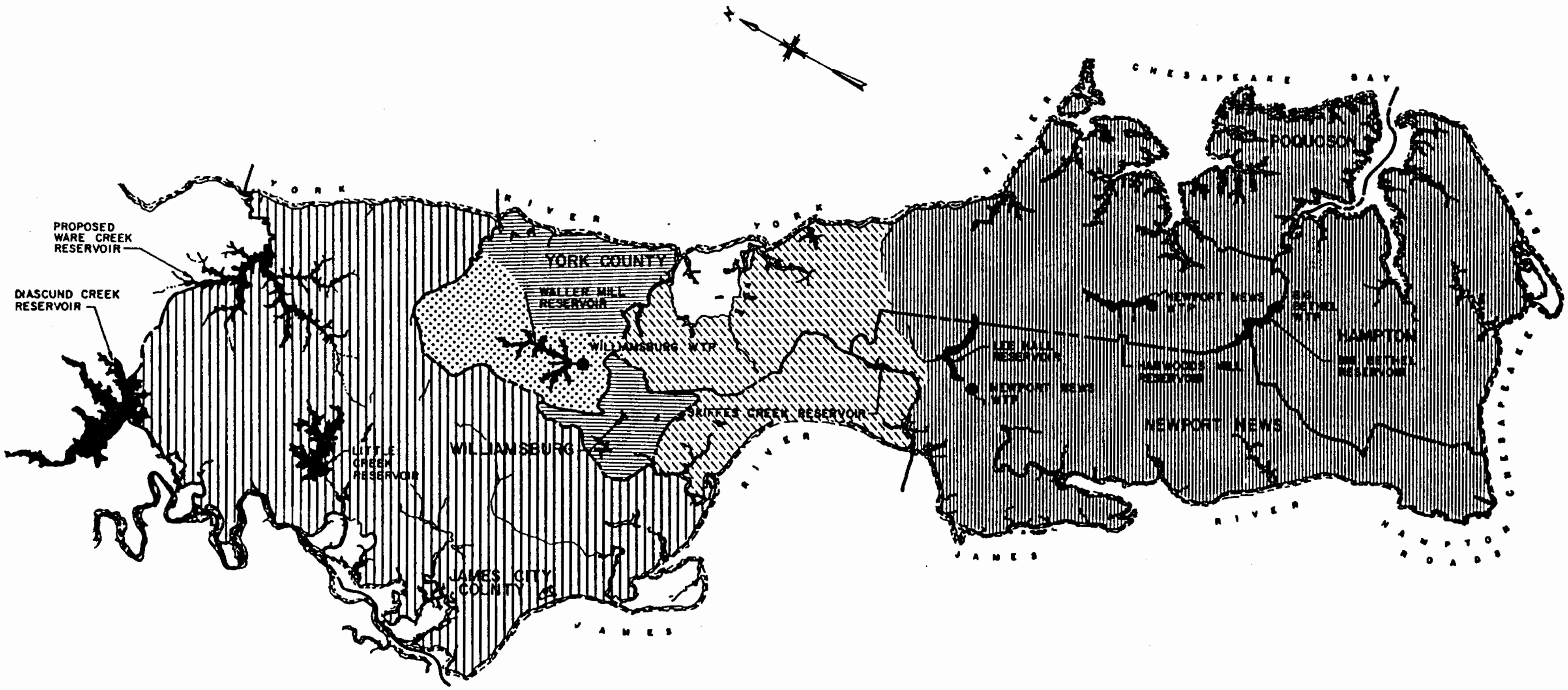
The Chickahominy River Pump Station at Walker's Dam discharges to the Old Chickahominy and New Chickahominy Mains. The Old Chickahominy Main consists of 10.3 miles of 34-inch main followed by 15.5 miles of 39-inch main, 5.2 miles of 34-inch main, and 1.4 mile of 30-inch main with outfalls to the Lee Hall and Harwood's Mill reservoirs.

Following the expansion of the Lee Hall WTP in conjunction with the construction of the Diascund Creek Reservoir, the 42-inch Diascund Main was installed from Diascund Creek Reservoir approximately 40 miles to Lee Hall Reservoir, with interconnections to the Old Chickahominy Main.

After expansions at Lee Hall WTP, installation of a third raw water main (the New Chickahominy Main) was begun to aid in the transmission of water from the Chickahominy River Pump Station to the Lee Hall and Harwood's Mill Reservoirs. The final segment of this main is projected to be completed in 1996.

The three mains are interconnected at many points along their lengths, to provide flexibility for operations, maintenance, and flow routing. Emergency connections/outfalls to Waller Mill Reservoir, the Williamsburg Water Treatment Plant, and Big Bethel

FIGURE 2-2



LEGEND

- NNW LOW PRESSURE ZONE
- NNW NORTHERN ZONE
- WILLIAMSBURG
- YORK COUNTY
- JAMES CITY SERVICE AUTHORITY
- ● EXISTING TREATMENT PLANT
- ——— POLITICAL BOUNDARY

JUNE 1992
LOWER VIRGINIA PENINSULA
REGIONAL RAW WATER SUPPLY PLAN
LOWER PENINSULA SERVICE AREAS

MALCOLM PIRNIE

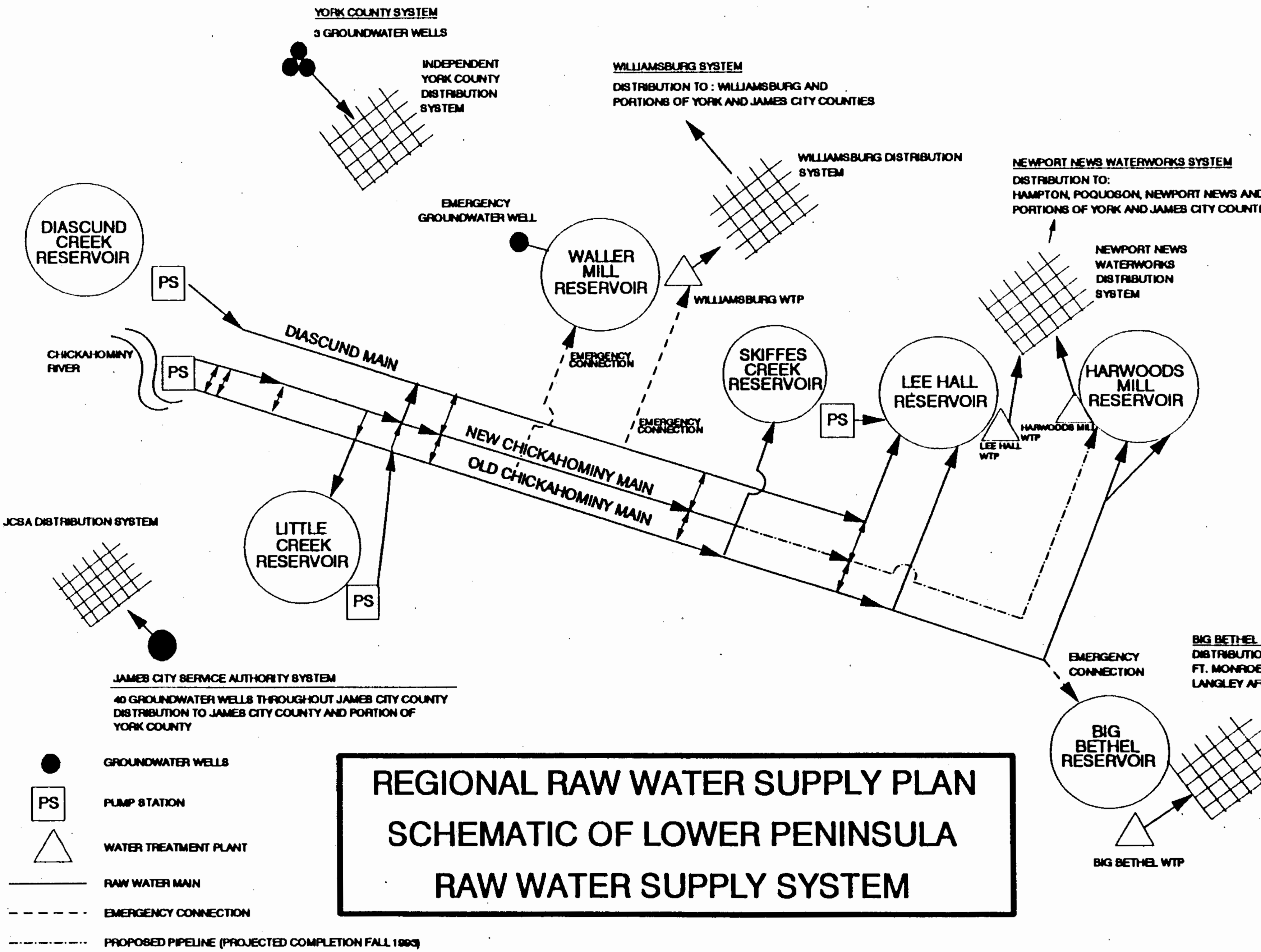

YORK COUNTY SYSTEM
3 GROUNDWATER WELLS
INDEPENDENT YORK COUNTY DISTRIBUTION SYSTEM
WILLIAMSBURG SYSTEM
DISTRIBUTION TO : WILLIAMSBURG AND PORTIONS OF YORK AND JAMES CITY COUNTIES
WILLIAMSBURG DISTRIBUTION SYSTEM
NEWPORT NEWS WATERWORKS SYSTEM
DISTRIBUTION TO: HAMPTON, POQUOSON, NEWPORT NEWS AND PORTIONS OF YORK AND JAMES CITY COUNTIES
NEWPORT NEWS WATERWORKS DISTRIBUTION SYSTEM
EMERGENCY GROUNDWATER WELL
DIASCUND CREEK RESERVOIR
WALLER MILL RESERVOIR
WILLIAMSBURG WTP
PS
CHICKAHOMINY RIVER
DIASCUND MAIN
EMERGENCY CONNECTION
SKIFFES CREEK RESERVOIR
LEE HALL RESERVOIR
HARWOODS MILL RESERVOIR
LEE HALL WTP
HARWOODS MILL WTP
NEW CHICKAHOMINY MAIN
OLD CHICKAHOMINY MAIN
JCSA DISTRIBUTION SYSTEM
LITTLE CREEK RESERVOIR
JAMES CITY SERVICE AUTHORITY SYSTEM
40 GROUNDWATER WELLS THROUGHOUT JAMES CITY COUNTY DISTRIBUTION TO JAMES CITY COUNTY AND PORTION OF YORK COUNTY
BIG BETHEL ARMY SYSTEM
DISTRIBUTION TO: FT. MONROE, NASA, LANGLEY AFB.
BIG BETHEL RESERVOIR
BIG BETHEL WTP
GROUNDWATER WELLS
PUMP STATION
WATER TREATMENT PLANT
RAW WATER MAIN
EMERGENCY CONNECTION
PROPOSED PIPELINE (PROJECTED COMPLETION FALL 1993)
REGIONAL RAW WATER SUPPLY PLAN
SCHEMATIC OF LOWER PENINSULA
RAW WATER SUPPLY SYSTEM

FIGURE 2-3

Reservoir are available. Figure 2-3 provides an illustration of the Newport News raw water transmission system and its interconnections and outfalls.

The four raw water pump stations in the Newport News system have a combined total capacity of 115 mgd. The table below lists the pump stations and their respective number of pumps and rated capacities.

Pump Station	Number of Pumps	Rated Capacity (mgd)
Chickahominy River	4	41
	6*	18.0*
Diascund Creek	2	30.3
Little Creek	2	40.4
Skiffes Creek	3	3.0
*For emergency use only		

Water Treatment

The Newport News Waterworks currently operates three treatment plants. Two of these plants, Lee Hall Plants No. 1 and 2, are interconnected and have a Virginia Department of Health (VDH) combined rated capacity of 54 mgd. Their combined physical capacity, or the maximum amount they could treat, is 57 mgd. The Harwood's Mill Plant has a VDH rated capacity of 31 mgd with a physical capacity of 40 mgd. Total rated capacity of the three plants is 85 mgd with a total physical capacity of 97 mgd.

Distribution

The system finished water storage capacity currently totals 32.2 million gallons (MG) in 15 existing storage facilities. There are 7 elevated tanks, 4 remote ground storage tanks, 3 plant site ground tanks, and 1 plant site clearwell.

2.3.2 City of Williamsburg

The City of Williamsburg Department of Public Utilities operates a water system serving approximately 17,500 people within the City, the College of William and Mary, Camp Peary in York County, and several subdivisions in James City and York Counties. The water system obtains raw water from the Waller Mill Reservoir, an augmentation well near the reservoir, and interconnections with the Newport News Waterworks raw water system.

Waller Mill Reservoir, located in York County, has 1.42 BG of total storage capacity. The watershed is approximately 7 square miles. A 505-foot deep augmentation well adjacent to the reservoir with discharge directly to the reservoir is rated at 500 gpm (0.72 mgd) and has a pumping capacity of 0.68 mgd. A 34-inch interconnecting line runs from the Newport News Old Chickahominy Raw Water Main to the Waller Mill Reservoir. An additional 12-inch line connects the 42-inch Diascund Raw Water Main directly to Williamsburg's Waller Mill WTP.

A contract for raw water supplied to Williamsburg from Newport News Waterworks currently specifies the allowable water purchase as 2.0 mgd during the months of June through September and 2.5 mgd for the remainder of the year. After July 1, 1994, the limits increase by 0.5 mgd if requested by Williamsburg by March 31, 1994, otherwise, the limits remain the same.

The Waller Mill WTP has a rated treatment capacity of 7 mgd and feeds a distribution system of five finished water storage tanks with a total capacity of 3.5 MG.

2.3.3 York County

The majority of York County's water supply needs are met by the Newport News Waterworks and Williamsburg water systems. Lower York County is served primarily by Newport News Waterworks while Upper York County receives its water from Williamsburg, Newport News Waterworks, several private water companies, and York County.

The York County Department of Environmental Services owns and operates three wells serving approximately 750 people in the Skimino Hills and Banbury Cross subdivisions. Well No. 1 is 305 feet deep and has a 60 gpm submersible pump that fills two 15,000-gallon storage tanks. Two 150 gpm booster pumps charge a 1,000-gallon hydro-pneumatic tank for distribution. Well No. 2 is 324 feet deep and has a 60 gpm submersible pump that discharges to a single 15,000-gallon storage tank. Two 160 gpm booster pumps charge a 1,000-gallon hydro-pneumatic tank for distribution. Well No. 3 is 283 feet deep, has a 70 gpm submersible pump, and discharges to a 30,000-gallon storage tank. Two 100 gpm booster pump charge a 2,000-gallon hydro-pneumatic tank for distribution. The system's permitted design capacity is 120,000 gallons per day with all three wells operating.

The York County Department of Environmental Services also owns two wells in the Lightfoot area of the County. The wells were completed in 1989 and have a total permitted withdrawal of 740 gpm. Lightfoot No. 1 and No. 2 were not in use as of March 1993.

The County sells water supplied by the Newport News Waterworks to Sydnor and two other private water companies. In addition, the U.S. Coast Guard Reserve Training Center and the Yorktown Naval Weapons Station are also supplied by the Newport News Waterworks. Camp Peary receives its water from the City of Williamsburg and Cheatham Annex Naval Supply Center obtains water from Jones Pond.

2.3.4 James City Service Authority

The James City Service Authority (JCSA) serves four local service areas within James City County. The Authority owns and operates 40 wells with an SWCB permitted withdrawal of 7.92 mgd. Several of the wells have either poor water quality or elevated fluoride levels.

The Authority purchases approximately 0.2 mgd from the City of Williamsburg and is also served by the Newport News Waterworks which currently provides approximately 7.3 mgd to County customers on a retail basis. The remaining County residents are serviced by privately owned systems.

2.3.5 U.S. Army at Fort Monroe

The Big Bethel Reservoir serves Langley Air Force Base, Fort Monroe, and NASA. The reservoir volume is 0.61 BG. The treatment plant has a rated capacity of 4 mgd and a finished water storage capacity of 4.85 MG. Fort Monroe, Langley Air Force Base, and NASA also purchase finished water from Newport News Waterworks when the Big Bethel system is off-line for maintenance or during drought periods.

2.3.6 Current Supply Summary

The characteristics of the current raw water sources for each of the five Lower Peninsula region water supply systems are summarized in Table 2-2.

2.3.7 Current Safe Yield

Table 2-3 contains a listing of reported system safe yields for the Lower Peninsula with references. Adjustments to these yields are necessary to account for reservoir seepage losses, transmission losses, and WTP losses.

The safe yields and reliable system delivery capacities for each public water supply system on the Lower Peninsula were calculated using the accepted SWCB methodology and are listed in Table 2-4. A complete explanation of safe yield determination methodology and a detailed review of safe yield analysis is available in the ***Water Supply, Demand and Deficit Projections*** report (Malcolm Pirnie, 1993). Figure 2-4 is a schematic representation of the overall regional system delivery capacity concept. The regional reliable system delivery capacity estimate of 60.8 mgd represents the estimated average daily volume of finished water available for distribution throughout a period of time in the future during which the drought of record rainfall pattern is repeated. It must be noted that the supplies are intended to satisfy average day treated water demands, not peak usage demands.

It should also be noted that the above safe yield value is an estimate of the current capability of the Lower Peninsula's public water supply systems to meet area demands. There is no guarantee that this safe yield will be as high in the future. For example, a more severe drought than those on record could occur, thereby causing a reassessment and reduction in system safe yield. In addition, any new surface water withdrawals developed on the Chickahominy River upstream of the Walker's Dam Pump Station, would reduce available flow for the Newport News system. Further depletion of groundwater resources, and development in groundwater recharge areas that reduces infiltration, would similarly cause declining yields for area groundwater systems.

2.3.8 Rate Structures

Newport News Waterworks

Water commodity rates are set to cover all capital and operating expenses incurred for the existing production and delivery of treated water. They are not artificially lowered or subsidized, and no minimum consumption charge is used. Thus, customers pay the true cost for the actual amount of water used and have a tangible incentive to conserve. A bi-monthly billing cycle allows customers to detect leaks more quickly and recognize the cost of high seasonal water use. The bi-monthly billing cycle also allows more frequent feedback on conservation efforts.

The Waterworks employs a two-block schedule of declining block rates. The unit price of water decreases as the quality used increases. The break point between the blocks is set at 30,000 cubic feet per month. The break point chosen effectively places most single and multi-family residential connections in the lower usage, higher rate block while placing large users in the high usage, low rate block.

Special charges to encourage water conservation have also been implemented. The Summer Conservation Rate (SCR) was implemented in May 1989 to establish more equitable rates by applying a surcharge to those who contribute toward seasonal peaking of demand on the water system.

The charge theoretically applies to non-essential, outside uses of water occurring during the summer months. Average winter months usage is used to set a threshold level. Any water used in excess of the threshold level during the summer months is deemed non-essential and is billed at the SCR.

A System Development Charge (SDC) was also implemented as a means of charging new system customers for the partial impact their additional use will have on the water supply system, such as the need for new water sources, increased treatment capacity, increased storage capacity, and additional distribution capability.

<u>City of Williamsburg</u>

Water rates are charged at a single uniform rate. The uniform rate is set to cover all capital and operating expenses incurred in the existing production and delivery of treated water.

As an action designed to apportion the cost of providing water fairly, an Availability Fee for new customers was also established. This fee is based on meter size and reflects the impact new customers will have on the water supply system and requires them to pay accordingly.

<u>York County</u>

Water rates are set at a uniform rate to cover all operational costs and, as a result, customers pay the true cost for the actual amount of water used.

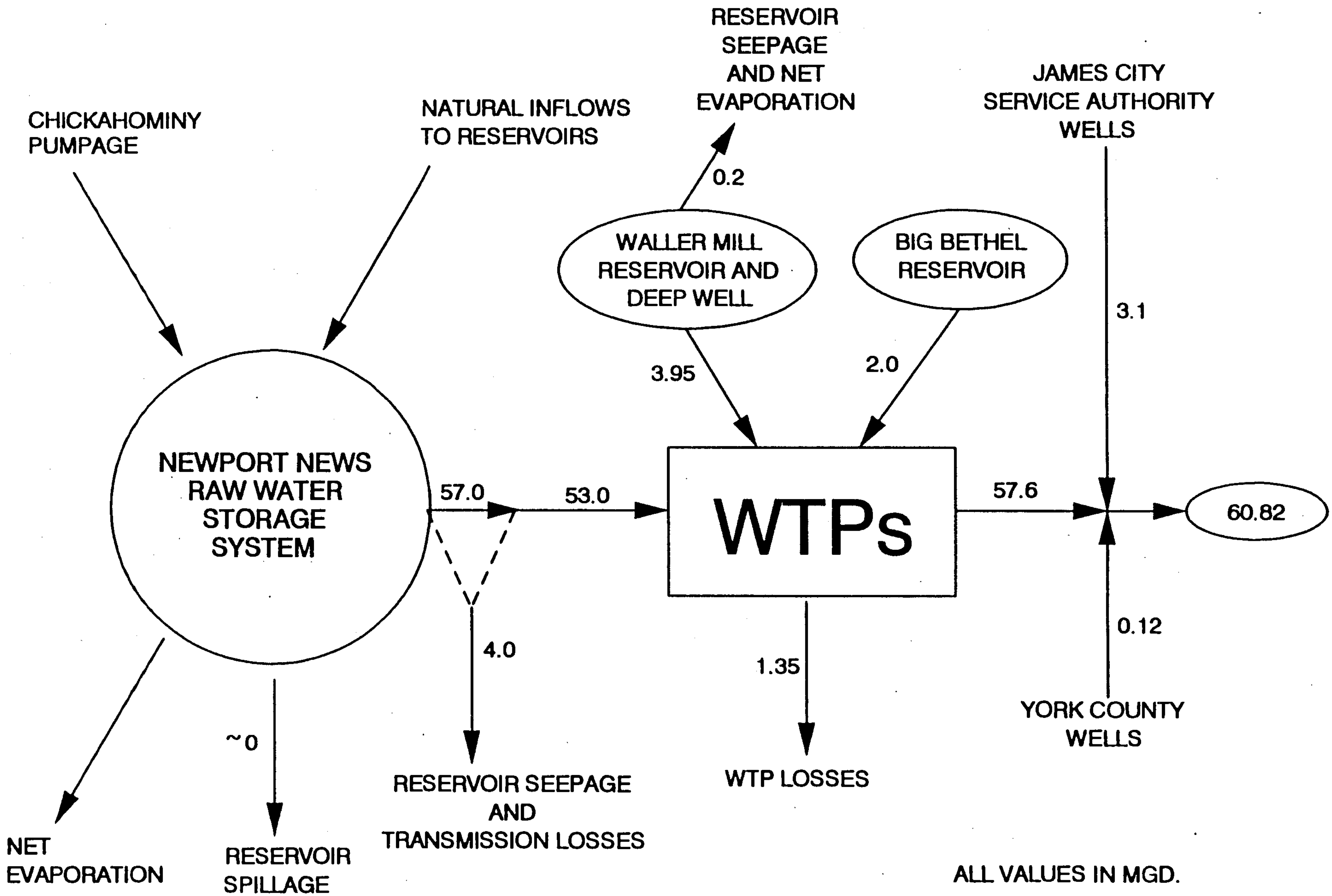
<u>James City Service Authority</u>

The Authority uses a uniform water rate. A Summer Surcharge Rate is also used to charge a higher rate for water used in excess of each customer's winter average. In addition, a System Facilities Charge was implemented to charge new customers for the impact they have on the system.

2.4 WATER SUPPLY CONCERNS

Water supply concerns relative to the RRWSG's objective include the dependency of certain areas on groundwater supplies, the designation of the Lower Peninsula area as a

REGIONAL SYSTEM DELIVERY CAPACITY



ALL VALUES IN MGD.

FIGURE 2-4

TABLE 2-2

EXISTING RAW WATER SOURCE CHARACTERISTICS

NEWPORT NEWS WATERWORKS

Chickahominy River

- 41 mgd capacity pump station at Walkers Dam
- 301 square mile drainage area at the intake
- 206.3 mgd estimated average daily flow at the intake (48 years of record)
- Pumping Rules:
  - A minimum of 10 cfs flow downstream from Chickahominy Reservoir (i.e., Walkers Dam) must be maintained at all times.
  - When water surface elevation upstream of Walkers Dam is ≤3.0 feet MSL, cannot pump to Little Creek Reservoir.
  - Chloride Action Plan recommends that pumping stop when chloride levels exceed 100 mg/l at the intake, or if chloride levels are between 70 and 100 mg/l for a week (self-imposed).

Reservoirs	Drainage Area (sq.mi.)	Total Storage (BG)	Water Surface Area (Acres)
Diascund Creek	44.6	3.49	1,110
Little Creek	4.6	7.48	947
Skiffes Creek	6.25	0.23	94
Lee Hall (Terminal)	14.6	0.88	493
Harwood's Mill (Terminal)	8.6	0.85	265
TOTALS	78.65	12.93	2,909

Sources: CDM, 1989

TABLE 2-2

EXISTING RAW WATER SOURCE CHARACTERISTICS
(Continued)

WILLIAMSBURG

Reservoir	Drainage Area (sq.mi.)	Total Storage (BG)	Water Surface Area (Acres)
Waller Mill	7.0	1.42	308

Groundwater Well No. 1

- Augments reservoir
- 505 ft. deep well
- 0.68 mgd pumping capacity

Sources: CDM, 1989
SWCB, 1983

YORK COUNTY

Groundwater Wells, Skimino Hills/Banbury Cross No. 1, No. 2 and No. 3:

- Serves Skimino Hills and Banbury Cross Subdivisions
    - 305 ft., 324 ft. and 283 ft. deep, respectively
    - Wells have submersible pumps which operate at between 60 and 70 gpm

Groundwater Wells, Lightfoot No. 1 and No. 2:

- Wells not in use as of March 1993
- 318 ft. and 310 ft. deep, respectively
- Stabilized yield of 410 gpm for No. 1 and 317 gpm for No. 2

Sources: Current VDH Engineering Description Sheet
Well completion reports

TABLE 2-2

EXISTING RAW WATER SOURCE CHARACTERISTICS
(Continued)

JAMES CITY SERVICE AUTHORITY

Groundwater Wells

- 40 wells located throughout the County
- Wells range in depth from 204 ft. to 725 ft. deep
- 35 wells on main system, 5 wells on 4 independent systems
- Total actual well pump capacity is 7.54 mgd

Source: JCSA, April, August, and October 1991.

BIG BETHEL

Reservoir	Drainage Area (sq.mi.)	Total Storage (BG)	Water Surface Area (Acres)
Big Bethel	7.9	0.61	238

Source: CDM, 1989

TABLE 2-3

REPORTED YIELDS OF EXISTING SYSTEMS

System	Reported Yield (mgd)	Reported Well Yield (mgd)	Reference
Newport News Waterworks			
Chickahominy River withdrawal and five storage reservoirs			SWCB-1 and
	57.0		USCOE
	60.0		VDH-1
	57.8		CDM
Williamsburg			
Waller Mill Reservoir (does not include 0.68 mgd Augmentation Well No. 1)	3.0		USCOE
	3.08		VDH-2
	3.5		SWCB-1
	4.5		W&W
York County			
Skimino Hills/Banbury Cross Wells No. 1, No. 2 and No. 3	0.120		VDH-3
Lightfoot Wells No. 1 and No. 2		1.067	SWCB-2
James City Service Authority			
40 groundwater wells		7.9	SWCB-3
	3.08		VDH-4
Big Bethel			
Big Bethel Reservoir	2.0		USCOE

TABLE 2-3

REPORTED YIELDS OF EXISTING SYSTEMS
(Continued)

SOURCES:

SWCB-1	Virginia State Water Control Board, "Safe Yield of Municipal Surface Water Supply Systems in Virginia." Planning Bulletin No. 335. March 1985.
USCOE	U.S. Army Corps of Engineers, Norfolk District, "Feasibility Report and Final Environmental Impact Statement - Water Supply Study, Hampton Roads, Virginia." December 1984.
VDH-1	Virginia Department of Health, Current Waterworks Operation Permits, 1988.
VDH-2	Virginia Department of Health, Water Description Sheet, as referenced in SWCB, "James Water Supply Plan." March 1988.
CDM	Camp Dresser & McKee, "Task 7 Letter Report on Methods to Increase Safe Yield". Prepared for the City of Newport News. December 1988.
W&W	Wiley and Wilson, "Comprehensive Water System Study for the City of Williamsburg, Virginia." April 1985.
VDH-3	Virginia Department of Health, Current Waterworks Operation Permit, 1988.
SWCB-2	Virginia State Water Control Board, Certificates of Groundwater Right, March 1991.
SWCB-3	Virginia State Water Control Board, Certificates of Groundwater Right.
VDH-4	Virginia Department of Health, Current Waterworks Operation Permits.

TABLE 2-4

ADOPTED YIELDS OF EXISTING SYSTEMS (MGD)

Supply System	Raw Water Safe Yield (mgd)	Reliable System Delivery Capacity (mgd)
Newport News Waterworks	57.0	51.9
Williamsburg	4.15	3.8
York County	0.12 0.70 (1995)	0.12 0.70 (1995)
James City Service Authority	3.10 4.23 (1995) 6.0 (2005)	3.10 4.23 (1995) 6.0 (2005)
Big Bethel	2.0 0.0 (2011)	1.9 0.0 (2011)
TOTAL FOR LOWER PENINSULA	**66.37** **68.08 (1995)** **69.85 (2005)** **67.85 (2011)**	**60.82** **62.53 (1995)** **64.30 (2005)** **62.40 (2011)**

groundwater management area, and the dependency of the RRWSG's major supplier (Newport News Waterworks) on the Chickahominy River.

Future groundwater development is restricted in the area by its identification as a groundwater management area. The SWCB has determined that overdevelopment of groundwater in this area would cause groundwater quality deterioration and salt water intrusion into depleted aquifers.

The dependency of Newport News Waterworks and its extended service area on Chickahominy River withdrawals leaves the area vulnerable in the event of a severe drought or Chickahominy River contamination.

Some of the region's water supply systems may experience considerable problems as a result of drought conditions. For example, Waterworks has experienced considerable water quality problems in its reservoirs when they have been markedly drawn down. Water quality was severely degraded and Diascund Creek Reservoir was classified as hypereutrophic on the basis of a mean total phosphorus concentration of 0.09 mg/l, when it was drawn down to between 20 and 25 percent of total capacity during an 8-month period in 1983 and 1984. Concentrations of phosphorus are higher during reservoir drawdown because of:

- Decreased settling time for tributary inflows of phosphorus.
- Increased exposure of fine-grained, phosphorus-rich bottom sediments to resuspending forces.
- Increased algal uptake of phosphorus directly from bottom sediments (Lynch, 1992).

2.5 HISTORICAL DEMANDS

Historical treated water usage data were analyzed from various reports and studies published by the state and by the Lower Peninsula jurisdictions to determine current demand. These included the following:

- *Water Supply Study, Hampton Roads, Virginia, Feasibility Report and Final Environmental Impact Statement*, Norfolk District, U.S. Army Corps of Engineers. December 1984.
- *Safe Yield of Municipal Surface Water Supply Systems in Virginia*, Commonwealth of Virginia, Virginia State Water Control Board, Planning Bulletin No. 335. March 1985.
- *Comprehensive Water System Study for the City of Williamsburg, Virginia*, Wiley & Wilson. April 1985.
- *Comprehensive Water Study*, Buchart-Horn, Inc., Prepared for the County of York. November 1985.

- ***Newport News Raw Water Management Plan***, Camp, Dresser & McKee. December 1989.

- ***James Water Supply Plan, Parts 1 and 2***, Virginia State Water Control Board, Planning Bulletin No. 337. March 1988.

- ***Water Distribution System Study***, Prepared for the City of Newport News, Camp, Dresser & McKee. November 1986.

In addition, treated water pumpage records and customer billing records for the past four or more years were obtained from the Lower Peninsula water purveyors to assist in this demand determination.

2.5.1 Raw Water Withdrawals

Average annual raw water withdrawals for each system in the Lower Peninsula are presented in Table 2-5. Average withdrawals for the later years presented in this table are approximately 52 to 55 mgd. (The safe yield of these systems is approximately 62 mgd).

2.5.2 Treated Water Demands

The average daily water demands for each public water supply system on the Lower Peninsula are listed in Table 2-6. The total regional finished water pumpage to distribution in the base Year 1990 was approximately 55.2 mgd. (Regional system delivery capacity is estimated to be 60.8 mgd).

A record of annual average daily metered consumption for the Newport News Waterworks system from 1968 to 1990 is presented graphically in Figure 2-5. Over this 22-year period, the average increase in demand was 2.65 percent per year.

Treated water consumption increased each year between 1983 and 1990 in the Newport News Waterworks system. However, increases in demand tapered off beginning in 1986. This moderation in demand occurred despite sizable increases in the number of connections to the system (e.g., 3,588 new connections in 1986 and 3,103 new connections in 1987). Three events may have contributed to this decline in per capita water usage.

First, in the summer of 1986, three new booster pumps were installed in the northern zone booster pump station. System pressure in the northern zone was lowered from 85 psi to 75 psi after pump replacement was complete. Main distribution system pressures were also lowered as a result of the pump installation. Pressure reduction in a service area will generally reduce water usage independent of other factors, because leaks and certain in-home water uses will decrease.

Secondly, Newport News Waterworks implemented three separate rate increases, which took effect on July 1, 1986, September 1, 1987, and September 1, 1988. Higher water prices can be expected to affect the water consumption habits of many users. In particular, large water users have decreased their consumption. Camp Dresser & McKee reported that 15 large water users, whose treated water needs are provided entirely by the Newport News Waterworks system, consumed an average daily total of 14.25 mgd in 1985 (CDM, 1986).

TABLE 2-5

AVERAGE ANNUAL RAW WATER WITHDRAWALS (1982-1990)
(mgd)

Water Supply System	1982	1983	1984	1985	1986	1987	1988	1989	1990
Newport News Waterworks[1]	39.79[2]	42.03[2]	42.15[2]	44.79[2]	47.18[2]	46.43	46.76	45.70	48.83
Williamsburg	3.04	2.98	3.15	3.42	3.66	3.36	3.54	3.63	3.49
York County	NA	0.041	0.034	0.039	0.044	0.044	0.049	0.049	0.051
James City Service Authority	0.75	0.85	0.87	0.93	1.13	1.37	1.40	1.64	1.70
Big Bethel	NA	2.75	3.04	2.93	NA	NA	2.57	--	--

NA = Not available

Notes: [1]Values for Newport News Waterworks represent terminal reservoir withdrawals.
[2]Approximate values, reliable data for 1982 to 1986 were not available for Lee Hall Reservoir.

Sources: Raw water pumpage reports provided by each water supply system.
SWCB, James Water Supply Plan, March 1988.[12]

TABLE 2-6

AVERAGE DAILY WATER VOLUMES PUMPED TO DISTRIBUTION (1984-1990)
(mgd)

Water Supply System	1984	1985	1986	1987	1988	1989	1990
Newport News Waterworks[1]	43.02	44.53	45.15	45.52	46.06	45.98[2,3]	48.41[2,4]
Williamsburg	3.04	3.33	3.58	3.26	3.44	3.52	3.39
York County	0.034	0.039	0.044	0.044	0.05	0.05	0.05
James City Service Authority	0.87	0.93	1.13	1.37	1.40	1.64	1.72
Big Bethel	2.58	2.29	2.38	2.66	2.53[5]	2.5	1.64
Total for Lower Peninsula	49.54	50.73	52.28	52.85	53.58	53.69	55.21

Notes:

[1] Values represent metered consumption for fiscal years 1984 - 1988 adjusted using a 6 percent unaccounted for treated water loss estimate, unless otherwise noted.

[2] Values represent calendar year finished water pumpage metered at the WTPs.

[3] May be low due to meter inaccuracies.

[4] Corrected using results of Pitometer Meter Tests.

[5] Fiscal year October 1 to September 30.

[6] Big Bethel WTP was down for part of 1990 and did not operate to full capacity.

Source: System pumpage records provided by each water supply system, unless noted otherwise.

NEWPORT NEWS WATERWORKS ANNUAL AVERAGE METERED CONSUMPTION (1968-1990)

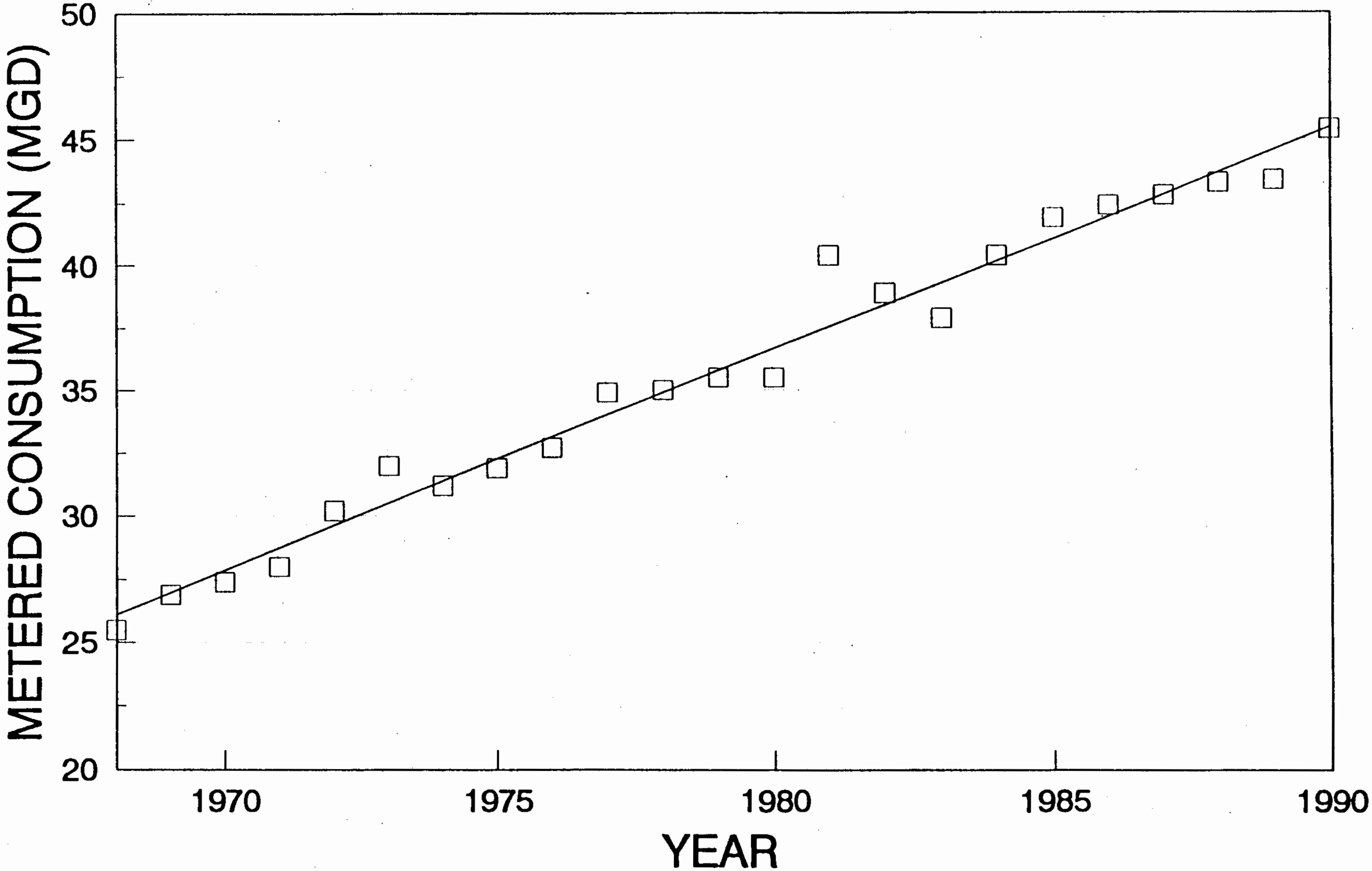


FIGURE 2-5

During 1987 and 1988, these same 15 users consumed an average of 12.94 mgd. This change represents a 9.2 percent decrease in demand for these customers.

Finally, in July 1986, Newport News Waterworks implemented voluntary water use restrictions. Voluntary "odd/even" watering and recommended periods for lawn watering were promoted in order to enhance water conservation during the 1986 drought.

The 1983 Comprehensive Water System Study for the City of Williamsburg by Wiley & Wilson presented data from a review of billing records which revealed the water demand for the City alone was 2.8 mgd. The 1990 average daily demand for the entire Williamsburg service area was approximately 3.4 mgd.

York County residents, including those living on federal installations, receive water supplies from several public water systems. The following table lists these systems and the demand that each supplied in York County in 1990.

Water System	Water Supplied to York County Users (1990)
York County	0.05 mgd
Newport News Waterworks	6.00 mgd
Williamsburg	0.53 mgd
TOTAL	**6.58 mgd**
Source: Purveyor Billing Records, 1990	

James City County residents are also served by several public water supply systems. The following table lists the public systems supplying water to customers within James City County and the demand that each supplied in the County in 1990.

Water System	Water Supplied to James City County Users (1990)
JCSA	1.72 mgd
Newport News Waterworks	7.13 mgd
Williamsburg	0.20 mgd
TOTAL	**9.05 mgd**
Source: Purveyor Billing Records, 1990	

The majority of the Lower Peninsula population is served by municipal water systems. The following table lists each jurisdiction and the percentage of the 1983 and 1990 population that was served by a public water system. Both York County and James City County are expected to have approximately 90 percent of the users in their jurisdictions served by public systems by the Year 2010.

Jurisdiction	Percentage of Population Served	
	1983	1990
City of Newport News	100	100
City of Hampton	100	100
City of Poquoson	100	100
City of Williamsburg	100	100
York County	75	80
James City County	56	70
Source: SWCB, 1988		

The existing water demands for each public water supply system in the Lower Peninsula, identified as average daily water volumes pumped to distribution, are presented graphically in Figure 2-6. Total regional finished water pumpage to distribution in the base Year 1990 was approximately 55.2 mgd. From 1984 - 1990, the average rate of increase per year was approximately 1.8 percent.

2.5.3 Large Water Users

A list of large treated water users on the Lower Peninsula and their current average daily consumption is presented in Table 2-7. The largest users are Anheuser-Busch, Langley AFB and NASA, Fort Eustis, Newport News Shipbuilding, and American Oil Company (Amoco).

2.5.4 Daily and Seasonal Demand Variations

The average daily demand (ADD) is the total amount of water pumped to distribution in a year, divided by the number of days in that year. For the Newport News system, the maximum day demand (MDD) averages about 1.4 times the average daily demand. The maximum hourly demand (MHD) is the highest single hour of water usage during the year. The MHD for the Newport News system is 1.8 to 1.9 times the ADD.

Seasonal variations of water demands are substantial in the Lower Peninsula. Williamsburg and James City County experience large tourist demands during the summer months. The Williamsburg water treatment plant currently treats between 3.5 to 4.6 mgd in the summer months compared with 2.6 to 3.3 mgd in the winter months. The James City County Commercial tourist demand is estimated to range form 0.1 mgd in the winter to 0.8

TABLE 2-7

LARGE USER WATER CONSUMPTION (1990)

User	Current Number of Employees	Daily Operations		Average Daily Consumption (mgd)			
		Days/Wk	Hrs/Day	Potable Use	Non-Potable Use	Total	Metered Public Supply
<u>Newport News</u>							
Union Carbide Industrial Gases	11	7	24	0.001	0.041	0.042	0.042
Dominion Terminal Associates	110	7	24	0.006	0.221	0.227	0.084
Pier IX Terminal Company	81	7	24	0.049	0.165	0.214	0.049
Siemens Automotive	800	7	24	0.026	0.030	0.056	0.056
CEBAF	628	--	--	0.024	0.035	0.059	0.059
Peninsula Hospital Services	44	5	8	0.045	0.0	0.045	0.045
Mary Immaculate Hospital	595	7	24	0.042	0.0	0.042	0.042
Riverside Regional Medical Center	2,000	7	24	0.131	0.010	0.141	0.141
Marva Maid Dairy	150	7	24	0.105	0.0	0.105	0.105
Neptune Fisheries, Inc.	135	5	12	0.183	0.0	0.183	0.183
Newport News Shipbuilding	26,500	5	8	2.403	6.497	8.900	2.403
<u>Hampton</u>							
Fort Monroe	4,000	7	24	--	--	0.587	0.587
Langley AFB	--	7	24	--	--	1.234	1.234
NASA	4,454	7	24	0.062	0.203	0.265	0.265
Sentara-Hampton General Hospital	1,000	7	24	0.075	0.025	0.100	0.100
DVA Medical Center	1,214	7	24	0.095	0.028	0.123	0.123
Howmet Turbine Corporation	1,152	6	24	0.163	0.0	0.163	0.163

TABLE 2-7
(Continued)

LARGE USER WATER CONSUMPTION (1990)

		Daily Operations		Average Daily Consumption (mgd)			
User	Current Number of Employees	Days/Wk	Hrs/Day	Potable Use	Non-Potable Use	Total	Metered Public Supply
Williamsburg							
Colonial Williamsburg	3,500	7	24	--	--	--	0.734
William and Mary	1,300	7	24	--	--	--	0.535
Camp Peary	--	7	24	--	--	--	0.071
York County							
Virginia Power	254	7	24	0.002	0.564	0.566	0.566
Amoco Oil Company	250	7	24	1.066	0.0	1.066	1.066
U.S. Coast Guard Training Center	1,292	7	24	0.075	0.004	0.079	0.075
U.S. Naval Weapon Station	3,394	5	10	0.197	0.460	0.657	0.657
James City County							
Anheuser Busch, Inc.	1,100	7	24	4.083	1.017	5.100	5.100
Eastern State Hospital	1,500	7	24	0.147	0.0	0.147	0.147

Sources: City of Newport News, Department of Public Utilities, January 1989.
Large Water User's Survey Forms, April 1991.

AVERAGE DAILY WATER VOLUMES PUMPED TO DISTRIBUTION (1984-1990)

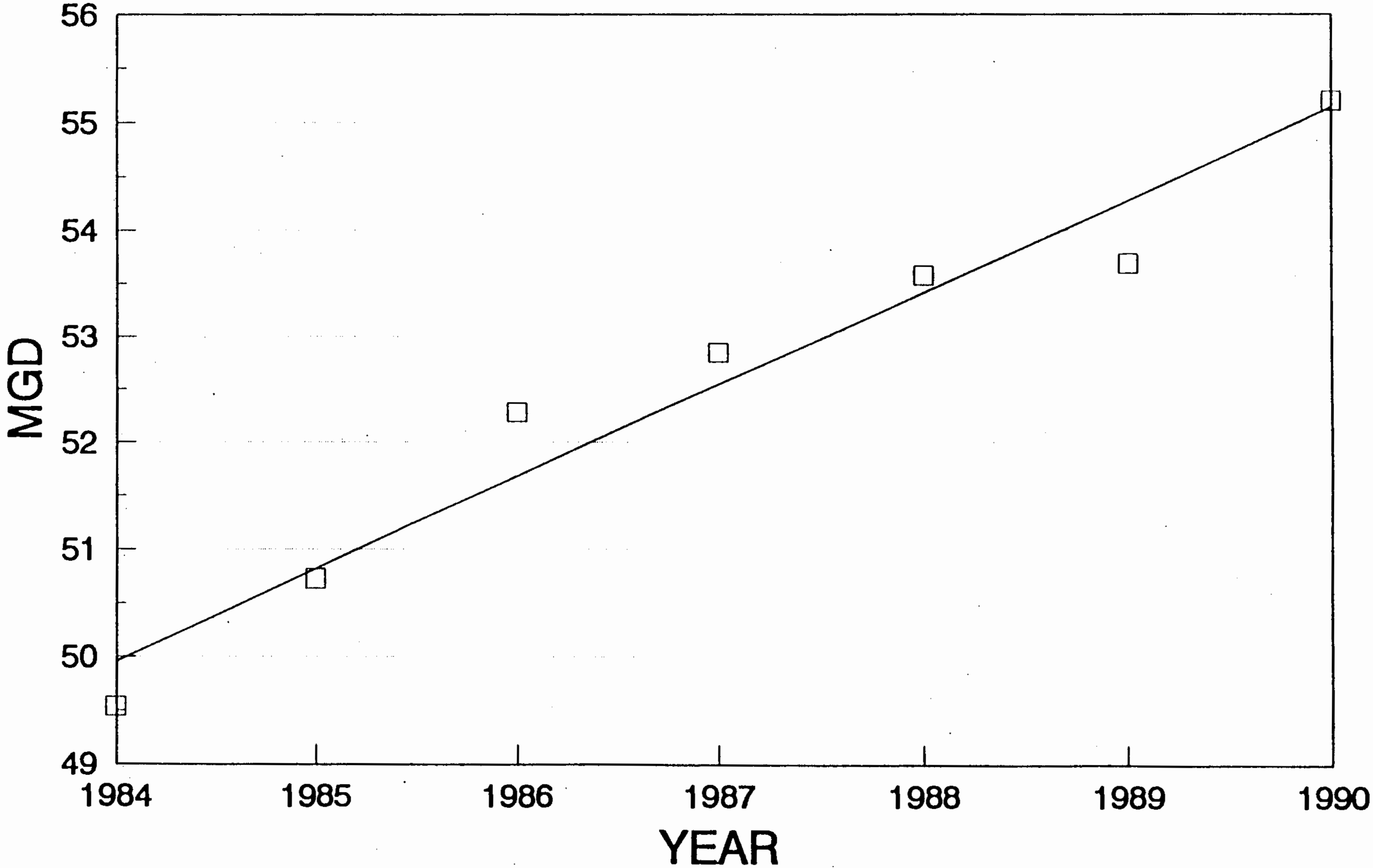


FIGURE 2-6

mgd in the summer. This range is 1.5 percent to 10.1 percent of the total water usage in James City County.

The variation in water usage in the Newport News system is presented in Table 2-8. The monthly water usage was calculated as a percentage of the annual average and averaged for the 4-year period, 1987 to 1990. The highest water demands for this period occurred in July and September. Seasonal variations in areas that do not have large tourist influxes are typically due to increased consumer usage in response to temperature variations.

2.6 PROJECTED DEMANDS

Population growth in the single most important predictor of future water demands. Population projections provided by the Lower Peninsula jurisdictions were reviewed, and projections for each jurisdiction were adopted by the RRWSG.

While population growth is a key indicator of future water demands, other factors can greatly impact demands. Demand management, through the implementation of effective conservation programs, can sizably reduce future demands.

The demand projections provided are based on the most recent data available and are presented in 10-year increments for the planning period 1990 to 2040 for each of the Lower Peninsula jurisdictions. The 50-year planning period for water supply planning was chosen due to long project implementation schedules and the life expectancy of the facilities once constructed. The 50-year planning period has been accepted by the U. S. Environmental Protection Agency (USEPA) as appropriate for such recent proposals as the Two Forks Reservoir project and the Ware Creek Reservoir project. Projections have been made for residential, commercial, industrial, and federal usage taking into account implementation of conservation measures.

2.6.1 Conservation

Water conservation is the conscious effort by a utility, business or individual to save water. Every gallon of water not used is one less to be stored, purified, and distributed. It also represents one less gallon that must be heated for washing or bathing, thus saving energy costs, or one less gallon of water that must pass through some form of wastewater treatment before it is returned to the environment.

There are different levels of conservation measures that can be implemented: 1) normal conservation measures, and 2) use restrictions. Normal conservation practices can provide long-term benefits by permanently reducing water demands during normal operating conditions. In comparison, use restrictions can be applied as part of a water management plan during severe droughts, or other extreme water shortages or emergencies. These restrictions are implemented to produce short-term, or temporary, reductions in water demand and result in economic and other undesirable impacts. By lowering the water demand during water emergencies, a smaller supply of water is required to meet the needs of the system. For purposes of this study, use restrictions are evaluated as an alternative to new source development projects.

The implementation of conservation measures will reduce the quantity of additional raw water needed, or postpone the need for new sources of supply. Raw water source development has the potential to adversely impact the natural environment. Therefore, implementation of an effective conservation program can help to minimize these impacts.

In summary, conservation measures can be used as a means to reduce the financial and environmental costs of developing new raw water supply sources. The RRWSG has already adopted many long-term conservation measures to reduce existing water demands. The opportunity to develop additional conservation programs is discussed in the remainder of the section.

Conservation Methods

A variety of water conservation programs have been undertaken in the Lower Peninsula to reduce existing water demands. Additional demand reductions are projected to occur as a result of a more aggressive conservation approach. The details of the approach are presented in ***Water Demand Reduction Opportunities*** (Report A) (Malcolm Pirnie, 1993), and are summarized herein. Report A is incorporated herein by reference and is an appendix to this document.

The first step in determining an appropriate conservation strategy for the Lower Peninsula was to collect information and summarize conservation practices currently in use in the Lower Peninsula. Water purveyors, commercial, institutional and light industrial users, heavy industrial users, and federal installations in the region implement varying forms of conservation programs. A summary of the measures currently implemented by water consumers in the Lower Peninsula is presented in Table 2-9.

As an indication of the success of these measures to date, an analysis was made of the Newport News Waterworks system using all 5/8-inch meter connections (the majority of which are residential) between 1982 and 1990. An active conservation program was implemented in 1986, which included system-wide pressure reductions, rate increases and implementation of voluntary use restrictions. A substantial decrease in per connection usage was observed in the years following implementation of these conservation measures.

Per capita and per employee water usage (applied for residential and commercial demand projections, respectively) are estimated to decline over the planning period to account for demand reductions resulting from the implementation of these conservation measures. Future per-capita demand reductions will also rely on even more aggressive conservation measures.

As part of the RRWSG's conservation strategy, Reasonable Conservation Objections (RCOs) were established for each of the RRWSG jurisdictions. RCOs were developed as reasonable, achievable goals based on documentation of the need for water and achievable per capita demand reductions through conservation.

Residential Water Usage RCO

For residential water use, the RCO is developed based on the amount of daily water needed per capita for essential water uses. This objective is developed on a per capita basis and not as a percent reduction. Using a percent reduction would require those residential users who have already achieved a reduction from the implementation of existing

TABLE 2-8

NEWPORT NEWS WATERWORKS AVERAGE MONTHLY DEMAND VARIATION (1987 - 1990)

Month	Percent of Annual Average
January	105
February	96
March	95
April	88
May	87
June	103
July	111
August	108
September	124
October	100
November	98
December	89

Source: Newport News Waterworks WTP Pumpage Reports.

TABLE 2-9

CONSERVATION PRACTICES CURRENTLY IMPLEMENTED ON THE LOWER PENINSULA

Purveyor or Water User Category	Conservation Measure
Newport News Waterworks	Comprehensive Water Conservation Plan Pressure Reductions Pipeline Replacement Program Recycling of Treatment Plant Process Waste Stream Meter Calibration and Change-out Program BOCA National Plumbing Code Enforcement Water Rates Set to Reflect the True Cost of Water Summer Conservation Rate System Development Charge Reduction from Five-Block to Two-Block Rate Schedule On-going Public Information Program
City of Williamsburg	Meter Calibration and Change-out Program Metering of All Customer Connections BOCA National Plumbing Code Enforcement Water Rates Set to Reflect the True Cost of Water Availability Fee
York County	Metering of all Connection Water Rates Set to Reflect the True Cost of Water BOCA National Plumbing Code Enforcement
James City Service Authority	Intensive Metering of Water Use Meter Replacement and Testing Program Leak Detection Surveys BOCA National Plumbing Code Enforcement Water Rates Set to Reflect the True Cost of Water Summer Surcharge Rate System Facilities Charge Public Education Program
Commercial, Institutional and Light Industrial Users	Retrofitting in Hospitals and Hotels/Motels Closed Loop Mechanical Systems in Hospitals Use of Non-Public Water Supplies for Irrigation BOCA Code Compliance Non-Potable Well Water Supplies used in Mechanical Systems
Heavy Industrial	Minimized Use of Public Water for Non-Potable Uses Closed Loop, Recycling Cooling Towers and Mechanical Systems Used Widely In-House Water Treatment Systems Use of Non-Potable Supplies for Irrigation and Dust Suppression

conservation measures to reduce their demands by the same percentage as those areas which have achieved less water demand reductions.

To determine the residential RCO, a literature review was conducted to characterize residential water usage. A national study (Brown and Caldwell, 1984) sponsored by the U.S. Department of Housing and Urban Development (HUD) was included in this review. This study characterized indoor water use and estimated the amount of water required in a conserving versus a non-conserving home. This HUD study was the only broadly accepted, scientifically based study of water usage characteristics identified in the research effort. It was, therefore, used as a basis for developing the RRWSG's residential RCO.

The HUD study methodology considered such factors as household size, age distribution, housing types, and income levels. The HUD study group characteristics were similar to and representative of the RRWSG region. Therefore, it was decided that the HUD data could be applied to the RRWSG study area.

The HUD study indicated that average indoor water usage in a non-conserving home is 77 gallons per capita per day (gpcpd). Through the use of water conserving fixtures and effective indoor water conservation techniques, the study indicated that average indoor water usage can reasonably be reduced to 60 gpcpd (Maddaus, 1987). Updated information on toilet leakage and shower time adjusted this total to 60.2 gpcpd. This indoor usage with conservation was adopted by the RRWSG.

To develop a residential RCO, a value must be added to the indoor usage value of 60.2 gpcpd to represent outdoor usage. After a careful review of billing cycles and usage patterns, an estimated outdoor use value of 6.7 gpcpd was adopted by the RRWSG. Adding this estimated outdoor usage value to the RRWSG adopted indoor usage value of 60.2 gpcpd results in an RCO of 66.9, or 67 gpcpd. This conservation goal was used as a basis for estimating future residential water demands within the study area. Current water usage of 72.9 gpcpd will need to be decreased by an average of 8.1 percent to meet the residential RCO.

Commercial Water Usage RCO

As a result of the variability of water use within the commercial category, it was not possible to define an RCO as calculated for residential water usage. However, because water is used in a similar manner as in the residential category, similar conservation measures used to achieve reductions in the residential category can also be applied to the commercial category. Therefore, the RCO for commercial demands was also set at an 8.1 percent reduction over base year demands.

Industrial Water Usage RCO

Due to the wide variety of industrial water uses and quantity requirements, and the inability to accurately predict the impact of influencing factors on future industrial demands, a specific RCO for existing industry on the Lower Peninsula was not defined. However, it is assumed that heavy industry on the Lower Peninsula will continue to be influenced to conserve water in the future as a result of financial incentives and regulatory requirements.

2.6.2 Conservation and Growth Management

This subsection summarizes the philosophies of the U.S. Fish and Wildlife Service (USFWS), U.S. Environmental Protection Agency (USEPA), National Wildlife Federation (NWF), Southern Environmental Law Center (SELC), and the Virginia State Water Control Board (SWCB) (now Virginia Department of Environmental Quality) concerning conservation and growth management as they may affect future demand.

U.S. Fish and Wildlife Service

Concerning conservation and growth management the USFWS has recommended that the RRWSG incorporate conservation measures and mandatory use restrictions into any water demand projections. In a letter dated August 20, 1990, addressed to Colonel Richard C. Johns of the Norfolk District, Corps of Engineers, the USFWS provided a succinct summary of their philosophy as follows:

> "The Service recommends that, in developing their water demand projections, the RRWSG incorporate conservation measures and mandatory use restrictions. Conservation measures should serve as a long-term approach to reducing municipal water demands and should include such measures as public education on water conservation practices and xeriscaping, rates based on consumption rather than base rates, and promoting the use of conservation plumbing fixtures. Mandatory use restrictions which reduce or eliminate withdrawal for unnecessary water uses such as car washing, lawn watering, swimming pools, and fountains should be implemented during droughts. All localities participating in the RRWSG should agree on the specific criteria that would constitute a drought and agree to concurrently implement the conservation measures as well as the mandatory use restrictions. Furthermore, as a means of conserving water, the Service recommends that localities focus on attracting non-water intensive development. In return, the Service will work toward promoting and implementing the conservation of water on federally-owned properties. As project demand projections rely on predictions about development in the Lower Peninsula area through the Year 2030, the Service also recommends that the RRWSG consider Chesapeake Bay Preservation Act and Clean Water Act regulations in their development predictions."

U.S. Environmental Protection Agency

It is the USEPA's recommendation, as stated in a letter dated March 6, 1990, to Colonel J. J. Thomas of the Norfolk District, Corps of Engineers, that "Conservation measures should be a very critical aspect in reducing water demand for the region as a whole." The USEPA further recommends that any water supply decisions should incorporate conservation measures to the greatest extent possible, and address planned growth and development scenarios within the region's control.

National Wildlife Federation

The NWF recommended a "... strong water conservation program as a complete or partial alternative to the proposals for diversions and dams and reservoirs." They further recommended an efficient allocation of the water resource at every stage of distribution and use. Such a planned allocation should incorporate the following:

- An audit of each system's current use for each season, class of user, and unaccounted-for water.
- A description and evaluation of the current pricing policies and schedule for each of the communities in the RRWSG.
- The institution and evaluation of a demand management pricing schedule.
- A stronger plumbing code with an estimation of the resulting water savings.
- The development and implementation of water use efficiency programs for industrial and commercial users.
- The institution of an effective public education program on water conservation.

These recommendations were included in a letter, dated September 27, 1990, to Colonel J. J. Thomas, District Engineer, USCOE.

Southern Environmental Law Center

The SELC recommended an aggressive water conservation program that would use pricing, education, incentives, industrial reuse, drought period restrictions, system pressure reduction, and plumbing efficiency requirements to reduce the proposed deficit. They further recommended that the RRWSG consider having equal water management requirements in each jurisdiction so that localities are not competing with each other to provide cheap or inefficiently provided water to attract industry or commerce. These recommendations were presented in a letter, dated August 17, 1990, to Colonel Richard C. Johns, District Engineer, Norfolk District, Corps of Engineers.

Virginia State Water Control Board

The SWCB recommended a close review of various pumpover options as a viable means of satisfying future demands. There were no comments specifically citing the impact conservation could have on water supply management in any letters received from the SWCB.

2.6.3 Population Projections

The primary step in developing demand projections was to estimate projected population growth. Population projections for each of the Lower Peninsula jurisdictions were developed through a review of various studies and data sources that estimate future population, and from consultation with local planners.

Local planning agencies were interviewed to obtain data and to discuss their respective growth patterns and projections. Projections made by local planning agencies include the number of persons residing within federal installations in their respective localities.

For purposes of this report, it has been assumed that local planning departments are the most reliable sources of information on past trends and future projections of population and development potential. For this reason, the RRWSG has relied heavily on information obtained from these departments.

The Virginia Employment Commission (VEC) projections (March 1990) were also reviewed. The VEC is vested with the authority to prepare official short- and long-term population projections for use by State agencies and the General Assembly. Population projections were obtained from the VEC in 10-year increments to the Year 2030. Projections to the Year 2000 were taken from the VEC report ***Virginia Population Projections, 2000*** (April 1990). This report estimated future population using a cohort component method of projecting demographic changes. This method recognizes that changes in population are the result of three factors: birth, death and migration. Each of these factors were projected separately and then combined to produce population projections (VEC, 1990). Projections from the Year 2000 to the Year 2030 are a linear extension of the 1980 through 2000 data reported in ***Virginia Population Projections, 2000*** and were computed by the VEC in March 1990. These unpublished data are primarily used as a reference point with which to compare projections developed by local planners.

The population predictions for each jurisdiction in the Lower Peninsula are summarized in Table 2-10 and presented graphically in Figure 2-7. Comparison of these data with state projections provides support to the adopted population projections. Table 2-11 presents the population projections for the study region adopted by the RRWSG, and also estimates of future study area population and total state population, as projected by the VEC.

The rate of population change projected for the Lower Peninsula by the RRWSG is 0.1 percent lower than the rate of population change projected by the VEC for both the study area and the state. It is likely that the differences can be attributed to the variations in methodologies used to estimate population between the VEC and the local planning departments. The VEC data are a linear extrapolation of population data for the period from 1980 to 2000. Therefore, these data do not take into account the effects of build-out on population growth. The projections adopted by the RRWSG do incorporate the impacts of build-out. If the VEC data were to incorporate build-out, they would more closely compare to the adopted projections.

The majority, but not all, of the total population in the Lower Peninsula is served by public water. Therefore, it was necessary to provide estimates of that portion of the population that would require public supply throughout the planning period. For York and James City Counties, the SWCB's (1988) assumed percentages of population served by the public water systems to the Year 2030 were applied to the projections. It was then assumed

TABLE 2-10

SUMMARY OF ADOPTED REGIONAL POPULATION PROJECTIONS BY JURISDICTION

Jurisdiction	Existing	Projected				
	1990	2000	2010	2020	2030	2040
Newport News	170,045	184,000	213,000	223,000	238,000	254,500
Hampton	133,793	146,200	155,940	166,410	177,570	188,085
Poquoson	11,005	14,328	17,061	20,187	23,215	26,243
Williamsburg	11,530	12,800	14,000	15,200	16,400	17,700
York County	42,422	50,950	57,580	64,580	71,580	78,580
James City County	34,859	51,700	61,700	64,700	67,800	71,200
TOTALS	**403,654**	**459,978**	**519,281**	**554,077**	**594,565**	**636,308**

TABLE 2-11

COMPARISON OF LOCAL AND STATE POPULATION PROJECTIONS

Year	Lower Peninsula		Virginia
	RRWSG	VEC	VEC
1990	403,654	405,200	6,230,000
2000	459,978 (1.4)	462,100 (1.4)	7,023,300 (1.3)
2010	519,218 (1.3)	519,000 (1.2)	7,827,900 (1.1)
2020	554,077 (0.7)	575,900 (1.1)	8,632,500 (1.0)
2030	594,565 (0.7)	632,800 (1.0)	9,437,100 (0.9)
2040	636,308 (0.7)		
Average Annual Growth (%)	**0.91**	**1.12**	**1.04**

( ) Values in parentheses represent the average annual rate of change in the preceding decade.

ADOPTED REGIONAL POPULATION PROJECTIONS

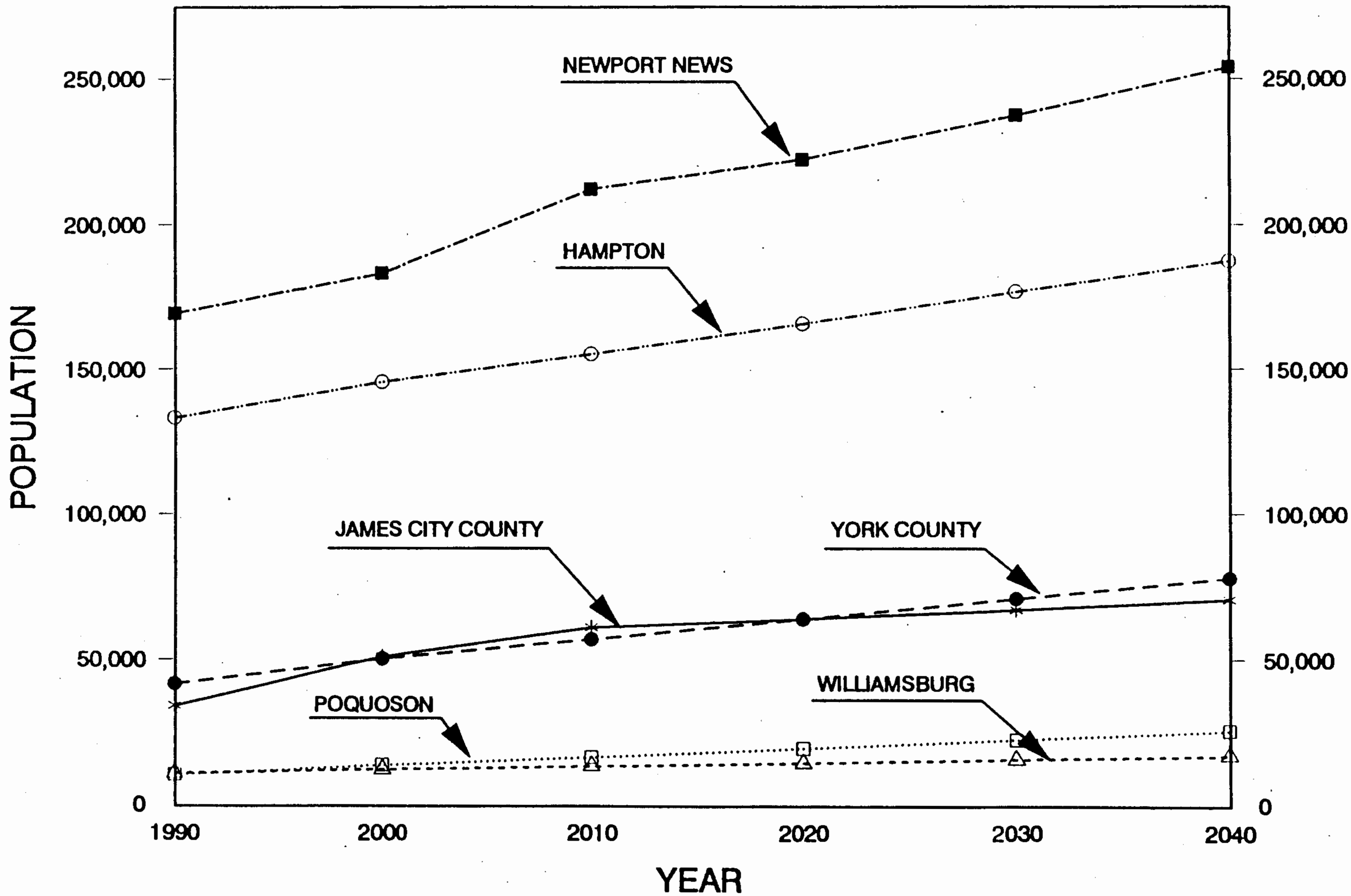


FIGURE 2-7

that the values presented in the report for population served in 2030 were applicable to the estimates of population served in the Year 2040. Table 2-12 presents the projections of regional civilian population served which are used in calculating future demands. These estimates also include adjustments deducting the portion of the total regional population that lives on local federal installations, since their water demand is counted as part of the federal installation demand.

Several external influences were identified as having an impact on estimating future population in the Tidewater area. The Chesapeake Bay Preservation Act (CBPA) limits development within areas designated as Resource Management Areas (RMAs) and/or Resource Protection Areas (RPAs). A study conducted for localities in the Virginia Peninsula estimated that approximately 10 percent of the region (excluding Williamsburg) would be designated as an RPA. Approximately 65 percent would be designated as an RMA (SDN Market Research, 1990).

This issue was discussed with representatives from local planning agencies. The general consensus was that the Act will probably not affect the total number of persons locating in the area. However, it is anticipated that the layout of development will change. Because development will be restricted in shoreline areas, it is likely that it will become intensified in other regions. One technique which may become more widely used is cluster zoning. This zoning methodology allows for more intense development in certain areas so that adjacent areas may be preserved. This technique could be used to protect the RPAs and RMAs while allowing for some level of development. There are also proposed changes to federal wetland delineation procedures that could, if implemented, dramatically reduce the acreage of federally regulated non-tidal wetlands in the area. These changes would also reduce the area regulated under the Chesapeake Bay Preservation Act.

2.6.4 Water Demand Projections with Conservation

Demand projections can be derived by several methods, all of which begin with a study of historical information to develop basic data applicable to the method used, and to determine trends in the data thus developed. Forecasts are then based on anticipated population and employment growth, or on growth in the number of water accounts served, with due regard to differences among water user categories and incorporating anticipated demand reductions resulting from conservation efforts.

Most methods used to project demand are multi-variable approaches that desegregate the total water demand into different user groups. Emphasis is often placed on segregating heavy industrial and commercial needs from residential usage, as their comparative rates of growth are not directly related, and the quantity of water used varies between groups.

For the purposes of this study, conservation goals and demand estimates have been developed for the following five water demand categories:

- Residential: This is the water demand of the general population living in the areas served. It does not include the military personnel living on federal installations or military dependents living off base in military housing served by a master meter.

- Commercial, Institutional and Light Industrial: This is the water demand created by employment at the workplace in the jurisdictions served, excluding those workplaces that are located on federal installations served by master meters. This category also includes light industrial establishments whose water use is similar to commercial demands, with little to no process water usage.

- Heavy Industrial: This is the demand imposed by large industrial water users in the systems. The demands for employee sanitary uses and process water are included.

- Federal Installations: This is the demand imposed by the federal installations located in the Lower Peninsula. It covers demand for installations serviced by a master meter and includes all uses at these locations, regardless of usage category.

- Unaccounted-for Water (UAW): This is the difference between a water utility's finished water production and all metered water usage (e.g., unmetered use from fire hydrants, distribution system leakage, etc.).

Data Sources

The following data sources were used in calculating projections of water demand in the Lower Peninsula:

- Survey of Water Fixture Use - Brown and Caldwell Consultants, Prepared for the U. S. Department of Housing and Urban Development (HUD), March 1984.

- Utility Records from each Purveyor within the Lower Peninsula.

- Large Water User's Survey.

- Survey of New Heavy Industry.

- IWR-MAIN Water Use Forecasting System - Planning and Management Consultants, Ltd., 1988.

- Report on Pitometer Master Meter Tests, Newport News, Virginia - Pitometer Associates, 1991.

- Comprehensive Water Study - Buchart-Horn, Inc., prepared for the County of York, November 1985.

- "Water Use Projections for James City County to 2040," James City County Staff, March 1986.

Demand Projection Methodologies

Lower Peninsula water demand projections through the Year 2040 have been adopted by the RRWSG which rely on current population and water demand information. Population projections were developed using 1990 census data, consultations in 1991 with

TABLE 2-12

PROJECTED CIVILIAN POPULATION SERVED BY PUBLIC WATER SYSTEMS

Jurisdiction	Year					
	1990	2000	2010	2020	2030	2040
Newport News	160,078 (100)	174,033 (100)	203,033 (100)	213,033 (100)	228,033 (100)	244,533 (100)
Hampton	128,798 (100)	141,205 (100)	150,945 (100)	161,415 (100)	172,575 (100)	183,090 (100)
Poquoson	11,005 (100)	14,328 (100)	17,061 (100)	20,187 (100)	23,215 (100)	26,243 (100)
Williamsburg	11,530 (100)	12,800 (100)	14,000 (100)	15,200 (100)	16,400 (100)	17,700 (100)
York County	27,418 (80)	39,335 (90)	45,302 (90)	51,602 (90)	57,902 (90)	64,202 (90)
James City County	24,401 (70)	43,945 (85)	55,530 (90)	58,230 (90)	61,020 (90)	64,080 (90)
TOTAL	**363,230**	**425,646**	**485,871**	**519,667**	**559,145**	**599,848**

( ) Values in parentheses represent the assumed percentage of total population served in a given year as reported in the SWCB's James Water Supply Plan, 1988.

the planning departments of each of the six Lower Peninsula jurisdictions, consultations in 1991 with the Hampton Roads Planning District Commission, and Virginia Employment Commission (VEC) population projections through the Year 2030 which were developed in March 1990. The base year for the population and water demand projections is the Year 1990.

The residential demand projections were developed using current population projections in conjunction with per-capita use figures calculated from actual metered residential billing records and the total population served on the Lower Peninsula in the Year 1990. These per-capita use rates are 72.9 gallons per capita per day (gpcpd) for Year 1990 declining to 67 gpcpd for Years 2010 through 2040 as a result of anticipated expansion in conservation efforts. The RRWSG's adopted demand projections only reflect demand reductions possible through implementation of "normal" water conservation measures. Additional short-term demand reductions possible through implementation of use restrictions during water supply emergencies are evaluated as a separate alternative in Section 3.4.30 of this document.

Commercial, institutional, and light industrial demand projections were developed using 1990 VEC employment figures in conjunction with per-employee use figures calculated from actual Year 1990 metered commercial, institutional, and light industrial billing records. The total regional employment was projected to increase in direct proportion to total population throughout the 50-year planning horizon. The per-employee use rates are 73.6 gallons per employee per day (gpepd) for Year 1990 declining to 67 gpepd for Years 2010 through 2040 as a result of anticipated expansion in conservation efforts.

Heavy industrial and federal installation demands were projected based on information obtained from a Large Water Users' Survey conducted by the RRWSG during the summer of 1991 and metered billing records for 1990. In addition, an extensive analysis was conducted of projected water demands as a result of new heavy industry on the Lower Peninsula.

Actual Year 1990 UAW demand on the Lower Peninsula represented 5.7 percent of total demand and UAW demand is projected to increase to a maximum of 10 percent by the Year 2040.

These water demand projections are conservatively low in light of past water demand growth trends on the Lower Peninsula. Over the 50-year planning horizon (Years 1990 through 2040), the RRWSG has projected an average annual water demand increase of 1.04 percent. In comparison, total metered consumption in Lower Peninsula water systems increased by an average of 2.53 percent per year between the Years 1970 and 1990.

Lower Peninsula Totals

The adopted Lower Peninsula demand projections are summarized in Table 2-13, disaggregated by jurisdiction. Unaccounted-for water is disaggregated to each jurisdiction based on the jurisdictions subtotal of metered demands. Figure 2-8 illustrates historical and projected Lower Peninsula system demands.

The relative distribution of demand between user categories is projected to change slightly over the planning period. The demand projections in Table 2-13 show heavy industrial demand showing the greatest increase, from 19 percent to 24 percent of metered demands. In comparison, residential, commercial, and federal installation demands are, over time, projected to represent smaller percentages of total Lower Peninsula demand.

An additional use of water in the Lower Peninsula is for irrigation. The U.S. Bureau of the Census' ***1987 Census of Agriculture*** is the most reliable published source of current data on irrigated land in the study area (U.S. Department of Commerce, 1987). According to this report, York and James City Counties are the only jurisdictions within the study area that contain irrigated agricultural acreage. York County was listed as having 41 irrigated acres as of 1987. This acreage had decreased from 63 acres in 1982. Assuming a typical value of eight inches of water per year applied to these 41 acres, this represents a water usage of 8.91 million gallons per year or 0.025 mgd. James City County was listed as having 40 irrigated acres in 1987, which is equivalent to an annual demand of 8.69 million gallons per year, or 0.024 mgd. These demands are exclusive of water demands used for irrigation at nurseries within the Lower Peninsula. Irrigation demands at nurseries are included in the commercial category of demand.

Water used for agricultural irrigation in the Lower Peninsula represents approximately 0.048 mgd on an annually averaged basis, the majority of which is supplied from private sources. Thus, agricultural irrigation represents a very small portion of total water demand in the study area and would have little impact on the projections of demand on public water systems. In addition, it is unlikely that the number of irrigated acres will increase in the future due to anticipated future development pressures.

2.6.5 Water Demand Projections By Purveyor

The demand projections made in Section 2.6.4 were presented by jurisdiction since they are based on population and employment projections made by the jurisdictions. To be more useful to the purveyors on the Lower Peninsula, these demand projections by jurisdiction have been aggregated and/or disaggregated to conform to the current and projected future service area boundaries for each purveyor.

<u>Disaggregation/Aggregation Methods</u>

A major portion of the Lower Peninsula is currently served by Newport News Waterworks. The Waterworks' service area includes Lower York and James City Counties west to approximately Route 199, and the Cities of Newport News, Poquoson and Hampton, except for NASA/Langley AFB and Fort Monroe, which are currently served by the Big Bethel system.

The Williamsburg system serves the City of Williamsburg and portions of York and James City Counties. The James City Service Authority and York County systems serve the western or "upper" areas within the Counties, with the remaining "lower" county areas served by Newport News Waterworks or Williamsburg.

To project demands for the Waterworks service area, the demands projected for York and James City Counties must be disaggregated by the purveyors that service each of the counties. These disaggregated jurisdictional demands are then aggregated for each purveyor to produce total demand projections by purveyor. The remainder of this section describes the methods used to desegregate demands in James City and York Counties.

TABLE 2-13

PROJECTED LOWER PENINSULA DEMANDS BY JURISDICTION (MGD)

JURIS. / YEAR	RESIDENTIAL	COMMERCIAL/ INSTIT./ LT. IND.	HEAVY INDUSTRIAL	FEDERAL INSTALL.	SUBTOTAL OF METERED DEMANDS	UAW	TOTAL
1990 (METERED)							
NEWPORT NEWS	11.90	3.37	2.74	1.30	19.31	1.14	20.44
HAMPTON	9.15	2.92	0.21	2.08	14.36	0.92	15.27
POQUOSON	0.77	0.06	0.00	0.00	0.83	0.05	0.88
WILLIAMSBURG	0.58	1.78	0.00	0.10	2.46	0.15	2.61
YORK COUNTY	2.34	1.41	2.18	0.64	6.57	0.38	6.94
JAMES CITY COUNTY	2.04	1.35	5.16	0.00	8.55	0.51	9.06
TOTAL	26.78	10.89	10.29	4.12	52.07	3.13	55.21
2000							
NEWPORT NEWS	12.18	3.52	2.94	1.80	20.44	1.49	21.93
HAMPTON	9.88	2.97	0.78	2.12	15.74	1.15	16.89
POQUOSON	1.00	0.07	0.02	0.00	1.10	0.08	1.18
WILLIAMSBURG	0.90	1.86	0.00	0.12	2.88	0.21	3.09
YORK COUNTY	2.75	1.47	2.96	0.78	7.96	0.58	8.54
JAMES CITY COUNTY	3.08	1.81	6.12	0.00	11.00	0.80	11.80
TOTAL	29.80	11.69	12.81	4.82	59.12	4.31	63.43
2010							
NEWPORT NEWS	13.60	4.14	3.53	2.40	23.68	1.95	25.63
HAMPTON	10.11	2.99	1.44	2.13	16.67	1.37	18.04
POQUOSON	1.14	0.08	0.05	0.00	1.28	0.10	1.38
WILLIAMSBURG	0.94	1.95	0.00	0.14	3.03	0.25	3.28
YORK COUNTY	3.04	1.46	4.06	0.78	9.33	0.77	10.10
JAMES CITY COUNTY	3.72	1.96	8.23	0.00	13.91	1.14	15.06
TOTAL	32.55	12.59	17.31	5.45	67.90	5.58	73.49
2020							
NEWPORT NEWS	14.27	4.39	3.67	2.40	24.73	2.27	27.00
HAMPTON	10.81	3.17	1.82	2.14	17.94	1.65	19.59
POQUOSON	1.35	0.09	0.07	0.00	1.52	0.14	1.65
WILLIAMSBURG	1.02	2.11	0.00	0.16	3.29	0.30	3.60
YORK COUNTY	3.46	1.59	4.59	0.78	10.41	0.96	11.37
JAMES CITY COUNTY	3.90	1.99	8.86	0.00	14.76	1.35	16.11
TOTAL	34.82	13.36	19.00	5.48	72.66	6.66	79.32
2030							
NEWPORT NEWS	15.28	4.79	3.82	2.40	26.28	2.66	28.95
HAMPTON	11.56	3.37	2.25	2.15	19.33	1.96	21.29
POQUOSON	1.56	0.11	0.09	0.00	1.75	0.18	1.93
WILLIAMSBURG	1.10	2.29	0.00	0.18	3.56	0.36	3.93
YORK COUNTY	3.88	1.71	5.18	0.78	11.56	1.17	12.73
JAMES CITY COUNTY	4.09	2.02	9.58	0.00	15.69	1.59	17.28
TOTAL	37.46	14.28	20.92	5.51	78.17	7.92	86.09
2040							
NEWPORT NEWS	16.38	5.16	3.99	2.40	27.93	3.10	31.03
HAMPTON	12.27	3.56	2.57	2.16	20.55	2.28	22.83
POQUOSON	1.76	0.12	0.10	0.00	1.98	0.22	2.20
WILLIAMSBURG	1.19	2.46	0.00	0.18	3.83	0.43	4.26
YORK COUNTY	4.30	1.86	5.62	0.78	12.56	1.40	13.96
JAMES CITY COUNTY	4.29	2.08	10.10	0.00	16.47	1.83	18.30
TOTAL	40.19	15.24	22.38	5.52	83.33	9.26	92.59

HISTORICAL AND PROJECTED LOWER PENINSULA SYSTEM DEMAND

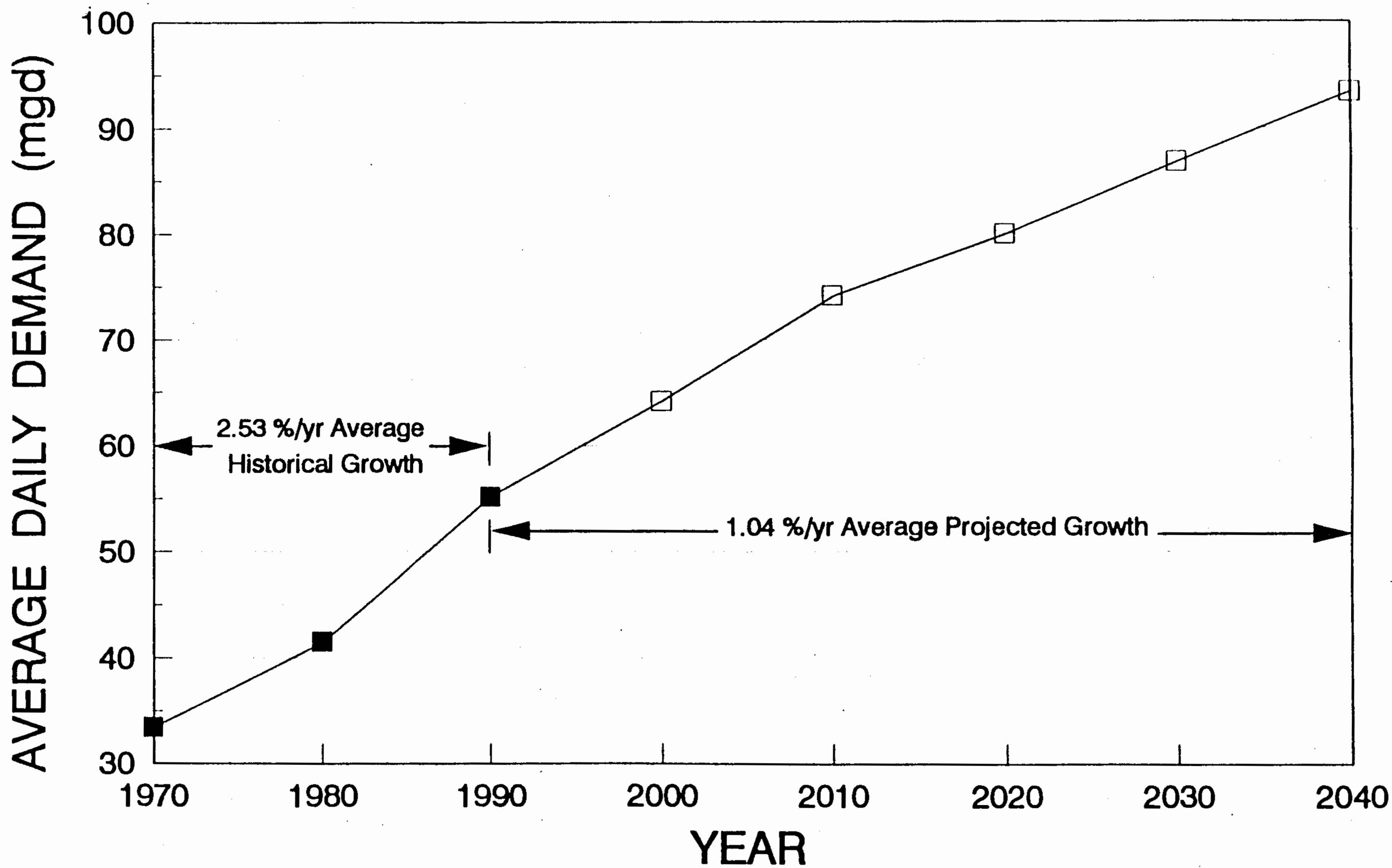


FIGURE 2-8

The total James City County demand must be disaggregated to the James City Service Authority, Newport News Waterworks and Williamsburg water systems, because all three of these purveyors currently serve parts of James City County, and are expected to continue to do so in the future. The demand supplied by the Williamsburg system is projected to remain constant into the future, because the areas of the County served by Williamsburg are already developed. The demand supplied by the Newport News Waterworks system is generally all the demand in Census Tract 801. A 1986 study (JCC, 1986) presented projected James City County demands by census tract. The table that follows shows a percentage breakdown of demand between Census Tract 801 and the remainder of the County based on the breakdown in the 1986 study.

DEMAND AS PERCENT OF TOTAL JAMES CITY COUNTY DEMAND				
	1990		2030	
User Category	Census Tract 801	Remainder of County	Census Tract 801	Remainder of County
Residential	29%	71%	20%	80%
Commercial	65%	35%	50%	50%
Industrial	95%	5%	80%	20%

Source: James City County, 1986.

The values for the residential and commercial demand split were used as a starting point in disaggregating demand between the James City Service Authority and Waterworks. However, these values were adjusted so that the demand on the Newport News Waterworks system due to those users did not substantially decrease. The industrial split in the preceding table was not used. Instead, a 90 percent Newport News Waterworks, 10 percent James City Service Authority split in the Year 2040 was used, since it better represents the current land use planning for the County presented in the 1991 draft Land Use Plan Map for James City County.

The York County demand was disaggregated similarly to the James City County demand. The demand supplied by the Williamsburg system was projected to remain constant, and the York County well system was projected to serve the increase in demand that is expected to occur in Census Tract 508, in excess of the demand currently supplied by the Williamsburg system. (A 1985 study by Buchart-Horn presented demand projections for the County by census tract). The following table shows the percentage breakdown of demand between Census Tract 508 and the remainder of the County, based on the 1985 study.

DEMAND AS PERCENT OF TOTAL YORK COUNTY DEMAND				
	2000		2010	
User Category	Census Tract 508	Remainder of County	Census Tract 508	Remainder of County
Residential	8	92	8.2	91.8
Commercial	26	74	26	74
Industrial	0	100	0	100

Disaggregated Demands

Using the percentage splits for demand in York and James City Counties presented in the preceding tables, and assuming the Williamsburg system supplies increased demands only within the City of Williamsburg and constant demands in those areas of York and James City Counties currently served, the demand projections by purveyor presented in Table 2-14 result.

2.6.6 Summary of Adopted Regional Projections

This section presents population and demand projections in a summary format, whereas Sections 2.6.1 through 2.6.5 provide more detailed breakdowns of population and demand projections and a description of the methods and assumptions used to produce these projections.

Population Projections

Total population within the Lower Peninsula is projected to increase over the 50-year planning period from a Year 1990 value of 403,654 to a Year 2040 value of 636,308. The greatest projected rate of increase is for James City County, which is projected to increase in population by 104 percent by the Year 2040, as compared to the projected regional increase of 58 percent.

Water demand projections for the region's public water systems do not depend directly on the region's total population. Rather, they depend on the population served by these systems. Table 2-15 presents projected total population and civilian population served by jurisdiction. The population served values do not include those people who live on federal installations or in base housing areas. This is necessary to prevent double counting of residential demands in both the Federal Installation and Residential demand categories.

Water Demand Projections

Total demand on public water supply systems within the Lower Peninsula Region is projected to increase 68 percent over the 50-year planning period from a Year 1990 value of 55.2 mgd to a Year 2040 value of 92.6 mgd. This is equivalent to an average annual demand growth rate of 1.04 percent. For comparison, total metered consumption in the

TABLE 2-14

PROJECTED LOWER PENINSULA DEMANDS BY PURVEYOR
(MGD)

YEAR / PURVEYOR	RESIDENTIAL	COMMERCIAL/ INSTIT./ LT. IND.	HEAVY INDUSTRIAL	FEDERAL INSTALL.	SUBTOTAL OF METERED DEMANDS	UAW	TOTAL
1990(METERED)							
NEWPORT NEWS WATERWORKS	24.57	8.39	10.22	2.48	45.66	2.75	48.41
WILLIAMSBURG	0.90	2.20	0.00	0.10	3.20	0.19	3.39
JAMES CITY SERVICE AUTHORITY	1.26	0.30	0.06	0.00	1.62	0.10	1.72
BIG BETHEL	0.00	0.00	0.00	1.54	1.54	0.10	1.64
YORK COUNTY	0.05	0.00	0.00	0.00	0.05	0.00	0.05
TOTAL	26.78	10.89	10.29	4.12	52.08	3.13	55.21
2000							
NEWPORT NEWS WATERWORKS	26.28	8.74	12.57	2.58	50.17	3.66	53.83
WILLIAMSBURG	1.12	2.18	0.00	0.12	3.42	0.25	3.66
JAMES CITY SERVICE AUTHORITY	2.28	0.72	0.18	0.00	3.18	0.23	3.42
BIG BETHEL	0.00	0.00	0.00	2.12	2.12	0.15	2.27
YORK COUNTY	0.13	0.05	0.06	0.00	0.23	0.02	0.25
TOTAL	29.80	11.69	12.81	4.82	59.12	4.31	63.43
2010							
NEWPORT NEWS WATERWORKS	28.38	9.36	16.74	3.18	57.66	4.74	62.40
WILLIAMSBURG	1.16	2.27	0.00	0.14	3.57	0.29	3.86
JAMES CITY SERVICE AUTHORITY	2.79	0.86	0.41	0.00	4.07	0.33	4.40
BIG BETHEL	0.00	0.00	0.00	2.13	2.13	0.18	2.31
YORK COUNTY	0.23	0.09	0.16	0.00	0.48	0.04	0.52
TOTAL	32.55	12.59	17.31	5.45	67.90	5.58	73.49
2020							
NEWPORT NEWS WATERWORKS	30.12	9.87	18.11	5.32	63.42	5.82	69.24
WILLIAMSBURG	1.34	2.33	0.00	0.16	3.83	0.35	4.18
JAMES CITY SERVICE AUTHORITY	3.04	0.92	0.62	0.00	4.58	0.42	5.00
BIG BETHEL	0.00	0.00	0.00	0.00	0.00	0.00	0.00
YORK COUNTY	0.31	0.23	0.28	0.00	0.82	0.08	0.90
TOTAL	34.82	13.36	19.00	5.48	72.66	6.66	79.32
2030							
NEWPORT NEWS WATERWORKS	32.42	10.42	19.55	5.33	67.71	6.86	74.57
WILLIAMSBURG	1.42	2.51	0.00	0.18	4.10	0.42	4.52
JAMES CITY SERVICE AUTHORITY	3.27	0.97	0.96	0.00	5.20	0.53	5.72
BIG BETHEL	0.00	0.00	0.00	0.00	0.00	0.00	0.00
YORK COUNTY	0.36	0.39	0.41	0.00	1.16	0.12	1.28
TOTAL	37.46	14.28	20.92	5.51	78.17	7.92	86.09
2040							
NEWPORT NEWS WATERWORKS	34.85	10.97	20.81	5.34	71.97	8.00	79.97
WILLIAMSBURG	1.51	2.68	0.00	0.18	4.37	0.49	4.86
JAMES CITY SERVICE AUTHORITY	3.43	1.04	1.01	0.00	5.48	0.61	6.09
BIG BETHEL	0.00	0.00	0.00	0.00	0.00	0.00	0.00
YORK COUNTY	0.40	0.54	0.56	0.00	1.50	0.17	1.67
TOTAL	40.19	15.24	22.38	5.52	83.33	9.26	92.59

TABLE 2–15
ADOPTED REGIONAL TOTAL POPULATION AND CIVILIAN POPULATION SERVED PROJECTIONS BY JURISDICTION

	EXISTING		PROJECTED									
	1990		2000		2010		2020		2030		2040	
JURISIDICTION	TOTAL POPULATION	CIVILIAN POPULATION SERVED	TOTAL POPULATION	CIVILIAN POPULATION SERVED	TOTAL POPULATION	CIVILIAN POPULATION SERVED	TOTAL POPULATION	CIVILIAN POPULATION SERVED	TOTAL POPULATION	CIVILIAN POPULATION SERVED	TOTAL POPULATION	CIVILIAN POPULATION SERVED
NEWPORT NEWS	170,045	160,078	184,000	174,033	213,000	203,033	223,000	213,033	238,000	228,033	254,500	244,533
HAMPTON	133,793	128,798	146,200	141,205	155,940	150,945	166,410	161,415	177,570	172,575	188,065	183,090
POQUOSON	11,005	11,005	14,328	14,328	17,061	17,061	20,187	20,187	23,215	23,215	26,243	26,243
WILLIAMSBURG	11,530	11,530	12,800	12,800	14,000	14,000	15,200	15,200	16,400	16,400	17,700	17,700
YORK COUNTY	42,422	27,418	50,950	39,335	57,580	45,302	64,580	51,602	71,580	57,902	78,580	64,202
JAMES CITY COUNTY	34,859	24,401	51,700	43,945	61,700	55,530	64,700	58,230	67,800	61,020	71,200	64,080
REGIONAL TOTAL	403,654	363,230	459,978	425,646	519,281	485,871	554,077	519,667	594,565	559,145	636,308	599,848

Lower Peninsula water system decreased an average of 2.53 percent per year between Years 1970 and 1990. As this comparison demonstrates, water demand in the region is projected to increase at a much slower rate than has occurred historically. Table 2-16 presents projected demands by jurisdiction and by purveyor. Table 2-17 presents the projected demands for the region and includes a summary description of the calculations used to project demands for each user category.

2.7 PROJECTED DEFICITS

Based on demand projections summarized in Section 2.6, a Lower Peninsula water demand of 92.6 mgd is expected in the Year 2040. This demand projection assumes continuation of existing conservation programs as well as implementation of new, more aggressive demand reduction measures in the future as discussed in Section 2.6.1. Section 2.3 concluded that the total reliable system delivery capacity (i.e., treated water yield) is currently 60.8 mgd, and is expected to increase to 62.5 mgd by 1995 and to 64.3 mgd by 2005, and decrease to 62.4 mgd after the Year 2010. Demand is projected to equal the reliable system delivery capacity by the Year 1998.

Reliable system delivery capacity, demand, and deficit projections for the Lower Peninsula are summarized in Table 2-18 by purveyor. Regional reliable system delivery capacity and demands for each user category are presented graphically in Figure 2-9. Year 2040 deficit projections are shown in Figure 2-10 by purveyor service area.

Lower Peninsula water supply deficit projections are discussed further in the following sections.

2.7.1 Interpretation of Regional Totals

The reliable system delivery capacity presented in Figure 2-9 assumes that source sharing would be implemented as needed. Inspection of the difference between supply and demand for each purveyor reveals that all will have a deficit in the Year 2040.

Summing the individual purveyors' demands and supplies assumes that worst case conditions occur simultaneously for all of the individual purveyors. This is a reasonable assumption given the relatively close proximity of the surface source watersheds and the prolonged duration of yield-controlling drought conditions.

The uncertainties associated with the safe yield analyses of the reservoir systems must also be considered. In particular, future droughts could be more severe than the drought of record used in estimating system safe yields. Conjunctive losses in the supply and treatment of raw water could also reduce current and near future system yields below the estimates adopted for this planning effort.

2.7.2 Interpretation of Purveyor Totals

An examination of the deficit values in Table 2-18 shows that none of the Lower Peninsula public water supply systems are currently in a deficit situation, and the Lower Peninsula area as a whole has a 5.6-mgd surplus. By the Year 2000, the Newport News Waterworks and Big Bethel systems are projected to have deficits of 1.9 and 0.4 mgd, respectively. Williamsburg, JCSA, and York County are projected to have slight surpluses of 0.1, 0.8, and 0.5 mgd, respectively, by the Year 2000. The surplus for York County is based on a projected increase in safe yield. If this increase is not realized, York County would also be in a deficit situation by the Year 2000.

Newport News Waterworks, Williamsburg, and York County are projected to have deficits in the Year 2040 of 28, 1.1, and 1.0 mgd, respectively. JCSA is projected to have demands approximately equal to supply in the Year 2040 with a projected deficit of 0.1 mgd. The projected 80 mgd Waterworks demand in the Year 2040 includes demands from the current Big Bethel service area. If the Big Bethel system is not abandoned, as assumed, the projected Waterworks deficit would be 26.2 mgd while the regional total deficit would be 28.3 mgd.

2.7.3 Adequacy of Supply Versus Deficit

Year 1990 demands on public water supplies in the Lower Peninsula averaged 55.2 mgd and are projected to increase throughout the planning period. The Year 1990 demand represents 91 percent of the region's 60.8 mgd reliable system delivery capacity. Under current VDH regulations, water purveyors represented by the RRWSG now have a clear duty to develop plans for expansion of their raw water supplies.

The Lower Peninsula public water supply systems are currently under stress and will be inadequate to meet the total projected regional demand during a severe drought after the Year 1998, as presented in Figure 2-10. It is estimated that the total available regional reservoir storage would be depleted in 5½ months during a hypothetical worst-case drought in which no Chickahominy River withdrawals or reservoir inflows from runoff occur. This assumes that the Lower Peninsula's reservoirs are full at the onset of the drought.

Planning, permitting, designing, and constructing new large-scale raw water supply facilities may take many years. Consequently, the projected deficit in the near future demonstrates the importance of investigating and implementing both interim and long-term water supply augmentation measures. The comparison of supply and demand shown in Figure 2-10 indicates that a treated water deficit of 30.2 mgd is expected in the Year 2040. This is assuming conservation efforts are successful to the degree projected in Section 2.6.

New supply sources which can increase the Lower Peninsula's reliable system delivery capacity by approximately 30 mgd are needed to satisfy the 92.6 mgd projected Year 2040 average day demand during a reoccurrence of the worst drought of record. This deficit does not account for losses between a new raw water source and the Lower Peninsula distribution systems. These could include transmission losses in future raw water pipelines, seepage losses from new reservoirs, internal water use at new WTPs, or concentrate discharges from membrane treatment processes. These losses would have to be subtracted from the raw water source yield of any new or expanded supply systems in order to determine the reliable system delivery capacity of such systems.

For example, the raw water source yield of a new reservoir must be adjusted to account for related raw water transmission pipeline losses, any reservoir losses not included in the basic safe yield analysis, and WTP usage. Based on current estimates for the Newport News Waterworks system, these losses are estimated as at least 10 percent of the

TABLE 2-16

ADOPTED LOWER PENINSULA DEMAND PROJECTIONS BY JURISDICTION AND PURVEYOR

(MGD)

JURISDICTION	EXISTING 1990	PROJECTED 2000	2010	2020	2030	2040
NEWPORT NEWS	20.44	21.93	25.63	27.00	28.95	31.03
HAMPTON	15.27	16.89	18.04	19.59	21.29	22.83
POQUOSON	0.88	1.18	1.38	1.65	1.93	2.20
WILLIAMSBURG	2.61	3.09	3.28	3.60	3.93	4.26
YORK COUNTY	6.94	8.54	10.10	11.37	12.73	13.96
JAMES CITY COUNTY	9.06	11.80	15.06	16.11	17.28	18.30
TOTAL	**55.21**	**63.43**	**73.49**	**79.32**	**86.09**	**92.59**
PURVEYOR						
NEWPORT NEWS WATERWORKS	48.41	53.83	62.40	69.24	74.57	79.97
WILLIAMSBURG	3.39	3.66	3.86	4.18	4.52	4.86
JAMES CITY SERVICE AUTHORITY	1.72	3.42	4.40	5.00	5.72	6.09
BIG BETHEL	1.64	2.27	2.31	0.00	0.00	0.00
YORK COUNTY	0.05	0.25	0.52	0.90	1.28	1.67
TOTAL	**55.21**	**63.43**	**73.49**	**79.32**	**86.09**	**92.59**

TAB__ 2-17

CALCULATION OF PROJECTED LOWER PENINSULA TOTAL WATER DEMAND
2000-2040
(mgd)

YEAR	TOTAL REGION. POPUL.	RESIDENTIAL: CIVILIAN POPUL. SERVED	RESIDENTIAL: REG. AVG GPCPD	RESIDENTIAL: DEMAND	COMM./INST./LIGHT. IND.: TOTAL COMM. EMPL.	COMM./INST./LIGHT. IND.: REG. AVG. GPEPD	COMM./INST./LIGHT. IND.: DEMAND	HEAVY WATER USE INDUSTRY: INDUSTRIAL EMPLOYMENT TOTAL	INDUSTRIAL EMPLOYMENT NEW: TOTAL	INDUSTRIAL EMPLOYMENT NEW: EXIST.	INDUSTRIAL EMPLOYMENT NEW: NEW	EXIST. IND. DEMAND	NEW INDUSTRY: GPEPD	NEW INDUSTRY: DEMAND	TOTAL IND. DEMAND	FEDERAL INSTALL.: DEMAND	UAW: SUB-TOTAL DEMAND	UAW: As % of fin. INCR. TO 10%: %	UAW: As % of fin. INCR. TO 10%: DEMAND	TOTAL DEMAND
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
1990	403654	363230	73	26.78	154645	70	10.89	32711				10.29	639		10.29	4.12	52.08	5.67	3.13	55.21
2000	459978	425646	70	29.80	174511	67	11.69	37275	4564	746	3818	10.37	640	2.44	12.81	4.82	59.12	6.80	4.31	63.43
2010	519281	485871	67	32.55	196654	64	12.59	42081	9370	1106	8264	12.02	640	5.29	17.31	5.45	67.90	7.60	5.58	73.48
2020	554077	519667	67	34.82	208717	64	13.36	44901	12190	1411	10779	12.10	640	6.90	19.00	5.48	72.65	8.40	6.66	79.32
2030	594565	559145	67	37.46	223125	64	14.28	48182	15471	1816	13655	12.18	640	8.74	20.92	5.51	78.17	9.20	7.92	86.09
2040	636308	599848	67	40.19	238170	64	15.24	51565	18854	3121	15733	12.31	640	10.07	22.38	5.52	83.33	10.00	9.26	92.59

[shaded] PROJECTED VALUES USED IN ARRIVING AT TOTAL DEMAND

LEGEND:

A -TOTAL PROJECTED POPULATION ON LOWER PENINSULA, FROM TABLE 4-1.

B -TOTAL PROJECTED RESIDENTIAL POPULATION SERVED ON LOWER PENINSULA, FROM TABLE 4-3.

C -PROJECTED RESIDENTIAL GALLONS PER CAPITA PER DAY USAGE RATE.

D -PROJECTED DEMAND, COLUMN B*C.

E -TOTAL PROJECTED EMPLOYMENT ON LOWER PENINSULA MINUS EMPLOYMENT IN HEAVY WATER USE INDUSTRY AND MILITARY EMPLOYMENT.

F -PROJECTED COMMERCIAL/INSTITUTIONAL/LIGHT INDUSTRIAL GALLONS PER EMPLOYEE PER DAY USAGE RATE, SAME PERCENTAGE REDUCTION DUE TO CONSERVATION AS IN RESIDENTIAL USAGE.

G -PROJECTED DEMAND, COLUMN E*F.

H -TOTAL PROJECTED EMPLOYMENT IN HEAVY WATER USE INDUSTRIES ON THE LOWER PENINSULA INCREASE IN THIS EMPLOYMENT IS DIRECTLY PROPORTIONAL TO INCREASE IN TOTAL POPULATION.

I -TOTAL NEW EMPLOYEES WORKING IN HEAVY WATER USE INDUSTRIES, COLUMN H-32,711.

J -NEW EMPLOYEES HIRED BY EXISTING HEAVY WATER USE INDUSTRIES ON THE LOWER PENINSULA DUE TO GROWTH OF THESE INDUSTRIES. SELF-PROJECTED BY EXISTING INDUSTRIES, FROM TABLE 4-11.

K -NEW EMPLOYEES HIRED BY FUTURE NEW HEAVY WATER USE INDUSTRIES ON THE LOWER PENINSULA COLUMN I-J.

L -PROJECTED DEMAND, SELF-PROJECTED BY EXISTING HEAVY WATER USE INDUSTRIES ON THE LOWER PENINSULA

M -PROJECTED HEAVY WATER USE INDUSTRIAL GALLONS PER EMPLOYEE PER DAY USAGE RATE, FROM SECTION 4.

N -PROJECTED DEMAND, COLUMN M*K.

O -PROJECTED TOTAL HEAVY WATER USE INDUSTRIAL DEMAND, COLUMN L+N.

P -FEDERAL INSTALLATIONS DEMAND, FROM TABLE 4-23.

Q -SUBTOTAL OF PROJECTED METERED DEMANDS, COLUMN D+G+O+P.

R -PROJECTED UNACCOUNTED-FOR WATER PERCENTAGE EXPRESSED AS PERCENT OF TOTAL FINISHED WATER PUMPED INTO THE DISTRIBUTION SYSTEM.

S -PROJECTED DEMAND, COLUMN Q*(R/(100-R))

T -TOTAL PROJECTED LOWER PENINSULA DEMANDS, COLUMN Q+S.

TABLE 2-18

LOWER PENINSULA SUPPLY, DEMAND AND DEFICIT PROJECTIONS BY PURVEYOR (MGD)

YEAR / PURVEYOR	SUPPLY (1)	DEMAND (2)	DEFICIT (3)
1990(METERED)			
NEWPORT NEWS WATERWORKS	51.90	48.41	-3.49
WILLIAMSBURG	3.80	3.39	-0.41
JAMES CITY SERVICE AUTHORITY	3.10	1.72	-1.38
BIG BETHEL	1.90	1.64	-0.26
YORK COUNTY	0.12	0.05	-0.07
TOTAL	60.82	55.21	-5.61
2000			
NEWPORT NEWS WATERWORKS	51.90	53.83	1.93
WILLIAMSBURG	3.80	3.66	-0.14
JAMES CITY SERVICE AUTHORITY	4.23	3.42	-0.81
BIG BETHEL	1.90	2.27	0.37
YORK COUNTY	0.70	0.25	-0.45
TOTAL	62.53	63.43	0.90
2010			
NEWPORT NEWS WATERWORKS	51.90	62.40	10.50
WILLIAMSBURG	3.80	3.86	0.06
JAMES CITY SERVICE AUTHORITY	6.00	4.40	-1.60
BIG BETHEL	1.90	2.31	0.41
YORK COUNTY	0.70	0.52	-0.18
TOTAL	64.30	73.49	9.19
2020			
NEWPORT NEWS WATERWORKS	51.90	69.24	17.34
WILLIAMSBURG	3.80	4.18	0.38
JAMES CITY SERVICE AUTHORITY	6.00	5.00	-1.00
BIG BETHEL	0.00	0.00	0.00
YORK COUNTY	0.70	0.90	0.20
TOTAL	62.40	79.32	16.92
2030			
NEWPORT NEWS WATERWORKS	51.90	74.57	22.67
WILLIAMSBURG	3.80	4.52	0.72
JAMES CITY SERVICE AUTHORITY	6.00	5.72	-0.28
BIG BETHEL	0.00	0.00	0.00
YORK COUNTY	0.70	1.28	0.58
TOTAL	62.40	86.09	23.69
2040			
NEWPORT NEWS WATERWORKS	51.90	79.97	28.07
WILLIAMSBURG	3.80	4.86	1.06
JAMES CITY SERVICE AUTHORITY	6.00	6.09	0.09
BIG BETHEL	0.00	0.00	0.00
YORK COUNTY	0.70	1.67	0.97
TOTAL	62.40	92.59	30.19

(1) RELIABLE SYSTEM DELIVERY CAPACITY OF EACH PURVEYOR'S SYSTEM FROM TABLE 2-4.
(2) PROJECTED DEMANDS ON EACH PURVEYOR'S SYSTEM FROM TABLE 2-16.
(3) REQUIRED NEW RELIABLE SYSTEM DELIVERY CAPACITY TO MEET PROJECTED DEMANDS. NEGATIVE VALUES INDICATE SURPLUS.

PROJECTED REGIONAL WATER DEMAND vs. RELIABLE SYSTEM DELIVERY CAPACITY

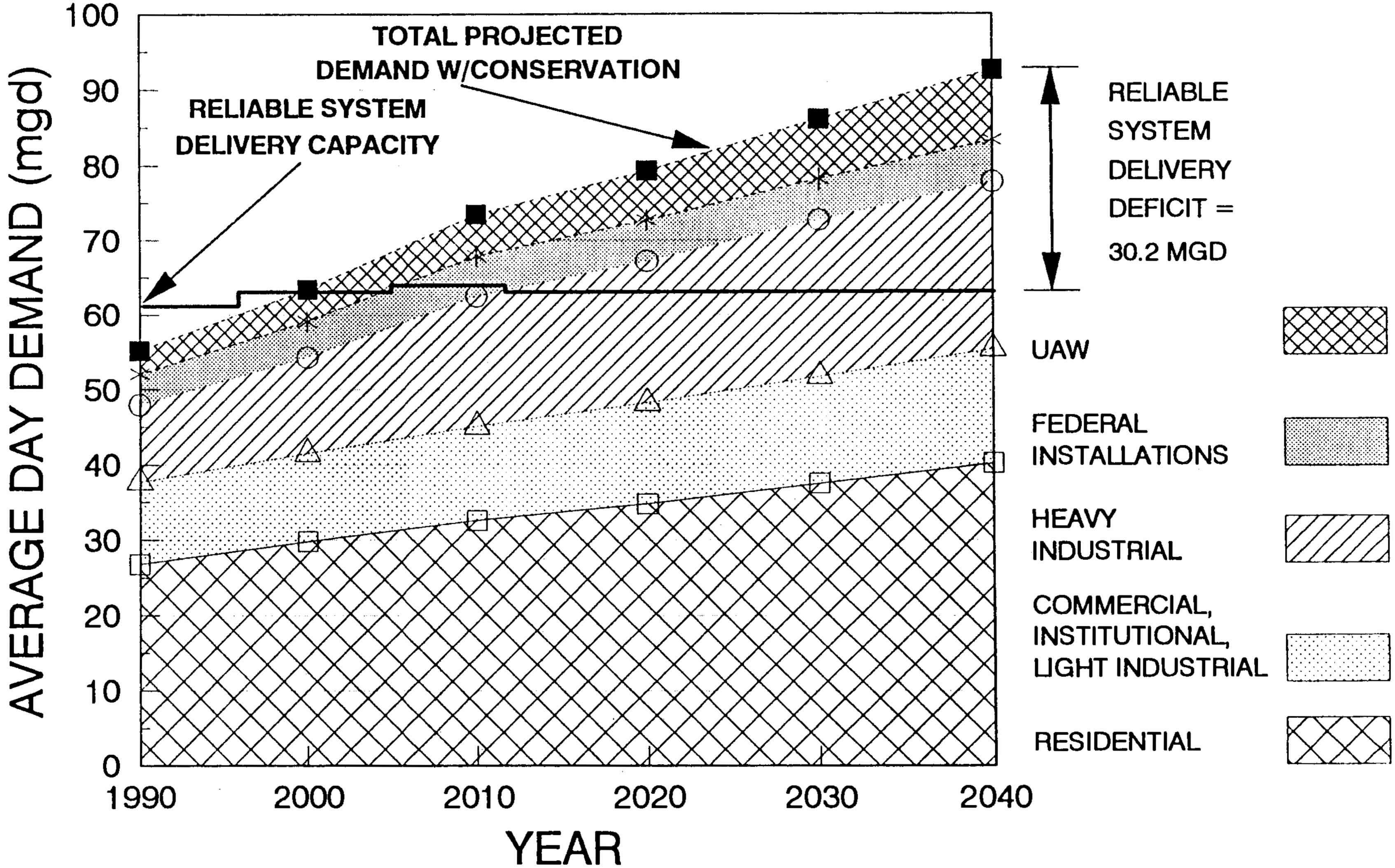
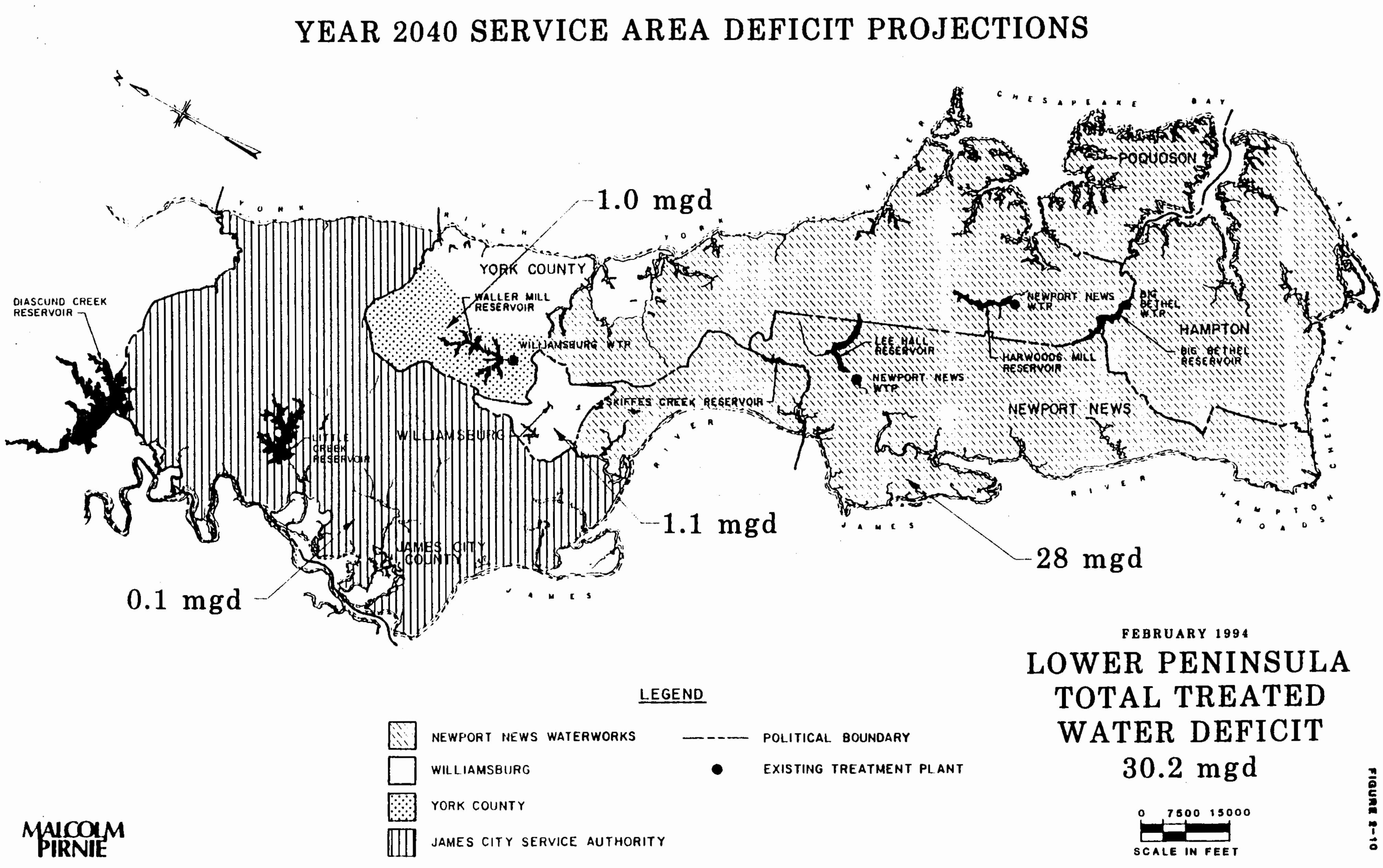


FIGURE 2-9



FEBRUARY 1994

LOWER PENINSULA TOTAL TREATED WATER DEFICIT 30.2 mgd

MALCOLM PIRNIE

FIGURE 2-10

raw water source yield. A new reservoir would therefore have to have a raw water yield of approximately 33 mgd to assure a reliable system delivery capacity of 30 mgd.

Different types of raw water supply systems will have different types and magnitudes of losses. The 33 mgd source safe yield value described above does not apply to groundwater projects or desalting alternatives. This value also does not account for any demands outside the Lower Peninsula such as supply commitments that may be necessary with new project host jurisdictions.

As discussed above, the value that must be used to compare alternative supply systems is the reliable system delivery capacity (or treated water yield). The new reliable system delivery capacity required to satisfy projected Lower Peninsula demands through the Year 2040 is 30.2 mgd. The new capacity required by year is presented in Table 2-19.

2.8 POLITICAL/INSTITUTIONAL CONSIDERATIONS

As part of the review and approval process, the Commonwealth of Virginia must approve any raw water supply project selected by the RRWSG. Historically, the state has provided only limited support for water supply development beyond its role of review and approval. In performing this role, state government has relied primarily on control created by a federal statute, the Section 401 Certification Program mandated by the Clean Water Act (CWA).

Newport News Waterworks' newest water supply source, Little Creek Reservoir constructed in 1979, was permitted under federal and state regulations dating from the early 1970s. Regulations have since changed considerably and are discussed below.

2.8.1 Current State Role

In order to identify the current role of the state, a review of the current situation is needed. Although water supply development advocacy on the state level is limited, several state water management activities do relate to water supply provision. These activities can be grouped into the four categories of: delegation of local government water supply development authority, water supply planning, financial and technical assistance, and regulation as discussed below.

<u>Delegation of Local Government Water Supply Development Authority</u>

Virginia is a "Dillon Rule" state. Simply put, the Dillon Rule means that local government can only do those things that they have been specifically empowered to do. Local powers depend on specific delegation of authority within local government charters and/or through enabling legislation. Virginia enabling legislation provides broad authority for local governments to develop water supplies. Localities generally have power to develop water supplies individually, or through formal arrangements for multi-jurisdictional participation such as water authorities.

Authority to develop water supplies generally exists for projects both inside and outside the boundaries of the project's owner. However, projects outside the boundaries of the owner usually require the consent of the host jurisdiction (or the approval of a special three-judge court to which appeals can be taken in the event consent is denied). Thus, extra-territorial projects generally cannot be undertaken on a unilateral basis but must involve agreements among the affected parties.

Water Supply Planning at the State Level

State legislation establishes authority for the Virginia State Water Control Board (SWCB) (now Virginia Department of Environmental Quality) to conduct general water supply planning for each of the state's major river basins and sub-basins. This authority also provides for planning assistance to local governments upon request.

For much of the time since 1972, when this responsibility was transferred to the SWCB from the Department of Conservation and Economic Development, state water supply planning efforts have appeared to receive less emphasis than water quality management activities. More recently, publicity over water supply shortage and conflict at some locations has created an increased emphasis on water supply issues.

Recent water supply planning in Virginia has included the completion of 11 river basin plans. These basin plans include inventories of water resources and a compilation of the water demand centers within the basins. Possible supply alternatives to meet future demands were also reviewed, but the state's preferences or assistance in the development of alternatives was not provided.

The SWCB has been granted legislative authority to conduct more specialized water supply planning and management as part of statutorily created regulatory programs. One such program is created by the Virginia Groundwater Act of 1973 (VGA). The VGA authorized special studies in relation to geographic areas proposed for designation of groundwater management areas. The entire Lower Peninsula now falls within the Eastern Virginia Groundwater Management Area. The Virginia Groundwater Management Act (VGMA) of 1992 repealed the VGA and added in its place measures for the management and control of groundwater resources by the SWCB. Groundwater withdrawal regulations pursuant to this act were first proposed in January 1993 (VR 680-13-07).

The Virginia Surface Water Management Areas Act (SWMAA) is a more recent statute directing water supply management. Here, the focus is on identification of geographical areas that have suffered, or are likely to suffer, injury to instream water use activities as a result of water withdrawals. Designation of a SWMA is dependent upon a general assessment of existing and projected water use in relation to the available supply within the various surface waters of the state. Adopted SWMA regulations became effective on June 3, 1992 (VR 680-15-03).

A related measure is the Virginia Water Protection Permit Act (VWPPA). A VWPP is to be issued as the state's certification (under CWA Section 401) of federal permit issuance for activities involving discharges to surface waters. Adopted VWPP regulations became effective on May 20, 1992 (VR 680-15-02).

State Financial and Technical Assistance

The Virginia Resources Authority (VRA) administers the Virginia Water Supply Revolving Fund. The Fund is used primarily for loans to local governments for the costs of wastewater projects. Interest rates and repayment terms are set by the Virginia Board of Health. VRA is authorized to issue bonds to raise money for the Fund, with the total

TABLE 2–19

LOWER PENINSULA WATER SUPPLY, DEMAND AND DEFICIT PROJECTIONS (mgd)

	SUPPLY	DEMAND	DEFICIT
YEAR	REGIONAL RELIABLE SYSTEM DELIVERY CAPACITY	REGIONAL DEMAND	REQUIRED NEW RELIABLE SYSTEM DELIVERY CAPACITY
1990	60.8	55.2	–5.6
2000	62.5	63.4	0.9
2010	64.3	73.5	9.2
2020	62.4	79.3	16.9
2030	62.4	86.1	23.7
2040	62.4	92.6	30.2

Negative values of deficit represent a regional surplus.

principal bond amount at any time not to exceed $400 million without prior approval by the General Assembly.

Water Supply Regulatory Powers of the State

Water supply development is an intensely regulated activity. Regulations applicable to municipal water supply development can be classified as health protection, resource allocation, and environmental protection.

Regulation of water quality to protect the health of waterworks customers is a long-established practice but has been intensified by enactment of the Federal Safe Drinking Water Act (SDWA) and subsequent amendments. Virginia has been granted primacy under the SDWA, with the effect that the Virginia Department of Health (VDH) is responsible for administering both state and federal laws applicable to waterworks operations (subject to certain oversight by the USEPA with respect to federal requirements). In addition to regulation of the quality of drinking water provided, Waterworks' regulations also control the source of supply by imposing minimum yield requirements. The VDH is responsible for issuing permits required for waterworks operation. The permit indicates the approved capacity of the system. The capacity is rated based on the least capacity of the individual components required for providing a reliable water supply. These include: raw water yield, water treatment capability, treated water storage, and water distribution capability. In addition, the VDH requires that improvements be planned when demands for three consecutive months are 80 percent or more of the capacity of that particular part of the operation.

Regulation of water supply development to achieve a desirable resource allocation is authorized by two previously described state statutes (i.e., VGMA and SWMAA). Both statutes can restrict withdrawals for public water supply purposes, but operate only within designated management areas.

The primary regulatory authority related to environmental protection is exercised by federal rather than state government. The principal regulatory measure is the permit required under Section 404 of the CWA for discharges of dredged or fill material into waters of the United States. The scope of coverage of this provision brings most water development activities (such as construction of dams and water intakes) within its coverage. General administrative responsibility for the Section 404 permit program rests with the USCOE, but the USEPA has the authority to veto issuance of a USCOE permit where it finds unacceptable adverse environmental impacts. The state must certify through the issuance of a VWPP that it has reviewed the permit application and found the project consistent with its water quality management programs.

The primary state regulatory measure concerning conservation is through the Building Officials and Code Administrators (BOCA) codes. The BOCA organization is a nonprofit organization which develops a series of performance-oriented model codes (BOCA, 1990). These codes were adopted by the Commonwealth of Virginia as part of the Uniform Statewide Building Code (USBC) (DHCD, 1987). These codes directly specify the use of water conservation fixtures, such as conservation type flushometer valves in water closets.

These codes apply to all new construction and some remodelling of existing structures. The USBC requires that:

> "When reconstruction, renovation, or repair of existing buildings is undertaken, existing materials and equipment may be replaced with materials and equipment of similar kind or replaced with greater capacity equipment in the same location when not considered a hazard; however, when new systems, materials, and equipment that were not part of the original existing building are added, the new systems, materials, and equipment shall be subject to the edition of the USBC in effect at the time of their installation. Existing parts of such buildings not being reconstructed, renovated, or repaired need not be brought into compliance with the current edition of the USBC."

BOCA sets maximum flow standards for a variety of fixtures and appliances. These standards set a maximum limit of 3.0 gallons per minute (gpm) at 80 pounds per square inch (psi) for showers, lavatories, and sinks. While conservation type showerheads are not directly called for in the BOCA codes, the maximum limit of 3.0 gpm precludes the use of most conventional showerheads, which have a flow rate of 7.0 gpm. Water closets are limited to 4.0 gallons per flushing cycle and urinals are limited to 1.5 gallons per cycle. In addition, lavatories in public facilities are limited to 0.5 gpm for those with standard valve or spring faucets and 0.25 gallons per cycle for self-closing metering valves (BOCA, 1990).

The plumbing codes currently in use in Virginia employ measures which are considered conservation-oriented. Advanced plumbing codes, as referred to in this document, are more restrictive plumbing codes than those already in place. This would probably include a requirement for the use of ultra-low-volume (ULV) toilets. In the Commonwealth of Virginia, plumbing codes can only be implemented at the State level of government and not by individual jurisdictions or water purveyors.

The USBC in Virginia was adopted from the BOCA National Plumbing Code. States are permitted to develop plumbing codes that implement stricter measures than those imposed by the National Plumbing Codes. However, localities in Virginia must obtain State authorization to develop a stricter code.

There are other legal incentives for developing a sound conservation program. For example, regulatory provisions exist for incorporating instream flow conditions in VWPPs. These instream flow conditions may require water conservation and reductions in water use by the permittee.

Likewise, the SWMA regulations stipulate that SWCB-approved conservation or management plans be included in Surface Water Withdrawal Permits. An approved conservation program must include:

- Use of water saving plumbing fixtures in new and renovated plumbing as provided under the Uniform Statewide Building Code.
- A water loss reduction program.
- A water use education program.

- Ordinances prohibiting waste of water generally and providing for mandatory water use restrictions, with penalties, during water shortage emergencies.

Proposed Groundwater Withdrawal Regulations also would require that applications for new Groundwater Withdrawal Permits include a water conservation plan approved by the SWCB. Conservation plan elements required would be similar to those required by the SWMA regulations.

2.8.2 State and Local Constraints

Constraints on water supply development activities imposed by Virginia law consist primarily of several direct control measures; indirect constraints have some effect on the operation of direct controls, but they are generally of a more limited nature than indirect federal constraints. Direct controls include specific regulatory measures applicable to public water supply operations, groundwater use permitting, and several measures controlling the construction and maintenance of dams. Indirect controls include the state environmental review process, the state antiquities protection program, the state project notification and review process, and state constraints on floodplain use.

The Commonwealth's political subdivisions (local governments) and circuit courts exercise considerable authority of relevance to the construction and operation of water supply facilities. Local controls attain their principal importance in situations where a political subdivision desires to construct and operate facilities outside its political boundaries, thereby potentially subjecting itself to regulation by the political subdivision where the facilities are to be located. In addition, since the different levels of government may simultaneously apply controls to an individual water resource project, conflicting decisions are possible. Major conflicts regarding water management can develop between state and local laws.

The relationship between state and local governments is a result of the fact that local governments are creatures of the state. In the approach employed in Virginia (Dillon Rule), local governments have only those powers enumerated in state enabling legislation. There is not inherent authority independent of state legislation. If a conflict occurs between state and local action, the concept of preemption again applies, and local authority must yield. There are, therefore, considerable legislative constraints relative to water resource development and conservation that would be difficult to change.

<u>Circuit Courts</u>

Procedures exist through which the circuit courts of the state can authorize certain water resource development projects. Primary mechanisms of this type include one pertaining to construction of milldams and related facilities and another concerning facilities for the storage of flood water.

Legislation applicable to milldams provides that any person desiring to construct a dam or canal to utilize a stream for operation of a water mill may request authorization from the circuit court of the county where the construction is proposed. Where such authorization is requested, the court is required to appoint five freeholders in the county who are charged with the duty of making a complete investigation of the site and reporting the likely impact of the proposed construction. If it appears that the proposed structure will result in obstructed fish passage, navigation disruptions, property loss, or health impacts, the court may not grant permission. Otherwise, permission is in the discretion of the court.

Riparian owners desiring to store water above average streamflow for later use may also request authorization from the circuit court of the county or city where the impoundment is proposed, providing the construction involved does not come within the jurisdiction of the milldam act, the water power development act administered by the State Corporation Commission (SCC), or the federal government.

Unlike the milldam act, the enabling legislation for storage of flood water provides for input from a state agency to the judicial proceedings for approval. In addition to general notice regarding each application, the applicant is required to send a copy of the application to SWCB. The mechanism for state-level input is a report by SWCB to the circuit court that addresses the following matters:

- The average flow of the stream at the point from which water for storage will be taken.

- Whether the proposed project conflicts with any other proposed or likely developments on the watershed.

- The effect of the proposed impoundment on pollution abatement to be evidenced by a certified statement together with such other relevant comments as the Board desires to make.

- Any other relevant matters which the Board desires to place before the court.

The final decision regarding a particular application is made by the court on the basis of the report and other evidence, including that obtained at a required public hearing. Legislative criteria to guide the court in its determination provide that the application be denied if it appears that other riparian owners will be injured or other justifiable reasons exist. It is specified that approval not be granted where SWCB indicates that reduction of pollution will be impaired or made more difficult.

Land Use Controls

Authority for land use planning and control has traditionally been delegated to the state's political subdivisions. Before 1975, state law authorized the governing body of each county and municipality to create a planning commission, but creation of such commissions was not specifically required. The 1975 session of the General Assembly amended the existing legislation to require the creation of such commissions by July 1, 1976. A local planning commission is to consist of at least five, but not more than 15 members, appointed by the governing body of the county or municipality.

The principal duty of each local planning commission is the preparation of a comprehensive plan for the physical development of land within its jurisdiction. Statutory guidelines for such plans provide for a survey of natural resources during plan preparation and specify that the plan may include the designation of areas for various types of public and private development and use. This provision appears to authorize incorporation of water and other natural resource considerations into the planning process, but leaves such matters largely to the discretion of the local commissions.

Authority to adopt and implement controls over land use is also delegated to local governmental units. The governing body of any county or municipality may enact a zoning ordinance through which special controls can be enforced. Provisions of the enabling legislation for zoning specifying the purposes of such ordinances and the extent of regulatory authority delegated are essentially silent with regard to water, but it is provided that consideration is to be given to the conservation of natural resources.

Land use controls serve as a potential mechanism through which a political subdivision could oppose water supply facilities proposed within its jurisdiction by a second political subdivision. If such controls are applicable to a proposed facility, they may provide a basis for prohibition or imposition of other constraints upon such a facility.

Wetlands Zoning Ordinances

The Virginia Wetlands Act (VWA) provides authority for political subdivisions in the coastal areas of the state to adopt a special wetlands zoning ordinance contained in the act. After adoption of the ordinance and creation of the required administrative board, non-exempted alteration of wetlands as defined in VWA is unlawful without a permit from the board. Local permit decisions can be reviewed and modified by the Virginia Marine Resources Commission (VMRC), and VMRC is authorized to administer a wetlands permit program in those political subdivisions in Tidewater that do not develop a local program.

Although the controls imposed by VWA constitute an important restriction on many development activities affecting coastal wetlands, public water supply projects are not likely to be restricted because VWA focuses on marine wetlands.

3.0 EVALUATION OF ALTERNATIVES (INCLUDING THE PROPOSED ACTION)

3.1 INTRODUCTION

This section outlines the legal background for the analysis of the alternatives identified, explains the alternatives analysis methodology used, and describes the results of the alternatives analysis.

3.2 CLEAN WATER ACT - SECTION 404 SITING CRITERIA

Federal regulations under Section 404 of the Clean Water Act (CWA) are designed to protect wetlands against developmental pressures, to the extent consistent with the overall national interest. One portion of the Section 404 regulations deals with practicable alternatives to development within wetlands.

This section examines the Section 404 siting criteria and contains a discussion of how wetlands are regulated at the Federal level, followed by an explanation of how these regulations were applied in the Regional Raw Water Study Group (RRWSG) study.

3.2.1 Section 404 Wetlands Program

The United States Congress enacted the CWA in 1972 to restore and maintain the chemical, physical, and biological integrity of the Nation's waters. Section 404 of the CWA regulates the discharge of dredged and fill material into waters of the United States and establishes a permit program to ensure that such discharges comply with pertinent environmental requirements (USEPA, 1989).

The Section 404 program is administered at the Federal level by the U.S. Army Corps of Engineers (USCOE) and the U.S. Environmental Protection Agency (USEPA). The U.S. Fish and Wildlife Service (USFWS) and the National Marine Fisheries Service (NMFS) have important advisory roles. The USCOE has the primary responsibility for the permit program and is authorized, after notice and opportunity for a public hearing, to issue permits for the discharge of dredged or fill material. The USEPA has important roles in several aspects of the Section 404 program including development of the environmental guidelines by which permit applications must be evaluated, review of proposed permits, prohibition of discharges with unacceptable adverse impacts, establishment of jurisdictional scope of waters of the United States, interpretation of Section 404 exemptions, and power to veto any 404 permit issued by the USCOE (USEPA, 1989).

Waters of the United States protected by the Clean Water Act include rivers, streams, estuaries, the territorial seas, and most lakes, ponds, and wetlands. Wetlands are a particularly important and sensitive segment of the Nation's waters and, therefore, merit special attention.

It is important to note that the Section 404 program does not prohibit activities in wetlands, but establishes a permit process which recognizes both developmental pressures and environmental concerns (USEPA, 1986). This balancing of developmental and environmental factors is encompassed in the Section 404 Guidelines. The practicable alternative test is further defined in statutory guidelines, administrative decisions, and litigation relating to Section 404.

3.2.2 Alternative Selection - Statutory Guidelines

According to the Council on Environmental Quality's (CEQ) National Environmental Policy Act (NEPA) regulations, 40 CFR § 1502.14, the discussion of alternatives "is the heart of the environmental impact statement." The regulation requires a presentation of "the environmental consequences of the proposal and the alternatives in comparative form," including a rigorous exploration and objective evaluation of "all reasonable alternatives," discussion of "reasonable alternatives not within the jurisdiction of the lead agency," "the alternative of no action," and "appropriate mitigation measures not already included in the proposed action or alternatives." The CEQ has also published a memorandum discussing "Questions and Answers on NEPA Regulations," 46 Federal Register 18026 (March 23, 1981), which states:

> In determining the scope of alternatives to be considered, the emphasis is on what is "reasonable" rather than on whether the proponent or applicant likes or is itself capable of carrying out a particular alternative. Reasonable alternatives include those that are practical or feasible from the technical and economic standpoint and using common sense, rather than simply desirable from the standpoint of the applicant.

The USCOE's NEPA regulations generally follow the CEQ's NEPA regulations. With respect to evaluation of alternatives, the USCOE's NEPA Implementation Procedures for the Regulatory Program provide that "[only reasonable alternatives need be considered in detail, as specified in 40 CFR §1502.14 (a)." These regulations state further:

> Reasonable alternatives must be those that are feasible and such feasibility must focus on the accomplishment of the underlying purpose and need (of the applicant or the public) that would be satisfied by the proposed Federal action (permit issuance).... Those alternatives that are unavailable to the applicant, whether or not they require Federal action (permits), should normally be included in the analysis of the no-Federal-action (denial) alternative.

Section 404(b)(1) Guidelines were developed by the USEPA in conjunction with the USCOE to restore and maintain the chemical, physical, and biological integrity of the waters of the United States (40 CFR, §230). The Guidelines specify that:

> "Except as provided under Section 404(b)(2) [pertaining to navigation], no discharge of dredged or fill material shall be permitted if there is a practicable alternative to the proposed discharge which would have less adverse impact on the aquatic ecosystem, so long as the

> alternative does not have other significant adverse environmental consequences" (40 CFR, §230.10).

Under these guidelines, an alternatives analysis must evaluate practicability as well as aquatic ecosystem impacts and other environmental consequences. The Guidelines also discuss the meaning of both "practicable" and "alternative" as follows:

> "An alternative is practicable if it is available and capable of being done after taking into consideration cost, existing technology, and logistics in light of overall project purposes. If it is otherwise a practicable alternative, an area not presently owned by the applicant which could reasonably be obtained, utilized, expanded, or managed in order to fulfill the basic purpose of the proposed activity may be considered" (40 CFR, §230.10).

To be practicable, an alternative must be both available and feasible (USEPA, 1986; USEPA, 1990). Availability does not require actual ownership, but, rather a reasonable expectation that acquisition could be realized for a site or technology which satisfies the basic purpose of the proposed activity; feasibility includes cost, technology, and logistical factors.

For the RRWSG's water supply alternatives, availability was defined as the likelihood of overcoming legal, regulatory, or institutional constraints that could severely delay (i.e., to point where demand exceeds supply) or prevent a water project from being implemented or performing satisfactorily. Major legislative, common law, and regulatory obstacles to implementation, as well as institutional issues which affect the ability of the RRWSG to obtain approvals from host jurisdictions, were the pertinent subjects considered. Technologies or sites may be deemed unavailable if institutional obstacles to project development are deemed insurmountable. Availability determinations were also based on assessments of the likelihood of state, federal, or local permit denials.

In this water supply study, feasibility was defined as the extent to which a given alternative is technologically reliable and implementable at reasonable cost. An alternative becomes less feasible as reliability and cost issues become increasingly likely to prevent a water project from being implemented or from satisfactorily operating to avoid unacceptable water supply shortages.

The basic statutory requirements of the regulations also state that the practicable alternatives be evaluated in terms of their impacts to the aquatic ecosystem as well as "other significant adverse environmental consequences."

In this water supply study, environmental suitability was defined as the extent to which environmental harm can be avoided. Since environmental values are protected by a variety of regulatory and institutional constraints, suitability can be defined as the extent to which a given alternative avoids constraints that could prevent implementation or satisfactory operation. Potential environmental impacts to wetlands, groundwater, cultural resources, land use, wildlife, and threatened and endangered species, as well as potential impacts to the aquatic ecosystem, were evaluated.

3.3 EVALUATION METHODOLOGY

3.3.1 Overview of Alternatives Analysis

As determined in Section 2.7, a projected 30.2-mgd treated water deficit will occur by the Year 2040 affecting the jurisdictions of the Lower Peninsula. To satisfy this deficit, various water supply alternatives throughout the region were identified and evaluated according to the procedures outlined in the Section 404 permit guidelines. Practicable alternative components were then assembled to form project alternatives that could meet the regional needs. For the purposes of the practicable alternatives analysis, a methodology based on the Section 404(b)(1) Guidelines was employed which requires that an alternative technology or site must be capable of satisfying the basic purpose of the proposed project, taking into consideration availability and technological, logistical, and economic feasibility.

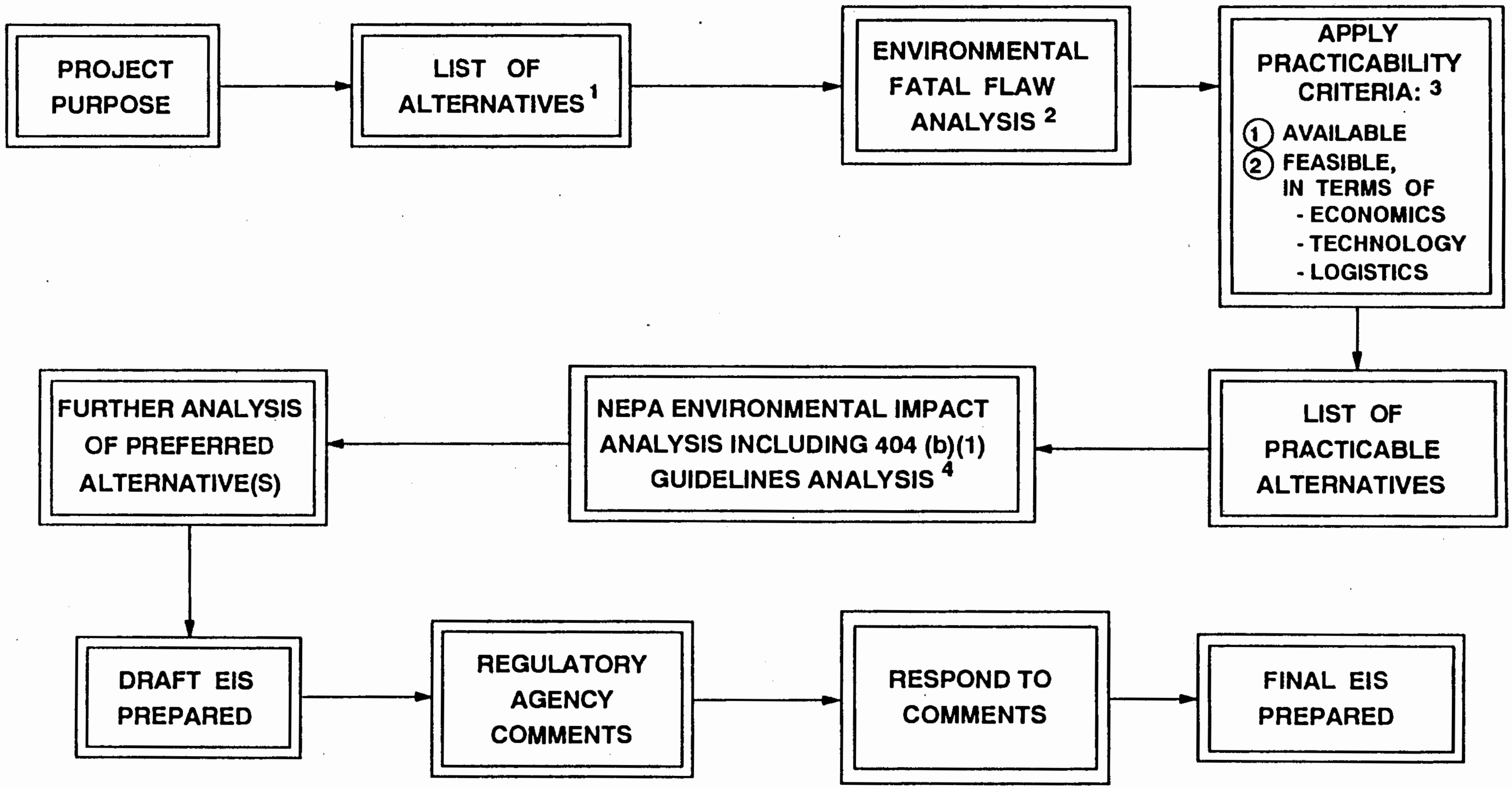
The Section 404(b)(1) Guidelines support a procedure as defined in the regulations that *"no discharge of dredged or fill material may be permitted if there is a practicable alternative to the project that would have less impact on the aquatic ecosystem, so long as the alternative does not have other significant adverse environmental consequences"* (40 CFR, §230.10). Under this procedure the following steps are necessary to select the preferred alternative(s):

- Eliminate alternatives that are not available.
- Eliminate alternatives that are not feasible.
- Eliminate alternatives that have more adverse impact on the aquatic ecosystem.
- Eliminate alternatives with other significant adverse environmental consequences.

In the RRWSG project, there are a large number of potential alternatives. As a result, the evaluation procedure has been optimized by applying evaluation factors in a slightly different manner (see Figure 3-1). The complete alternatives analysis methodology is presented in ***Methodology for Identifying, Screening, and Evaluating Alternatives*** (Report C) (Malcolm Pirnie, 1993). Report C is incorporated herein by reference and is an appendix to this document.

In this procedure, alternatives with unacceptable adverse effects on the aquatic ecosystem, or other obvious significant adverse environmental consequences, were first screened, in an environmental fatal flaw analysis. Practicability criteria were then applied to develop a list of remaining alternatives that are available, and feasible, in terms of cost and technological reliability. Practicable alternatives were then evaluated according to environmental impact criteria to identify the least damaging, practicable alternative(s). Environmental impact categories were developed based on NEPA public interest factors and impact categories for aquatic ecosystems identified in the CWA Section 404(b)(1) Guidelines.

FIGURE 3-1



NOTES:

1. FIRST DEFINED IN USCOE's DECEMBER 17, 1990 SCOPING SUMMARY PREPARED FOLLOWING CLOSE OF COMMENT PERIOD ON USCOE's AUGUST 1, 1990 PUBLIC NOTICE.
2. STEP ELIMINATES, IN PART, ALTERNATIVES WITH UNACCEPTABLE ENVIRONMENTAL IMPACTS.
3. STEP ELIMINATES ALTERNATIVES WHICH ARE NOT PRACTICABLE AS DEFINED IN THE SECTION 404 GUIDELINES.
4. STEP IDENTIFIES PRACTICABLE ALTERNATIVES WHICH HAVE LEAST OVERALL ENVIRONMENTAL IMPACT.

MALCOLM PIRNIE

FEBRUARY 1993
LOWER VIRGINIA PENINSULA
REGIONAL RAW WATER SUPPLY STUDY
METHODOLOGY FOR IDENTIFYING, SCREENING, AND EVALUATING ALTERNATIVES

3.3.2 Practicability Criteria

Four practicability criteria were used in the evaluation. These criteria are availability, cost, technological reliability, and logistics. Availability considered the legal, regulatory, and institutional obstacles that a particular alternative faced. Cost considered the overall, life-cycle cost of an alternative relative to other practicable alternatives and the affordability of projected customer water rate increases. Technological reliability considered the unavoidable failure potential, public health concerns, effectiveness of available treatment technologies, and stage of technological development associated with each alternative. The impact of logistics on project implementation was considered under the availability, cost, and technological reliability criteria. Each of these criteria are discussed in more detail in the following sections.

Availability

Legal, regulatory, and institutional issues can severely delay (i.e., to a point where demand exceeds supply) or even prevent a water development project from being implemented. Necessary land and water rights must be acquired, and in some cases defended in litigation; permits from federal, state, and local agencies obtained; and approvals from other localities obtained in cases of a project located outside the boundaries of the project's owner. An alternative may be considered unavailable if legal, regulatory, or institutional obstacles are insurmountable (e.g., the USCOE, USEPA, Virginia Department of Environmental Quality (VDEQ), Virginia Department of Health (VDH), or another state, federal, or local agency determines that an alternative is not permittable). Any determination of unavailability is based on documentation of severe delays, uncertainties associated with potential permit denials, or other insurmountable legal or institutional constraints.

Cost

Alternatives may be deemed economically infeasible if they are too costly to implement. For example, an alternative that involves costly raw water treatment may impose an unacceptable financial burden on the system's customers (USEPA, 1990). In addition, water purveyors have a responsibility to provide a reasonable cost water supply to their customers, if such a supply is available.

For this study, total life-cycle costs (i.e., capital and operating costs of storage, transmission, and treatment) have been estimated for many of the alternatives. Major costs identified are those associated with construction, land acquisition, power, and/or mitigation.

The affordability of estimated water rates resulting from alternatives has also been examined in light of current state and federal affordability criteria for utility fees. As part of Virginia's Revolving Loan Fund, the Virginia State Water Control Board (SWCB) developed guidelines for determining reasonable wastewater treatment costs for households. These affordability criteria were developed as a percentage of median household income (MHI) and are published in the ***Virginia Revolving Loan Fund - Program Design Manual*** (SWCB, 1991). "More affluent areas" are defined by the SWCB as having a MHI greater than $29,000 per year, which would include the estimated Year 1990 Lower Peninsula MHI of $31,050 per year. The SWCB's corresponding upper limit for affordability is set at 1.5 percent of MHI for wastewater treatment bills in more affluent areas.

The USEPA is now developing guidelines for determining reasonable wastewater treatment costs for households. These affordability criteria are also defined as percentages of MHI and are published in the draft ***Combined Sewer Overflow Financial Capability Assessment Guidebook*** (USEPA, 1993). The affordability ranges developed by the USEPA reflect the Agency's previous experience with water pollution control programs and are defined as follows:

- Readily Affordable: ≤ 1 Percent of MHI
- Affordable: 1 to 2 Percent of MHI
- More Difficult to Afford: ≥ 2 Percent of MHI

These affordability criteria ranges are not expected to change when the USEPA's aforementioned report is finalized later in 1993. As of April 1993, the USEPA estimates that residents in only 4 to 6 percent of communities in the United States incur wastewater treatment costs which exceed a level representing 2 percent of MHI. Costs above the 2 percent MHI level are usually considered very difficult to afford (H. Farmer, USEPA, personal communication, 1993).

The USEPA has not progressed as far in establishing affordability criteria for drinking water costs as for wastewater treatment costs. As of May 1993, the agency did not have any official affordability scale for drinking water. However, for some time the USEPA has been reviewing the variance and exemption process and requirements under the Safe Drinking Water Act (SDWA), and considering how affordability should be determined. Prior to September 1991 the USEPA was considering the following affordability ranges with respect to the community served by the water system:

- Affordable: < 1.4 Percent of MHI
- More Detailed Analysis Required: 1.4 to 2 Percent of MHI
- Unaffordable: > 2 Percent of MHI

The 2 percent of MHI affordability cutoff was developed on at least two bases. First, only a small percentage of communities incur water costs greater than this level. Second, costs for other utilities (e.g., wastewater, electricity, natural gas, telephone) may be in the 2 percent of MHI range. The percentage of MHI approach has been considered since households are often more sensitive to rate increases than other water demand sectors (A. W. Marks, USEPA, personal communication, 1993).

As of May 1993, the USEPA was considering a new "market-based" approach for determining affordability under the SDWA. Under this potential approach, system improvements would not be considered affordable if a community cannot obtain the necessary financing. As of May 1993, the USEPA Office of Groundwater and Drinking Water had not released a timetable for issuing SDWA affordability criteria as part of a rule or as guidance (A. W. Marks, USEPA, personal communication, 1993).

For this study, average Year 1992 Lower Peninsula household water costs were estimated at $170 per year, or 0.55 percent of the estimated Year 1990 Lower Peninsula MHI of $31,050 per year. Based, in part, on state and federal affordability criteria for utility fees that have been developed, or are being developed, an affordability cutoff of 1.5 percent of Lower Peninsula MHI was adopted for this study. In the RRWSG's judgement, this cost feasibility cutoff is conservatively high since it equates to nearly a tripling of consumer drinking water costs.

The rate impacts of several alternatives were projected and compared to the RRWSG's adopted affordability criterion. For example, for an alternative with a present worth life cycle cost estimate of $10.1 million per mgd of treated water safe yield, the projected rate impact calculation considered the annual costs of capital debt service, treatment, distribution, and utility administration. These costs were apportioned to the projected sales of water from the new source. These sales were proportional to the projected deficit. The projected average rate over the 40-year period from the Year 2000 to 2040 for this alternative is $10.30 per thousand gallons in Year 1992 dollars. For an average Lower Peninsula household using 73,000 gallons of water per year, this represents approximately 2.4 percent of the estimated Year 1990 Lower Peninsula MHI. Thus, according to the RRWSG's adopted affordability criterion, this alternative would be infeasible due to excessive cost.

Based on the results of this analysis and rate analyses for alternatives with present worth life cycle cost estimates of between $5 million and $10 million per mgd, alternatives with present worth life cycle cost estimates which are greater than approximately $8 million per mgd of treated water safe yield will be considered infeasible due to excessive cost. Such components would result in household water bills which exceed the RRWSG's adopted affordability criterion of 1.5 percent of Lower Peninsula MHI.

Technological Reliability

Alternatives may be deemed technically infeasible if they are judged vulnerable to mechanical or electrical failures, pipe failures, downtime, or other system disruptions that cannot be eliminated or adequately reduced through redundancy in the design. Storage, or the capacity to deliver partial flows during disruptions, could improve reliability. Serious public health concerns (i.e., documented water quality problems) associated with use of certain water supply sources, as expressed by VDH staff or other qualified experts, may also render an alternative infeasible with respect to technological reliability. In addition, the effectiveness of USEPA-determined Best Available Technology in the treatment of water may be evaluated in determining if an alternative is technologically reliable.

The practicability analysis also examines the reliability of certain technologies. For example, aquifer storage and recovery (ASR) is a relatively new water management technology which is still in the experimental stage in the Virginia Coastal Plain Province. There are major areas of technical uncertainty concerning implementation of ASR in the Lower Peninsula that could reduce its reliability. For example, ASR may be technically infeasible if hydraulic or water/soil chemistry problems preclude development of a suitable aquifer storage zone.

Logistics

Alternatives may be undesirable because of logistical factors. For example, from a logistical standpoint, it may be infeasible to implement several small alternatives rather than a single alternative which can supply all, or most, of the Lower Peninsula's additional water needs. However, logistical factors are taken into consideration under the availability, cost, and technological reliability criteria described above, and no separate logistical evaluation of alternatives was conducted.

3.4 ALTERNATIVES CONSIDERED

This section contains brief descriptions, safe yield estimates, and results of practicability analyses for 31 alternatives. Taken individually, each alternative has the potential to achieve all or part of the goal of providing dependable, long-term public water supply for the Lower Peninsula. The alternatives analysis demonstrated that many alternatives were either:

- Environmentally fatally flawed.
- Unavailable based on permitting, host approval, or legal constraints.
- Infeasible based on cost or technological reliability.

It was not necessary to evaluate all alternatives with respect to all practicability criteria because an alternative can be screened out based on any one of the criteria. The complete practicability analysis is presented in ***Alternatives Assessment***, (Volume I - Practicability Analysis) (Report D) (Malcolm Pirnie, 1993). Report D (Volume I) is incorporated herein by reference and is an appendix to this document.

The general locations of the alternatives are depicted in Figure 3-2 (see map pocket at rear of report). Alternative descriptions are presented in Table 3-1.

3.4.1 Lake Genito

Description

This alternative would require construction of a dam and reservoir on the Appomattox River, and an intake and pump station at Lake Chesdin in the vicinity of the existing Brasfield Dam. The constructed Lake Genito would store 113.7 billion gallons and cover an area of 10,500 acres at a normal pool elevation of 250 feet msl. The reservoir would extend 33 miles upstream on the Appomattox River.

Controlled releases from Lake Genito to Lake Chesdin would allow the Lower Peninsula to withdraw water from Lake Chesdin for transmission to Diascund Creek Reservoir. This would require the construction of a 43-mile, 48-inch, 40-mgd capacity pipeline terminating at the headwaters of Diascund Creek. A 40-mgd pump station near the Diascund Creek dam, a 5.5-mile, 40-mgd capacity pipeline from Diascund Creek Reservoir to Little Creek Reservoir, and a new intake structure and pump station at Lake Chesdin would also be required.

Safe Yield

Safe yield calculations were performed as part of the ***Lake Genito Project Hydrologic Evaluation*** (Black & Veatch, 1988). A computer-based hydrologic model was used to assess

TABLE 3-1

ALTERNATIVE COMPONENTS CONSIDERED	
1. Lake Genito	New 78-foot high dam across the Appomattox River near Genito, Virginia on Amelia/Powhatan County boundary; 113.7-billion gallon lake draining 715 square miles, covering 10,500 acres at pool elevation of 270 feet, and extending 33 miles upstream. Controlled releases from Lake Genito allow pumping from new 40 mgd* intake structure on Lake Chesdin to headwaters of Diascund Creek Reservoir through new 43-mile, 48-inch pipeline. New 40 mgd pump station and 5.5-mile, 42-inch pipeline from Diascund Creek Reservoir to Little Creek Reservoir also required.
2. Lake Chesdin	Water pumped from new 40 mgd intake structure on Lake Chesdin to headwaters of Diascund Creek Reservoir through new 43-mile, 48-inch pipeline. New 40 mgd pump station and 5.5-mile, 42-inch pipeline from Diascund Creek Reservoir to Little Creek Reservoir also required.
3. Lake Anna	Water pumped from new 40 mgd intake structure on Lake Anna (in Louisa County) to headwaters of Diascund Creek Reservoir through new 66-mile, 48-inch pipeline. New 40 mgd pump station and 5.5-mile, 42-inch pipeline from Diascund Creek Reservoir to Little Creek Reservoir also required.
4. Lake Gaston	Water pumped from new 40 mgd intake structure on Lake Gaston (in Brunswick County) to headwaters of Diascund Creek Reservoir through new 86-mile, 54-inch pipeline. New 40 mgd pump station and 5.5-mile, 42-inch pipeline from Diascund Creek Reservoir to Little Creek Reservoir also required.
5. Rappahannock River (above Fredericksburg)	Water pumped from new 75 mgd intake structure on Rappahannock River (in Spotsylvania County, above Embry Dam) to headwaters of Diascund Creek Reservoir through new 89-mile, 66-inch pipeline. New 40 mgd pump station and 5.5-mile, 42-inch pipeline from Diascund Creek Reservoir to Little Creek Reservoir also required.

TABLE 3-1
(Continued)

ALTERNATIVE COMPONENTS CONSIDERED	
6. James River (above Richmond) without New Off-Stream Storage	Water pumped from new 40 mgd intake structure on James River (in Chesterfield County, above Bosher's Dam) to headwaters of Diascund Creek Reservoir through new 50-mile, 48-inch pipeline. New 40 mgd pump station and 5.5-mile, 42-inch pipeline from Diascund Creek Reservoir to Little Creek Reservoir also required.
7. City of Richmond Surplus Raw Water	Water pumped from new 40 mgd intake structure at the Richmond Water Treatment Plant to the headwaters of Diascund Creek Reservoir through new 34-mile, 48-inch pipeline. New 40 mgd pump station and 5.5-mile, 42-inch pipeline from Diascund Creek Reservoir to Little Creek Reservoir also required.
8. City of Richmond Surplus Treated Water	Treated water (25 mgd average, 37 mgd maximum) pumped from Richmond Water Treatment Plant to Waterworks' northern distribution zone in James City County, through new 64-mile transmission main (42-inch pipeline in urban Richmond area; dual 30-inch pipelines with booster pump station for remainder of route).
9. James River (between Richmond and Hopewell)	Water pumped from new 40 mgd pump station on James River in Henrico County (near Hatcher Island) to headwaters of Diascund Creek Reservoir through new 25-mile, 48-inch pipeline. New 40 mgd pump station and 5.5-mile, 42-inch pipeline from Diascund Creek Reservoir to Little Creek Reservoir also required.
10. Ware Creek Reservoir	New 50-foot high dam across Ware Creek on New Kent/James City County boundary; 6.87-billion gallon lake draining 17.4 square miles and covering 1,238 acres at pool elevation of 35 feet. Water pumped from new 20 mgd intake structure to Waterworks raw water mains through new 3.6-mile, 30-inch pipeline. New 1.5-mile, 30-inch pipeline from Waterworks raw water mains to Ware Creek Reservoir also required.

TABLE 3-1
(Continued)

ALTERNATIVE COMPONENTS CONSIDERED	
11. Ware Creek Reservoir & Pamunkey, Mattaponi, and/or Chickahominy River Pumpovers	Similar to No. 10, with 40 mgd pump station and 3.6-mile, 42-inch pipeline from Ware Creek Reservoir to Waterworks raw water mains; plus water pumped from Pamunkey River to Diascund Creek Reservoir (120 mgd pump station, 11.4 miles of 66-inch pipeline and 6.2 miles of 54-inch pipeline), Mattaponi River to Diascund Creek Reservoir (45 mgd pump station, 16.8-mile, 48-inch pipeline), and/or Chickahominy River to Little Creek and Ware Creek Reservoirs (expansion of pump station to 61 or 81 mgd; improvement of all or part of pipeline from Chickahominy River to Little Creek Reservoir; and new 1.5-mile, 42-inch pipeline to Ware Creek Reservoir from existing raw water pipeline). Pamunkey and Mattaponi options also require new 40 mgd pump station and 4.9-mile, 42-inch pipeline from Diascund Creek Reservoir to Ware Creek Reservoir.
12. Ware Creek Reservoir & James River Pumpover (above Richmond)	Similar to No. 10, with 40 mgd pump station and 3.6-mile, 42-inch pipeline from Ware Creek Reservoir to Waterworks raw water mains; plus water pumped from new 75 mgd pump station on James River in Chesterfield County (above Bosher's Dam) to Diascund Creek Reservoir through new 50-mile, 60-inch pipeline. New 40 mgd pump station and 4.9-mile, 42-inch pipeline from Diascund Creek Reservoir to Ware Creek Reservoir also required.
13. Black Creek Reservoir & Pamunkey River Pumpover	Two new dams across southern and eastern branches of Black Creek in New Kent County; 8.4-billion gallon interconnected lake draining 5.5 square miles and covering 1,146 acres at pool elevation of 100 feet; supplemented with water pumped from new 120 mgd pump station on Pamunkey River in New Kent County (at Northbury) through new 5-mile, 66-inch pipeline. Water pumped from new 40 mgd reservoir intake structure to headwaters of Diascund Creek Reservoir through new 7.5-mile, 42-inch pipeline. New 40 mgd pump station and 5.5-mile, 42-inch pipeline from Diascund Creek Reservoir to Little Creek Reservoir also required.
14. Black Creek Reservoir & James River Pumpover (above Richmond)	Similar to No. 13, but supplemented with water pumped from new 75 mgd pump station on James River in Chesterfield County (above Bosher's Dam) through new 43-mile, 60-inch pipeline.

TABLE 3-1
(Continued)

ALTERNATIVE COMPONENTS CONSIDERED	
15. King William Reservoir & Mattaponi River Pumpover	New 90-foot high dam across Cohoke Mill Creek in King William County; 21.7-billion gallon lake draining 13.2 square miles and covering 2,234 acres at pool elevation of 90 feet; supplemented with water from new 75 mgd pump station on Mattaponi River in King William County (at Scotland Landing) through new 1.5-mile, 54-inch pipeline. Water delivered to headwaters of Diascund Creek Reservoir through new 9.9-mile, 42- and 60-inch gravity-flow pipeline (40 mgd capacity). Also includes new 40 mgd pump station and 5.5-mile, 42-inch pipeline from Diascund Creek Reservoir to Little Creek Reservoir.
16. King William Reservoir & Pamunkey River Pumpover	Same as No. 15, but supplemented with water pumped from Pamunkey River near Montague Landing in King William County (100 mgd pump station, 5.7-mile, 60-inch pipeline) instead of Mattaponi River.
17. Chickahominy River Pumping Capacity Increase	Increase pumping capacity of existing Waterworks Chickahominy River pump station in New Kent County from 41 mgd to 61 mgd.
18. Chickahominy River Pumping Capacity Increase and Raise Diascund and Little Creek Dams	Same as No. 17, plus modifying Waterworks' Diascund Creek and Little Creek dams to increase normal pool elevations by 2 feet.
19. Aquifer Storage and Recovery, Constrained by Number of Wells	Withdraw water from Chickahominy River at full capacity when streamflow is high and demand is low; treat and store underground for later use. Treated water injected through new system of 12 wells into underground aquifers when raw water source capacity exceeds system demand; subsequently recovered from same wells when customer demand exceeds treated water supply. Well locations limited to Waterworks property with good access to distribution system.
20. Aquifer Storage and Recovery, Unconstrained by Number of Wells	Same as No. 19, limited only by Chickahominy River withdrawal capacity and amount of surplus streamflow available (about 19 new wells required).
21. Fresh Groundwater Development	New well fields in western James City County and/or eastern New Kent County; used to augment Diascund Creek and Little Creek Reservoirs when system reservoir storage is below 75 percent of total capacity.

TABLE 3-1
(Continued)

ALTERNATIVE COMPONENTS CONSIDERED	
22. Groundwater Desalination as the Single Long-Term Alternative	Large-scale withdrawals from about 27 new wells located throughout the Lower Peninsula and drilled into deep, brackish aquifers, treated in about four or five new desalination plants.
23. Groundwater Desalination in Newport News Waterworks Distribution Area	60 Small-scale withdrawals from about five new wells located adjacent to Waterworks distribution facilities and drilled into deep, brackish aquifers, treated in four new reverse osmosis desalination plants.
24. James River Desalination	Water pumped from new 70 mgd off-shore intake, subaqueous pipeline and pump station on James River (in James City County, about 3,000 feet upstream of Jamestown Ferry Landing) to new 44 mgd reverse osmosis desalination plant near Waller Mill Reservoir through new 9-mile, dual 36-inch pipeline. A 20-mile, 36-inch pipeline and outfall (26 mgd capacity) also required for concentrate disposal. An alternative James River intake site is located 14 miles farther upstream at Sturgeon Point in Charles City County.
25. Pamunkey River Desalination	Water pumped from new 65 mgd intake on Pamunkey River (east of Cohoke Marsh, near Chestnut Grove Landing in New Kent County) to new 44 mgd desalination plant near Waller Mill Reservoir through new 25-mile, 54-inch pipeline. An 8.2-mile, 30-inch pipeline and outfall (21 mgd capacity) also required for concentrate disposal.
26. York River Desalination	Water pumped from new 85 mgd intake on York River (between Sycamore Landing and York River State Park in New Kent County) to new 44 mgd reverse osmosis desalination plant near Waller Mill Reservoir through new 13.6-mile, dual 42-inch pipeline. A 20-mile, 36-inch pipeline and outfall (41 mgd capacity) also required for concentrate disposal.
27. Cogeneration	Purchase drinking water produced through distillation process powered by excess steam from privately-owned cogeneration facility. New intake on York or James River required for raw water source and power plant cooling water; discharge structure and pipeline also required for return of cooling water and concentrate disposal. Private initiative required; capacity, specifications and viability dependent on location and design of privately-owned cogeneration plant and sale of power to a utility company.

TABLE 3-1
(Continued)

ALTERNATIVE COMPONENTS CONSIDERED	
28. Wastewater Reuse as a Source of Potable Water	Blending highly treated wastewater with potable raw water supplies, using new advanced wastewater reclamation plant adjacent to existing HRSD York River WWTP, new multi-compartment reclaimed water lagoon, and new reclaimed water pump station and pipelines to Harwood's Mill and Lee Hall reservoirs.
29. Wastewater Reuse for Non-Potable Uses	One to four systems, each located adjacent to an existing HRSD WWTP on the Lower Peninsula, each providing advanced treatment of WWTP effluent to produce non-potable water suitable for industrial cooling and industrial process use. Each system would include an advanced wastewater reclamation plant, reuse water pump station, distribution system, and storage facilities.
30. Use Restrictions	Contingency measures beyond normal conservation measures, employed to produce short-term reductions in water demand during water supply emergencies; implemented in tiered fashion as emergency intensifies: Tier 1 - voluntary use restrictions; Tier 2 - mandatory use restrictions; and Tier 3 - water rationing.
31. No Action	Do nothing to provide additional raw water supply or curtail water use on the Lower Peninsula. To limit growth, water purveyors could place moratoriums on new hook-ups. (Consideration of this alternative is required in Environmental Impact Statements.)

* mgd = million gallons per day

the affect of alternative operating scenarios, minimum in-stream flow (MIF) conditions, and drawdown constraints on safe yield of the Lake Genito-Lake Chesdin system.

The calculated safe yield of the total reservoir system, Lake Genito plus Lake Chesdin, ranged from 122 to 271 mgd depending on the operating scenario and MIF requirement (Black & Veatch, 1988). Given this range of yield, the proposed reservoir system has the potential to satisfy the water needs of the Lower Peninsula as well as those of the Lake Genito host or "PACC" jurisdictions (Powhatan, Amelia, Cumberland, and Chesterfield Counties) and ARWA members (Chesterfield, Dinwiddie, and Prince George Counties, and the Cities of Colonial Heights and Petersburg). In addition, Chesterfield County's 4.3 billion gallon Swift Creek Reservoir can currently supply 12 mgd based upon the rated capacity of the reservoir water treatment plant. Therefore, depending on how the Genito/Chesdin system is operated, enough surplus raw water could be available to provide a 30.2-mgd treated water safe yield benefit for the Lower Peninsula.

Practicability Analysis

The magnitude of Lake Genito's potential environmental impact is markedly greater than for other alternatives under consideration. Because of these "environmental fatal flaws," this alternative is regarded as unavailable. In addition, Lake Genito is not currently considered permittable by federal regulatory and advisory agencies. Therefore, this alternative is considered unavailable and impracticable at this time.

3.4.2 Lake Chesdin

Description

This alternative would require construction of a 40-mgd intake structure and pumping station at Brasfield Dam (Lake Chesdin) and a 43-mile, 48-inch, 40-mgd capacity raw water pipeline to convey excess Lake Chesdin spills from Lake Chesdin to Diascund Creek Reservoir. A 40-mgd pump station near the Diascund Creek dam, and a 5.5-mile, 40-mgd capacity pipeline from Diascund Creek Reservoir to Little Creek Reservoir would also be required.

The intakes, pump stations, pipeline routes, and outfalls for this alternative are identical to those previously described for the Lake Genito alternative (see Section 3.4.1).

Safe Yield

This alternative's treated water safe yield benefit was calculated at 11.9 mgd using the Newport News Raw Water System Safe Yield Model for a 58-year simulation period.

Practicability Analysis

The estimated present value cost of this alternative per mgd of treated water safe yield benefit would result in projected household water bills which exceed the RRWSG's adopted affordability criterion. In addition, the Lake Chesdin alternative is not considered practicable by federal regulatory and advisory agencies. Therefore, this alternative is considered infeasible and impracticable at this time.

3.4.3 Lake Anna

Description

Lake Anna is an existing 99.4 billion gallon impoundment on the North Anna River which covers 13,000 acres and drains a 243 square mile area (SWCB, 1988). Virginia Power owns and operates this impoundment as a source of cooling water required by two nuclear power plant reactors.

This alternative would require the construction of an intake and a 40-mgd raw water pump station on Lake Anna, approximately 66 miles of 48-inch, 40-mgd capacity raw water pipeline, an outfall on the headwaters of Diascund Creek Reservoir, a 40-mgd pump station near the Diascund Creek Reservoir dam, and a 5.5-mile, 40-mgd capacity pipeline from Diascund Creek Reservoir to Little Creek Reservoir. The intake and pump station would be located adjacent to the existing pump station, and the pipeline would parallel the existing Diascund raw water transmission main.

Safe Yield

A continuous withdrawal of 40 mgd was assumed, with no MIF restrictions or restrictive operating rules. Assuming that raw water transmission, reservoir seepage, and water treatment losses total approximately 10 percent of Lake Anna withdrawals, this alternative would provide a treated water safe yield benefit greater than the projected Year 2040 Lower Peninsula deficit of 30.2 mgd.

Practicability Analysis

Virginia Power is strongly opposed to the use of Lake Anna as a public water supply. In addition, there are severe legal and technical constraints which exist with respect to this alternative. As a result, this alternative is not considered available by federal regulatory and advisory agencies. Therefore, this alternative is considered unavailable and impracticable at this time.

3.4.4 Lake Gaston

Description

This alternative would consist of an intake and a 40-mgd raw water pump station on Lake Gaston, approximately 86 miles of 54-inch, 40-mgd capacity raw water pipeline, and an outfall at Diascund Creek Reservoir. The design capacity of the Lake Gaston pipeline system to Virginia Beach is not sufficient to accommodate this additional flow.

A new 40-mgd capacity intake structure and pump station would be required at the Diascund Creek Reservoir dam to convey water through a 5.5-mile, 42-inch, 40-mgd capacity pipeline to the Little Creek Reservoir.

Safe Yield

A continuous withdrawal of 40 mgd was assumed, with no MIF restrictions or restrictive operating rules. Assuming that raw water transmission, reservoir seepage, and water treatment losses total approximately 10 percent of Lake Gaston withdrawals, this alternative would provide a treated water safe yield benefit greater than the projected Year 2040 Lower Peninsula deficit of 30.2 mgd.

Practicability Analysis

Legal conflicts have stalled the City of Virginia Beach's progress on the Lake Gaston Pipeline Project for more than 9 years. Given the likelihood of strong project opposition arguing the potential for cumulative impacts, it is expected that equally or more challenging legal conflicts than Virginia Beach has experienced would block or severely delay any proposal by the RRWSG for additional withdrawals from Lake Gaston. This alternative is also not considered available by federal regulatory and advisory agencies. Therefore, this alternative is considered unavailable and impracticable at this time.

3.4.5 Rappahannock River Above Fredericksburg

Description

This alternative would consist of an intake and 75-mgd raw water pump station on the Rappahannock River above Fredericksburg, approximately 89 miles of 66-inch, 75-mgd capacity river water pipeline, an outfall on the headwaters of the Diascund Creek Reservoir, a 40-mgd pump station near the Diascund Creek dam, and a 5.5-mile, 40-mgd capacity pipeline from Diascund Creek Reservoir to Little Creek Reservoir.

Safe Yield

The treated water safe yield benefit of this alternative was calculated at 7.9 mgd using the Newport News Raw Water System Safe Yield Model for a 58-year simulation period.

Practicability Analysis

The estimated present value cost of this alternative per mgd of treated water safe yield benefit would result in projected household water bills which exceed the RRWSG's adopted affordability criterion. In addition, the current pursuit of additional Rappahannock River withdrawals by Fredericksburg-area jurisdictions would greatly magnify the degree of difficulty associated with the RRWSG gaining approvals for this alternative. For these reasons, this alternative is not considered practicable by federal regulatory and advisory agencies. Therefore, this alternative is considered unavailable, infeasible, and impracticable at this time.

3.4.6 James River Above Richmond Without New Off-Stream Storage

Description

This alternative would involve a 40-mgd raw water intake and pumping station located on the James River, approximately 50 miles of 48-inch, 40-mgd capacity river water pipeline, a 40-mgd pump station near the Diascund Creek dam, and a 5.5-mile, 40-mgd capacity pipeline from Diascund Creek Reservoir to Little Creek Reservoir.

Safe Yield

This alternative's safe yield benefit was calculated using the Newport News Raw Water System Safe Yield Model for 51-year simulation periods. Treated water safe yield benefits of 7.1 and 7.9 mgd were calculated for 40- and 75-mgd James River diversion capacities, respectively.

Practicability Analysis

The estimated present value cost of this alternative per mgd of treated water safe yield benefit would result in projected household water bills which exceed the RRWSG's adopted affordability criterion. In addition, the Richmond Regional Planning District

Commission (RRPDC) has taken a strong position against Lower Peninsula withdrawals from the James River above Richmond. This position indicates that this alternative is institutionally not permittable. Furthermore, the intense competition for James River water between the City of Richmond and Henrico County could severely delay any RRWSG efforts to pursue this alternative. For these reasons, this alternative is not considered practicable by federal regulatory and advisory agencies. Therefore, this alternative is considered unavailable, infeasible, and impracticable at this time.

3.4.7 City of Richmond Surplus Raw Water

Description

This alternative would involve a 40-mgd raw water intake and pumping station located in the City of Richmond, approximately 34 miles of 48-inch, 40-mgd capacity raw water pipeline, a 40-mgd pump station near the Diascund Creek dam, and a 5.5-mile, 40-mgd capacity pipeline from Diascund Creek Reservoir to Little Creek Reservoir.

Safe Yield

For purposes of calculating maximum theoretical yield, it was initially assumed that a continuous withdrawal of 40 mgd was possible, with no MIF restrictions or restrictive operating rules. With these assumptions, and assuming that raw water transmission, reservoir seepage, and water treatment losses total approximately 10 percent of withdrawals, this alternative would provide a safe yield benefit greater than the projected Year 2040 Lower Peninsula deficit of 30.2 mgd. However, in light of recent consultation with the USCOE and SWCB, a treated water safe yield benefit of 7.1 mgd is instead assumed for this alternative.

Practicability Analysis

The estimated present value cost of this alternative per mgd of treated water safe yield benefit would result in projected household water bills which exceed the RRWSG's adopted affordability criterion. In addition, the RRPDC has taken a strong position against Lower Peninsula withdrawals from the James River at Richmond. This position indicates that this alternative is institutionally not permittable. For these reasons, this alternative is not considered practicable by federal regulatory and advisory agencies. Therefore, this alternative is considered unavailable, infeasible, and impracticable at this time.

3.4.8 City of Richmond Surplus Treated Water

Description

This alternative would involve the transmission of treated water approximately 64 miles from the Richmond Water Treatment Plant (WTP) to the Northern Zone of the Newport News Waterworks distribution system in James City County. The transmission main from Richmond would be designed to handle average and maximum day flows of 25 and 37 mgd, respectively, in the Year 2040. A single 42-inch, or dual 30-inch diameter main would be required, and would connect to the Newport News Waterworks system at the Upper York Ground Storage Tank.

Safe Yield

The "preferred water system alternative" in the ***Regional Water Resources Plan for Planning District 15*** calls for expansion of the Richmond WTP capacity to 132 mgd. However, it is possible that for relatively low incremental costs the WTP capacity could be expanded to 150 mgd through the use of higher filtration rates. This increase in rated capacity would have to be permitted by the VDH, which has indicated some concerns about such a proposal (RRPDC, 1992). If Richmond is successful in expanding its WTP capacity to 150 mgd, then this alternative's potential treated water safe yield benefit would increase from 12.1 to 23.9 mgd on an average day demand basis. For purposes of this analysis, it is assumed that this is the case and that this alternative offers a maximum treated water safe yield of 23.9 mgd.

Practicability Analysis

The estimated present value cost of this alternative per mgd of treated water safe yield benefit would result in projected household water bills which exceed the RRWSG's adopted affordability criterion. In addition, there are major uncertainties concerning the availability of surplus treated water from the City of Richmond. These uncertainties are outside the control of RRWSG member jurisdictions. For these reasons, this alternative is not considered practicable by federal regulatory and advisory agencies. Therefore, this alternative is considered unavailable, infeasible, and impracticable at this time.

3.4.9 James River Between Richmond and Hopewell

Description

This alternative would consist of an intake and 40-mgd raw water pump station on the James River between Richmond and Hopewell, approximately 25 miles of 48-inch, 40-mgd capacity river water pipeline, an outfall at Diascund Creek Reservoir, a 40-mgd pump station near the Diascund Creek dam, and a 5.5-mile, 40-mgd capacity pipeline from Diascund Creek Reservoir to Little Creek Reservoir.

Safe Yield

A continuous withdrawal of 40 mgd was assumed, with no MIF restrictions or restrictive operating rules. Assuming that raw water transmission, reservoir seepage, and water treatment losses total approximately 10 percent of James River withdrawals, this alternative would provide a treated water safe yield benefit greater than the projected Year 2040 Lower Peninsula deficit of 30.2 mgd.

Practicability Analysis

The Virginia Department of Health (VDH) has taken a strong position against withdrawals from the James River between Richmond and Hopewell for public water supply. These comments are discussed below and indicate that this alternative is not considered permittable by the State. In addition, this alternative is not considered practicable by federal regulatory and advisory agencies. Therefore, this alternative is considered unavailable and impracticable at this time.

3.4.10 Ware Creek Reservoir

Description

This alternative would require the construction of a dam on Ware Creek at "Dam Site V" as documented in the ***Final Environmental Impact Statement - James City County's Water Supply Reservoir on Ware Creek*** (USCOE, 1987). The dam would be a 50-foot high, 1,450-foot long structure located approximately 1,000 feet downstream from the confluence of Ware Creek and France Swamp on the boundary between James City and New Kent Counties. The 1,238-acre reservoir would drain 17.4 square miles and store 6.87 billion gallons at a normal pool elevation of 35 feet msl. Ware Creek Reservoir could be supplied solely by natural inflows from drainage basin runoff. A 20-mgd raw water intake and pump station would also be required at Ware Creek Reservoir to convey raw water through a 3.6-mile, 30-inch, 20-mgd capacity pipeline to the existing Newport News Waterworks raw water mains. Approximately 1.5 miles of 30-inch pipeline would be required from the existing Newport News Waterworks' raw water mains to Ware Creek Reservoir.

Safe Yield

This alternative's treated water safe yield benefit for the Lower Peninsula was calculated at 7.1 mgd using the Newport News Raw Water System Safe Yield Model for a 58-year simulation period. This safe yield is based upon operation of Ware Creek Reservoir as an interconnected component of the existing Newport News Waterworks raw water system. Without this interconnection, Malcolm Pirnie has estimated this project's treated water safe yield benefit for the Lower Peninsula at 4.7 mgd.

Practicability Analysis

The history of regulatory and judicial proceedings associated with this alternative demonstrate the highly uncertain fate of Ware Creek Reservoir as a local supply (i.e., without modification or expansion to serve a larger regional need). In December 1993 the U.S. Court of Appeals for the Fourth Circuit issued a decision upholding the USEPA's second "veto" of James City County's proposed Ware Creek Reservoir Project. Consequently, this alternative (without expansion) is currently considered impracticable. This practicability determination is made with the understanding that there are also serious concerns regarding long-term reservoir water quality deterioration given the extensive nature of planned development in the watershed.

In the interests of serving more of the RRWSG's future needs and avoiding legal challenges wherever possible, only an expanded Ware Creek Reservoir alternative will be carried forward for further environmental analysis.

3.4.11 Ware Creek Reservoir With Pumpovers From Pamunkey, Mattaponi, and/or Chickahominy Rivers

Description

This alternative would involve a raw water intake and pumping station located on the Pamunkey, Mattaponi, and/or Chickahominy Rivers, a river water pipeline from the river source(s) to Diascund Creek Reservoir, Diascund Creek Reservoir withdrawal and transmission improvements which depend on the river source, a 1,450-foot long dam on Ware Creek, and Ware Creek Reservoir withdrawal and transmission improvements. Each of the three possible river pumpover sources are discussed individually.

Pamunkey River

A 120-mgd raw water intake and pumping station would be located in the vicinity of Northbury on the southern bank of the Pamunkey River in northwestern New Kent County. Northbury is located approximately 40 river miles upstream from the mouth of the Pamunkey River. From Northbury, river withdrawals would be pumped to Diascund Creek Reservoir through 11.4 miles of 66-inch, 120-mgd capacity pipeline and 6.2 miles of 54-inch, 80-mgd capacity pipeline. A 40-mgd capacity outfall on Diascund Creek in New Kent County would also be required.

Mattaponi River

A 45-mgd raw water intake and pumping station would be located in the vicinity of Scotland Landing on the southern bank of the Mattaponi River in King William County. Scotland Landing is located 24.2 river miles upstream from the mouth of the Mattaponi River. From Scotland Landing, river withdrawals would be pumped to Diascund Creek Reservoir through 16.8 miles of 48-inch, 45-mgd capacity pipeline. The raw water pipeline outfall would be located on Beaverdam Creek in New Kent County.

Chickahominy River (81-mgd Total Withdrawal Capacity)

The City of Newport News Waterworks' existing Walkers pumping station capacity, when pumping to Little Creek and/or Ware Creek reservoirs, would be expanded to 81 mgd, approximately equal to the capacity of the existing intake works. This intake and pumping station site is located on the northern bank of the Chickahominy River in southeastern New Kent County.

For this pumpover, up to 81 mgd would be pumped approximately 7.5 miles to Little Creek Reservoir in James City County, where 41 mgd would be discharged, while 40 mgd would flow an additional 1.8 miles to Ware Creek Reservoir. Under this method of operation, no flow from the Walkers pump station would be conveyed directly to the terminal reservoirs, although the capability to do so would still exist. If Ware Creek and Little Creek reservoirs were full, all flow from the Walkers pump station would be directed to the terminal reservoirs, although at a rate less than the 81-mgd maximum rate previously mentioned.

To facilitate diversion of water to Ware Creek Reservoir, approximately 1.5 miles of pipeline would be required from the existing Newport News Waterworks raw water mains to Ware Creek Reservoir, and the replacement or paralleling of all or a portion of the existing Old Chickahominy main from Walkers pump station to the existing Little Creek outfall.

Chickahominy River (61-mgd Total Withdrawal Capacity)

An alternative to expanding the City of Newport News Waterworks' existing Chickahominy River withdrawal capacity to 81 mgd would be to increase the Walkers pumping capacity to 61 mgd, when pumping water to Little Creek and/or Ware Creek reservoirs.

For this pumpover, up to 61 mgd of raw water would be pumped from the Walkers pumping station to either Little Creek or Ware Creek reservoirs. Similar to the 81-mgd option previously described, no flow from the Walkers pumping station would be conveyed directly to the terminal reservoirs when the maximum flow of 61 mgd is being discharged to Little Creek and/or Ware Creek reservoirs.

The pumpover to Ware Creek would require 1.5 miles of pipeline from the existing Newport News Waterworks raw water mains to Ware Creek Reservoir, as described for the 81-mgd option.

Diascund Creek Reservoir Withdrawal and Transmission Improvements

For the Pamunkey and Mattaponi river pumpover scenarios, a new 40-mgd capacity intake structure and pump station would be required at the Diascund Creek Reservoir dam to convey water through a 4.9-mile, 42-inch 40-mgd capacity pipeline to Ware Creek Reservoir.

For the Pamunkey and Mattaponi river pumpover scenarios, the majority of water diverted to Ware Creek Reservoir would come from these rivers via Diascund Creek Reservoir. Other lesser amounts of water would be diverted to Ware Creek Reservoir from the Chickahominy River. In order to receive these potential water diversions, two raw water outfalls are proposed in the Ware Creek Reservoir watershed. This outfall would be used to receive water diverted from Diascund Creek Reservoir.

For the Pamunkey and Mattaponi river pumpover scenarios, a second outfall would be located on France Swamp near the southernmost point of the proposed reservoir normal pool area. This outfall would be used to receive water diverted from the Chickahominy River.

Ware Creek Reservoir

A dam on Ware Creek would be constructed at "Dam Site V" as documented in the ***Final Environmental Impact Statement - James City County's Water Supply Reservoir on Ware Creek*** (USCOE, 1987). This 50-foot high, 1,450-foot long dam would be located approximately 1,000 feet downstream from the confluence of Ware Creek and France Swamp on the boundary between James City and New Kent counties. The 1,238-acre reservoir would drain 17.4 square miles and store 6.87 billion gallons at a normal pool elevation of 35 feet msl.

A 40-mgd raw water intake and pump station would be required at Ware Creek Reservoir to convey raw water through a 3.6-mile, 42-inch 40-mgd capacity pipeline to the existing Newport News Waterworks raw water mains. The intake and pump station would be located on the France Swamp branch of the reservoir, on the northern tip of a small peninsula, approximately 1.1 miles east-southeast of the Route 600 crossing of Interstate 64 in James City County.

Safe Yield

This alternative's safe yield benefit was calculated using the Newport News Raw Water System Safe Yield Model for 58-year simulation periods. Individual pumpovers and some combinations of pumpovers were evaluated in conjunction with Ware Creek Reservoir. Treated water safe yield benefits, as listed below, were calculated for the various pumpover scenarios considered.

Pumpover Source (River(s))	**Diversion Capacity (mgd)**	**Treated Water Safe Yield Benefit (mgd)**
Pamunkey	40	14.9
Pamunkey	70	18.6
Pamunkey	100	21.9
Pamunkey/Chickahominy	100 / 61	24.3
Pamunkey	120	24.1
Pamunkey/Chickahominy	120 / 61	24.9
Mattaponi	45	18.8

Pumpover Source (River(s))	Diversion Capacity (mgd)	Treated Water Safe Yield Benefit (mgd)
Mattaponi	60	18.8
Mattaponi	75	19.0
Mattaponi	100	19.0
Chickahominy	61	13.3
Chickahominy	81 *	13.0

* Assumed MIF policy is more restrictive than that used in the simulation of the 61 mgd maximum Chickahominy River withdrawal capacity.

The above safe yield determinations are based on operation of Ware Creek Reservoir as an interconnected component of the existing Newport News Waterworks system.

Practicability Analysis

Separate practicability assessments for the Pamunkey, Mattaponi, and Chickahominy River pumpover scenarios are summarized below.

Pamunkey Pumpover

Based on information compiled to date, there is no basis for deeming this alternative (with Pamunkey River pumpover) impracticable. Therefore, the Ware Creek Reservoir with Pumpover from Pamunkey River alternative has been retained for further environmental analysis.

Mattaponi Pumpover

A substantial reduction in project safe yield would occur as a result of using the Mattaponi River rather than the Pamunkey River as a pumpover source for Ware Creek Reservoir. Based on safe yield modeling results presented previously, this reduction would be more than 5 mgd. Consequently, 30.2-mgd project alternative which includes Ware Creek Reservoir with Mattaponi River pumpover would require development of a greater number of water sources than the Pamunkey River pumpover option. Environmental impacts associated with developing more water sources would likewise be greater.

The pipeline route required for the Mattaponi River pumpover scenario would be longer than for the Pamunkey River pumpover and would require crossing an additional river basin divide and the Pamunkey River. As a result, additional stream crossings and greater land disturbance would occur. Energy requirements to pump river withdrawals would also be greater, thereby creating additional energy consumption and associated impacts from increased energy production. With these increased construction and operating costs, total project costs for the Mattaponi River pumpover scenario would be higher with no reduction in impacts.

King William County has authority under the local consent provisions of Title 15.1 of the Code of Virginia, and other statutory authorities, to review and approve or disapprove any public water supply project components that would be built by any other jurisdiction and located in King William County. One of the key requirements for obtaining the County's local consent is the ability of an alternative to provide the County with a future water supply. Without a reservoir in King William County, Mattaponi River withdrawals would not supply the County with a reliable water supply during low flow periods when the MIF policy would prohibit river withdrawals. Therefore, the County has stated its opposition to a Mattaponi River withdrawal without a local reservoir (D. S. Whitlow, King William County, personal communication, 1992). King William County has thus given a strong indication that it would deny local consent for the construction of the Mattaponi River intake structure, pumping station, and raw water transmission line required for this Ware Creek Reservoir pumpover alternative.

The RRWSG has concluded that based on the environmental, technical, and political constraints summarized above, a Mattaponi River pumpover to Ware Creek Reservoir is impracticable. Based on this evaluation, and the following practicability analysis for the Chickahominy River pumpover, the RRWSG has also concluded that only the Pamunkey River pumpover to Ware Creek Reservoir should be retained for further environmental analysis of this alternative.

Chickahominy Pumpover

The 0.8 mgd incremental safe yield benefit from raising the maximum Chickahominy River withdrawal to 61 mgd is not considered sufficient to justify its inclusion as part of this alternative.

Given the current regulatory emphasis on streamflow protection, increasing the maximum Chickahominy River withdrawal would likely trigger more restrictive MIF requirements. Therefore, increasing the maximum Chickahominy withdrawal, to supply and substantially augment the safe yield of Ware Creek Reservoir, is not considered to be available from a regulatory standpoint.

The Governor's conditional consent and approval of Little Creek Dam suggests that the maximum Chickahominy River withdrawal cannot be increased, at least without approval of the Governor.

The Chickahominy River is already critical to the welfare of the Lower Peninsula and excessive reliance on this single river source would not be prudent. Additional reliance on the Chickahominy would not provide a backup source in the event of water quality excursions or extreme low flows that severely limit Chickahominy River withdrawals. Also, with the uncertainties of future more restrictive MIF policies, it is not prudent to increase reliance on the Chickahominy River.

Several water quality concerns represent a considerable cumulative threat to long-term water quality in the Chickahominy River. Greater reliance on Chickahominy withdrawals would magnify this threat and would not provide an alternative source in the event of contamination.

Increasing the maximum Chickahominy River withdrawal to 61 mgd would raise the maximum withdrawal to 30 percent of average streamflow at the intake. There is no precedent in Virginia for this degree of reliance on a river source by a major municipal water purveyor.

Based on concerns with respect to reliability of water quality and quantity, increasing the maximum Chickahominy River withdrawal is not considered feasible as part of a long-term alternative.

For the reasons outlined above, increasing the maximum Chickahominy River withdrawal to 61 mgd or more, in conjunction with building Ware Creek Reservoir, is not considered practicable. Likewise, this alternative is not considered practicable by federal regulatory and advisory agencies. Therefore, this alternative is considered unavailable, infeasible, and impracticable at this time.

3.4.12 Ware Creek Reservoir With Pumpover From James River Above Richmond

Description

This alternative would involve a 75-mgd raw water intake and pumping station located on the James River, approximately 50 miles of 75 mgd-capacity river water pipeline, a 40-mgd intake and pump station near the Diascund Creek dam, a 4.9-mile, 40-mgd capacity pipeline from Diascund Creek Reservoir to Ware Creek Reservoir, a 1,450-foot long dam on Ware Creek, and Ware Creek Reservoir withdrawal and transmission improvements.

Safe Yield

This alternative's safe yield benefit was calculated using the Newport News Raw Water System Safe Yield Model for 51-year simulation periods. Treated water safe yield benefits of 21.1 and 28.3 mgd were calculated for 40- and 75-mgd James River diversion capacities, respectively. These safe yield determinations are based on operation of Ware Creek Reservoir as an interconnected component of the existing Newport News Waterworks system. The assumed James River MIF policy and pumpover scenarios were identical to those used for the James River above Richmond without New Off-Stream Storage alternative (see Section 3.6.2).

Practicability Analysis

The RRPDC has taken a strong position against Lower Peninsula withdrawals from the James River above Richmond. This position indicates that this alternative is institutionally not permittable. Furthermore, the intense competition for James River water between the City of Richmond and Henrico County could severely delay any RRWSG efforts to pursue this alternative. For these reasons, this alternative is not considered practicable by federal regulatory and advisory agencies. Therefore, this alternative is considered unavailable and impracticable at this time.

3.4.13 Black Creek Reservoir with Pumpover From Pamunkey River

Description

This alternative would involve a 120-mgd raw water intake and pumping station located on the Pamunkey River, approximately 5 miles of 120-mgd capacity and 1.2 miles of 50-mgd capacity river water pipeline, a 1,200-foot long dam on the Southern Branch Black Creek, a 1,100-foot long dam on the eastern branch of Black Creek, an intake structure within the Southern Branch impoundment area and a 20-mgd reservoir interconnection pipeline, a 40-mgd intake and pump station on the eastern branch of Black Creek, a 7.5-mile, 40-mgd raw water pipeline, a 40-mgd intake and pump station near the Diascund Creek dam, and a 5.5-mile, 40-mgd capacity pipeline from Diascund Creek Reservoir to Little Creek Reservoir.

Safe Yield

This alternative's safe yield benefit was calculated using the Newport News Raw Water System Safe Yield Model for 58-year simulation periods. Treated water safe yield benefits of 11.6 mgd, 15.8 mgd, 19.3 mgd, and 21.3 mgd were calculated for Pamunkey River diversion capacities of 40 mgd, 70 mgd, 100 mgd, and 120 mgd, respectively.

Practicability Analysis

Based on information compiled to date, there is no basis for deeming this alternative impracticable. Therefore, this alternative has been retained for further environmental analysis.

3.4.14 Black Creek Reservoir With Pumpover From James River Above Richmond

Description

This alternative would involve a 75-mgd raw water intake and pumping station located on the James River, approximately 43 miles of 75-mgd capacity river water pipeline, a 1,200-foot long dam on the Southern Branch Black Creek, a 1,100-foot long dam on the eastern branch of Black Creek, an intake structure within the Southern Branch impoundment area and a 20-mgd reservoir interconnection pipeline, a 40-mgd intake and pump station on the eastern branch of Black Creek, a 7.5-mile, 40-mgd raw water pipeline, a 40-mgd intake and pump station near the Diascund Creek dam, and a 5.5-mile, 40-mgd capacity pipeline from Diascund Creek Reservoir to Little Creek Reservoir.

Safe Yield

This alternative's safe yield benefit was calculated using the Newport News Raw Water System Safe Yield Model for 51-year simulation periods. Treated water safe yield benefits of 17.6 and 25.4 mgd were calculated for 40- and 75-mgd James River diversion capacities, respectively. These determinations are based on operation of Black Creek Reservoir as an interconnected component of the existing Newport News Waterworks system.

Practicability Analysis

The estimated present value cost of this alternative per mgd of treated water safe yield benefit would result in projected household water bills which exceed the RRWSG's adopted affordability criterion. In addition, RRPDC has taken a strong position against Lower Peninsula withdrawals from the James River above Richmond. This position indicates that this alternative is institutionally not permittable. Furthermore, the intense competition for James River water between the City of Richmond and Henrico County could severely delay any RRWSG efforts to pursue this alternative. For these reasons, this alternative is not considered practicable by federal regulatory and advisory agencies. Therefore, this alternative is considered unavailable, infeasible, and impracticable at this time.

3.4.15 King William Reservoir With Pumpover From Mattaponi River

Project Description

This alternative would involve a 75-mgd raw water intake and pumping station located on the Mattaponi River, approximately 1.5 miles of 54-inch, 75-mgd capacity river water pipeline, a 2,400-foot long dam on Cohoke Mill Creek, a 9.9-mile, 42-inch and 60-inch, 40-mgd capacity gravity raw water pipeline, a 40-mgd pump station near the Diascund Creek dam, and a 5.5-mile, 40-mgd capacity pipeline from Diascund Creek Reservoir to Little Creek Reservoir.

Safe Yield

This alternative's safe yield benefit was calculated using the Newport News Raw Water System Safe Yield Model for 58-year simulation periods. Treated water safe yield benefits, as listed below, were calculated for the various pumpover scenarios considered.

Mattaponi River Diversion Capacity (mgd)	Treated Water Safe Yield Benefit (mgd)
45	21.9
60	24.2
75	26.4
100	29.5

Practicability Analysis

Based on information compiled to date, there is no basis for deeming this alternative impracticable. Therefore, this alternative has been retained for further environmental analysis.

3.4.16 King William Reservoir With Pumpover From Pamunkey River

Description

This alternative would involve a 100-mgd raw water intake and pumping station located on the Pamunkey River, approximately 5.7 miles of 60-inch, 100-mgd capacity river water pipeline, a 2,400-foot long dam on Cohoke Mill Creek, a 9.9-mile, 42-inch and 60-inch, 40-mgd capacity gravity raw water pipeline, a 40-mgd pump station near the Diascund Creek dam, and a 5.5-mile, 40-mgd capacity pipeline from Diascund Creek Reservoir to Little Creek Reservoir.

Safe Yield

This alternative's safe yield benefit was calculated using the Newport News Raw Water System Safe Yield Model for 58-year simulation periods. Treated water safe yield benefits of 15.4 mgd, 21.6 mgd, and 25.1 mgd were calculated for Pamunkey River diversion capacities of 40 mgd, 70 mgd, and 100 mgd, respectively. These determinations are based on operation of King William Reservoir as an interconnected component of the existing Newport News Waterworks system.

Practicability Analysis

The pipeline route to King William Reservoir from the Pamunkey River would be nearly four times as long as from the Mattaponi River and would require a larger diameter pipeline. As a result, additional stream crossings and greater land disturbance would occur. Energy requirements to pump river withdrawals would also be greater, thereby creating additional energy consumption and associated impacts from increased energy production. With these increased construction and operating costs, total project costs for the Pamunkey River pumpover scenario would be higher with no reduction in impacts.

Existing and projected future water demands are much greater in the Pamunkey River basin than in the Mattaponi River basin. Estimated Year 1990 consumptive water use in the Pamunkey River basin is 15 times as great as that estimated for the Mattaponi River basin. This disparity would grow even larger as a result of Hanover County's active pursuit of major Pamunkey River withdrawals to supply the proposed Crump Creek Reservoir or an alternative sidehill impoundment.

The number of existing and planned discharges to the Pamunkey River gives rise to water quality reliability concerns that do not exist for the Mattaponi River. There are currently several point source discharges to the Pamunkey River basin including four SWCB-designated "major" municipal and industrial discharges upstream of Northbury. In addition, Hanover County, King William County, and New Kent County have each recently planned or proposed new wastewater treatment plant (WWTP) discharges to the mainstem Pamunkey River or its tributaries. In contrast, there are currently no major municipal or industrial discharges in the Mattaponi River basin. Furthermore, the SWCB has no record of any permitted point sources in the SWCB-designated "waterbody" which Scotland Landing falls within. This waterbody extends more than 30 river miles upstream of and 11 river downstream of Scotland Landing.

Pamunkey River withdrawals could impact existing dischargers to the basin. With proposed Pamunkey River withdrawals in place, permitted wastewater dischargers within a state-designated public water supply zone would have to comply with more stringent water quality standards. In addition, disinfection requirements would apply to permitted sewage discharges which are within 15 miles upstream or one tidal excursion downstream from the water supply intake. Compliance with these more stringent state standards could require dischargers to provide additional wastewater treatment. Such impacts are not anticipated in the Mattaponi River due to the absence of existing or planned discharges.

King William County has authority under the local consent provisions of Title 15.1 of the Code of Virginia, and other statutory authorities, to review and approve or disapprove any public water supply project components that would be built by any other jurisdiction and located in King William County. The County has stated its opposition to Lower Peninsula withdrawals from the Pamunkey River for use in augmenting storage in the proposed King William Reservoir (D. S. Whitlow, King William County, personal communication, 1992). King William County has thus given a strong indication that it would deny local consent for the construction of the Pamunkey River intake structure, pumping station, and raw water transmission line required for this King William Reservoir pumpover alternative. This position indicates that this alternative is institutionally not permittable.

The RRWSG has evaluated various pumpover scenarios for King William Reservoir and concluded that only one version of the King William Reservoir alternative should be retained for further environmental analysis. Based on the environmental, technical, and political constraints of this alternative summarized above, a Pamunkey River pumpover to King William Reservoir is considered less practicable than a Mattaponi River pumpover. Therefore, a Pamunkey River pumpover scenario for King William Reservoir was not retained for further environmental analysis.

3.4.17 Chickahominy River Pumping Capacity Increase

Description

This alternative would involve increasing the pumping capacity of the existing Newport News Waterworks Chickahominy River pumping station to 61 mgd, when pumping water to Little Creek Reservoir only. Existing station rehabilitation plans and the addition of a new Little Creek Reservoir outfall will result in a maximum pumping capacity to Little Creek of 57.5 mgd. Once this rehabilitation is complete, the installation of two additional pumps would provide a maximum pumping capacity to Little Creek of 61 mgd.

Safe Yield

This alternative's treated water safe yield benefit was calculated at 0.2 mgd using the Newport News Raw Water System Safe Yield Model for a 58-year simulation period. The lack of a substantial safe yield benefit for this alternative illustrates that available raw water storage is currently the limiting factor in the safe yield of the Newport News Waterworks system. In combination with other alternatives involving new storage, the safe yield benefit would be greater (see Sections 3.4.11 and 3.4.18).

Practicability Analysis

The 0.2 mgd incremental safe yield benefit from raising the maximum Chickahominy River withdrawal to 61 mgd is not considered sufficient to justify it as practicable.

Given the current regulatory emphasis on streamflow protection, increasing the maximum Chickahominy River withdrawal could trigger more restrictive MIF requirements. Therefore, increasing the maximum Chickahominy withdrawal is not considered to be available from a regulatory standpoint.

The Governor's conditional consent and approval of Little Creek Dam suggests that the maximum Chickahominy River withdrawal cannot be increased, at least without approval of the Governor.

The Chickahominy River is already critical to the welfare of the Lower Peninsula and excessive reliance on this single river source would not be prudent. Additional reliance on the Chickahominy would not provide a backup source in the event of water quality excursions or extreme low flows that severely limit Chickahominy River withdrawals. Also, with the uncertainties of future more restrictive MIF policies, it is not prudent to increase reliance on the Chickahominy River.

Several water quality concerns represent a considerable cumulative threat to long-term water quality in the Chickahominy River. Greater reliance on Chickahominy withdrawals would magnify this threat and would not provide an alternative source in the event of contamination.

Increasing the maximum Chickahominy River withdrawal to 61 mgd would raise the maximum withdrawal to 30 percent of average streamflow at the intake. There is no precedent in Virginia for this degree of reliance on a river source by a major municipal water purveyor.

Based on the preceding concerns with respect to availability and reliability of water quality and quantity, increasing the maximum Chickahominy River withdrawal to 61 mgd, or more, is currently considered unavailable, infeasible, and impracticable. In addition, this alternative is not considered practicable by federal regulatory and advisory agencies.

3.4.18 Chickahominy River Pumping Increase and Raising Diascund and Little Creek Dams

Description

This alternative would involve increasing the pumping capacity of the existing Newport News Waterworks Chickahominy River pumping station (as discussed in Section 3.4.17), and increasing reservoir storage. Normal pool elevations of Newport News Waterworks' Little Creek and Diascund Creek reservoirs would be raised by 2 feet, and the Chickahominy River pump station maximum pumping capacity, when pumping to Little Creek Reservoir only, would be increased to 61 mgd.

Raising the normal pool elevation at Little Creek would require, at a minimum, the addition of a flood/splash wall across the top of the dam, modifications to the spillway intake tower, and the addition of a supplementary emergency spillway. Raising the normal pool elevation at Diascund Creek would require, at a minimum, the modification of the existing spillway structure and pump station, the addition of a splash wall across the top of the dam and the addition of a supplementary emergency spillway.

Safe Yield

This alternative's potential treated water safe yield benefit was calculated at 5.0 mgd using the Newport News Raw Water System Safe Yield Model for a 58-year simulation period.

Practicability Analysis

Increasing the maximum Chickahominy River withdrawal to 61 mgd, or more, is currently considered unavailable, infeasible, and impracticable. Given this practicability determination, a new analysis was performed to evaluate the benefit of raising the Diascund and Little Creek dams without increasing the maximum Chickahominy River pumping capacity. As a result, the treated water safe yield benefit for this alternative would decline from 5.0 mgd to 1.3 mgd. With a safe yield of only 1.3 mgd, the estimated present value cost of this alternative per mgd of treated water safe yield benefit would result in projected household water bills which exceed the RRWSG's adopted affordability criterion. For these reasons, this alternative is not considered practicable by federal regulatory and advisory agencies. Therefore, this alternative is considered unavailable, infeasible, and impracticable at this time.

3.4.19 Aquifer Storage and Recovery Constrained By Number of Wells

Description

Aquifer storage and recovery (ASR) typically involves:

- The seasonal underground storage of treated drinking water in a suitable aquifer during times when the raw water source capacity exceeds system demand.
- The subsequent recovery from the same wells to meet peak or emergency demands beyond the raw water source capacity. Generally, the only treatment required for the recovered water is chlorination.

ASR does not supply water in and of itself, but is instead a water management technique. As with other water supply alternatives, an acceptable source of raw water must first be identified.

The Chickahominy River is the largest fresh surface water source within the Lower Peninsula study area. As such, it offers greater potential to supply a Lower Peninsula ASR system than other local fresh surface water sources. Newport News Waterworks' existing Chickahominy River withdrawal above Walkers Dam was thus chosen as a potential raw water source for this evaluation.

It was assumed that raw water transmission, water treatment, and finished water distribution capacity would be available as required to obtain the maximum ASR safe yield benefit. The additional capacities and specific improvements required in transmission, treatment, and distribution facilities have not been quantified or detailed to date.

Chickahominy River withdrawals would eventually be treated and pumped into the distribution system. Any treated water in excess of system demand would be injected into the aquifer storage zone to be used when raw water supplies cannot meet all of the treated water demands.

It was assumed that ASR wells would be developed in areas adjacent to existing Newport News Waterworks pumping stations, finished water storage tanks, and water treatment plants. Twelve potential ASR well locations were identified which have good access to Newport News Waterworks' finished water distribution system and are located on property owned by Waterworks.

A realistic upper limit for single ASR well injection rates would be approximately 1½ mgd. Therefore, the 12 well system could have a total maximum injection rate of 18 mgd. Given the 6.7 mgd estimated safe yield benefit for this alternative (see below) and an assumed maximum day demand (MDD) factor of 1.45, the ASR withdrawal facilities would be sized to supply a MDD on the order of 9.7 mgd. Assuming 1 to 2 mgd average ASR well withdrawal capacities, 5 to 10 dual-purpose ASR wells (i.e, injection and recovery) would be required. The remaining 2 to 7 wells could be dedicated ASR injection wells.

<u>Safe Yield</u>

This alternative's treated water safe yield benefit was estimated at 6.7 mgd by performing aquifer storage depletion analysis.

<u>Practicability Analysis</u>

ASR technology in the Virginia Coastal Plain Province is still in the experimental stage and there is no present basis for assuming that this technology may be applied on the Lower Peninsula. In addition, there are large uncertainties about how the quality of injected potable water and the aquifer storage zone itself will be impacted by operation of an ASR system. Given these uncertainties, this alternative is not considered to be technologically reliable. The proposed ASR system would also have the potential to cause regional aquifer drawdown impacts during the long sustained withdrawal periods required for this alternative. These potential drawdown impacts create considerable uncertainty as to whether this alternative would be permittable by the State. For these same reasons, this alternative is not considered practicable by federal regulatory and advisory agencies. Therefore, this alternative is considered unavailable, infeasible, and impracticable at this time.

3.4.20 Aquifer Storage and Recovery Unconstrained By Number of Wells

Description

General characteristics and principal criteria governing the site-specific feasibility of aquifer storage and recovery (ASR) systems are described in Section 3.4.19. This ASR alternative is distinguished from that previously considered in Section 3.4.19 in that it is not constrained by the number of ASR wells.

Safe Yield

This alternative's treated water safe yield benefit was estimated at 9.4 mgd by performing aquifer storage depletion analysis. The assumptions used in developing this safe yield estimate were identical to those used for the ASR Constrained by Number of Wells alternative (see Section 3.4.19) with the exception of the number of ASR wells.

Practicability Analysis

ASR technology in the Virginia Coastal Plain Province is still in the experimental stage and there is no present basis for assuming that this technology may be applied on the Lower Peninsula. In addition, there are large uncertainties about how the quality of injected potable water and the aquifer storage zone itself will be impacted by operation of an ASR system. Given these uncertainties, this alternative is not considered to be technologically reliable. The proposed ASR system would also have the potential to cause regional aquifer drawdown impacts during the long sustained withdrawal periods required for this alternative. These potential drawdown impacts create considerable uncertainty as to whether this alternative would be permittable by the State. For these same reasons, this alternative is not considered practicable by federal regulatory and advisory agencies. Therefore, this alternative is considered unavailable, infeasible, and impracticable at this time.

3.4.21 Fresh Groundwater Development

Description

This alternative would involve construction of new well fields in western James City County and/or eastern New Kent County near Diascund Creek and Little Creek reservoirs. These wells would have a total production capacity of 10 mgd and would be used to augment storage in Diascund Creek and Little Creek reservoirs during periods when Newport News Waterworks system reservoir storage is below 75 percent of total capacity.

Little Creek Reservoir Site

Because of its large total storage volume (7.48 billion gallons), small drainage area (4.6 square miles), and large withdrawal capacity (55 mgd), it was determined that this 10 mgd alternative should rely on the maximum amount of groundwater that is available from the Little Creek Reservoir site. Maximizing withdrawal from the Little Creek site would also provide a more efficient means of maintaining the water levels in this reservoir when the minimum flow restrictions on the Chickahominy River would alternatively require pumpover from the Diascund Creek Reservoir.

To provide groundwater to the reservoir, the wells would discharge raw water either into existing surface drainageways of the reservoir, or directly to the reservoir, depending on the individual well location. At the Little Creek site, a maximum of four wells could be used to provide emergency raw water supply without causing unacceptable well interference effects. If water levels in the Middle Potomac Aquifer decline due to withdrawals by others, the number and location of wells required at both the Little Creek and Diascund Creek sites could change. The well sites are spaced approximately 8,000 feet apart around the perimeter of the reservoir. Approximate well locations are listed below:

Well Number	Production Rate (gpm)	Latitude	Longitude
LC-1	800	37°22'14"	76°50'34"
LC-2	800	37°22'57"	76°48'35"
LC-3	800	37°21'01"	76°50'10"
LC-4	800	37°21'53"	76°48'45"

Diascund Creek Reservoir Site

Approximately 5.4 mgd of the total 10-mgd groundwater production capacity would be provided by the Diascund Creek well field. The Diascund Creek Reservoir's relatively large drainage area (44.6 square miles) and the higher aquifer transmissivity in the area allow for greater flexibility in determining the location of wells. Four wells located adjacent to the reservoir, each producing 1,000 gpm, would provide approximately 5.76 mgd of emergency raw water supply from this site, making the total well water production approximately 10.36 mgd. A slight downward modification of the production rate of any or all of the wells from the proposed 1,000 gpm would achieve a total withdrawal rate of 10 mgd. This could be achieved by decreasing the proposed production rate in all four Diascund Creek Reservoir wells to 950 gpm. The approximate locations of these wells are indicated below.

Well Number	Production Rate (gpm)	Latitude	Longitude
DC-1	950	37°26'50"	76°54'04"
DC-2	950	37°27'02"	76°52'20"
DC-3	950	37°25'44"	76°55'03"
DC-4	950	37°25'46"	76°53'31"

Safe Yield

This alternative's treated water safe yield benefit was calculated at 4.4 mgd using the Newport News Raw Water System Safe Yield Model for a 58-year simulation period. This determination was based on the assumption that the wells would not be used until Newport News Waterworks reservoir storage falls to a 75 percent drought alert level (i.e., 75 percent of total system capacity including dead storage).

Practicability Analysis

Based on information compiled to date, there is no basis for deeming this alternative impracticable. Therefore, this alternative has been retained for further environmental analysis.

3.4.22 Groundwater Desalination As The Single Long-Term Alternative

Description

This alternative would involve new large-scale groundwater withdrawals from the deep, brackish aquifers in the Lower Peninsula. Potential locations of the withdrawals would include areas located in the City of Newport News, James City County, and York County. The areas of Copeland Industrial Park, Lee Hall, Harwood's Mill, and Little Creek Reservoir were selected as well field locations based on ease of integration with existing finished water storage and distribution system facilities, availability of existing property and easements, and to minimize drawdown by distributing the required large withdrawals in areas of higher aquifer yield. Groundwater withdrawals would require use of desalination technology, particularly in the long-term, as water levels decline and higher TDS waters are withdrawn.

The amount of firm brackish groundwater withdrawal capacity necessary to produce approximately 30.2 mgd of average day demand treated water safe yield was estimated at 54 mgd.

Approximately 27 wells would be required to produce at least 54 mgd of firm well yield. The individual well fields would typically include 4 to 6 wells each, depending on actual local yields and available locations.

Safe Yield

Assuming that it is always possible to use the full 54 mgd of firm withdrawal capacity, this alternative would provide a treated water safe yield benefit approximately equal to the projected Year 2040 Lower Peninsula deficit of 30.2 mgd.

Practicability Analysis

The Lower Peninsula is located entirely within the boundaries of the Eastern Virginia Groundwater Management Area (EVGMA). The SWCB has taken a strong position against new large-scale groundwater withdrawals in the EVGMA. Given the widespread regional aquifer drawdown impacts expected for this alternative, it is extremely doubtful that the State would permit this alternative. For these same reasons, this alternative is not considered practicable by federal regulatory and advisory agencies. Therefore, this alternative is considered unavailable and impracticable at this time.

3.4.23 Groundwater Desalination in Newport News Waterworks Distribution Area

Description

This alternative would involve the development of up to 10 mgd of deep brackish groundwater supply from wells screened in the Middle Potomac and Lower Potomac aquifers. A reverse osmosis (RO) process would be utilized to reduce levels of dissolved solids, sodium, chloride, fluoride, and iron to drinking water quality. These dissolved constituents are typically elevated in the Middle Potomac and Lower Potomac aquifers beneath the eastern region of the York-James Peninsula. The wells would be installed at finished water storage and distribution locations within the City of Newport News or on existing Newport News Waterworks property.

This groundwater alternative would include four individual RO treatment facilities, with pre-engineered buildings to house treatment processes, chemical pre-treatment and post-treatment systems, additional transfer pumps, and concentrate lines for discharge of process reject. The deep wells and individual RO treatment plants would be located adjacent to, and would discharge finished water to, the following existing finished water storage facilities in the Newport News Waterworks system:

- Site 1 - Copeland Industrial Park Ground Storage Tank
- Site 2 - Upper York County Ground Storage Tank
- Site 3 - Harwood's Mill WTP Clearwell
- Site 4 - Lee Hall WTP Clearwell

Blended groundwater from the Middle Potomac and Lower Potomac aquifers would be used to supply the RO treatment facilities to take advantage of the favorable water quality of the Middle Potomac and the increased yield available from the Lower Potomac.

Potential concentrate outfall locations are as follows:

▪ Site 1 (Copeland Park)	Hampton Roads south of the mouth of Salters Creek
▪ Site 2 (Upper York County)	South bank of Queens Creek
▪ Site 3 (Harwood's Mill)	West bank of the Poquoson River
▪ Site 4 (Lee Hall)	South bank of Skiffes Creek

<u>Safe Yield</u>

The safe yield of this alternative depends on the individual well yields, the recovery percentages realized for the various water qualities, and the maximum day demand factor expected in the system. For a blended raw water quality of 2,000 to 4,000 mg/l TDS, recoveries of up to 80 percent can be expected with currently available RO membranes. The projected maximum week demand factor for the Lower Peninsula through the Year 2040 is 1.25. Using these values, and assuming a 10-mgd firm well production capacity, the estimated treated water safe yield benefit of this alternative is 6.4 mgd.

<u>Practicability Analysis</u>

Large-scale groundwater withdrawals are not considered to be available. However, based on information compiled to date, there is no basis for deeming this smaller-scale groundwater desalting alternative impracticable. Therefore, this alternative has been retained for further environmental analysis.

3.4.24 James River Desalination

<u>Description</u>

Jamestown Intake

This alternative would involve a 70-mgd raw water intake and pumping station on the James River; 9 miles of dual 36-inch, 70-mgd capacity raw water pipelines; an RO desalting facility capable of producing 44 mgd of finished water; a 20-mile, 36-inch 26-mgd capacity concentrate disposal pipeline; and a concentrate disposal outfall. Finished water would be supplied directly to the Lower Peninsula water distribution systems. Thus, to provide an average day demand (ADD) treated water safe yield of 30.2 mgd, this alternative must actually be able to supply a maximum day demand (MDD) of 1.45 times the ADD, or approximately 44 mgd.

Sturgeon Point Intake

This alternative would involve a 60-mgd raw water intake and pumping station on the James River; 21.5 miles of dual 36-inch, 60-mgd capacity raw water pipelines; an electrodialysis reversal (EDR) desalting facility capable of producing 44 mgd of finished water; a 20-mile, 24-inch concentrate disposal pipeline; and a concentrate disposal outfall. Finished water would be supplied directly to the Lower Peninsula water distribution systems, with MDD supply provided as described for the Jamestown intake option.

Compared to the Jamestown intake alternative, this project would have a less expensive and smaller intake and raw water pump station, a much longer raw water feed pipeline, smaller conventional treatment facilities, less expensive desalination process units, and a smaller diameter concentrate outfall pipeline.

<u>Safe Yield</u>

Jamestown Intake

With an approximate recovery rate of 60 percent and 10 percent RO module bypass, withdrawals of 70 mgd would produce 44 mgd of desalinated surface water. Assuming no MIF requirement, and assuming a Lower Peninsula MDD factor of 1.45, this alternative would provide a treated water safe yield benefit of approximately 30.2 mgd. Larger James River withdrawal and treatment capacities could produce treated water safe yield benefits in excess of 30.2 mgd. However, the projected Year 2040 Lower Peninsula deficit is 30.2 mgd, and is used for planning purposes in this study.

Sturgeon Point Intake

It was assumed that an MIF policy would not apply to the raw water withdrawal. With an approximate overall recovery rate of 75 percent, withdrawals of 60 mgd would produce at least 44 mgd of desalinated surface water. With MDD supplied as described above, this alternative would provide a treated water safe yield benefit of approximately 30.2 mgd. Again, treated water safe yield benefits in excess of 30.2 mgd would be possible, but are not deemed necessary to meet the projected Year 2040 Lower Peninsula deficit.

<u>Practicability Analysis</u>

Utilization of the lower James River as a source of public water supply raises specific concerns pertaining to water quality and the reliability of available treatment technologies to consistently produce a safe drinking water product. Treatment of water from either a highly variable estuary source, or a brackish/tidal fresh source, to drinking water standards has not been accomplished on a permanent basis at any scale. Any process for treating water from such a source must, therefore, be considered experimental.

The proposed Jamestown intake site would be located at the lower end of the turbidity maximum zone of the lower James River estuary. This zone is caused by the interaction and mixing of salt water and freshwater in the river, and is affected by tides, streamflow, and climatic events. The turbidity maximum zone acts as a trap for nutrients, sediment, and toxics; and has widely fluctuating salinity levels which vary in response to the daily and monthly tidal cycle, seasonal changes in streamflow, and short- and long-term climatic events.

The pesticide kepone was trapped in the turbidity maximum zone of the James River following its discharge into the river in the early 1970s. Kepone is currently trapped in the bottom sediments of this portion of the river. The severity of short-term impacts to the river due to the construction of a submerged 3,300-foot intake pipeline is unknown, as are the effects on future water quality due to shipping channel maintenance dredging. However, the possible risks associated with the existing kepone contamination are serious concerns.

The widely fluctuating salinity levels in this zone of the river are also a concern due to the difficulties they would cause in controlling the treatment process, and the increased possibility of varying product water quality and disruptions to treatment processes. Salinity swings of 2 to 4 ppt could occur approximately every 6 hours at the intake due to the normal tidal cycle.

The proposed Sturgeon Point intake site would be located at the lower end of the tidal freshwater zone of the lower James River estuary. Saltwater intrudes up to and beyond Sturgeon Point in the fall of most years, when freshwater river flows are typically lowest. During these salinity intrusion events, the turbidity maximum zone of the river would extend upstream past Sturgeon Point. Salinity levels at Sturgeon Point during these events could change dramatically in response to tides, changing streamflow, and climatic events. Turbidity in the river also would be expected to increase during a salinity intrusion event. Similar to the Jamestown intake site, kepone is trapped to some degree in the bottom sediments of the river at this point. Similar concerns related to intake construction also exist for Sturgeon Point.

The treatment technologies required to safely treat water withdrawn at Sturgeon Point may at times conflict. Proper coordination of treatment operations would be critical to ensuring the production of acceptable finished water. The combination of initial conventional treatment followed by an EDR desalting process has not yet been operated at a substantial scale in the United States. This combination must, therefore, be considered experimental.

Moving the intake site upstream to Sturgeon Point and closer to Hopewell would reduce the magnitude of seasonal and daily salinity variation; however, the intake site would also be exposed to higher risks of contamination. These risks must be taken into account while planning a water project with a 50-year life (or longer) and a very large user population.

Located at and above Hopewell is a large, diverse industrial complex. These industries have released large quantities of chemical contaminants in the past. The best known case involved the discharge into the river during the early 1970s of an estimated 100,000 pounds of the pesticide kepone. The vast majority of this kepone is believed to remain in bottom sediments in the reach of the river between Hopewell and Jamestown. This kepone could be disturbed by man's activities, including dredging, or by a severe hurricane or other natural event. The City of Richmond's Combined Sewer Overflow program will accumulate and divert contaminated runoff toward the lower James River. Finally, there is the potential for catastrophic spill events. In the late-1970s, an ocean-going sulfur freighter struck and became lodged under the Benjamin Harrison Bridge downstream of Hopewell. No spill occurred, but the accident highlights the future potential for catastrophic spill events on a heavily-travelled and used river.

In recent years, the concern over potential adverse health effects as a result of many forms of microbial contamination, and from long-term exposure to very small quantities of inorganic and organic chemicals, has been increasing. These concerns are being addressed by the USEPA as new regulations are released to implement the Safe Drinking Water Act Amendments of 1986. The 1986 Amendments required maximum contaminant levels (MCLs) to be established for an initial 83 contaminants with additional MCLs to be established for defining acceptable drinking water quality in the future.

The health risk assessments for the initial 83 contaminants and final regulations for them are not expected to be completed before the end of this decade. Even then, the MCLs will be established based on the assumption that the best quality, most pristine, naturally occurring available water source will be used. The use of less than pristine raw water sources and the possibility of synergistic effects due to combinations of organic and inorganic contaminants will not be addressed at all by these MCLs. The use of raw water sources with substantial upstream point source discharges and intensive watershed development, even when in compliance with all current MCLs and other regulations, has the potential to increase human health risks.

As presented in this document, there are other sources of potable water which have not been shown to be unavailable to the RRWSG. These water sources are of better quality than the lower James River and do not present a potential pubic health risk on a year-round basis as does this alternative. Furthermore, due to raw water quality variability and treatment control concerns, and the lack of experience in treating water sources similar to the James River at Jamestown or Sturgeon Point, both variations of this desalting alternative are considered experimental. Therefore, this alternative is not considered to be technologically reliable.

In recent years the VDH has taken a strong stance against use of the James River below Hopewell as a public water supply source. This opposition was most recently stated in a July 6, 1993 letter in which the VDH outlined its specific concerns (A. R. Hammer, VDH, personal communication, 1993). Since there are other sources of potable water which have not been shown to be unavailable to the RRWSG, it does not appear that the State would approve the James River Desalination alternative.

The estimated present value cost of this alternative per mgd of treated water safe yield benefit would result in projected household water bills which exceed the RRWSG's adopted affordability criterion. This conclusion is true for both the Jamestown and Sturgeon Point intake sites.

For the reasons summarized above, the James River Desalination alternative is considered unavailable, infeasible, and impracticable at this time.

3.4.25 Pamunkey River Desalination

Description

This alternative would involve a 65-mgd raw water intake and pumping station on the Pamunkey River; a 25-mile, 54-inch 65-mgd capacity raw water pipeline; an RO or EDR desalting facility capable of producing 44 mgd of finished water; an 8.2-mile, 30-inch 21-mgd capacity concentrate disposal pipeline; and a concentrate disposal outfall. Finished water would be supplied directly to the Lower Peninsula water distribution systems. Thus, to provide an ADD treated water safe yield of 30.2 mgd, this alternative must actually be able to supply a MDD of 1.45 times the ADD, or approximately 44 mgd.

Safe Yield

With an approximate recovery rate of 70 percent and 10 percent RO module or EDR unit bypass, withdrawals of up to 65 mgd would be required to produce 44 mgd of desalinated surface water. Assuming no MIF requirement, and assuming a Lower Peninsula MDD factor of 1.45, this alternative could theoretically provide a treated water safe yield benefit of approximately 30.2 mgd.

However, a major limitation upon safe yield exists since this alternative involves a river withdrawal for which compliance with an MIF policy would likely be required. In December 1991 the SWCB agreed that it is appropriate to assume that an MIF policy would be in place for any new Pamunkey River withdrawal considered as part of this study (J. P. Hassell, SWCB, personal communication, 1991). Therefore, during droughts with extended periods of low river flow at or below the MIF level(s), withdrawals could not occur.

This desalting alternative would produce finished water without any intermediate raw water storage step, and would thus rely on the Pamunkey River as a constant source of feed water. In order for this alternative to provide its theoretical 30.2-mgd safe yield benefit, continuous Pamunkey River withdrawals of up to 65 mgd must, therefore, be allowed throughout the drought of record. Since this alternative does not include new raw water storage, and since an MIF policy would severely limit or preclude Pamunkey River withdrawals for extended periods (i.e., 10 consecutive months), the potential safe yield benefit of this alternative is negated.

Practicability Analysis

The Pamunkey River Desalination alternative is not expected to offer a treated water safe yield benefit. For this reason, this alternative is not considered practicable by the USCOE and USEPA. Therefore, this alternative is considered infeasible and impracticable at this time

3.4.26 York River Desalination

Description

This alternative would involve an 85-mgd raw water intake and pumping station on the York River; 13.6-miles of dual 42-inch, 85-mgd capacity raw water pipelines; an RO desalting facility capable of producing 44 mgd of finished water; a 20-mile, 36-inch 41-mgd capacity concentrate disposal pipeline; and a concentrate disposal outfall. Finished water would be supplied directly to the Lower Peninsula water distribution systems. Thus, to provide an ADD treated water safe yield of 30.2 mgd, this alternative must actually be able to supply a MDD of 1.45 times the ADD, or approximately 44 mgd.

Safe Yield

With an approximate product water recovery rate of 50 to 55 percent, withdrawals of up to 85 mgd would be required to produce 44 mgd of desalinated surface water. Assuming no MIF requirement, and assuming a Lower Peninsula MDD factor of 1.45, this alternative would provide a treated water safe yield benefit of approximately 30.2 mgd. Larger York River withdrawal and treatment capacities could produce treated water safe yield benefits in excess of 30.2 mgd. However, the projected Year 2040 Lower Peninsula deficit is 30.2 mgd, and is used for planning purposes in this study.

Practicability Analysis

Utilization of the York River as a source of public water supply raises specific concerns pertaining to water quality and the reliability of available treatment technologies to consistently produce a safe drinking water product. Treatment of water from a highly variable estuary source to drinking water standards has not been accomplished on a permanent basis at any scale. Any process for treating water from such a source must, therefore, be considered experimental.

The intake site proposed for York River withdrawals is located just below the turbidity maximum zone of the lower York River estuary. This zone is caused by the interaction and mixing of salt water and freshwater in the river, and is affected by tides, streamflow, and climatic events. The turbidity maximum zone acts as a trap for nutrients, sediment, and toxics; and has widely fluctuating salinity levels which vary in response to the daily and monthly tidal cycle, seasonal changes in streamflow, and short- and long-term climatic events. On a seasonal basis, the salinity may vary between 10 and 25 ppt in this zone.

The widely fluctuating salinity levels in this zone of the river are a concern due to the difficulties they would cause in controlling the treatment process, and the increased possibility of varying product water quality and disruptions to treatment processes. Salinity swings could occur approximately every 6 hours at the intake due to the normal tidal cycle.

The possibility of relocating the proposed York River intake to a site with less variable water quality was considered. However, downstream of the currently proposed location is the York River State Park and the Taskinas Creek marsh area. Below the park is the Camp Peary Naval Reservation, the U.S. Naval Supply Center - Cheatham Annex, and the U.S. Naval Weapons Station. These facilities extend along the south bank of the York River to Yorktown, except for areas where the Colonial National Historical Parkway separates the U.S. Naval Weapons Station from the river. Below the developed waterfront area of Yorktown, the Colonial National Historical Park and U.S. Coast Guard Reserve Training Center extend to Marlbank Creek. It is unlikely that access to the south bank of the York River could be obtained across any of these military installations, or state and national park areas. The York River WWTP outfall is located just downstream of Marlbank Creek. Potential downstream intake locations are thus not considered viable.

Upstream of the current location are several miles of saltwater marsh, including the marshes at the mouth of Ware Creek. Upstream of these marshes and Philbates Creek is an open river bank area. However, the York River offshore of this area of river bank is shallow. Above Philbates Creek, the York River begins to transition to brackish estuary and the turbidity maximum zone occurs. Water quality in this zone would be even more variable than that at the currently proposed withdrawal site. Upstream withdrawal sites would also be in closer proximity to an existing Kraft pulp and paper mill in the Town of West Point

(Chesapeake Corporation) which discharges to the Pamunkey River approximately 10 river miles upstream of the proposed withdrawal site. Potential upstream intake locations are thus not considered viable.

Due to raw water quality variability and treatment control concerns, and the lack of experience in treating water from a source of this type, this York River desalting alternative is considered experimental. Therefore, this alternative is not considered to be technologically reliable.

The estimated present value cost of this alternative per mgd of treated water safe yield benefit would result in projected household water bills which exceed the RRWSG's adopted affordability criterion.

For the reasons outlined above, this alternative is not considered practicable by the USCOE and USEPA. Therefore, the York River Desalination alternative is considered infeasible and impracticable at this time.

3.4.27 Cogeneration

Description

This alternative would produce drinking water through desalination processes powered by excess steam from a privately-owned cogeneration facility. The alternative would involve locating a cogeneration facility on the Lower Peninsula, selling electricity to a utility company, and producing desalted water from excess steam production for sale to Lower Peninsula water purveyors.

To date, the only cogeneration facility which has been proposed for the Lower Peninsula is one originally proposed by Hadson Development Corporation (Hadson). This proposal would involve construction of a 165 megawatt (MW) pulverized coal-fired cogeneration power plant and multiple effect distillation (MED) desalination facility located off U.S. Route 60 between Skiffes Creek and BASF Corporation property in southeastern James City County. James River feed water was also proposed for facility use. Subsequently, Hadson's parent company sold its 100 percent interest in this proposed cogeneration project to LG&E Energy Systems (LG&E). It is not yet known whether LG&E will pursue this project as originally planned by Hadson.

With this alternative, it is assumed that a proposed intake could be located on the James or York rivers. River water would be used to cool the power plant as well as provide for a raw water source for the distillation process. A discharge structure would also be required for return of the cooling water and concentrate disposal.

The implementation of this alternative relies largely on the viability of a private cogeneration vendor willing to construct such a facility on the Lower Peninsula and sell water produced from the excess steam. The feasibility of this type of arrangement is primarily driven by a combination of electrical energy production markets as well as water production costs.

Safe Yield

The potential water production capacity of the distillation facility is dependent on the power plant capacity. Information from the Hadson cogeneration proposal indicates that the maximum distilled water production capacity from the proposed 165 MW facility would be 20 mgd. However, in early discussions between Hadson and Newport News Waterworks, a water production rate of 5 to 10 mgd was discussed. The safe yield from cogeneration facilities is highly variable and dependent upon individual private vendor proposals. As a result, a safe yield number cannot be assigned to this alternative at this time.

Practicability Analysis

The VDH has taken a strong position against use of the lower James River as a public water supply source; and there appear to be other sources of potable water which have not been shown to be unavailable to the RRWSG. In this case, therefore, it does not appear that the State would approve this cogeneration alternative (Hadson proposal) since it would rely on lower James River withdrawals. Additionally, the RRWSG member jurisdictions have not received any formal proposals from private cogeneration vendors to sell water produced from excess steam. For these same reasons, this alternative is not considered practicable by federal regulatory and advisory agencies. Therefore, this alternative is considered unavailable and impracticable at this time.

3.4.28 Wastewater Reuse as a Source of Potable Water

Description

This alternative would involve blending highly treated wastewater with potable raw water supplies as a means of increasing total raw water supplies. Increasing potable water supplies with highly treated wastewater in this way is considered "indirect reuse" of wastewater, as opposed to "direct" or "pipe to pipe" recycle. This indirect wastewater reuse alternative would consist of an advanced wastewater reclamation plant close to the existing Hampton Roads Sanitation District (HRSD) York River WWTP; a multi-compartment, reclaimed water lagoon; a reclaimed water pump station; and pipelines to Harwood's Mill and Lee Hall reservoirs.

Safe Yield

This alternative's Year 2040 treated water safe yield benefit was calculated at 6.5 mgd using the Newport News Raw Water System Safe Yield Model for a 58-year simulation period. This determination was based on the assumption that steady streams of advanced WWTP effluent would be discharged to Harwood's Mill and Lee Hall reservoirs at rates of 4 mgd and 3 mgd, respectively. The Year 1992 treated water safe yield benefit would be approximately 3.7 mgd based on advanced WWTP effluent being discharged to Harwood's Mill and Lee Hall reservoirs at rates of 1 mgd and 3 mgd, respectively.

The reported treated water safe yield benefits assume that combined losses associated with WWTP effluent transmission, seepage from the terminal reservoirs, and treatment would be on the order of 5 percent of total simulated raw water safe yield benefits.

Practicability Analysis

The VDH has taken a strong position against wastewater reuse as a source of potable water. The VDH position indicates that this alternative is not considered permittable by the State. There are also major public health concerns associated with potable reuse which bring into question the technological reliability of the alternative. For these reasons, this alternative is not considered practicable by federal regulatory and advisory agencies. Therefore, this alternative is considered unavailable and impracticable at this time.

3.4.29 Wastewater Reuse For Non-Potable Uses

Description

This alternative would involve advanced treatment of WWTP effluent to produce non-potable water, suitable for industrial cooling and industrial process use. The utilization of WWTP effluent as a non-potable water source would allow existing potable water sources to satisfy additional potable water demands. This wastewater reuse alternative would consist of one or more reuse water systems. Each system would include an advanced wastewater reclamation plant, reuse water pump station, distribution system, and storage facilities. Each system would be located adjacent to an existing Hampton Roads Sanitation District (HRSD) WWTP on the Lower Peninsula.

Safe Yield

The current and short-term projected average daily flows at the Williamsburg, York River, and Boat Harbor WWTPs were evaluated. Allowing for low flow periods below the average, these flows represent a current reliable source of at least 20 mgd that may be made available for industrial reuse. However, the safe yield for this alternative is represented by the amount of potable public water supply water usage that is converted to this non-potable supply, thus freeing the potable water supply for use by others. By reducing the demand for traditional potable water, this alternative would make available an additional supply of potable water that could be utilized by new customers. Additionally, the safe yield reflects only that use of non-potable water that traditionally would have been supplied by the potable public supply system. The use of non-potable reuse water instead of low quality groundwater by an existing industry, or by a new industry that in the past would have used groundwater but that currently cannot obtain a groundwater permit, would not represent any overall safe yield benefit to the potable public supply system.

In December 1991 Malcolm Pirnie conducted a telephone survey of existing large industrial water customers on the Lower Peninsula. Industrial customers surveyed use in excess of 100,000 gallons per day of potable public water for non-potable uses. Based on this survey, approximately 2.5 mgd of current potable water usage could be served by a non-potable water supply. This represents approximately 25 percent of the total 1990 heavy industrial demand for public water. Assuming this ratio will be similar for new industry, approximately 2.5 mgd of new heavy industrial demand could be served by a non-potable water supply in the Year 2040. Therefore, a long-term treated water safe yield benefit of between 0 and 5 mgd may be possible through implementation of this alternative.

Practicability Analysis

The RRWSG member jurisdictions cannot dictate whether industrial water users or other large water users develop separate distribution systems which make use of treated wastewater effluent for non-potable uses. Lower Peninsula water purveyors could build their own separate distribution systems to supply non-potable water demands with treated wastewater effluent. However, it is anticipated that the costs of doing so would be excessive in comparison to other alternatives under consideration.

While this alternative has not been shown to be impracticable, it will not be carried forward for further environmental analysis. Instead, as recommended by federal regulatory and advisory agencies, this alternative is included as part of the regional conservation plan presented in the ***Water Demand Reduction Opportunities*** report (Malcolm Pirnie 1993).

3.4.30 Use Restrictions

Description

A use restrictions operating schedule has been developed for the Lower Peninsula which employs similar techniques to those applied in other areas. This schedule, which includes storage threshold levels applicable to each use restriction tier, is presented in the following table.

Reservoir Storage Capacity (% of total)	Demand Reduction Measures
100-70	Normal Conservation Measures
70-55	Voluntary Restrictions (Tier 1)
55-45	Mandatory Restrictions (Tier 2)
45-33	Water Rationing (Tier 3)
33-11	Emergency/Disaster Conditions

Demand reduction objectives have been developed for the residential, commercial, heavy industrial, and federal installations water demand categories. These use restriction objectives are presented as demand reduction factors. For both the residential and commercial sectors, these demand reduction objectives are in addition to an 8.1 percent reduction goal (to be achieved through normal conservation measures) which is factored into the tables presented below.

The annual average per capita residential usage objectives for the Lower Peninsula are as follows:

Demand Reduction Measures	Average Annual Usage Goals (gpcpd)	Demand Reduction Factors
Voluntary Restrictions (Tier 1)	64	0.955
Mandatory Restrictions (Tier 2)	62	0.925
Water Rationing (Tier 3)	57	0.85

Commercial use restriction objectives, presented as demand reduction factors, are as follows:

Demand Reduction Measures	Average Annual Goals (%)	Demand Reduction Factors
Voluntary Restrictions (Tier 1)	4.5	0.955
Mandatory Restrictions (Tier 2)	7.5	0.925
Water Rationing (Tier 3)	15	0.85

Heavy industrial use restriction objectives, presented as demand reduction factors, are as follows:

Demand Reduction Measures	Average Annual Goals (%)	Demand Reduction Factors
Voluntary Restrictions (Tier 1)	4.5	0.955
Mandatory Restrictions (Tier 2)	7.5	0.925
Water Rationing (Tier 3)	15	0.85

Federal Installations use restriction objectives, presented as demand reduction factors, are as follows:

Demand Reduction Measures	Average Annual Goals (%)	Demand Reduction Factors
Voluntary Restrictions (Tier 1)	4.5	0.955
Mandatory Restrictions (Tier 2)	7.5	0.925
Water Rationing (Tier 3)	15	0.85

Safe Yield

This alternative's treated water safe yield benefit was calculated at 1.5 mgd using the Newport News Raw Water System Safe Yield Model for a 58-year simulation period. This determination was based on the demand reduction factors and corresponding raw water storage threshold levels defined in the preceding description of this alternative.

Practicability Analysis

Based on information compiled to date, there is no basis for deeming the Use Restrictions alternative impracticable. Therefore, this alternative has been retained for further environmental analysis.

3.4.31 No Action

Description

The Council on Environmental Quality (CEQ) National Environmental Policy Act (NEPA) regulations, specify that the alternative of "no action" be included in the analysis of project alternatives (40 CFR § 1502.14).

The No Action alternative could be expanded to include those alternatives which would not require a federal or state permit. At least two alternatives would require no federal or state permits: Use Restrictions and No Action. However, for purposes of this EIS, the Use Restrictions alternative is evaluated separately (see Section 3.4.30).

Under the No Action alternative, the RRWSG would do nothing to provide additional raw water supply or curtail water use on the Lower Peninsula. To limit growth, water purveyors could place moratoriums on new hook-ups. New industry and other water users would, therefore, be unable to locate in the region due to a lack of treated water supply.

Safe Yield

No safe yield benefit is associated with the No Action alternative and, as a result, deficit projections presented in Section 2.7 would be anticipated throughout the planning period.

Practicability Analysis

The No Action alternative is not considered feasible or practicable since it does not contribute to a solution of the basic project purpose. Nevertheless, the No Action alternative has been retained for further environmental analysis pursuant to the CEQ NEPA regulations (40 CFR § 1502.14).

3.4.32 Additional Alternatives Considered

The RRWSG considered two additional reservoir alternatives that were identified during the course of interagency scoping. These alternatives were not included in the original list of 31 alternatives in the USCOE's ***Conceptual Scoping Outline for the Lower Peninsula's Raw Water Supply Draft EIS*** (W. H. Poore, Jr., USCOE - Norfolk District, personal communication, 1990). Nevertheless, efforts were made by the RRWSG to evaluate the practicability of these alternatives and the results of these investigations are summarized below.

Black Creek Reservoir with Pumpover from Mattaponi River

It is anticipated that a substantial reduction in project safe yield would occur as a result of using the Mattaponi River rather than the Pamunkey River as a pumpover source for Black Creek Reservoir. This conclusion is supported by safe yield evaluations conducted for Ware Creek Reservoir with pumpover from either the Pamunkey or Mattaponi rivers. Consequently, 30.2-mgd project alternative which includes Black Creek Reservoir with Mattaponi River pumpover would likely require development of a greater number of water sources than the Pamunkey River pumpover option. Environmental impacts associated with developing more water sources would likewise be greater.

The pipeline route required for the Mattaponi River pumpover scenario would be longer than for the Pamunkey River pumpover and would require crossing an additional river basin divide and the Pamunkey River. As a result, additional stream crossings and greater land disturbance would occur. Energy requirements to pump river withdrawals would also be greater, thereby creating additional energy consumption and associated impacts from increased energy production. With these increased construction and operating costs, total project costs for the Mattaponi River pumpover scenario would be higher with no reduction in impacts.

King William County has authority under the local consent provisions of Title 15.1 of the Code of Virginia, and other statutory authorities, to review and approve or disapprove any public water supply project components that would be built by any other jurisdiction and located in King William County. One of the key requirements for obtaining the County's local consent is the ability of an alternative to provide the County with a future water supply. Without a reservoir in King William County, Mattaponi River withdrawals would not supply the County with a reliable water supply during low flow periods when the MIF policy would prohibit river withdrawals. Therefore, the County has stated its opposition to a Mattaponi River withdrawal without a local reservoir (D. S. Whitlow, King William County, personal communication, 1992). King William County has thus given a strong indication that it would deny local consent for the construction of the Mattaponi River intake structure, pumping station, and raw water transmission line required for this Black Creek Reservoir pumpover alternative.

The RRWSG has concluded that based on the environmental, technical, and political constraints summarized above, a Mattaponi River pumpover to Black Creek Reservoir is impracticable. Given these findings, this alternative has not been retained for further environmental analysis.

Ware Creek Reservoir (Three Dam Alternative) with Pamunkey River Pumpover

As a first step, it was determined that the Ware Creek Reservoir three dam alternative could provide a maximum Lower Peninsula treated water safe yield benefit of 18.8 mgd if augmented by a 120 mgd capacity Pamunkey River pumpover.

Currently, the RRWSG only considers the alternatives listed below (excluding Ware Creek Reservoir with Pumpover from Pamunkey River) to be practicable. The Lower Peninsula treated water safe yield benefits associated with each alternative are shown in parentheses.

- Black Creek Reservoir with Pumpover from Pamunkey River (21.3 mgd)
- King William Reservoir with Pumpover from Mattaponi River (26.4 mgd)
- Fresh Groundwater Development (4.4 mgd)
- Groundwater Desalination in Newport News Waterworks Distribution Area (6.4 mgd)
- Use Restrictions (1.5 mgd)

Given this list of practicable alternatives, a 1.5 mgd deficit reduction could be provided through implementation of the Use Restrictions alternative to augment the maximum 18.8 mgd safe yield benefit for the Ware Creek Reservoir three dam alternative. The remaining 9.9 mgd of the projected Year 2040 Lower Peninsula deficit of 30.2 mgd would have to come from another reservoir (i.e., Black Creek Reservoir or King William Reservoir) or from both of the practicable groundwater alternatives.

It is unlikely that required federal and state regulatory approvals would be granted for a project involving development of Black Creek or King William reservoir in addition to the Ware Creek Reservoir three dam alternative. For this reason, this scenario is considered unavailable and impracticable at this time.

Together, the two practicable groundwater alternatives would have a combined withdrawal capacity of 20 mgd and would provide an estimated 10.8 mgd treated water safe yield benefit, or slightly more than the remaining 9.9 mgd deficit. A groundwater modeling analysis was conducted by Malcolm Pirnie using the USGS Coastal Plain Model to assess whether simultaneous operation of the two practicable groundwater alternatives would be permittable under recently proposed SWCB Groundwater Withdrawal Regulations (VR 680-13-07). The results from this analysis demonstrate that drawdown impacts to other current groundwater users, and the potential for saline groundwater intrusion, would make it very unlikely that such joint withdrawals could be permitted under the proposed regulations. For these reasons, this joint groundwater development scenario is considered unavailable and impracticable at this time.

Given the findings discussed above, the Ware Creek Reservoir three dam alternative has not been retained for further environmental analysis.

3.5 SUMMARY OF PRACTICABILITY ANALYSES

This section summarizes the results of practicability analyses conducted for the 31 alternative components as described in Section 3.0. Table 3-2 contains the results of the life cycle cost estimates prepared for 19 of the 31 components. It was not necessary to evaluate all components with respect to cost, because several were eliminated based on other criteria. Table 3-3 contains the 19 life cycle cost estimates, ranked from low to high, in terms of total cost per mgd of safe yield for each alternative component. Table 3-4 summarizes the fatal flaws which caused many alternatives to be considered impracticable.

The following alternative components (excluding the No Action alternative) are currently considered practicable, and each has been retained for further consideration as part of an overall 30.2-mgd treated water supply project alternative:

Alternative Component	Safe Yield (mgd)
Ware Creek Reservoir with Pumpover from Pamunkey River	24.1
Black Creek Reservoir with Pumpover from Pamunkey River	21.3
King William Reservoir with Pumpover from Mattaponi River	26.4
Fresh Groundwater Development	4.4
Groundwater Desalination in Newport News Waterworks Distribution Area	6.4
Use Restrictions	1.5
No Action*	0.0

* Although not considered feasible, the No Action alternative has been retained for further environmental analysis pursuant to CEQ NEPA regulations.

The locations of key physical features of the practicable alternative components are shown in Figure 3-3 (see map packet at rear of the report) and Figures 3-4 through 3-8. The three reservoir alternatives are also shown schematically in Figures 3-9 through 3-11.

The grouping of practicable alternative components into project alternatives must satisfy the following three criteria:

1. The project alternative must provide additional treated water safe yield at least equal to the projected deficit for each year through the Year 2040; that is, it must satisfy both short- and long-term demands.

TABLE 3-2

SUMMARY OF ALTERNATIVE COMPONENTS LIFE CYCLE COST ESTIMATES

(Year 1992 Present Worth in $ million)

DISCOUNT RATE = 7.00%

Alternative Components	Safe Yield (MGD)	Raw Water Project Total Cost	Raw Water Project Cost per MGD	Treatment & Transmission Total Cost	Treatment & Transmission Cost per MGD	Complete Alternative Total Cost	Complete Alternative Cost per MGD
2. Lake Chesdin	11.9	107.61	9.04	11.19	0.94	118.80	9.98
5. Rappahannock River above Fredericksburg	7.9	251.34	31.82	7.43	0.94	258.77	32.76
6. James River above Richmond w/o New Off-Stream Storage	7.1	122.44	17.25	6.67	0.94	129.11	18.19
7. City of Richmond Surplus Raw Water	7.1	92.13	12.98	6.67	0.94	98.80	13.92
8. City of Richmond Surplus Treated Water	23.9					198.91	8.32
10. Ware Creek Reservoir	7.1	45.54	6.41	6.67	0.94	52.21	7.35
11. Ware Creek Reservoir with Pumpover from Pamunkey River	24.1	127.51	5.29	22.66	0.94	150.17	6.23
12. Ware Creek Reservoir with Pumpover from James River	28.3	197	6.96	26.61	0.94	223.61	7.90
13. Black Creek Reservoir with Pumpover from Pamunkey River	21.3	123.65	5.81	20.02	0.94	143.67	6.75
14. Black Creek Reservoir with Pumpover from James River	25.4	202.64	7.98	23.88	0.94	226.52	8.92
15. King William Reservoir with Pumpover from Mattaponi River	26.4	127.57	4.83	24.82	0.94	152.39	5.77
16. King William Reservoir with Pumpover from Pamunkey River	25.1	140.24	5.59	23.60	0.94	163.84	6.53
17. Chickahominy River Pumping Capacity Increase	0.2	0.64	3.20	0.19	0.94	0.83	4.14
18. Chick. River Pumping Cap. Incr. & Raise D.C. and L.C. Dams	5.0	16.04	3.21	4.70	0.94	20.74	4.15
21. Fresh Groundwater Development	4.4	5.74	1.30	4.14	0.94	9.88	2.24
22. Groundwater Desalination as the Single Long-Term Alt.	30.2					78.68	2.61
23. Groundwater Desalination in NN Waterworks Dist. Area	6.4					34.21	5.35
24. James River Desalination	30.2					261.63	8.66
26. York River Desalination	30.2					344.72	11.41

TABLE 3–3

RANKED ALTERNATIVE COMPONENTS LIFE CYCLE COST ESTIMATES

(Year 1992 Present Value Cost in $ million)

DISCOUNT RATE = 7.00%

Alternatives In Order of Cost Per MGD (Low to High)	Treated Water Safe Yield (MGD)	Total Cost per MGD of Safe Yield	Impracticable due to Cost
21. Fresh Groundwater Development	4.4	2.24	
22. Groundwater Desalination as the Single Long–Term Alternative	30.2	2.61	
17. Chickahominy River Pumping Capacity Increase	0.2	4.14	
18. Chick. River Pumping Cap. Incr. and Raise D.C. and L.C. Dams	5.0	4.15	
23. Groundwater Desalination in NN Waterworks Dist. Area	6.4	5.35	
15. King William Reservoir with Pumpover from Mattaponi River	26.4	5.77	
11. Ware Creek Reservoir with Pumpover from Pamunkey River	24.1	6.23	
16. King William Reservoir with Pumpover from Pamunkey River	25.1	6.53	
13. Black Creek Reservoir with Pumpover from Pamunkey River	21.3	6.75	
10. Ware Creek Reservoir	7.1	7.35	
12. Ware Creek Reservoir with Pumpover from James River	28.3	7.90	
8. City of Richmond Surplus Treated Water	23.9	8.32	X
24. James River Desalination	30.2	8.66	X
14. Black Creek Reservoir with Pumpover from James River	25.4	8.92	X
2. Lake Chesdin	11.9	9.98	X
26. York River Desalination	30.2	11.41	X
7. City of Richmond Surplus Raw Water	7.1	13.92	X
6. James River above Richmond w/o New Off–Stream Storage	7.1	18.19	X
5. Rappahannock River above Fredericksburg	7.9	32.76	X

TABLE 3-4
PRACTICABILITY ANALYSIS SCREENING RESULTS

ALTERNATIVE COMPONENTS		PRACTICABILITY CRITERIA FATAL FLAWS			IMPRACTICABLE ALTERNATIVE COMPONENTS
NAME	SAFE YIELD (mgd)	AVAILABILITY	COST	TECHNOLOGICAL RELIABILITY	
LAKE GENITO	30.2	USCOE, USEPA, and USFWS Opposition due to Impacts			
LAKE CHESDIN	11.9		Exceeds RRWSG Criterion		
LAKE ANNA	30.2	Virginia Power Opposition			
LAKE GASTON	30.2	Local Consent & Legal Delays			
RAPPAHANNOCK RIVER ABOVE FREDERICKSBURG	7.9	Local Competition for Source	Exceeds RRWSG Criterion		
JAMES RIVER ABOVE RICHMOND WITHOUT NEW OFF-STREAM STORAGE	7.1	Local Consent (RRPDC Opposition) & Local Competition for Source	Exceeds RRWSG Criterion		
CITY OF RICHMOND SURPLUS RAW WATER	7.1	Local Consent (RRPDC Opposition)	Exceeds RRWSG Criterion		
CITY OF RICHMOND SURPLUS TREATED WATER	23.9	Availability Highly Uncertain and Outside RRWSG Control	Exceeds RRWSG Criterion		
JAMES RIVER BETWEEN RICHMOND AND HOPEWELL	30.2	VDH Opposition due to Public Health Concerns			
WARE CREEK RESERVOIR	7.1	Two USEPA vetoes		Water quality reliability concerns due to watershed development	
WARE CREEK RESERVOIR WITH PUMPOVER FROM PAMUNKEY RIVER *	24.1				
WARE CREEK RESERVOIR WITH PUMPOVER FROM JAMES RIVER ABOVE RICHMOND	28.3	Local Consent (RRPDC Opposition) & Local Competition for Source			
BLACK CREEK RESERVOIR WITH PUMPOVER FROM PAMUNKEY RIVER	21.3				
BLACK CREEK RESERVOIR WITH PUMPOVER FROM JAMES RIVER ABOVE RICHMOND	25.4	Local Consent (RRPDC Opposition) & Local Competition for Source	Exceeds RRWSG Criterion		
KING WILLIAM RESERVOIR WITH PUMPOVER FROM MATTAPONI RIVER	26.4				
KING WILLIAM RESERVOIR WITH PUMPOVER FROM PAMUNKEY RIVER	25.1	Local Consent (King William County Opposition) & Local Competition for Source	Higher Costs and Impacts than for Mattaponi River Pumpover	More Water Quality Reliability Concerns than for Mattaponi River Pumpover	

* Mattaponi River and expanded Chickahominy River pumpovers to Ware Creek Reservoir are not considered practicable.

TABLE 3-4
PRACTICABILITY ANALYSIS SCREENING RESULTS
(Continued)

ALTERNATIVE COMPONENTS			PRACTICABILITY CRITERIA FATAL FLAWS			IMPRACTICABLE ALTERNATIVE COMPONENTS
NUMBER	NAME	SAFE YIELD (mgd)	AVAILABILITY	COST	TECHNOLOGICAL RELIABILITY	
17	CHICKAHOMINY RIVER PUMPING CAPACITY INCREASE	0.2	Need Governor's Approval Amended & Could Trigger Higher MIF		Excessive Reliance on River Source Unprecedented in Virginia	
18	CHICKAHOMINY RIVER PUMPING CAPACITY INCREASE AND RAISE DIASCUND AND LITTLE CREEK DAMS	5.0	Need Governor's Approval Amended & Could Trigger Higher MIF	Exceeds RRWSG Criterion without Chickahominy Pumping Capacity Increase	Excessive Reliance on River Source Unprecedented in Virginia	
19	ASR CONSTRAINED BY NUMBER OF WELLS	6.7	VDEQ Permittability Uncertain Due to Potential Regional Aquifer Drawdown		Experimental Technology in Virginia & Uncertain Quality after Injected	
20	ASR UNCONSTRAINED BY NUMBER OF WELLS	9.4	VDEQ Permittability Uncertain Due to Potential Regional Aquifer Drawdown		Experimental Technology in Virginia & Uncertain Quality after Injected	
21	FRESH GROUNDWATER DEVELOPMENT	4.4				
22	GROUNDWATER DESALINATION AS THE SINGLE LONG-TERM ALTERNATIVE	30.2	VDEQ Permittability Uncertain Due to Potential Regional Aquifer Drawdown			
23	GROUNDWATER DESALINATION IN NEWPORT NEWS WATERWORKS DISTRIBUTION AREA	6.4				
24	JAMES RIVER DESALINATION	30.2	VDH Opposition due to Public Health Concerns	Exceeds RRWSG Criterion	Experimental Application of Technology & Uncertain Water Quality Reliability	
25	PAMUNKEY RIVER DESALINATION	0.0	VDEQ MIF Policy Requirement Negates Safe Yield Benefit			
26	YORK RIVER DESALINATION	30.2		Exceeds RRWSG Criterion	Experimental Application of Technology & Uncertain Water Quality Reliability	
27	COGENERATION	Unknown	VDH Opposition due to Public Health Concerns & No Proposals Exist for Water Sales			
28	WASTEWATER REUSE AS A SOURCE OF POTABLE WATER	3.7-6.5	VDH Opposition due to Public Health Concerns		Uncertainties with Adequacy of Treatment Technology	
29	WASTEWATER REUSE FOR NON-POTABLE USES *	0.0-5.0	RRWSG can not Dictate whether Large Water Users Implement			
30	USE RESTRICTIONS	1.5				
31	NO ACTION **	0.0	Does not Contribute to Solution of Basic Project Purpose			

* Non-Potable Reuse is already included as part of the regional conservation plan and will not be carried forward for further environmental analysis.

** Although not considered feasible, the No Action alternative will be retained for further environmental analysis pursuant to the CEQ's NEPA regulations.

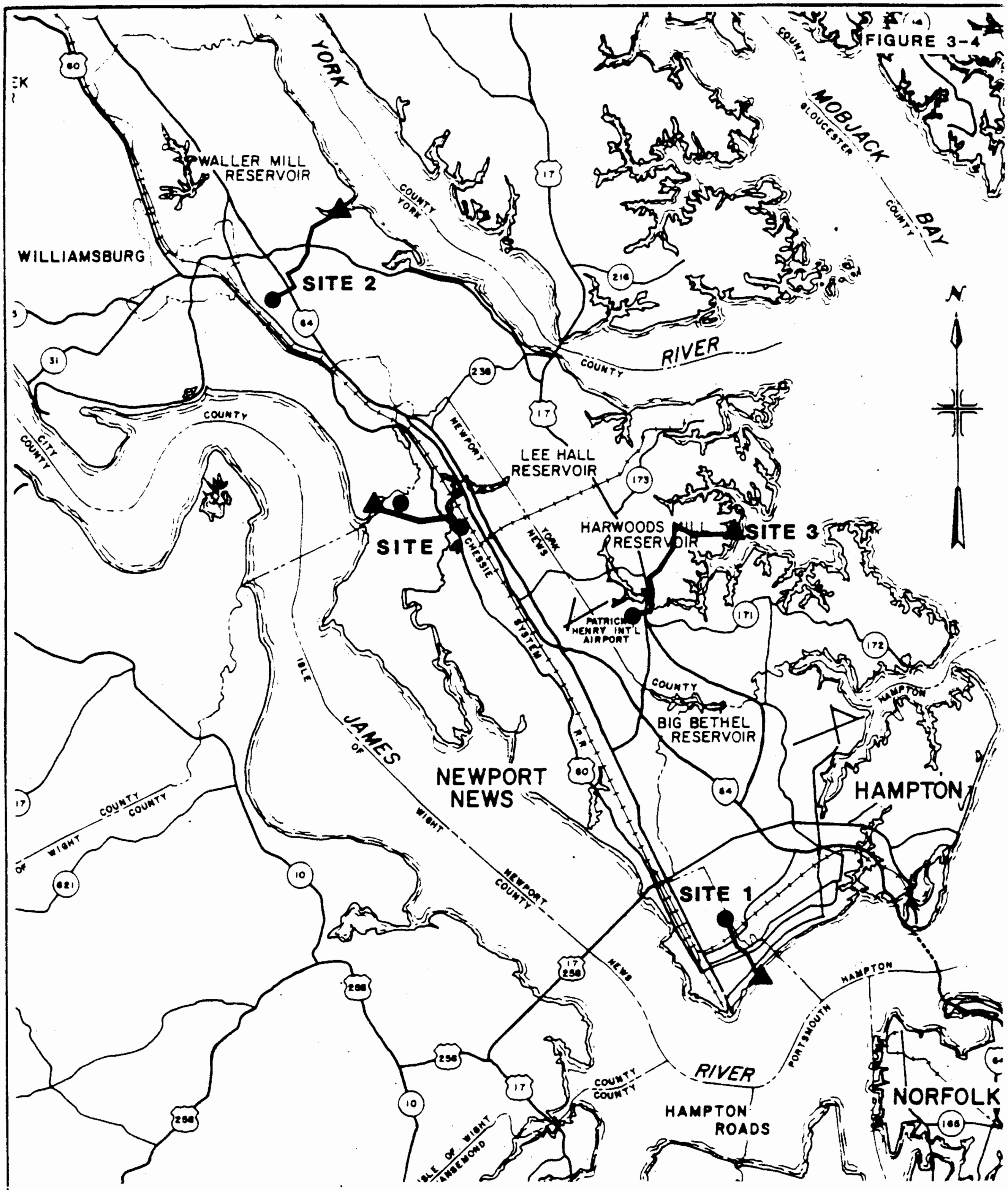


FIGURE 3-4

LEGEND

- GROUNDWATER WITHDRAWAL
- CONCENTRATE DISCHARGE OUTFALL
- CONCENTRATE DISCHARGE PIPELINE

MALCOLM PIRNIE

MARCH 1993

LOWER VIRGINIA PENINSULA
REGIONAL RAW WATER SUPPLY STUDY
ENVIRONMENTAL ANALYSIS

GROUNDWATER DESALTING ALTERNATIVE
PROJECT LOCATION

5 0 5

SCALE IN MILES

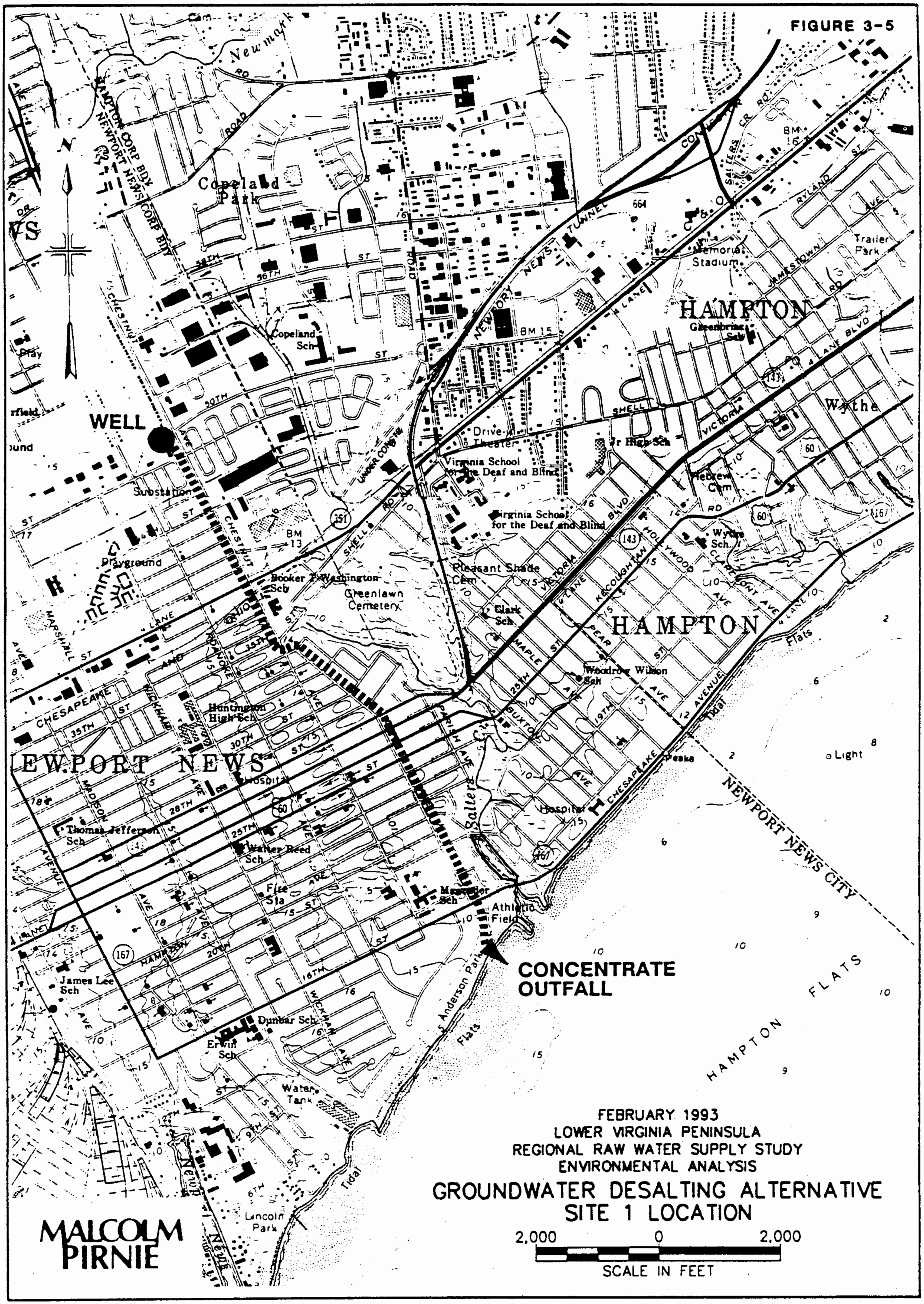
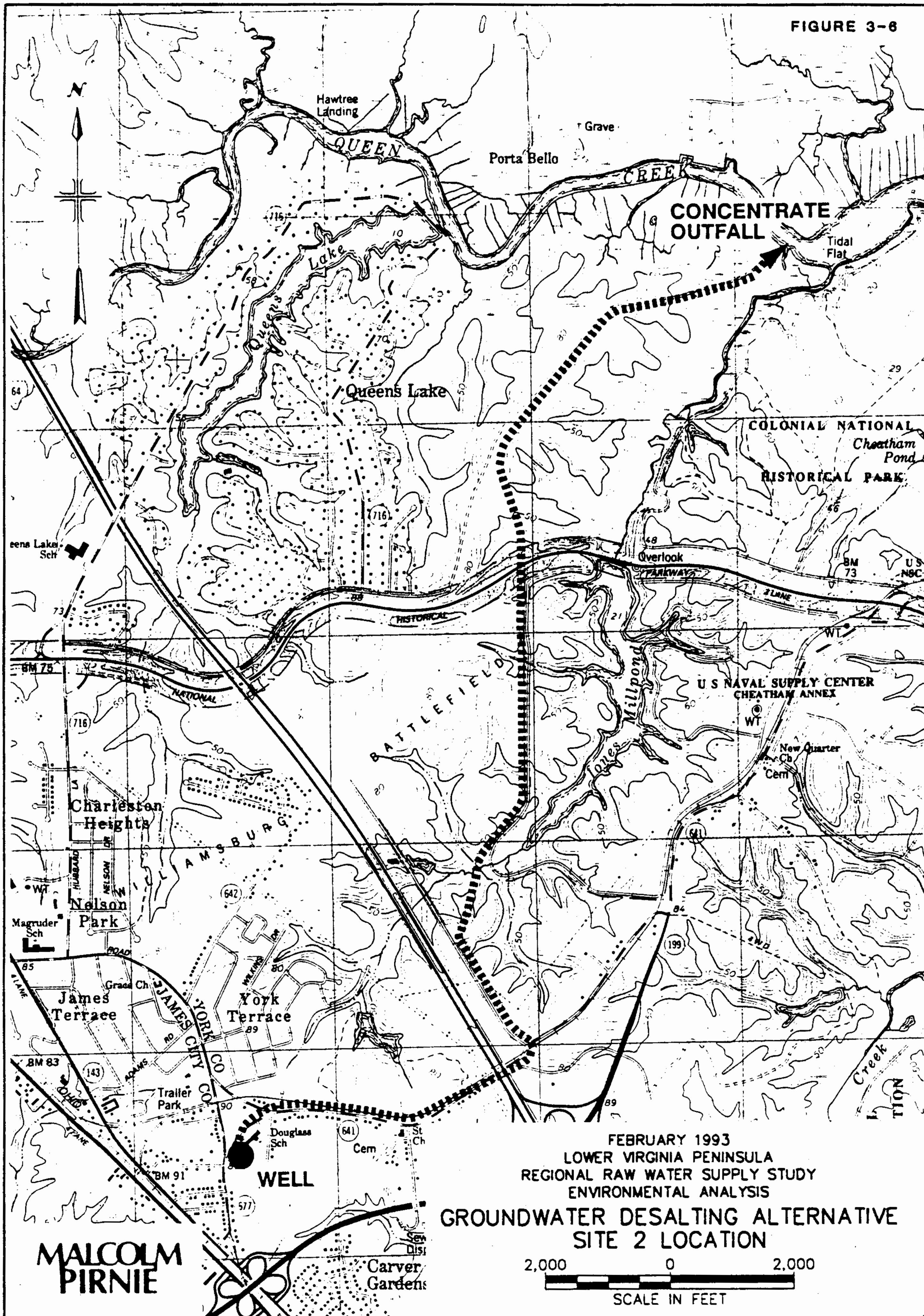


FIGURE 3-5
WELL
CONCENTRATE
OUTFALL
HAMPTON
NEWPORT NEWS
NEWPORT NEWS CITY
HAMPTON FLATS
Copeland Park
Memorial Stadium
Greenlawn Cemetery
Pleasant Shade Cem
Virginia School for the Deaf and Blind
Booker T. Washington Sch
Huntington High Sch
Thomas Jefferson Sch
Walter Reed Sch
Woodrow Wilson Sch
Dunbar Sch
Erwin Sch
James Lee Sch
Lincoln Park
Water Tank
Athletic Field
Substation
Playground
Trailer Park
FEBRUARY 1993
LOWER VIRGINIA PENINSULA
REGIONAL RAW WATER SUPPLY STUDY
ENVIRONMENTAL ANALYSIS
GROUNDWATER DESALTING ALTERNATIVE
SITE 1 LOCATION
2,000
0
2,000
SCALE IN FEET
MALCOLM PIRNIE

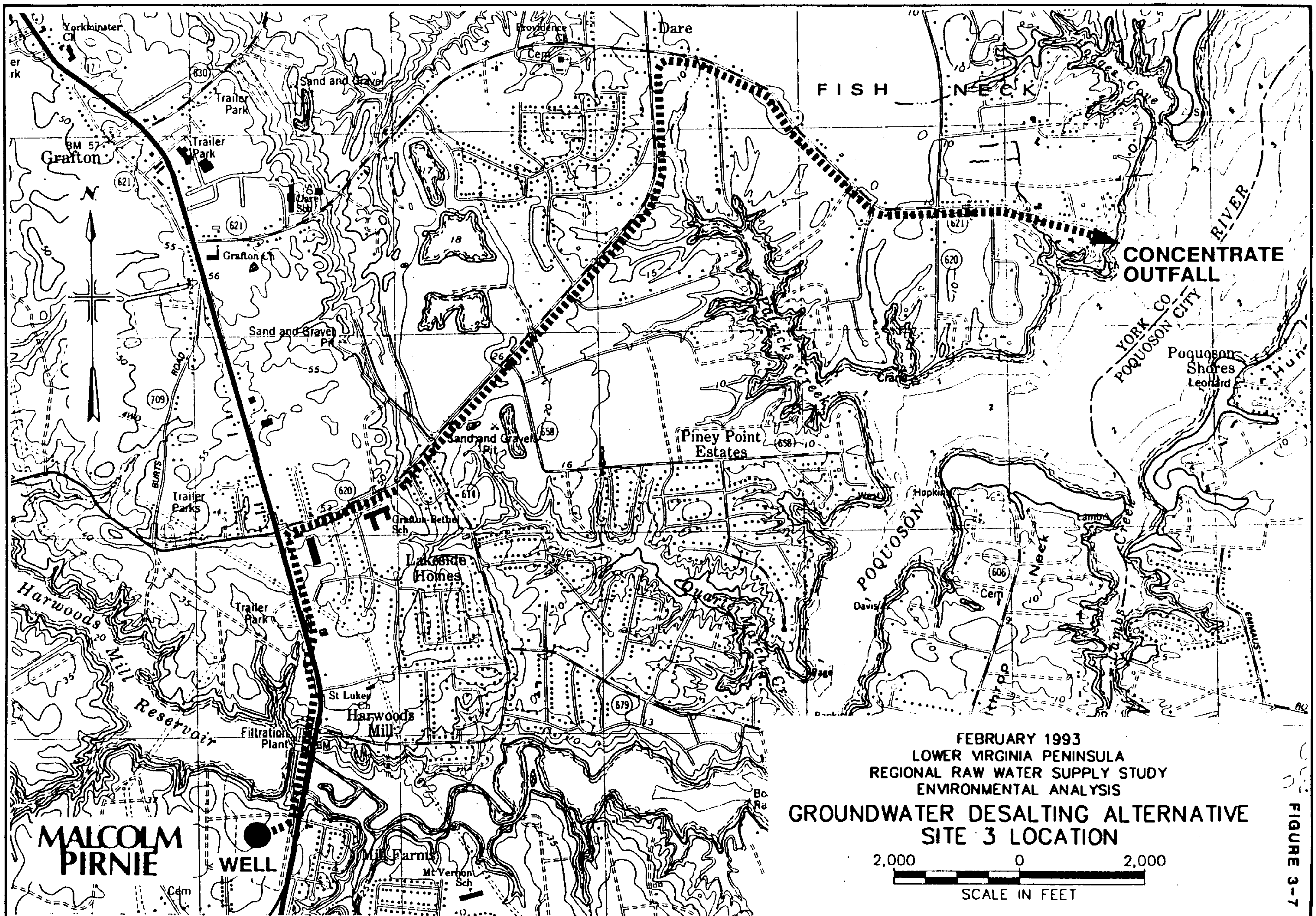


FEBRUARY 1993
LOWER VIRGINIA PENINSULA
REGIONAL RAW WATER SUPPLY STUDY
ENVIRONMENTAL ANALYSIS

GROUNDWATER DESALTING ALTERNATIVE
SITE 2 LOCATION

2,000 0 2,000
SCALE IN FEET

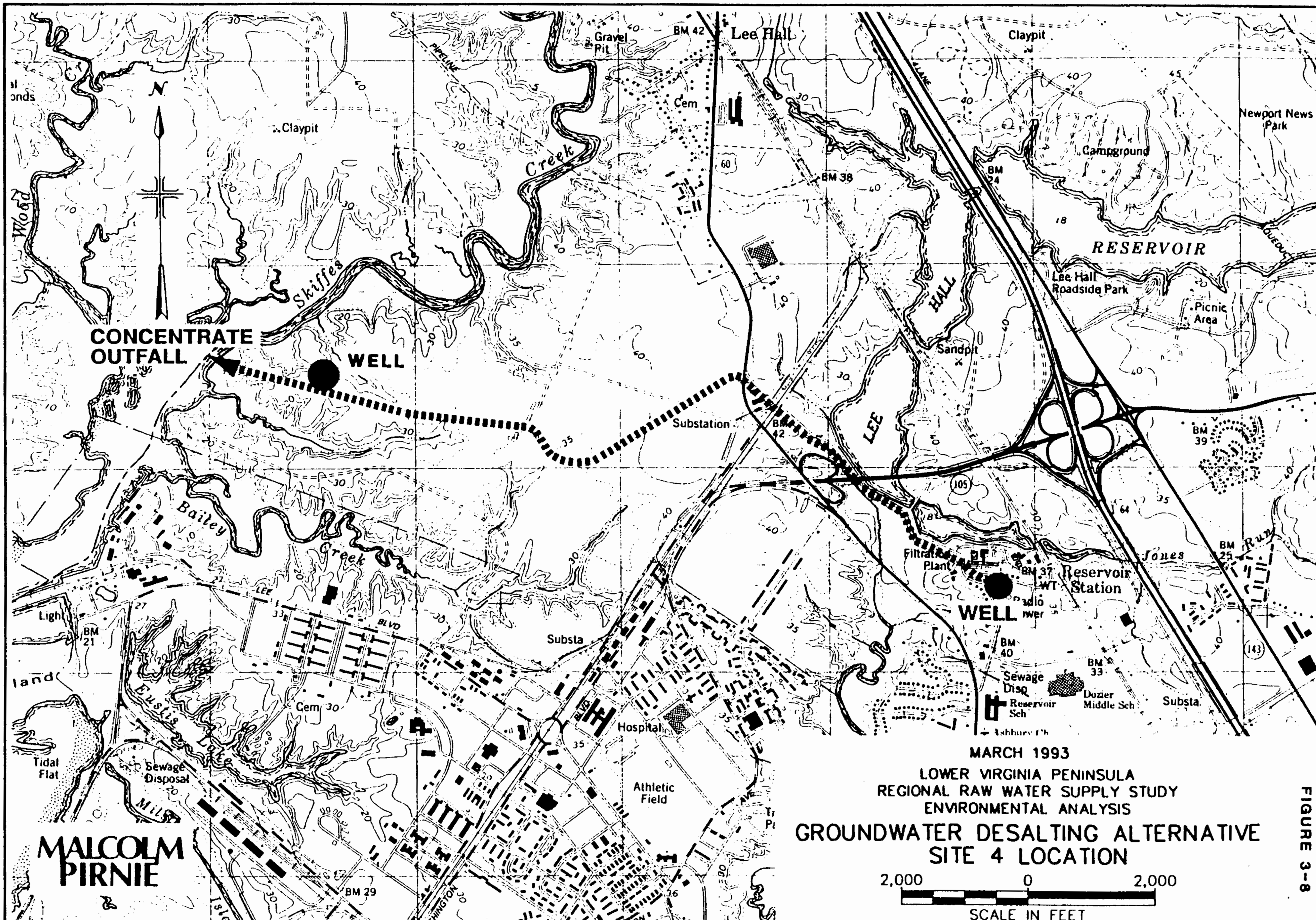
MALCOLM PIRNIE



FEBRUARY 1993
LOWER VIRGINIA PENINSULA
REGIONAL RAW WATER SUPPLY STUDY
ENVIRONMENTAL ANALYSIS

GROUNDWATER DESALTING ALTERNATIVE
SITE 3 LOCATION

FIGURE 3-7



MARCH 1993

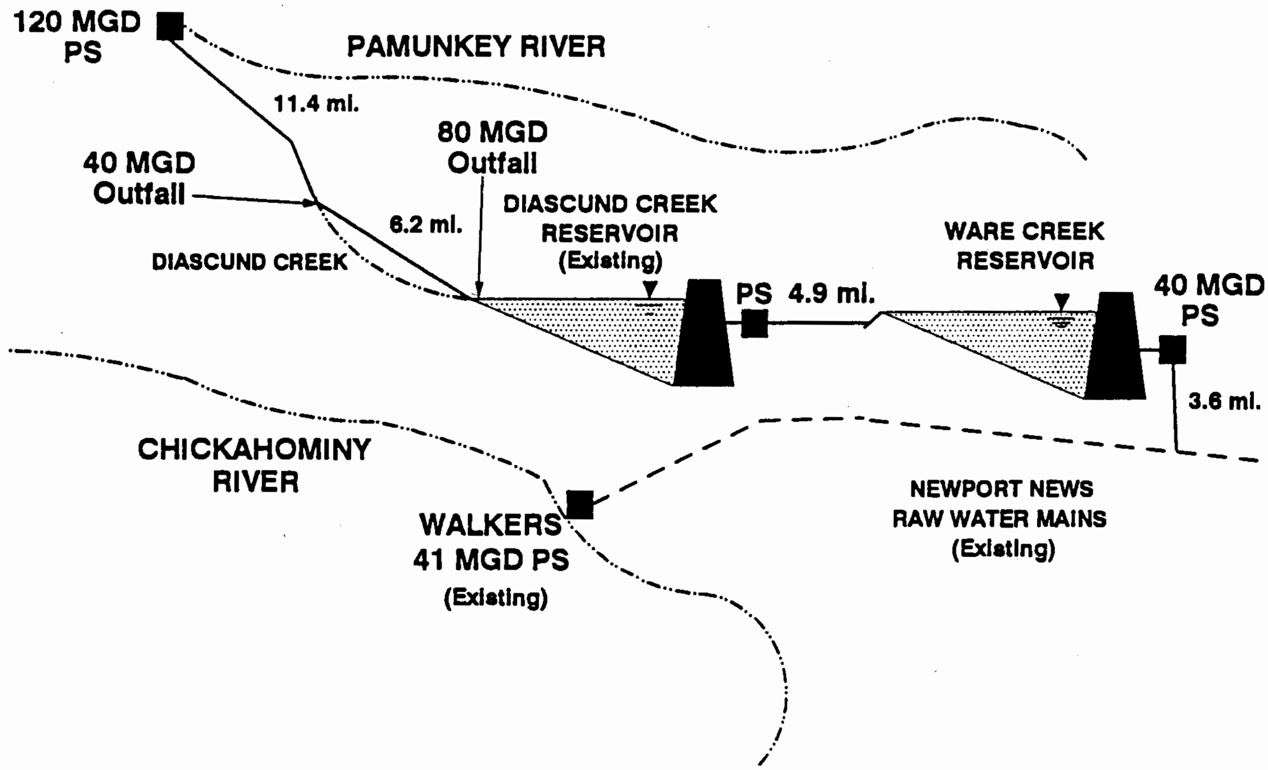
LOWER VIRGINIA PENINSULA
REGIONAL RAW WATER SUPPLY STUDY
ENVIRONMENTAL ANALYSIS

GROUNDWATER DESALTING ALTERNATIVE SITE 4 LOCATION

2,000 0 2,000
SCALE IN FEET

FIGURE 3-8

EXPANDED WARE CREEK PROJECT CONCEPT



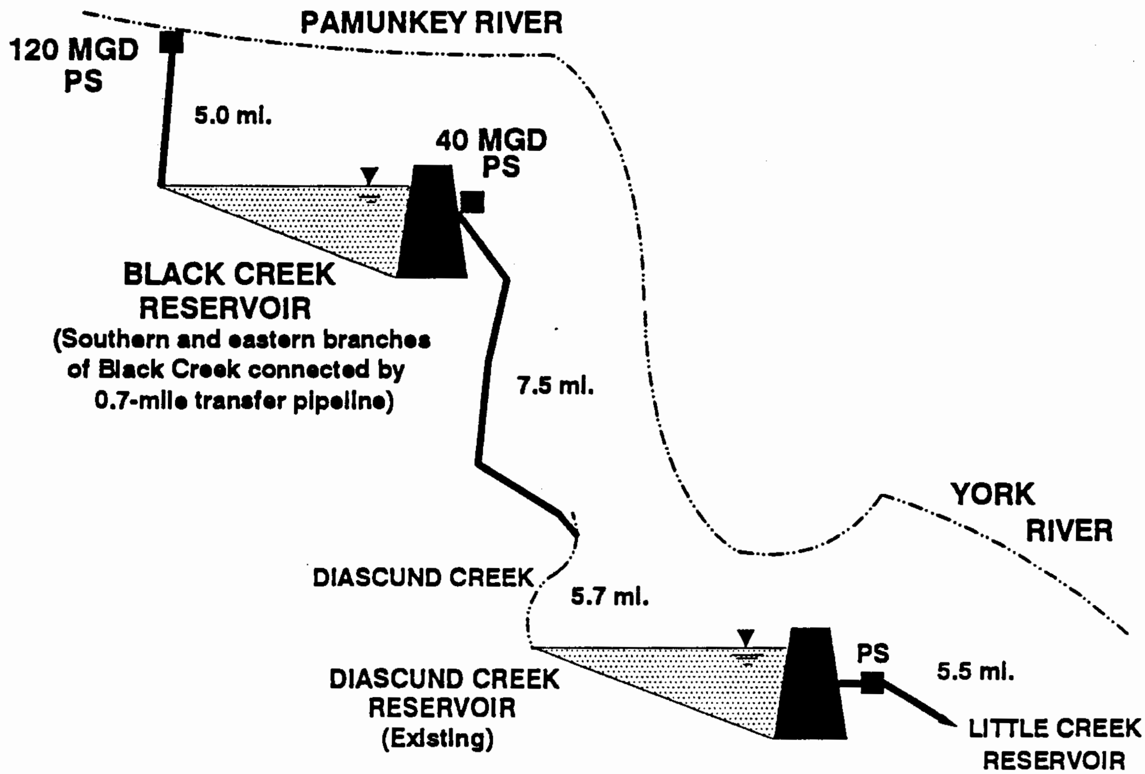
PROJECT FEATURES

- 120 mgd Pamunkey River intake and pump station near Northbury in New Kent County
- 11.4-mile, 120 mgd and 6.2-mile, 80 mgd capacity pipeline from Northbury to Diascund Creek headwaters (40 and 80 mgd outfalls)
- 40 mgd intake and pump station at Diascund Creek Reservoir
- 4.9-mile, 40 mgd capacity pipeline from Diascund to Ware Creek Reservoir
- 40 mgd intake and pump station at Ware Creek
- 3.6-mile, 40 mgd capacity pipeline from Ware Creek to NN raw water mains (can also serve as outfall line to Ware Creek)
- Ware Creek dam 1,450 ft long at a crest elevation of 48 ft. msl
- Ware Creek Reservoir characteristics:

Total Volume	6.87 BG
Surface Area	1,238 ac
Normal Pool Elevation	35 ft. msl
Minimum Pool Elevation	16.5 ft. msl
Dead Storage Volume	25%
Reservoir Drainage Area	17.4 sq mi
Minimum Reservoir Release	0.4 - 1.6 mgd

Figure 3-10

BLACK CREEK RESERVOIR PROJECT CONCEPT



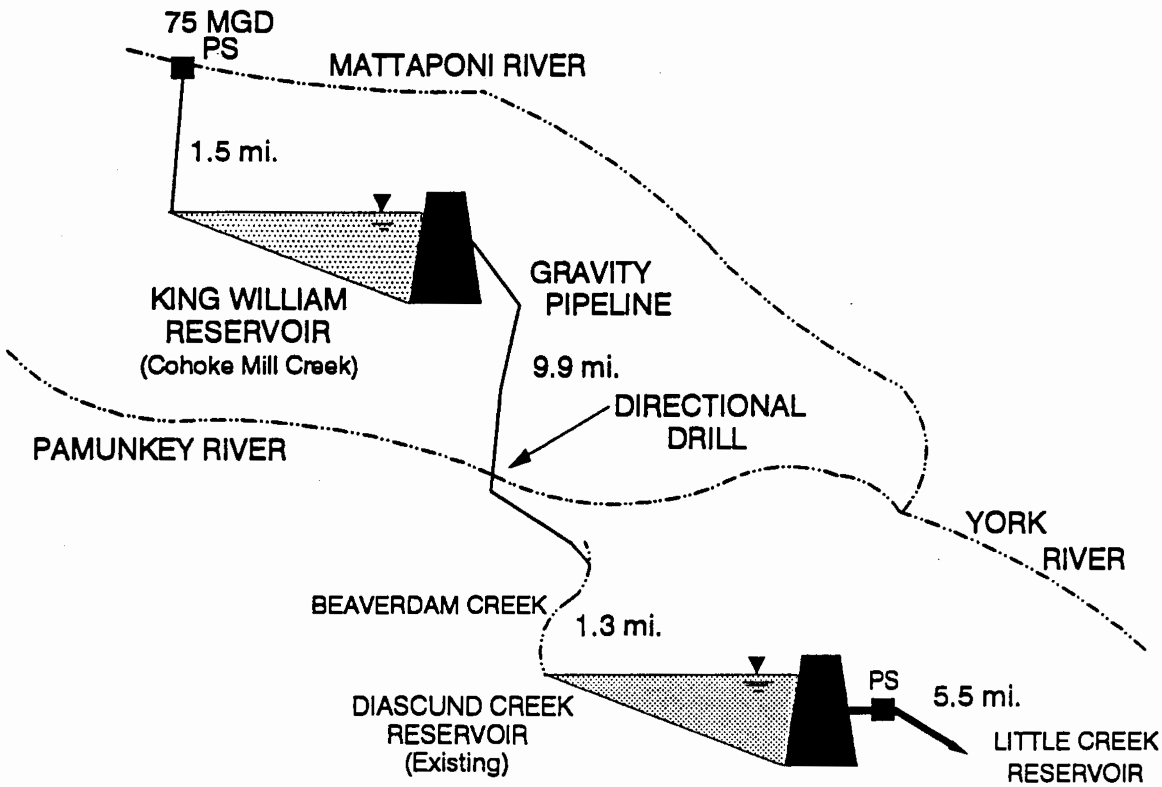
PROJECT FEATURES

- 120 mgd Pamunkey River intake and pump station in vicinity of Northbury
- 5-mile, 120 mgd capacity pipeline from Pamunkey River to Black Creek Res.
- 40 mgd intake and pump station on the eastern branch of Black Creek Res.
- 7.5-mile, 40 mgd capacity pipeline for BC Reservoir withdrawals
- Pipeline terminus on Diascund Creek in New Kent County
- Pipeline discharge flows 5.7 miles to Diascund Creek Reservoir
- 40 mgd intake and pump station at Diascund Creek Reservoir
- 5.5-mile, 40 mgd capacity pipeline from Diascund to Little Creek Reservoir
- Dams 85 and 95 feet high at crest elevations of 110 feet msl
- Black Creek Reservoir characteristics:

Total Volume	8.4 BG
Surface Area	1,146 ac
Normal Pool Elevation	100 ft. msl
Minimum Pool Elevation	70 ft. msl
Dead Storage Volume	25%
Reservoir Drainage Area	5.5 sq mi
Minimum Reservoir Release	1.2 mgd

Figure 3-11

KING WILLIAM RESERVOIR PROJECT CONCEPT



PROJECT FEATURES

- 75 mgd Mattaponi River intake and pump station at Scotland Landing
- 1.5-mile, 75 mgd capacity pipeline from Mattaponi River to K. W. Reservoir
- 9.9-mile, 40 mgd capacity gravity pipeline for K. W. Reservoir withdrawals
- Gravity pipeline terminus at 35 ft. msl on Beaverdam Creek in New Kent County
- Gravity pipeline discharge flows 1.3 mi downstream to Diascund Creek Reservoir
- 40 mgd intake and pump station at Diascund Creek Reservoir
- 5.5-mile, 40 mgd capacity pipeline from Diascund to Little Creek Reservoir
- K. W. Reservoir dam 2,400 ft long and 90 ft high at a crest elev. of 100 ft. msl
- King William Reservoir characteristics:

Total Volume	21.7 BG
Surface Area	2,234 ac
Normal Pool Elevation	90 ft. msl
Minimum Pool Elevation	70 ft. msl
Dead Storage Volume	47%
Reservoir Drainage Area	13.2 sq mi
Minimum Reservoir Release	3 mgd

2. The project alternative must have the least cumulative environmental impact possible, while satisfying Criterion No. 1.

3. The combination of project alternative components should be institutionally acceptable and cumulatively feasible while satisfying Criteria No. 1 and No. 2.

From the preceding list of practicable alternative components, it has been demonstrated that to satisfy the projected Year 2040 regional water demand, any project alternative must include a reservoir component. Thus, there will be three basic project alternatives, each of which may have several variations, based on the yield produced by the respective reservoir component.

The alternative components carried forward into the environmental analysis include the Ware Creek, Black Creek, and King William reservoir and pumpover components, with groundwater (fresh or desalted) and use restrictions to make up the remaining project deficit. Based on the results of the environmental analysis presented in Volume II of the ***Alternatives Assessment*** report, the environmental impacts of non-reservoir practicable project components rank as follows:

Alternative Component	**Safe Yield (mgd)**	**Environmental Impact**
Use Restrictions	1.5	Least
Fresh Groundwater Development	4.4	
Groundwater Desalination in Newport News Waterworks Distribution Area	6.4	Most

Generally, these three components will be added from least impact to most impact while taking into consideration Criteria Nos. 1 and 3 above.

The next step in defining project alternatives is to determine the short-term needs, that is, the demand that will be required until a reservoir can realistically be expected to come on line. In order to implement a reservoir component, it could take approximately 7 to 10 years from the present to permit, design, construct, and fill a reservoir for use. For this analysis, the Ware Creek Reservoir component is considered to take only 7 years, or until the Year 2000, since it is ahead of Black Creek and King William reservoir in permitting and preliminary engineering studies.

It is projected that regional demand will exceed supplies by the Year 1998 with additional projected demands of approximately 0.7 mgd per year thereafter. Although the interim regional needs are less than 4 mgd, the projected interim needs of Newport News Waterworks approach 6 mgd with a deficit appearing as early as the Year 1996. The demands of the other regional water supply systems would continue to be met with existing supplies through this period. Also, this interim need includes the deficit that would be observed in the Big Bethel system that would be supplied by Newport News Waterworks. Therefore, the interim demands of the projects are as shown below:

Reservoir	Time to Completion (Years)*	Interim Regional Deficit (mgd)	Newport News Waterworks Deficit** (mgd)
Ware Creek	7	1.5	2.7
Black Creek	10	3.8	5.6
King William	10	3.8	5.6

* Time to completion could vary from these estimates. Therefore, interim supply deficits may vary from the values presented.

** Newport News Waterworks is projected to be in a deficit situation earlier than other Lower Peninsula water purveyors.

There is one other factor that needs to be considered when assembling the project alternatives. Fresh groundwater and groundwater desalination are not independent of one another. Some combination of fresh groundwater and brackish groundwater may be available beyond the limits of each individual component described (i.e., 10 mgd of fresh groundwater during periods of substantial reservoir drawdown to produce a 4.4-mgd safe yield, or 10 mgd of brackish groundwater for desalination to produce a safe yield of 6.4 mgd). However, it is not considered feasible to rely on pumping a total of 20 mgd of groundwater for permanent use on the Lower Peninsula. Therefore, an alternative that relies on both components developed to their full capacities will not be considered practicable. Another factor that will be considered is that the fresh groundwater safe yield of 4.4 mgd may actually be slightly higher when combined with an additional storage component.

Based on the above information, the project alternatives were assembled around each reservoir component as follows:

Practicable Project Alternatives

	Project Yield (mgd)		
Alternative Component	**Alt. A Ware Creek**	**Alt. B Black Creek**	**Alt. C King William**
Use Restrictions	1.5 (1.5)	1.5 (1.5)	1.5 (1.5)
Fresh Groundwater	4.4 (1.2)	4.4 (4.1)	2.3 (4.1)
Reservoir with Pamunkey River	24.1	21.3	---
Reservoir with Mattaponi River	---	---	26.4
Groundwater Desalting	0.2	3.0	---
Total Supply	**30.2 (2.7)**	**30.2 (5.6)**	**30.2 (5.6)**

Note: Bracketed numbers indicate the interim supply yield or demand reduction required until a reservoir component is operational.

These project alternatives have now been established in a manner so that they can be further evaluated on a common basis. They all meet the projected regional deficit of 30.2 mgd through the Year 2040 and have been assembled from practicable components with the least potential environmental impacts. Also, these components have been added in such a manner as to fulfill projected interim demands before the reservoir component can be implemented.

3.6 SUMMARY OF ENVIRONMENTAL CONSEQUENCES

Environmental consequences of the seven evaluated alternatives are summarized and presented in Table 3-5. A detailed discussion of environmental consequences is presented in Section 5.0.

3.7 RRWSG'S PREFERRED PROJECT ALTERNATIVE

3.7.1 Impact Scoring for Practicable Alternative Components

Table 3-6 is a matrix containing impact scores for each of the seven alternative components evaluated. The basis for each of the assigned impact scores is presented in the ***Alternatives Assessment (Volume II - Environmental Analysis)*** (Malcolm Pirnie, 1993). The impact scores have been totalled separately for the 16 aquatic ecosystem impact categories, and for all 23 environmental impact categories.

Differentiation for magnitude of impact within individual impact categories was made by assigning relative numerical scores ranging from +3 to -3. Weighting factors were not used for the 23 impact categories. These impact category scoring and weighting procedures are in accordance with guidance contained in the USCOE's June 1992 summary (W. H. Poore, USCOE - Norfolk District, personal communication, 1992) of federal and state agency comments on the ***Methodology for Identifying, Screening, and Evaluating Alternatives*** (Malcolm Pirnie, 1993).

Previous efforts to develop impact category weighting factors included a March 12, 1992 Interagency Coordination Meeting attended by USCOE, USEPA, USFWS, and NMFS staff, RRWSG representatives, and Malcolm Pirnie scientists. Federal agency staff provided comments, but a consensus was not reached on an appropriate weighting mechanism. Subsequent to this meeting, the USEPA, USFWS, NMFS, SWCB, and the Virginia Council on the Environment provided written comments to the USCOE on the ***Methodology for Identifying, Screening, and Evaluating Alternatives***. The USCOE summarized these federal and state agency comments in the above-referenced document. In this summary, the USCOE recommended that the RRWSG present a comparative impact table using the proposed impact scores (+3 to -3) without any impact category weighting factors. In further support of the impact scoring procedure, the USCOE wrote that *"the use of a negative to positive scale is standard for comparative impact tables and makes favorable versus unfavorable impacts readily discernible."*

Based on the total impact scores, the seven alternative components were ranked as follows with respect to their potential environmental impacts on the aquatic ecosystem and other public interest factors:

1. Use Restrictions **(least damaging)**

2. King William Reservoir with Pumpover from Mattaponi River

3. Fresh Groundwater Development

4. Black Creek Reservoir with Pumpover from Pamunkey River

5. Groundwater Desalination in Newport News Waterworks Distribution Area

6. Ware Creek Reservoir with Pumpover from Pamunkey River

7. No Action **(most damaging)**

A noteworthy conclusion from this environmental analysis is that the Groundwater Desalination alternative is considered more damaging overall than some of the reservoir alternatives. The principal reason for this determination is that the groundwater desalination alternative was only assigned a positive impact score for its benefits to municipal and private water supplies. Corresponding groundwater desalination scores for other impact categories were either 0 (no impact) or negative. The reservoir alternatives would also offer benefits to municipal and private water supplies. However, in contrast to the Groundwater Desalination alternative, the reservoirs would also offer substantial benefits through enhancement of freshwater fisheries, expansion of water-related recreational opportunities, creation of new parks, direct and indirect benefits to groundwater resources and, in some cases, socioeconomic benefits. These reservoir benefits are reflected in positive impact scores for several impact categories.

The Fresh Groundwater Development alternative is ranked as less damaging than the Groundwater Desalination alternative. One of the reasons for this difference is that the fresh groundwater withdrawals would be discharged to existing reservoirs when they are drawn down to critical levels. This type of reservoir storage augmentation would provide some benefits to aquatic biota that depend on these freshwater aquatic ecosystems. Also, this fresh groundwater alternative does not have the impacts associated with much longer concentrate discharge pipelines and associated concentrate outfalls, as would occur with groundwater desalination.

Of the three reservoir alternatives, Ware Creek Reservoir is considered by the RRWSG to be the most damaging overall. Some of the principal reasons for this conclusion are listed below:

- Ware Creek Reservoir would have the largest impact on water quality conditions below a proposed dam site. The reservoir would eliminate a tidal freshwater zone, and greatly reduce or eliminate oligohaline areas below the dam site.

- Intense development in the planned "Stonehouse Community" would be within the Ware Creek Reservoir watershed. This extensive development represents the most serious threat to continued long-term water quality in any of the three proposed reservoirs.

- The Ware Creek Reservoir alternative would cause the largest reduction in streamflow levels below a proposed dam site (86 to 96 percent reduction in average flow).

- The proposed Ware Creek Reservoir dam site is in tidal and navigable waters of the United States. In contrast, the Black Creek and King William reservoir dam sites are located in non-tidal waters which are upstream of existing manmade obstructions such as dams and road crossings.

- The Ware Creek Reservoir alternative would rely on Pamunkey River withdrawals, while the King William Reservoir alternative would rely on Mattaponi River withdrawals. Estimated Year 1990 consumptive water use in the Pamunkey River basin is over 13 times as great as that estimated for Mattaponi River basin.

- The Ware Creek Reservoir site contains the largest known population of a sensitive species (98-nest Great Blue Heron rookery).

- The Ware Creek Reservoir site is currently used by anadromous fish including Striped Bass. There is no evidence, and a low probability, that either the Black Creek or King William reservoir sites are used by anadromous fish.

- Ware Creek Reservoir would impact the largest and most diverse area of wetlands (590 acres of tidal and non-tidal wetlands).

- Ware Creek Reservoir would provide a 2.3-mgd lower treated water safe yield benefit for the Lower Peninsula than King William Reservoir. Therefore, Ware Creek Reservoir would have less beneficial impact on municipal and private water supply systems.

- Ware Creek Reservoir would inundate the greatest number of identified cultural resources (45 sites).

- Ware Creek Reservoir would impact the largest number of existing roadways including potential impacts to Interstate 64 which are as yet unresolved.

Overall, the Black Creek Reservoir alternative is considered by the RRWSG to be more environmentally damaging than the King William Reservoir alternative. Some of the primary reasons for this conclusion are listed below:

- The Black Creek Reservoir alternative would rely on Pamunkey River withdrawals, while the King William Reservoir alternative would rely on Mattaponi River withdrawals. Estimated Year 1990 consumptive water use in the Pamunkey River basin is over 13 times as great as that estimated for the Mattaponi River basin.

- The King William Reservoir impoundment site, and areas immediately below the proposed dam site, are already isolated from anadromous fish passage by the existing Cohoke Millpond Dam. The millpond dam is located 1.8 river miles downstream of the proposed King William Reservoir Dam. By comparison, only lesser manmade obstructions to fish passage, such as road crossings, exist below the proposed Black Creek Reservoir dam sites. With minor improvements at existing culverts and a submerged roadbed, fish passage at these crossings could be facilitated.

- King William Reservoir would result in the loss of 1,719 acres of forested habitat compared to 752 acres for Black Creek Reservoir. This type of habitat is very common to the area. These losses represent less than 2 percent and 1 percent of the forested land within King William and New Kent counties, respectively. However, King William Reservoir would result in creation of nearly twice as much valuable fish habitat as Black Creek Reservoir (2,234 acres versus 1,146 acres). These freshwater systems are scarce in both New Kent and King William counties.

- Because Cohoke Mill Creek is already impounded below the proposed King William Reservoir dam site, it is already subject to a substantial degree of flow moderation during high runoff events. In contrast, the floodplain areas and associated floodplain wetland communities below the proposed Black Creek Reservoir dam sites would be subjected to greatly reduced flood flows from those currently experienced. As a result, floodplain wetlands hydrology would be severely limited. The vegetated wetlands between the proposed Black Creek Reservoir impoundment sites and the Pamunkey River cover nearly four times as much area, and are much more diverse, than those located between the proposed King William Reservoir dam site and the Pamunkey River.

- Black Creek Reservoir would provide a 5.1-mgd lower treated water safe yield benefit for the Lower Peninsula than King William Reservoir. Therefore, Black Creek Reservoir would have less beneficial impact on municipal and private water supply systems.

- Given the list of practicable alternative components, a 30.2-mgd project alternative involving Black Creek Reservoir would have to include another reservoir alternative, or development of both fresh and brackish groundwater sources. In comparison, a 30.2-mgd project alternative involving King William Reservoir would only require development of one groundwater alternative. Therefore, a project alternative involving Black Creek Reservoir would have impacts associated with development of a greater number of water sources.

- Black Creek Reservoir would result in the displacement of at least 14 existing houses, and the potential for inundation or other direct impacts to at least 8 additional houses under construction or built within the proposed reservoir buffer zones. In contrast, no existing houses have been identified which would be displaced by the proposed King William Reservoir.

The No Action alternative is considered by the RRWSG to be the most damaging overall of the seven alternatives evaluated. This alternative would result in major negative impacts to the quality and quantity of existing water supplies, future land use development potential, and socioeconomic conditions on the Lower Peninsula.

It must be emphasized that the impact ranking order for alternative components is based on the use of impact scores ranging from +3 to -3 for 23 unweighted impact categories. This study does not imply that critical water resource impact categories such as wetlands, fish and invertebrates, hydrology, and water quality are of equal importance as categories such as air quality and aesthetics. Instead, the scoring totals are presented as being indicative, in general, of the relative overall impacts of the seven alternative components. It is understood that different government agencies and other interested parties may view certain impact categories as more important than others in their consideration of this overall impact analysis.

Clearly there are differences in the relative importance of the 23 impact categories with respect to water supply projects. Given this premise, a hypothetical weighting scheme was developed to test the sensitivity of the results presented in Table 3-6 to the assignment of various impact category weighting factors. These hypothetical weighting factors were developed based on the technical judgement of Malcolm Pirnie scientists and input received from federal and state regulatory agencies at, and following, the previously mentioned March 12, 1992 Interagency Coordination Meeting. A weighting factor range of 1 to 4 was used, with 4 being most important. These weighting factors, and the resulting weighted impact scores for the seven alternatives, are presented in Table 3-7.

On a relative basis, the weighted scoring results presented in Table 3-7 do not differ substantially from the unweighted results in Table 3-6. There was only one change in the ranking order for alternatives based on total scores for all 23 impact categories. The Ware Creek Reservoir alternative went from being ranked next to most damaging, to being ranked most damaging. For alternative ranking based on total aquatic ecosystem impact category scores, the two alternatives ranked as most damaging (No Action and Ware Creek Reservoir) again switched places.

This presentation of weighted scoring results is not intended to replace the unweighted results contained in Table 3-6. Instead, this analysis was used to demonstrate that the ranking order for alternatives appears to be quite insensitive to the potential assignment of impact category weighting factors.

3.7.2 Comparison of Alternative Component Practicability

As shown in Table 3-6, the Use Restrictions and King William Reservoir alternatives are considered least damaging, and next to least damaging, respectively, of the alternatives considered in this environmental analysis. The recommendation of specific alternative components as part of an overall project alternative should also be supported by the results of the practicability analysis presented in the ***Alternatives Assessment (Volume I - Practicability Analysis*** (Malcolm Pirnie, 1993). Therefore, a brief discussion is presented below on the relative technical merits of the five practicable alternatives which involve water supply source development.

The Use Restrictions alternative, although considered practicable, does not lend itself to evaluation using these same technical criteria and is omitted from the following discussion. The No Action alternative is not considered practicable since it does not contribute to a solution of the basic project purpose. Nevertheless, the No Action alternative was retained for this environmental impact analysis pursuant to the Council on

Environmental Quality's NEPA regulations. Given these factors, the practicability of the No Action alternative is also omitted from the following discussion.

Safe Yield Benefits

King William Reservoir would have 2½ to 3 times more storage capacity (21.7 billion gallons) than the Black Creek (8.4 billion gallons) and Ware Creek (6.9 billion gallons) reservoirs, respectively. In addition, King William Reservoir would have a dead storage volume equal to 47 percent of total capacity, as compared to only 25 percent for the other two reservoir alternatives. A 25 percent dead storage volume is the minimum level recommended by the Virginia Department of Health (VDH) for water quality protection. Given these factors, the King William Reservoir alternative offers the greatest potential for future expansion to supply water to a larger region than the Lower Peninsula and/or to meet water demands beyond the Year 2040.

The fresh and brackish groundwater alternatives would produce estimated treated water safe yield benefits of 4.4 mgd and 6.4 mgd, respectively. Given their relatively low supply benefits, these alternative components are considered supplementary to the reservoir alternatives which are each capable of providing more than 20 mgd of the Lower Peninsula's projected Year 2040 treated water deficit of 30.2 mgd.

Availability

Host Jurisdiction Approval

The City of Newport News has executed a host jurisdiction agreement with King William County for the King William Reservoir alternative. Over the past two years, no progress has been made between Newport News and James City County on a project development agreement for the Ware Creek Reservoir alternative. While an agreement with James City County may be possible, acceptable resolution of safe yield, operational, and financing issues remains uncertain at this time. For Black Creek Reservoir, approval by New Kent County may be difficult to obtain since displacement of at least 14 existing houses and impacts to additional subdivided land with a total assessed value of approximately $6.55 million would occur. Clearly, without a host jurisdiction agreement, the availability of the Black Creek Reservoir alternative as a regional water supply solution remains uncertain.

With respect to the Fresh Groundwater alternative, James City County has recently taken a position of public opposition to this alternative. This opposition surfaced following a March 30, 1992 application which was submitted to the SWCB by the City of Newport News Waterworks for a smaller version of this alternative in western James City County. In formal comments to the SWCB concerning this application, the County stated: "... *we oppose the issuance of these withdrawal permits at least until such time as a reliable supply of surface water is available to the County*" (J. T. P. Horne, James City County, personal communication, 1992). This local opposition would likely delay implementation of this alternative within, and possibly outside of James City County, until some agreement between the City of Newport News and James City County could be negotiated.

As of May 1993, negotiations between the City of Newport News and New Kent County for fresh groundwater development in New Kent County were underway. The two

TABLE 3-6

ENVIRONMENTAL IMPACT SCORING SUMMARY FOR ALTERNATIVE COMPONENTS (UNWEIGHTED)

IMPACT CATEGORY	ALTERNATIVE COMPONENT						
	1 WC	BC 2	KW3	FCW4	GWD5	VR 6	NK7
Substrate **	−2	−2	−2	−1	−1	0	0
Water Quality **	−3	−1.5	−2	−1.5	−1.5	0	−2.5
Hydrology **	−3	−2	−2	−1	−0.5	0	−1
Endangered, Threatened, and Sensitive Species **	−2	−1	−2	0	0	0	−0.5
Fish and Invertebrates **	−1	1	2	1	−1	0	−1
Other Wildlife **	−3	−2	−2	−0.5	−0.5	0	−0.5
Sanctuaries and Refuges **	0	0	0	0	0	0	0
Wetlands and Vegetated Shallows **	−3	−2	−2	−0.5	−0.5	0	−1
Mud Flats **	0	0	0	0	−2	0	−1
Riffle and Pool Complexes **	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Municipal and Private Water Supplies **	2	1.5	2.5	0.5	1	0.5	−3
Recreational and Commercial Fisheries **	0	1	2	0.5	−1	0	−1
Other Water−Related Recreation **	3	3	3	0	−1	−1	−2
Aesthetics **	−2	−1.5	−1.5	−0.5	−1.5	−0.5	−1
Parks and Preserves **	3	3	3	0	−1.5	−1	−1
Cultural Resources **	−3	−2.5	−2.5	−0.5	−1.5	0	0
Groundwater Resources	2	2	2	−2	−1	0	−0.5
Land Use	−2	−3	−2	−0.5	−1	−1	−3
Soil and Mineral Resources	−2	−2	−3	−1	−1	0	0
Air Quality	−1.5	−1	−0.5	0	−1	0	0
Noise	−1.5	−1	−1	−0.5	−1	0	0
Infrastructure	−3	−2	−1.5	−1	−0.5	0	0
Socioeconomic Impacts	3	−3	1	−1	−1	−2	−3
TOTAL AQUATIC ECOSYSTEM IMPACT SCORE	−14	−5	−3.5	−3.5	−12.5	−2	−15.5
ALTERNATIVE RANK (from aquatic ecosystem score)	*6*	*4*	*2 (tie)*	*2 (tie)*	*5*	*1*	*7*
OVERALL TOTAL IMPACT SCORE	−19	−15	−8.5	−9.5	−19	−5	−22
ALTERNATIVE RANK (from total score)	*5 (tie)*	*4*	*2*	*3*	*5 (tie)*	*1*	*7*

Alternative Components
1. Ware Creek Reservoir with Pumpover from Pamunkey River
2. Black Creek Reservoir with Pumpover from Pamunkey River
3. King William Reservoir with Pumpover from Mattaponi River
4. Fresh Groundwater Development
5. Groundwater Desalination in Newport News Waterworks Distribution Area
6. Use Restrictions
7. No Action

Impact Score	Definition
+3	Major positive
+2	Moderate positive
+1	Minor positive
0	No impact
−1	Minor negative
−2	Moderate negative
−3	Major negative

Note: Impact categories followed by "**" are aquatic ecosystem impact criteria adapted from the Clean Water Act Section 404(b)(1) Guidelines.

TABLE 3–7

ENVIRONMENTAL IMPACT SCORING SUMMARY FOR ALTERNATIVE COMPONENTS (WEIGHTED)

IMPACT CATEGORY	WEIGHT (1 to 4)	ALTERNATIVE COMPONENT 1	2	3	4	5	6	7
Substrate **	2	−4	−4	−4	−2	−2	0	0
Water Quality **	4	−12	−6	−8	−6	−6	0	−10
Hydrology **	4	−12	−8	−8	−4	−2	0	−4
Endangered, Threatened, and Sensitive Species **	4	−8	−4	−8	0	0	0	−2
Fish and Invertebrates **	4	−4	4	8	4	−4	0	−4
Other Wildlife **	3	−9	−6	−6	−1.5	−1.5	0	−1.5
Sanctuaries and Refuges **	3	0	0	0	0	0	0	0
Wetlands and Vegetated Shallows **	4	−12	−8	−8	−2	−2	0	−4
Mud Flats **	3	0	0	0	0	−6	0	−3
Riffle and Pool Complexes **	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Municipal and Private Water Supplies **	2	4	3	5	1	2	1	−6
Recreational and Commercial Fisheries **	3	0	3	6	1.5	−3	0	−3
Other Water–Related Recreation **	2	6	6	6	0	−2	−2	−4
Aesthetics **	1	−2	−1.5	−1.5	−0.5	−1.5	−0.5	−1
Parks and Preserves **	2	6	6	6	0	−3	−2	−2
Cultural Resources **	3	−9	−7.5	−7.5	−1.5	−4.5	0	0
Groundwater Resources	3	6	6	6	−6	−3	0	−1.5
Land Use	2	−4	−6	−4	−1	−2	−2	−6
Soil and Mineral Resources	1	−2	−2	−3	−1	−1	0	0
Air Quality	1	−1.5	−1	−0.5	0	−1	0	0
Noise	1	−1.5	−1	−1	−0.5	−1	0	0
Infrastructure	2	−6	−4	−3	−2	−1	0	0
Socioeconomic Impacts	2	6	−6	2	−2	−2	−4	−6
TOTAL AQUATIC ECOSYSTEM IMPACT SCORE		**−56**	**−23**	**−20**	**−11**	**−35.5**	**−3.5**	**−44.5**
ALTERNATIVE RANK (from aquatic ecosystem score)		*7*	*4*	*3*	*2*	*5*	*1*	*6*
OVERALL TOTAL IMPACT SCORE		**−59**	**−37**	**−23.5**	**−23.5**	**−46.5**	**−9.5**	**−58**
ALTERNATIVE RANK (from total score)		*7*	*4*	*2 (tie)*	*2 (tie)*	*5*	*1*	*6*

Alternative Components
1. Ware Creek Reservoir with Pumpover from Pamunkey River
2. Black Creek Reservoir with Pumpover from Pamunkey River
3. King William Reservoir with Pumpover from Mattaponi River
4. Fresh Groundwater Development
5. Groundwater Desalination in Newport News Waterworks Distribution Area
6. Use Restrictions
7. No Action

Impact Score	Definition
+3	Major positive
+2	Moderate positive
+1	Minor positive
0	No impact
−1	Minor negative
−2	Moderate negative
−3	Major negative

Note: Impact categories followed by "**" are aquatic ecosystem impact criteria adapted from the Clean Water Act Section 404(b)(1) Guidelines.

jurisdictions are considering development of deep groundwater withdrawals within New Kent County to supply future County needs and augment storage in Diascund Creek Reservoir.

The Groundwater Desalination alternative is the most "available" of the five water supply source development alternatives from a host jurisdiction approval standpoint. This is because the groundwater well and reverse osmosis treatment facilities associated with this alternative would be built within the City of Newport News, or in York County on property owned by the City of Newport News Waterworks. Two of the four concentrate discharge pipelines would be located within the City of Newport News. The other two concentrate discharge pipelines would pass through areas of York County not owned by the City of Newport News Waterworks.

Competition for Source Water

The Mattaponi River, as the proposed river pumpover source for the King William Reservoir alternative, offers a distinct advantage over the Pamunkey River which is the proposed pumpover source for the Ware Creek and Black Creek reservoirs. That is, King William Reservoir would rely on a 45-mgd lower river withdrawal capacity (75 mgd versus 120 mgd), yet would provide a greater safe yield benefit than either Ware Creek or Black Creek reservoirs.

The Pamunkey River basin contains much more existing and projected future withdrawal capacity and consumptive water use than the Mattaponi River basin. This includes Hanover County's active pursuit of major Pamunkey River withdrawals to supply the proposed Crump Creek Reservoir or an alternative sidehill impoundment. Less anticipated competition for Mattaponi River water is a distinct advantage associated with the King William Reservoir alternative.

Both groundwater alternatives are located within the Eastern Virginia Groundwater Management Area where competition for development of future groundwater supplies is high among local jurisdictions and private water supply developers.

<u>Cost</u>

Life cycle costs have been estimated for all five practicable water supply source development alternatives. These costs have been related to the estimated treated water safe yield benefit of each alternative component to provide a more equal comparison. All five alternatives are considered affordable according to the screening criteria used and described in Section 3.3. As shown in the following table, the Fresh Groundwater alternative is by far the most cost-effective alternative. The other four alternatives do not vary widely in cost-effectiveness. However, potential future expansion of the King William Reservoir alternative, as discussed previously, would result in this alternative being even more cost-effective than the other two reservoir proposals. More detailed alternative cost estimate breakdowns are presented in the ***Alternatives Assessment (Volume I - Practicability Analysis)***.

Alternative Component	Lower Peninsula Treated Water Safe Yield (mgd)	Year 1992 Present Value Cost per mgd of Safe Yield
Ware Creek Reservoir	24.1	$6.23M
Black Creek Reservoir	21.3	$6.75M
King William Reservoir	26.4	$5.77M
Fresh Groundwater	4.4	$2.24M
Groundwater Desalination	6.4	$5.35M

Technological Reliability

For the five water supply source development alternatives, principal reliability concerns focus on the anticipated long-term water quality of the proposed river or groundwater sources, and within the proposed reservoir watersheds.

River Pumpover Water Quality

Currently, there are no "major" (as classified by the SWCB) existing or planned municipal or industrial discharges in the Mattaponi River basin. This represents a distinct long-term advantage for the King William Reservoir alternative.

For the Ware Creek and Black Creek reservoir alternatives, the proposed river pumpover source is the Pamunkey River. There are currently four major municipal and industrial discharges upstream of the proposed intake site at Northbury. In addition to these existing Pamunkey basin discharges, Hanover County currently plans to put in place two major wastewater treatment plant (WWTP) discharges to the Pamunkey River upstream of Northbury. King William County's plans include a small WWTP discharge into a Pamunkey River tributary upstream of Northbury.

Ware Creek Reservoir could also be affected by an increase in phosphorus loading which may result in eutrophic conditions within the reservoir. The Ware Creek Reservoir alternative would include a direct pumpover from the Pamunkey River to Diascund Creek Reservoir, from where water would be conveyed to Ware Creek Reservoir. For the other two reservoir alternatives, water from the Pamunkey or Mattaponi rivers would be pumped to a large intermediate storage reservoir (either Black Creek Reservoir or King William Reservoir) prior to transmission to Diascund Creek Reservoir. The pipeline configuration for the Black Creek Reservoir alternative would also allow a portion of the Pamunkey River withdrawals to be pumped directly to Diascund Creek, bypassing Black Creek Reservoir. Longer hydraulic retention times in King William and Black Creek reservoirs would allow for much greater removal of phosphorus and other water quality constituents before any raw water actually enters Diascund Creek Reservoir and the rest of the existing Lower Peninsula raw water storage system. Owing to its much larger storage capacity and dead storage volume, these benefits should be greatest for the King William Reservoir alternative, and could greatly improve the treatability of the raw water.

Reservoir Watershed Water Quality

There is minimal existing or planned development within the 13.2-square mile King William Reservoir watershed. There are some concerns regarding groundwater quality and surface water runoff quality since portions of the King William County Landfill are located within the proposed reservoir drainage area. However, in December 1993, King William County discontinued acceptance of waste at this landfill. Present County plans are to begin, in April 1994, a formal landfill closure process to be certified by the Commonwealth. In addition, the ***King William Reservoir Project Development Agreement*** specifies conditions for possible removal and relocation of deposited solid waste, if necessary. It is anticipated that these Agreement provisions would preclude any reservoir water quality problems that might otherwise occur as a result of the landfill.

Intense development plans associated with the planned "Stonehouse Community" represent a noteworthy water quality concern associated with the Ware Creek Reservoir alternative. This 7,230-acre planned community would occupy nearly half of the land draining into the proposed reservoir within James City and New Kent counties. Within James City County, Stonehouse would ultimately include 3.8 million square feet of commercial space and 4,411 dwelling units. Given the magnitude of this development, and historical water quality conditions in other highly developed reservoir watersheds, there would be a great risk of long-term reservoir water quality deterioration, despite implementation of best management practices and other measures designed to protect water quality.

Marked residential growth has occurred and continues to occur in portions of the proposed 5.5-square mile Black Creek Reservoir watershed. For example, the Clopton Forest residential subdivision borders the western edge of the Southern Branch Black Creek reservoir site. This large subdivision has the potential to impact reservoir water quality by contributing non-point source runoff from roads, sediment loads from home and road construction activities, nutrient loads from lawn fertilizer runoff, and migration of pollutants from septic tanks.

Groundwater Quality

A principal water quality concern associated with the Fresh Groundwater Development alternative concerns the level of phosphorus in the Middle Potomac Aquifer. Phosphorus concentrations in the Middle Potomac Aquifer near Little Creek Reservoir are not expected to be a problem. However, there appears to be an increasing trend in phosphorus concentrations to the west, toward Diascund Creek Reservoir. If phosphorus concentrations in the wells near Diascund Creek Reservoir are high, then phosphorus loading to the reservoir could be substantial and could result in reservoir management and water treatment problems associated with increasingly eutrophic reservoir conditions.

Elevated sodium levels in the groundwater also represent a potential concern, particularly since physicians now recommend various restricted sodium intakes to a portion of the population. If drinking water were to exceed VDH-recommended maximum sodium levels, water use would be restricted for some customers.

Due to the potential for reservoir water quality impacts from fresh groundwater discharge, use of groundwater without pretreatment should be approached with caution. Screening multiple aquifer zones and blending the groundwater prior to discharge to the reservoirs would be one technique for partially mitigating these potential impacts.

For the region encompassed by the brackish groundwater desalting alternative, available water quality data for the Middle Potomac and Lower Potomac aquifers are very limited. Therefore, it is currently difficult to assess whether successful treatment of the proposed feed water can be accomplished using a conventional low-pressure membrane system designed for brackish waters. Additional groundwater quality monitoring would be required to better characterize the site-specific water quality at the proposed withdrawal points.

<u>Summary</u>

Based on investigations to date, the King William Reservoir alternative is ranked superior to the other two reservoir alternatives with respect to each of the technical evaluation criteria discussed above. For the two groundwater alternatives, brackish groundwater withdrawals may be more available than fresh groundwater withdrawals. However, fresh groundwater withdrawals, if available, are much more cost-effective. Important water quality concerns or data gaps are associated with each groundwater alternative.

3.7.3 RRWSG's Proposed Project Alternative

Based on the environmental impact scoring results, the three practicable alternative components which appear to be the least damaging are listed below and are proposed as <u>long-term</u> components of an overall 30.2-mgd project alternative. Lower Peninsula treated water safe yield benefits associated with each alternative component are shown in parentheses.

- Use Restrictions (1.5 mgd)
- Fresh Groundwater Development (4.4 mgd)
- King William Reservoir with Pumpover from Mattaponi River (26.4 mgd)

The inclusion of King William Reservoir as part of this overall project alternative is also supported by the results of the practicability analysis presented in the ***Alternatives Assessment (Volume I - Practicability Analysis)*** and summarized above. The environmental impact analysis <u>and</u> technical merits of the King William Reservoir alternative support its inclusion as part of the proposed overall 30.2-mgd project alternative. Based on these conclusions, the RRWSG has applied to the USCOE for a permit pursuant to Section 10 of the Rivers and Harbors Act and Section 404 of the Clean Water Act to construct the King William Reservoir Project.

A tiered use restriction program should be developed immediately so that it may be implemented when the need arises. These use restrictions would be contingency measures, beyond routine conservation measures, employed to produce short-term demand reductions during water supply emergencies. In the near future, fresh groundwater development should also be implemented to augment existing reservoir storage when reservoir levels are depressed. Through the Year 2040, the Lower Peninsula's projected 30.2-mgd treated water supply deficit can be met with a combination of use restrictions, fresh groundwater withdrawals developed to provide a long-term treated water safe yield benefit of at least 2.3 mgd, and the King William Reservoir developed as summarized in Figure 3-11.

Assuming a 10-year time to completion for King William Reservoir, interim groundwater supplies yielding between 3 and 4 mgd would be required to satisfy projected interim water supply deficits before the new reservoir becomes operational. This estimate also assumes implementation of use restrictions capable of reducing short-term demands by at least 1.5 mgd.

3.7.4 RRWSG's Proposed Wetlands Mitigation Plan

A conceptual plan has been developed to mitigate for the loss of 452 acres of on-site palustrine vegetated wetlands filled and/or inundated by reservoir construction. This number represents the total amount of wetlands in the impact area (479) minus the amount of palustrine open water wetlands (27). This plan calls for the creation/restoration of approximately 266 acres of forested, scrub-shrub, and emergent wetlands along the perimeter of the proposed reservoir, in the reclaimed borrow area to be utilized to construct the dam, in various small impoundments in the headwaters of the small tributaries to Cohoke Mill Creek, and in prior converted croplands found in the watershed. In addition, this plan calls for the creation of approximately 186 acres of forested and scrub-shrub wetlands on two sites west of the proposed dam site. These constructed wetlands are located within 4,000 feet of the Cohoke Mill Creek watershed. The reservoir mitigation plan has been designed so that the project goal of "no net loss" of wetland function or acreage will be attained.

Figure 3-12 presents the conceptual mitigation plan and depicts the location of the various plan components. Additional description of the various proposed wetland designs is provided below.

The proposed wetland mitigation plan was developed based on the following objectives:

- Provide a ratio of 1.0 to 1.0 compensation for vegetated wetland acreage lost as a result of project construction.

- Create a wetland system with functional values equal to or greater than existing wetland values.

- Enhance wetland values by improving the following functions: aquatic habitat diversity, wetland-dependent wildlife habitat diversity, floodflow alteration, sediment/toxicant retention, and nutrient removal/transformation.

Reservoir Fringe Wetlands

This portion of the plan allows for the establishment of approximately 50 acres of forested and scrub-shrub wetlands along the perimeter of the proposed reservoir. Wetland vegetation will be established in areas between 88 and 92 feet msl with slopes less than or equal to 10 percent. A conceptual cross-section is shown in Figure 3-13.

The mitigation plan creates two wetland zones in appropriate areas along the perimeter of the reservoir (Figure 3-13). Zone A represents the area between 88 and 90 feet msl. Creation of palustrine scrub-shrub wetlands is planned for this area. Zone B (Figure 3-13) represents the area between 90 and 92 feet msl. Creation of palustrine forested wetlands is planned for this zone. The mitigation plan requires selective plantings within these zones to augment existing vegetation and facilitate wetland creation. A listing of species selected for planting is given in Table 3-8. The potential also exists for natural succession to create additional emergent wetlands and submerged aquatic vegetation in open water areas. In addition, standing timber will be left around the reservoir fringe above elevation 84 feet msl. However, only those areas specifically designated for planting are included in calculations of the acreage of wetlands.

Sands, fine sands, and sandy loams of the Nevarc-Remlik-Johnston association dominate the soils found on the slopes and terraces of the reservoir/impact area. Due to the sandy texture and nutrient-poor nature of the B-horizon and C-horizon of these soils, topsoil will need to be placed in the mitigation area to promote vigorous plant growth. In the two mitigation zones, existing upland forested vegetation will be removed and the native soils will be excavated to 1 foot below the specified final grade. Trees and native soils will be left in place below the 88 foot contour and above the 92 foot contour in the vicinity of the various fringe mitigation areas. One foot of topsoil will be used to bring the planting areas up to final grade. Topsoil from on-site sources is recommended due to the lack of noxious plants in the vicinity of the site. The topsoil should have a sandy loam or fine sandy loam texture, if possible.

The proposed forested wetland areas will be planted with container grown or balled and burlapped trees transplanted from wetland nursery areas. Each transplant will be fertilized at the time of planting with an application of Agriform 22-8-2 at the manufacturer's recommended rate.

Following planting, open areas between plants will be seeded with an appropriate grass mixture. The mixture will be applied at a recommended rate of application of 220 lbs/acre and mulched with weed-free straw to help prevent soil erosion.

It is assumed that reservoir soils will be sufficiently saturated to an elevation of 92 feet msl to support a forested wetland community in Zone A, which will be vegetated with the species identified in Table 3-8. This assumption is justified based on the soil types located within the project area and the biological characteristics of the species (i.e., ability to tolerate saturated soils or periods of drying) which will be planted within the zone.

In general, the upward movement of water due to capillarity in sandy soils such as the Evesboro series is fairly rapid; however, the capillary fringe of the soils has been estimated to extend only 15 inches above the water table. In loamy soils, the rate of movement is somewhat slower, but the capillary fringe is greater and is estimated to extend 35 inches from the water table (Brady, 1974). It is assumed for this study that the water table in Zone B (which extends a linear distance of no more than 20 feet from the normal pool

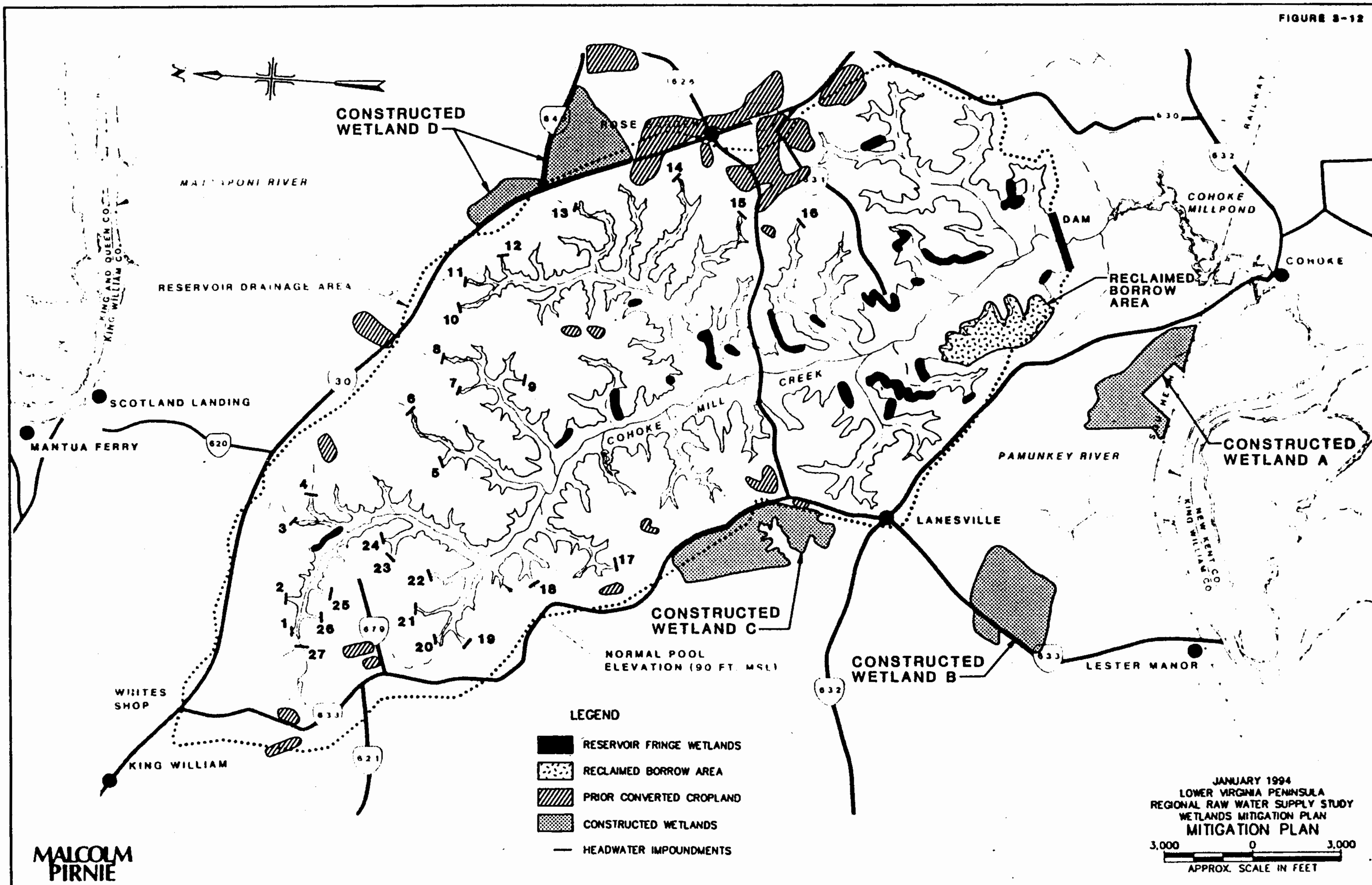
TABLE 3-8

SPECIES SELECTED FOR PLANTING IN CREATED WETLAND ZONES

RESERVOIR FRINGE WETLANDS

Wetland Zone	Scientific Name	Common Name	Elevation (MSL)
Scrub-Shrub Zone A	Cephalanthus occidentalis Alnus serrulata Vaccinium corymbosum Viburnum dentatum Cornus amomum	Buttonbush Smooth Alder Highbush Blueberry Southern Arrowwood Silky Dogwood	88 - 90
Forested Zone B	Acer rubrum Liquidambar styraciflua Fraxinus pennsylvanica	Red Maple Sweetgum Green Ash	90 - 92

FIGURE 3-12



CONSTRUCTED WETLAND D
ROSE
MATTAPONI RIVER
RESERVOIR DRAINAGE AREA
KING AND QUEEN CO.
KING WILLIAM CO.
SCOTLAND LANDING
MANTUA FERRY
COHOKE MILL CREEK
COHOKE MILLPOND
DAM
COHOKE
RECLAIMED BORROW AREA
CONSTRUCTED WETLAND A
PAMUNKEY RIVER
NEW KENT CO.
KING WILLIAM CO.
LANESVILLE
CONSTRUCTED WETLAND C
CONSTRUCTED WETLAND B
LESTER MANOR
NORMAL POOL ELEVATION (90 FT. MSL)
WHITES SHOP
KING WILLIAM
RAILWAY
LEGEND
RESERVOIR FRINGE WETLANDS
RECLAIMED BORROW AREA
PRIOR CONVERTED CROPLAND
CONSTRUCTED WETLANDS
HEADWATER IMPOUNDMENTS
JANUARY 1994
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REGIONAL RAW WATER SUPPLY STUDY
WETLANDS MITIGATION PLAN
MITIGATION PLAN
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APPROX. SCALE IN FEET
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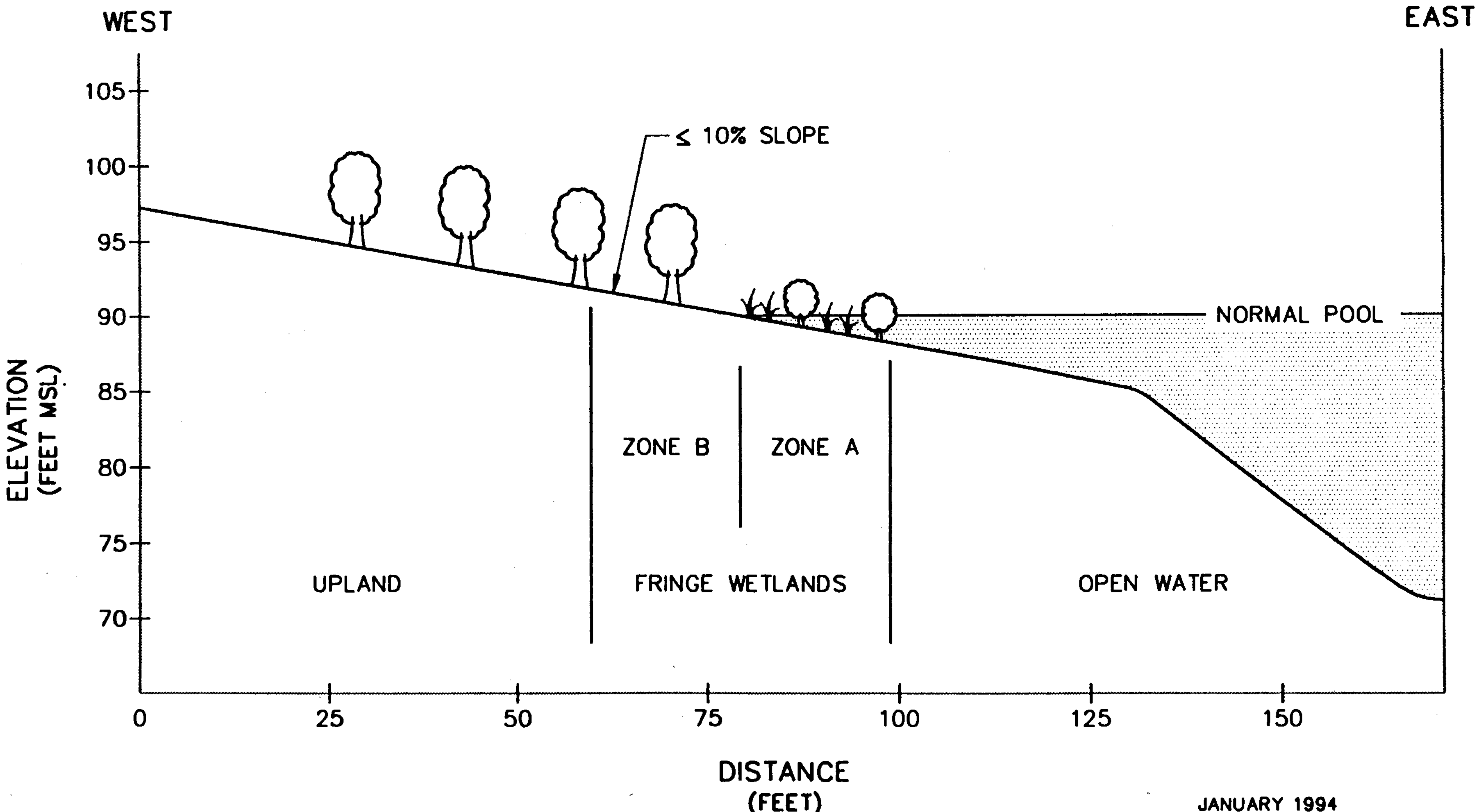
RESERVOIR FRINGE WETLANDS



MALCOLM PIRNIE

JANUARY 1994
LOWER VIRGINIA PENINSULA
REGIONAL RAW WATER SUPPLY STUDY
WETLANDS MITIGATION PLAN
RESERVOIR FRINGE WETLANDS
SCALE AS NOTED

FIGURE 3-13

elevation in the entire mitigation area) is located at approximately the same elevation as the normal pool elevation of the reservoir (90 feet msl).

Based on the general information on the capillarity of sands and loamy sands, it is anticipated that the capillary fringe of the soils in the mitigation area will extend from the water table 15 inches upward, at a minimum. Therefore, at the 92-foot contour elevation, the fringe would be located, at most, 9 inches below the surface. The relationship between the expected location of the capillary fringe and the bottom of the species' root systems at the time of planting is illustrated in Figure 3-14.

The forested wetland tree stock which will be used to vegetate the area will have approximately a 0.5-inch caliper, with a minimum root ball diameter of 12 inches (American Association of Nurserymen, 1990). Tree stock will be planted at a minimum depth of 8 inches. Therefore, the bottom of the root ball at the 92-foot contour elevation would be located within the capillary fringe. The bottom of the root ball would be within the capillary fringe beginning at a point just down gradient of the 92-foot contour elevation. This figure represents a worst-case scenario relationship. It is likely that the capillary fringe may extend further toward the surface, or the transplants may be more deeply planted.

The species chosen for vegetating the forested wetland zone are designated on the ***National List of Plant Species that Occur in Wetlands*** (USFWS, 1988) as either facultative (FAC) or facultative wetland (FACW) species. Red Maple and Sweet Gum are both regionally designated as FAC plants which are able to adapt to wet or dry conditions. Green Ash is more often located in wet areas than dry areas, but can withstand dry conditions. Because each of these species has the ability to tolerate dry conditions, and it is expected that once the root systems of the plants begin to grow, they will be located within the capillary fringe of the water table, it is assumed that the area between 90 and 92 feet will be saturated sufficiently to support a forested wetland community.

Reclaimed Borrow Area

A wetland system would also be created northeast of Virginia State Route 632, approximately 3,000 feet northwest of the proposed dam site (Figure 3-12). The basic contours of this wetland would be created concurrently with the excavation of sandy and clay soils for construction of the dam. Upon final contouring of the mitigation area, it would be planted as shown on the conceptual cross-section (Figure 3-15).

The plan for this wetland calls for the creation of approximately 66 acres of diverse wetland habitat, including ponds, emergent zones, and a forested area. Because the King William Reservoir site is located within the East Coast Migratory Flyway, the wetland mitigation plan includes habitat for breeding and migratory waterfowl. Islands would be created in the wetland to provide nesting and roosting sites for waterfowl.

The various components of the planned reclaimed borrow area wetland are discussed below.

- Hydrology - The proposed mitigation site would be hydrologically supported by the created reservoir. The normal pool elevation of the reservoir would be 90 feet msl. A berm at the eastern edge of the excavation/mitigation area would help to retain floodwaters in the wetland. The berm would be graded to 90 feet msl. At full pool, water would rise above the berm and spread out into the wetland.

Although water levels in the ponds would fluctuate seasonally in response to rainfall and reservoir drawdown, it is expected that water levels in the open water areas would range from 0 to 3.0 feet during much of the year.

- Soils - Soils in the mitigation area are composed primarily of low permeability clays and high permeability sands. Consequently, they are not a suitable planting substrate. Therefore, where suitable, the upper 12 to 18 inches of topsoil from the excavation/mitigation area would be stockpiled on site. In addition, the hydric soils excavated from the dam site would be transported and stockpiled on site. Prior to planting, the soils would be spread to a depth of approximately 12 inches on the final contours to be planted. Because plantings are not proposed for the open water zone, stockpiled soils would not be spread in this zone.

- Proposed Vegetation for Wetland Zones - The proposed mitigation plan would create 60 acres of palustrine wetlands. The plan incorporates two wetland zones around open water areas. The wetland zones would include an emergent marsh and a forested wetland. The plant species associated with each zone are listed in Table 3-9. The plant species were selected for their adaptability to wetland conditions, for species diversity, for enhancement of existing plant communities, and for their attractiveness to wildlife as habitat and a food source.

The plants selected for each of the zones would be planted in random groupings of individual species to create a greater interspersion of species and provide for plant diversity throughout each zone. Plants would be placed in an area best suited to their hydrologic tolerance. Specific species would also be utilized to improve wetland functions. To control soil erosion on the embankments, to slow water velocity and to trap sediments, Black Willow (Salix nigra) and Smooth Alder (Alnus serrulata) would be planted in erosion-prone areas in the inflow/outflow locations and adjacent to stabilized rip-rap channels. Emergent plant species would be planted at the edge of the open water areas to limit sedimentation and erosion at the wetland/open water interface.

Headwater Impoundments

Headwater impoundments will be created between the 90 and 95 foot contours in ravines which presently contain narrow wetlands. These areas would be inundated during the late winter and early spring, and under normal conditions would remain saturated throughout the growing season. It is expected that 90 acres of new wetlands would be created by these impoundments.

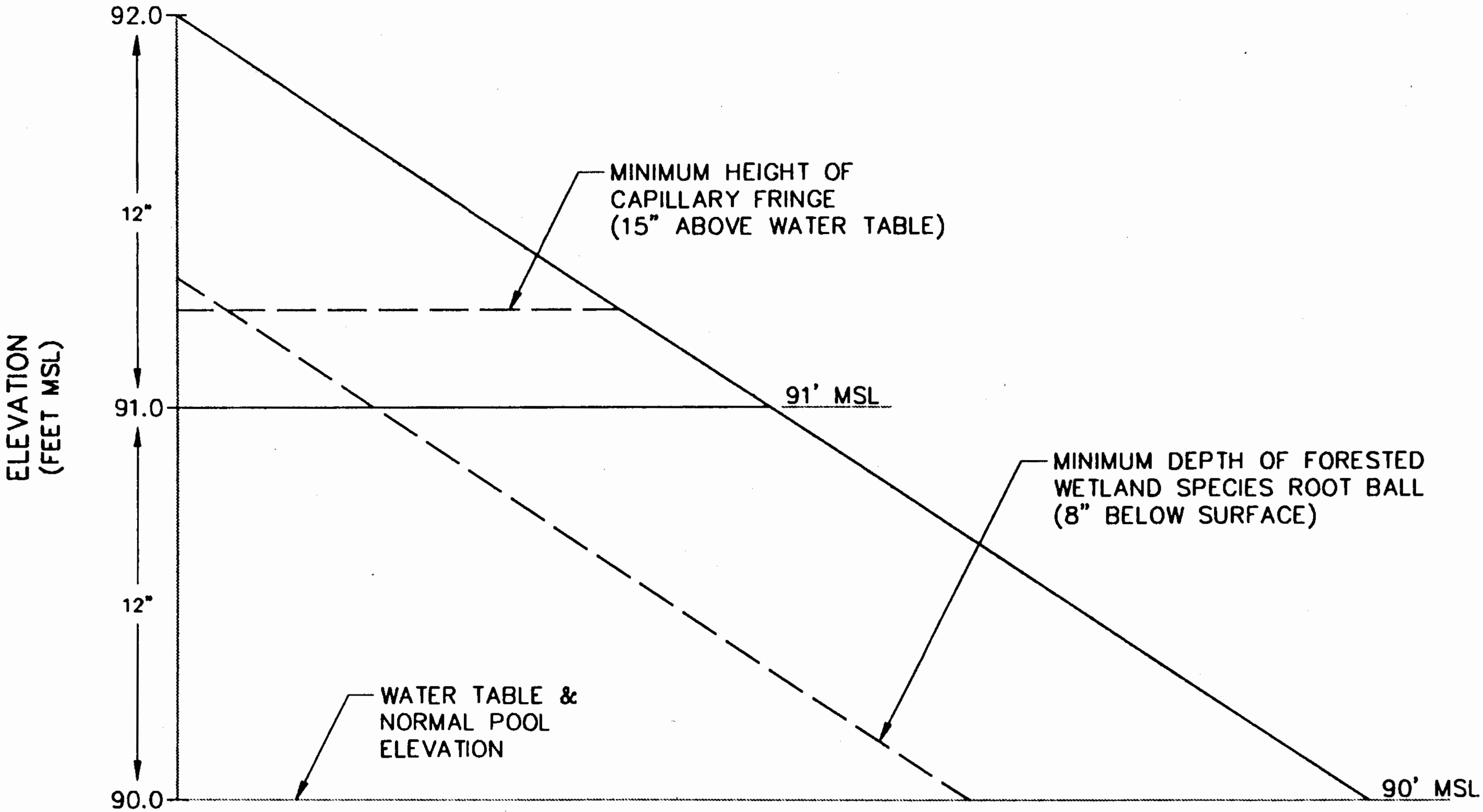
Permanently inundated impoundments will be established adjacent to the reservoir by creating 4-foot high berms in the perimeter arms of the reservoir (Figure 3-16). The crest of these earthen berms would be 90 feet, which corresponds to the normal pool elevation of the proposed reservoir. When the reservoir water level is at or above normal pool, these impoundments would be directly connected with the reservoir. An estimated 200 - 250 acres of land exists between the 87- and 90-foot contours at the reservoir site.

TABLE 3-9

SPECIES SELECTED FOR PLANTING IN CREATED WETLAND ZONES

RECLAIMED BORROW AREA

Wetland Zone	Scientific Name	Common Name
Open Water	Lemna minor	Duckweed
Emergent Marsh	Cephalanthus occidentalis Sagittaria latifolia Scirpus americanus Sparganium americanum	Buttonbush Duck Potato Threesquare Rush Eastern Burreed
Forested Wetland	Acer rubrum Liquidambar styraciflua Fraxinus pennsylvanica Alnus serrulata Cornus amomum	Red Maple Sweet Gum Green Ash Smooth Alder Silky Dogwood



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WETLANDS MITIGATION PLAN

RELATIONSHIP BETWEEN CAPILLARY FRINGE AND ZONE B SPECIES TRANSPLANTS (WORST-CASE SCENARIO)

NOT TO SCALE

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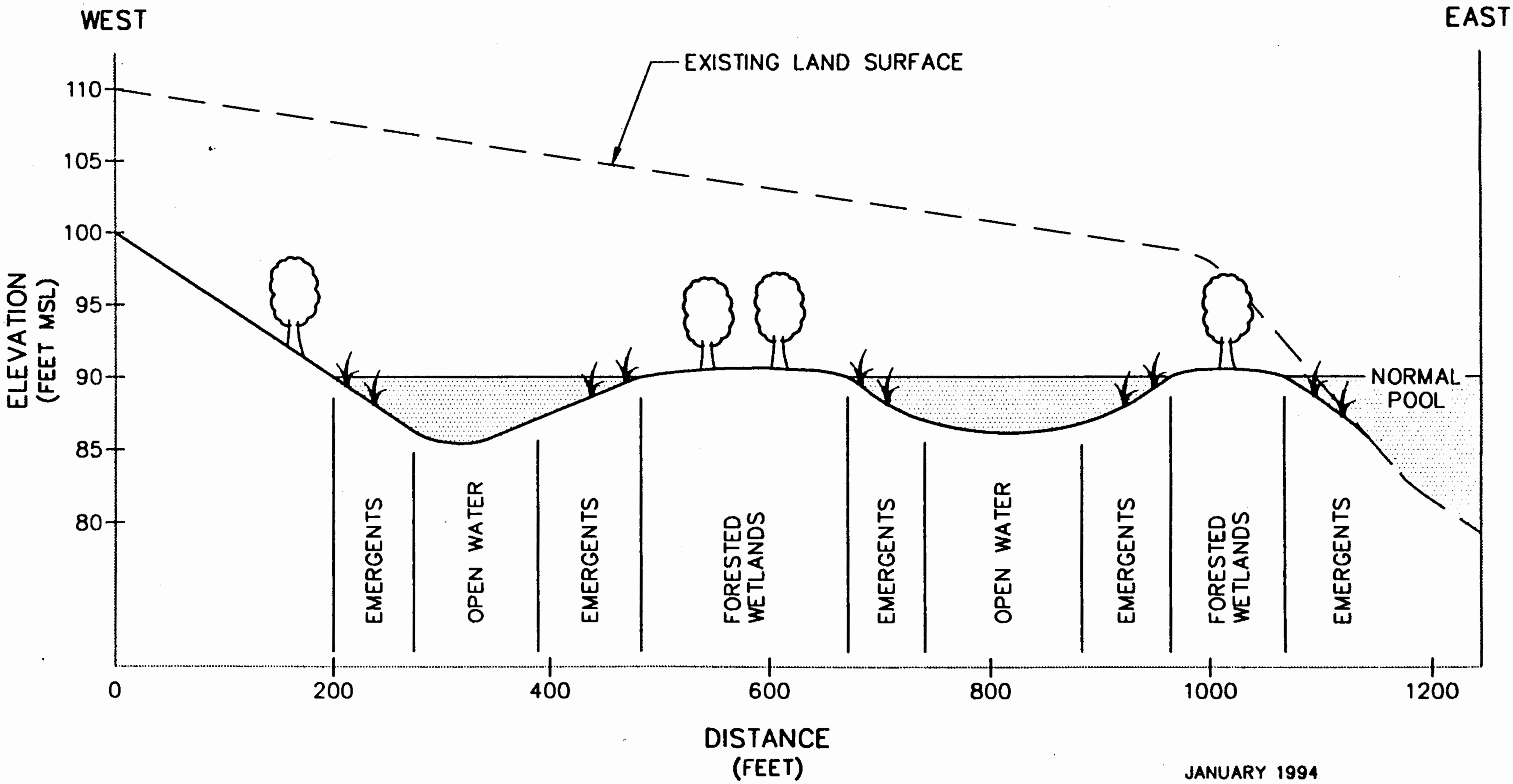
FIGURE 3-14

RECLAIMED BORROW AREA



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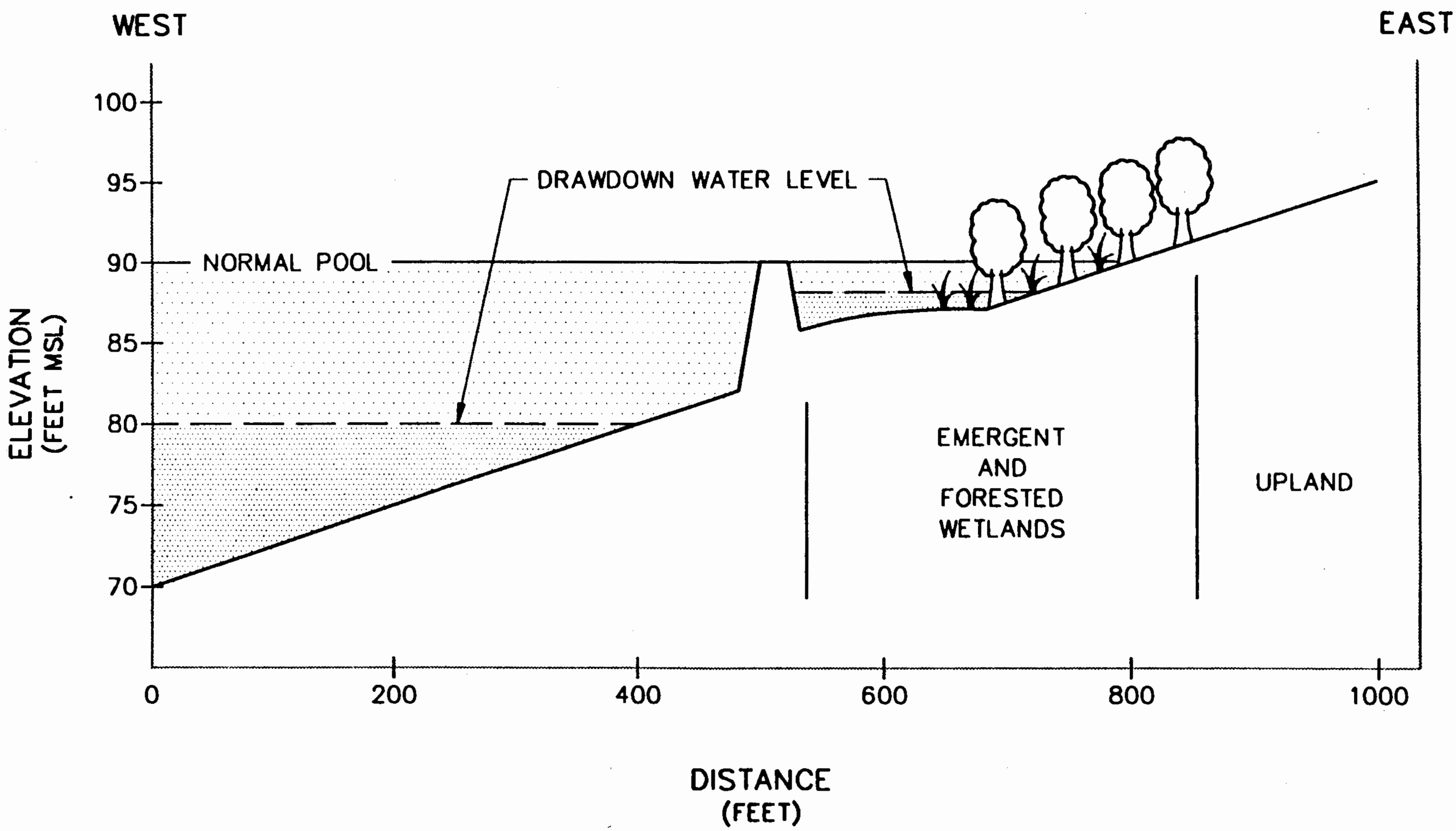
LOWER VIRGINIA PENINSULA
REGIONAL RAW WATER SUPPLY STUDY
WETLANDS MITIGATION PLAN
RECLAIMED BORROW AREA
SCALE AS NOTED

FIGURE 3-15

HEADWATER IMPOUNDMENT
(WITHIN NORMAL POOL AREA)



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REGIONAL RAW WATER SUPPLY STUDY
WETLANDS MITIGATION PLAN
HEADWATER IMPOUNDMENT
WITHIN NORMAL POOL AREA
SCALE AS NOTED

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FIGURE 3-16

There should be ample opportunities for establishing wetlands through the construction of perimeter arm headwater impoundments.

Planting is not proposed for these newly created wetlands. An adequate seed source exists in the narrow wetlands that would be impounded. Typical trees found in the wetlands include Red Maple, River Birch (Betula nigra), Ironwood (Carpinus caroliniana), Green Ash, Sweetgum, Black Gum (Nyssa sylvatica), Sweetbay (Magnolia virginiana), and Redbay (Persea borbonia). Highbush Blueberry (Vaccinium corymbosum), Smooth Alder, and Southern Arrowood are commonly found in the shrub layer.

In addition to the impoundments adjacent to the normal pool area, this mitigation plan calls for the establishment of headwater impoundments above the normal pool area. A plan view of the this type of headwater impoundment is shown in Figure 3-17. A typical cross-section is shown in Figure 3-18. Permanently inundated impoundments would be established by creating 4-foot high berms in the intermittent tributaries above the normal pool. These berms would be constructed at 96 feet and would crest at 100 feet.

The hydrology of the proposed mitigation areas would be supplied by a variety of sources. For example, the impoundment depicted in Figure 3-17 would be supplied by intermittent streams from the north, west, and southwest. Upon completion of the impoundment, stream flow would be collected in the mitigation area from the three streams feeding into the area. The mitigation area would also receive groundwater discharge and sheet flow from upgradient land to the north and west. This particular mitigation site drains an area measuring about 0.7 square miles in size. The hydrology of these impoundments would be maintained through the existing water table along the ridges and depressions of the Cohoke Mill Creek watershed moving towards the creek.

Prior Converted Cropland

The mitigation plan calls for the restoration of 60 acres of wetlands on "prior converted cropland" and "farmed wetlands" in and immediately adjacent to the Cohoke Mill Creek watershed. "Prior converted cropland" is defined by the U.S. Department of Argriculture Soil Conservation Service (SCS) as wetlands which were both manipulated (drained or otherwise physically altered to remove excess water from the land) and cropped before December 23, 1985, to the extent that they no longer exhibit important wetland values. Farmed wetlands are wetlands which were both manipulated and cropped before December 23, 1985, but which continue to exhibit important wetland values. Specifically, farmed wetlands include cropped potholes, depressions, and areas with 15 or more consecutive days (or 10 percent of the growing season, whichever is less) of inundation during the growing season.

This plan would involve the establishment of wetlands on prior converted cropland and farmed wetlands adjacent to Virginia State Route 30 in and immediately adjacent to the Cohoke Mill Creek watershed. Much of the cropland currently being farmed is underlain by Daleville soils which are hydric soils. Figure 3-19 depicts an aerial photo of the vicinity taken in March 1993. The aerial photograph shows large areas of standing water on cultivated Daleville soils. Daleville soils are deep and poorly drained. They formed in loamy fluvial and marine sediments. Daleville soils are on upland flats and in slight depressions, and are classified as fine-loamy, siliceous, thermic Typic Paleaquults.

The proposed mitigation sites would be hydrologically supported mainly by surface water. Intermittent streams would be diverted into mitigation areas, drainfields or drain tiles would be removed, and drainage ditches would be blocked or filled, thereby reestablishing wetland hydrology.

The proposed mitigation plan will create approximately 60 acres of palustrine forested and emergent wetlands on prior converted cropland. Soils in the mitigation area are currently utilized for cropland; therefore, topsoil will not need to be established in these areas prior to planting.

The proposed mitigation plan incorporates two zones that would be planted around open water areas in each mitigation site (Figure 3-20). The wetland zones would include emergent marshes and forested wetland areas. The plant species associated with each zone are listed in Table 3-10. These species were selected for species diversity and for their attractiveness to wildlife as a food source.

Conservation easements would be established on these mitigation areas. Conservation easements are voluntary agreements to preserve land in perpetuity. Although filed with the deed, they do not transfer land ownership, but rather spell out a landowner's commitments to protect the existing or enhanced character of his property. This is a flexible concept, and the documents may be written to protect land in accordance with a landowner's wishes.

Only the specific use rights that landowners choose to give up would be placed as restrictions on their properties. Landowners will be allowed to own, sell, lease, mortgage, or otherwise use the properties consistent with the terms of the conservation easements. The mitigation areas would be removed from farming activities, and dedicated to wetlands protection; however, ownership would be retained by the present landowners. Conservation easements would not give the general public any rights to the land unless the present landowners decide to include such rights in the easements.

The conservation easements established for the mitigation sites could be given either to a qualified non-profit organization or a public body such as King William County. The recipient of the easements will accept them in writing and agree to enforce the terms of the easements to assure that future owners of the properties abide by them.

A conservation easement is enforced by the organization or public body to which it is donated, by court action if necessary. Some easements name another entity as a back-up enforcer in case the original donor organization is unable or unwilling to ensure compliance with the easement. The recipient of the easement is responsible for monitoring it on a regular basis to assure that the current landowner is complying with the terms of the easement.

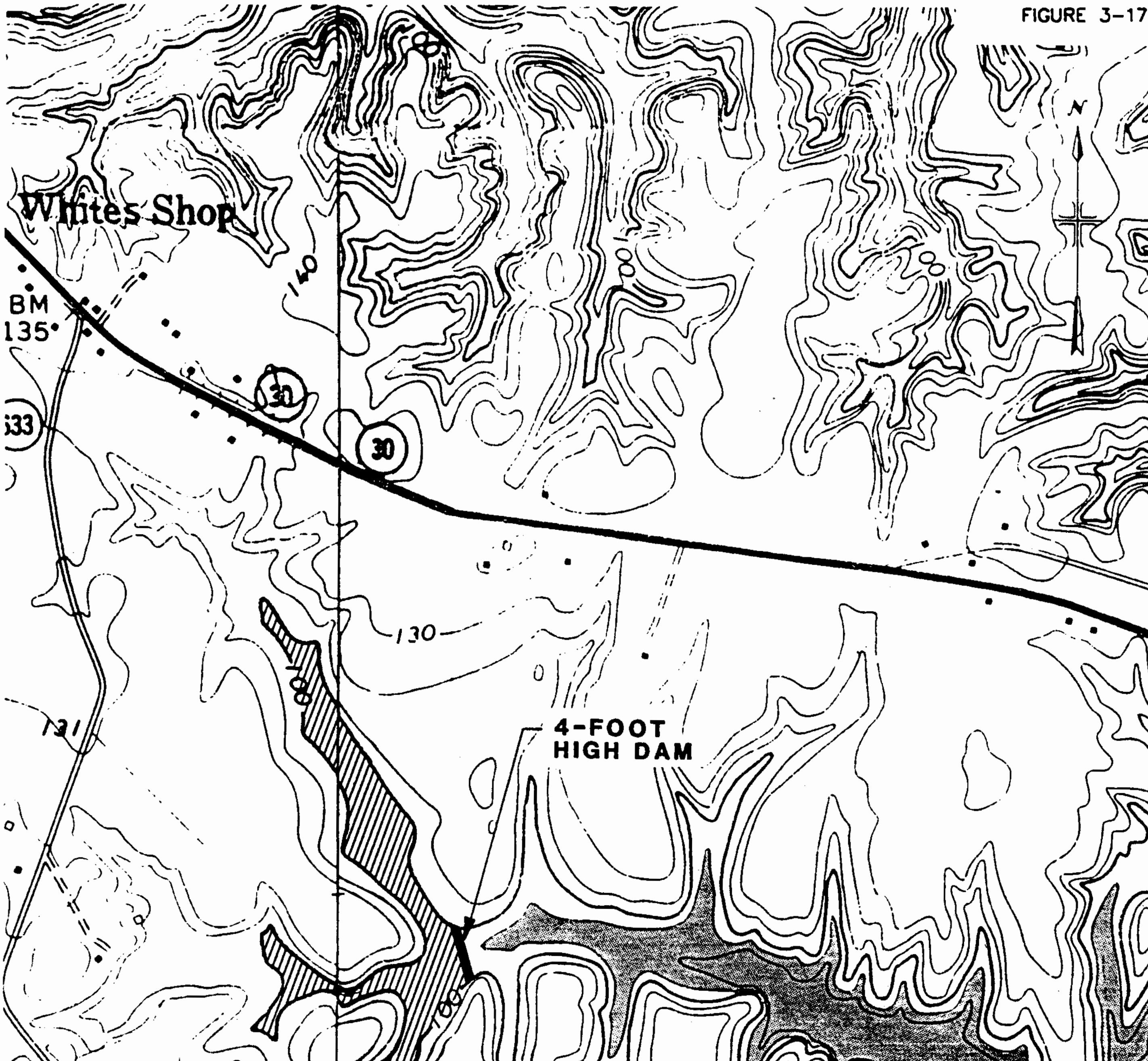
It is important to note that there are several tax advantages in donating conservation easements. A taxpayer may deduct as a charitable donation the difference in value between the land before an easement is donated (unrestricted value) and after it is donated (restricted value). If the easement is highly restrictive, this could amount to a large tax deduction. In order to qualify for the deduction, the land involved must meet certain Interal

TABLE 3-10

SPECIES SELECTED FOR PLANTING IN CREATED WETLAND ZONES

PRIOR CONVERTED CROPLAND

Wetland Zone	Scientific Name	Common Name
Emergent	Scirpus americanus Scirpus atrovirens Carex crinita Sagittaria latifolia Cyperus sp.	Threesquare Rush Green Bulrush Fringed Sedge Duck Potato Flatsedge
Forested	Acer rubrum Quercus palustris Quercus phellos	Red Maple Pin Oak Willow Oak



LEGEND

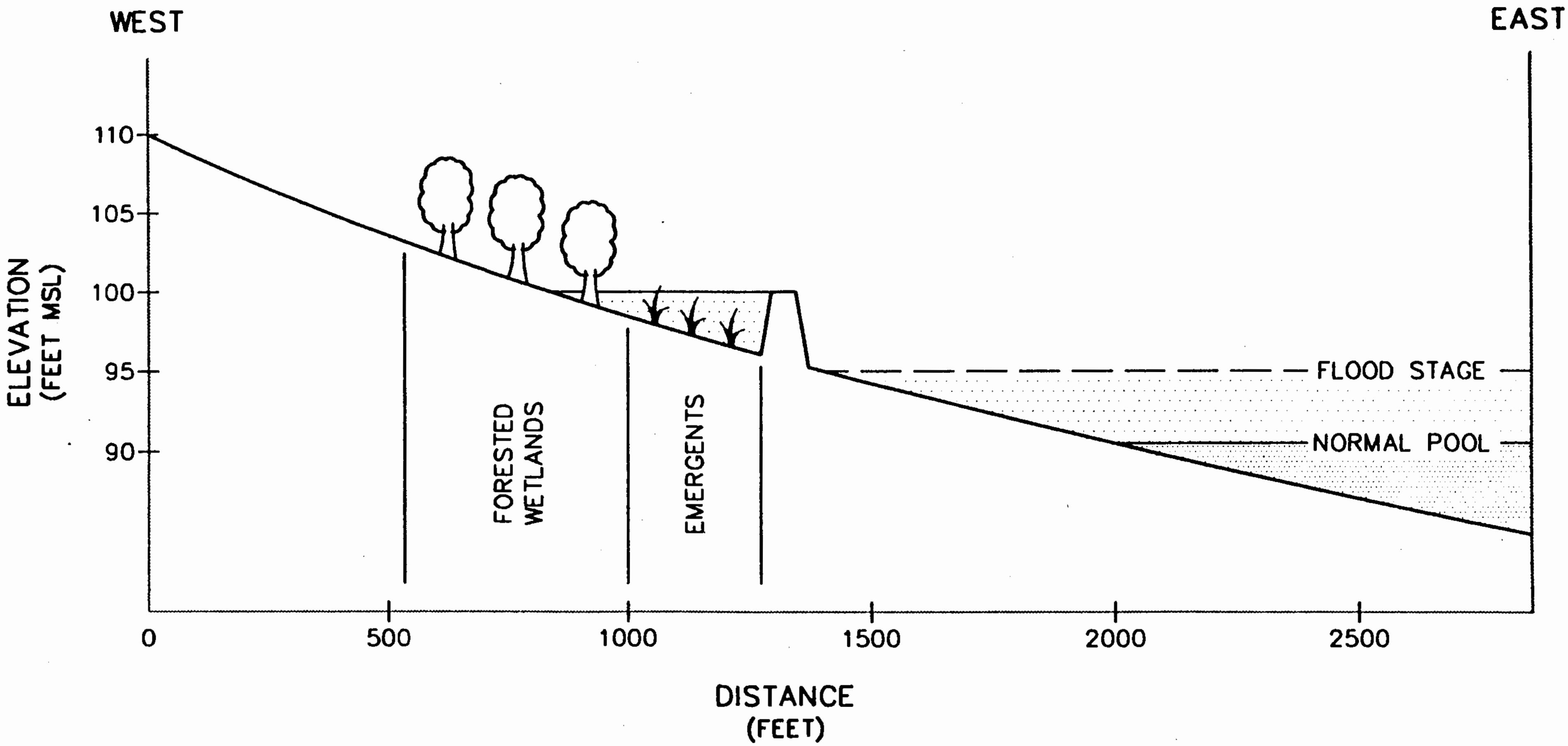
HEADWATER IMPOUNDMENT

NORMAL POOL (90 FT. MSL)

MALCOLM PIRNIE

JANUARY 1994
LOWER VIRGINIA PENINSULA
REGIONAL RAW WATER SUPPLY STUDY
WETLANDS MITIGATION PLAN
HEADWATER IMPOUNDMENT
PLAN VIEW
SCALE: 1"=1000'

HEADWATER IMPOUNDMENT
(ABOVE NORMAL POOL AREA)



JANUARY 1994
LOWER VIRGINIA PENINSULA
REGIONAL RAW WATER SUPPLY STUDY
WETLANDS MITIGATION PLAN
HEADWATER IMPOUNDMENT
ABOVE NORMAL POOL AREA
SCALE AS NOTED

MALCOLM PIRNIE

FIGURE 3-18

FIGURE 3-19

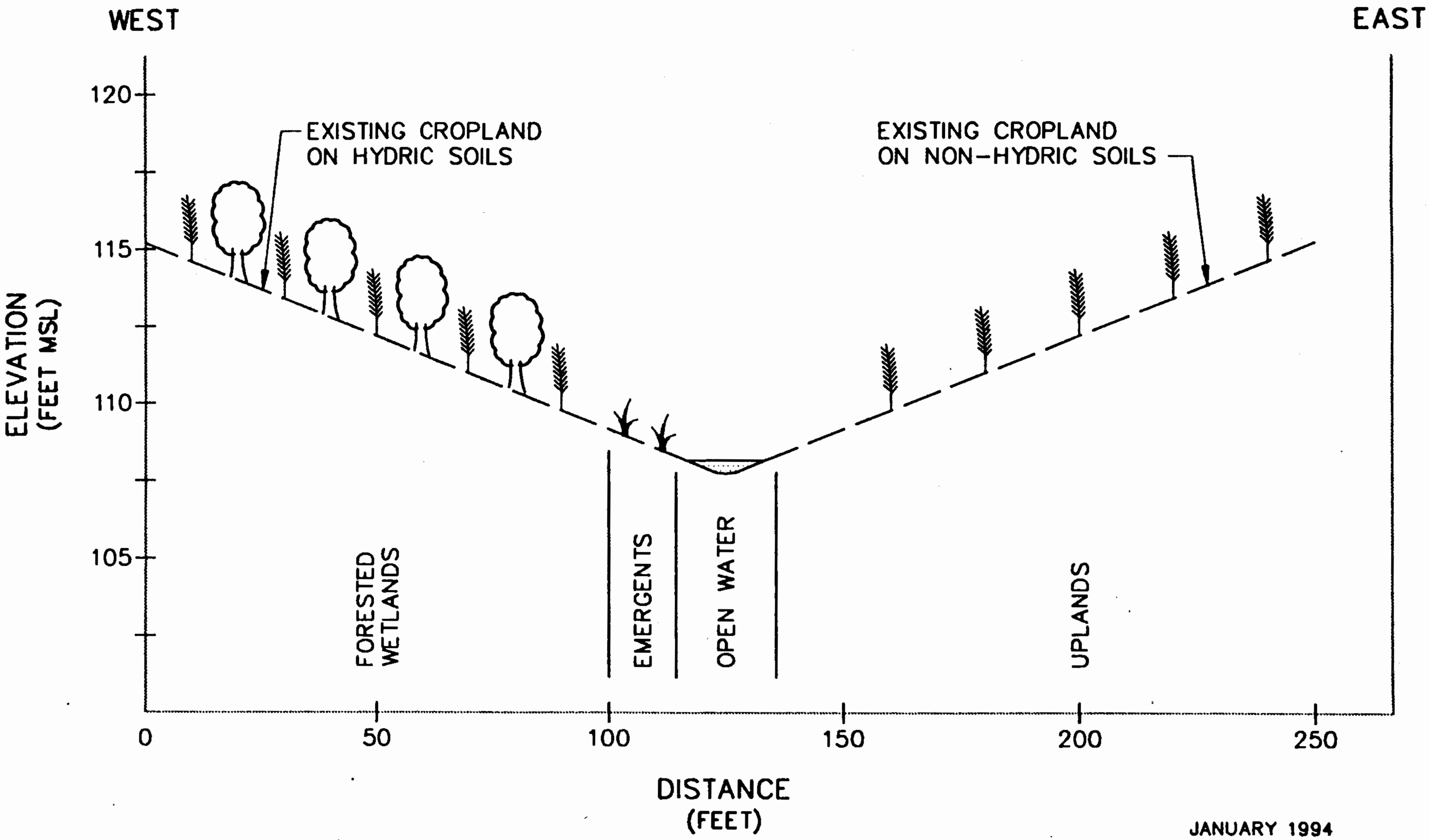
LEGEND

PRIOR CONVERTED CROPLAND

MALCOLM PIRNIE

JANUARY 1994
LOWER VIRGINIA PENINSULA
REGIONAL RAW WATER SUPPLY STUDY
WETLANDS MITIGATION PLAN
PRIOR CONVERTED CROPLAND
SCALE: 1"=1000'

PRIOR CONVERTED CROPLAND



JANUARY 1994
LOWER VIRGINIA PENINSULA
REGIONAL RAW WATER SUPPLY STUDY
WETLANDS MITIGATION PLAN

PRIOR CONVERTED CROPLAND CROSS-SECTION

SCALE AS NOTED

MALCOLM PIRNIE

FIGURE 3-20

Revenue Service criteria to establish public benefit, such as scenic enjoyment by the general public, preservation of natural ecosystems, or public education or recreation.

It is plausible that conservation easements on the mitigation sites would qualify for federal or state tax deductions or lower assessed value. Landowners may also be compensated under federal programs for the value of the land taken out of production. However, it should be emphasized that this land represents marginal cropland when compared to adjacent well-drained land.

Constructed Wetlands

One wetland system would be created immediately north of the Southern Railway right-of-way, 1 mile west-southwest of the proposed King William Reservoir dam site (Figure 3-12, Constructed Wetland A). A second wetland system would be constructed adjacent to Virginia State Route 633, 1 mile southwest of Lanesville (Figure 3-12, Constructed Wetland B).

The plan calls for the creation of 186 acres of diverse wetland habitat, including ponds, scrub-shrub, and forested areas. Site A covers 145 acres and Site B covers 160 acres. It is expected that new wetlands can be created on 60 to 62 percent of the sites; approximately 87 acres of wetlands will be established on Site A and 99 acres will be created on Site B, totalling 186 acres of new wetlands. The various components of the wetland mitigation plan are discussed below:

Site A

The proposed mitigation site would be hydrologically supported by a combination of surface water stream flow, groundwater, and sheet flow. Two streams cross the site. An intermittent tributary to the Pamunkey River drains the western portion of the mitigation site and an intermittent tributary to Cohoke Mill Creek drains the eastern portion of the site. Control structures would be constructed adjacent to the Southern Railway right-of-way to control water levels in the mitigation area. In addition, the site would be graded, in several locations, to intercept the seasonal high water table.

Weir structures would be set at appropriate levels in the two intermittent streams to allow flooding the mitigation area during prolonged storm events. It is possible that the mitigation site would also receive some groundwater seepage and sheet flow from the hill located northeast of the site.

Soils on Site A are composed primarily of Myatt loam, Daleville silt loam, and Roanoke silt loam, all of which are hydric soils. The western portion of the site also contains some areas underlain by non-hydric Craven fine sandy loam. Where suitable, the upper 12 to 18 inches of topsoil from graded areas will be stockpiled on-site. Prior to planting, the soils will be spread to a depth of approximately 12 inches on the final contours to be planted.

The proposed mitigation area would contain 87 acres of palustrine wetlands. The proposed mitigation plan incorporates scrub-shrub and forested wetland areas (Figure 3-21). The plant species associated with each zone are listed in Table 3-11.

Site B

The proposed mitigation site would be hydrologically supported by a combination of surface water stream flow, groundwater, and sheet flow. One stream is located at the eastern perimeter of the site. The unnamed intermittent stream is a tributary of the Pamunkey and drains a 350-acre forested watershed. A control structure will be constructed at the southeastern corner of the site, to control water levels in the mitigation area. In addition, the site will be graded to intercept the seasonal high water table.

A weir structure will be set at an appropriate level in the intermittent stream to allow flooding of the mitigation area during prolonged storm events. It is possible that the mitigation site would also receive some groundwater seepage and sheet flow from the hill located to the north of the site. In addition, agricultural ditches located west of Virginia State Route 633 will be filled with hydric soil plugs, thereby re-hydrating the western portion of the site.

Soils on Site B are composed primarily of hydric Myatt loam and Roanoke silt loam. The upper 12 to 18 inches of topsoil from graded areas will be stockpiled on-site. Prior to planting, the soils will be spread to a depth of approximately 12 inches on the final contours to be planted.

The proposed mitigation area would contain 99 acres of palustrine forested wetlands, as shown in Figure 3-22. The plant species associated with Site B are listed in Table 3-12.

Alternate Sites

Two additional sites were designated as alternate locations for constructed wetlands. One wetland system could be created west of Virginia State Route 633, 3,000 feet north of Lanesville (Figure 3-12, Constructed Wetland C). A second wetland could be created east of State Route 30, 4,000 feet north of Rose Garden (Figure 3-12, Constructed Wetland D). These sites would be utilized only if Sites A and B prove impractical to develop.

Sites C and D cover 190 and 180 acres, respectively, and consist of recently harvested pine plantations on hydric soils. It is possible that 186 acres of palustrine forested and scrub-shrub wetlands could be established on the two sites. A vegetative assemblage similar to that specified in Tables 3-11 and 3-12 could be established on the sites.

Functional Assessment of Created Wetlands

The project's overall net impact on various wetland functions is expected to be positive. The project is expected to provide increased wildlife migration and wintering habitat, aquatic habitat, groundwater recharge, floodflow alteration, sediment/toxicant retention, sediment stabilization, and nutrient removal/transformation. In addition, the project is expected to provide increased recreational opportunities. Wildlife breeding habitat is expected to be unchanged or slightly improved as a result of this project. Reservoir construction is expected to reduce production export and groundwater discharge. The project's impacts on these various functional values is assessed below.

The overall effect of the project on the fish and wildlife resources of the site is expected to be positive.

TABLE 3-11

SPECIES SELECTED FOR PLANTING IN CREATED WETLAND ZONES

CONSTRUCTED WETLAND A

Wetland Zone	Scientific Name	Common Name
Scrub-Shrub Wetland	Alnus serrulata Cephalanthus occidentalis Cornus amomum Juncus spp. Polygonum punctatum Sagittaria latifolia Sparganium americanum Viburnum lentago	Smooth Alder Buttonbush Silky Dogwood Rushes Dotted Smartweed Duck Potato Eastern Burreed Nannyberry
Forested Wetland	Cyperus spp. Fraxinus pennsylvanica Juncus spp. Magnolia virginica Nyssa sylvatica Quercus phellos Saururus cernuus Vaccinium corymbosum Viburnum lentago	Flatsedges Green Ash Rushes Sweetbay Magnolia Black Gum Willow Oak Lizard's Tail Highbush Blueberry Nannyberry

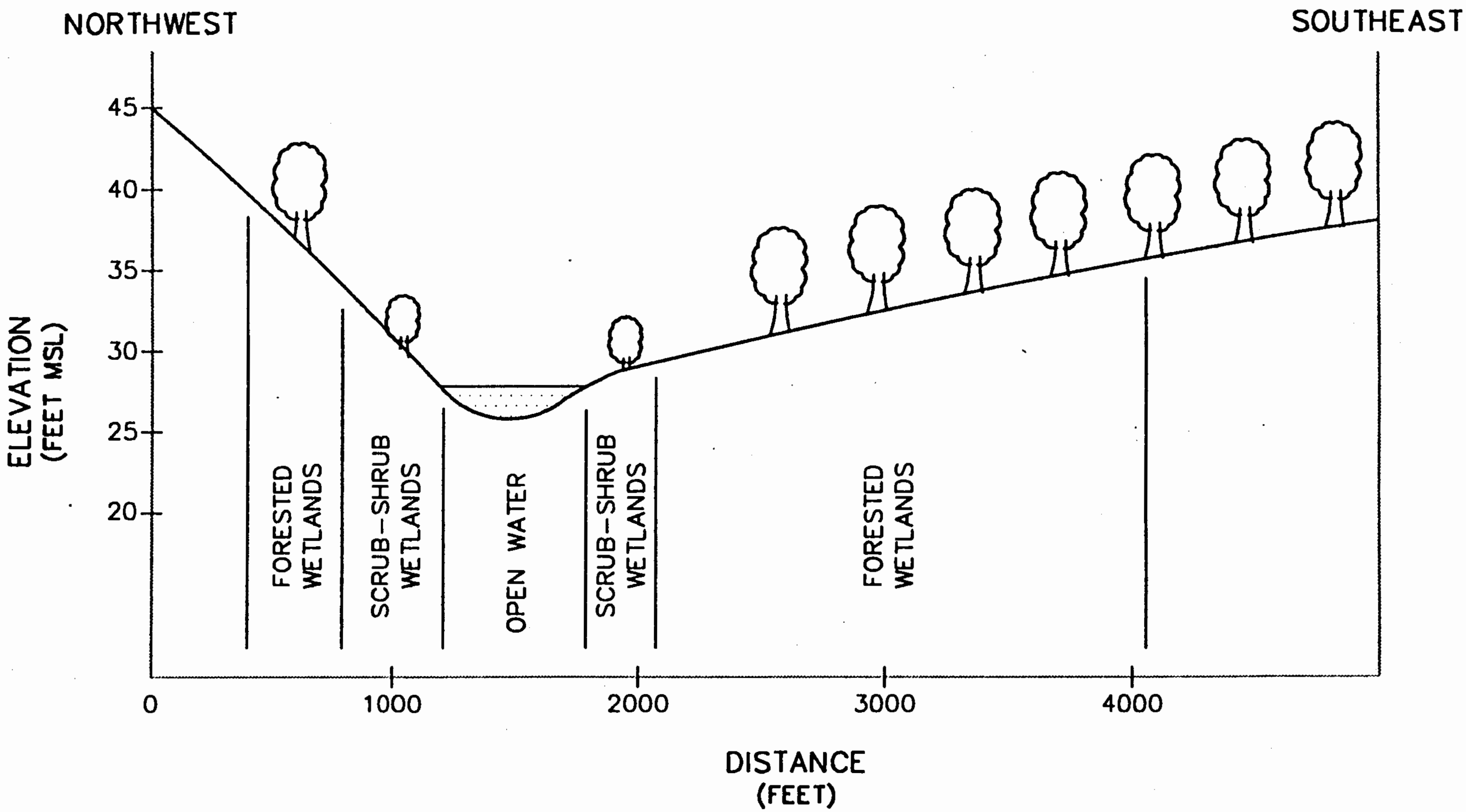
TABLE 3-12

SPECIES SELECTED FOR PLANTING IN CREATED WETLAND ZONES

CONSTRUCTED WETLAND B

Wetland Zone	Scientific Name	Common Name
Forested Wetland	Acer rubrum	Red Maple
	Carex spp.	Sedges
	Cornus amomum	Silky Dogwood
	Juncus spp.	Rushes
	Lindera benzoin	Northern Spicebush
	Magnolia virginica	Sweetbay Magnolia
	Nyssa sylvatica	Black Gum
	Quercus phellos	Willow Oak
	Saururus cernuus	Lizard's Tail
	Vaccinium corymbosum	Highbush Blueberry

CONSTRUCTED WETLAND A

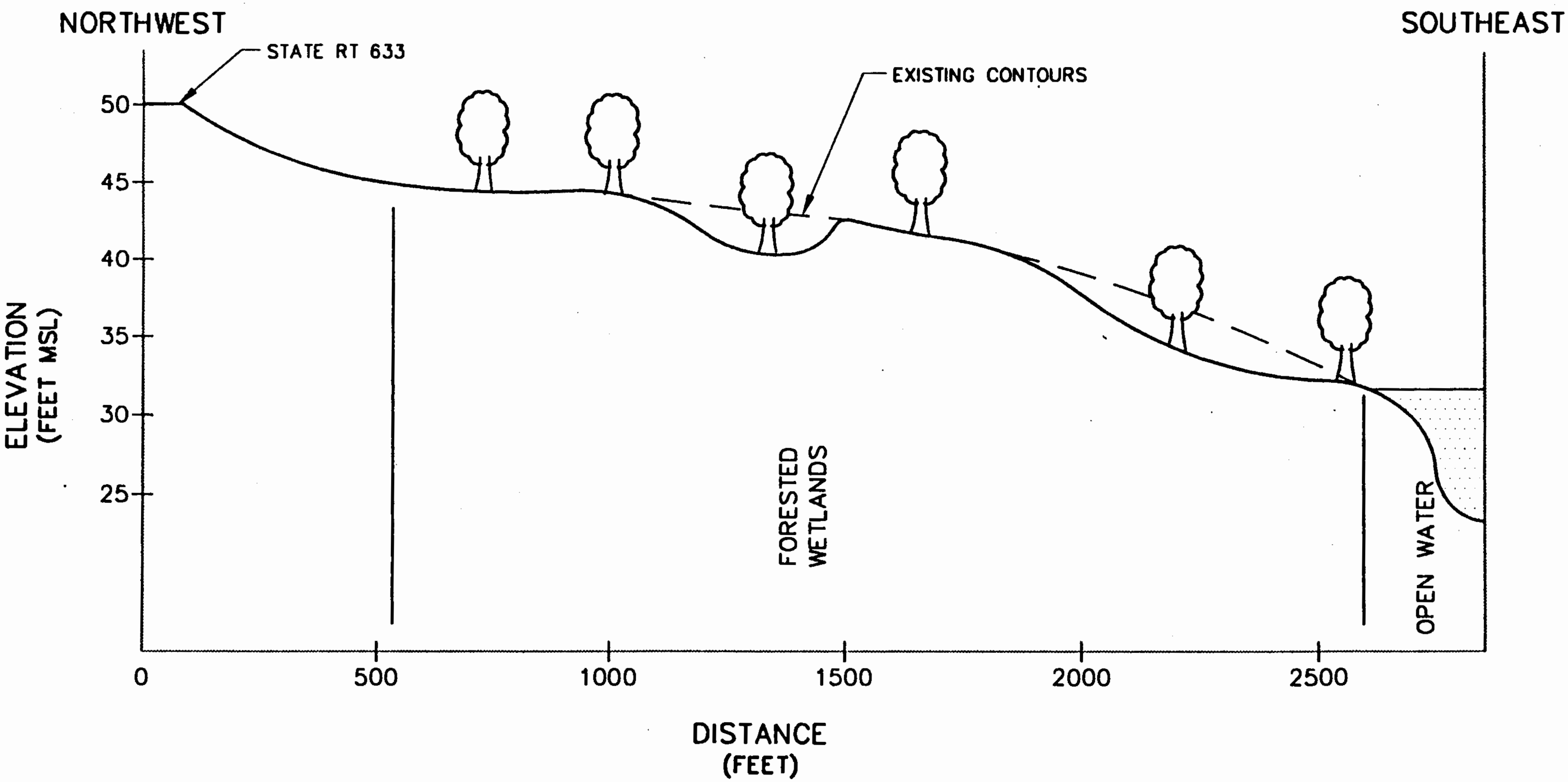


MALCOLM PIRNIE

JANUARY 1994
LOWER VIRGINIA PENINSULA
REGIONAL RAW WATER SUPPLY STUDY
WETLANDS MITIGATION PLAN
CONSTRUCTED WETLAND A
SCALE AS NOTED

FIGURE 3-21

CONSTRUCTED WETLAND B



MALCOLM PIRNIE

JANUARY 1994
LOWER VIRGINIA PENINSULA
REGIONAL RAW WATER SUPPLY STUDY
WETLANDS MITIGATION PLAN
CONSTRUCTED WETLAND B
SCALE AS NOTED

FIGURE 3-22

The vegetated edge, provided through the establishment of emergent and shrub vegetation in the reservoir fringe wetlands, headwater impoundments, reclaimed borrow areas, and constructed wetlands will increase fish and water dependent wildlife populations.

The proposed mitigation plan should result in an increased avifaunal diversity on the site. Primarily terrestrial species will benefit from the planting of shrubbery and fruit-producing vegetation in the wetland mitigation areas. Bird species currently inhabiting the site should continue to find this area desirable. Waterfowl species which utilize the area for wintering and during migration should continue to do so. Certain waterfowl species such as Mallard (Anas platyrhyncos), Black Duck (Anas rubripes), and Canada Goose (Branta canadensis) should find increased habitat and more suitable nesting sites.

Species reported to nest on the site include Wood Duck and Canada Goose. Mallard and Black Duck are known to nest in the region and are suspected to nest on the site. Canada Geese typically nest on the shore of lakes or ponds where there is shallow water and an abundance of herbaceous plant foods. They winter in ice-free lakes or ponds that provide resting and feeding sites. Wood Ducks also utilize the shallow waters of ponds, lakes, or marshes having abundant floating and emergent vegetation. They require deciduous or coniferous trees with large cavities for nesting, usually within several hundred yards of water. Mallards rarely nest in cavities, but typically settle near the water's edge where the ground is slightly dry and vegetation is plentiful. Shallow water enables the ducks to bottom feed. Black Ducks usually nest on the ground, with the nest well-hidden in vegetation and close to the water. Occasionally they will use old crow and hawk nests or natural or excavated cavities in trees. These ducks breed in the marshy borders of water bodies and in streams and wooded swamps. They winter in extensive open marshes and commonly return to the same wintering area each year (Bellrose, 1976).

It is anticipated that the open water reservoir with surrounding wetlands will be used extensively by a variety of resident and migratory waterfowl. The habitat requirements described in the literature for the above waterfowl species will be fulfilled by the proposed reservoir project and mitigation plan. The shallow water marsh established in the reclaimed borrow area, headwater impoundments, and reservoir fringe wetlands will provide nesting areas for many of these species. Additionally, many waterfowl species, including those above, should find this habitat attractive as a migratory stop-over and wintering area.

Cohoke Mill Creek currently supports various species of bass, sunfish, and pickerel. The establishment of a reservoir at the site of the present-day stream will allow existing fish populations to migrate from the creek to the reservoir. It is expected that Largemouth Bass (Micropterus salmoides), Redfin Pickerel, Black Crappie (Pomoxis nigromaculatus), and various sunfish and minnows will find cover in the reservoir.

The increased moisture levels created in the reservoir fringe wetlands, headwater impoundments, reclaimed prior converted cropland, and constructed wetlands may eventually attract many species of salamanders such as the Spotted Salamander (Ambystoma maculatum), Marbled Salamander (Ambystoma opacum), Two-lined Salamander (Eurycea bisliniata), Slimy Salamander (Plethodon glutinosus), and Spotted Newt (Notopthalmus viridescens). These species utilize open water habitats for egg laying and larval growth. Numerous frog and toad species such as the Northern Cricket Frog (Acris crepitans), Spring Peeper (Hyla crucifer), Green Frog (Rana clamitans), Bullfrog (Rana catesbeiana), Pickerel

Frog (Rana palustris), and Fowler's Toad (Bufo woodhousei) also utilize open water habitat for reproduction.

Various reptile species such as turtles will benefit from the deep water reservoir and surrounding wetland. Lizard species such as the Five-lined Skink (Eumeces fasciatus) thrive in damp woodland leaf litter. Snake species such as the Worm Snake (Carphophis amoenus), and the Ringnecked Snake (Diadophis punctatus) thrive in moist habitats. Species such as the Black Rat Snake, the Eastern Ribbon Snake (Thamnophis sauritus), and the Common Garter Snake (Thamnophis sirtalis), utilize wetland environments, and the Northern Water Snake (Nerodia sipedon) utilizes freshwater habitats.

Wildlife species that traditionally rely on the availability of terrestrial land such as the Eastern Cottontail and the White-tailed Deer will also experience an increased habitat value through the implementation of the proposed project. Although the open water reservoir will not greatly increase habitat value for these two species, the edge ecotone will provide food and water that would not be available in an open wooded forest. The scrub-shrub wetland will also provide cover and increased year-round food sources for these species.

As a result of the comprehensive mitigation plan, negative impacts to the species present on the King William Reservoir site should be minimized. The construction of the reservoir itself should result in an overall positive increase in species diversity.

Placement of the dam across Cohoke Mill Creek should maintain or slightly increase the wetland's ability to alter floodflows, trap sediments and toxicants, and remove or transform nutrients. Dams typically trap sediment and pollutants behind them over time. In addition, the shrub swamps and emergent wetlands that would become established in the reclaimed borrow area, headwater impoundments, and reservoir fringe areas will remove some nutrients and toxicants from sheet flow coming into the reservoir. The reservoir will add minor nutrient removal and transformation capabilities.

It is expected that production export will be reduced through dam construction. The dam effectively closes the wetland's outlet, which is an important factor in the ability of a wetland to transport primary productivity downstream.

Groundwater recharge functions will be greatly enhanced by the 2,234-acre reservoir. At a normal pool elevation of 90 feet msl, approximately 21.7 billion gallons of water would be in storage between the adjacent upland areas. Alteration of the existing groundwater flow patterns is expected in the Cohoke Mill Creek and adjacent watersheds. A corresponding increased lateral seepage due to the rise in water table elevation and relationship to the Pamunkey and Mattaponi Rivers has been estimated at 1.5 mgd. In addition to lateral seepage, underseepage below the dam structure has been estimated at 0.5 mgd, although the elevation of the water table below the dam should be altered. Additional springs and/or seeps are possible in the Cohoke Mill Creek watershed. Slumping, mass transport, and increased erosion impacts from lateral seepage are not expected.

Increased recharge to surficial sands and/or the Yorktown Aquifer system could be a potential benefit to local and regional groundwater resources, depending on recharge water quality. Based on water quality data for the Mattaponi River compiled by Malcolm

Pirnie, an initial screening of the proposed King William Reservoir watershed, and a salinity intrusion impact study (Hershner et al., 1991), there will be little effect to overall water quality of the shallow aquifer system. Construction of the King William Reservoir would directly benefit the groundwater resources of the region and lessen the potential for saltwater encroachment in deeper aquifers.

Table 3-13 presents wetland cover types and approximate acreages of wetlands to be created/restored through implementation of this mitigation plan. The mitigation plan will result in creation and restoration of 452 acres of wetlands to offset filling and inundation of 452 acres of vegetated wetlands, thereby providing a 1 to 1 replacement of vegetated wetlands lost due to reservoir construction.

Monitoring Plan

A 3-year monitoring plan ensuring 85 percent areal vegetative coverage of the mitigation areas is proposed. The mitigation areas will be monitored for three growing seasons following the planting of the site. Following each annual monitoring period, a report will be submitted to the USCOE (Norfolk District).

During the monitoring period, two site visits will be made during the first growing season: early spring (April - May) and mid-summer (July - August). The purpose of the spring visit will be to note evidence of soil erosion, plant success, and wildlife utilization of the site. During the summer visit, the health and vigor of the plantings will be determined, insect damage noted, and colonization of undesirable plant species (i.e., Phragmites, and Purple Loosestrife) will be identified. During subsequent monitoring periods, an annual visit will be made during the height of the growing season (July and August).

To collect monitoring data, an overview of the entire site will be conducted from the perimeter of the mitigation areas, and transects will be established across the sites. Within each of the vegetation zones along the designated transects, a randomly selected meter square sampling quadrat will be established on each side of the transect line to collect information on plant diversity and density. In addition, percent areal coverage will be determined using the Line Intercept Method. In the event coverage is less than 85 percent, plants that have not survived will be replaced with in-kind transplants. With the exception of loss due to herbivory, if a specific plant species has a survivorship of less than 50 percent, a substitute plant species will be considered. Based on the results of each site visit, measures will be taken as required to correct any problems that may exist (i.e., insect infestation, wildlife damage, plant disease). If needed, application of herbicides and pesticides approved for use in water supply watersheds will be undertaken in accordance with USEPA requirements. The use of herbicides or pesticides will be limited to treat severe, on-going problems that threaten the functional values of the wetland.

The transects and each of the sampling quadrats will be photographed and keyed to a site base map. Upon completion of the seasonal tasks, a compilation of data will be prepared, complete with field data forms, mapping and a photolog. The resulting annual report will be submitted to the USCOE at the end of each growing season.

Invasion by noxious plants can negatively affect the success of the mitigation project. The vegetative diversity of the mitigation area may be reduced, thereby compromising the created wetland functional values. Potential invader species and proposed corrective actions are discussed below.

Purple Loosestrife (Lythrum salicaria), a Eurasian weed, has little wildlife value and is extremely prolific. It can easily take over recently planted areas, creating a monotypic stand with little wildlife value. The most effective way to control the plant is to remove by hand the first plants that emerge. It is essential to carefully bag and remove the plants from the site. If the plants are allowed to go to seed, control becomes more difficult because a seed bank will establish (Eggars, 1992).

If Purple Loosestrife becomes established to the point where hand removal is not feasible, application of a herbicide approved for use in wetlands/waters is the next option. Herbicide treatment on an annual basis may be required to control the species. The herbicide of choice is Rodeo; however, this chemical is not selective and kills desirable plants as well as noxious invaders. Garbon 3A is a herbicide presently being tested for the use in wetlands/waters and may be approved in the near future. Garbon 3A is selective for dicots; thus, it would kill species such as Purple Loosestrife without harming monocots such as cattails, bur-reeds, and sedges (Eggars, 1992).

Phragmites is another invasive species which can interfere with mitigation projects. The plant has the potential to form persistent monotypic stands. One of the few proven methods of removing Phragmites from mitigation areas is to create water depths where it cannot survive. Persistent water depths of 18 to 24 inches will usually suppress the plant.

Under certain circumstances, an herbicide such as Rodeo will eliminate Phragmites. Application during the late summer when the plant is in bloom and treatment early during the following growing season will effectively eliminate Phragmites.

If either Purple Loosestrife or Phragmites infestation becomes an issue at the proposed mitigation sites, the following steps will be taken:

- Evaluate extent of infestation.
- Individual plants may be manually removed from the mitigation area.
- If removal by hand is not effective, other control techniques such as herbicide application or temporary flooding of the mitigation area will be evaluated.
- Once the invasive species are controlled, regrading and replanting will take place, if necessary, to achieve 85 percent areal coverage.

The project, as designed, will most likely achieve proper wetland hydrology. If proper wetlands hydrology is not being maintained in the mitigation area, due to drought or excessive water drawdowns, the feasibility of modifying reservoir operations or re-contouring mitigation areas will be examined.

Another potential problem is the inability to achieve sufficient vegetative cover in the mitigation areas. If 85 percent areal coverage is not achieved, supplemental planting will be initiated during the 3-year monitoring period. Mitigation areas will be regraded and

TABLE 3-13

WETLAND MITIGATION SUMMARY

Area	Wetland Cover Types	Acres Created
Reservoir Fringe Wetlands	Palustrine Forested and Scrub-Shrub	50
Reclaimed Borrow Area	Palustrine Forested and Emergent	66
Headwater Impoundments	Palustrine Forested and Emergent	90
Prior Converted Cropland and Farmed Wetlands	Palustrine Forested and Emergent	60
Constructed Wetlands	Palustrine Forested and Scrub-Shrub	186
Total Wetlands Created		**452**

replanted only as a last resort when all other attempts to achieve an appropriate coverage have failed. Additionally, the planted species may be reviewed to determine if other species may be better suited to the mitigation sites.

Summary

Implementation of the RRWSG's proposed wetlands mitigation plan will create a total of approximately 206 acres of palustrine forested, scrub-shrub, and emergent wetlands along the perimeter of, in the headwaters of, and in the borrow area adjacent to the proposed reservoir. Implementation of this plan will also create approximately 60 acres of palustrine forested and emergent wetlands in prior converted cropland, in and immediately adjacent to the Cohoke Mill Creek watershed. In addition, this plan calls for the construction of 186 acres of palustrine forested and scrub-shrub wetlands in the vicinity of the Cohoke Mill Creek watershed.

The mitigation plan will result in a 1 to 1 replacement of vegetated wetlands lost due to reservoir construction. In addition to the mitigation of lost wetlands acreage, the 2,234-acre reservoir will create lacustrine conditions which did not exist in the project area prior to the inception of the project. Construction of the impoundment within the Cohoke Mill Creek floodplain will enhance habitat for aquatic and wetland-dependent wildlife species, as well as improve groundwater recharge, floodflow alteration, sediment/toxicant retention, sediment stabilization, and nutrient removal/transformation functional values. The reservoir is also expected to provide increased recreational opportunities.

4.0 AFFECTED ENVIRONMENT

4.1 INTRODUCTION

This section of the Environmental Report describes the affected environment in terms of the physical, biological, cultural, and socioeconomic resources that would be impacted by each of the six practicable alternatives and the No Action alternative. A more detailed review of these topics is contained in ***Alternatives Assessment (Volume II - Environmental Analysis)*** (Malcolm Pirnie, 1993). This report is incorporated herein by reference and is an appendix to this document.

Each of the practicable alternatives identified in Section 3.5 are evaluated regarding the affected environment in each of the following general categories:

- Physical Resources: Descriptions of the physical resources associated with the alternatives are provided. Substrate, water quality, hydrology, groundwater resources, soil and mineral resources, and air quality are included in this general category. Riffle and pool complexes were also considered. However, these complexes are not generally found in the Coastal Plain of Virginia. Because all of the practicable alternatives under evaluation would be located in the Coastal Plain, these features are not analyzed in this document.

- Biological Resources: Descriptions of endangered, threatened, and sensitive species; fish and invertebrates; other wildlife; sanctuaries and refuges; wetlands and vegetated shallows; and mud flats are provided for each of the alternatives.

- Cultural Resources: Descriptions of archaeological and historical sites associated with the alternatives are provided.

- Socioeconomic Resources: Descriptions of the socioeconomic resources associated with the alternatives are provided. Municipal and private water supplies, recreational and commercial fisheries, other water-related recreation, aesthetics, parks and preserves, land use, noise, infrastructure, and other socioeconomic resources are included in this general category.

A comparative summary of the affected environment associated with each alternative is also included at the conclusion of this section.

4.2 PHYSICAL RESOURCES

This section provides a general description of the physical environment at the proposed project sites for each of the seven alternatives evaluated. Physical resource categories evaluated are described below.

<u>Substrate</u>

This section identifies the existing aquatic ecosystem substrate at project areas associated with each alternative. Aquatic ecosystem substrate is considered to be the benthic material underlying all open water areas and constitutes the soil-water interface of wetlands. It is distinguished from soils by permanent or frequent inundation.

In some cases the difference between aquatic ecosystem substrate and soil is difficult to distinguish. For example, in such cases where the predicted effect would occur at a shore-water interface the effect was assumed to be greater on the submerged substrate, and therefore, considered affecting primarily the substrate.

The substrate impact category was developed directly from a portion of the Clean Water Act Section 404 (b)(1) Guidelines for potential impacts on physical and chemical characteristics of the aquatic ecosystem (40 CFR § 230.20),

Water Quality

This section describes the existing water quality of surface waters in project areas, including all existing lakes, reservoirs, streams, and rivers. The water quality impact category was developed from portions of the Clean Water Act Section 404 (b)(1) Guidelines which address potential impacts on physical and chemical characteristics of the aquatic ecosystem. These characteristics include suspended particulates/turbidity (40 CFR § 230.21), water (40 CFR § 230.22), and salinity gradients (40 CFR § 230.25).

Hydrology

This section describes the existing surface water or groundwater hydrology in project areas associated with each alternative. The hydrology impact category was developed from portions of the Clean Water Act Section 404 (b)(1) Guidelines which address potential impacts on physical characteristics of the aquatic ecosystem. These characteristics include current patterns and water circulation (40 CFR § 230.23) and normal water fluctuations (40 CFR § 230.24).

Groundwater Resources

This section describes the groundwater resources which could be impacted by each of the proposed alternatives. This impact category was included as a public interest factor to consider pursuant to the National Environmental Policy Act.

Soil and Mineral Resources

This section describes soils and mineral resources located within project areas associated with the alternatives. The soil and mineral resources impact category was developed as a public interest factor to consider pursuant to the National Environmental Policy Act.

Air Quality

This section identifies the existing air quality in the vicinity of project areas associated with each alternative component. The air quality impact category was developed as a public interest factor to consider pursuant to the National Environmental Policy Act.

4.2.1 Ware Creek Reservoir with Pumpover from Pamunkey River

Substrate

Intake

Lanexa Mucky Silty Clay appears to be the parent soil of the river substrate that would be affected in the vicinity of the proposed intake station.

Reservoir

Soils located within the proposed Ware Creek Reservoir pool area are the parent material for the substrate that would be affected by construction of the proposed Ware Creek Reservoir. Generally, the soils found in the proposed reservoir area are considered coastal plain upland soils, given the group designation of Emporia-Craven-Uchee.

Pipeline

The area of substrate disturbance at each minor stream crossing was assumed to be 2,500 square feet (pipeline right-of-way (ROW) width (50 feet) multiplied by the length of the crossing). Substrate types at the proposed crossings include: Johnston Mucky Loam, Roanoke Silt Loam, Tomotely Loam, and substrates of the Nevarc-Remlik and Slagle-Emporia complexes.

There are four pipeline outfall locations associated with this component. The first outfall would be located at the headwaters of Diascund Creek, approximately 5.7 river miles upstream from the normal pool area of Diascund Creek Reservoir. Typical substrate found at this outfall site originates from Johnston Mucky Loam soil. The second outfall would be located on Diascund Creek, approximately 0.6 river miles upstream of the normal pool area of Diascund Creek Reservoir. The affected substrate at this location is similar to the substrate found at the first outfall location. The third outfall would be located on the Bird Swamp arm of the proposed Ware Creek Reservoir. Typical substrate at this location originates from the Emporia Complex soils. The fourth outfall structure would be located on the France Swamp arm of the proposed Ware Creek Reservoir. Typical substrate at this location originates from the Emporia Complex soils.

Water Quality

Intake

At the proposed Pamunkey River intake location, the Pamunkey River is designated as "effluent limited" by the Virginia State Water Control Board (SWCB, 1992). Downstream of Northbury, between Sweet Hall Landing and West Point, the Pamunkey River is designated as "nutrient enriched." A SWCB monitoring station for the Chesapeake Bay Tributary Monitoring Program is located at White House, approximately 5.8 river miles downstream from Northbury. General water quality data for this station for the Water Years 1984 through 1987 are summarized in Table 4-1.

The SWCB has identified two permitted point source discharges to the Pamunkey River between River Mile 29.5 (at the mouth of Big Creek) and River Mile 57.3 (at the mouth of Totopotomoy Creek (SWCB, 1992). Both of these permitted discharges are downstream from the proposed intake site. Currently, there are no notable point source discharges in the immediate vicinity of Northbury. However, there are currently four SWCB-designated "major" municipal and industrial discharges upstream of Northbury. In addition, non-point sources, such as agricultural runoff, drain into the Pamunkey River and impact water quality.

A review of planned wastewater treatment plant (WWTP) discharges to the mainstem Pamunkey River and its tributaries was conducted by Malcolm Pirnie in January 1992. By the Year 2000, it is anticipated that a 5 to 8 mgd WWTP discharge by Hanover County would be in place approximately 1 river mile upstream of Nelson's Bridge (State Route 615) (R. Barrows, Hanover County, personal communication, January 1992). This potential discharge location is approximately 28 river miles upstream of Northbury. Hanover County has also identified a potential 1 mgd WWTP discharge point on the Pamunkey River near the U.S. Route 301 Bridge, approximately 45 river miles upstream of Northbury.

In June 1993 King William County submitted a VPDES permit application to the Virginia Department of Environmental Quality (VDEQ), Water Division (formerly SWCB) for a 25,000 gallon per day WWTP discharge to an unnamed branch of Moncuin Creek (a tributary of the Pamunkey River), upstream of a bridge crossing by U.S. Route 360. Ultimately this discharge may be increased to 0.5 mgd (D. S. Whitlow, King William County, personal communication, June 1993). This proposed discharge location is approximately 10.5 river miles upstream of Northbury.

In July 1992 the SWCB issued a VPDES permit to New Kent County for a planned 0.25-mgd WWTP discharge at an existing outfall for the Cumberland Hospital WWTP at the northern end of Route 637 just north of the community of New Kent. This discharge to Cumberland Thorofare (a side-channel of the mainstem Pamunkey River) is approximately 17 river miles downstream of Northbury.

Given the great amount of current and planned development in the Pamunkey River basin, the number of municipal and industrial WWTP discharges in the basin is expected to grow. This growth will continue to represent a water quality reliability concern with respect to potential use of the Pamunkey River as a drinking water supply.

Reservoir

Water quality in both Ware Creek and Diascund Creek reservoirs would be affected under this alternative, since water from the Pamunkey River would be discharged directly to Diascund Creek prior to pumping to Ware Creek.

Most of the flow to Diascund Creek Reservoir is contributed through five main tributaries in the reservoir watershed area. The largest of these tributaries are Diascund Creek to the northwest of the reservoir, Beaverdam Creek to the north of the reservoir, and Wahrani Swamp to the northeast of the reservoir. Water quality characteristics for Diascund Creek and Beaverdam Creek are summarized in Table 4-2.

TABLE 4-1

PAMUNKEY RIVER WATER QUALITY AT WHITE HOUSE

Parameter	Units	Number Samples	Mean	Minimum	Maximum
pH	SI	108	6.93	5.60	8.29
Salinity	g/L	177	0.004	0	0.1
Transparency	M	53	0.7	0.3	1.4
Dissolved Oxygen	mg/l	198	7.1	2.9	12.9
Chlorophyll a	mg/l	41	5.34	0.38	29.01
Total Organic Carbon	mg/l	115	7	4	14
Total Phosphorus	mg/l	121	0.07	0.02	0.21
Dissolved Phosphorus	mg/l	121	0.03	0.01	0.05
Orthophosphate	mg/l	115	0.02	0.01	0.05
Nitrate	mg/l	121	0.23	0.01	0.65
Nitrite	mg/l	121	0.01	0.01	0.30
Total Kjeldahl Nitrogen	mg/l	121	0.06	0.05	0.25
Ammonia	mg/l	120	0.6	0.1	1.9
Silicon	mg/l	121	10	1.1	38

Source: Tributary Water Quality 1984-1987 Data Addendum - York River (SWCB, 1989).

TABLE 4-2

DIASCUND CREEK RESERVOIR WATER QUALITY

Parameter	Units	Depth	Number Samples	Mean	Min.	Max.
pH	SI	3 ft	36	7.3	6.6	8.3
pH	SI	18	34	6.9	6.4	8.0
Chlorophyll a	mg/l	3 ft	96	31	0.5	147
Total Phosphorus	mg/l	3 ft	88	0.04	0.005	0.26
Total Nitrogen	mg/l	3 ft	35	0.53	0.2	1.3
Total Nitrogen	mg/l	18 ft	33	1.5	0.2	5.6
Dissolved Oxygen	mg/l	3 ft	91	8.3	4.4	13.2
Dissolved Oxygen	mg/l	18 ft	91	4.3	0.0	13.1
Total Organic Carbon	mg/l	3 ft	45	8.2	5.5	11
Total Organic Carbon	mg/l	18 ft	37	9.3	6.3	15

Source: Newport News Raw Water Management Plan, CDM, 1989.

DIASCUND CREEK RESERVOIR TRIBUTARY WATER QUALITY

		Diascund Creek				Beaverdam Creek			
Parameter	Units	Number Samples	Mean	Min.	Max.	Number Samples	Mean	Min.	Max.
pH	SI	30	6.9	6	8.8	32	6.9	6.2	8.3
Fluoride	mg/l	ND	ND	ND	ND	3	< 0.1	< 0.1	< 0.1
Chloride	mg/l	29	9.7	4.1	75	32	12	5	75
Sulfate	mg/l	ND	ND	ND	ND	3	2	1.8	2.3
Total Phosphorus	mg/l	35	0.082	0.011	0.23	32	0.077	0.01	0.186
Orphosphate	mg/l	35	0.014	< 0.001	0.59	31	0.014	< 0.001	0.59
Iron	mg/l	35	2.5	0.63	4.8	31	3.1	0.65	9.6
Manganese	mg/l	35	0.11	0.04	0.26	35	0.21	0.02	0.9

Sources: Prugh et al., 1988, 1989, 1990, 1991, and 1992.
USGS Station 02042726 - Diascund Creek at State Route 628.
USGS Station 02042736 - Beaverdam Creek at State Route 632.

Note: ND = No Data

Presently, there are no permitted facilities discharging to Diascund Creek Reservoir. However, there is an inactive WWTP which was constructed for use at the recently vacated Virginia Department of Corrections (VDC) Camp 16, off of State Route 634, northeast of Wahrani Swamp. The point of discharge for the WWTP is in New Kent County on an unnamed tributary of Wahrani Swamp. This WWTP has never discharged wastewater (D. Osborne, SWCB, personal communication, 1992); however, in June 1992 the SWCB issued a VPDES to the VDC for this facility. In February 1993 Henrico County and New Kent County officials announced that Henrico, Goochland, and New Kent counties will build a regional jail at the old VDC Camp 16 site and on adjacent property by July 1994 (Wagner, 1993). Consequently, it is possible that the VDC's old Camp 16 WWTP may be used as part of the planned regional jail.

Diascund Creek Reservoir stratifies in the summer months, typically between June and August (CDM, 1989). Principally because of the depth of Diascund Creek Reservoir, an anoxic hypolimnion can develop. The water in Diascund Creek Reservoir is designated as eutrophic by the SWCB (SWCB, 1992). Some water quality parameters measured for Diascund Creek Reservoir are summarized in Table 4-2.

Below the reservoir, Diascund Creek is a tidal freshwater tributary of the Chickahominy River. There is no minimum flow-by requirement, and the preferred mode of operation is not to allow any water to spill over the dam or emergency spillway. Flow to Diascund Creek from the reservoir is from seepage through the dam and overflow during periods of wet weather.

Ware Creek is a relatively small and shallow system, with saline water at the mouth of the creek (10 to 19 ppt), brackish water between River Miles 2.5 and 5.6 from the mouth of the creek, and fresh water (less than 1 ppt) upstream from River Mile 5.6. Water quality data are available for Ware Creek from a USGS monitoring station at Richardson Millpond. Water quality samples taken at this station between 1985 and 1991, on a quarterly basis, are included in Table 4-3.

The water quality in Ware Creek has been described as *"relatively good despite the fact that phosphorus, iron, manganese and zinc have exceeded Virginia or USEPA criteria"* (USCOE, 1987). Previous studies have attributed these excess values, phosphorus in particular, to the prior location of a WWTP at the headwaters of France Swamp which operated until November 1979. However, based on the data obtained for Ware Creek and France Swamp, there is no longer an extreme difference in phosphorus concentrations between these two streams. It is therefore unlikely that the former WWTP is still the primary source of phosphorus. It is more likely that non-point sources are now the greatest contributors of nutrients.

In March 1977, due to high coliform bacteria levels, the waters of Ware Creek were condemned by the VDH, thereby prohibiting shellfishing. The shellfish condemnation area extends from the mouth of Ware Creek to its headwaters including the tributaries (SWCB, 1992).

In January 1992 the SWCB issued a VPDES permit to Branscome Concrete, Inc. for the Branscome Concrete Toano Plant in James City County. This permit allows discharge of truck washdown and storm water runoff to a tributary of France Swamp in the proposed Ware Creek Reservoir drainage area.

The Massie Debris Landfill is also located within the proposed Ware Creek Reservoir watershed. This active landfill is located immediately south of State Route 168/30 (H. J. Winer, VDWM, personal communication, 1992), at the confluence of France Swamp and one of its tributaries. Based on USGS topographic information and aerial photography, a portion of the landfill may be within the normal pool area for the proposed reservoir.

Stonehouse Inc., a wholly-owned subsidiary of Chesapeake Corporation, formally announced plans for its proposed "Stonehouse New Community" in March 1989. This would be a 7,230-acre planned community within the 11,141-acre Ware Creek watershed of James City and New Kent counties. The James City County portion of the Stonehouse development would occupy 4,000 acres (J. C. Dawson, James City County, personal communication, September 1992) or approximately 40 percent of the 9,903 acres (excluding the normal reservoir pool area) that would drain to Ware Creek Reservoir. Additional areas within the New Kent County portion of Stonehouse would also be within the reservoir watershed. As a consequence, activities both directly and indirectly associated with the development could have a substantial impact on the water quality of Ware Creek. Rezoning for the 5,750 acres of this development within James City County was approved by the James City County Board of Supervisors in November 1991.

According to James City County, plans for Stonehouse include a reservoir buffer zone extending 50 feet beyond the 50-foot elevation contour or 100 feet from the reservoir pool level (R. P. Friel, James City County, personal communication, 1991). A storm water management plan has been developed for this community to reduce the impact of development on the proposed reservoir (Langley and McDonald, 1990). Oil/water separators would be required at all stream crossings, and the sewer system would be designed to minimize potential threats to reservoir water quality. Best management practices (BMPs) would be maintained by James City County at Stonehouse's expense. The quantity and quality of the storm water runoff would be monitored. If runoff quantity or quality exceeds limits set based on previous storm water analysis, the BMPs for subsequent phases would be modified and existing development might be retrofitted to meet the limits (J. C. Dawson, James City County, personal communication, September 1992). These control measures previously described for Stonehouse should afford some degree of water quality protection for Ware Creek. However, given the magnitude of the Stonehouse project, there would still be a noteworthy risk of long-term reservoir water quality deterioration due to the extensive nature of planned residential and commercial development in the watershed.

Pipeline

Construction of 26.3 miles of pipeline for this alternative would involve minor crossings of 5 perennial and 16 intermittent streams. Pamunkey River withdrawals would be pumped to the Diascund Creek Reservoir drainage basin, discharging to two outfall locations on Diascund Creek. Raw water would then be pumped from Diascund Creek Reservoir to either Ware Creek Reservoir or the existing Newport News Waterworks mains. Diascund Creek Outfall Site 1 would be near the headwaters of Diascund Creek, where the estimated average flow is 1.0 mgd. Projected maximum raw water discharge from the

TABLE 4-3

WARE CREEK WATER QUALITY AT RICHARDSON MILLPOND

Parameter	Units	Number Samples		Mean	Min.	Max.
		Total	Above DL			
pH	SI	33	33	7.3	6.1	8.7
Specific Conductance	μS/cm	33	33	123	90	180
Alkalinity	mg/l	23	23	36	24	53
Dissolved Oxygen	mg/l	30	30	9.1	3.4	13.2
Dissolved Oxygen (Sat.)	mg/l	30	30	92	44	134
Total Organic Carbon	mg/l	32	32	7	3.5	12
Total Phosphorus	mg/l	32	28	0.04	0.01	0.08
Dissolved Phosphorus	mg/l	32	12	0.01	0.01	0.03
Nitrate+Nitrite	mg/l	32	11	0.09	0.005	0.52
Nitrite	mg/l	32	4	0.01	0.005	0.03
Total Kjeldahl Nitrogen	mg/l	33	32	0.8	0.2	1.9
Ammonia	mg/l	32	29	0.03	0.01	0.13
Iron	μg/l	33	33	498	70	2,000
Manganese	μg/l	33	28	30	4	140

Sources: Prugh et al., 1988, 1989, 1990, 1991, and 1992.

USGS Station 01677000 - Ware Creek at State Route 600.

Note: DL = Detection Limit

Pamunkey River to this outfall location is 40 mgd. Diascund Creek Outfall Site 2 would be just upstream of the reservoir, where the estimated average flow is 8.7 mgd. Projected maximum raw water discharge from the Pamunkey to this outfall location is 80 mgd.

Existing water quality data for the Pamunkey River near the proposed intake site are presented in Table 4-1. The closest USGS water quality monitoring station for Diascund Creek is approximately 2.8 river miles downstream from Outfall Site 1 and approximately 1.1 river miles upstream from Outfall Site 2. Water quality data from this station are summarized in Table 4-2, and are used to represent existing water quality conditions for Diascund Creek.

Hydrology

Intake

The proposed intake site on the Pamunkey River at Northbury would be located in New Kent County, approximately 40 river miles upstream of the mouth of the Pamunkey River (see Figures 3-2 and 4-1). Tidal freshwater conditions exist at the proposed intake location and the mean tidal range is 3.3 feet at Northbury (USDC, 1989).

Contributing drainage area at Northbury is approximately 1,279 square miles. The proposed 120-mgd maximum withdrawal capacity represents 15.6 percent of the estimated average freshwater discharge at Northbury (770 mgd). More detailed streamflow characteristics of the Pamunkey River at the proposed intake site are presented in Table 4-4.

Reservoir

Ware Creek and its principal tributaries, France Swamp, Cow Swamp, and Bird Swamp, drain a generally undisturbed watershed of approximately 17.4 square miles above the proposed dam site. The proposed dam site is situated approximately 1,000 feet downstream of the confluence of Ware Creek and France Swamp and is located 4.7 river miles upstream of the mouth of Ware Creek where it empties into the York River (Wilber et al., 1987).

Ware Creek flows in a northeasterly direction into the York River. The hydrologic system of the drainage area primarily consists of tidally and non-tidally influenced, perennial and intermittent streams. While drainage from Bird Swamp is interrupted by a minor impoundment, Richardson's Millpond, flow from the remainder of the Ware Creek basin is unobstructed by manmade impoundments.

The proposed dam site would be located in tidal waters where the channel is approximately 75 feet wide (Wilber et al., 1987). The variable discharge of freshwater from Ware Creek and the creek's depth relative to the estuarine tidal influx of the York River results in large-scale fluctuations in the salinity of waters in the creek system over relatively short periods of time (USEPA, 1992).

For this analysis it is assumed that all streams up to the proposed normal pool elevation of 35 feet msl would be affected. A total of 37.1 river miles of perennial and intermittent streams are located within the proposed reservoir pool area up to elevation 35 feet msl. Data concerning the stream system within the drainage area are presented in Table 4-5.

To estimate existing streamflow at the proposed dam site, the streamflow record from Ware Creek near Toano (10/79 to 10/81 and 3/82 to 9/90) was adjusted to the contributing reservoir drainage area of 17.4 square miles. Average streamflow at the proposed dam site is estimated to be 11.1 mgd.

Pipeline

The construction of 26.3 miles of pipeline would be required for this alternative. The pipeline would cross 5 perennial and 16 intermittent streams. This alternative component would also involve raw water discharges into the headwaters of Diascund Creek and Ware Creek reservoirs. Two raw water outfalls (40 mgd and 80 mgd capacities) would be located on perennial segments of Diascund Creek. The Ware Creek Reservoir headwaters (Bird Swamp and France Swamp) discharges would be located at intermittent portions of these streams. Existing average streamflows at the Diascund Creek outfall locations were estimated based on the same streamflow record listed previously in the description of Ware Creek Reservoir streamflows, and were adjusted to the drainage areas at the points of discharge.

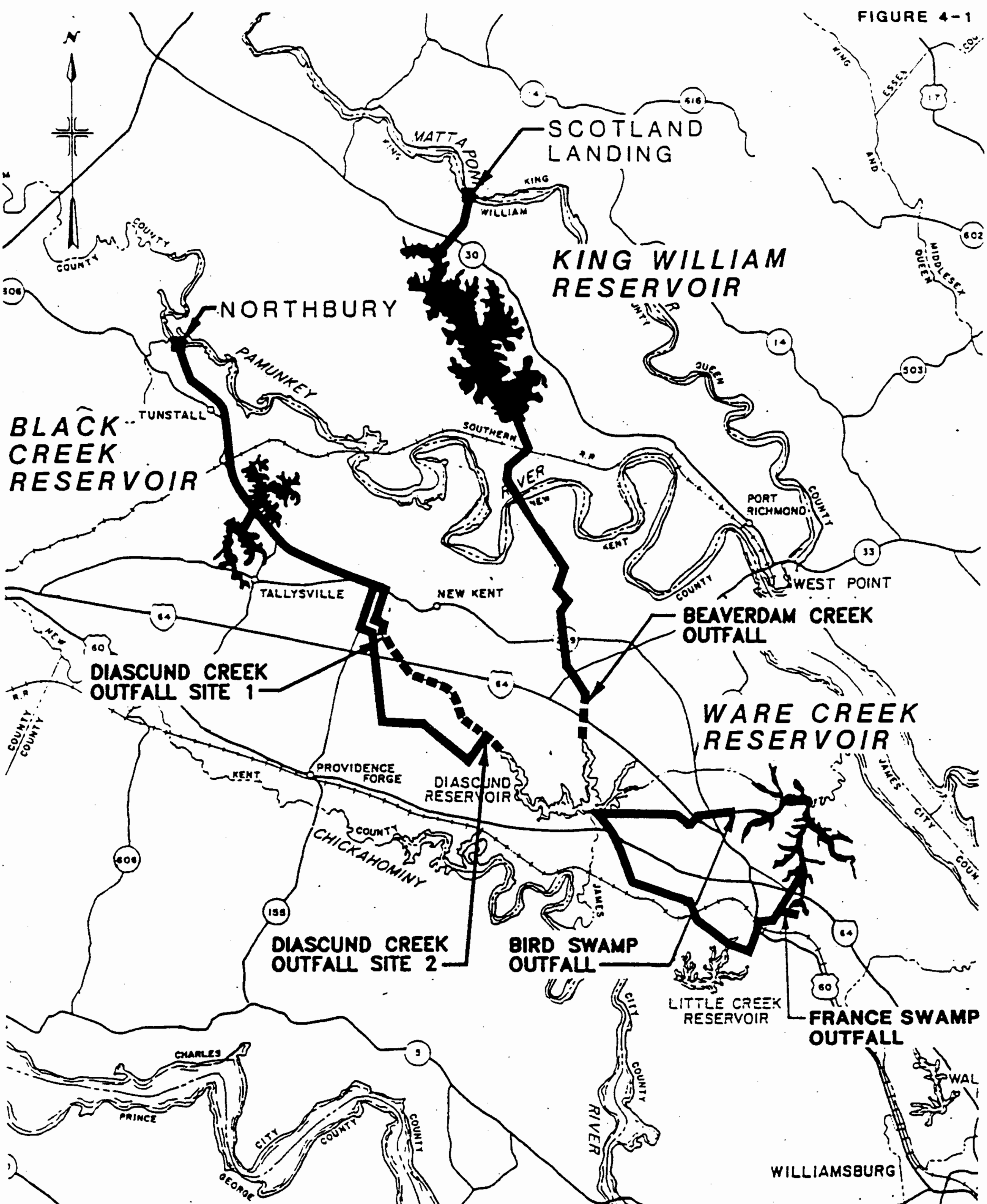
Field studies were conducted in July 1992 and January 1993 to obtain stream cross-sectional measurements at the proposed raw water discharge locations on Diascund Creek. To identify the potential hydrologic impacts of the proposed raw water discharges, Manning's Equation for Open Channel-Uniform Flow was used to approximate the depth of flow which could result from each proposed raw water discharge.

At Outfall Site 1 on Diascund Creek, estimated average discharge is 1.0 mgd based on a 1.6-square mile drainage area. It is assumed that the maximum discharge would be the maximum pipeline capacity at the outfall (40 mgd), plus the estimated average discharge at the site. Therefore, maximum discharge at Outfall Site 1 during pumpover operations is assumed to be 41 mgd. Diascund Creek Outfall Site 1, based on Manning's Equation, has an estimated channel capacity of at least 53 mgd. Therefore, the existing channel should be capable of accommodating maximum flows during pumpover operations.

At Outfall Site 2 on Diascund Creek, estimated average discharge is 8.7 mgd based on a 13.55-square mile drainage area. It is assumed that the maximum discharge would be the combined maximum raw water discharge of the two outfalls (120 mgd), plus the estimated average discharge at the site. Therefore, the maximum discharge at Outfall Site 2 during pumpover operations is assumed to be 128.7 mgd. The channel of Diascund Creek at Outfall Site 2 is easily capable of accommodating maximum flows during pumpover operations. At this proposed outfall site, two main Diascund Creek channels exist, each of which is at least 20 feet wide. The total bottom area of Diascund Creek at this point is 150 to 200 feet wide.

The Bird Swamp and France Swamp discharges would be directly to Ware Creek Reservoir.

FIGURE 4-1



APRIL 1993
LOWER VIRGINIA PENINSULA
REGIONAL RAW WATER SUPPLY STUDY
ENVIRONMENTAL ANALYSIS

LOCATIONS OF RESERVOIR/PUMPOVER ALTERNATIVES

5 0 5
SCALE IN MILES

MALCOLM PIRNIE

TABLE 4–4

CHARACTERISTICS OF PAMUNKEY RIVER DISCHARGE AT NORTHBURY

EXCEEDANCE PROBABILITY *(percent)*	DISCHARGE, mgd											
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
100	90.0	90.0	137.7	219.5	135.4	62.7	13.1	3.7	3.7	1.9	18.7	37.5
95	169.0	275.3	358.1	319.7	205.0	116.2	66.5	40.5	24.4	29.8	84.4	131.5
90	240.1	355.6	435.9	363.7	234.0	131.5	82.5	60.4	43.6	53.5	114.0	168.3
85	332.7	423.7	489.5	406.9	264.6	146.2	92.5	75.0	55.8	65.8	128.5	212.6
80	390.8	494.9	544.5	456.6	296.7	166.0	103.1	82.6	61.9	80.3	148.4	259.3
75	437.5	562.1	604.2	507.1	328.1	182.0	112.5	91.0	71.1	95.6	176.7	291.4
70	474.2	608.8	660.0	555.2	355.6	202.5	124.7	103.2	83.4	110.1	205.7	328.1
65	523.9	669.2	704.4	601.9	383.9	219.5	135.4	114.0	96.4	124.7	231.7	355.6
60	562.9	725.8	761.0	650.1	408.7	241.8	153.7	126.2	108.7	138.4	259.3	389.3
55	614.9	780.1	810.7	699.0	446.2	262.3	172.1	140.7	121.6	153.0	283.1	431.2
50	671.5	818.3	879.5	742.6	483.4	284.5	189.7	161.2	140.0	170.6	306.7	476.2
45	738.8	873.6	958.0	803.0	523.1	314.3	206.5	181.8	156.8	193.5	328.9	523.9
40	787.7	948.3	1,040.1	871.9	573.6	341.9	231.7	206.5	176.2	218.0	373.2	570.5
35	881.1	1,040.1	1,147.2	948.3	648.5	374.9	258.5	245.5	200.6	249.3	432.1	638.6
30	971.3	1,177.8	1,271.1	1,063.1	722.0	416.8	286.8	283.1	228.7	283.1	508.6	717.4
25	1116.6	1,338.4	1,453.1	1,231.3	818.3	464.2	335.0	336.5	259.3	339.6	588.7	810.7
20	1353.7	1,590.8	1,728.4	1,453.1	940.7	558.3	402.3	419.1	311.2	418.1	676.8	963.6
15	1674.9	1,988.5	2,126.1	1,850.8	1,094.8	666.1	523.0	544.5	367.1	539.2	818.3	1,246.6
10	2268.4	2,500.9	2,814.5	2,455.0	1,468.4	871.9	725.5	833.6	539.2	873.6	1,170.1	1,717.2
5	3472.2	3,449.5	3,824.0	3,816.3	2,279.1	1,379.8	1,223.7	1,667.3	1,162.5	2,080.9	2,099.7	2,755.8
0	17997.2	14,072.3	11,089.6	32,432.4	9,167.3	19,119.9	9,865.9	30,056.5	17,622.2	11,930.8	10,401.2	12,083.8

Notes: Exceedance flows calculated based upon 1929–1987 USGS gaged streamflows adjusted to the estimated 1,279 square mile contributing drainage area at Northbury.

Historical mean annual streamflow at Northbury is estimated to be 770 mgd.

TABLE 4-5

WARE CREEK RESERVOIR STREAM ORDER ANALYSIS

Stream Order [1]	River Miles		Total
	Perennial [2]	Intermittent [3]	
First	1.82	19.37	21.19
Second	3.30	7.44	10.74
Third	3.96	0.00	3.96
Fourth	1.06	0.00	1.06
Fifth	0.15	0.00	0.15
		Total	37.10

[1] Smallest tributaries are classified as "order 1". The point at which two first order streams join the channel is the beginning of a second order segment, and so on.

[2] A perennial stream maintains water in its channel throughout the year.

[3] An intermittent stream flows only in direct response to precipitation. It may be dry for a large part of the year, ordinarily more than three months.

Groundwater Resources

Setting

The surface of the Virginia Coastal Plain consists of a series of broad, gently sloping, highly dissected north-south trending terraces, bounded by seaward-facing, ocean escarpments (Meng and Harsh, 1988). The geology is characterized by a series of southeastward dipping beds of marine and nonmarine sand, silt, clay, and gravel. This wedge of unconsolidated deposits ranges in thickness from only several feet near Richmond to over 2,000 feet near Hampton, Virginia. In western James City County this sediment veneer is estimated at 1,100 feet in thickness (Brown et al., 1972).

The unconsolidated sediments overlie a crystalline bedrock basement that also slopes gently to the east. In general, the stratigraphic section consists of a thick sequence of nonmarine sediments overlain by a thinner sequence of marine deposits. The age of the sediments range from Quaternary to Late Cretaceous.

The primary aquifers in order of increasing depth consist of the Quaternary or Columbia, the Yorktown, the Chickahominy-Piney Point, the Aquia, and the Cretaceous or Potomac system. Water occurs under leaky artesian conditions in the multi-layer aquifer system. The Columbia and Yorktown Aquifers are both exposed at the surface and in river and stream valleys throughout most of the Virginia Coastal Plain. Therefore, these individual units will be characterized with respect to the proposed reservoir location and the Pamunkey River intake.

Columbia Aquifer

The upper surface of the water table lies within this unit and ranges from several feet to as much as 40 feet below land surface. The aquifer thickness ranges from 10 to 60 feet and is estimated at 20 feet in the vicinity of the reservoir (Harsh, 1980). The aquifer is used for small water supplies with yield ranging from 3 to 30 gal/min (Lichtler and Wait, 1974). This unit contains approximately 25 to 60 billion gallons of water in storage in the James City County area, and water levels have not declined appreciably due to local or regional pumping. Estimated withdrawals from the Columbia Aquifer in 1983 totaled approximately 0.1 mgd in southeastern Virginia. The water table elevation currently ranges from approximately elevation 5 to 20 feet msl at the proposed location of the dam site (Gannett Fleming, 1992).

Because this aquifer lies at the surface, it is recharged directly by precipitation. Discharge is by evaporation and transpiration, seepage into rivers and streams, downward leakage to confined aquifers, and pumping. Water in the aquifer moves from areas of high elevation (generally corresponding to land-surface topographic highs) toward streams, lakes, and swamps. Because the sand intervals of this unit are recharged by local rainfall, this unit is subject to extreme fluctuation in water level during drought periods. The Columbia Aquifer is an important part of the hydrologic system because it is a source of recharge to the underlying multi-layer, confined aquifer system.

Table 4-6 summarizes water quality data for the Columbia Aquifer across the entire York-James Peninsula.

Yorktown Aquifer

Also referred to as the Yorktown-Eastover Aquifer, this unit is present throughout the coastal plain, except along stream valleys in the western third where it has been removed by erosion. The thickness of the aquifer is highly variable and generally depends on the elevation of the land surface. Thickness ranges from a featheredge at the up-dip limit to 160 feet at a well in the City of Hampton. The lithology of the aquifer varies from gravelly-to-silty sand, interbedded with silt, clay, and shell. West of James City County this aquifer is the water-table aquifer and is overlain by the Yorktown confining unit in James City County and to the east.

Water enters the aquifer by downward vertical leakage from the Columbia Aquifer and by groundwater flow from the west along the outcrop of the Pliocene and Miocene sediments. Discharge is likely by flow to the east to surface water bodies, slow downward leakage to underlying aquifers, and by pumping. Approximately 45 to 100 billion gallons of water is contained in storage in the aquifer (Harsh, 1980) with well yields ranging from 5 to 80 gallons per minute.

A summary of water quality data for the Yorktown-Eastover Aquifer across the entire York-James Peninsula is presented in Table 4-7. The Yorktown-Eastover Aquifer has not been used as a primary source of water supply in the project area because higher well yields have been developed in underlying aquifers. However, several domestic supply wells have been identified in the City of Williamsburg and the community of Norge in James City County.

Soil and Mineral Resources

Intake

In the vicinity of the proposed Pamunkey River intake site at Northbury, the major soil grouping present is the Altavista-Dougue-Pamunkey (Hodges et al., 1985). The two major soils expected to be affected are the Nevarc-Remlik complex and the Pamunkey Fine Sandy Loam, the latter soil is considered a prime agricultural soil (Hodges et al., 1985). There are no mineral resources presently mined at or near the proposed intake facility site (Virginia Division of Mineral Resources (VDMR), 1976; Sweet and Wilkes, 1990).

Reservoir

Soils located within the proposed pool area of Ware Creek Reservoir constitute the affected environment. The major soil grouping in this area is the Emporia-Craven-Uchee soils (Hodges et al., 1985). These soils are found on mostly upland ridges and side slopes. Approximately 20 acres of these soils are considered prime agricultural soils. There are no mineral recovery facilities located within the vicinity of the proposed Ware Creek Reservoir area (VDMR, 1976; Sweet and Wilkes, 1990).

Construction of the Ware Creek Reservoir dam and associated emergency spillway would disturb approximately 14 acres of soil, as a result of excavation and subsequent deposition of fill material and associated structures.

TABLE 4-6

SUMMARY OF WATER QUALITY ANALYSES FROM COLUMBIA AQUIFER IN THE YORK-JAMES PENINSULA

Water Quality Constituent	N	Maximum	Minimum	Mean	Median	Standard Deviation
Calcium, dissolved, mg/l	17	86.00	2.90	42.21	43.00	25.51
Magnesium, dissolved, mg/l	17	14	.09	5.02	4.3	3.77
Potassium, dissolved, mg/l	12	4.3	.6	2.22	1.85	1.14
Sodium, dissolved, mg/l	13	55	5.2	25.2	20	16.55
Alkalinity as $CaCO_3$, mg/l	5	406	15	169.6	126	154.94
Chloride, dissolved, mg/l	19	93	9.7	34.28	27	22.48
Sulfate, dissolved, mg/l	17	29	1.32	9.81	6	9.13
Specific conductance, μs/cm	7	628	114	345.43	339	177.38
pH, standard units	15	8.05	6.5	7.56	7.8	.5
Nitrogen, nitrite plus nitrate dissolved, mg/l	1	—	--	--	<.01	--
Phosphate, ortho., dissolved, mg/l	0	—	--	--	--	--
Organic carbon, total, mg/l	0	—	--	--	--	--
Hardness, total as $CaCO_3$, mg/l	18	220	16	102.17	107.5	62.54
Fluoride, dissolved, mg/l	18	0.5			.21	--
Silica, dissolved, mg/l	13	40	6.6	21.31	20	11.14
Iron, total, μg/l	7	710	80	408.57	350	248.29
Iron, dissolved, μg/l	4	5200	90	1477.5	310	2484.17
Manganese, total, μg/l	5	5900	30	1250	70	2600
Manganese, dissolved, μg/l	2	610	200	405	405	--
Dissolved solids, residue at 180°C, mg/l	15	762	63	262	227	168

[N is number of samples, $CaCO_3$ is calcium carbonate, mg/l is milligrams per liter, μg/l is micrograms per liter, μs/cm is microsiemens per centimeter, °C is degrees Celsius, -- indicates insufficient number of constituent analyses, < indicates less than value shown.]

Source: Laczniak and Meng, 1988.

TABLE 4-7

SUMMARY OF WATER QUALITY ANALYSES FROM YORKTOWN-EASTOVER AQUIFER IN THE YORK-JAMES PENINSULA

Water Quality Constituent	N	Maximum	Minimum	Mean	Median	Standard Deviation
Calcium, dissolved, mg/l	34	261.00	1.80	59.93	65.50	45.18
Magnesium, dissolved, mg/l	34	39	.1	5.82	3.45	8.02
Potassium, dissolved, mg/l	25	16	.8	4.4	2.6	4.11
Sodium, dissolved, mg/l	26	804	3.5	86.84	20.5	182.84
Alkalinity as $CaCO_3$, mg/l	11	294	12	154.18	167	82.79
Chloride, dissolved, mg/l	35	1190	3.1	96.47	21.5	248.53
Sulfate, dissolved, mg/l	35	119	1.13	16.24	9.9	21.32
Specific conductance, μs/cm	18	4380	285	720.89	427	938.04
pH, standard units	21	8.9	7.1	7.63	7.55	.42
Nitrogen as $NO_2 + NO_3$, dissolved, mg/l	4	.25	<.01	--	.1	--
Phosphate, ortho., dissolved, mg/l	5	.52	<.01	--	.09	--
Organic carbon, total, mg/l	1	--	--	--	4.6	--
Hardness, total as $CaCO_3$, mg/l	30	812	5.	170.71	165	139.14
Fluoride, dissolved, mg/l	29	.9	<.01	--	.1	--
Silica, dissolved, mg/l	26	40	9.7	18.04	15.5	8.48
Iron, total, μg/l	11	8700	30	1909.09	710	3677.08
Iron, dissolved, μg/l	13	120	<.01	--	20	--
Manganese, total, μg/l	3	210	40	123.33	120	85.05
Manganese, dissolved, μg/l	2	170	110	140	140	--
Dissolved solids, residue at 180°C, mg/l	29	2280	108	328	248	390

[N is number of samples, $CaCO_3$ is calcium carbonate, mg/l is milligrams per liter, μg/l is micrograms per liter, μs/cm is microsiemens per centimeter, °C is degrees Celsius, -- indicates insufficient number of constituent analyses, < indicates less than value shown.]

Source: Laczniak and Meng, 1988.

Pipeline

This alternative would include the construction of approximately 26.3 miles of raw water pipeline. Assuming a construction right-of-way (ROW) of 50 feet, the expected total soil disturbance for this alternative would be 159 acres. Table 4-8 lists the types of soils along the pipeline route that would be affected.

There are four pipeline outfall locations associated with this alternative. The first outfall would be located at the headwaters of Diascund Creek, approximately 5.7 river miles upstream from the normal pool area of Diascund Creek Reservoir. Soil at this location consists of Johnston Mucky Loam (Hodges et al., 1985) which is included in the hydric soils list of Virginia (USDA, 1985). Because the Johnston series of soils are deep and poorly drained, flooding and ponding are typical for this area and it is common to find these soils mainly along streams where channel overflow is frequent. The second outfall would be located on Diascund Creek, approximately 0.6 river miles upstream of the normal pool area of Diascund Creek Reservoir. The soils found at this location are similar to those found at the first outfall location. The third outfall would be located on the Bird Swamp arm of Ware Creek Reservoir. The soil series at this location is Emporia Complex (Hodges et al., 1985). These soils are deep, very steep, well drained, and formed over layers of fossil shells. Emporia complex soils are typically found on side slopes along rivers, creeks, and drainage ways. The fourth outfall structure would be located on the France Swamp arm of Ware Creek Reservoir. Soils at this location are similar to those found at the third outfall location.

Air Quality

The intake and most of the pipeline would be located in New Kent County and the balance of the pipeline would be built in James City County. The reservoir would be located mostly in James City County with a portion extending into New Kent County. The VDAPC has classified New Kent County as attainment (or unclassifiable) for all criteria air pollutants. James City County has been classified as non-attainment for ozone and attainment for all other criteria air pollutants. No indication of a nuisance dust problem in this area has been recorded.

4.2.2 Black Creek Reservoir with Pumpover from Pamunkey River

Substrate

Intake

The existing substrate that would be affected due to construction of the proposed intake facilities on the Pamunkey River is discussed in Section 4.2.1.

Reservoir

Substrates found in the proposed Black Creek Reservoir area originate from soils which are considered of the Coastal Plain Uplands, Side Slopes, and Upland Flood Plains category (Hodges et al., 1989). There are two soil groupings from this category affected by this alternative component, Caroline-Emporia and Nevarc-Remlik-Johnston.

Pipeline

The area of substrate disturbance at each minor stream crossing was assumed to be 2,500 square feet (pipeline ROW width (50 feet) multiplied by the length of pipeline crossing). Substrate types at the proposed pipeline crossings include: Johnston Mucky Loam, Roanoke Silt Loam, Slagle Fine Sandy Loam, Tomotely Loam, and substrates of the Nevarc-Remlik and Slagle-Emporia complexes.

There are two outfall locations associated with this component that would affect existing substrate. The first outfall would be located at the headwaters of Diascund Creek, approximately 5.7 river miles upstream from the normal pool area of Diascund Creek Reservoir. Typical substrate found at this outfall site originates from Johnston Mucky Loam soil. The second outfall would be located on Little Creek Reservoir, approximately 2,000 feet south of St. Johns Church on State Route 610. The affected substrate is similar to the substrate found at the first outfall location.

Water Quality

Intake

Existing water quality conditions at the proposed Pamunkey River intake site are discussed in Section 4.2.1.

Reservoir

Potential reservoir water quality concerns exist due to the growing presence of homes in close proximity to the proposed reservoir boundaries. Examination of aerial photography flown in March 1989, review of New Kent County plats of subdivision and 1992 House Numbering Maps, and a windshield survey conducted in June 1992 confirm that the Clopton Forest residential subdivision borders the western edge of the proposed Southern Branch Black Creek reservoir site. This large subdivision has the potential to impact reservoir water quality by contributing non-point source runoff. No point source discharges have been identified within the proposed reservoir watershed.

Estimates of the water quality for Black Creek in this report are based on water quality information from Crump Creek and Matadequin Creek. Crump Creek is a tributary of the Pamunkey River located in central Hanover County east of U.S. Route 301 and northeast of the City of Richmond. Matadequin Creek is also a tributary of the Pamunkey River and, near its mouth, is located on the New Kent County - Hanover County line. Matadequin Creek flows into the Pamunkey River approximately 0.2 river miles upstream of Northbury. Water quality data for Crump Creek and Matadequin Creek were used as surrogates for Black Creek water quality conditions because all three creeks have similar watershed areas, topography (morphology), and land use within the watershed areas. This information is used only as a best estimate of existing water quality for Black Creek and is not intended to represent the actual water quality. Water quality data for Crump Creek and Matadequin Creek are summarized in Tables 4-9 and 4-10, respectively.

TABLE 4-8

WARE CREEK RESERVOIR ALTERNATIVE
SOILS WITHIN THE PIPELINE ROUTE

Map * Symbol	Soil Name	Description
1A	Altavista	Fine sandy loam, 0-2 % slopes. Very deep, nearly level, moderately well drained
2A	Altavista-Dogue complex	0-2% slopes. Very deep, nearly level, moderately well drained
3A	Augusta	Fine sandy-loam, 0-2% slopes. Very deep, nearly level, poorly drained
5A	Bojac	Loamy-sand, 0-2% slope. Very deep, nearly level, well drained
6B	Caroline	Loam, 2-6% slope. Very deep, gently sloping, well drained
7B	Caroline-Emporia complex	2-6% slope. Very deep, gently sloping, well drained. On broad upland ridges
7C	Caroline-Emporia complex	6-10% slope. Very deep, gently sloping, well drained. On broad upland ridges
9A	Conetoe	Loamy sand., 0-4% slopes. Very deep, nearly level, well drained. On low river terraces
10B	Craven	Loam, 2-6% slope.Very deep, gently sloping, moderately well drained
10C	Craven	Loam, 6-10% slopes. Very deep, strongly sloping, moderately well drained
11B	Craven-Caroline complex	2-6% slopes. Very deep, gently sloping soils. On narrow ridgetops and side slopes
12B	Craven-Uchee complex	2-6% slope. Very deep, gently sloping. On narrow ridgetops.
13A	Dogue	Fine sandy-loam, 0-2% slope. Very deep, nearly level, moderately well drained
15B	Emporia	Fine sandy-loam, 2-6% slope. Very deep, gently sloping, well drained
16A	Johnston (Hydric)	Mucky-loam, 0-2% slopes. Very deep, nearly level. very poorly drained
18B	Kempsville	Gravelly fine sandy-loam, 2-6% slopes. Very deep, gently sloping, well drained
19B	Kempsville-Emporia complex	2-6% slopes. Very deep, gently sloping, well drained. On upland ridges
19C	Kempsville-Emporia complex	6-10% slopes. Very deep, strongly sloping, well drained. On upland ridges
20B	Kempsville-Suffolk complex	2-6% slope. Very deep, gently sloping, well drained. On medium upland ridges
21A	Lanexa (Hydric)	Mucky-silty clay, 0-1% slope, frequently flooded. Deep, nearly level, poorly drained
23A	Munden	Sandy-loam, 0-2% slope. Very deep, nearly level, moderately well drained. On ridges
26D	Nevarc-Remlic complex	6-15 % slope. Very deep, moderately steep. On side slopes along rivers
26E	Nevarc-Remlic complex	15-25% slopes. Very deep, steep. On sides of slopes along rivers and creeks
26F	Nevarc-Remlic complex	25-60% slopes. Very deep, very steep. On sides of slopes along rivers & creeks
28B	Norfolk	Fine sandy-loam, 2-6% slopes. Very deep, gently sloping, well drained
30B	Pamunkey	Fine sandy-loam, 2-6% slope. Very deep, gently sloping, and well drained
31A	Roanoke (Hydric)	Silt-loam, 0-2% slopes. Very deep, nearly level, and poorly drained
33A	Slagle	Fine sandy-loam, 0-2% slope. Very deep, gently sloping, and moderately well drained
34B	Slagle-Emporia complex	0-2% slope. Very deep, gently sloping. On upland ridges and depressions
35A	State	Very fine sandy-loam., 0-2% slope. Very deep, nearly level, well drained
37A	Tarboro	Loamy sand, 0-4% slope. Very deep, nearly level to gentle slope and excessively drained
40B	Uchee	Loamy-fine sand, 2-6% slope. Very deep, gently sloping, and well drained
41B	Udorthents	Loamy, gentle slope. Consists of pits providing foundation materials and areas of landfills

Map ** Symbol	Soil Name	Description
10B	Craven	Loam, 2-6% slope.Very deep, gently sloping, moderately well drained
10C	Craven	Loam, 6-10% slopes. Very deep, strongly sloping, moderately well drained
11C	Craven-Uchee complex	6-10% slope. Moderately well drained Craven soil & well drained Uchee soil
14B	Emporia	Fine sandy-loam, 2-6% slope. Very deep, gently sloping, well drained
15D	Emporia complex	10-15% slope. Deep, moderately well drained Emporia soils & similar soils over fossil shells
15E	Emporia complex	15-25% slope. Deep, steep, well drained Emporia soils & similar soils over fossil shells
15F	Emporia complex	25-50% slope. Deep, very steep, well drained Emporia soils & similar soils over fossil shells
17	Johnston complex (Hydric)	Mucky-loam, 0-2% slopes. Very deep, nearly level. very poorly drained
18B	Kempsville	Gravelly fine sandy-loam, 2-6% slopes. Very deep, gently sloping, well drained
19B	Kempsville-Emporia complex	2-6% slopes. Very deep, gently sloping, well drained. On upland ridges
20B	Kenansville	Loamy-fine sand, 2-6% slope. Deep, gently sloping, and well drained. On upland ridges
25B	Norfolk	Fine sandy-loam, 2-6% slopes. Very deep, gently sloping, well drained
29A	Slagle	Fine sandy-loam, 0-2% slope. Very deep, gently sloping, & moderately well drained
29B	Slagle	Fine sandy-loam, 2-6% slope. Very deep, gently sloping, & moderately well drained
31B	Suffolk	Fine-sandy loam, 2-6% slope. Deep, gently sloping and well drained
34B	Uchee	Loamy-fine sand, 2-6% slope. Very deep, gently sloping, & well drained

Source used for the identification of soil types was the Soil Survey of New Kent County, Virginia (Hodges et al, 1989)

* Source used for the identification of soil types was the Soil Survey of James City and York Counties and the City of Williamsburg, Virgina (Hodges et al, 1985)

TABLE 4-9

CRUMP CREEK WATER QUALITY

Parameter		Units	Number Samples	Mean	Minimum	Maximum
pH		SI	12	6.3	6.1	6.6
Alkalinity		mg/l	12	5.3	2.5	7.0
Hardness		mg/l	12	16	12	22
Total Dissolved Solids	(TDS)	mg/l	12	47	33	60
Biochemical Oxygen Demand	(BOD_5)	mg/l	11	1.6	0.9	3.9
Total Organic Carbon	(TOC)	mg/l	12	6.8	4.2	10.5
Total Phosphorus	(TP)	mg/l	12	0.066	0.028	0.100
Orthophosphate	(OPO_4)	mg/l	12	0.03	0.01	0.09
Total Nitrogen	(TN)	mg/l	2	1.22	0.94	1.49
Nitrate	(NO_3)	mg/l	12	0.298	0.111	0.480
Total Kjeldahl Nitrogen	(TKN)	mg/l	12	0.9	0.2	3.6
Ammonia	(NH_3)	mg/l	12	< 0.3	0.1	0.6
Chloride	(Cl)	mg/l	12	8.7	5.7	17
Fluoride	(F)	mg/l	12	< 0.15	< 0.10	0.27
Arsenic	(As)	mg/l	12	< 0.0021	< 0.0005	0.0039
Barium	(Ba)	mg/l	12	< 0.13	< 0.05	0.20
Calcium	(Ca)	mg/l	12	2.14	1.55	2.65
Cadmium	(Cd)	mg/l	12	< 0.005	< 0.002	0.005
Chromium	(Cr)	mg/l	12	< 0.016	< 0.005	0.050
Copper	(Cu)	mg/l	12	< 0.009	< 0.005	0.010
Iron	(Fe)	mg/l	12	2.07	1.10	3.18
Lead	(Pb)	mg/l	12	< 0.04	< 0.02	0.05
Magnesium	(Mg)	mg/l	12	1.18	0.76	1.40
Manganese	(Mn)	mg/l	12	0.066	0.035	0.094
Mercury	(Hg)	mg/l	12	< 0.0005	< 0.0005	< 0.0005
Selenium	(Se)	mg/l	12	< 0.0021	< 0.0005	0.0030
Silver	(Ag)	mg/l	12	< 0.006	< 0.002	0.010
Sodium	(Na)	mg/l	12	5.0	3.9	9.2
Zinc	(Zn)	mg/l	12	0.010	0.005	0.018

Source: Crump Creek Reservoir Project Development Report, Black and Veatch, Inc., 1989.

TABLE 4-10

MATADEQUIN CREEK WATER QUALITY

Parameter		Units	Number Samples	Mean	Minimum	Maximum
pH		SI	11	6.4	5.4	7.2
Alkalinity		mg/l	9	10	8	13
Hardness		mg/l	7	28	20	44
Total Dissolved Solids	(TDS)	mg/l	9	48	35	59
Turbidity		JTU	5	6.9	4.1	12
Specific Conductance		μS/cm	9	54	46	58
Dissolved Oxygen	(DO)	mg/l	10	8.9	6.5	12.7
Fecal Coliform		/100 mL	6	107	< 100	500
Biochemical Oxygen Demand	(BOD_5)	mg/l	9	1.9	1	4
Total Organic Carbon	(TOC)	mg/l	8	4.8	2.2	6.9
Total Phosphorus	(TP)	mg/l	8	< 0.1	< 0.1	0.14
Orthophosphate	(OPO_4)	mg/l	4	< 0.04	< 0.04	0.05
Nitrate	(NO_3)	mg/l	9	0.15	0.02	0.41
Total Kjeldahl Nitrogen	(TKN)	mg/l	9	0.5	0.3	0.6
Ammonia	(NH_3)	mg/l	9	< 0.04	< 0.04	0.07
Chloride	(Cl)	mg/l	7	5	4	6
Fluoride	(F)	mg/l	7	< 0.1	< 0.05	0.25
Arsenic	(As)	mg/l	9	< 0.01	< 0.01	< 0.01
Cadmium	(Cd)	mg/l	9	< 0.01	< 0.01	< 0.01
Chromium	(Cr)	mg/l	7	< 0.01	< 0.01	< 0.01
Copper	(Cu)	mg/l	7	< 0.01	< 0.01	< 0.01
Iron	(Fe)	mg/l	7	2.2	1.1	3.1
Lead	(Pb)	mg/l	7	< 0.01	< 0.01	< 0.01
Manganese	(Mn)	mg/l	7	0.062	0.041	0.090
Nickel	(Ni)	mg/l	7	< 0.01	< 0.01	< 0.01
Zinc	(Zn)	mg/l	7	< 0.01	< 0.01	0.011

Source: USEPA STORET data retrieval in January 1993 for period August 1990 - November 1992.

Pipeline

The construction of 20.3 miles of pipeline for this alternative would involve minor crossings of 10 perennial and 14 intermittent streams. One major crossing of an arm of Little Creek Reservoir would also be required. Under this alternative, Pamunkey River withdrawals would either be pumped to Black Creek Reservoir for intermediate storage or directly to Diascund Creek Reservoir headwaters. Average flow at the point of discharge on Diascund Creek is estimated at 1.0 mgd. The maximum proposed discharge at this point is 40 mgd for this alternative.

Water quality data for the Pamunkey River near the proposed intake site are presented in Table 4-1. Water quality data from Diascund Creek are included in Table 4-2.

Hydrology

Intake

The hydrologic characteristics of the Pamunkey River in the vicinity of the proposed Northbury intake site are described in Section 4.2.1.

Reservoir

Two tributaries of Black Creek, the Southern Branch Black Creek and the eastern branch of Black Creek, drain a combined watershed of 5.47 square miles above the two proposed dam sites.

Black Creek flows in a northerly direction into the Pamunkey River. The hydrologic system of the drainage area primarily consists of non-tidal, perennial, and intermittent streams. While drainage from the Southern Branch Black Creek is interrupted by a minor impoundment, Crumps Millpond, flow from the remainder of the proposed Black Creek Reservoir drainage area is unobstructed by manmade impoundments.

For this analysis it is assumed that all streams up to the proposed normal pool elevation of 100 feet msl would be affected. A total of 13.7 river miles of perennial and intermittent streams are located within the proposed reservoir pool area up to elevation 100 feet msl. Data concerning the stream system within the drainage area are presented in Table 4-11.

To estimate existing combined streamflow at the proposed dam sites, the streamflow record from Totopotomoy Creek near Studley (10/77 to 9/90) was adjusted to the contributing reservoir drainage area of 5.47 square miles. Average combined streamflow at the proposed dam sites is estimated to be 3.8 mgd.

Pipeline

The construction of 20.3 miles of pipeline would be required for this alternative component. The pipeline would cross 10 perennial and 14 intermittent streams. One major crossing of an arm of Little Creek Reservoir would also be required. This alternative would also involve a raw water discharge into a perennial segment of the headwaters of Diascund

Creek. Existing average streamflow was estimated based on the same streamflow record listed previously in the description of Ware Creek Reservoir streamflows (Section 4.2.1), and was adjusted to the drainage area at the point of discharge. Based on an estimated contributing drainage area of 1.6 square miles at Diascund Creek Outfall Site 1, average streamflow at this point is estimated at 1.0 mgd.

Field studies were conducted in July 1992 and January 1993 to obtain stream cross-sectional measurements at the proposed raw water discharge location on Diascund Creek. To identify the potential hydrologic impacts of the proposed raw water discharge to Diascund Creek, Manning's Equation for Open Channel-Uniform Flow was used to approximate the depth of flow which could result from a raw water discharge in the vicinity of Inspection Sites 1 and 2.

At Outfall Site 1 on Diascund Creek, estimated average discharge would be 1.0 mgd based on a 1.6-square mile drainage area. It is assumed that the maximum discharge would be the maximum pipeline capacity (40 mgd) plus the estimated average discharge at the site. Therefore, maximum discharge at Outfall Site 1 during pumpover operations is assumed to be 41 mgd. Diascund Creek Outfall Site 1, based on Manning's Equation, has an estimated channel capacity of at least 53 mgd. Therefore, the existing channel should be capable of accommodating maximum flows during pumpover operations.

<u>Groundwater Resources</u>

The geologic and hydrogeologic setting for this reservoir alternative is the Virginia Coastal Plain Physiographic Province. This location, is therefore, very similar to that already described for the Ware Creek Reservoir alternative component. At the proposed location of the two-dam reservoir alternative, the Columbia Aquifer is reportedly thin to absent. The Yorktown Aquifer and overlying Yorktown confining unit, are therefore, the primary surficial hydrogeologic units at the proposed project site. The general characteristics of this unit are described in Section 4.2.1.

<u>Soil and Mineral Resources</u>

Intake

The affected environment for the Pamunkey River intake, located at the Northbury site, is discussed in Section 4.2.1.

Reservoir

Generally, the soils found in the proposed Black Creek Reservoir area are considered of the Coastal Plains Uplands, Side Slopes, and Upland Flood Plains category (Hodges et al., 1989). There are two soil groupings that would be affected by construction of the proposed Black Creek Reservoir, Caroline-Emporia and Nevarc-Remlik-Johnston. Approximately 17 acres of these soils are considered prime agricultural soils.

There are no known mineral recovery facilities that would be affected by the construction of the proposed reservoir (VDMR 1976; Sweet and Wilkes, 1990).

TABLE 4-11

BLACK CREEK RESERVOIR STREAM ORDER ANALYSIS

Stream Order [1]	River Miles		Total
	Perennial [2]	Intermittent [3]	
First	0.34	7.04	7.38
Second	4.39	0.54	4.93
Third	1.43	0.00	1.43
		Total	13.74

1 Smallest tributaries are classified as "order 1". The point at which two first order streams join the channel is the beginning of a second order segment, and so on.

2 A perennial stream maintains water in its channel throughout the year.

3 An intermittent stream flows only in direct response to precipitation. It may be dry for a large part of the year, ordinarily more than three months.

Pipeline

Construction of the 20.3 miles or raw water pipelines associated with this alternative would cause the disturbance of approximately 123 acres of soils. Associated with the pipeline are two raw water outfall locations. The first outfall would be located at the headwaters of Diascund Creek, approximately 5.7 river miles upstream from the normal pool area of Diascund Creek Reservoir. Johnston Mucky Loam soil is present at this site (Hodges et al., 1989) which is included in the hydric soils list of Virginia (USDA, 1985). These soils are nearly level, very poorly drained, and have generally formed over layers of shell. They are usually found on flood plains and along major drainageways. The second outfall location would be located on Little Creek Reservoir, approximately 2,000 feet south of St. Johns Church on State Route 610. The affected soil is similar in type to the soils found at the first outfall location. Table 4-12 lists the type of soils affected by the pipeline and outfall structures.

Air Quality

The intake, reservoir and most of the pipeline would be located in New Kent County and the balance of the pipeline would be built in James City County. The air quality in New Kent County is considered satisfactory while James City County is not in attainment of the ozone ambient air quality standard. There is residential development near the proposed reservoir area which might be sensitive to construction activities. No indication of a nuisance dust problem in this area has been recorded.

4.2.3 King William Reservoir with Pumpover from Mattaponi River

Substrate

Intake

Lanexa Mucky Silty Clay appears to be the parent soil of the affected river substrate in the vicinity of the proposed pump station.

Reservoir

Soils located within the proposed pool area of King William Reservoir are the parent material for the substrate that would be affected by construction of King William Reservoir. Generally, the substrates in this area originate from soils which are categorized as Coastal Plain Uplands, Side Slopes, and Upland Flood soils (Hodges et al., 1985) The major grouping is Nevarc-Remlik-Johnston.

Pipeline

The area of substrate disturbance at each minor stream crossing was assumed to be 2,500 square feet (pipeline ROW width (50 feet) multiplied by the length of the crossing).

There are two raw water outfall locations associated with this alternative that are expected to affect aquatic ecosystem substrate. The first outfall would be located 1.3 river miles upstream of the normal pool area of Diascund Creek Reservoir, on Beaverdam Creek. Substrate at this outfall location originates from Johnston Mucky Loam soil. The second raw water outfall location would be located on Little Creek Reservoir, approximately 2,000 feet south of St. Johns Church on State Route 610. The affected substrate is the same as that found at the first outfall location. Substrate types at the proposed crossings and outfall locations include: Altavista and Slagle Fine Sandy Loams, Johnston Mucky Loam, Matten Muck, Munden Sandy Loam, Roanoke Silt Loam, Tetotum soils, Tomotely Loam, Daleville soils, and soils of the Nevarc-Remlik and Bibb-Kinston complexes. Johnston Mucky Loam, Matten Muck, Roanoke Silt Loam, Tomotely Loam and Daleville soils are included in the hydric soils list of Virginia (USDA, 1985).

Water Quality

Intake

All surface waters within the Mattaponi River basin have been designated as "effluent limited" by the SWCB (SWCB, 1992). Well downstream of Scotland Landing, in the estuarine portion of the river from Clifton to West Point, the Mattaponi River is designated as "nutrient enriched."

There are currently no SWCB-designated "major" municipal or industrial discharges in the Mattaponi River basin. In addition there are no point sources in the SWCB-designated "Mattaponi River-Walkerton Waterbody" which Scotland Landing falls within.

Southern International Company operated a wood preserving facility in King and Queen County which had a permitted stormwater discharge to Dickeys Swamp at U.S. Route 360. This waterbody is a tributary of Garnetts Creek which flows into the Mattaponi River across from Scotland Landing. The owner of this facility declared bankruptcy and the facility is now inactive. The USEPA has since been in charge of a site cleanup since some containers leaked onto a concrete bermed area. This site cleanup has been completed and the facility is now idle. Although SWCB staff requested that the discharge permit be revoked, the permit was upheld and is valid until 1995 (D. Barnes, SWCB, personal communication, 1994).

The SWCB maintains a water quality monitoring station on the Mattaponi River at the Walkerton Bridge (State Route 629), approximately 5 river miles upstream of Scotland Landing. According to the ***Virginia Water Quality Assessment 1990 - 305(b) Report to EPA and Congress*** (SWCB, 1990), there were no violations of water quality standards at this station. In addition, no point sources were known to affect this station. There were also no violations of the water quality standards reported for the Mattaponi River-Walkerton Waterbody in the ***Virginia Water Quality Assessment for 1992 - 305(b) Report to EPA and Congress*** (SWCB, 1992).

Available water quality data were compiled for the Mattaponi River at Scotland Landing (River Mile 24.2), Mantua Ferry (River Mile 24.5), and Walkerton (River Mile 29.1). Water quality for these three stations are summarized in Tables 4-13 through 4-15. These data were collected between Years 1972 and 1991.

TABLE 4-12

BLACK CREEK RESERVOIR ALTERNATIVE

SOILS WITHIN THE PIPELINE ROUTE

Map * Symbol	Soil Name	Description
1A	Altavista	Fine sandy loam, 0-2 % slopes. Very deep, nearly level, moderately well drained
2A	Altavista-Dogue complex	0-2% slopes. Very deep, nearly level, moderately well drained
3A	Augusta	Fine sandy-loam, 0-2% slopes. Very deep, nearly level, poorly drained
5A	Bojac	Loamy-sand, 0-2% slope. Very deep,nearly level, well drained
6B	Caroline	Loam, 2-6% slope. Very deep, gently sloping, well drained
7B	Caroline-Emporia complex	2-6% slope. Very deep, gently sloping, well drained. On broad upland ridges
7C	Caroline-Emporia complex	6-10% slope. Very deep, gently sloping, well drained. On broad upland ridges
9A	Conetoe	Loamy sand., 0-4% slopes. Very deep, nearly level, well drained. On low river terraces
10C	Craven	Loam, 6-10% slopes. Very deep, strongly sloping, moderately well drained
11B	Craven-Caroline complex	2-6% slopes. Very deep, gently sloping. On narrow ridgetops and side slopes
13A	Dogue	Fine sandy-loam, 0-2% slope. Very deep, nearly level, moderately well drained
15B	Emporia	Fine sandy-loam, 2-6% slope. Very deep, gently slpoing, well drained
16A	Johnston (Hydric)	Mucky-loam, 0-2% slopes. Very deep, nearly level, very poorly drained
18B	Kempsville	Gravelly fine sandy-loam, 2-6% slopes. Very deep, gently sloping, well drained
19B	Kempsville-Emporia complex	2-6% slopes. Very deep, gently sloping, well drained. On upland ridges
19C	Kempsville-Emporia complex	6-10% slopes. Very deep, strongly sloping, well drained. On upland ridges
21A	Lanexa (Hydric)	Mucky-silty clay, 0-1% slope, frequently flooded. Deep, nearly level, poorly drained
23A	Munden	Sandy-loam, 0-2% slope. Very deep, nearly level, moderately well drained. On ridges
26D	Nevarc-Remlic complex	6-15 % slope. Very deep, moderately steep. On side slopes along rivers
26E	Nevarc-Remlic complex	15-25% slopes. Very deep, steep. On sides of slopes along rivers and creeks
26F	Nevarc-Remlic complex	25-60% slopes. Very deep, very steep. On sides of slopes along rivers & creeks
28B	Norfolk	Fine sandy-loam, 2-6% slopes. Very deep, gently sloping, well drained
30B	Pamunkey	Fine sandy-loam, 2-6% slope. Very deep, gently sloping, and well drained
31A	Roanoke (Hydric)	Silt-loam, 0-2% slopes. Very deep, nearly level, and poorly drained
33A	Slagle	Fine sandy-loam, 0-2% slope. Very deep, gently sloping, & moderately well drained
34B	Slagle-Emporia complex	0-2% slope. Very deep, gently sloping. On upland ridges and depressions
37A	Tarboro	Loamy sand, 0-4% slope. Very deep, nearly level to gentle slope & excessively drained
41B	Udorthents	Loamy, gentle slope. Consists of pits providing foundation materials & areas of landfills

* Source used for the identification of soil types was the Soil Survey of New Kent County, Virginia (Hodges et al, 1989)

TABLE 4-13

MATTAPONI RIVER WATER QUALITY AT SCOTLAND LANDING

Parameter	Units	Mean	Std. Dev.	Min.	Max.	Number Samples
Temperature	C	25.1	3.8	13.9	30.0	35
pH	SI	6.53	0.35	5.6	7.5	34
Dissolved Oxygen	mg/l	5.96	0.91	4.9	8.8	35
BOD_5	mg/l	1.27	0.67	0.3	2.0	7
Fecal Coliforms	/100 ml	283	996	< 100	6000	35
Alkalinity	mg/l	9.0	0.0	9.0	9.0	1
Ammonia	mg/l	BDL	-	BDL	BDL	21
Nitrate	mg/l	0.143	0.077	0.030	0.320	21
Total Kjeldahl Nitrogen	mg/l	0.365	0.109	0.200	0.500	20
Total Phosphorus	mg/l	0.114	0.065	<0.10	0.40	21
Chloride	mg/l	21.9	57.2	2	300	29
Arsenic	μg/l	BDL	-	BDL	BDL	3
Cadmium	μg/l	BDL	-	BDL	BDL	7
Chromium	μg/l	BDL	-	BDL	BDL	11
Copper	μg/l	11.8	6.0	< 10	30	11
Lead	μg/l	BDL	-	BDL	BDL	10
Mercury	μg/l	0.52	0.06	<0.5	0.7	11
Nickel	μg/l	BDL	-	BDL	BDL	3
Zinc	μg/l	23.6	38.8	< 10	190	25

Source: USEPA STORET data retrieval in May 1989 for period June 1972-October 1975.

Notes: BDL = Below Detection Limit

TABLE 4-14

MATTAPONI RIVER WATER QUALITY AT MANTUA FERRY

Parameter	Units	Level
Temperature	C	15
pH	SI	5.9
Turbidity	NTU	11.0
Total Organic Carbon	mg/l	7.5
Specific Conductance	μmhos/cm	68
Total Dissolved Solids	mg/l	51
Alkalinity	mg/l	6.0
Hardness	mg/l	15.3
Chloride	mg/l	7.5
Sodium	mg/l	9.4
Aluminum	μg/l	70
Chromium	μg/l	BDL
Copper	μg/l	BDL
Iron	μg/l	770
Lead	μg/l	BDL
Manganese	μg/l	30
Zinc	μg/l	46

Source: B. F. Goodrich laboratory analysis of sample collected by Malcolm Pirnie on January 24, 1989.

Note: BDL = Below Detection Limit.

TABLE 4-15

MATTAPONI RIVER WATER QUALITY AT WALKERTON

Parameter	Units	Number Samples	Mean
Temperature	(C)	139	19
pH	(SI)	114	6.7
Salinity	(g/l)	293	0.0017
Dissolved Oxygen	(mg/l)	139	7.5
Chlorophyll a	(μg/l)	42	5
Total Organic Carbon	(mg/l)	113	8.3
Total Kjeldahl Nitrogen	(mg/l)	118	0.58
Ammonia	(mg/l)	119	0.07

Source: Tributary Water Quality 1984-1987 Data Addendum - York River (SWCB, 1989) and more recent database updates.

Reservoir

Estimates of the water quality for Cohoke Mill Creek in this report are based on water quality information from Crump Creek and Matadequin Creek. Crump Creek is a tributary of the Pamunkey River located in central Hanover County east of U.S. Route 301 and northeast of the City of Richmond. Matadequin Creek is also a tributary of the Pamunkey River and, near its mouth, is located on the New Kent County - Hanover County line. Matadequin Creek flows into the Pamunkey River approximately 0.2 river miles upstream of Northbury. Water quality data for Crump Creek and Matadequin Creek were used as surrogates for Cohoke Mill Creek water quality conditions because all three creeks have similar watershed areas, topography (morphology), and land use within the watershed areas. This information is used only as a best estimate of existing water quality for Cohoke Mill Creek and is not intended to represent the actual water quality. Water quality data for Crump Creek and Matadequin Creek are summarized in Tables 4-9 and 4-10, respectively.

Within the Cohoke Mill Creek watershed there is minimal existing or planned development. There are some concerns regarding groundwater quality and surface water runoff quality since portions of the King William County Landfill are located within the reservoir drainage area. This 85-acre landfill parcel is located above the proposed normal pool elevation (90 feet msl), along the south side of State Route 30, near the intersection of State Routes 30 and 640. Landfill operations began in February 1988 (A. Martin, King William County, personal communication, 1988).

The *King William Reservoir Project Development Agreement* (King William County and City of Newport News, 1990) specifies conditions and financial arrangements under which early closure of the King William County Landfill could occur if this project is pursued as a preferred alternative. It is anticipated that these Agreement provisions would preclude any reservoir water quality problems that might occur as a result of landfill activities.

Pipeline

Under this alternative, Mattaponi River withdrawals would be pumped to King William Reservoir for intermediate storage. From King William Reservoir, raw water withdrawals would be conveyed to the Diascund Creek Reservoir basin, for eventual transmission to Newport News Waterworks' terminal reservoirs. The construction of 17.0 miles of pipeline for this alternative would involve minor crossings of nine perennial and 17 intermittent streams. In addition, the pipeline would cross the Pamunkey River and an arm of Little Creek Reservoir.

The proposed discharge location in the Diascund Creek Reservoir basin would be near the headwaters of Beaverdam Creek. Existing average streamflow at this outfall site is estimated at 3.5 mgd. The maximum flow rate from the pipeline to Beaverdam Creek would be 40 mgd. Water quality for Beaverdam Creek is routinely measured by the USGS at Station 02042736, approximately 0.6 miles upstream from the proposed discharge location. Water quality data for this monitoring station are summarized in Table 4-2.

Hydrology

Intake

The proposed intake site on the Mattaponi River at Scotland Landing would be located in King William County, approximately 24.2 river miles upstream of the mouth of the Mattaponi River. Tidal freshwater conditions exist at the proposed intake location. The mean tidal range is 3.9 feet at Walkerton, approximately 5 river miles upstream of Scotland Landing (USDC, 1989).

Contributing drainage area at Scotland Landing is approximately 781 square miles. The proposed 75 mgd maximum withdrawal capacity represents 15.1 percent of the estimated average freshwater discharge at Scotland Landing (498 mgd). More detailed streamflow characteristics of the Mattaponi River at the proposed intake site are presented in Table 4-16.

Reservoir

Cohoke Mill Creek drains a watershed of 13.17 square miles above the proposed King William Reservoir dam site. Cohoke Mill Creek flows in a southerly direction into Cohoke Millpond, which is an existing impoundment downstream of the proposed dam site, and tributary to the Pamunkey River. The upper end of Cohoke Millpond and the Cohoke Millpond Dam itself are located approximately 0.4 river miles and 1.8 river miles, respectively, downstream of the proposed King William Reservoir dam site.

The hydrologic system of the proposed King William Reservoir drainage area primarily consists of non-tidal, perennial and intermittent streams. Flow from the King William Reservoir drainage area is, for the most part, unobstructed by manmade impoundments. However, in the central portion of the proposed reservoir site, the main channel of Cohoke Mill Creek passes through a triple 10-foot by 10-foot box culvert underneath State Route 626. In addition, just upstream of the Route 626 crossing are the remains of the Valley Millpond Dam. Virginia Department of Transportation as-built plan and profile sheets for Route 626 (1959) show that the top of this old earthen dam had an average elevation of 40 feet msl when the area was surveyed in 1957. Immediately upstream of the remains of the old dam and the Route 626 embankment is a wide emergent wetland area which was presumably once an open water habitat known as Valley Millpond in 1919. The normal pool elevation of Valley Millpond was 37 feet msl as shown on the 1919 USGS topographic map.

For this analysis it is assumed that all streams up to the proposed normal pool elevation of 90 feet msl would be affected. A total of 28.3 river miles of perennial and intermittent streams are located within the proposed reservoir pool area up to elevation 90 feet msl. Data concerning the stream system within the drainage area are presented in Table 4-17.

To estimate existing streamflow at the proposed dam site, streamflow records from Piscataway Creek near Tappahannock (7/51 to 9/90) and Totopotomoy Creek near Studley (10/77 to 9/90) were adjusted to the contributing reservoir drainage area of 13.17 square miles. Average streamflow at the proposed dam site is estimated to be 9.3 mgd.

TABLE 4-16

CHARACTERISTICS OF MATTAPONI RIVER DISCHARGE AT SCOTLAND LANDING

EXCEEDANCE PROBABILITY (percent)	DISCHARGE, mgd											
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
100	69.9	97.8	122.4	139.7	69.9	23.9	13.1	9.9	5.2	6.9	37.8	57.5
95	115.1	241.2	280.6	230.0	118.7	53.4	29.6	19.7	13.1	16.9	60.8	100.6
90	204.6	304.0	353.3	272.0	149.1	69.0	38.6	24.6	20.9	27.9	78.5	159.8
85	288.8	366.0	390.3	301.1	177.9	83.8	46.0	31.2	26.3	37.8	95.3	196.8
80	323.8	417.8	429.3	341.8	200.5	101.5	54.2	37.8	33.7	48.1	120.0	226.4
75	347.5	447.8	466.7	378.0	226.4	120.8	62.8	46.0	42.3	60.0	144.6	249.8
70	379.6	483.9	503.7	415.0	251.4	139.7	72.3	57.5	50.9	72.3	165.5	272.8
65	414.1	518.9	542.7	462.6	281.8	156.9	81.4	70.6	64.9	86.3	190.6	305.7
60	451.9	552.2	617.9	519.3	316.8	179.1	93.3	82.6	76.4	100.3	214.1	332.4
55	491.0	583.0	665.6	575.2	360.3	198.0	106.0	95.3	93.7	113.4	235.0	361.1
50	533.7	617.9	731.3	624.4	397.3	216.9	121.6	111.8	108.5	127.3	258.0	392.7
45	587.5	656.1	799.9	671.7	443.7	237.5	135.6	128.6	125.3	141.7	279.7	434.7
40	638.0	714.9	866.8	731.3	493.8	262.1	150.3	147.0	143.0	172.1	314.7	486.5
35	702.1	792.1	928.5	813.4	562.0	291.7	167.6	179.1	165.5	207.0	352.1	529.6
30	764.1	866.8	1,002.4	903.8	633.5	327.0	196.4	206.6	189.0	236.2	387.8	586.6
25	821.7	949.1	1,101.0	1,027.1	723.1	377.2	233.3	238.3	219.0	269.5	445.3	652.4
20	895.6	1,043.5	1,195.5	1,195.5	814.7	449.5	261.3	285.9	262.9	327.8	524.2	755.1
15	1,068.2	1,166.7	1,359.9	1,355.7	969.5	536.5	309.7	365.3	396.0	454.8	671.3	895.6
10	1,327.0	1,339.3	1,532.4	1,565.3	1,150.3	658.6	401.0	522.2	916.2	632.7	871.0	1,064.0
5	1,713.2	1,676.2	1,967.9	1,939.1	1,516.0	953.1	793.3	850.4	50,784.0	1,047.6	1,121.6	1,479.0
0	6,211.8	7,164.9	8,627.5	8,235.0	4,206.9	13,310.9	3,894.7	10,024.3	148,454.5	5,077.9	4,445.2	5,891.3

Notes: Exceedance flows calculated based upon 1941–1987 USGS gaged streamflows adjusted to the estimated 781 square mile contributing drainage area at Scotland Landing.

Historical mean annual streamflow at Scotland Landing is estimated to be 498 mgd.

TABLE 4-17

KING WILLIAM RESERVOIR STREAM ORDER ANALYSIS

Stream Order [1]	River Miles		Total
	Perennial [2]	Intermittent [3]	
First	3.07	15.32	18.39
Second	3.94	0.76	4.70
Third	5.16	0.00	5.16
		Total	28.25

[1] Smallest tributaries are classified as "order 1". The point at which two first order streams join the channel is the beginning of a second order segment, and so on.

[2] A perennial stream maintains water in its channel throughout the year.

[3] An intermittent stream flows only in direct response to precipitation. It may be dry for a large part of the year, ordinarily more than three months.

Pipeline

The construction of 17.0 miles of pipeline would be required for this alternative component. The pipeline would cross 9 perennial and 17 intermittent streams. Two major crossings would also be required, and would include the Pamunkey River and an arm of Little Creek Reservoir.

This alternative component would also involve a raw water discharge into a perennial segment of the headwaters of Beaverdam Creek, which is a major tributary of Diascund Creek Reservoir. Existing average streamflow at this location was estimated based on the same streamflow record listed previously in the description of Ware Creek Reservoir streamflows (Section 4.2.1), and was adjusted to the drainage area at the point of discharge. Based on an estimated contributing drainage area of 5.42 square miles at the discharge location on Beaverdam Creek, average streamflow at this point is estimated to be 3.5 mgd.

Field studies were conducted in July 1992 and January 1993 to obtain stream cross-sectional measurements at the proposed raw water discharge location on Beaverdam Creek. The proposed discharge location is located approximately 0.75 river miles upstream of Interstate 64 and 1.3 river miles upstream of the normal pool area of Diascund Creek Reservoir. Field measurements were taken in this immediate vicinity.

To identify the potential hydrologic impacts of the proposed raw water discharge, Manning's Equation for Open Channel-Uniform Flow was used to approximate the depth of flow which could result from the discharge.

At the proposed outfall site, estimated average discharge is 3.5 mgd based on a 5.42-square mile drainage area. It is assumed that the maximum discharge would be the maximum pipeline capacity (40 mgd), plus the estimated average discharge at the site. Therefore, maximum discharge at the outfall site during reservoir withdrawal operations is assumed to be 43.5 mgd. Based on Manning's Equation, the Beaverdam Creek outfall site has an estimated channel capacity of 43 mgd. Therefore, the existing channel should be capable of accommodating maximum flows during King William Reservoir withdrawal operations.

Groundwater Resources

The general hydrogeologic setting applicable to this alternative is presented in Section 4.2.1.

Soil borings conducted by Mueser Rutledge Consulting Engineers (MRCE) in 1989 and Malcolm Pirnie in 1991, indicate that approximately 20 to 50 feet of the Columbia Aquifer is present overlying the Yorktown Formation in the vicinity of the proposed reservoir. The existing water table elevation ranges from approximately 50 to 95 feet msl across the watershed and adjacent uplands (MRCE, 1989). The permeability of the Columbia Aquifer in this area is reported as 1×10^{-2} cm/sec, and represents a substantial source of leakage (in the form of underseepage) from the reservoir. Beneath the sands of the Columbia Aquifer, Yorktown sediments have a reported 2×10^{-2} cm/sec permeability consisting of fine sand and occasional shells. The overlying Yorktown confining unit, consisting of a stiff green-gray silty clay, was encountered in only two of five borings, and therefore, is considered to be intermittent in this area. SWCB data files show that the unconsolidated water-table aquifers are an important source of domestic groundwater in the Middle Peninsula (Siydula et al., 1977). In addition, these aquifers when combined with the shallow Yorktown Aquifer system supply potable water for agriculture and other users in the area.

<u>Soil and Mineral Resources</u>

Intake

In the vicinity of the proposed Mattaponi River intake site at Scotland Landing, the major soil series present are Tetotum, Bojac, and Tarboro. Tetotum soil is very deep, nearly level, and moderately well drained. This soil is found on low terraces along the river. Bojac soil is very deep, nearly level, and well drained. It is on low stream terraces along the Mattaponi River. Tarboro soil is very deep, nearly level to gently sloping, and somewhat excessively drained. It is found mostly on low stream terraces along rivers and creeks. There are no important mineral resource recovery facilities located on or near the proposed intake facility site (VDMR, 1976; Sweet and Wilkes, 1990).

Reservoir

Soils located within the proposed pool area of King William Reservoir constitute the affected environment. Nevarc-Remlik-Johnston appears to be the major soil association. Approximately 342 acres of these soils are considered prime agricultural soils.

There are no mineral recovery facilities located in the vicinity of the proposed pool area of King William Reservoir. However, during 1975, sand and gravel were produced near Aylett, Virginia by the Fox Gravel Company for concrete and masonry purposes, highway construction and maintenance, and other use. This mining operation is located approximately 16 river miles upstream from the proposed Scotland Landing intake site. Presently, Aylett Sand and Gravel Corporation mines sand and gravel in Aylett (VDMR, 1976; Sweet and Wilkes, 1990).

The earthen dam and emergency spillway included in this alternative would temporarily disturb approximately 100 acres of soil. The dam footprint would cover approximately 23 acres after construction, while the emergency spillway would cover approximately 11 acres. Impervious cover including access roads, walks, and structures associated with the King William Reservoir dam would cover approximately 4 acres.

Pipeline

SCS soil survey maps were used in conjunction with USGS topographic maps to determine the types of soils that would be affected by construction of approximately 17.0 miles of raw water pipeline associated with this alternative. There are two raw water outfall locations associated with this alternative. The first outfall would be located 1.3 river miles upstream of the normal pool area of Diascund Creek Reservoir, on Beaverdam Creek. The soil type at this location is Johnston Mucky Loam. This soil is very deep, nearly level, and very poorly drained. It is on floodplains and along major drainageways throughout the survey area. The second outfall would be located on Little Creek Reservoir, approximately 2,000 feet south of St. Johns Church on State Route 610. Soil types at this location are similar to those found at the first outfall location. Table 4-18 lists the types of soils that would be affected by the construction of the pipeline and the pipeline outfall structures.

Air Quality

The intake, reservoir and portions of the pipeline would be located in King William County with the balance of the pipeline being built in New Kent and James City Counties. King William and New Kent Counties have been classified as attainment (or unclassifiable) with acceptable levels of all criteria air pollutants. James City County has been classified as non-attainment for ozone and attainment for all other criteria air pollutants. There is little residential development near the proposed reservoir area which might be sensitive to construction activities. However, there are recreational uses close down stream, in Cohoke Millpond, which could be sensitive to air quality impacts if fugitive dust emissions were not adequately controlled. No indication of a nuisance dust problem the project development area has been recorded.

4.2.4 Fresh Groundwater Development

Substrate

Well Sites

Because all of the well sites associated with this alternative are located in upland areas, there would be no affect on aquatic ecosystem substrates.

Pipelines

Each well associated with this alternative has a corresponding pipeline which would transport water to an existing reservoir. These pipelines would not directly affect any aquatic ecosystem substrate.

The construction of the outfall structure associated with Well DC-1 would impact substrate originating from the Nevarc-Remlik complex. This soil type is very deep, with steep slopes of 15 to 25 percent.

The construction of the DC-2 well outfall structure would impact substrate originating from the Nevarc-Remlik complex. This soil type is similar to that located at the DC-1 location, distinguished only by the greater slopes of 25 to 60 percent.

The affected substrate located at the proposed DC-3 outfall location is the same as that found at the proposed DC-2 outfall location.

At the proposed DC-4 outfall location the affected substrate originates from the Emporia Complex soil. This soil type consists of Emporia soils and similar soils that are well drained and deposited over fossil shells. Slopes range from 15 to 25 percent.

The construction of the proposed outfall structures associated with Wells LC-1 and LC-3 would impact substrate originating from the Udorthents series of soils. These soils consist of deep, well drained and moderately well drained loamy soils. Slopes range from 2 to 30 percent.

The construction of the proposed outfall structures associated with Wells LC-2 and LC-4 would impact substrate originating from the Emporia complex. These soils are moderately well drained and are found deposited over fossil shells. Slopes range from 15 to 50 percent.

Water Quality

Based on results from a Test Well Program conducted for the City of Newport News Waterworks in 1988, approximately four deep production wells would be required in each of two well fields (Geraghty & Miller, 1988). The wells would be screened in the Middle Potomac aquifer at approximate depths of between 515 and 740 feet below msl.

Some groundwater quality data for the Potomac aquifers are available for both the Diascund Creek and Little Creek areas. Water quality data from the Diascund test well and two USGS monitoring wells adjacent to Little Creek Reservoir were used to represent groundwater quality characteristics for this alternative. Groundwater quality data for these wells are summarized in Table 4-19.

Phosphate concentration was not measured in the Diascund well and ranged from 0.03 to 0.06 mg/l in the Little Creek wells. Phosphorus concentration for the Little Creek discharge is not expected to be a problem. There appears, however, to be an increasing trend in groundwater phosphorus concentrations to the west, toward Diascund Creek. In the Delmarva Well, west of the Diascund well, phosphorus concentration averaged 0.29 mg/l. If the phosphorus concentration in the Diascund well is similar, the phosphorus loading could be considerable. The sodium concentration, like the chloride concentration, is also high in the groundwater. In the Diascund well, sodium concentration averages 273 mg/l and at Little Creek, sodium ranges from 450 mg/l in the deeper well to 100 mg/l in the shallower well.

Existing surface water conditions for Diascund Creek Reservoir are described in Section 4.2.1. Surface water quality data for Little Creek Reservoir are summarized in Table 4-20.

Hydrology

This alternative component would involve fresh groundwater withdrawals made from new well fields in western James City County and/or New Kent County. Up to 10 mgd of new permitted groundwater withdrawal capacity would be used to augment Diascund Creek and Little Creek reservoirs when Newport News Waterworks system reservoir volume is below 75 percent of total capacity. A discussion of the affected hydrologic regime for the Fresh Groundwater Withdrawals alternative is presented below in the description of Groundwater Resources.

Groundwater Resources

Setting

Fresh groundwater withdrawals have been targeted specifically for the Middle Potomac Aquifer. Due to the potential for impacts (via leakage) to the multi-aquifer system, the affected environment is not limited only to the Middle Potomac. A description of the general hydrogeologic setting of the Virginia Coastal Plain Province is included in

TABLE 4-18

KING WILLIAM RESERVOIR ALTERNATIVE

SOILS WITHIN THE PIPELINE ROUTE

Map * Symbol	Soil Name		Description
1A	Altavista		Fine sandy loam, 0-2 % slopes. Very deep, nearly level, moderately well drained
3A	Augusta		Fine sandy-loam, 0-2% slopes. Very deep, nearly level, poorly drained
7B	Caroline-Emporia complex		2-6% slope. Very deep, gently sloping, well drained on broad upland ridges
9A	Conetoe		Loamy sand, 0-4% slopes. Very deep, nearly level, well drained. On low river terraces
13A	Dogue		Fine sandy-loam, 0-2% slope. Very deep, nearly level, moderately well drained
16A	Johnston	(Hydric)	Mucky-loam, 0-2% slopes. Very deep, nearly level, very poorly drained
22A	Matten	(Hydric)	Muck, 0-1% slope. Deep, nearly level, and poorly drained. In freshwater swamps
23A	Munden		Sandy-loam, 0-2% slope. Very deep, nearly level, moderately well drained. On ridges
26D	Nevarc-Remlic complex		6-15 % slope. Very deep, moderately steep. On side slopes along rivers
26E	Nevarc-Remlic complex		15-25% slopes. Very deep, steep. On sides of slopes along rivers and creeks
26F	Nevarc-Remlic complex		25-60% slopes. Very deep, very steep. On sides of slopes along rivers & creeks
30B	Pamunkey		Fine sandy-loam, 2-6% slope. Very deep, gently sloping, and well drained
35A	State		Very fine sandy-loam., 0-2% slope. Very deep, nearly level, well drained
38A	Tetotum		0-2% slopes. Very deep, nearly level, and moderately well drained
39A	Tomotely	(Hydric)	Loam, 0-2% slope. Very deep, nearly level, poorly drained. On broad flats
41B	Udorthents		Loamy, gentle slope. Consists of pits providing foundation materials & areas of landfills

Map ** Symbol	Soil Name		Description
4D	Remlic-Suffolk complex		6-15% slope
4F	Remlic-Suffolk complex		15-50% slope
8A	Slagle		Fine sandy-loam, 0-2% slope. Very deep, gently sloping, & moderately well drained
8B	Slagle		Fine sandy-loam, 2-6% slope. Very deep, gently sloping, & moderately well drained
10A	Suffolk		Fine-sandy loam, 0-2% slope. Deep, gently sloping and well drained
10B	Suffolk		Fine-sandy loam, 2-6% slope. Deep, gently sloping and well drained
11A	Conetoe		Loamy sand, 0-4% slopes. Very deep, nearly level, and well drained
13B	Wickham		0-2% slope
14B	Bojac		Loamy sand, 2-6% slope. Very deep, nearly level, and well drained
15B	Kempsville		0-2% slope
21B	Kenansville		Loamy-fine sand, 0-4% slope. Deep, gently sloping, and well drained. On upland ridges
34A	Emporia		Fine-sandy loam, 0-2% slope. Very deep, gently sloping, well drained
38A	Craven		Loam, 0-2% slope. Very deep, gently sloping, moderately well drained
38B	Craven		Loam, 2-6% slope. Very deep, gently sloping, moderately well drained
61A	Roanoke	(Hydric)	Silt-loam, 0-2% slope. Very deep, nearly level, and poorly drained
65	Daleville	(Hydric)	0-2% slope
132A	Eunola		0-2% slope
145	Tomotely		Loam, 0-2% slope. Very deep, nearly level, poorly drained. On broad flats
149	Seabrook		Loamy sand, 0-2% slope. Very deep, nearly level, and moderately well drained

* Source used for the identification of soil types was the Soil Survey of New Kent County, Virginia (Hodges et al, 1989)
** Source used for the identification of soil types was the Soil Survey of King William County, Virginia (Hodges et al, 1985)

TABLE 4-19

DIASCUND CREEK AND LITTLE CREEK GROUNDWATER QUALITY

		Diascund Creek Test Well				James City County Wells	
Parameter	**Units**	**Number Samples**	**Mean**	**Minimum**	**Maximum**	**56h25**	**56h26**
pH		5	8.1	8.0	8.1	7.8	7.9
Conductivity	μMHOs/cm	ND	ND	ND	ND	2200	540
Total Dissolved Solids	mg/l	5	690	676	702	1190	310
Alkalinity	mg/l	ND	ND	ND	ND	484	262
Hardness	mg/l	ND	ND	ND	ND	18	54
Chloride	mg/l	5	81	74	84	340	6
Turbidity	NTU	5	0.13	0.08	0.24	ND	ND
Sulfate	mg/l	5	22	2.3	28	61	11
Nitrate	mg/l	5	0.25	0.18	0.50	< 0.1	< 0.1
Ammonia	mg/l	ND	ND	ND	ND	0.09	0.04
Phosphorus	mg/l	ND	ND	ND	ND	0.03	0.06
Fluoride	mg/l	5	2.7	2.5	2.7	0.3	1.1
Calcium	mg/l	ND	ND	ND	ND	5.1	18
Iron	mg/l	5	0.26	0.23	0.29	1	0.78
Magnesium	mg/l	ND	ND	ND	ND	1.2	2.3
Manganese	mg/l	5	0.03	0.01	0.07	0.03	0.06
Sodium	mg/l	5	273	215	289	450	100
Zinc	mg/l	5	0.075	0.061	0.087	0.02	< 3.0

Sources: Geraghty & Miller (1988) for Diascund Creek Test Well.
Laczniak and Meng (1988) for James City County Wells.

Notes: ND = No Data

TABLE 4-20

LITTLE CREEK RESERVOIR WATER QUALITY

Parameter	Units	3 to 10 foot Depth				30 to 40 foot Depth			
		Number Samples	Mean	Min.	Max.	Number Samples	Mean	Min.	Max.
Conductivity	μMHOs/cm	58	107	78	140	58	122	81	211
pH	SI	58	7.1	6.4	8.1	57	6.8	6.3	7.4
Temperature	C	58	18	2	31	58	10	2.5	17
Dissolved Oxygen	mg/l	58	9.2	6.3	13.4	58	4.8	0	13.2
Dissolved Oxygen (Sat.)	%	58	95	68	120	58	40	0	100
Alkalinity	mg/l	37	21	15	28	23	23	14	45
Sulfate	mg/l	6	6.6	5.5	7.0	6	5.7	<1	7.5
Chlorides	mg/l	37	12	8.4	15	37	13	7.8	31
Nitrate	mg/l	60	0.022	<0.005	0.089	60	0.045	<0.005	0.329
Ammonia	mg/l	59	0.042	<0.002	0.188	60	0.332	<0.002	1.9
Total Kjeldahl Nitrogen	mg/l	60	0.6	<0.2	1.4	60	0.9	0.3	3.1
Total Phosphorus	mg/l	60	0.015	<0.004	0.107	60	0.015	0.004	0.105
Iron (Total)	μg/l	37	388	80	1700	37	4240	200	28000
Manganese (Total)	μg/l	37	70	<10	390	37	539	20	1600
Total Organic Carbon	mg/l	30	6.9	4.8	11	23	6.7	5.2	9.4
Chlorophyll a	μg/l	18	10	3.3	21.4	18	7.5	1.2	18
Pheophytin a	μg/l	18	5	0	21	18	5.6	0.1	25

Sources: Prugh et al., 1988, 1989, 1990, 1991, and 1992.

USGS Station 0204275430 - Little Creek Reservoir.

Section 4.2.1. Table 4-21 summarizes the basic characteristics of the aquifers in the York-James Peninsula that would be affected.

Soil and Mineral Resources

Well Sites

Each individual well near Little Creek Reservoir would be located in an upland area. The first well, designated as LC-1, would be installed in Craven Uchee complex soils. These soils consist of moderately well drained Craven soils and well drained Uchee soils. Areas of this complex are on side slopes and narrow ridge tips. Well LC-2 would be installed in Emporia complex soils. This complex consists of areas of deep, very steep, well drained Emporia soils, and areas of similar soils that formed over layers of fossil shells. Well LC-3 would be installed in the Udorthents Loamy soil unit. This unit consists of deep, well drained, and moderately well drained loamy soil material in areas where the soils have been disturbed during past excavation and grading activities. Well LC-4 would be installed in soils similar to Well LC-1.

The wells surrounding Diascund Creek Reservoir would be installed in upland areas. The first well, designated as DC-1, would be installed in Craven Loam. This soil is very deep, strongly sloping, and moderately well drained. It is found on narrow to medium-sized upland ridges and side slopes. Well DC-2 would be installed in Craven-Caroline complex. This complex consists of very deep, gently sloping soils on narrow ridgetops and side slopes. Well DC-3 would be installed in Nevarc-Remlik complex. This complex consists of very deep, very steep soils on side slopes along rivers, creeks, and drainageways. This complex consists of about 40 percent moderately well drained Nevarc soil, 35 percent well drained Remlik soil, and 25 percent included soils. Well DC-4 would be installed in Emporia complex soils. This complex consists of areas of deep, steep, well drained Emporia soils, and areas of similar soils that formed over layers of fossil shells.

Pipeline

Each fresh groundwater well would require a pipeline to convey the pumped groundwater from the well to its respective reservoir. Construction of each pipeline would require a 40-foot maximum ROW width extending from the well site and traveling the shortest distance to the discharge site on the respective reservoir.

Air Quality

The fresh groundwater alternative would involve land clearing, excavation, and construction to install eight wells and construct short pipelines. The proposed pipelines and most of the fresh groundwater wells would lie in James City County with some wells in New Kent County. There is residential development near the proposed pipeline route which might be sensitive to construction activities. No indication of a nuisance dust problem in this area has been recorded.

4.2.5 Groundwater Desalination in Newport News Waterworks Distribution Area

Substrate

Intake

The four wells included in this alternative are each located in upland areas, therefore, no effects on aquatic ecosystem substrates are anticipated.

Pipeline

The concentrate discharge pipeline from the Copeland Industrial Park groundwater well (Site 1) would not cross any streams. However, the outfall structure and associated riprap would disturb approximately 1,000 square feet of aquatic ecosystem substrate approximately 200 feet south of the entrance to Salters Creek, a tributary to Hampton Roads harbor.

The concentrate discharge pipeline from the Upper York County groundwater well (Site 2) would cross one perennial and one intermittent stream. The outfall structure and associated riprap would disturb approximately 1,000 square feet of aquatic ecosystem substrate on Queens Creek, a tributary to the York River.

The concentrate discharge pipeline from the Harwood's Mill groundwater well (Site 3) would cross the upper portion of the Poquoson River, immediately downstream of Harwood's Mill Reservoir. The remainder of the pipeline would cross one perennial and one intermittent stream. The outfall of the pipeline would disturb approximately 1,000 square feet of aquatic substrate on the Poquoson River, at Howards Landing.

The concentrate discharge pipeline from the Lee Hall groundwater well (Site 4) would not cross any streams along its route to Skiffe's Creek. The outfall structure and associated rip rap would disturb approximately 1,000 square feet of substrate on Skiffe's Creek.

Water Quality

Blended groundwater from the Middle Potomac and Lower Potomac aquifers would be used to supply the RO treatment facilities to take advantage of the favorable water quality of the Middle Potomac and the increased yield available from the Lower Potomac. Water quality data for both of the aquifers are presented in ***Groundwater Resources of the York-James Peninsula of Virginia*** (Laczniak and Meng, 1988). Existing deep wells on the Lower Peninsula include a 910-foot deep well in the Copeland Park area which penetrates approximately 130 feet of the Middle Potomac aquifer (59D-20), a USGS observation well cluster near Newport News Park which penetrates all the Potomac aquifers to a depth of 1,425 feet below sea level (58F 50-55), a NASA Research Center well drilled to 2,053 feet below sea level which encountered all the Potomac aquifers (59E 5), and a test well for the U.S. Army at the Big Bethel WTP drilled to approximately 1,000 feet below the ground surface. Water quality data available from four of these wells are presented in Table 4-22.

Based on the limited water quality data available from the USGS and SWCB for these well locations, a blended raw water quality ranging from 2,000 to 4,000 mg/l TDS could be expected using the Middle Potomac and Lower Potomac aquifers. It should be noted that a single water sample taken from the Middle Potomac aquifer at the Big Bethel WTP site reported 4,787 mg/l of chloride. Feed water with this quality could not be

Environmental Impact Checklist

Issue and Text Reference	N/A	Adequately Covered	Not Adequately Covered	Comments
ASSESSMENT OF POTENTIAL ENVIRONMENTAL IMPACTS				
The Environmental Impact Assessment discusses primary, secondary, and cumulative impacts during all stages, including initial site preparation and construction; facility operation, and post-facility or site closure for the following (p. 4-36):				
1. Pollutant Generation, Transport, and Receptors (p. 4-40)				
a. Air Resources (p. 4-40)				
1) identification of emission sources and project emission rates and comparison to national, state, and local standards and limitations				
2) comparison of predicted atmospheric levels with national, state, or local ambient levels				
3) description of stack emissions during operation and maintenance activities and comparison with existing national, state, and local standards				
4) identification of best mitigation measures to avoid or minimize adverse impacts				
b. Water Resources (p. 4-42)				
1) address potential for water quality to be degraded by various factors				
2) prediction of pollutant concentrations in water bodies and comparison with existing national, state, and local water quality standards and criteria				
3) identification of best mitigation measures to avoid or minimize adverse impacts				
c. Geological Resources (p. 4-45)				
1) determination of potential soil loss and mitigation activities				
2) identification of potential contamination sources and mitigation measures				
d. Biological Resources (p. 4-46)				
1) consideration of potential losses of biological resources within site boundaries				
2) description of effluent and emission concentrations and their potential effects to vegetation and wildlife				

Issue and Text Reference	N/A	Adequately Covered	Not Adequately Covered	Comments
3) discussion of bioaccumulative effects from facility emissions and discharges				
4) identification of best mitigation measures to avoid or minimize adverse impacts				
2. Habitat Alteration (p. 4-46)				
a. Biological Resources (p. 4-47)				
1) address potential for construction and site preparation activities to alter critical habitats for wildlife				
2) consideration of potential for secondary changes in habitats following construction and site preparation activities				
3) assessment of possible permanent loss or displacement of vegetation habitat due to operation				
4) identification of changes in local species composition, diversity, and abundances resulting from loss of specific habitats				
5) identification of best mitigation measures to avoid or minimize adverse impacts				
3. Waste Management and Pollution Prevention (p. 4-52)				
a. description of facility waste management plan with procedures for treatment, handling, and disposal				
b. discussion of projected facility waste characteristics				
c. identification of best mitigation measures to avoid or minimize adverse impacts				
4. Socioeconomic Impacts (p. 4-53)				
a. Land Use (p. 4-54)				
1) identification of the existing or planned land use areas lost due to site preparation and construction activities				
2) determination of conflicting zoning requirements and land uses with site preparation and construction activities				
3) description of anticipated changes in near by land use as a result of the facility and evaluation of conflicts that could arise during operations				
4) identification of best mitigation measures to avoid or minimize adverse impacts				
b. Economic Activity (p. 4-57)				
1) address changes in employment patterns				

Issue and Text Reference	N/A	Adequately Covered	Not Adequately Covered	Comments
2) address ability of available labor pool to meet project-related employment needs				
3) identification of economic multipliers used in analysis and their source				
4) discussion of potential change in overall economic activity in region				
5) identification of best mitigation measures to avoid or minimize adverse impacts				
c. Population and Housing (p. 4-58)				
1) address the relationship between employment increases and population in-migration				
2) identification of deficiencies in available housing for the potential increased workforce and their families				
3) identification of best mitigation measures to avoid or minimize adverse impacts				
d. Community Services and Public Finance (p. 4-59)				
1) identification of deficiencies in community services and infrastructure during project construction and operation				
2) identification of shortfalls in transportation capacity due to either primary or secondary impacts of the project				
3) identification of best mitigation measures to avoid or minimize adverse impacts				
e. Transportation (p. 4-61)				
1) assessment of proposed project's consistency with local and/or regional transportation plans				
2) evaluation of changes in LOS resulting from the proposed project and alternatives				
3) evaluation of the effect of heavy vehicle traffic on affected pavement and bridges				
4) description of mitigation measures to offset adverse impacts to structural integrity and public safety				
f. Health and Safety (p. 4-62)				
1) evaluation of whether construction, operation, and maintenance activities present health and safety hazards to humans working or living at or near the project site				

Issue and Text Reference	N/A	Adequately Covered	Not Adequately Covered	Comments
2) discussion of potential effects of facility noise levels on workers, local communities, and local flora and fauna				
3) analysis of potential long-term contaminant bioaccumulation within the food chain				
4) identification of best mitigation measures to avoid or minimize adverse impacts				
g. Environmental Equity (p. 4-63)				
1) determination of the equity of changes in employment patterns attributable to site preparation and construction activities				
2) determination of the equity of community structure changes caused by project construction and operation				
3) identification of best mitigation measures to avoid or minimize adverse impacts				
5. Cultural Resources (p. 4-63)				
a. identification of any historical or cultural resources in close proximity to the site following correspondence with appropriate authorities				
b. discussion of mitigation measures necessary to preserve items of archaeological, historical, or cultural interest				
c. determination of the extent to which construction, operation, and maintenance activities disrupt the aesthetic or sensory attributes of the site				
d. determination of whether the facility components are designed with consideration given to human factors				
MITIGATION MEASURES				
1. Mitigation Measures (p. 4-68)				
a. description of mitigation activities for all significant impacts to both the natural and human (socioeconomic) environments				
b. description of mitigation measures with adequate information to evaluate environmental consequences and residual impacts				
c. identification of best mitigation measures to avoid or minimize potential impacts during <u>all</u> stages of the project, including siting and design, facility operation, and post facility closure.				

Issue and Text Reference	N/A	Adequately Covered	Not Adequately Covered	Comments
d. support of the following types of mitigation measures, in the following decreasing order of preference: - Avoidance or prevention - Minimization - Reduction or elimination over time - Correction - Compensation.				
e. implementation plan (schedule) and criteria for performance for all mitigation measures.				
f. responsible entity assigned to carrying out each mitigation measure.				
g. measures are socially and culturally acceptable.				
h. adequate financial and non-financial resources to implement the measures.				

TABLE 4-21

HYDROGEOLOGIC DESCRIPTIONS, CHARACTERISTICS, AND WELL YIELDS OF AQUIFERS IN THE YORK-JAMES PENINSULA

Aquifer Name and Description	Well Yield (gal/min)		Hydrologic Characteristics
	Common Range	May Exceed	
Columbia Aquifer: Sand and gravel, commonly clayey; interbedded with silt and clay. Fluvial to marine in origin, disposition resulted in terrace-type deposits from varying Pleistocene sea levels.	3-30	40	Generally unconfined, semi-confined locally. Most productive in eastern area, very thin to missing in central and western areas. Water is very hard calcium-bicarbonate type. Highly susceptible to contamination from surface pollutants. Elevated concentrations of iron and nitrate in some areas. Possibility of salty water in coastal regions.
Yorktown-Eastover Aquifer: Sand, commonly shelly; interbedded with silt, clay, shell beds, and gravel. Shallow, embayed marine in origin, deposition resulted in interfingering near-shore deposits from marine transgressions.	5-80	200	Multiaquifer unit. Mostly confined, unconfined updip in outcrop areas. Thickness dependent on altitude of land surface. Highest yields in eastern area, thin to missing in western area. Water is hard to very hard sodium calcium sodium bicarbonate type and generally suitable for most uses. Aquifer not present in western area.
Chickahominy-Piney Point Aquifer: Sand, moderately glauconitic, shelly; interbedded with silt, clay, and thin, indurated shell beds. Shallow, inner marine shelf in origin, deposition result of marine transgression.	10-110	200	Important aquifer in central area; yields moderate to abundant supplies to domestic, small industrial, and municipal wells. Water is soft to hard, calcium sodium bicarbonate type and generally suitable for most uses. Aquifer not present in western area.
Aquia Aquifer: Sand, glauconitic, shelly; interbedded with thin, indurated shell beds and silty clay intervals. Shallow, inner to middle marine shelf in origin, deposition result of marine transgression.	15-210	350	Important aquifer in central area; yields moderate supplies to domestic, small industrial, and municipal wells. Water is soft sodium bicarbonate type, with elevated iron, sulfide, and hardness locally. Aquifer not present in eastern area.

TABLE 4-21
(Continued)

HYDROGEOLOGIC DESCRIPTIONS, CHARACTERISTICS, AND WELL YIELDS OF AQUIFERS IN THE YORK-JAMES PENINSULA

Aquifer Name and Description	Well Yield (gal/min)		Hydrologic Characteristics
	Common Range	May Exceed	
Upper Potomac Aquifer: Sand, very fine to medium, micaceous, lignitic, and clayey; interbedded with silty clays; confined, restricted to central and eastern areas. Shallow, estuarine and marginal marine in origin, sediments result of first major marine inundation of Cretaceous deltas.	20-400	1,000	Multiaquifer unit. Restricted to subsurface, yields largest supply of water in study area. Water is soft sodium chloride bicarbonate type with elevated chlorides in eastern area.
Middle Potomac Aquifer: Sand, fine to coarse, occasional gravels; interbedded with silty clays; generally confined, unconfined in outcrop areas of northwestern Coastal Plain and major stream valleys near Fall Line. Fluvial in origin, sediments result of deltaic deposition.	20-160	700	Multiaquifer unit. Yields second largest supply of water in study area. Water is moderately hard, sodium chloride bicarbonate type, with elevated chlorides in eastern area.
Lower Potomac Aquifer: Sand, medium to very coarse, and gravels, clayey; generally confined, unconfined only in northwestern area of Coastal Plain. Fluvial in origin, sediments result of deltaic deposition.	100-800	1,500	Multiaquifer unit. Yields third largest supply of water. Water is soft to very hard, and of a sodium bicarbonate to sodium chloride type, with elevated chlorides and dissolved solids in eastern area. Thickest of all aquifers.

[gal/min is gallons per minute]

Source: Laczniak and Meng, 1988.

TABLE 4-22

POTOMAC AQUIFER WATER QUALITY FOR BRACKISH GROUNDWATER WITHDRAWALS

Parameter	Units	Mean	Minimum	Maximum	Count
pH	SI	7.5	7.0	8.0	4
Total Dissolved Solids	g/l	3.94	1.39	7.96	4
Alkalinity	mg/l	346	225	422	4
Nitrate	mg/l	< 0.1	< 0.1	< 0.1	4
Ammonia	mg/l	1.04	0.42	2.7	4
Phosphorus	mg/l	< 0.04	< 0.01	0.1	4
Silica	mg/l	22	15	32	4
Total Organic Carbon	mg/l	0.7	0.3	1.3	4
Chloride	mg/l	2,085	540	4,400	4
Sulfate	mg/l	158	64	350	4
Fluoride	mg/l	1.0	0.2	2	4
Boron	mg/l	1.7	1.5	1.8	4
Calcium	mg/l	38	6.1	82	4
Magnesium	mg/l	22	2.4	59	4
Sodium	mg/l	1,465	520	3,000	4
Potassium	mg/l	28	13	62	4
Iron	mg/l	4.1	0.69	8.7	4
Manganese	mg/l	0.12	0.03	0.22	4
Zinc	mg/l	0.3	0.01	1.0	4

Sources: USGS groundwater Observation Well 58F-50 (unpublished data received from SWCB for sample collected on July 16, 1986.

USGS groundwater Observation Wells 58F-51, 58F-52, and 59E-6 (Laczniak and Meng, 1988).

successfully treated with a conventional low-pressure membrane system designed for brackish water. This highlights the fact that blended water quality at each site would depend on the site-specific water quality and yield of each aquifer.

Under this alternative, it was assumed that five, 2-mgd wells would be used to supply up to 10 mgd of brackish groundwater. The proposed locations for these wells are as follows:

▪ Site 1 (Copeland Park)	One well	2 mgd
▪ Site 2 (Upper York County)	One well	2 mgd
▪ Site 3 (Harwood's Mill)	One well	2 mgd
▪ Site 4 (Lee Hall)	Two wells	4 mgd
Total	**Five wells**	**10 mgd**

Assuming recoveries of 80 percent, the RO process would produce 400,000 gallons per day of reject concentrate at each of the 2-mgd raw water sites and 800,000 gallons per day at the 4-mgd raw water site. Outfalls would be directed to brackish or saline surface waters and permitted as regulated discharges. The concentrate outfall locations would be as follows:

▪ Site 1 (Copeland Park)	Hampton Roads south of the mouth of Salters Creek
▪ Site 2 (Upper York County)	South bank of Queens Creek
▪ Site 3 (Harwood's Mill)	West bank of the Poquoson River
▪ Site 4 (Lee Hall)	South bank of Skiffe's Creek

Surface water quality data near each of these proposed outfall locations are available from Chesapeake Bay Program Monitoring Stations. Water quality data are summarized in Tables 4-23 and 4-24. Three of the discharge locations; the mouth of the Poquoson River, Hampton Roads, and the mouth of Queens Creek; have relatively high salinities and would be classified as polyhaline, with salinities typically ranging between 18 ppt to 28 ppt. The other discharge location, at the mouth of Skiffe's Creek would be classified as mesohaline to oligohaline, with salinities typically ranging between 3 ppt and 10 ppt.

<u>Hydrology</u>

Wells

This alternative component would involve deep brackish groundwater withdrawals made from wells developed in the City of Newport News and on Newport News Waterworks property located in York County. Up to 10 mgd of new permitted groundwater withdrawal capacity would be used to supply raw water to four reverse osmosis (RO) treatment facilities.

A discussion of the affected hydrologic regime and potential hydrologic impacts associated with these deep brackish groundwater withdrawals is presented below in the description of Groundwater Resources.

Pipeline

Approximately 13.4 miles of new concentrate discharge pipeline would be required for this alternative component. Two perennial and two intermittent stream crossings would be required along the pipeline routes. These minor stream crossings would be accomplished via conventional cut and fill techniques. For Site 3, the concentrate discharge pipeline would also cross the Poquoson River. This could be accomplished by suspending the pipeline across the existing U.S. Route 17 overpass pipeline crossing structure. The concentrate discharge pipelines would terminate at outfall sites located on four tidal water bodies previously listed.

The estimated maximum rate of concentrate discharge into the receiving water bodies is 0.8 mgd for the Site 1 (Lee Hall) discharge into Skiffe's Creek, and 0.4 mgd for each of the remaining three sites.

<u>Groundwater Resources</u>

Setting

Withdrawals are proposed from the high yielding brackish region of the Middle and Lower Potomac Aquifers that are present beneath the City of Newport News and property in York County owned by Newport News Waterworks. Anticipated depths for the proposed five-well system range from 800 to 1,200 feet with well depths increasing to the east. Due to the lack of data from the deeper aquifers in the eastern third of the city, a test well would be needed to document the vertical distribution of water quality and to confirm the yield of the aquifer(s). The horizontal distribution of brackish water in the Middle and Lower Potomac Aquifers on the James-York Peninsula has not been studied in detail. The SWCB concluded in 1981 that "...the Lower Cretaceous aquifer is capable of producing large quantities of brackish groundwater for desalting purposes or for other uses where saltiness is not objectionable." (Siydula et al., 1981). Use of these brackish aquifers has not been substantially expanded in the region since 1981, indicating the current availability of this resource.

Based on the limited water quality data available from the USGS and SWCB for well locations on the Peninsula, a blended raw water quality ranging from 2,000 to 4,000 mg/l TDS could be expected using the Middle Potomac and Lower Potomac aquifers. It should be noted that a single water sample taken from the Middle Potomac aquifer at the Big Bethel WTP site reported 4,787 mg/l of chloride.

<u>Soil and Mineral Resources</u>

This alternative would involve the construction of approximately 13.4 miles of concentrate pipeline. Soils within the estimated 65 acres of pipeline ROW would be disturbed during pipeline construction.

<u>Air Quality</u>

The Groundwater Desalination alternative would involve installation of five groundwater wells and excavation and construction activities to construct four concentrate

TABLE 4-23

JAMES RIVER WATER QUALITY AT PROPOSED CONCENTRATE DISCHARGE LOCATIONS

James River Station LE 5.1
Near Skiffe's Creek

Parameter	Units	Mean	Minimum	Maximum	Count
pH	SI	7.2	3.1	8.8	69
Salinity	g/l	5.8	0.05	16	179
Nitrate	mg/l	0.29	0.05	0.80	83
Ammonia	mg/l	0.09	0.05	0.50	82
Phosphate	mg/l	0.08	0.02	0.4	83
Silica	mg/l	4.5	1.2	13	81
Total Organic Carbon	mg/l	6.1	2.0	12	83

James River Station LE 5.4
In Hampton Roads Harbor

Parameter	Units	Mean	Minimum	Maximum	Count
pH	SI	7.93	4.82	9.49	77
Salinity	g/l	22.3	12.5	30.2	332
Nitrate	mg/l	0.08	0.01	0.36	82
Ammonia	mg/l	0.06	0.05	0.2	77
Phosphate	mg/l	0.06	0.03	0.16	82
Silica	mg/l	1.3	0.0	5.2	80
Total Organic Carbon	mg/l	6	2	15	82

Source: Tributary Water Quality 1984-1986 Data Addendum - James River (SWCB, 1987).

TABLE 4-24

YORK RIVER WATER QUALITY
AT PROPOSED CONCENTRATE DISCHARGE LOCATIONS

York River Station LE 4.2
Near Queens Creek

Parameter	Units	Mean	Minimum	Maximum	Count
pH	SI	7.7	6.3	8.9	106
Salinity	g/l	20	7.7	26	391
Nitrate	mg/l	0.1	0.1	0.1	119
Ammonia	mg/l	0.1	0.0	0.1	86
Phosphate	mg/l	0.1	0.0	0.5	120
Silica	mg/l	2.7	0.0	24	118
Total Organic Carbon	mg/l	6	2	16	115

Source: Tributary water quality 1984-1987 Data Addendum - York River (SWCB, 1989).

discharge pipelines. Two sets of facilities would be located in the City of Newport News and the other two sets of facilities would be in York County. Therefore, this entire alternative falls in an ozone non-attainment area. Additionally, the proposed concentrate discharge pipelines would be constructed in medium to high density residential areas which should be sensitive to construction activities. No indication of a nuisance dust problem in this area has been recorded, however.

4.2.6 Use Restrictions

Substrate
No aquatic ecosystem substrate would be affected by use restrictions.

Water Quality
Implementation of use restrictions is not expected to impact existing water quality conditions.

Hydrology
The hydrology of water resources in the project areas is described in Sections 4.2.1 through 4.2.5.

Groundwater Resources
The setting for evaluating effects of the Use Restrictions alternative on the groundwater resources of the region is described in Sections 4.2.1 through 4.2.5.

Soils and Mineral Resources
Use restrictions would not have any effect on soils or mineral resources.

Air Quality
The implementation of use restrictions would not adversely effect ambient air quality.

4.2.7 No Action

Substrate
If no action was taken, there would be no aquatic ecosystem substrate would be affected.

Water Quality
The existing water quality conditions in the project region are described in Sections 4.2.1 through 4.2.5.

Hydrology
If the No Action alternative were taken, existing Lower Peninsula water supply sources would be relied on more and more heavily to meet increasing demand. The potential impacts of this reliance are addressed in Section 5.2.7.

Groundwater Resources
The groundwater resources setting for evaluating this alternative is described in Sections 4.2.1 through 4.2.5.

Soil and Mineral Resources
This alternative would not affect soils or mineral resources.

Air Quality
If no action was taken, these would be no adverse affect on ambient air quality.

4.3 BIOLOGICAL RESOURCES

This section provides a general description of the biological environment at proposed project sites for each of the seven alternatives evaluated. Biological resource categories evaluated are described below.

Endangered, Threatened, or Sensitive Species
This section provides a listing of all state- or federally-listed endangered or threatened species, or sensitive species (any candidates for state or federal listing) which could be affected by implementation of the alternatives. The endangered, threatened, and sensitive species impact category was developed from a portion of the Clean Water Act Section 404 (b)(1) Guidelines which addresses the potential impacts on biological characteristics of the aquatic ecosystem (40 CFR § 230.30).

Fish and Invertebrates
This section lists the fish and invertebrates and other aquatic organisms in the food web that may be affected by the implementation of the alternatives. Aquatic organisms in the food web include fin fish, crustaceans, mollusks, insects, annelids, planktonic organisms, and plants and animals on which they feed and depend on for their needs. All forms and life stages are included in this category. The fish and invertebrates impact category was developed from a portion of the Clean Water Act Section 404 (b)(1) Guidelines which addresses potential impacts on biological characteristics of the aquatic ecosystem (40 CFR § 230.31).

Other Wildlife
This section identifies wildlife which may be affected by implementation of the alternatives which are not addressed in the Endangered, Threatened, and Sensitive Species category or the Fish and Invertebrates category. Game and non-game species are identified. The other wildlife category was developed from a portion of the Clean Water Act Section 404 (b)(1) Guidelines which addresses potential impacts on biological characteristics of the aquatic ecosystem (40 CFR § 230.32),

Sanctuaries and Refuges
This section identifies any sanctuaries and refuges which could be affected by the implementation of the evaluated alternatives. For purposes of this analysis, sanctuaries and refuges are defined as areas designated under federal, state, or local authority to be managed principally for the preservation and use of fish and wildlife resources. The sanctuaries and refuges impact category was developed from a portion of the Clean Water Act Section 404 (b)(1) Guidelines which addresses potential impacts on special aquatic sites (40 CFR § 230.40),

Wetlands and Vegetated Shallows
Wetlands are defined as areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Where wetlands are adjacent to open water, they generally constitute the transition to upland (40 CFR § 230.41, 1980). Vegetated shallows are permanently

inundated areas that under normal circumstances support communities of rooted aquatic vegetation.

In this section, wetlands and vegetated shallows are identified and categorized in the vicinity of the various alternative components, based on analysis of existing literature, aerial photography, wetland inventories, field visits, and the results of a wetland evaluation study. Data are presented describing the type, composition and ecological value of the resource. The wetlands and vegetated shallows category was developed directly from a portion of the Clean Water Act Section 404 (b)(1) Guidelines which addresses potential impacts on special aquatic sites. These sites include wetlands (40 CFR § 230.41) and vegetated shallows (40 CFR § 230.43),

Mud Flats

In this section, mud flats are identified in the vicinity of the various alternative components. Mud flats are broad, flat areas along the coast, in coastal rivers to the head of tidal influence, and in inland lakes, ponds, and riverine systems. Tidal mud flats are typically exposed at low tides and inundated at high tides with water at or near the surface of the substrate (40 CFR § 230.42, 1980). The mud flats impact category was developed from a portion of the Clean Water Act Section 404 (b)(1) Guidelines which addresses potential impacts on special aquatic sites (40 CFR § 230.42).

4.3.1 Ware Creek Reservoir with Pumpover from Pamunkey River

Endangered, Threatened, or Sensitive Species

Intake

In the 1984 *Feasibility Report and Final Environmental Impact Statement, Water Supply Study - Hampton Roads, Virginia*, the USCOE evaluated an alternative which would involve a pumpover from the Pamunkey River at the Northbury intake site. With the exception of transient individuals, the study documented that there were no known federal endangered or threatened species in the vicinity of the proposed intake site (USCOE, 1984).

Project areas for this alternative were reviewed by the Virginia Department of Conservation and Recreation (VDCR) Division of Natural Heritage, the Virginia Department of Game and Inland Fisheries (VDGIF), and the Virginia Department of Agriculture and Consumer Services (VDACS), to identify any known natural heritage resources or endangered, threatened or sensitive species in these areas. Project review conducted by these agencies resulted in the identification of no known natural heritage resources or endangered or threatened animal, plant or insect species in the immediate vicinity of the proposed intake site at Northbury (T. J. O'Connell, VDCR, personal communication, 1992; H. E. Kitchel, VDGIF, personal communication, 1992; J. R. Tate, VDACS, personal communication, 1992).

The VDCR also provided a list of natural heritage resources of the tidal Pamunkey River. Five of the nine species listed by the VDCR are either endangered, threatened, or candidate species at the federal and/or state levels (see Table 4-25).

The Sensitive Joint-vetch (*Aeschynomene virginica*) is an annual legume which has been identified by the VDCR as a natural heritage resource of the tidal Pamunkey River in King William and New Kent counties (J. R. Tate, VDACS, personal communication, 1993). The closest known population of this species occurs approximately 5 miles downstream of the proposed intake site (C. Clampitt, VDCR, personal communication, 1992). Until recently, the species was proposed for listing as a federal threatened species and was a candidate for listing by the State. However, in June 1992, the species became a federally listed threatened species and thus, will now receive protection by the Federal and State Governments. On January 11, 1993, a Notice of Intended Regulatory Action by the VDACS was published in ***The Virginia Register***. This proposed regulatory action would list Sensitive Joint-vetch as a state endangered species.

The VIMS conducted a study of the Sensitive Joint-vetch (also referred to as the Northern Joint-vetch) in the vicinity of the proposed intake site on the Pamunkey River. The study is documented in ***Identification of Historic Locations of Aeschynomene virginica in the Tidal Freshwater Zone of the Pamunkey River, Virginia*** (Perry, 1993) which is included as an appendix to the ***Biological Assessment for Practicable Reservoir Alternatives*** (Malcolm Pirnie, 1994) which is appended to this document as Report E. The study consisted of a review of historical data on the species for the area of the Pamunkey River from Sweet Hall Marsh upstream to the US 360 bridge crossing of the river. The proposed intake site is included in this area.

The VIMS study identified the Sensitive Joint-vetch as having been recorded at three sites along the Pamunkey River from Sweet Hall Marsh to Whitehouse. The locations of these populations are described in the VIMS report included in Report E. Each of the three sites supported viable populations as of the summer of 1991 (Perry, 1993). None of the known Sensitive Joint-vetch populations are located in the immediate vicinity of the proposed intake site at Northbury.

The VDACS indicated that there are numerous populations of the state endangered plant Mat-forming Water-hyssop located in the tidal region of the Pamunkey River which are of concern (J. R. Tate, VDACS, personal communication, 1992). The Mat-forming Water-hyssop is a state-listed endangered species which has no federal status. On January 11, 1993, a Notice of Intended Regulatory Action by the VDACS was published in ***The Virginia Register***. This proposed regulatory action would remove Mat-forming Water-hyssop from the Virginia endangered or threatened species list.

Mat-forming Water-hyssop is a perennial herb which was identified by the VDACS as occurring in the vicinity of the project area and is listed by the VDCR as a natural heritage resource of the tidal Pamunkey River. It has been found in King and Queen, King William, and New Kent counties. The closest known population of this species occurs approximately 5 miles downstream of the proposed intake site (C. Clampitt, VDCR, personal communication, 1992).

The Bald Eagle (*Haliaetus leucocephalus*), which is a state-and federally-listed endangered species, was identified by the VDCR and the VDGIF as occurring within the project area, and is included on the VDCR list of natural heritage resources of the tidal Pamunkey River. Several known Bald Eagle nesting areas are found along the Pamunkey River, two of which are located within 3 miles of Northbury. The closest site, Montague Creek, is approximately 2 river miles downstream, while the Macon Creek nesting site is approximately 3 river miles downstream (H. E. Kitchel, VDGIF, personal communication, 1992). Malcolm Pirnie biologists observed the Bald Eagle in flight approximately 2 river miles downstream of Northbury in May 1990 (Malcolm Pirnie, 1990).

TABLE 4-25

ENDANGERED, THREATENED, AND CANDIDATE SPECIES OF THE TIDAL PAMUNKEY RIVER

Scientific Name	Common Name	Federal Status	State Status
Aeschynomene virginica	Sensitive Joint-vetch	LT	PE
Bacopa stragula	Mat-forming Water-hyssop	NL	LE
Cassia fasciculata var. macrosperma	Prairie Senna	C2	NL
Haliaeetus leucocephalus	Bald Eagle	LE	LE
Lasmigona subvirdis	Atlantic Heelsplitter	C2	NL

Federal Legal Status

LE - Listed endangered
LT - Listed threatened
C2 - Candidate, Category 2
NL - No listing available

State Legal Status

LE - Listed endangered
PE - Proposed endangered
NL - No listing available

Sources: VDCR, 1992; VDACS, 1993.

The Prairie Senna (*Cassia fasciculata var-macrosperma*) and the Atlantic Heelsplitter (*Lasmigona subvirdis*) are two candidate species for federal listing and are included on the VDCR list of resources of the tidal Pamunkey River. The Prairie Senna is a plant which has been found in King William and New Kent counties. The Atlantic Heelsplitter is a freshwater mussel which prefers small streams, quiet pools or eddies with gravel and sand bottoms.

Reservoir

In the USCOE's 1984 evaluation of the Ware Creek Reservoir as a component of a regional water supply alternative, the Small Whorled Pogonia *(Isotria medeoloides)* was identified as occurring in James City County. Small Whorled Pogonia is a member of the orchid family and is a state- and federally-listed endangered species.

A botanical survey of the Ware Creek watershed in October 1983 for the Small Whorled Pogonia did not reveal any individuals of the species (Scanlan, 1983). However, the month of June is considered to be the most appropriate time of the year to conduct a field survey for this plant in this region (D.M.E. Ware, The College of William of Mary, personal communication, March 1993).

Additional limited field studies were conducted in the Ware Creek Reservoir watershed as part of the ***Natural Areas Inventory of the Lower Peninsula of Virginia: City of Williamsburg, James City County, York County*** (Clampitt, 1991). Participants in this study spent a total of 8 hours in the Ware Creek watershed searching for Small Whorled Pogonia and three other plant species - 4 hours on August 17, 1989 and 4 hours on July 24, 1990 (with two participants on each visit). Limited areas along Ware Creek and Bird Swamp were inspected but no Small Whorled Pogonia were found. The field surveyors prepared a site survey summary indicating that more exploration should be performed in the Ware Creek drainage farther upstream and the Bird Swamp drainage farther downstream (D.M.E. Ware, The College of William and Mary, personal communication, July 1993).

The USFWS recently recommended conducting additional surveys for the Small Whorled Pogonia at Ware Creek Reservoir due to the existence of potential habitat at the reservoir site (K. L. Mayne, USFWS, personal communication, 1993). The USFWS-recommended methodology for conducting the survey, and the methodology selected for the survey are described in detail in Report E.

Potential habitat for the Small Whorled Pogonia within the proposed Ware Creek Reservoir area was identified in May 1993 by Dr. Donna Ware of the College of William and Mary, based on topographic mapping and color-infrared aerial photography of the area. A total of 56 potential locations were identified, and the total area of prime habitat was estimated to be 90 acres.

Malcolm Pirnie biologists reviewed ***The Survey of the Ware Creek Watershed for Whorled Pogonia*** (Scanlan, 1983) to determine which areas of the watershed had been examined during the 1983 survey. Only 7 of the 56 sites identified by Dr. Ware as prime habitat had been previously examined. Only one of these sites was identified in the 1983 survey as not having the potential for prime habitat. This site was therefore removed from the search area. Because the 1983 survey was conducted in October, and the best time to identify the species in the field is June, it is unlikely that the plant would have been noted if present. Therefore, the 6 remaining areas surveyed in 1983 were included in the proposed search area in addition to the remaining 49 potential habitat areas identified by Dr. Ware.

The RRWSG attempted to schedule field surveys of these areas for June 1993. However, they were unable to obtain access to the properties through Chesapeake Corporation and its subsidiaries (which own a majority of the land within the proposed reservoir watershed) or through James City County. As a result, access was not obtained in time to conduct a survey during June, which is the optimal time for surveying for the species. In September 1993 the USCOE helped to obtain RRWSG access to the Ware Creek Reservoir site. The RRWSG is currently planning to conduct a Small Whorled Pogonia survey of the proposed reservoir area in June 1994. The results of this survey will be included in the Final EIS for public review.

The 1984 USCOE feasibility report identified the Bald Eagle as potentially being present in the Ware Creek system. The USCOE's 1987 Final EIS on James City County's proposed Ware Creek Reservoir (USCOE, 1987) also stated that Bald Eagles have been sighted in the project area, but no active nests within the project area had been found as of 1983.

The VDACS has not identified any state-listed threatened or endangered plant or insect species as occurring in the vicinity of the proposed dam site and downstream areas. (J. R. Tate, VDACS, personal communication, 1992). Limited field studies conducted in October 1992 by Malcolm Pirnie field biologists also did not reveal the presence of threatened or endangered species in the vicinity of the proposed dam site.

The USFWS has indicated that there is a potential that Sensitive Joint-vetch may occur in suitable habitat within Ware Creek (K. L. Mayne, USFWS, personal communication, 1993). The VIMS conducted a study of the Sensitive Joint-vetch in the tidal wetlands of Ware Creek. This study is documented in ***Investigation of Potential Distribution of Aeschynomene virginica in the Tidal Wetlands of Ware Creek, Virginia*** (Perry, 1993) which is included as an appendix to the ***Biological Assessment for Practicable Reservoir Alternatives*** (Malcolm Pirnie, 1994) which is appended to this document as Report E.

Methods used in the VIMS study included a review of historical data on the species and a field survey of the project area by boat. The study area included tidal emergent wetlands on both sides of Ware Creek from its confluence with the York River upstream to the portion of Ware Creek where emergent wetlands end and forested wetlands dominate. Habitats which appeared similar to those which contain populations of the species were further investigated by walking the habitat area and inspecting for the Sensitive Joint-vetch. No extant populations of *Aeschynomene virginica* were located within the study area. However, numerous examples of the species' habitat were located in Ware Creek (Perry, 1993).

Pipeline

The USCOE feasibility report evaluated an alternative which would involve a pumpover from the Pamunkey River at the Northbury intake site and a transmission pipeline to the headwaters of Diascund Creek. This route encompasses a portion of the pipeline route for the Ware Creek alternative evaluated herein. At the time of the study, it was documented that there were no known federal endangered or threatened species located in the vicinity of the project area with the exception of transient individuals (USCOE, 1984).

The VDCR indicated that the pipeline route from the proposed intake site at Northbury to Ware Creek Reservoir would come in close contact to an active Bald Eagle nest. No additional species were identified by the VDGIF as being known to occur in proximity to the proposed pipeline (H. E. Kitchel, VDGIF, personal communication, 1992).

The VDACS identified no state-listed threatened or endangered plant or insect species known to occur in sites associated with pipeline routes for this alternative component (J. R. Tate, VDACS, personal communication, 1992).

Fish and Invertebrates

Intake

Fish collection records for the vicinity of the intake are summarized and included in Table 4-26.

A literature search was conducted to determine which species of anadromous fish have historically used the Pamunkey River as a spawning or nursery area and to identify those species which are likely to still use the river. The following five species of anadromous fish have been documented as using the Chesapeake Bay and its tributaries for spawning and nursery grounds:

- Striped Bass (*Morone saxatilis*)
- American Shad (*Alosa sapidissima*)
- Hickory Shad (*Alosa mediocris*)
- Alewife (*Alosa pseudoharengus*)
- Blueback Herring (*Alosa aestivalis*)

Invertebrate species which may occur in the tidal freshwater region of the Pamunkey River are typical of those occurring in the tidal freshwater portions of the Chesapeake Bay and its tributaries. A listing of these species is included in Table 4-27. The proposed intake site is 3.7 miles downstream of the nearest leased oyster bed (VMRC, 1992).

Reservoir

Existing water bodies within the reservoir impact area include Ware Creek; intermittent and perennial streams associated with Bird Swamp, France Swamp, and Cow Swamp; and Richardson's Millpond.

Fish collections in Ware Creek and France Swamp have been conducted between 1980 and 1993 and are summarized in Tables 4-28 and 4-29. These records were provided by the VDGIF.

An environmental assessment of aquatic resources in Ware Creek was conducted in 1981 (Buchart-Horn, 1981). This assessment indicated that a diverse freshwater fish population exists within Ware Creek's upper tidal portion and its major tributary France Swamp. Freshwater sections of Ware Creek are dominated by game species such as Largemouth Bass and Sunfish. Oligohaline and mesohaline sections of Ware Creek contain estuarine fish fauna. The most abundant game fish species in these areas is the White Perch.

Available information concerning the presence of anadromous fish in Ware Creek was reviewed for this regional study. The Virginia Institute of Marine Science (VIMS) has indicated that Ware Creek may be too far downstream on the York River to attract large spawning runs of herring (J. G. Loesch, VIMS, personal communication, 1992).

A 5½-month study was conducted by James R. Reed & Associates (1982) to determine whether Ware Creek and its tributaries are used as spawning or nursery areas by anadromous fish, specifically Striped Bass, American Shad, Alewife, and Blueback Herring. These species are known to occur in the York River.

The James R. Reed & Associates (1982) study suggested that the nursery value of Ware Creek appears to be more important than its spawning value for anadromous fish and that no major spawning occurs there. The slow current velocities and soft substrate characteristics of Ware Creek were not deemed conducive to egg and larval survival. Of the species studied, Alewife and Blueback Herring were considered most likely to spawn in Ware Creek. Striped Bass and American Shad were not considered likely to use Ware Creek for spawning since the slow moving current and soft substrate of Ware Creek is not the preferred habitat for these species. However, Striped Bass sport fishing occurs at the mouth of Ware Creek (James R. Reed & Associates, 1982).

The U.S. National Marine Fisheries Service (NMFS) considers Ware Creek to be "...a suitable but unutilized site for andromous spawning (*Alosa spp.*)..." (E. W. Christoffers, NMFS, personal communication, 1986). However, the NMFS and USCOE have also stated that when high freshwater discharges during spawning season coincide with years of high anadromous fish populations, Ware Creek may be used as a spawning area for alosid species such as Alewife and Blueback Herring (E. W. Christoffers, NMFS, personal communication, 1986; USCOE, 1987). For several years, populations of these species have been at historic lows and recent sampling efforts have failed to reveal the species' presence in Ware Creek (VDGIF, 1992). Ware Creek is actively used for spawning and as nursery by semi-anadromous White Perch (E. W. Christoffers, NMFS, personal communication, 1986).

The VDGIF conducted fish sampling at the proposed Ware Creek Reservoir site in the summer and fall of 1992. As part of this sampling effort, VDGIF biologists observed Striped Bass in Ware Creek and France Swamp, and at upstream of the proposed Ware Creek dam site (Dowling, 1993). Fish sampling was conducted again in May 1993 by the VDGIF. The results of this study indicated that Ware Creek, at and above the dam site, was being used by juvenile Atlantic Croaker, White Perch, and Striped Bass. Based on these surveys, the VDGIF concluded that "...Ware Creek, above the proposed dam site, serves as a diverse and important transition zone between brackish and freshwater fish communities that warrants protection" (D. C. Dowling, personal communication, 1993).

Benthic invertebrates were collected at several sites in Ware Creek and France Swamp in November 1980 and April 1981 by James R. Reed & Associates (Buchart-Horn, 1981). A complete listing of the observed species is included in Table 4-30.

TABLE 4-26

FISH SPECIES OF THE PAMUNKEY RIVER (1949 - 1978)

Scientific Name	Common Name	1949	1950	1954	1955	1958	1967	1969	1971	1973	1978
Acipenser oxyrhynchus	Atlantic Sturgen	■									
Alosa aestivalis	Blueback Herring	■							■		■
Alosa mediocris	Hickory Shad										■
Alosa pseudoharengus	Alewife							■	■	■	■
Alosa sapidissima	American Shad								■		■
Amia calva	Bowfin	■							■		
Anguilla rostrata	American Eel	■		■					■	■	
Aphredoderus sayanus	Pirateperch								■		
Brevoortia tyrannus	Atlantic Menhaden										■
Centrarchus macropterus	Flier	■									
Clinostomus funduloides	Rosyside Dace								■		
Cyprinus carpio	Common Carp								■		
Dorosoma cepedianum	Gizzard Shad	■						■	■		
Enneacanthus gloriosus	Bluespotted Sunfish	■							■		
Erimyzon oblongus	Creek Chubsucker							■			
Esox niger	Chain Pickerel	■									
Etheostoma olmstedi	Tessellated Darter	■		■	■		■			■	■
Fundulus diaphanus	Banded Killifish	■		■	■		■		■		
Fundulus heteroclitus	Mummichog									■	
Gambusia affinis	Mosquitofish	■							■	■	
Hybognathus regius	Eastern Silvery Minnow	■		■	■		■			■	■
Ictalurus catus	White Catfish	■		■	■		■		■		■
Ictalurus natilis	Yellow Bullhead								■		

TABLE 4-26

FISH SPECIES OF THE PAMUNKEY RIVER (1949 - 1978)

Scientific Name	Common Name	1949	1950	1954	1955	1958	1967	1969	1971	1973	1978
Ictalurus nebulosus	Brown Bullhead								■		
Ictalurus punctatus	Channel Catfish	■		■	■		■		■	■	■
Lepisosteus osseus	Longnose Gar	■		■					■		■
Lepomis auritus	Redbreast Sunfish	■		■	■		■		■	■	
Lepomis gibbosus	Pumpkinseed	■		■	■		■		■	■	
Lepomis macrochirus	Bluegill	■							■	■	
Menidia beryllina	Inland Silverside	■								■	
Micropterus salmoides	Largemouth Bass	■					■		■	■	
Morone americana	White Perch	■		■	■				■	■	■
Morone saxatilis	Striped Bass	■		■	■				■		■
Moxostoma macrolepidotum	Shorthead Redhorse	■		■	■			■	■		■
Notemigonus crysoleucas	Golden Shiner	■		■			■		■		■
Notropus amoenus	Comely Shiner								■		
Notropus analostanus	Satinfin Shiner	■		■	■				■	■	■
Notropus hudsonius	Spottail Shiner	■		■	■	■	■		■	■	■
Noturus gyrinus	Tadpole Madtom	■		■							■
Perca flavescens	Yellow Perch	■		■	■		■	■		■	
Petromyzon marinus	Sea Lamprey		■								
Pomoxis nigromaculatus	Black Crappie	■								■	
Semotilus corporalis	Fallfish	■									
Strongylura manna	Atlantic Needlefish	■									
Trinectes maculatus	Hogchoker	■									

Sources: H. E. Kitchel, VDGIF, personal communications, August 9, 1989 and August 11, 1992.
■ Indicates observation of fish species in particular year.

TABLE 4-27

TYPICAL INVERTEBRATES OF THE CHESAPEAKE BAY AND ITS TRIBUTARIES, TIDAL FRESHWATER ZONE

Scientific Name	Common Name
Anodonta sp.	Freshwater Mussels
Callinectes sapidus	Blue Crab
Cambarus diogens	Burrowing Crayfish
Cordylophora caspia	Freshwater Hydroid
Ferrissia spp.	Coolie Hat Snail
Gammarus sp.	Scuds
Goniobasis virginica	Hornshell Snail
Hydrobia spp.	Seaweed Snails
Lampsilis spp.	Freshwater Mussels
Leptodora kindtii	Giant Water Flea
Lironeca ovalis	Fish Gilled Isopod
Musculium spp.	Long-siphoned Fingernail Clams
Mytilopsis leucophaeata	Platform Mussel
Olencira praegustator	Fish-mouth Isopod
Orconectes limosus	Coastal Plains River Crayfish
Pectinatella sp.	Freshwater Bryozoan
Physa gyrina	Pouch Snail
Pisidium spp.	Pill Clam
Rangia cuneata	Brackish Water Clam
Sphaerium spp.	Short-siphoned Fingernail Clam

From: Lippson, A. J., and R. L. Lippson, 1984. Life in the Chesapeake Bay, The John Hopkins University Press, Baltimore, Maryland.

TABLE 4-28

FISH SPECIES OF WARE CREEK (1980-1993)

Scientific Name	Common Name	1980	1981	1982	1992	1993	Location*
Acantharcus pomotis	Mud Sunfish	■					
Amia calva	Bowfin				■		E
Anchoa mitchilli	Bay Anchory				■		E
Anguilla rostrata	American Eel	■	■	■	■		B,E,S
Aphredoderus sayanus	Pirate Perch	■	■	■	■		B,S
Cyprinodon variegatus	Sheepshead Minnow			■			G,S
Cyprinus carpio	Common Carp			■	■	■	E
Dorosoma cepedianum	Gizzard Shad			■	■	■	E,G,S
Enneacanthus gloriosus	Bluespotted Sunfish	■	■	■		■	E,S
Erimyzon oblongus	Creek Chubsucker	■	■		■		E
Etheostoma olmstedi	Tessellated Darter		■				
Fundulus diaphanus	Banded Killifish				■	■	E
Fundulus heteroclitus	Mummichog			■	■	■	E,G,S
Gambusia affinis	Mosquitofish	■	■	■	■		B,E,S
Gobiosoma bosci	Naked Goby			■			S
Ictalurus catus	White Catfish		■	■	■		E,G,S
Ictalurus natalis	Yellow Bullhead	■	■				
Ictalurus nebulosus	Brown Bullhead	■			■	■	B,E,S
Lepisosteus osseus	Longnose Gar			■	■	■	E
Lepomis auritus	Redbreast Sunfish	■					
Lepomis gibbosus	Pumpkinseed	■	■	■	■		B,E,S
Lepomis gulosus	Warmouth			■	■		B
Lepomis humilis	Orange Spotted Sunfish	■					
Lepomis macrochirus	Bluegill	■	■	■	■	■	B,E,S
Leostomus xanthurus	Spot			■	■		E
Menidia beryllina	Inland Silverside			■	■	■	E,S
Micropogonias undulatus	Atlantic Croaker				■	■	E
Micropterus salmoides	Largemouth Bass	■		■	■		B,E,S
Morone americana	White Perch	■		■	■	■	E,G,S
Monroe saxatilis	Striped Bass				■	■	E
Mugil cephalus	Striped Mullet				■		E
Notemigonus crysoleucas	Golden Shiner			■	■	■	E,S
Perca flavescens	Yellow Perch	■			■		E
Pomatomous saltatrix	Bluefish			■			S

TABLE 4-28

FISH SPECIES OF WARE CREEK (1980-1993)

Scientific Name	Common Name	1980	1981	1982	1992	1993	Location*
Pomoxis nigromaculatus	Black Crappie				■		E
Strongylura marina	Atlantic Needlefish			■			S
Umbra pygmaea	Eastern Mudminnow				■		B

Sources: Buchart-Horn, 1981; James R. Reed & Associates, 1982; H. E. Kitchel, VDGIF, personal communication, August 11, 1992; Dowling, 1993; and D. C. Dowling, VDGIF, personal communication, June 23, 1993.

■ Indicates observation of fish species in particular year.

* Sampling locations are indicated on Figure 6.5-1.

TABLE 4-29

FISH SPECIES OF FRANCE SWAMP (1980 - 1992)

Scientific Name	Common Name	1980	1981	1992	Location*
Acantharcus pomotis	Mud Sunfish	■			U
Anchoa mitchilli	Bay Anchory			■	E
Anguilla rostrata	American Eel	■	■	■	B,E,U
Aphredoderus sayanus	Pirate Perch	■	■	■	B,U
Dorosoma cepedianum	Gizzard Shad			■	E
Enneacanthus gloriosus	Bluespotted Sunfish	■	■	■	B,E,U
Erimyzon oblongus	Creek Chubsucker	■	■	■	E,U
Esox americanus	Redfin Pickerel	■		■	B,U
Etheostoma nigrum	Johnny Darter	■			U
Etheostoma olmstedi	Tessellated Darter	■	■	■	B,U
Fundulus diaphanus	Banded Killifish			■	E
Fundulus heteroclitus	Mummichog			■	E
Gambusia affinis	Mosquitofish	■		■	B,E,U
Ictalurus catus	White Catfish	■		■	E
Ictalurus natalis	Yellow Bullhead	■		■	B,E,U
Ictalurus nebulosus	Brown Bullhead	■		■	E,U
Leostomus xanthurus	Spot			■	E
Lepisosteus osseus	Longnose Gar			■	E
Lepomis gibbosus	Pumpkinseed	■	■	■	E,U
Lepomis macrochirus	Bluegill	■		■	B,E,U
Menidia beryllina	Inland Silverside			■	E
Micropogonias undulatus	Atlantic Croaker			■	E
Micropterus salmoides	Largemouth Bass			■	E
Morone americana	White Perch	■		■	E,U
Morone saxatilis	Striped Bass			■	E
Mugil cephalus	Striped Mullet			■	E
Notemigonus crysoleucas	Golden Shiner	■		■	E,U
Perca flavescens	Yellow Perch			■	E

TABLE 4-29

FISH SPECIES OF FRANCE SWAMP (1980 - 1992)

Page 2 of 2

Scientific Name	Common Name	1980	1981	1992	Location*
Pomoxis nigromaculatus	Black Crappie			▪	E
Trinectes maculatus	Hogchoker			▪	E
Umbra pygmaea	Eastern Mudminnow			▪	B

Sources: Buchart-Horn, 1981; H. E. Kitchel, VDGIF, personal communication, August 11, 1992; and Dowling, 1993.

- ▪ Indicates observation of fish species in particular year.
- * Sampling locations are indicated in Figure 6.5-1.

TABLE 4-30

INVERTEBRATE SPECIES OF WARE CREEK AND FRANCE SWAMP (1980 - 1981)

Class or Order	Common Name	Species	Location*
Hirudinea	Leeches		
		Glossophnid spp.	3
		Helobdella elongata	1
		Myzobdella lugubris	4
Isopoda	Aquatic Sow Bugs		
		Cyathura polita	3,4
		Edotea triloba	4
Amphipoda	Scuds, Sideswimmers & Shrimps		
		Corophium lacustre	3,4
		Grammarus spp.	1,2,3
		Hyalella azteca	3
		Leptochirus plumulosus	3,4
		Orchestia grillus	4
Decapoda	Freshwater Crayfish		
		Callinectes spp.	4
		Crayfish	1,2
		Palaemonetes spp.	1
Megaloptera	Hellgrammites, Dobsonfies & Fishflies	*Sialis spp.*	2,3
Trichoptera	Caddisflies		
		Brachycentrus spp.	1,2
		Dolophilodes spp.	2
		Hydropsyche spp.	1
Tricladia	Triclad Flatworms		
		Dugesia spp.	1
Nemertean	Nemertine Worms		4

TABLE 4-30

INVERTEBRATE SPECIES OF WARE CREEK AND FRANCE SWAMP (1980 - 1981)

Class or Order	Common Name	Species	Location*
Gastropoda	Snails & Slugs		
		Amnicola spp.	1
		Campeloma spp.	1,2
		Ferrissia spp.	1
		Gillia spp.	1,2
		Gyraulus spp.	1
		Lymnea spp.	1
		Melampis spp.	1
		Physa spp.	1,2
Bivalvia	Clams & Mussels		
		Elliptio campanulata	2
		Musculium spp.	1,3
		Pisidium spp.	1,2,3
Polychaeta	Sea Worms		
		Hypaniola grayi	3,
		Laeonereis culveri	3,4
Oligochaeta	Aquatic Earthworms		
		Limnodrilus spp.	3
		Lumbricilus spp.	1,2,3
		Nais spp.	1,4
		Peloscolex multiseptosus	1,2,3
Hemiptera	Water Bugs		
		Belostoma spp.	2,4
		Pelocoris spp.	1
Coleoptera	Water Beetles		
		Berosus spp.	3
		Bidessus spp.	2
Ephemeroptera	Mayflies		
		Baetisea spp.	1

TABLE 4-30

INVERTEBRATE SPECIES OF WARE CREEK AND FRANCE SWAMP (1980 - 1981)

Class or Order	Common Name	Species	Location*
Odonata	Damselflies & Dragonflies		
		Agrion spp.	2
		Archilestes spp.	1,2
		Dorocordulia spp.	2,3
		Erythemis spp.	1
		Gomphus spp.	1,3
		Marcromia spp.	1
		Octogomphus spp.	2
		Perithemus spp.	1
		Plathemis spp.	1
		Tetragoneuria spp.	1,3
		Triacanthagyna spp.	2
Diptera	True Flies		
(family) Ceratopogonidae	Biting Midges	*Palpomyia spp.*	3
(family) Chironomidae	True Midges	*Chironomus spp.*	1,3
		Coelotanypus spp.	1,2,3
		Cricotopus spp.	3
		Cryptochironomus spp.	3
		Dicrotendipes spp.	1,3
		Polypedilum spp.	1,3
		Proclauidus spp.	3
(family) Dolichopodidae	Dolichopotid Flies	*Unknown*	2
(family) Simuliidae	Blackfiles	*Simulium spp.*	1
(family) Tipulidae	Craneflies	*Tipula spp.*	1

Source: Buchart-Horn, 1981.

*Sampling locations are indicated in Figure 6.5-1.

Pipeline

Construction of new pipeline associated with this alternative would require minor crossings of 5 perennial and 16 intermittent streams. Fish species expected to occur in these streams are similar to those found in France Swamp (see Table 4-29).

Invertebrate species found within intermittent and perennial streams crossed by the pipeline are expected to be typical of those found in freshwater regions of the Lower Peninsula (see Table 4-31).

<u>Other Wildlife</u>

Intake

Field studies conducted by Malcolm Pirnie during the spring of 1990 determined that the proposed Northbury intake site is relatively isolated and that the predominant vegetation cover types are agricultural fields and forests. An analysis of color-infrared aerial photography of the proposed intake site was conducted and vegetation community types were classified according to Anderson et al. (1976). Community types were identified as follows:

- Mixed Forest
- Deciduous Forest
- Pine Plantation and Coniferous Forest
- Old Field/Agricultural
- Palustrine Forested Broad-Leaved Deciduous
- Scrub-Shrub
- Emergent/Open Water

The predominate forest type at the proposed intake location is deciduous. To determine the potential wildlife species occurring at the intake site location, the VDGIF was contacted. A search of the Biota of Virginia (BOVA) database was conducted, and a listing of species anticipated to occur in riparian habitats of the Pamunkey River was generated. Based on this information and a literature review, typical wildlife species of each community type were identified. Listings of typical wildlife species according to vegetation community types are included in ***Alternatives Assessment (Volume II - Environmental Analysis)*** (Malcolm Pirnie, 1993) Section 6.6.1, which is appended to this report. The predominant vegetation cover types at the proposed intake site are deciduous forest and agricultural fields.

Species noted by Malcolm Pirnie scientists in the vicinity of the intake include Bald Eagle, Eastern Kingbird, Great Blue Heron, Green Heron, Indigo Bunting, Mallard, Osprey, Pileated Woodpecker, Red-tailed Hawk, Sanderling, Turkey Vulture, and Beaver (Malcolm Pirnie, 1990).

Reservoir

Based on review of color-infrared aerial photography of the proposed Ware Creek Reservoir watershed, vegetation community types were classified according to Anderson et al. (1976). According to Anderson's methodology and field inspections, vegetation community types in the watershed area were estimated to consist of 1,384 acres of coniferous forest, 222 acres of deciduous forest, 5,959 acres of mixed forest, 590 acres of wetlands and open water, and 2,346 acres of agricultural, residential, open field, and shrub communities. The remaining 640 acres of the watershed consist of roads, light commercial areas, and industrial areas which would not be heavily utilized by wildlife. Based on information provided from the VDGIF's BOVA database and a literature review, wildlife species anticipated to occur in the project vicinity were identified. These species are included in ***Alternatives Assessment (Volume II - Environmental Analysis)*** (Malcolm Pirnie, 1993) Section 6.6.1, which is appended to this document.

Based on review of color-infrared aerial photography and field inspections, it was estimated that the reservoir pool area consists of 582 acres of mixed forested land, 19 acres of coniferous forested land, 24 acres of deciduous forest, 590 acres of wetlands and open water, and 4 acres of agricultural, residential, and open field communities. The remaining area consists of roads which have very limited habitat value. The primary cover type of the reservoir pool area is forested land which comprises approximately 625 acres of the proposed 1,238 acre pool area.

Field investigations were conducted by the USFWS on March 17, 1981 and April 8, 1981 to determine wildlife composition in the reservoir area. Foxes are the major predatory mammal associated with the forested regions of the watershed. Omnivorous mammals typical of this community type include the Opossum and the Raccoon. White-tailed Deer are also common throughout forested habitats. Smaller mammals noted within the project area include the Gray Squirrel, White-footed Mouse, Meadow Vole, Cotton Mouse, Marsh Rice Rat, and Muskrat. Forest edge habitat is utilized by White-tailed Deer, Striped Skunk, and many old field small mammals including the Wood Mouse, Cottontail Rabbit, and Meadow Vole (Buchart-Horn, 1981). Mammals associated with aquatic habitats in the project vicinity include Mink, Beaver, Muskrat, and River Otter (USCOE, 1984).

Based on previous studies, the Red-eyed Vireo is the most common bird in the deciduous forested area (Buchart-Horn, 1981). Common warblers include the Prothonotary Warbler, Black and White Warbler, Pine Warbler, and Yellow-throated Warbler. Other characteristic bird species include the Ovenbird, Woodthrush, Carolina Chickadee, Tufted Titmouse, and various woodpeckers.

Large areas of mature forest provide necessary habitat for predators such as hawks and owls. Species noted include the Great Horned Owl, Screech Owl, and Barred Owl (Buchart-Horn, 1981). The Red-tailed Hawk has also been frequently noted in this area. The Black Vulture and Turkey Vulture are abundant in the project area. The presence of large oaks and occasional hickories in the Ware Creek watershed provides suitable habitat for Turkey.

Forest edge habitat is important for a variety of bird species. Field Sparrows and Song Sparrows are common permanent residents in forest edge communities. The Mockingbird, Robin, Indigo Bunting, Chipping Sparrow, and Cardinal also utilize these areas for nesting. The Common Yellowthroat, Eastern Bluebird, Yellow Breasted Chat, and the

TABLE 4-31

TYPICAL FRESHWATER INVERTEBRATES OF THE LOWER VIRGINIA PENINSULA

Scientific Name	Common Name
Alasmidonta undulata	Triangle Floater Mussel
Anodonta cataracta	Eastern Floater
Anodonta grandis	Giant Floater Mussel
Cambarus bartonii	Crayfish
Cambarus diogenes	Crayfish
Cambarus robustus	Crayfish
Elliptio angustata	Carolina Lance Mussel
Elliptio complanata	Eastern Elliptio
Elliptio congaraea	Carolina Slabshell Mussel
Elliptio lanceolata	Yellow Lance Mussel
Fallicambarus uhleri	Crayfish
Ligumia nasuta	Eastern Pond Mussel
Orconectes limosus	Crayfish
Strophitus undulatus	Squawroot Mussel

Source: H. E. Kitchel, VDGIF, personal communication, August 11, 1992.

Yellow Rumped Warbler have also been noted in the area. Predatory birds such as the Red-tailed and Red-shouldered Hawks utilize the forest edge and agricultural/old-field areas to prey on small mammals (Buchart-Horn, 1981).

Ware Creek is an extremely productive ecosystem utilized by species such as Wood Duck, Black Duck, Blue-winged Teal, and Great Egret. Wood Ducks find nesting trees in the forested areas and a stable source of food in wetland (especially herbaceous) vegetation and benthic invertebrates. These Wood Ducks also congregate in large communal roosts in Ware Creek wetlands in the fall.

Black Duck, a species which has undergone a dramatic decline in population in recent years, are attracted to the Ware Creek aquatic system by the ample foods of the freshwater marshes (including Wild Rice) and areas of shallow water which provide important wintering habitat for migratory species (USCOE, 1984). Bald Eagle have also been noted in the area, and the potential also exists for nesting of this species in the proposed impact area (USCOE, 1984).

An additional identified resource is a Great Blue Heron (*Ardea herodias*) rookery located on both sides of France Swamp, north of the intersection of U.S. Route 60 and Interstate 64. This rookery contained 98 nests during a 1990 survey (D. Bradshaw, VDGIF, personal communication, 1993). The Great Blue Heron is ranked by the State as being rare to uncommon, but not threatened or endangered. It is currently protected under the Migratory Bird Treaty Act (T. O'Connell, VDCR, personal communication, 1992). This species, considered to be a species of special concern by the USFWS, thrives in natural habitats, preferentially nesting in riparian swamps such as the rookery in France Swamp (USEPA, 1992).

Common amphibians and reptiles found in the forested community include the Green Frog, Spotted Salamander, Marbled Salamander, Slimy Salamander, Red-backed Salamander, Grey Treefrog, Northern Black Racer, Black Rat Snake, Eastern Hognose Snake, Eastern Kingsnake, Southern Copperhead, Broad-headed Skink, Ground Skink, Five-lined Skink, and Southern Five-lined Skink.

The American and Fowler's Toads are common around cultivated fields. Freshwater creeks and ponds in the project area also support amphibians and reptiles such as the Bullfrog, Leopard Frog, Pickerel Frog, and Red Spotted Newt. Snakes noted in wetland and open water habitats of the project area include the Northern Water Snake, Brown Water Snake, Red-bellied Water Snake, and the Eastern Cottonmouth. Snapping Turtles have also been noted in this community type (Buchart-Horn, 1981).

Pipeline

Assuming a pipeline right-of-way width of 50 feet, the new pipeline would disturb approximately 159 acres of land. Existing vegetation community types along the pipeline route were identified through review of USGS topographic mapping and color-infrared aerial photography. Based on a review of these resources, the 26.3 miles of new pipeline would impact primarily mixed forested and agricultural land. Typical wildlife species of these community types are included in ***Alternatives Assessment (Volume II - Environmental Analysis)*** (Malcolm Pirnie, 1993) Section 6.6.1, which is appended to this document.

Sanctuaries and Refuges

No existing designated sanctuaries or refuges are located within the vicinity of the proposed intake, Ware Creek Reservoir watershed, or pipeline routes associated with this alternative (VDCR, 1989; Delorme Mapping Company, 1989; RRPDC, 1991; JCC, 1991).

Wetlands and Vegetated Shallows

Intake

Tidal freshwater marshes and swamps are found along the Pamunkey River from Hill Marsh (near Romancoke) upstream to Hanover County (Doumlele, 1979). In a classification system based on salinity, these areas lie between the oligohaline (average annual salinity between 0.5 and 5.0 ppt) and non-tidal freshwater wetland zones. The lack of dominance by estuarine marsh grasses (*Spartina spp.*) distinguishes tidal freshwater marshes from oligohaline and higher salinity marshes. Tidal freshwater marshes are characterized by a large, diverse assemblage of broad-leaved plants, grasses, rushes, shrubs, and herbaceous vegetation (Odum et al., 1984).

Tidal marsh inventories of King William County and New Kent County were reviewed and the Northbury intake site was inspected in order to characterize tidal marshes along the Pamunkey in the vicinity of the site. These tidal freshwater marshes are typically dominated by Arrow Arum (*Peltandra virginica*), Pickerelweed (*Pontederia cordata*), Spatterdock (*Nuphar luteum*), Wild Rice (*Zizania aquatica*), and Rice Cutgrass (*Leerzia oryzoides*). In areas where salinities periodically extend into oligohaline ranges (0.5 to 5.0 ppt), species such as Big Cordgrass, Common Three-square (*Scirpus americanus*), Narrow-leaved Cattail (*Typha angustifolia*), smartweeds (*Polygonum spp.*), Arrow Arum, Wild Rice and Water Hemp (*Amaranthus cannabinus*) become the most prevalent community components (Silberhorn and Zacherle, 1987; Odum et al., 1984).

Tidal freshwater swamps are also common along the Pamunkey and are often closely associated with the tidal freshwater marshes. Occurring primarily landward of the marsh, these forested areas are dominated by trees such as Red Maple (*Acer rubrum*), Black Gum (*Nyssa sylvatica*), and ash (*Fraxinus sp.*). In addition, tidal swamps typically support a diverse understory of emergent herbs and shrubs (Silberhorn and Zacherle, 1987; Odum et al., 1984).

The Northbury intake site was inspected by Malcolm Pirnie biologists in May 1990. The majority of the site consists of upland agricultural and forested land. A small pond (LOWZ) is found approximately 500 feet east of the pump station site and about 100 feet south of the Pamunkey River. A narrow fringe of wetland vegetation is located on the south shore of the Pamunkey.

A palustrine forested wetland (PF01R) is found directly across from the intake site, on the King William County side of the Pamunkey River. This tidal freshwater swamp is dominated by trees such as River Birch (*Betula nigra*), Sycamore (*Platanus occidentalis*), Red Maple, Sweet Gum (*Liquidambar styraciflua*), and Black Gum. The swamp gradually becomes marshland at points 500 feet upstream and 1,000 feet downstream from the intake site. The upstream marsh consists mainly of Wild Rice, Rice Cutgrass, Spatterdock, Pickerelweed, and Arrow Arum; the downstream marsh is dominated by Arrow Arum, Pickerelweed, Marsh Hibiscus, Spatterdock, Wild Rice, Water Willow (*Decodon verticillatus*), and Spotted Jewelweed (*Impatiens capensis*) (Silberhorn and Zacherle, 1987).

Reservoir

Wetlands at the proposed Ware Creek Reservoir site have been identified and delineated using the ***Corps of Engineers Wetland Delineation Manual*** (USCOE, 1987). The methodology used to delineate wetlands at the site included a combination of in-house and routine on-site methods for estimating wetland impacts. A detailed description of the methodology used to conduct the delineation is presented in the report ***Wetland Delineation of King William, Ware Creek and Black Creek Reservoir Sites*** (Malcolm Pirnie, 1994) which is appended to this document as Report F.

Available information from existing map sources was first compiled in-house to identify wetland acreage at the site. The following wetland acreages were obtained through interpretation of the listed map sources for the proposed Ware Creek Reservoir site:

Map Source	Acres of Wetlands
USFWS NWI Maps	507
SCS Soils Maps	501
Aerial Photo Estimate [1]	600
Ware Creek EIS (USCOE) [2]	425
USFWS (1985) [3]	583
James City County [4]	653

Notes:

1 Malcolm Pirnie aerial photo estimate, based only on interpretation of photography

2 USCOE, 1987

3 U.S. Department of the Interior (1985); 539 acres vegetated; add 44 open water to result in 583 acres

4 James City County Comprehensive Plan and Zoning Maps adopted 1991. Maps depict only James City County area of 591 acres. New Kent County portion adds 62 acres.

Because review of these individual sources did not result in similar wetland acreage estimates, color-infrared aerial photography of the site was obtained. Detailed mapping of the area was compiled in the delineation using the following sources:

- USGS Topographic Maps - Toano Quadrangle (Scale 1 inch= 2,000 feet)
- USFWS NWI Maps - Toano Quadrangle (Scale 1 inch = 2,000 feet)
- SCS Soils Maps - James City County and New Kent County.
- Ware Creek EIS - Wetland Delineation (USCOE, 1987)

- Aerial Photography - 1982 NHAP (Scale 1 inch = 1,250 feet; Date Flown; 3/7/82)

- James City County Mapping - Zoning maps adopted 1992 (Wetlands and 2-foot contours)

- VIMS Tidal Wetland Inventory, 1980

A preliminary wetland map was prepared using the 1982 NHAP photography as a base and overlaying the USGS topographic maps adjusted to the same scale. Because access to the Ware Creek site was initially denied, alternative means were used to verify the estimates made from the photography. These included:

- Limited field verification of wetland maps.

- Study of similar watersheds nearby which had been photographed and mapped.

Brief site visits were made before it became clear that access to the site had been denied. Six sites were visited which appeared to contain wetlands, based on aerial photography interpretation, but were not identified as wetlands on the Ware Creek EIS map prepared during regulatory review of James City County's permit application. Additional wetlands not depicted on the EIS wetland map or in the total wetland acreage defined in the EIS were identified at each site. This field exercise indicated that there was a close correlation between the wetland areas identified from the aerial photography and actual wetland areas in the field.

As a second means of verification, another watershed near Ware Creek was identified which could be used as a surrogate for Ware Creek because of its characteristic steep banks and flat-bottomed areas. Wetlands in this surrogate watershed were identified and delineated using both aerial photography and field verification. Six sites were selected for field verification. In each case, the wetlands were field-verified and were nearly identical to the areas delineated as wetlands through aerial photography interpretation.

James City County 2-foot contour maps were also used to provide a more exact determination of the boundaries of "flat areas" at the base of slopes. Using these maps, in conjunction with aerial photographs, the wetlands delineated increased, primarily in the upstream reaches of the watershed. Planimetering the final adjusted wetland map resulted in 612 acres of wetlands which would be impacted by construction of the Ware Creek Reservoir (see Report F, Plate 3). Because the methodology which was used to arrive at this number compared closely to the actual wetland delineations at Black Creek and King William Reservoir sites, it was believed that this method would provide an accurate estimate of wetlands at the Ware Creek Reservoir site.

Once access to the Ware Creek site was granted, representatives from the RRWSG and James City County conducted field mapping of the Ware Creek wetlands. All parties involved in the mapping followed the methodology described in the 1987 USCOE Manual which uses the three parameter approach. Mapping teams conducted the delineation. Wetland dimensions were measured by pacing and "chaining," and the wetland/upland border was marked directly on 1 inch = 100 feet scale topographic maps. In wetland/upland mosaic areas, a wetland percentage of the area was determined through either transects or visual estimates which were also agreed upon by all team members.

Upon completion of the field mapping, each final map (at a scale of 1 inch = 100 feet) was planimetered three times by three different people to arrive at the final delineated wetland area. A total of 590 acres of wetlands were delineated at the site below elevation 35 feet MSL (normal pool elevation).

The final figure, 590 acres, agrees closely with the estimate using photointerpretation (612 acres). The difference represents less than a 4 percent deviation from the field-verified area. This close agreement between the two methodologies demonstrates the reliability of the methodology used on the King William and Black Creek sites and ensures the comparability of the three estimates.

General descriptions of wetland types are presented in the ***Final Environmental Impact Statement - James City County's Water Supply Reservoir on Ware Creek*** (USCOE, 1987). General wetland areas at the Ware Creek Reservoir site, based on James City County's report are presented in Figures 4-2 and 4-3 and are characterized in Table 4-32. Detailed descriptions and a map of delineated wetlands at the site using the RRWSG methodology described above are presented in Report F.

Wetlands in the tidal portion of Ware Creek near its confluence with the York River are dominated by Salt-marsh Cordgrass. Herbaceous wetlands grade from a mixture of Big Cordgrass, Saltmarsh Cordgrass, and bulrushes (*Scirpus spp.*) in the oligohaline mid-sections, to a mixture of Wild Rice, cattails (*Typha spp.*), Pickerelweed, Arrow Arum, and bulrushes in the tidal freshwater areas. In the non-tidal freshwater emergent areas, cattails, bur-reeds (*Sparganium spp.*), Rice Cutgrass, and smartweeds are common (USCOE, 1987).

Typical tree species found in forested wetlands in the Ware Creek area include Red Maple, Black Gum, Green Ash (*Fraxinus pennsylvanica*), Sycamore, and Sweetgum. Shrubs and understory species include Black Willow (*Salix nigra*), Alder (*Alnus sp.*), Northern Spicebush (*Lindera benzoin*), Poison Ivy (*Toxicodendron radicans*), Lizard's Tail (*Saururus cernuus*), blueberries (*Vaccinium spp.*), sedges (*Carex spp.*) and various ferns (USCOE, 1987).

Scrub-shrub wetlands at the site are commonly vegetated with Alder, Black Willow, Buttonbush (*Cephalanthus occidentalis*), and Red Maple and Sweetgum saplings. Typical understory vegetation includes bur-reeds, cattails, and Rice Cutgrass (USCOE, 1987).

A wetland evaluation was completed for tidal and non-tidal wetlands that would be affected by construction of Ware Creek Reservoir. The USCOE Wetland Evaluation Technique (WET) was utilized to assess the functional values of the wetlands at Ware Creek (Adamus et al., 1987; Adamus et al., 1991). WET is a broad-brush approach to wetlands evaluation and is based on information about predictors of wetland functions that can be gathered quickly. WET estimates the probability that a function will occur in a wetland and provides insight into the importance of those functions. Results of the WET analysis are summarized in Tables 4-33 and 4-34.

The results presented in these tables appear counter-intuitive based on existing field data. The overall value of the Ware Creek estuarine wetlands appears to be underestimated by the WET model. These wetlands are located in an oligohaline/tidal freshwater transition zone and provide many more benefits to fish and wildlife than oligohaline, mesohaline, or haline marshes. Yet, the WET program evaluates near-freshwater, oligohaline, mesohaline and haline wetlands equally. Therefore, wetlands found within the Ware Creek Reservoir impact area contain the combined value of tidal and non-tidal systems and should perhaps receive a higher rating.

The USCOE, USFWS, USEPA, VDGIF, and James City County completed a HEP analysis for the local Ware Creek Reservoir project as proposed by James City County. Fish and wildlife habitat values for each important cover type in the drainage area were studied. Forested wetland, scrub-shrub wetland, herbaceous wetland, lacustrine open water, and estuarine open water were among the cover types analyzed for the study.

HEP analyses use species-specific Habitat Suitability Index (HSI) models to quantitatively assess habitat quality for particular species based upon selected habitat characteristics. These models yield HSIs that vary from 0.0 for unsuitable habitat to 1.0 for optimal habitat for the modeled species. HSIs are multiplied by acreage to determine Habitat Units (HUs).

Nine species were evaluated for the HEP study. The lists of cover types and representative species were combined to yield evaluation elements. Subsequently, baseline calculations of HSIs and HUs were completed. Results of the study are summarized in Table 4-35.

The baseline calculations show that forested and herbaceous wetlands at the Ware Creek site provide moderate habitat values for the indicator wildlife species evaluated.

Pipeline

Wetland crossings along the 26.3 miles of new pipeline would occur at 5 perennial and 16 intermittent stream crossings. The majority of affected wetlands would be palustrine forested, broad-leaved deciduous wetlands. Typical tree species of these Virginia Coastal Plain palustrine systems include Sweetgum, River Birch, Black Gum, Red Maple, Green Ash, and Sycamore.

<u>Mud Flats</u>

No mud flats are located in the immediate vicinity of the Northbury intake site based on review of USGS topographic maps and USFWS NWI maps. The closest mud flat to the intake site is located 8,000 feet downstream. No mud flats exist upstream of the site.

No mud flats were identified within the proposed reservoir area or below the proposed dam site on Ware Creek. Also, no mud flats were identified along the pipeline route.

4.3.2 Black Creek Reservoir with Pumpover from the Pamunkey River

<u>Endangered, Threatened, or Sensitive Species</u>

Intake

Endangered, threatened and other sensitive species likely to be found in the vicinity of the proposed Northbury intake site on the Pamunkey River are described in Section 4.3.1.

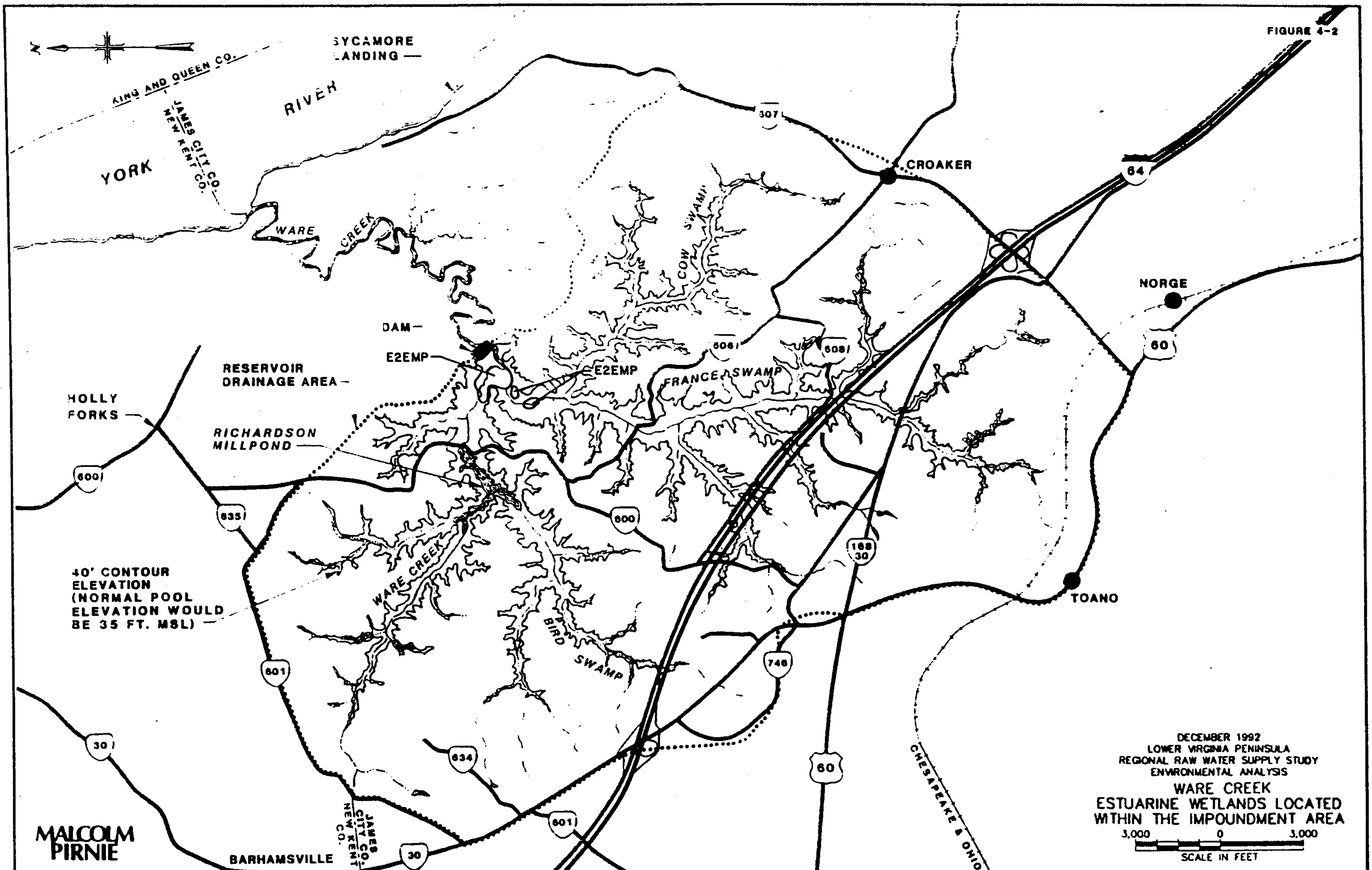


FIGURE 4-2
N
SYCAMORE LANDING
KING AND QUEEN CO.
JAMES CITY CO.
NEW KENT CO.
YORK RIVER
WARE CREEK
COW SWAMP
CROAKER
307
64
NORGE
60
DAM
E2EMP
E2EMP
606
608
FRANCE SWAMP
RESERVOIR DRAINAGE AREA
HOLLY FORKS
RICHARDSON MILLPOND
600
635
600
168 30
TOANO
40' CONTOUR ELEVATION (NORMAL POOL ELEVATION WOULD BE 35 FT. MSL)
WARE CREEK
BIRD SWAMP
601
746
30
634
60
CHESAPEAKE & OHIO
601
JAMES CITY CO.
NEW KENT CO.
BARHAMSVILLE
30
MALCOLM PIRNIE
DECEMBER 1992
LOWER VIRGINIA PENINSULA
REGIONAL RAW WATER SUPPLY STUDY
ENVIRONMENTAL ANALYSIS
WARE CREEK
ESTUARINE WETLANDS LOCATED
WITHIN THE IMPOUNDMENT AREA
3,000 0 3,000
SCALE IN FEET

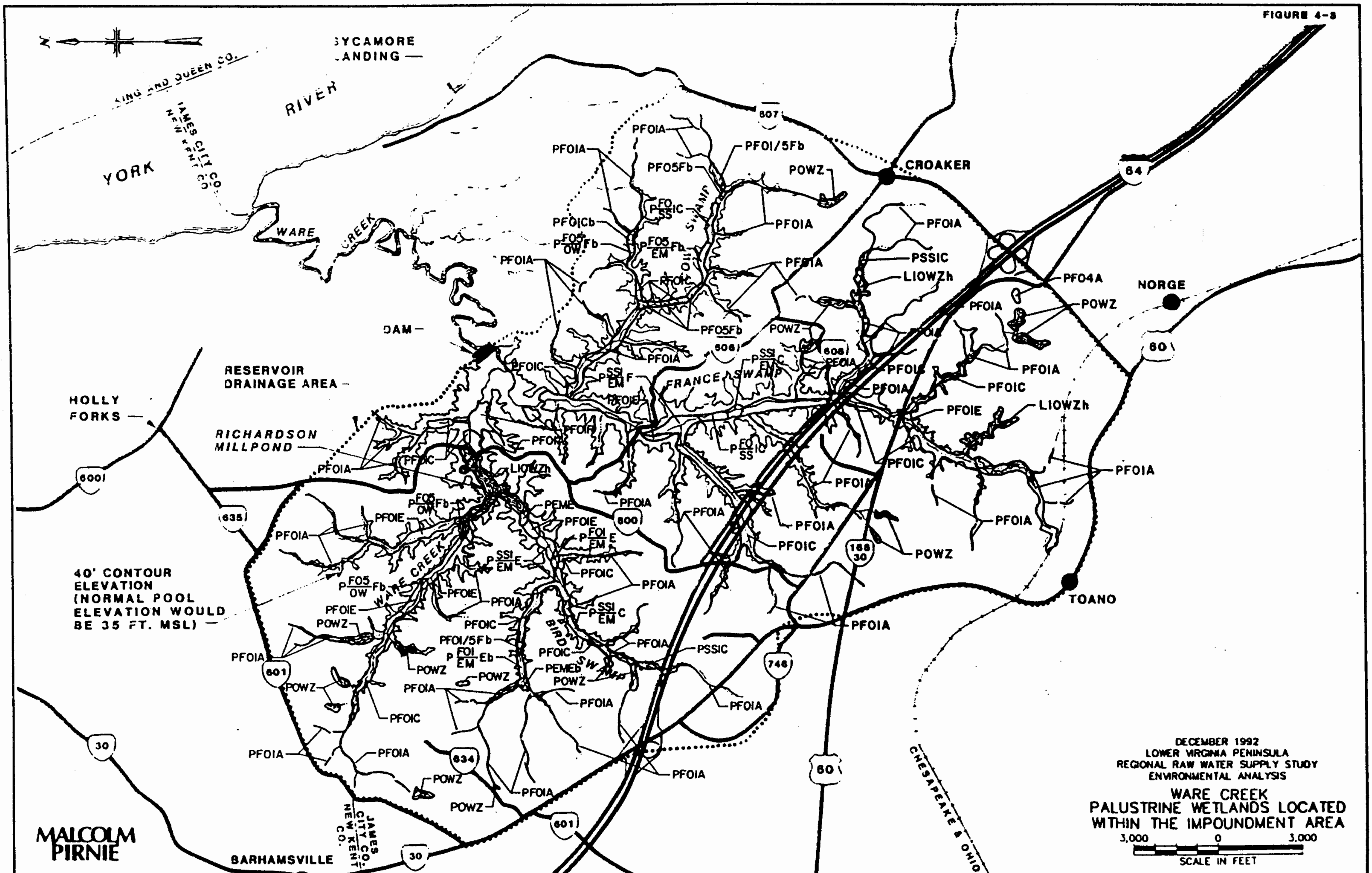


FIGURE 4-3

DECEMBER 1992
LOWER VIRGINIA PENINSULA
REGIONAL RAW WATER SUPPLY STUDY
ENVIRONMENTAL ANALYSIS

WARE CREEK
PALUSTRINE WETLANDS LOCATED
WITHIN THE IMPOUNDMENT AREA

3,000 0 3,000
SCALE IN FEET

TABLE 4-32 WETLAND CATEGORIES AT THE WARE CREEK IMPOUNDMENT SITE	
	Palustrine Forested
	Emergent (Palustrine and Estuarine)
	Palustrine Scrub-Shrub
	Palustrine Open Water
	Estuarine Open Water
	Lacustrine Open Water
Source:	Final Environmental Impact Statement, James City County's Water Supply Reservoir on Ware Creek (USCOE, 1987).

TABLE 4-33

SUMMARY OF WET ANALYSIS RESULTS
WARE CREEK RESERVOIR ESTUARINE WETLANDS

Function/Value	Evaluation Criteria		
	Social Significance	Effectiveness	Opportunity
Groundwater Recharge	M	L	*
Groundwater Discharge	M	L	*
Floodflow Alteration	M	L	L
Sediment Stabilization	L	H	*
Sediment/Toxicant Retention	M	L	H
Nutrient Removal/Transformation	M	M	H
Production Export	*	M	*
Wildlife Diversity/Abundance	H	*	*
Wildlife Diversity/Abundance (Breeding)	*	M	*
Wildlife Diversity/Abundance (Migration)	*	L	*
Wildlife Diversity/Abundance (Wintering)	*	H	*
Aquatic Diversity/Abundance	L	M	*
Uniqueness/Heritage	H	*	*
Recreation	L	*	*

Note: "H" = High
"M" = Moderate
"L" = Low
"*" = Functions and values are not evaluated by the WET program.

TABLE 4-34

SUMMARY OF WET ANALYSIS RESULTS
WARE CREEK RESERVOIR PALUSTRINE WETLANDS

Function/Value	Evaluation Criteria		
	Social Significance	Effectiveness	Opportunity
Groundwater Recharge	M	L	*
Groundwater Discharge	M	L	*
Floodflow Alteration	L	H	M
Sediment Stabilization	L	H	*
Sediment/Toxicant Retention	H	H	H
Nutrient Removal/Transformation	H	L	H
Production Export	*	M	*
Wildlife Diversity/Abundance	H	*	*
Wildlife Diversity/Abundance (Breeding)	*	H	*
Wildlife Diversity/Abundance (Migration)	*	H	*
Wildlife Diversity/Abundance (Wintering)	*	H	*
Aquatic Diversity/Abundance	L	L	*
Uniqueness/Heritage	H	*	*
Recreation	L	*	*

Note: "H" = High
"M" = Moderate
"L" = Low
"*" = Functions and values are not evaluated by the WET program.

TABLE 4-35

BASELINE CALCULATIONS OF HABITAT SUITABILITY INDICES (HSIs) AND HABITAT UNITS (HUs)
WARE CREEK RESERVOIR

Evaluation Element	HSI	HU
Forested Wetland		
Pileated Woodpecker	0.79	217.80
Gray Squirrel	0.49	135.09
American Woodcock (wintering habitat)	0.32	88.22
Wood Duck (brood habitat)	0.28	77.20
Beaver	0.55	151.64
Scrub-Shrub Wetland		
Wood Duck (brood habitat)	0.71	52.11
Beaver	0.95	69.73
American Woodcock	0.38	27.89
Yellow Warbler	0.87	63.86
Herbaceous Wetland		
Wood Duck (brood habitat)	0.68	134.71
Beaver	0.85	168.39
Red-Winged Blackbird	0.26	165.49
Lacustrine Open Water Wetland		
Beaver	0.87	57.86
Largemouth Bass	0.77	51.20
Estuarine Open Water		
Spot (juvenile)	0.97	64.99
Total		**1526.18**

Source: Final Environmental Impact Statement, James City County's Water Supply Reservoir on Ware Creek (USCOE, 1987)

Reservoir

In the evaluation of Black Creek Reservoir conducted as part of the USCOE's ***Feasibility Report and Final Environmental Impact Statement, Water Supply Study - Hampton Roads Virginia***, with the exception of transient individuals, there were no known federal endangered or threatened species identified in the project area (USCOE, 1984).

The VDGIF review of this proposed reservoir site resulted in the identification of three known species of concern in the project vicinity: Mabee's Salamander (*Ambystoma mabeei*), Bald Eagle *(Haliaeetus leucocephalus)*, and the Northern Diamondback Terrapin (*Malaclemys terrapin*).

Mabee's Salamander is a state-listed threatened species. While individuals have not been documented in the project area, suitable habitat for the species may be present. The Bald Eagle is documented as occurring in New Kent County. This species has federal endangered species status. While no known active nests or concentration areas are located within several miles of the impoundment, the species may occasionally be present in the vicinity of the reservoir site. The Northern Diamondback Terrapin, which is a candidate for federal protection, is commonly found in brackish and saltwater estuaries and tidal marshes; therefore, it is not likely to be impacted by the impoundment (S. Carter-Lovejoy, VDGIF, personal communication, 1992).

The VDACS indicated that no state-listed threatened or endangered plant or insect species are known to occur in the immediate area of the proposed Black Creek Reservoir (J. R. Tate, VDACS, personal communication, 1992).

The USFWS has indicated that a historic record for the Small Whorled Pogonia (*Isotria medeoloides*) is known for New Kent County and appropriate habitat for this species may exist at the Black Creek Reservoir site (K. L. Mayne, USFWS, personal communication, 1993). Small Whorled Pogonia is a state- and federally-listed endangered species. Due to the potential for occurrences of the species within the project area, the USFWS recommended conducting a survey of appropriate habitat within the proposed reservoir area. The USFWS-recommended methodology for conducting this survey, and the methodology selected for the survey are described in detail in Report E.

Potential habitat for the Small Whorled Pogonia within the proposed Black Creek Reservoir was identified in May 1993 by Dr. Donna Ware of The College of William and Mary, based on topographic mapping and color-infrared aerial photography of the area. A total of 35 potential locations were identified, and the total area of prime habitat was estimated to be 147 acres.

Malcolm Pirnie conducted field surveys of the proposed reservoir site in early July 1993. Thirty-five potential Small Whorled Pogonia habitat sites were investigated. No individuals of Small Whorled Pogonia were identified within suitable habitat in the project area. These field studies are documented in the ***Biological Assessment for Practicable Reservoir Alternatives*** (Malcolm Pirnie, 1994) which is appended to this document as Report E.

Pipeline

The USCOE (1984) evaluated a project involving a pumpover from the Pamunkey River at Northbury to Black Creek Reservoir and a pipeline to the headwaters of Diascund Creek. It was documented that at the time of the study there were no known federal endangered or threatened species in the vicinity of the pipeline route, with the exception of transient individuals.

The VDCR review of the pipeline routes from the proposed intake site at Northbury to Black Creek Reservoir indicates that the pipeline would be located approximately 0.5 miles to the south of the existing nest (T. J. O'Connell, VDCR, personal communication, 1992). The VDGIF also identified this active nest as being located in proximity to the proposed pipeline route to Black Creek Reservoir. No additional species were identified by the VDGIF as being known to occur in proximity to the proposed pipeline route (H. E. Kitchel, VDGIF, personal communication, 1992).

The VDACS identified no state-listed threatened or endangered plant or insect species associated within pipeline routes for this alternative component (J. R. Tate, VDACS, personal communication, 1992).

Fish and Invertebrates

Intake

Existing conditions at the proposed Northbury intake site are described in Section 4.3.1.

Reservoir

Fish collection results of a 1983 survey of Black Creek conducted by the VDGIF are included in Table 4-36. In addition, Malcolm Pirnie conducted Black Creek fish surveys in May 1990 (Malcolm Pirnie, 1990) and May 1992. Results of these surveys are included in Tables 4-37 and 4-38. Based on these limited studies, it does not appear that Black Creek is currently utilized as a spawning or nursery area by anadromous fish.

Invertebrate species within the Black Creek Reservoir pool area are expected to be typical of those found in freshwater regions of the Lower Peninsula. A listing of these species is included in Table 4-31.

Pipeline

Construction of new pipeline associated with this alternative would require minor crossings of 10 perennial and 14 intermittent streams. Fish species expected to occur in these streams would be similar to those found in freshwater tributaries of the Chesapeake Bay (see Table 4-39). Invertebrate species found within intermittent and perennial streams crossed by the pipeline are expected to be typical of freshwater invertebrates of the Lower Peninsula (see Table 4-31).

TABLE 4-36

FISH SPECIES OF BLACK CREEK (1983)*

Scientific Name	Common Name
Anguilla rostrata	American Eel
Aphredoderus sayanus	Pirate Perch
Clinostomus funduloides	Rosyside Dace
Enneacanthus gloriosus	Blue-spotted Sunfish
Erimyzon oblongus	Creek Chubsucker
Esox americanus	Redfin Pickerel
Etheostoma olmstedi	Tessellated Darter
Hybognathus regius	Eastern Silvery Minnow
Lamptera aepyptera	Least Brook Lamprey
Lepomis macrochirus	Bluegill
Micropterus dolomieui	Smallmouth Bass
Moxostoma erythrurum	Golden Redhorse
Nocomis leptocephalus	Bluehead Chub
Notemigonus crysoleucas	Golden Shiner
Noturus gyrinus	Tadpole Madtom
Semotilus corporalis	Fallfish
Semotilus stromaculatus	Creek Chub
Umbrae pygamaea	Eastern Mudminnow

Source: H. E. Kitchel, VDGIF, personal communication, August 11, 1992.

* Sampling locations within Black Creek unspecified in VDGIF records.

TABLE 4-37

FISH SPECIES OF BLACK CREEK (1990)

Scientific Name	Common Name	Location*
Anguilla rostrata	American Eel	E
Aphredoderus sayanus	Pirate Perch	G
Clinostomus funduloides	Rosyside Dace	G
Enneacanthus gloriosus	Blue-spotted Sunfish	E
Esox americanus	Redfin Pickerel	G
Etheostoma olmstedi	Tessellated Darter	G
Micropterus dolomieui	Smallmouth Bass	E
Moxostoma erythrurum	Golden Redhorse	E
Noturus gyrinus	Tadpole Madtom	E
Semotilus stromaculatus	Creek Chub	G
Umbrae pygmaea	Eastern Mudminnow	E, G

Source: Preliminary Report on Field Studies for the Environmental Impact Statement, Malcolm Pirnie, 1990.

TABLE 4-38

FISH SPECIES OF BLACK CREEK (1992)

Scientific Name	Common Name	Size	Location*
Anguilla rostrata	American Eel	6" - 12"	B, C, D
Esox americanus	Grass Pickerel	2" - 6"	C
Etheostoma nigrum	Johnny Darter	2"	C
Lepomis auritus	Redbreast Sunfish	2" - 5"	B, C, D
Lepomis gibosus	Pumpkinseed	2" - 3"	B, C
Lepomis gulosus	Warmouth	2" - 3"	B, C
Micropiterus salmoides	Largemouth Bass	3" - 4"	C
Moxostoma erythrurum	Golden Redhorse	2" - 6"	C
Notropis amoenis	Comely Shiner	2"	C
Noturus gyrinus	Tadpole Madtom	2" - 5"	C
Rhinichthys atratulus	Black-nosed Dace	2"	C
Semotilus atromaculatus	Creek Chub	3" - 6"	B
Umbra pygmaea	Eastern Mudminnow	2"	B, C

Source: Malcolm Pirnie field survey conducted on May 26, 1992.

TABLE 4-39

FISH SPECIES OF THE FRESHWATER TRIBUTARIES OF THE CHESAPEAKE BAY

Scientific Name	Common Name
Family Acipenseridae	**Sturgeons**
Acipenser brevirostrum	Shortnose Sturgeon
Acipenser oxyrhynchus	Atlantic Sturgeon
Family Anguillidae	**Freshwater Eels**
Anguilla rostrata	American Eel
Family Atherinidae	**Silversides**
Membras martinica	Rough Silverside
Menidia beryllina	Inland Silverside
Menidia menidia	Atlantic Silverside
Family Belonidae	**Needlefishes**
Strongylura marina	Atlantic Needlefish
Family Catostomidae	**Suckers**
Catostomus commersoni	White Sucker
Erimyzon oblongus	Creek Chubsucker
Family Centrachidae	**Sunfishes**
Lepomis gibbosus	Pumkinseed
Lepomis macrochirus	Bluegill
Micropterus dolomieui	Smallmouth Bass
Micropterus salmoides	Largemouth Bass
Pomoxis annularis	White Crappie
Pomoxis nigromaculatus	Black Crappie

TABLE 4-39

FISH SPECIES OF THE FRESHWATER TRIBUTARIES OF THE CHESAPEAKE BAY

Scientific Name	Common Name
Family Clupeidae	**Herrings**
Alosa aestivalis	Blueback Herring
Alosa mediocris	Hickory Shad
Alosa pseudoharengus	Alewife
Alosa sapidissima	American Shad
Brevoortia tyrannus	Atlantic Menhaden
Dorosoma cepedianum	Gizzard Shad
Dorosoma petenense	Threadfin Shad
Family Cyprinidae	**Minnows and Carps**
Carassius auratus	Goldfish
Hybognathus nuchalis	Silvery minnow
Notemigonus crysoleucas	Golden Shiner
Notropis analostanus	Satinfin Shiner
Notropis hudsonius	Spottail Shiner
Family Cyprinodontidae	**Killifishes**
Cyprinodon variegatus	Sheepshead Minnow
Fundudlus diaphanus	Banded Killifish
Fundulus heteroclitus	Munnichog
Fundulus majalis	Stripped Killifish
Lucania parva	Rainwater Killifish
Family Engraulidae	**Anchovies**
Anchoa mitchilli	Bay Anchovy

TABLE 4-39

FISH SPECIES OF THE FRESHWATER TRIBUTARIES OF THE CHESAPEAKE BAY

Scientific Name	Common Name
Family Esocidae	**Pikes**
Esox americanus	Redfin Pickerel
Esox niger	Chain Pickerel
Family Gasterosteidae	**Sticklebacks**
Gasterosteus aculeatus	Threespine Stickleback
Family Ictaluridae	**Bullhead Catfishes**
Ictalurus catus	White Catfish
Ictalurus nebulosus	Brown Bullhead
Ictalurus punctatus	Channel Catfish
Family Lepisosteidae	**Gars**
Lepisosteus osseus	Longnose Gar
Family Percichthyidae	**Temperate Basses**
Morone americana	White Perch
Morone saxatilis	Striped Bass
Family Percidae	**Perches**
Etheostoma olmstedi	Tessellated Darter
Perca flavescens	Yellow Perch
Family Poeciliidae	**Livebearers**
Gambusia affinis	Mosquitofish
Family Sciaenidae	**Drums**
Leiostomus xanthurus	Spot
Micropogonias undulatus	Atlantic Croaker

TABLE 4-39

FISH SPECIES OF THE FRESHWATER TRIBUTARIES OF THE CHESAPEAKE BAY

Scientific Name	Common Name
Family Soleidae	**Soles**
Trinectes maculatus	Hogchoker
Family Umbridae	**Mudminnows**
Umbra pygmaea	Eastern Mudminnow

Source: Lippson, A.J. and R.L. Lippson. 1984. Life in the Chesapeake Bay. The John Hopkins University Press, Baltimore, Maryland.

One major crossing of an arm of Little Creek Reservoir would also be required for this alternative. Fish species present in Little Creek Reservoir are discussed in Section 4.3.4. Invertebrate species within the Little Creek Reservoir pool area are expected to be typical of those found in freshwater regions of the Lower Peninsula (see Table 4-31).

Other Wildlife

Intake

Existing conditions at the proposed Pamunkey River intake site are described in Section 4.3.1.

Reservoir

Based on review of color-infrared aerial photography of the proposed project site, community types were classified according to Anderson et al. (1976). The VDGIF was also contacted and the BOVA database was examined. A listing of wildlife species having the potential to occur at the proposed site was compiled based on community types. In addition, Malcolm Pirnie biologists conducted field studies at the Black Creek Reservoir site during May and June of 1990. Wildlife species noted during these investigations are listed below:

- Copperhead (*Agkistrodon contortrix*)
- Cottonmouth (*Agkistrodon piscivorus*)
- Painted Turtle (*Chrysemys picta*)
- Wild Turkey (*Meleagris gallopavo*)
- Beaver (*Castor canadensis*)
- Muskrat (*Ondatra zibethica*)

According to Anderson's methodology and field inspections, vegetation community types in the reservoir drainage area, including the pool area, were estimated to consist of 320 acres of coniferous forest, 77 acres of deciduous forest, 2,375 acres of mixed forest, 458 acres of agricultural, residential and open field community types, and 289 acres of wetlands and open water. The remaining area consists of roads which have limited habitat value. Wildlife species typical of these community types are included in ***Alternatives Assessment (Volume II - Environmental Analysis)*** (Malcolm Pirnie, 1993) Section 6.6.2, which is appended to this document.

Vegetation communities within the pool area of the reservoir were estimated to include 20 acres of coniferous forest, 47 acres of deciduous forest, 685 acres of mixed forest, and 108 acres of agricultural, residential and open field communities. Wetlands and open water within the pool area were estimated to consist of 285 acres. The remaining area within the proposed pool area consists of roads which have limited habitat value.

Typical mammals, birds, amphibians and reptiles in the project vicinity are expected to be the same as those identified in Section 4.3.1 as occurring in the vicinity of the proposed Ware Creek Reservoir alternative.

Mature forested areas and forest edge habitat in the project area are described in Section 4.3.1 in reference to the habitat value of these areas to wildlife species.

The Pamunkey River is considered to be one of the top three waterfowl areas in the state. Wood Duck, Black Duck, and Mallard usage of the Pamunkey is heavy (USCOE, 1984). Black Creek, a tributary of the Pamunkey is a productive system utilized by species such as Great Egret, Wood Duck, Black Duck, and Blue-winged Teal.

A search of VDGIF records was conducted for the area downstream of the proposed impoundment. This research identified several heron rookeries approximately 0.5 miles downstream of Black Creek's confluence with the Pamunkey River (H. E. Kitchel, VDGIF, personal communication, 1992).

A HEP analysis was conducted by the USCOE and the USFWS to determine the value of the habitat proposed for impoundment (USFWS, 1983). The value of the habitat was determined by measuring vegetative components for selected species and determining the appropriate suitability index from species models to obtain a species index. This index is multiplied by the amount of available habitat to obtain habitat units (HU) for the evaluated species. Based on this analysis, it was determined that the total available HUs would decrease by 6,601 HUs over the life of the project. This represents a loss of 40.2 percent in the watershed.

Pipeline

Assuming a pipeline right-of-way width of 50 feet, the new pipeline would disturb approximately 123 acres of land (excluding Little Creek Reservoir crossing). Existing vegetation community types along the proposed pipeline route were identified through review of USGS topographic mapping, and color-infrared aerial photography.

A 4.3-mile portion of the proposed pipeline route follows existing rights-of-way through New Kent and James City counties. Because these areas are periodically mowed, vegetation would be typical of early stages of succession, or the old field community type. The remaining 16 miles of the pipeline route consists of primarily mixed forested land and agricultural lands. Wildlife species typical of these community types are included in ***Alternatives Assessment (Volume II - Environmental Analysis)*** (Malcolm Pirnie, 1993) Section 6.6.2, which is appended to this document.

Sanctuaries and Refuges

No existing designated sanctuaries or refuges are located within the vicinity of the proposed intake, Black Creek Reservoir watershed, or pipeline routes associated with this alternative (VDCR, 1989; VDCR, 1991; Delorme Mapping Company, 1989; RRPDC, 1991).

Wetlands and Vegetated Shallows

Intake

A description of the wetlands located adjacent to and downstream of the Northbury intake site is included in Section 4.3.1.

Reservoir

Wetlands at the proposed Black Creek Reservoir site have been identified and delineated using the ***Corps of Engineers Wetland Delineation Manual*** (USCOE, 1987). The methodology used to delineate wetlands at the site included a combination of in-house and routine on-site methods for estimating wetland impacts. A detailed description of the methodology used to conduct the delineation is presented in the report ***Wetland Delineation of King William, Ware Creek and Black Creek Reservoir Sites*** (Malcolm Pirnie, 1994) which is appended to this document as Report F.

Available information from existing map sources was first compiled in-house to identify wetland acreage at the site. The following wetland acreages were obtained through interpretation of the listed map sources for the proposed Black Creek Reservoir site:

Map Source	Acres of Wetlands
USFWS NWI Maps	158
SCS Soils Maps	246
Aerial Photo Estimate [1]	250
Notes: [1] Malcolm Pirnie aerial photo estimate, based only on interpretation of photography	

Because review of these individual sources did not result in similar wetland acreage estimates, color-infrared aerial photography of the site was obtained. Detailed wetland mapping of the proposed reservoir area was conducted by compiling the following map sources:

- USGS Topographic Maps - New Kent Quadrangle (Scale: 1 inch = 2,000 feet)
- USFWS NWI maps - New Kent Quadrangle (Scale: 1 inch = 2,000 feet)
- SCS Soils Maps - New Kent County
- Aerial Photography - 1982 NHAP (Scale 1 inch = 1,300 feet; Date flown; 4/24/84)

- Aerial Photography - 1989 NAPP (Scale 1 inch = 830 feet; Date flown; 3/11/89)

A preliminary wetlands map was developed using the 1989 1 inch = 830 feet NAPP photography as a base and overlaying the USGS topographic map adjusted to the same scale. The 1989 photography was used for Black Creek because of the poor quality of the 1982 photography which made vegetation types difficult to discern.

Once the preliminary map was completed, field studies were conducted to correct the map based on the actual field conditions. The entire wetland boundary was inspected, and the wetland line adjusted in several places. A summary of the field work is presented in the report ***Wetland Delineation of King William, Ware Creek and Black Creek Reservoir Sites*** (Malcolm Pirnie, 1994) which is appended to this document as Report F. Based on this analysis, there are 285 acres of wetlands that would be impacted at the Black Creek Reservoir site below an elevation of 100 feet MSL (spillway elevation). Further verification of this estimate will be conducted in 1994 and will be included in the Final Environmental Impact Statement for public review. Based on previous wetland delineation analyses, the estimate of wetland acreage within the proposed Black Creek Reservoir pool is not expected to change more than 10 - 15 percent from the current estimate.

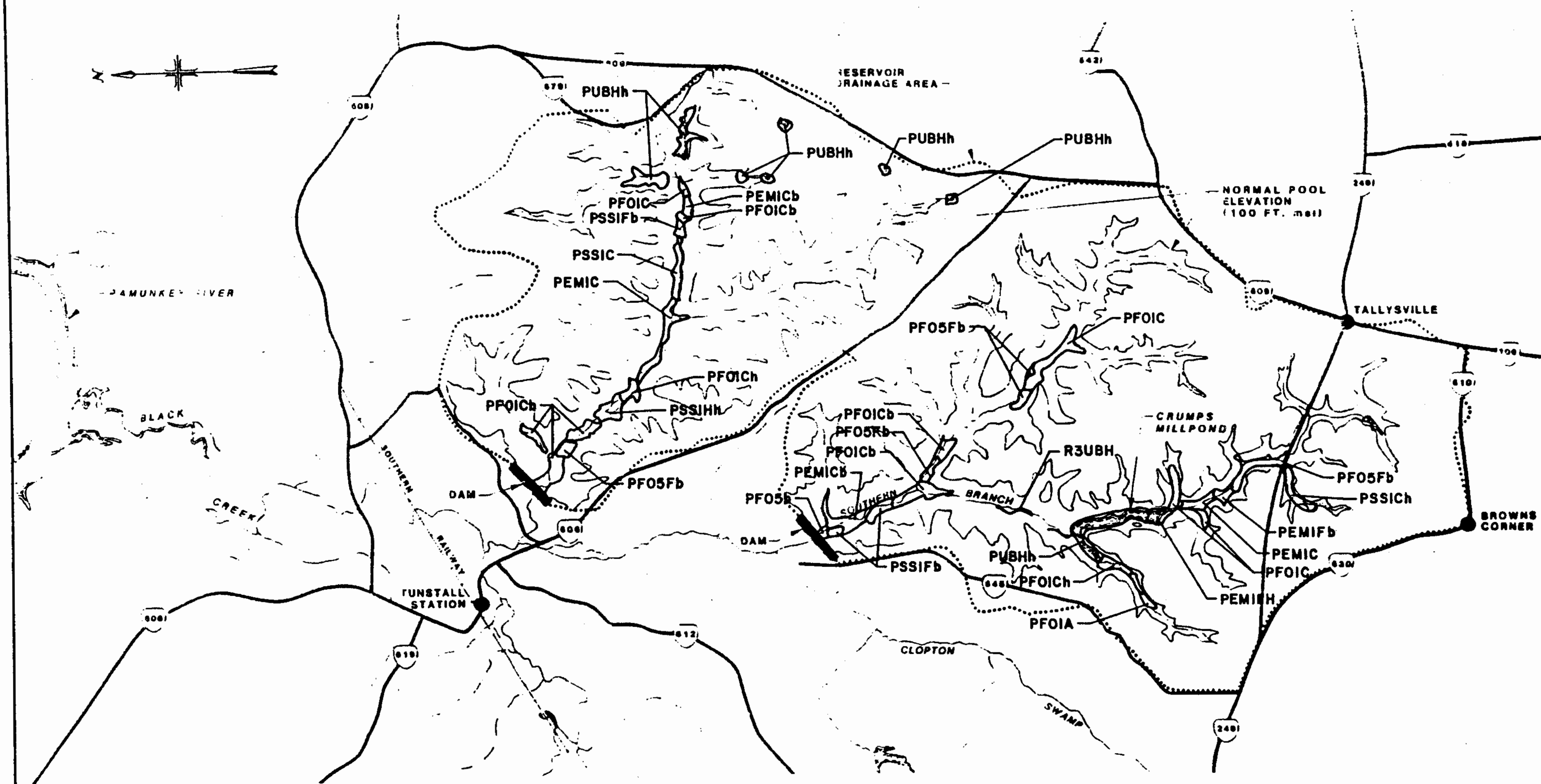
General wetland areas at the Black Creek Reservoir site, based on USFWS NWI maps are presented in Figure 4-4. The fifteen wetland categories identified on the NWI mapping are presented in Table 4-40. Detailed descriptions and a map of delineated wetlands at the site using the RRWSG methodology described above are presented in Report F.

Typical species found in non-tidal forested wetlands at the site include Red Maple, Alder, Tulip Poplar (*Liriodendron tulipifera*), River Birch, Black Willow, Arrowood (*Viburnum dentatum*), and various sedges, cattails, rushes, and ferns. Typical species found in palustrine emergent wetlands include sedges, Soft Rush (*Juncus effusus*), Woolgrass Bulrush (*Scirpus cyperinus*), Sensitive Fern (*Onoclea sensibilis*), Cinnamon Fern (*Osmunda cinnamomea*), and cattails. Non-tidal scrub-shrub wetlands represent an intermediate successional stage between emergent and forested systems and are very important to a wide variety of fish and wildlife species. Typical species in these scrub-shrub wetlands include Northern Spicebush, Alder, Buttonbush, Arrowood, and various young willows, maples, gums and ashes. Understory species include various sedges, ferns, grasses, rushes and cattails.

A wetland evaluation was completed for the non-tidal wetlands that would be affected by the construction of Black Creek Reservoir. The USCOE Wetland Evaluation Technique (WET) model was utilized to assess the functional values of on-site wetlands. Results of the WET analysis are summarized in Table 4-41.

The USFWS completed a ***Draft Coordination Act Report, Southside/Northside Water Supply Study*** which included a HEP analysis of the proposed Black Creek Reservoir (USFWS, 1983). The HEP study assessed various wildlife habitat values for each important cover type in the Black Creek drainage. Deciduous forested wetland, herbaceous wetland, herbaceous/shrub wetland and lacustrine open water were among the cover types analyzed. Results of this HEP study are summarized in Table 4-42.

FIGURE 4-4



DECEMBER 1992
LOWER VIRGINIA PENINSULA
REGIONAL RAW WATER SUPPLY STUDY
ENVIRONMENTAL ANALYSIS

BLACK CREEK
WETLANDS LOCATED WITHIN
THE IMPOUNDMENT AREA

2,000 0 2,000
APPROX. SCALE IN FEET

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TABLE 4-40

WETLAND CATEGORIES AT THE BLACK CREEK IMPOUNDMENT SITE

USFWS Ecological Classification	Wetland Description
PFO1Cb	Palustrine forested, broad-leaved deciduous, seasonal, beaver.
PFO5Fb	Palustrine forested, dead, semi-permanent, beaver.
PSS1Hh	Palustrine scrub-shrub, broad-leaved deciduous, permanent, diked/impounded.
PFO1Ch	Palustrine forested, broad-leaved deciduous, seasonal, diked/impounded.
PEM1C	Palustrine emergent, persistent, seasonal.
PSS1C	Palustrine scrub-shrub, broad-leaved deciduous, seasonal
PSS1Fb	Palustrine scrub-shrub, broad-leaved deciduous, semi-permanent, beaver.
PEM1Cb	Palustrine emergent, persistent, seasonal, beaver.
PFO1C	Palustrine forested, broad-leaved deciduous, seasonal.
PUBHh	Palustrine unconsolidated bottom permanent, diked/impounded.
PFO1A	Palustrine forested, broad-leaved deciduous, temporary.
PEM1Fh	Palustrine emergent, persistent, semi-permanent, diked/impounded.
PEM1Fb	Palustrine emergent, persistent semi-permanent, beaver.
PSS1Ch	Palustrine scrub-shrub, broad-leaved deciduous, seasonal, diked/impounded.
R3UBH	Riverine upper perennial, unconsolidated bottom, permanent.

Source: USFWS NWI map for the Tunstall, Virginia Quadrangle (1" = 2,000' scale).

TABLE 4-41

SUMMARY OF WET ANALYSIS RESULTS
BLACK CREEK RESERVOIR WETLANDS

Function/Value	Evaluation Criteria		
	Social Significance	Effectiveness	Opportunity
Groundwater Recharge	M	L	*
Groundwater Discharge	M	M	*
Floodflow Alteration	M	M	M
Sediment Stabilization	M	H	*
Sediment/Toxicant Retention	M	H	H
Nutrient Removal/Transformation	H	L	H
Production Export	*	M	*
Wildlife Diversity/Abundance	H	*	*
Wildlife Diversity/Abundance (Breeding)	*	H	*
Wildlife Diversity/Abundance (Migration)	*	H	*
Wildlife Diversity/Abundance (Wintering)	*	H	*
Aquatic Diversity/Abundance	M	L	*
Uniqueness/Heritage	H	*	*
Recreation	L	*	*

Note: "H" = High
"M" = Moderate
"L" = Low
"*" = Functions and values are not evaluated by the WET program.

TABLE 4-42

BASELINE CALCULATIONS OF HABITAT SUITABILITY INDICES (HSIs) AND HABITAT UNITS (HUs)
BLACK CREEK RESERVOIR

Evaluation Element	HSI	HU
Gray Squirrel	0.60	1312.80
White-tailed Deer	0.80	2419.20
Beaver	1.00	950.00
White-footed Mouse	1.00	2850.00
Mourning Dove	0.80	156.00
Wood Duck	0.20	449.80
Barred Owl	1.00	2328.00
Red-tailed Hawk	0.40	901.60
Eastern Meadowlark	0.40	28.80
Pine Warbler	0.20	431.00
Veery	0.50	1394.50
Bullfrog	0.90	216.90
Total		**13,438.60**

Source: Draft Coordination Act Report, Southside/Northside Water Supply Study (USFWS, 1983)

The baseline calculations show that herbaceous/scrub-shrub, and lacustrine wetlands provide moderate to high habitat values for the indicator wildlife species evaluated.

Pipeline

Wetland crossings along the 20.3 miles of new pipeline would occur at 10 perennial and 14 intermittent stream crossings. The majority of affected wetlands would be palustrine forested, broad-leaved deciduous wetlands. Typical tree species of these Virginia Coastal Plain palustrine systems include Sweetgum, River Birch, Black Gum, Red Maple, Green Ash, and Sycamore.

The pipeline would also cross the open water of an arm of Little Creek Reservoir.

<u>Mud Flats</u>
No mud flats are located in the immediate vicinity of the Northbury intake site based on review of USGS topographic maps and USFWS NWI maps. The closest mud flat to the intake site is located 8,000 feet downstream and no mud flats exist upstream of the site.

No mud flats were identified within the proposed reservoir area. A mud flat exists on the Pamunkey River approximately 11,000 feet downstream of the dam on the eastern branch of Black Creek.

No mud flats were identified along the pipeline route.

4.3.3 King William Reservoir with Pumpover from the Mattaponi River

<u>Endangered, Threatened, or Sensitive Species</u>

Intake

The VDCR provided a list of natural heritage resources of the tidal Mattaponi River. Five of the nine species listed by the VDCR are either endangered, threatened, or candidate species at the federal and/or state levels (see Table 4-43).

A large population of the Sensitive Joint-vetch (*Aeschynomene virginica* consisting of five sub-populations is known along the Mattaponi River in King and Queen and King William counties (J. R. Tate, VDACS, personal communication, 1993). The closest known population of this species has historically been observed on the north side of the Mattaponi River, across from the proposed intake site (C. Clampitt, VDCR, personal communication, 1992).

The VIMS conducted a study of the Sensitive Joint-vetch in the vicinity of the proposed intake site on the Mattaponi River. The study is documented in ***Distribution of <u>Aeschynomene virginia</u> in the Scotland Landing Region of the Mattaponi River, Virginia*** (Perry, 1993) which is included as an appendix to the ***Biological Assessment for Practicable Reservoir Alternatives*** (Malcolm Pirnie, 1994) which is appended to this document as Report E.

Methods used in the VIMS study included a review of historical data on the species and a field survey of the project area by boat. Habitats which appeared similar to those which contain populations of the species were further investigated by walking the habitat area and inspecting for the Sensitive Joint-vetch. Although approximately 2.5 acres of the species' habitat were identified in this area, no specimens of *Aeschynomene virginica* were located along either side of the Mattaponi River in the vicinity of Scotland Landing (Perry, 1993).

The VDACS indicated that there are numerous populations of the state endangered plant Mat-forming Water-hyssop located in the tidal portion of the Mattaponi River which are of concern. Some of these known populations are located in close proximity to the proposed intake site (J. R. Tate, VDACS, personal communication, 1992).

Mat-forming Water-hyssop is a perennial herb which was identified by the VDACS as occurring in the vicinity of the project area and is listed by the VDCR as a natural heritage resource of the tidal Mattaponi River. It has been found in King and Queen, King William, and New Kent counties. The closest known population of this species occurs approximately 1 mile downstream of the proposed intake site (C. Clampitt, VDCR, personal communication, 1992).

The Bald Eagle (*Haliaeetus leucocephalus*), which is a state- and federally-listed endangered species, was identified by the VDCR as a Natural Heritage Resource of the tidal Mattaponi River. It has been found in several counties adjacent to the river.

The Prairie Senna (*Cassia fasciculata varmacrosperma*) and the Yellow Lampmussel (*Lampsilis cariosa*) are two candidate species for federal listing and are included on the VDCR list of resources of the tidal Mattaponi River.

Reservoir

The VDGIF review of the proposed reservoir site identified three species of concern in the vicinity of the proposed reservoir: Mabee's Salamander (*Ambystoma mabeei*), Bald Eagle, and the Northern Diamondback Terrapin (*Malaclemys terrapin*).

Mabee's Salamander is a state-listed threatened species. While individuals have not been documented in the project area, suitable habitat for the species may be present. The Northern Diamondback Terrapin, which is a candidate for federal protection, is commonly found in brackish and saltwater estuaries and tidal marshes; therefore, it is not likely to be impacted by the impoundment (S. Carter-Lovejoy, VDGIF, personal communication, 1992).

Review of the proposed King William Reservoir site by the VDACS identified no known state-listed threatened or endangered plant or insect species as occurring in the immediate area of the proposed reservoir (J. R. Tate, VDACS, personal communication, 1992). The Bald Eagle is documented as occurring in King William County. While no known active nests or concentration areas are located within several miles of the impoundment, the species may occasionally be present in the vicinity of the impoundment.

The USFWS indicated that a Bald Eagle nest is located near the proposed King William Reservoir site (K. L. Mayne, USFWS, personal communication, 1993). This nest was constructed during the 1992 nesting season and two eaglets were produced from that nest. The Bald Eagle nest is located along Cohoke Mill Creek, approximately 375 feet

TABLE 4-43

ENDANGERED, THREATENED, AND CANDIDATE SPECIES OF THE TIDAL MATTAPONI RIVER

Scientific Name	Common Name	Federal Status	State Status
Aeschynomene virginica	Sensitive Joint-vetch	LT	PE
Bacopa stragula	Mat-forming Water-hyssop	NL	LE
Cassia fasciculata var. macrosperma	Prairie Senna	C2	NL
Haliaeetus leucocephalus	Bald Eagle	LE	LE
Lampsilis cariosa	Yellow Lampmussel	C2	NL

Federal Legal Status

LE - Listed endangered
LT - Listed threatened
C2 - Candidate, Category 2
NL - No listing available

State Legal Status

LE - Listed endangered
PE - Proposed endangered
NL - No listing available

Sources: VDCR, 1992; VDACS, 1993.

downstream of the toe of the proposed dam. Dam excavation and cofferdam construction area limits could extend approximately 100 feet downstream of this toe. A proposed new county route from Route 632 to Route 630 to provide access to the dam and serve as replacement to Route 626, would pass within approximately 675 feet downstream of the eagle nest. Other project features in the vicinity of the eagle nest would include a gravity pipeline routed on the east side of Cohoke Mill Creek and an emergency spillway on the west abutment of the proposed King William Dam.

On April 8, 1993, Malcolm Pirnie and RRWSG representatives participated in a helicopter flight over areas which included the King William Reservoir Project area. The Bald Eagle nest was visible at this time and an adult eagle was observed in the nest. Another eagle was observed in a tree along Cohoke Mill Creek just upstream of the proposed King William Dam footprint.

On April 14, 1993 Malcolm Pirnie staff visited the proposed King William Dam site and observed an adult Bald Eagle in flight. The Bald Eagle nest was also observed from the ground.

The USFWS has also indicated that appropriate habitat for the Small Whorled Pogonia (*Isotria medeoloides*) may exist at the King William Reservoir site (K. L. Mayne, USFWS, personal communication, 1993). The USFWS recommended conducting a survey of appropriate habitat in the reservoir area. The USFWS-recommended methodology for conducting the survey, and the methodology selected for the survey are described in detail in Report E.

Potential habitat for the Small Whorled Pogonia within the proposed King William Reservoir was identified in May 1993 by Dr. Donna Ware of The College of William and Mary, based on topographic mapping and color-infrared aerial photography of the area. A total of 37 potential locations were identified, and the total area of potential prime habitat was estimated to be 164 acres.

Malcolm Pirnie conducted field surveys of the proposed reservoir site in June 1993 to investigate the potential Small Whorled Pogonia habitat sites. One individual of Small Whorled Pogonia was identified in approximately 60 to 70 year old upland deciduous forest adjacent to a cleared forested area. The individual was noted at the lower section of a southwest slope between two small streams.

Pipeline

Project review conducted by the VDCR, VDGIF and VDACS identified no known natural heritage resources or endangered or threatened animal, plant or insect species along pipeline route associated with the King William Reservoir alternative component (T. J. O'Connell, VDCR, personal communication, 1992; H. E. Kitchel, VDGIF, personal communication, 1992; J. R. Tate, VDACS, personal communication, 1992).

Fish and Invertebrates

Intake

Fish collection records for the Mattaponi River between 1939 and 1961 are summarized and included in Table 4-44.

Five species of anadromous fish have been documented utilizing the tidal freshwater reaches of the Mattaponi River for spawning and nursery grounds (Massmann, 1953; Olney et al., 1985):

- Striped Bass (*Morone saxatilis*)
- American Shad (*Alosa sapidissima*)
- Hickory Shad (*Alosa mediocris*)
- Alewife (*Alosa pseudoharengus*)
- Blueback Herring (*Alosa aestivalis*)

Invertebrate species which may occur in the tidal freshwater region of the Mattaponi River are typical of those occurring in the tidal freshwater portions of the Chesapeake Bay and its tributaries. A listing of these species is included in Table 4-27.

Reservoir

There are no VDGIF records of fish or invertebrate surveys for Cohoke Mill Creek within the proposed impoundment area (VDGIF, 1992). Because Cohoke Mill Creek is a tributary to the Pamunkey River, fish species found in Cohoke Mill Creek would be similar to those listed in Table 4-26.

To determine which fish and invertebrate species currently inhabit the impoundment site, sampling was conducted by Malcolm Pirnie biologists along Cohoke Mill Creek in May and June 1990 (Malcolm Pirnie, 1990). Fish species recorded at these sites are included in Table 4-45. There are presently no commercial fisheries in Cohoke Mill Creek. The creek is cut off from anadromous fish migration by the existing Cohoke Millpond Dam, and organics produced in the creek are trapped in the pond and are generally not available to commercial fish nursery areas (Malcolm Pirnie, 1989). Invertebrate species observed by Malcolm Pirnie biologists in Cohoke Mill Creek are recorded in Table 4-46. Because this water body is typical of Lower Peninsula freshwater streams, invertebrate species listed in Table 4-31 may occur in addition to species noted by Malcolm Pirnie.

In November 1992, the VDGIF conducted an electrofishing survey by boat in Cohoke Millpond, downstream of the proposed reservoir site (D. C. Dowling, VDGIF, personal communication, 1992). Fish species captured during this VDGIF survey are presented in Table 4-47.

Pipeline

TABLE 4-44

FISH SPECIES OF THE MATTAPONI RIVER (1939-1961)

Scientific Name	Common Name	1939	1954	1958	1961
Alosa sapidissima	American Shad				■
Anguilla rostrata	American Eel				■
Enneacanthus gloriosus	Bluespotted Sunfish		■		
Etheostoma olmstedi	Tessellated Darter		■		
Fundulus diaphanus	Banded Killifish	■	■	■	■
Hybognathus regius	Eastern Silvery Minnow		■	■	■
Ictalurus catus	White Catfish		■	■	■
Lepomis auritus	Redbreast Sunfish		■		
Lepomis gibbosus	Pumpkinseed				■
Morone americana	White Perch		■		
Morone saxatilis	Striped Bass		■		
Notropis hudsonius	Spottail Shiner		■	■	
Trinectes maculatus	Hogchoker				■

Sources: H. E. Kitchel, VDGIF, personal communications, August 9, 1989 and August 11, 1992.

■ Indicates observation of fish species in particular year.

TABLE 4-45

FISH SPECIES OF COHOKE MILL CREEK (1990)

Scientific Name	Common Name	Location*
Anguilla rostrata	American Eel	A, B
Enneacanthus gloriosus	Blue-spotted Sunfish	B
Esox americanus	Redfin Pickerel	B
Etheostoma olmstedi	Tessellated Darter	B
Moxostoma erythrurum	Golden Redhorse	A
Noturus gyrinus	Tadpole Madtom	A, B
Umbrae pygmaea	Eastern Mudminnow	A, B

Source: Preliminary Report on Field Studies for the Environmental Impact Statement, Malcolm Pirnie, 1990.

TABLE 4-46

INVERTEBRATE SPECIES OF COHOKE MILL CREEK (1990)

Scientific Name	Common Name	Location*
Argia spp.	Damselfly	A
Cicindela spp.	Tiger Beetle	A
Corydalus cornutus	Eastern Dobsonfly	A
Gerris spp.	Water Strider	B
Palaemonetes paludosus	Grass Shrimp	A
Procambarus spp.	Crayfish	A

Source: Preliminary Report on Field Studies for the Environmental Impact Statement, Malcolm Pirnie, 1990.

TABLE 4-47

FISH SPECIES OF COHOKE MILLPOND (1992)

Scientific Name	Common Name	Location*
Erimyzon oblongus	Creek Chubsucker	C
Lepomis gibbosus	Pumpkinseed	C
Lepomis gulosus	Warmouth	C
Lepomis macrochirus	Bluegill	C
Lepomis microlophus	Redear Sunfish	C
Micropterus salmoides	Largemouth Bass	C
Notemigonus crysoleucas	Golden Shiner	C
Perca flavescens	Yellow Perch	C
Pomoxis nigromaculatus	Black Crappie	C

Source: Boat electrofishing results from a November 1992 survey conducted by the VDGIF (D. C. Dowling, VDGIF, personal communication, 1992).

Construction of new pipeline associated with this alternative would require minor crossings of 9 perennial and 17 intermittent streams. Fish species expected to occur in these streams would be similar to those found in freshwater tributaries of the Chesapeake Bay (see Table 4-39). Invertebrate species found within intermittent and perennial streams crossed by the pipeline are expected to be typical of freshwater invertebrates of the Lower Peninsula (see Table 4-31).

Major crossings of the Pamunkey River and an arm of Little Creek Reservoir would also be required for this alternative. Fish and invertebrate species present in the Pamunkey River are discussed in Section 4.3.1 and listed in Tables 4-26 and 4-27, respectively. Fish species present in Little Creek Reservoir are discussed in Section 4.3.4. Invertebrate species within the Little Creek Reservoir pool area are expected to be typical of those found in freshwater regions of the Lower Peninsula (see Table 4-31).

Other Wildlife

Intake

Field studies of the proposed intake site were conducted by Malcolm Pirnie during the Spring of 1990 to determine the feasibility of the site as a potential raw water intake/pumping station location (Malcolm Pirnie, 1990). Based on review of color-infrared aerial photography, vegetation community types at the site were classified according to Anderson et al. (1976). Community types adjacent to the intake area include coniferous forest, deciduous forest, mixed forest, old field, and wetlands. Wildlife species typical of these community types are included in ***Alternatives Assessment (Volume II - Environmental Analysis)*** (Malcolm Pirnie, 1993) Section 6.6.3, which is appended to this document.

Reservoir

To determine the potential wildlife species within the reservoir drainage area, color-infrared aerial photography of the proposed reservoir site was examined. Based on this review, community types were classified according to Anderson et al. (1976). The VDGIF was also contacted and the BOVA database was also examined. Based on this information, a listing of wildlife species having the potential to occur at the proposed site was compiled based on community types. In addition, Malcolm Pirnie biologists conducted field studies at the King William Reservoir site during May and June 1990. Wildlife species noted during these investigations are listed below:

- Painted Turtle (*Chrysemys picta*)
- Sharp-shinned Hawk (*Accipiter striatus*)
- Red-winged Blackbird (*Agelaius phoeniceus*)
- Wood Duck (*Aix sponsa*)
- Great Blue Heron (*Ardea herodias*)
- Red-tailed Hawk (*Buteo jamaicensis*)

- Belted Kingfisher (*Megaceryle alcyon*)
- Wild Turkey (*Meleagris gallopavo*)
- Beaver (*Castor canadensis*)

According to Anderson's methodology and field inspections, vegetation community types in the reservoir drainage area including the pool area were estimated to consist of 1,773 acres of coniferous forest, 1,671 acres of deciduous forest, 2,381 acres of mixed forest, 1,966 acres of agricultural, residential, and open field communities, and 479 acres of wetlands and open water communities. The remaining area consists of roads with minimal wildlife habitat value. Wildlife species typical of these community types are included in ***Alternatives Assessment (Volume II - Environmental Analysis)*** (Malcolm Pirnie, 1993) Section 6.6.3, which is appended to this report.

Vegetation community types in the reservoir pool area were estimated to consist of 229 acres of coniferous forest, 750 acres of deciduous forest, 609 acres of mixed forest, 160 acres of agricultural/open field communities, and 479 acres of wetlands and open water. The remaining area consists of roads which have limited habitat value.

Typical mammals, birds, amphibians and reptiles in the project vicinity are expected to be the same a those identified in Section 4.3.1 for Ware Creek.

Mature forested areas and forest edge habitat in the project area are described in Section 4.3.1 in reference to the habitat value of these areas to wildlife species.

Pipeline

Assuming a pipeline right-of-way width of 50 feet, a new pipeline would disturb approximately 94 acres of land (excluding Pamunkey River and Little Creek Reservoir crossings and directional drill segment below high ground). Existing vegetation community types along the proposed pipeline route were identified through review of USGS topographic mapping, and color-infrared aerial photography.

A 4.3-mile portion of the pipeline route would follow existing rights-of-way through King William, New Kent, and James City counties. Because these areas are periodically mowed, vegetation would remain in early successional stages. Wildlife species found in these areas would be similar to those found in agricultural fields. Along the remainder of the route, which encompasses approximately 12.7 miles, the pipeline would primarily traverse mixed forested and agricultural lands. Wildlife species typical of these community types are included in ***Alternatives Assessment (Volume II - Environmental Analysis)*** (Malcolm Pirnie, 1993) Section 6.6.3, which is appended to this document.

<u>Sanctuaries and Refuges</u>

No existing designated sanctuaries or refuges are located within the vicinity of the proposed intake at Scotland Landing, King William Reservoir watershed, or pipeline routes for this alternative (VDCR, 1989; Delorme Mapping Company, 1989; KWCPD, 1991; JCC, 1991).

Wetlands and Vegetated Shallows

Intake

Tidal freshwater marshes and swamps are found along the Mattaponi River from Gleason Marsh (southwest of Truhart) upstream to the Village of Aylett (Silberhorn and Zacherle, 1987; Doumlele, 1979). These freshwater wetlands are similar to those tidal wetlands found on the Pamunkey River (see Section 4.3.1).

The Scotland Landing intake site was inspected by Malcolm Pirnie biologists in January 1989 and by SDN Water Resources engineers in October 1989. The site consists of a large tract of upland situated on a small bluff well above the floodplain of the Mattaponi River. No wetlands are found within the footprint of the proposed pump station site; scouring on the outside bend of the river has prevented the accumulation of fringe wetlands on the southern bank of the Mattaponi.

An extensive tidal freshwater marsh is located directly across from the intake site, on the King and Queen County side of the Mattaponi River. This marsh is dominated by herbaceous species such as Pickerelweed, Arrow Arum, Spatterdock, Wild Rice, and Beggar Ticks with lesser amounts of smartweeds, Arrow-leaved Tearthumb (*Polygonum sagittatum*), Rice Cutgrass, and Walter's Millet (*Echinochloa walteri*) (Priest et al., 1987).

A small tidal freshwater marsh is located about 500 feet downstream from the intake site on the south side of the Mattaponi. This small "pocket" marsh is dominated by Sweet Flag (*Acorus calamus*), Pickerelweed, Arrow Arum, and Spatterdock (Silberhorn and Zacherle, 1987).

Reservoir

Wetlands at the proposed King William Reservoir site have been identified and delineated using the ***Corps of Engineers Wetland Delineation Manual*** (USCOE, 1987). The methodology used to delineate wetlands at the site included a combination of in-house and routine on-site methods for estimating wetland impacts. A detailed description of the methodology used to conduct the delineation is presented in the report ***Wetland Delineation of King William, Ware Creek and Black Creek Reservoir Sites*** (Malcolm Pirnie, 1994) which is appended to this document as Report F.

Available information from existing map sources was first compiled in-house to identify wetland acreage at the site. The following wetland acreages were obtained through interpretation of the listed map sources for the proposed King William Reservoir site:

Map Source	Acres of Wetlands
USFWS NWI Maps	293
SCS Soils Maps	554
Aerial Photo Estimate [1]	500
Notes: [1] Malcolm Pirnie aerial photo estimate, based only on interpretation of photography	

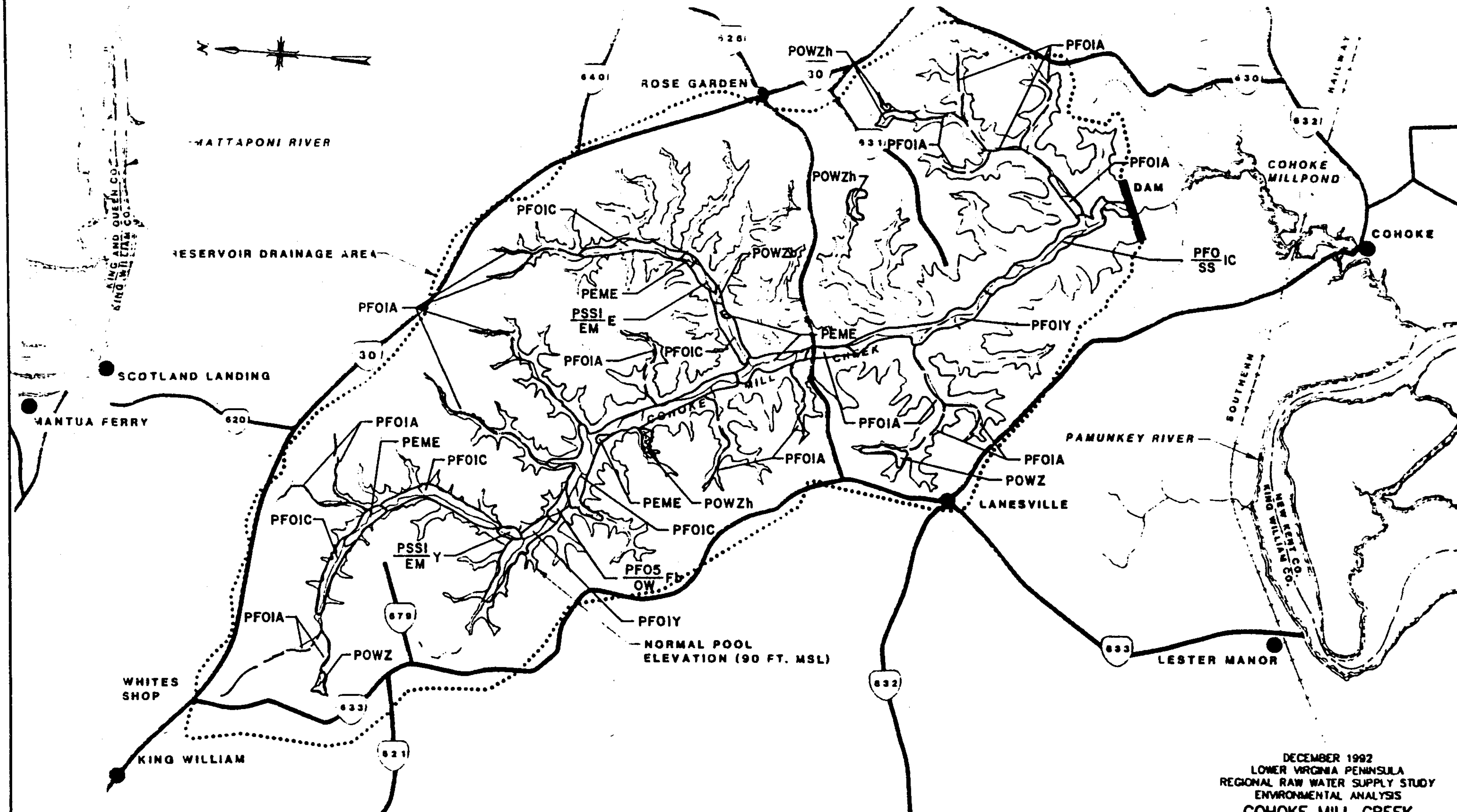
Because review of these individual sources did not result in similar wetland acreage estimates, color-infrared aerial photography of the site was obtained. Detailed wetland mapping of the proposed reservoir area was conducted by compiling the following map sources:

- USGS Topographic Maps - New Kent, King and Queen Courthouse, and King William Quadrangles (Scale: 1 inch = 2,000 feet)
- USFWS NWI maps - New Kent, King and Queen Courthouse, and King William Quadrangles (Scale: 1 inch = 2,000 feet)
- SCS Soils Maps, 1990 (Scale 1 inch=1,320 feet)
- Aerial Photography - 1982 NHAP (Scale 1 inch = 1,270 feet; Date flown; 3/29/82)
- Aerial Photography - 1989 Air Survey Corporation maps (Scale 1 inch= 200 feet, and 1 inch = 1,000 feet; Date flown; 3/7/93)

A preliminary wetlands map was developed using the 1982 NHAP 1 inch = 1,270 feet as a base and overlaying the USGS topographic maps adjusted to the same scale. The 1993 photography (scale 1 inch = 1,000 feet) was used to verify areas on the NHAP mapping that were difficult to interpret.

Once the preliminary map was completed, field studies were conducted to verify the accuracy of the mapping. Virtually the entire proposed reservoir perimeter was inspected, and the wetland line adjusted in several places. A summary of the field work is presented in the report ***Wetland Delineation of King William, Ware Creek and Black Creek Reservoir Sites*** (Malcolm Pirnie, 1994) (see Report F). Based on this analysis, there are 479 acres of wetlands that would be impacted at the King William Reservoir site below an elevation of 90 feet MSL (spillway elevation). Further verification of this estimate will be conducted in 1994 and included in the Final EIS for public review.

General wetland areas at the King William Reservoir site, based on USFWS NWI maps are presented in Figure 4-5. The ten wetland categories identified from NWI mapping



DECEMBER 1992
LOWER VIRGINIA PENINSULA
REGIONAL RAW WATER SUPPLY STUDY
ENVIRONMENTAL ANALYSIS

COHOKE MILL CREEK WETLANDS LOCATED WITHIN THE IMPOUNDMENT AREA

3,000 0 3,000
APPROX. SCALE IN FEET

MALCOLM PIRNIE

are presented in Table 4-48. Detailed descriptions and a map of wetlands at the site delineated using the RRWSG methodology described above are presented in Report F.

Typical species found in non-tidal forested wetlands include Red Maple, Smooth Alder (*Alnus serrulata*), Bayberry (*Myrica cerifera*), Sycamore, River Birch, Silky Dogwood (*Cornus amomum*), and various sedges, rushes, cattails, ferns, and grasses. Dominant species in palustrine forested/scrub-shrub wetlands include Smooth Alder, Bayberry, Silky Dogwood, Buttonbush, and various young maples, ashes, gums, and willows. Dominant species in palustrine emergent wetlands at the site include sedges (*Carex spp.*), Soft Rush, Arrow Arum, Sensitive Fern, Switch Grass (*Panicum virgatum*), Smartweeds, Pickerelweed, Woolgrass Bulrush, Marsh Fern (*Thelypteris thelypteroides*), and Broad-leaved Cattail (*Typha latifolia*), with American Beech (*Fagus grandiflora*) and American Holly (*Ilex opaca*) in drier portions. Palustrine open water wetlands, palustrine scrub-shrub/palustrine emergent wetlands and palustrine forested/palustrine open water wetlands are also located within the proposed reservoir area.

A wetland evaluation was completed for the non-tidal wetlands that would be affected by the construction of King William Reservoir. The USCOE Wetland Evaluation Technique (WET) model was utilized to assess the functional values of on-site wetlands at Cohoke Mill Creek. Results of the WET analysis are summarized in Table 4-49.

Pipeline

Wetland crossings along the 17 miles of new pipeline would occur at 9 perennial and 17 intermittent stream crossings. The majority of affected wetlands would be palustrine forested, broad-leaved deciduous wetlands. Typical tree species of these Virginia Coastal Plain palustrine systems include Sweetgum, River Birch, Black Gum, Red Maple, Green Ash, and Sycamore.

The pipeline would also cross the Pamunkey River and the open water of an arm of Little Creek Reservoir.

<u>Mud Flats</u>

No mud flats are located in the immediate vicinity of the intake site at Scotland Landing on the Mattaponi River based on review of USGS topographic maps and USFWS NWI maps; however, mud flats are located 3,500 feet upstream of the intake site and 2,200 feet downstream of the intake site.

No mud flats were identified within the proposed reservoir area or below the proposed dam site on Cohoke Mill Creek. Also, no mud flats were identified along the pipeline route.

4.3.4 Fresh Groundwater Development

<u>Endangered, Threatened, or Sensitive Species</u>

Project review conducted by the VDCR, VDGIF, and VDACS identified no known natural heritage resources or endangered or threatened animal, plant or insect species at the eight proposed groundwater well locations at Diascund Creek and Little Creek reservoirs (T. J. O'Connell, VDCR, personal communication, 1992; H. E. Kitchel, VDGIF, personal communication, 1992; J. R. Tate, VDACS, personal communication, 1992).

Fish and Invertebrates

Diascund and Little Creek reservoirs are currently monitored by a fishery management program in cooperation with the VDGIF. Fish stocking of the Little Creek Reservoir was initiated in 1982 and continued through 1992. Species stocked include Largemouth Bass, Bluegill, Blue Catfish, Channel Catfish, and Walleye (D. L. Fowler, VDGIF, personal communication, 1992). Fish surveys conducted by VDGIF in 1990 revealed that Bluegill, Red-ear Sunfish, Blueback Herring, and Largemouth Bass were the most abundant fish species in Little Creek Reservoir.

Fish species stocked at Diascund Creek Reservoir between 1969 and 1980 include Red-ear Sunfish, Northern Pike, Muskellunge, and Channel Catfish (D. L. Fowler, VDGIF, personal communication, 1992). Fish surveys conducted by VDGIF in 1990 revealed that Bluegill, Largemouth Bass, Yellow Perch, and Red-ear Sunfish were the most abundant fish species in Diascund Creek Reservoir.

Invertebrate species present in these two reservoirs would be typical of those found in freshwater regions of the Lower Peninsula (see Table 4-31).

Other Wildlife

Existing vegetation community types in the vicinity of proposed groundwater well locations along the perimeter of Diascund Creek and Little Creek reservoirs were identified based on review of USGS topographic maps and color-infrared aerial photography. Vegetation community types were classified according to Anderson et al. (1976). Based on this analysis, the predominant vegetation community type within the proposed impact area would be mixed forested. Wildlife species typical of this community type are included in ***Alternatives Assessment (Volume II - Environmental Analysis)*** (Malcolm Pirnie, 1993) Section 6.6.1, which is appended to this document.

Sanctuaries and Refuges

There are no existing designated sanctuaries or refuges in the immediate vicinity of the proposed groundwater well locations at Diascund Creek and Little Creek Reservoirs.

Wetlands and Vegetated Shallows

The eight proposed well sites located at Little Creek and Diascund Creek reservoirs are all located in upland areas. The discharge pipelines to the reservoirs would not cross wetland areas, assuming that the pipelines would travel the shortest distances to stream beds.

Mud Flats

No mud flats are located in the vicinity of proposed groundwater wells or associated pipelines and outfall structures at Diascund Creek or Little Creek Reservoirs.

TABLE 4-48

WETLAND CATEGORIES AT THE COHOKE MILL CREEK IMPOUNDMENT SITE

USFWS Ecological Classification	Wetland Description
PFO5/OWFb	Palustrine forested dead; open water, semi-permanent, beavers
POWZb	Palustrine open water, intermittently exposed/permanent, beavers
PSS1/EMY	Palustrine scrub-shrub, broad-leaved deciduous, emergent, saturated/semi-permanent/seasonals
PSS1/EME	Palustrine scrub/shrub, broad-leaved deciduous, emergent, seasonal saturated
PEME	Palustrine emergent, seasonal saturated
PFO/SS1C	Palustrine forested broad-leaved deciduous;scrub-shrub, seasonal
FLO1Y	Palustrine forested broad-leaved deciduous, saturated/semi-permanent/seasonals
PFO1C	Palustrine forested broad-leaved deciduous, seasonal
PFO1A	Palustrine forested broad-leaved deciduous, temporary
POWZh	Palustrine open water, intermittently exposed/permanent, diked/impounded

Source: USFWS NWI maps for the King William, King and Queen Court House, New Kent, and Tunstall, Virginia Quadrangles (1" = 2,000' scale).

TABLE 4-49

SUMMARY OF WET ANALYSIS RESULTS
KING WILLIAM RESERVOIR WETLANDS

Function/Value	Evaluation Criteria		
	Social Significance	Effectiveness	Opportunity
Groundwater Recharge	M	L	*
Groundwater Discharge	H	M	*
Floodflow Alteration	M	H	M
Sediment Stabilization	M	H	*
Sediment/Toxicant Retention	M	H	H
Nutrient Removal/Transformation	H	L	H
Production Export	*	M	*
Wildlife Diversity/Abundance	H	*	*
Wildlife Diversity/Abundance (Breeding)	*	H	*
Wildlife Diversity/Abundance (Migration)	*	H	*
Wildlife Diversity/Abundance (Wintering)	*	H	*
Aquatic Diversity/Abundance	M	L	*
Uniqueness/Heritage	H	*	*
Recreation	L	*	*

Note: "H" = High
"M" = Moderate
"L" = Low
"*" = Functions and values are not evaluated by the WET program.

4.3.5 Groundwater Desalination in Newport News Waterworks Distribution Area

Endangered, Threatened, or Sensitive Species

The VDCR has records of Loesel's Twayblade (*Liparis loeselii*) along State Route 641 near Jones Pond in York County. This very rare fen orchid does not have federal or state legal status, nor is it a candidate for listing. The concentrate pipeline for the Site 2 (Upper York County) facilities would parallel a portion of State Route 641 on the southwest side of Interstate 64 before crossing the interstate along Route 641. However, after crossing to the northeast side of Interstate 64, the pipeline would leave Route 641 and avoid portions of the road which are located near Jones Pond. Therefore, negative impacts to Loesel's Twayblade are not anticipated as a result of the proposed concentrate pipeline construction.

VCDR did not identify any natural heritage resources in the other groundwater desalination project areas (T. J. O'Connell, VDCR, personal communication, 1993).

Fish and Invertebrates

Wells would be installed at finished water storage and distribution locations within the City of Newport News and on existing Newport News Waterworks property in York County. Because withdrawal locations are spread evenly across the service area, the amount of pipeline required is reduced, and the local groundwater levels would not be as deeply depressed. Therefore, potential impacts to the Coastal Plain aquifer system, and the surface water bodies which recharge the aquifers, would be minimized. Any potential effects on fish and invertebrates due to groundwater withdrawals should be negligible.

The Site 1 (Copeland Industrial Park Ground Storage Tank) concentrate discharge pipeline route would not cross any streams. The outfall would discharge into Hampton Roads. Fish and invertebrate species typical of this water body would be typical of those found in the polyhaline waters (18 to 30 ppt salinity) of the lower Chesapeake Bay.

The Site 2 (Upper York County Ground Storage Tank) concentrate discharge pipeline route would cross one perennial tributary of Jones Millpond and one intermittent tributary of Jones Millpond. Centrarchid (i.e. sunfish) species would most likely dominate in this habitat type. Fish species occurring in this water body would be similar to those listed in the freshwater tributaries of the Chesapeake Bay (see Table 4-39). Invertebrate species would be similar to those listed in Table 4-27. The proposed concentrate pipeline would discharge into polyhaline waters on Queens Creek, a tributary of the York River.

The Site 3 (Harwood's Mill WTP Clearwell) concentrate discharge pipeline route would cross one perennial and one intermittent stream. Fish and invertebrate species present in these streams would be similar to those listed in Tables 4-39 and 4-27, respectively. The concentrate pipeline outfall would be on the Poquoson River in polyhaline waters.

The Site 4 (Lee Hall WTP Clearwell) concentrate discharge pipeline route would not cross any streams. The outfall at Skiffe's Creek would occur in waters which are typically mesohaline and sometimes oligohaline. Anadromous and resident fish surveys were conducted on Skiffe's Creek in April 1990 and August 1990, respectively (International

Science & Technology, 1990). Fish species identified during these surveys are listed in Table 4-50.

Other Wildlife

Each of the wells and associated RO (reverse osmosis) treatment plants are within the City of Newport News or on existing Newport News Waterworks property, within urbanized areas. A maximum area of disturbance of approximately 1 acre would be required for each well and treatment plant. Assuming a maximum pipeline right-of-way width of 40 feet, an additional 65 acres would be disturbed to construct 13.4 miles of new pipeline. The majority of the alternative sites are located in developed areas. Wildlife species typical of these areas would be similar to those found in agricultural fields (see ***Alternatives Assessment (Volume II - Environmental Analysis***) (Malcolm Pirnie, 1993)), but because of the proximity of human activity, species diversity would be expected to be limited.

Sanctuaries and Refuges

There are no existing designated sanctuaries or refuges within the project areas associated with this alternative.

Wetlands and Vegetated Shallows

The facilities at Site 1 (Copeland Industrial Park Ground Storage Tank) would not affect wetland areas. The proposed concentrate discharge pipeline would run southeast along Chestnut Avenue, to Oak Avenue, to Hampton Avenue, and terminate at Anderson Park emptying directly into Hampton Roads. This pipeline would not cross any wetlands between the Copeland Industrial Park and Anderson Park. The outfall structure and associated rip-rap would affect an estuarine intertidal flat, regularly inundated wetland (E2FLN).

The Site 2 (Upper York County Groundwater Storage Tank) facilities would include concentrate pipeline crossings of one perennial and one intermittent stream. The concentrate discharge pipeline would leave the Upper York County site and follow State Route 641/642, cross under Interstate 64, cross the Cheatham Annex railroad spur, follow Winchester Road, run due north parallel to the Cheatham Annex - Jones Pond area property line, and cross the Colonial National Historic Parkway, eventually emptying into Queens Creek, approximately 5,500 feet upstream from its confluence with the York River. The outfall structure and associated rip-rap would affect estuarine intertidal emergent, irregularly inundated wetlands (E2EMP).

The Site 3 (Harwood's Mill WTP Clearwell) facilities would include concentrate pipeline crossings of one perennial and one intermittent stream. The concentrate discharge pipeline would leave the Harwood's Mill site and run north on U.S. Route 17, northeast on Lakeside Drive, and east on Dare Road, eventually emptying into the Poquoson River south of Hodges Cove. The outfall structure and associated rip-rap would affect an estuarine intertidal, open water wetland (E2OWN).

The facilities at Site 4 (Lee Hall WTP Clearwell) would not affect wetland areas. The concentrate discharge pipeline would leave the Lee Hall site and run north, cross U.S. Route 60, and head west on Picketts Line and Enterprise Drive, eventually emptying into

TABLE 4-50

FISH SPECIES OF SKIFFE'S CREEK (1990)

Scientific Name	Common Name
Alosa sapidissima	American Shad
Anchoa mitchilli	Bay Anchovy
Brevoortia tyrannus	Atlantic Menhaden
Cynoscion regalis	Weakfish
Dorosoma cepedianum	Gizzard Shad
Fundulus majalis	Striped Killifish
Ictalurus catus	White Catfish
Ictalurus melas	Black Bullhead
Ictalurus punctatus	Channel Catfish
Leiostomus xanthurus	Spot
Menidia beryllina	Inland Silverside
Micropogonias undulatus	Atlantic Croaker
Morone americana	White Perch
Morone saxatilis	Striped Bass
Mugil cephalus	Striped Mullet
Pomatomus saltatrix	Bluefish
Trinectes maculatus	Hogchoker
Source: International Science & Technology, 1990.	

Skiffe's Creek adjacent to the Oakland Industrial Park. The outfall structure and associated rip-rap would affect estuarine intertidal emergent, irregularly inundated wetlands (E2EMP).

There is no submerged aquatic vegetation (SAV) found in the vicinity of the Queens Creek, Skiffe's Creek, or Hampton Roads concentrate discharge points. SAV beds are found 2,900 feet east of, and 1,100 feet northeast of, the Poquoson River discharge point. Ground-truth surveys completed in 1989 and 1990 by VIMS in conjunction with the SAV publication listed above reported that Eelgrass (*Zostera marina*) and Widgeongrass (*Ruppia maritima*) were the dominant species in these SAV beds.

Mud Flats

The facilities at Site 1 (Copeland Industrial Park Ground Storage Tank) would not affect mud flat areas. The concentrate discharge pipeline would not cross mud flat areas between Copeland Industrial Park and Anderson Park. However, mud flats do exist at the location of the proposed concentrate pipeline outfall structure and associated rip-rap.

The facilities at Site 2 (Upper York County Ground Storage Tank) would not affect mud flat areas. The concentrate discharge pipeline would not cross mud flats between the Upper York County site and the Queens Creek outfall structure. No mud flats were identified in the immediate vicinity of the outfall structure on Queens Creek based on review of USGS topographic maps and USFWS NWI maps; however, mud flats are located 400 feet upstream and 500 feet downstream of the discharge area.

No mud flats were identified in the project areas for the proposed facilities at Site 3 (Harwood's Mill WTP Clearwell) and Site 4 (Lee Hall WTP Clearwell).

4.3.6 Use Restrictions

Endangered, Threatened, or Sensitive Species

The implementation of the Use Restrictions alternative should not affect endangered, threatened, or sensitive species.

Fish and Invertebrates

The implementation of the Use Restrictions alternative should have no effect on fish and invertebrate species on the Lower Peninsula.

Other Wildlife

The implementation of the Use Restrictions alternative should have no effect on existing wildlife on the Lower Peninsula.

Sanctuaries and Refuges

The implementation of the Use Restrictions alternative should have no effect on sanctuaries or refuges in the region.

Wetlands and Vegetated Shallows

The implementation of the Use Restrictions alternative would have no effect on wetlands in the region.

Mud Flats

The implementation of the Use Restrictions alternative would have no effect on mud flats in the region.

4.3.7 No Action

Endangered, Threatened, or Sensitive Species

Endangered, threatened, and sensitive species within project areas are described in Sections 5.3.1 through 5.3.6.

Fish and Invertebrates

Fish and invertebrates within project areas are described in Sections 5.3.1 through 5.3.6.

Other Wildlife

Wildlife species dependent on communities within project areas are identified in Sections 4.3.1 through 4.3.5.

Sanctuaries and Refuges

If no action is taken to augment the existing water supplies on the Lower Peninsula, existing designated sanctuaries and refuges would not be affected.

Wetlands and Vegetated Shallows

The No Action alternative would require that the RRWSG jurisdictions increasingly rely on existing reservoirs to satisfy growing water demands. The Harwood's Mill, Lee Hall, Skiffe's Creek, Diascund Creek, Little Creek, Waller Mill, and Big Bethel impoundments would be utilized to supply larger amounts of raw water. As a result, these reservoirs would be increasingly drawn down to levels which could negatively effect adjacent wetland communities.

Wetlands within project areas are described in Sections 4.3.1 through 4.3.5.

Mud Flats

The No Action alternative would result in more frequent and severe drawdowns in existing water supply reservoirs serving the Lower Peninsula. Mud flats along the peripheral areas of reservoirs would, therefore, be more exposed to the atmosphere.

4.4 CULTURAL RESOURCES

The cultural resources impact category was developed, in part, from a portion of the Clean Water Act Section 404 (b)(1) Guidelines which addresses potential effects on human use characteristics (40 CFR § 230.54). In addition, Section 106 of the National Historic Preservation Act of 1966 (16 U.S.C. § 470(f)) requires that the head of any Federal department or independent agency having authority to license any undertaking shall, prior to the issuance of the license, take into account the effect of the undertaking on any district, site, building, structure, or object that is included in or eligible for inclusion in the National Register of Historic Places (see generally 36 CFR § 800).

In Virginia, the Director of the Virginia Department of Historic Resources (VDHR) functions as the State Historic Preservation Officer, and is responsible for conducting review of projects involving federal action to assure their compliance with Section 106.

The VDHR designates cultural resources as archaeological and architectural resources. Archaeological resources are further categorized as prehistoric and historic sites. Prehistoric sites date from B.C. to 1700 and frequently include Native American sites; historic sites date from 1700 to the present. Architectural sites include structures or structural remains, which either date back in time and/or are unique enough to be considered culturally significant.

4.4.1 Ware Creek Reservoir with Pumpover from Pamunkey River

Intake

The proposed intake site on the Pamunkey River was investigated in conjunction with the ***Phase IA Cultural Resource Survey for the Proposed King William Reservoir, King William County, Virginia and the Proposed Black Creek Reservoir, New Kent County, Virginia*** (MAAR Associates, 1994), which is appended to this document as Report G. While a complete Phase IA Survey was not conducted for the pump station site, the area was examined as part of the study. The study identified the presence of one prehistoric site at the proposed pump station site on the Pamunkey River, and indicated that it is likely that other sites may be present in floodplain areas.

VDHR records indicate that there is an architectural resource in the vicinity of the proposed Pamunkey River withdrawal site at Northbury. "Chericoke" is located in King William County approximately 0.7 miles north of the Northbury withdrawal site. This site is designated as 50KW13 by the VDHR.

The proposed intake site at Northbury was also evaluated by the USCOE feasibility study (1984). While the general project area was defined as having a high potential for cultural resources, no known sites were identified in the vicinity of the proposed intake site.

Reservoir

In the USCOE's (1984) evaluation of Ware Creek Reservoir, the "Stonehouse" archaeological site was identified as being located adjacent to the proposed dam and roadway. This site is listed on the National Register of Historic Places.

A coordination meeting to discuss cultural resource studies associated with RRWSG water supply alternatives was held at the Virginia Department of Historic Resources (VDHR) offices on April 22, 1993. Representatives from the VDHR, USCOE, RRWSG, MAAR Associates and Malcolm Pirnie were in attendance. It was agreed at this meeting that the RRWSG would rely on the report ***A Phase I Archaeological Survey of the Proposed Ware Creek Reservoir Area - James City and New Kent Counties, Virginia*** (Hunter and Kandle, 1986) to obtain cultural resources information for the proposed Ware Creek Reservoir area.

In the report by Hunter and Kandle (1986), the identification of resources was limited to the area at and below the proposed 35-foot normal pool elevation. Approximately 45 percent of the total pool area was surveyed, and it was estimated that 85 percent of high probability areas of the entire pool area were examined in this survey. A total of 45 prehistoric and historic-period sites were identified at or below the 35-foot contour level, and an estimated 10 additional sites may be found in the unsurveyed portion of the project site. The report cited that an additional 16 historic-period sites are listed in the general project area.

Pipeline

Six known cultural resource sites identified through review of VDHR records are located along the proposed pipeline route for this alternative component, and are listed below along with their VDHR identification codes:

Historic Sites:

- Unnamed site (44NK81). This site is classified as an historic, domestic site. It was last investigated in December 1979.

- Mrs. Hockaday's House (44JC269). This site is classified as a domestic site and was most recently investigated in November 1983.

- Boswell House (44JC297). This site is classified as a domestic site and was most recently investigated in November 1983.

Architectural Site:

- Saint Peter's Church (63NK27). This church is listed on the National Register of Historic Places and is currently used for regular church services. The proposed pipeline route would transect the registered acreage of the property.

- Burnt Ordinary (47JC63). This site houses an 18th century tavern which was burnt during the revolution. It was most recently investigated in July 1971.

- Slater House (47JC19).

In addition to the above listed sites, several archaeological sites are located within the vicinity of the proposed pipeline route through the community of Toano.

4.4.2 Black Creek Reservoir with Pumpover from Pamunkey River Intake

Cultural resources in the vicinity of the proposed Pamunkey River intake site at Northbury are discussed in Section 4.4.1.

Reservoir

A Phase IA Cultural Resources Survey was conducted for the proposed Black Creek Reservoir area in New Kent County during the summer of 1993 by MAAR Associates, Inc. This survey is described in ***Phase IA Cultural Resource Survey for the Proposed King William***

Reservoir King William County, Virginia and the Proposed Black Creek Reservoir, New Kent County, Virginia (MAAR Associates, 1994) which is appended to this document as Report G.

Research for the Phase IA survey included literature and archival review. Materials reviewed included:

- Archaeological and architectural site files at the VDHR.
- Maps at the Virginia State Library, the Virginia Historical Society, the Library of Congress, and the National Archives.
- Secondary historic sources identified at Swem Library at The College of William and Mary.
- Museums at the Mattaponi and Pamunkey Indian reservations in King William County.

Architectural resources greater than 50 years old in the immediate vicinity of the reservoir site were also inventoried.

Additional steps in the study included the development of a predictive model for the reservoir site using data from two previous reservoir studies conducted in similar environments. A field reconnaissance was also conducted on accessible tracts of the site and on some associated pipeline routes.

No previously identified prehistoric archaeological sites were identified in the Black Creek Reservoir area. Only one previously recorded architectural site, Crump's Mill, is located within the reservoir area. Available information from the VDHR on the identified site and its VDHR identification code are presented below:

- Crump's Mill (63NK70). The mill dates from the 18th century and has undergone renovations. It is believed that the mill was earlier "Clopton's Mill" which was owned by the Clopton family whose home stood in the vicinity of the site. The mill is located within the boundaries of the proposed reservoir site and would be inundated with a normal pool elevation of 100 feet msl.

The predictive model for the Black Creek Reservoir area, based on soil types and topography, suggest that there should be few, if any, prehistoric sites located in the impoundment area.

The Phase IA Cultural Resources Survey report by MAAR Associates (1994) was reviewed, in draft form, by the VDHR in the Fall of 1993 (H. B. Mitchell, VDHR, personal communication, 1993). Comments received from the VDHR are appended to the MAAR report, which is appended to this document as Report G. The proposed Black Creek Reservoir project was cited as having the potential for adverse effects on the following four properties (VDHR and MAAR identification codes are listed):

- Crump's Mill (VDHR 63-70)

- Iden (VDHR 63-41; MAAR 2)
- VDHR 63-203 (MAAR 13)
- VDHR 63-178 (MAAR 70)

The New Kent County Historical Society has indicated that there are 14 additional known historic sites in the vicinity of the proposed Black Creek Reservoir site (J. M. H. Harris, New Kent County Historical Society, personal communication, 1992):

- McKay House and Route 606 - located outside the reservoir watershed.
- Brickhouse site - located within the reservoir normal pool area.
- Water Mill - located within the reservoir normal pool area.
- Mt. Prospect - located within the reservoir watershed.
- Longquarter - located within the reservoir watershed.
- Cherry Lane - located within the reservoir watershed.
- Glebe House - located within the reservoir watershed.
- Wade House and Graveyard - located within the reservoir watershed.
- Grafts - located within the reservoir watershed.
- Nances - located within the reservoir watershed.
- Harrison House - located within the reservoir watershed.
- Ford House - located within the reservoir watershed.
- Crumps House - located within the reservoir normal pool area.
- Callowell-Clopton House - located within the reservoir watershed.

Pipeline

As part of the Phase IA Cultural Resources Survey conducted for the proposed Black Creek Reservoir (see Report G), information was collected to identify cultural resources which could be affected along some of the associated pipeline routes. However, a complete Phase IA Survey of the pipeline routes was not conducted. The pipeline route was identified as passing near two or three previously recorded sites west of Tunstall Station and two National Register sites (MAAR Associates, 1994). The closest previously recorded sites along the portion of the pipeline route from the pump station site to the reservoir site are designated as 44NK77 and 44NK81 by the VDHR. The two National Register sites are St.

Peter's Church and Marl Hill. Available information on the architectural sites is presented below.

Architectural Sites:

- Saint Peter's Church (63NK27). This church is listed on the National Register of Historic Places and is currently used for regular church services. It was originally built in 1701. The proposed pipeline route would transect the registered acreage of the property.

- Marl Hill (63NK19). This architectural site is listed on the National Register of Historic Places.

Pipeline routes which would connect the proposed reservoir with Diascund Creek Reservoir and the existing Waterworks system have some potential for cultural resources, but the route is likely to have fewer archaeological resources than the pipeline route from the Pamunkey River to the proposed reservoir (MAAR Associates, 1994).

Review of VDHR records for this alternative indicated that two additional archaeological sites are located along the pipeline route. Additional known archaeological resources are located within the vicinity of the pipeline. Available information on the identified sites and their VDHR identification codes are presented below.

Prehistoric Sites:

- 44JC642 - This site is classified as a possible campsite. It was last investigated in October 1990. Due to badly eroding site conditions, no further work was recommended.

- 44JC644 - This site is classified as a possible campsite. It was last investigated in October 1990. Due to badly eroding site conditions, no further work was recommended.

The USCOE's evaluation for this alternative component indicated that portions of the pipeline would be located in a region with a high potential for cultural resources (USCOE, 1984).

4.4.3 King William Reservoir with Pumpover from Mattaponi River Intake

Based on review of VDHR records, no known cultural resources occur within or directly adjacent to the proposed Mattaponi River intake and pump station site at Scotland Landing.

As part of the ***Phase IA Cultural Resource Survey for the Proposed King William Reservoir, King William County, Virginia and the Proposed Black Creek Reservoir, New Kent County, Virginia*** (MAAR Associates, 1994), which is appended to this document as Report G, the area was identified as having a high potential for cultural resources. This intake site was reviewed as part of the study, but a full Phase IA Survey was not conducted at the site.

Reservoir

The VDHR conducted a review of the project site in May 1992 and verified that there are no known cultural resources below the 110-foot contour elevation. However, three known historic structures exist above the 110-foot contour which could potentially be affected. These resources and their respective VDHR identification codes are identified below:

Architectural Sites:

- Canton (50KW11)
- Colosse Baptist Church (50KW15)
- Malbourne (50KW40)

A Phase IA Cultural Resources Survey was conducted for the proposed King William Reservoir area in King William County during the summer of 1993 by MAAR Associates, Inc. This survey is summarized in the Phase IA Cultural Resource Survey report (MAAR Associates, 1994).

Research for the Phase IA survey included literature and archival review. Materials reviewed included:

- Archaeological and architectural site files at the VDHR.
- Maps at the Virginia State Library, the Virginia Historical Society, the Library of Congress, and the National Archives.
- Secondary historic sources identified at Swem Library at The College of William and Mary.
- Museums at the Mattaponi and Pamunkey Indian reservations in King William County.

Architectural resources greater than 50 years old in the immediate vicinity of the reservoir site were also inventoried.

Additional steps in the study included the development of a predictive model for the reservoir site using data from two previous reservoir studies conducted in similar environments. A field reconnaissance was also conducted on accessible tracts of the site and on some associated pipeline routes.

No previously recorded cultural resources were identified in the King William Reservoir area. However, there are recorded historic structures in the vicinity of the reservoir site. The predictive model for the proposed King William Reservoir site, based on soil types and topography, suggests that there will be a relatively large number of prehistoric sites within the impoundment area. Field reconnaissance of the area resulted in the identification of an earthen dam, an ice house, and a total of six prehistoric sites.

The Phase IA Cultural Resources Survey report by MAAR Associates (1994) was reviewed, in draft form, by the VDHR in the Fall of 1993 (H. B. Mitchell, VDHR, personal communication, 1993). Comments received from the VDHR are appended to the MAAR report, which is appended to this document as Report G. No surveyed properties were identified as potentially being affected by the proposed project (H. B. Mitchell, VDHR, personal communication, 1993).

The King William County Historical Society has indicated that there are 15 additional known historic sites in the vicinity of the proposed King William Reservoir Site (S. A. Colvin, King William County Historical Society, personal communication, 1993):

- Mt. Hope - located within the reservoir watershed.
- Mt. Rose - located within the reservoir watershed.
- Free Hall - located within the reservoir watershed.
- Locust Hill - located within the reservoir watershed.
- Sheltons - located within the reservoir watershed.
- French Town - located within the reservoir watershed.
- Lilly Point - located within the reservoir watershed.
- Poplar Springs - located within the reservoir watershed.
- Brooks Springs - located within the reservoir watershed.
- Cedar Lane - located within the reservoir watershed.
- Rose Garden House - located within the reservoir watershed.
- Woodside - located within the reservoir watershed.
- Marl Hill - located within the reservoir watershed.
- Churchville - located outside the reservoir watershed.
- Bethany Church - located outside the reservoir watershed.

Pipeline

As part of the Phase IA Cultural Resources Survey conducted for the proposed King William Reservoir (see Report G), information was collected to identify cultural resources which could be affected along the associated pipeline routes. However, a complete Phase IA Survey of the pipeline routes was not conducted. Based on this study, it is likely that previously unidentified resources would be affected in these areas. The pipeline route was also identified as passing near to the site of Cook's Mill (44NK79) and traversing stream valleys which have a high potential for cultural resources.

Based on review of VDHR records, a total of three additional known archaeological sites, and no architectural sites, are identified by the VDHR as being located within or directly adjacent to the proposed pipeline route for this alternative component. Available information describing the identified sites and their respective VDHR identification codes are presented below:

- Hechler Quarry (44NK101). This site is classified as a "Village" and was last investigated in October 1983. No chronological placement has been identified.

Prehistoric Sites:

- 44JC642 - This site is classified as a possible campsite. It was last investigated in October 1990. Due to badly eroding site conditions, no further work was recommended.

- 44JC644 - This site is classified as a possible campsite. It was last investigated in October 1990. Due to badly eroding site conditions, no further work was recommended.

4.4.4 Fresh Groundwater Development

The VDHR conducted a search of its cultural resource site inventory for the project areas encompassed by the Fresh Groundwater alternative and identified two previously recorded archaeological sites in the vicinity of the Diascund Creek Reservoir well sites. However, VDHR indicated that impacts to these sites should not occur given the considerable distances which separate these sites from the project areas.

The VDHR identified seven archaeological sites in the vicinity of the Little Creek Reservoir well sites. All of these sites are 19th century domestic sites predicted to exist on the basis of historic maps. None of the sites have been verified through site visit. These sites' VDHR identified codes are: 44JC204, 44JC205, 44JC206, 44JC207, 44JC208, 44JC209, and 44JC263.

4.4.5 Groundwater Desalination in Newport News Waterworks Distribution Area

The VDHR conducted a search of its cultural resource site inventory for the project areas encompassed by this Groundwater Desalination alternative. The results of this search are summarized below for each of the four groundwater desalting project areas.

Site 1 - The VDHR did not identify any previously recorded archaeological sites within the Site 1 area.

Site 2 - The VDHR identified 47 previously recorded archaeological sites in close proximity to the Site 2 project area. The majority of these sites were identified in a survey of the York County New Quarter Park conducted in 1978. None of these sites have been evaluated for National Register eligibility. Of the four groundwater desalting project areas, VDHR believes that Site 4 has the greatest potential to affect previously unidentified archaeological sites.

Site 3 - The VDHR identified five previously recorded archaeological sites in close proximity to the Site 3 project area.

Site 4 - The VDHR identified 18 previously recorded archaeological sites in close proximity to the Site 4 project area. Of these 18 sites, 4 appear to be directly in the path of the proposed concentrate discharge pipeline. None of these sites have been evaluated for National Register eligibility. Of the four groundwater desalting project areas, VDHR believes that Site 4 has the greatest potential to affect previously unidentified archaeological sites.

4.4.6 Use Restrictions

Implementation of the Use Restrictions alternative would not affect any cultural resources.

4.4.7 No Action

If no action is taken by local purveyors to augment existing water supplies, there would be no affect on cultural resources within the region.

4.5 SOCIOECONOMIC RESOURCES

This section provides a general description of the socioeconomic environment in the vicinity of project areas for the alternatives. Socioeconomic resource categories by which the alternatives were evaluated are described below.

<u>Municipal and Private Water Supplies</u>
Municipal and private water supplies consist of surface water or groundwater which is directed to the intake of a municipal or private water supply system. This section identifies these resources in the vicinity of alternatives. The municipal and private water supplies impact category was developed directly from a portion of the Clean Water Act Section 404 (b)(1) Guidelines which addresses potential effects on human us characteristics (40 CFR § 230.50).

<u>Recreational and Commercial Fisheries</u>
Recreational and commercial fisheries consist of harvestable fish, crustaceans, shellfish, and other aquatic organisms used by man. This section describes the use of project areas for recreational and commercial fishing. The recreational and commercial fisheries impact category was developed directly from a portion of the Clean Water Act

Section 404 (b)(1) Guidelines which address potential effects on human use characteristics (40 CFR § 230.51).

Other Water-Related Recreation

Water-related recreation encompasses activities undertaken for amusement and relaxation. These activities include consumptive uses such as harvesting resources by hunting or fishing, and non-consumptive uses such as canoeing and sight-seeing. This section describes existing water-related recreational opportunities in project areas. The other water-related recreation impact category was developed directly from a portion of the Clean Water Act Section 404 (b)(1) Guidelines which address potential effects on human use characteristics (40 CFR § 230.52).

Aesthetics

Aesthetics applies to the perception of beauty by one or a combination of the senses of sight, hearing, touch, and smell. This section describes the aesthetic setting of each potential project site. The aesthetics impact category was developed from a portion of the Clean Water Act Section 404 (b)(1) Guidelines which address potential effects on human use characteristics (40 CFR § 230.53).

Parks and Preserves

This section describes the existing parks and preserves within proposed project ares. For purposes of this analysis, parks and preserves are defined as areas designated under federal, state, or local authority to be managed for their aesthetic, educational, recreational, or scientific value. Parks are more commonly designed to provide recreational and aesthetic benefits to the public, while preserves are commonly used for educational or scientific pursuits. The parks and preserves impact category was developed from a portion of the Clean Water Act Section 404 (b)(1) Guidelines which address potential effects on human use characteristics (40 CFR § 230.54).

Land Use

This section describes existing land uses within the proposed project areas. Current land use was determined primarily through review of aerial photography and contact with the jurisdictions involved. The land use impact category was developed as a public interest factor to consider pursuant to the National Environmental Policy Act.

Noise

This section discusses existing noise in the vicinity of each alternative component. The noise impact category was developed as a public interest factor to consider pursuant to the National Environmental Policy Act.

Infrastructure

This section describes the existing infrastructure in the vicinity of each alternative component. Transportation, utilities, and navigation are discussed. The infrastructure impact category was developed as a public interest factor to consider pursuant to the National Environmental Policy Act.

Direct, Indirect, and Cumulative Socioeconomic Impacts

The following indicators of the socioeconomic well-being of an area may be affected as a result of water supply development: regional population; existing land use; income and income distribution; property values; local tax base; existing lifestyles; residential, commercial, and industrial growth; and recreational services. The socioeconomic impacts category was developed as a public interest factor to consider pursuant to the National Environmental Policy Act.

4.5.1 Ware Creek Reservoir with Pumpover from Pamunkey River

Municipal and Private Water Supplies

Intake

An analysis of existing water use and cumulative streamflow reduction in the Pamunkey River basin was conducted. Total reported surface and groundwater withdrawals within the entire Pamunkey River basin, exclusive of power use and non-consumptive industrial cooling water withdrawals, averaged 20.2 mgd in the Year 1990 (P. E. Herman, SWCB, personal communication, 1993). However, surface water withdrawals made by Chesapeake Corporation which have recently been reported as 16.65 mgd (SWCB, 1988) must be added to this figure.

Additional water use for thermoelectric power generation was reported as 2,064.1 mgd for 1990, and is the largest single use of water within the basin. There are also many irrigators in the Pamunkey River basin whose total withdrawals between 1984 and 1991 averaged 496 million gallons per year (or 2.72 mgd assuming all irrigation occurs between April and September) (G. S. Anderson, USGS, personal communication, 1991; S. Torbeck, SWCB, personal communication, 1992). USGS hydrologists have estimated that the installed capacity of irrigation equipment along the Pamunkey River is approximately 25 mgd (Black & Veatch, 1989).

Summing all of the above withdrawal figures result in an estimated current average water withdrawal of 2,103.7 mgd within the Pamunkey River basin. Of this current estimated water demand in the basin (exclusive of Virginia Power and Chesapeake Corporation), 12 percent is for domestic, commercial, and institutional use; 12 percent is for irrigation; and 76 percent is for industrial and manufacturing purposes.

Actual net streamflow reductions would be less than total Pamunkey basin withdrawals since the 2,103.7-mgd figure includes all reported groundwater withdrawals and ignores surface water return flows such as wastewater treatment plant effluent and crop irrigation return flows (i.e., non-consumptive surface water withdrawals). Consumptive use is the portion of water withdrawn that is not returned to the resource because it has been evaporated, transpired, incorporated into products or crops, consumed by man or livestock, or otherwise removed from the water environment. The portion of the withdrawal that is not consumed is returned to the resource.

The ***York Water Supply Plan*** (SWCB, 1988) contains an estimated consumptive use factor of 0.44 for the Pamunkey River basin (excluding Chesapeake Corporation and Virginia Power withdrawals) which is based on published USGS data (Solley et. al., 1983). Applying this factor to reported average Year 1990 withdrawals (excluding Chesapeake Corporation and Virginia Power) and estimated irrigation withdrawals results in an estimated consumptive use of 10.1 mgd. Chesapeake Corporation's (West Point Facility) Pamunkey River withdrawals are non-consumptive industrial cooling water withdrawals. For Virginia Power, the SWCB (1988) has estimated that approximately 1.5 percent of the water withdrawn at Lake Anna is consumed. This equates to a Year 1990 consumptive use of 31.0 mgd at Lake Anna. Adding together all of the estimated consumptive uses results in an estimated Year 1990 consumptive use of 41.1 mgd within the entire Pamunkey River basin.

Total freshwater discharge at the mouth of the Pamunkey River is estimated at 879 mgd. Estimated Year 1990 consumptive water use in the basin represents 4.7 percent of the average discharge. A list and location map of major reservoirs, stream intakes, and groundwater withdrawals within the Pamunkey River basin is presented in Table 4-51 and Figure 4-6.

Reservoir

Effective March 25, 1991, the SWCB granted Stonehouse, Inc. the right to withdraw a total of 184,096,600 gallons per month (6.05 mgd) from its 10 wells within the Ware Creek watershed. In addition to these wells, many individual homeowners in the vicinity of the proposed Ware Creek Reservoir site have their own wells. No municipal or private surface water supplies were identified in the immediate vicinity of the proposed reservoir site.

Pipeline

Two raw water outfalls (40 mgd and 80 mgd capacities) would be located on Diascund Creek upstream of Newport News Waterworks' Diascund Creek Reservoir. There are no known municipal or private water supplies along Diascund Creek upstream of the existing reservoir. However, Diascund Creek Reservoir itself is part of a municipal water supply system (i.e., Newport News Waterworks).

<u>Recreational and Commercial Fisheries</u>

Intake

The Pamunkey River and its banks in the proposed project area are utilized for recreational fishing. The nearest public boat ramp on the Pamunkey River is near Putneys Mill in New Kent County, off of Route 607, and approximately 2.8 river miles downstream of Northbury (Delorme Mapping Company, 1989).

Commercially important fish species harvested during 1989, 1990, and 1991 in the Pamunkey River included catfish, American Shad, Striped Bass, and American Eel. Blue Crab (*Callinectes sapidus*) are also harvested from the Pamunkey River (VMRC, 1992).

Reservoir

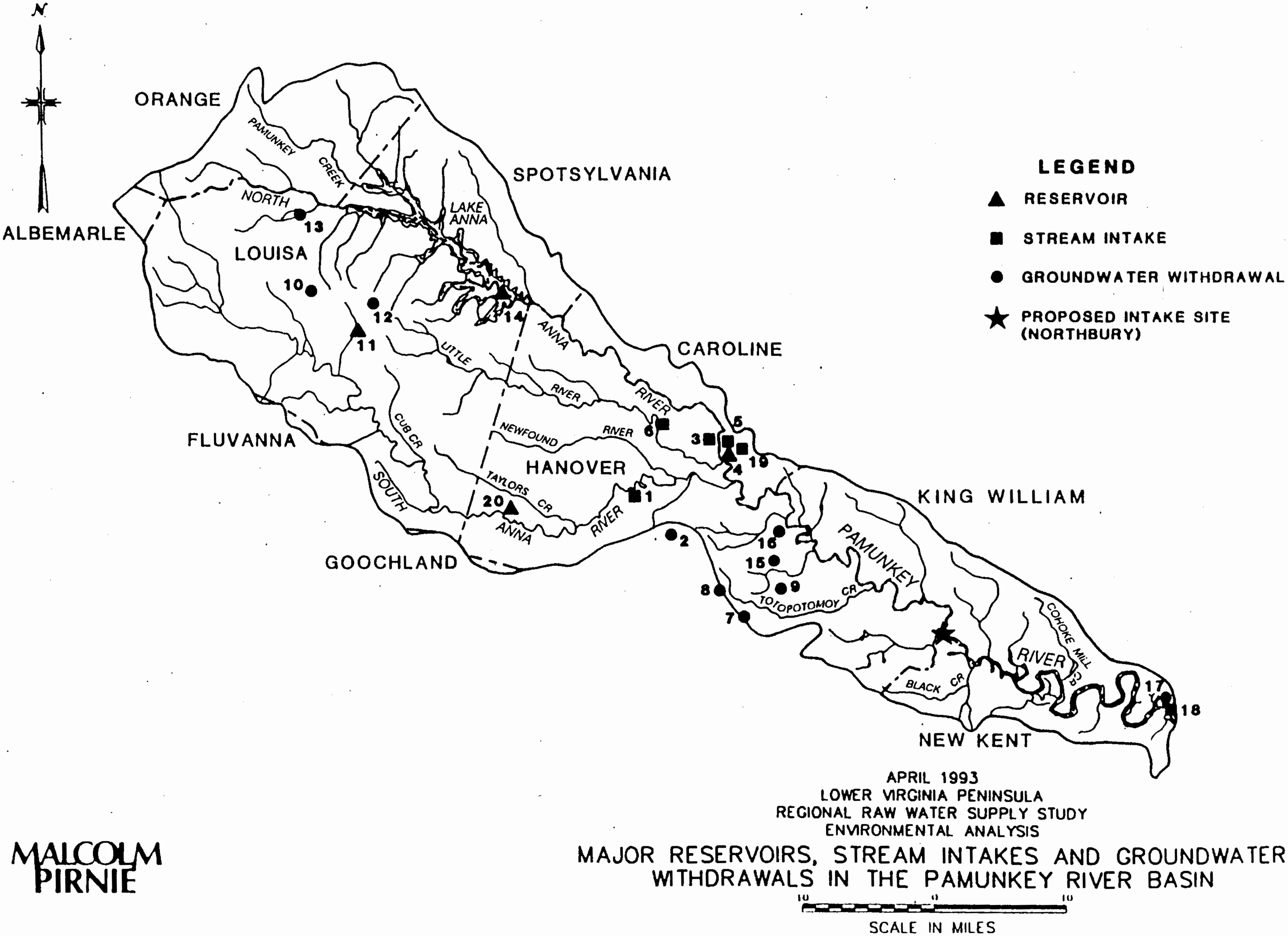
According to the USEPA, minimal recreational fishing in the Ware Creek Basin occurs, except for occasional fishing in Richardson's Millpond (USEPA, 1992). Richardson's Millpond has not been surveyed by the VDGIF and is not currently stocked (D. L. Fowler, VDGIF, personal communication, 1992). Recreational fishing is limited due to lack of public access. However, recreational navigation does include the use of small powerboats and canoes on Ware Creek (USCOE, 1987). Fish species present in the Ware Creek Reservoir impoundment are discussed in Section 4.3.1.

TABLE 4-51

MAJOR RESERVOIRS, STREAM INTAKES, AND GROUNDWATER WITHDRAWALS IN THE PAMUNKEY RIVER BASIN

Map Number (a)	Description	1990 Withdrawal (b) (mgd)
1	Stream Intake South Anna River Town of Ashland (Ashland WTP)	0.903
2	Groundwater Withdrawal 3 Wells Hanover County	0.019 (c)
3	Stream Intake North Anna River Hanover County (Doswell WTP)	1.833
4	Stream Intake North Anna River Bear Island Paper Company (Doswell Plant)	0.462
5	Reservoir (Meadows Pond) Bear Island Paper Company (Doswell Plant)	0.995
6	Stream Intake Little River General Crushed Stone Company (Verdon Plant)	0.256
7	Groundwater Withdrawal 13 Wells Hanover County and Private	0.144 (c)
8	Groundwater Withdrawal 3 Wells Hanover County and Private	0.027 (c)
9	Groundwater Withdrawal 6 Wells Hanover County and Private	0.086 (c)
10	Groundwater Withdrawal 2 Springs, 4 Wells Town of Mineral	0.079
11	Reservoir (Northeast Creek) Louisa County Water Authority	0.155
12	Groundwater Withdrawal 4 Wells, 1 Spring Louisa County Water Authority	0.005
13	Groundwater Withdrawal 2 Wells Blue Ridge Shores	0.047
14	Reservoir (Lake Anna) Virginia Power	2,064.1
15	Groundwater Withdrawal 2 Wells Virginia Department of Corrections (Barrett Learning Center)	0.022
16	Groundwater Withdrawal 2 Wells Virginia Department of Corrections (Hanover Learning Center)	0.022
17	Groundwater Withdrawal 2 Wells Town of West Point	0.415
18	Stream Intake Pamunkey River Chesapeake Corporation (West Point Facility)	16.65 (d)
19	Stream Intake North Anna River Diamond Energy (Doswell Combined Cycle Facility)	Operational since April 1992
20	Retention Ponds (runoff-fed) Closed System off South Anna River Feldspar Corporation (Montpelier Plant)	14.400

a) See Figure 4-6.
b) Reported 1990 withdrawals retrieved from the Virginia Water Use Data System (P.E. Herman, SWCB, personal communication, 1993).
c) 1984 withdrawal as reported in York Water Supply Plan (SWCB, 1988).
d) 1983 non-consumptive industrial cooling water withdrawal as reported in York Water Supply Plan (SWCB, 1988).



APRIL 1993
LOWER VIRGINIA PENINSULA
REGIONAL RAW WATER SUPPLY STUDY
ENVIRONMENTAL ANALYSIS

MALCOLM PIRNIE

MAJOR RESERVOIRS, STREAM INTAKES AND GROUNDWATER WITHDRAWALS IN THE PAMUNKEY RIVER BASIN

FIGURE 4-6

Because Ware Creek's shallow depth would limit access by larger commercial vessels, this area has a limited potential for commercial fisheries.

The nearest leased shellfish area to the proposed impoundment site extends from the mouth of Ware Creek to a point approximately 1.6 river miles upstream of the mouth (VMRC, 1992). Any shellfish beds in Ware Creek have been closed by the Virginia Department of Health due to high coliform bacteria levels in the creek (J. C. Dawson, James City County, personal communication, November 1992). Invertebrates of commercial importance would not be abundant farther upstream in the actual impoundment site due to the low salinity at and upstream of the proposed dam site.

Pipeline

Based on review of USGS topographic maps and color infrared aerial photography of the pipeline route, most of the route traverses forested lands.

<u>Other Water-Related Recreation</u>

Intake

The Pamunkey River and its bottomlands in the proposed project area are utilized for various recreational pursuits including fishing, hunting, and boating. The nearest public boat ramp on the Pamunkey River is near Putneys Mill in New Kent County, off State Route 607, and approximately 2.8 river miles downstream of Northbury (Delorme Mapping Company, 1989). The Pamunkey River is tidal at the proposed intake location and is well-suited for year-round recreational boat activity. Several privately owned duck blinds and hunt clubs are located in the vicinity of Northbury (J. Taylor, VDGIF, personal communication, 1992).

Reservoir

As noted in the USEPA's second veto of James City County's proposed Ware Creek Reservoir, the Ware Creek watershed supports numerous species of birds and mammals sought by hunters (USEPA, 1992). Existing use of the Ware Creek Reservoir watershed for water-related recreation includes hunting, fishing, boating, and canoeing; however, there is no public access in the basin and most of the land adjacent to the waterway is posted. Recreational navigation is limited to small powerboats and canoes because of the shallow depth of Ware Creek (USCOE, 1987). According to the USEPA, administrative records indicate that there is minimal recreational fishing in the Ware Creek basin except for occasional fishing in Richardson's Millpond (USEPA, 1992). Several privately owned duck blinds and hunt clubs are located in the basin (USCOE, 1987).

Pipelines

Based on review of USGS topographic maps and color-infrared aerial photography of the pipeline route, most of the 26.3-mile route traverses forested lands. It is likely that portions of this area are leased to private hunt clubs.

Aesthetics

Intake

The aesthetic value of the proposed river intake area is its predominantly natural, scenic beauty. The shoreline surrounding the Pamunkey River in the vicinity of the proposed intake is a sloping, forested terrain which is relatively undeveloped in the immediate vicinity. Four houses were identified within 500 feet of the proposed pump station, with the nearest house located 300 feet from the pump station site (see Table 4-52).

Reservoir

The Ware Creek watershed is mostly rural with residential and commercial development scattered along roads and highways. The aesthetic value of the proposed reservoir area is its scenic beauty, a product of its vegetation and wildlife. However, Ware Creek has limited and seasonally variable visibility from public roads, so its aesthetic appeal is present but is not apparent to the casual observer. No houses were identified within the pool area or within 500 feet of the proposed dam site. A total of 33 houses were identified within 500 feet of the proposed reservoir pool area, with the nearest house located approximately 50 feet from the pool area (see Table 4-52).

Ware Creek is included in the U.S. National Park Service's (NPS) Nationwide Rivers Inventory as part of the York River System. The principal features of Ware Creek which elevate it to inventory status are its free-flowing and generally undeveloped nature; a channel length greater than 5 river miles; and being adjacent to or within a related land area that possesses an outstanding remarkable geologic, ecologic, cultural, historic, scenic, botanical, recreational, or other similar value (NPS, 1981; J. G. Eugster, NPS, personal communication, 1983). The Wild and Scenic Rivers Act (16 U.S.C. 1271) establishes a procedure for designating certain rivers or river segments for protection as part of the National Wild and Scenic River System. The first step in this procedure is for a waterway to be listed on the Nationwide Rivers Inventory. Waterways on the Inventory are not protected by law, but Federal agencies must give special consideration to actions which could preclude a waterway on the Inventory from eventually being listed as a Wild and Scenic River (USCOE, 1987).

Pipeline

The pipeline route would traverse mostly rural areas; however, 107 houses were identified within 300 feet of the proposed pipeline route (see Table 4-52).

Parks and Preserves

Intake

The Pamunkey River is not currently designated as part of the Virginia Scenic Rivers System (VSRS). However, the Pamunkey River is identified in the ***1989 Virginia Outdoors Plan*** as being worthy of future evaluation.

TABLE 4-52

SUMMARY OF HOUSES NEAR THE PROPOSED ALTERNATIVE PROJECT AREAS

Alternative	Intake * within 500 feet		Dam within 500 feet		Reservoir within 500 feet		Pipeline within 300 feet		Total	
	Average Distance To Houses (feet)	Number of Houses	Average Distance To Houses (feet)	Number of Houses	Average Distance To Houses (feet)	Number of Houses	Average Distance To Houses (feet)	Number of Houses	Average Distance To Houses (feet)	Number of Houses
Ware Creek Reservoir	425	4	0	0	354	33	133	107	192	144
Black Creek Reservoir **	425	4	0	0	300	38	171	62	228	104
King William Reservoir	0	0	0	0	263	28	188	45	217	73
Fresh Groundwater Development	350	9	N/A	N/A	N/A	N/A	0	0	350	9
Groundwater Desalination In Newport News Waterworks Distribution Area	400	19	N/A	N/A	N/A	N/A	140	205	162	224

* Major river withdrawal or groundwater withdrawal points.
** Does not include 14 existing houses that would be directly impacted by the proposed Black Creek Reservoir.
*** Includes other buildings besides houses (e.g., schools, churches, etc.).
N/A = Not Applicable

There is currently one site in the Pamunkey River basin which is listed as part of the Chesapeake Bay National Estuarine Research Reserve System (CBNERRS). Sweet Hall Marsh, which is located approximately 24.5 river miles downstream of the proposed Northbury intake site, consists of an extensive tidal freshwater marsh with adjacent non-tidal bottomland forest on the mainland side and shallow flats on the river side (USDC and VIMS, 1990).

No other existing parks or preserves are located in the vicinity of the proposed Pamunkey River intake at Northbury.

Reservoir

There are no existing parks or preserves located within the Ware Creek Reservoir drainage area (USCOE, 1987; VDCR, 1989; JCC, 1991; RRPDC, 1991). However, the York River is identified in the ***1989 Virginia Outdoors Plan*** as being worthy of future evaluation under the VSRS.

Pipeline

No existing parks or preserves are located along the proposed pipeline route for this alternative component (VDCR, 1989; RRPDC, 1991; JCC, 1991).

Land Use

Intake

Field studies were conducted by Malcolm Pirnie during the spring of 1990 to determine the feasibility of the Northbury site as a potential raw water intake location. These studies indicated that the proposed Northbury intake site is a relatively isolated area with the predominant land uses being farmland and forest. Based on review of color-infrared aerial photography of the area, it is estimated that approximately 1.5 acres of farmland and 1.5 acres of forest would be affected by construction at the intake site. In addition, a small amount of land disturbance may be required for construction of an access road to the pump station and for placement of electrical transmission lines to power the pump station.

Expected future land use at the intake site is conservation lands. Conservation lands are designated by New Kent County "to ensure the protection of environmentally sensitive lands from inappropriate development" (RRPDC, 1991). Designation of an area as a conservation area does not preclude development. However, any development in these areas must be conducted in accordance with local, state, and federal environmental regulations.

Additional land use designations are applicable to the proposed intake site, and serve to regulate development at this site. The Chesapeake Bay Preservation Act is intended to protect and improve the water quality of the Chesapeake Bay. The goals of the Act are achieved through the regulation of development within designated Chesapeake Bay Preservation Areas (CBPAs). The CBPA has two components: Resource Protection Areas (RPAs) and Resource Management Areas (RMAs).

Within New Kent County, CBPAs have not been comprehensively mapped. Rather, site surveys are required to identify CBPAs in regions along rivers or streams depicted on USGS topographic maps which are proposed for development (N. Hahn, New Kent County, personal communication, 1992). It is likely that the proposed intake site would be designated as an RPA.

Development is limited within RPAs and RMAs. In an RPA, only water dependent uses are allowed. Specific performance criteria must be met, such as preservation of natural vegetation, minimal disturbance of land, and control of sedimentation and erosion. In an RMA, uses allowed under the local zoning ordinance are still allowed, but development must meet specific performance criteria.

An additional zoning designation which regulates development within project areas is the Agricultural and Forestal District (AFD). This zoning designation was set forth in the Virginia Agricultural and Forestal Districts Act of 1977 (Section 15.1-1512.D Virginia Code).

The proposed intake site is located entirely within the Hampstead-Northbury-Shimokins AFD. AFDs are defined by New Kent County as "land which requires conservation and protection for the production of food and other agricultural and forestal products and as such is a valuable natural and ecological resource providing open spaces for clean air and adequate and safe water supplies and other aesthetic purposes and is therefore valuable to the public interest" (New Kent County, 1991).

Reservoir

Land use data were compiled for the Ware Creek Reservoir watershed by Langley and McDonald in 1990. This information is presented in Table 4-53. The majority of the watershed consists of forested, agricultural, and residential land (69, 13, and 7 percent, respectively). Less than 2 percent of the total watershed area supports commercial or industrial uses, which are concentrated in the Toano area. Existing land uses within New Kent and James City counties are presented in Tables 4-54 and 4-55, respectively. These data are presented to provide an indication of the relative abundance of specific land use types within the region.

Because the land use data presented in Table 4-53 were collected in 1990, these data provide an indication of existing land use in the watershed. It is expected that the acreage of residential and commercial land uses within the watershed have increased to a small degree, and vacant land and forested acreage have decreased accordingly. It is expected that land uses within the pool area have not changed appreciably.

Color-infrared aerial photography of the reservoir site was inspected to determine land use areas within the proposed normal pool area (see Table 4-56). Land uses within the proposed reservoir pool area, with the exception of wetlands and forests, were measured directly from the color-infrared aerial photographs using planimetry. The primary land use within the reservoir pool area is forested land, which comprises approximately 625 acres of the 1,238-acre pool area. Residential acreage includes all subdivisions, groups of homes, and individual homes which are not associated with agricultural operations. The agricultural rural/residential acreage includes all agricultural lands and houses or structures associated

TABLE 4-53

WARE CREEK RESERVOIR WATERSHED LAND USE (1990)

Land Use Category	Acreage	% of Total
Light Commercial/Industrial	212	1.9
Residential	804	7.2
Roads	428	3.8
Agricultural	1,474	13.2
Forest	7,565	67.9
Wetlands and Open Water	590	5.4
Recreational	68	0.6
TOTAL	**11,141**	**100**

Source: Based on October 25, 1990 mapping of existing land use in the watershed (Langley and McDonald, 1990) and field investigations of wetland areas.

TABLE 4-54

NEW KENT COUNTY LAND USE (1989)

Land Use Category	Acreage	Percent of Total
Forest, Open Space, and Agricultural	126,556	93.3
Residential	5,846	4.3
Commercial	501	0.4
Industrial	112	0.1
Transportation/Utilities	2,521	1.9
Public Services	144	0.1
TOTAL	**135,680**	**100**

Source: RRPDC, 1991.

TABLE 4-55

JAMES CITY COUNTY LAND USE (1991)

Land Use Category	Land Use (Acres)	Percent of Total
Agriculture	13,000	14.1
Residential	15,000	16.3
Commercial	2,800	3.0
Industrial	1,300	1.4
Public Use (includes military land and public parks)	9,300	10.1
Forestry, Wetlands, Inland Water, Roads, Unimproved, Other	50,824	55.1
TOTAL	**92,224**	**100.0**

Source: T. Funkhouser, James City County, personal communication, 1991.

Note: Developed acreage for commercial and industrial uses includes an estimate of acreage of land uses that are grandfathered for an existing use or are operating under a special use permit.

There are currently 18,149 acres of land (20 percent of the total area) within Agricultural and Forestal Districts. James City County staff estimate that approximately 60,000 acres (65 percent of the total area) are in forests of one form or another.

TABLE 4-56

WARE CREEK RESERVOIR NORMAL POOL AREA LAND USE (1982)

Land Use Category	Acreage	% of Total[1]
Agricultural/Rural Residential [2]	4	0.3
Wetlands and Open Water	590	47.7
Forest	625	50.5
Roads	19	1.5
TOTAL	**1,238**	**100**

1 Percent of total column may not sum to 100 percent due to rounding associated with the individual percentages presented for each land use category.

2 Agricultural/Rural Residential acreage includes all agricultural lands and houses or structures associated with these lands.

Source: Planimetry of identified land use boundaries on NHAP color-infrared aerial photography taken on March 29, 1982 (approximate scale 1" = 1,270') and field investigations of wetland areas.

with these lands. Wetland and open water areas were identified through detailed field mapping of wetland areas.

No existing houses were identified that would be displaced by the proposed reservoir or dam.

Within the New Kent County portion of the watershed, anticipated future uses of the land are agriculture and conservation lands. The lands designated as conservation areas are concentrated along the York River and its tributaries in the watershed, while agricultural land is expected to comprise the remainder of the region (RRPDC, 1991).

A portion of the reservoir drainage area is designated for future industrial and commercial development in the vicinity of Toano. The majority of the watershed, however, is designated for low-density residential and mixed use development. Much of this anticipated growth in the watershed is expected as part of the Stonehouse Community (JCC, 1991).

The Stonehouse Community is currently being planned by Stonehouse Inc., which is a subsidiary of Chesapeake Corporation. The total community would comprise 7,230 acres located within the Ware Creek watershed of James City and New Kent counties. Rezoning for the 5,750 acres of this development within James City County was approved by the James City County Board of Supervisors in November 1991. Of James City County's 5,750 acres within Stonehouse, 4,000 acres would be in the reservoir drainage area (J. C. Dawson, James City County, personal communication, September 1992).

In accordance with the Chesapeake Bay Preservation Act, the entire land area of James City County is designated as a CBPA. Ware Creek, its tributaries and adjacent areas in James City County are designated as RPAs while the remainder of the watershed is located within an RMA.

CBPAs have not been comprehensively mapped within New Kent County. However, Ware Creek, its tributaries, and adjacent areas located within New Kent County are likely to be located within an RMA or an RPA.

Approximately 323 acres of the York River AFD are located within the northern section of the reservoir watershed in New Kent County. Of this area, approximately 126 acres would be located within the proposed reservoir normal pool area (N. Hahn, New Kent County, personal communication, 1992). Within James City County, approximately 120 acres of the Barnes Swamp AFD would be located within the reservoir normal pool area.

It is anticipated that a buffer area around the normal pool area of the reservoir would be acquired by the RRWSG to regulate adjacent land uses to protect reservoir water quality. Existing land uses within the buffer area would include those land use types listed in Table 4-56 as occurring within the watershed.

Pipeline

The proposed pipeline, with a length of 26.3 miles and an assumed right-of-way (ROW) width of 50 feet, would disturb approximately 159 acres of land. Based on review of USGS topographic mapping and color-infrared aerial photography of the route, the pipeline would traverse forested land, agricultural land, and some commercial land.

A summary of affected land use in project areas for this alternative is included in Table 4-57.

Noise

Estimated construction time of the Ware Creek Reservoir alternative is approximately 2 to 3 years. This alternative component would include an intake and pumping station at the Pamunkey River, a pumping station at Diascund Creek Reservoir, and a pumping station at Ware Creek Reservoir. Six 20 mgd pumps would be needed at the Pamunkey River pumping station and four 10 mgd pumps would be required at both the Diascund Creek Reservoir and Ware Creek Reservoir pumping stations. There are very few residences within 500 feet of the proposed Pamunkey River intake and pumping station site, some near the Diascund Creek Reservoir pumping station, and a fair density of residences in the vicinity of the Ware Creek Reservoir pumping station which might be sensitive to elevated noise levels associated with the alternative. Background noise levels in the vicinity of the pumping stations would be those typical of a rural atmosphere.

Infrastructure

Transportation

The principal transportation routes through the immediate vicinity of the proposed impoundment area are Interstate 64 and State Route 168/30. There are numerous other lower order state routes throughout the reservoir area. Portions of State Routes 168/30, 600, and 606 would be inundated by construction of the reservoir. Interstate 64 crosses three arms of France Swamp and one arm of Bird Swamp.

The Chesapeake & Ohio Railway passes through the southern portion of the Ware Creek Reservoir drainage area. No rail lines fall within the proposed impoundment area.

The proposed pipeline route would parallel and/or cross several existing roadways and rail lines located in New Kent County (NKC) and James City County (JCC). These roadways and rail lines include Interstate 64, (NKC and JCC), U.S. Route 60 (JCC), State Routes 607 (NKC), 606 (NKC), 612 (NKC), 609 (NKC), 642 (NKC), 249 (NKC), 608 (NKC), 628 (NKC), 621 (JCC), 622 (JCC), 601 (JCC), 30 (JCC), and 168/30 (JCC), and the Southern Railway (NKC) and Chesapeake & Ohio Railway (JCC).

Utilities

Short-term energy requirements for this alternative would be related to fuel and electricity needed for construction activities. Diesel fuel would be necessary for the operation of land clearing, excavation, and construction equipment. Electricity would be needed from the local utility to support construction activities unless diesel generators were utilized to generate electricity at the project site. Long-term operation of the pumping stations would require a source of electricity for the pump motors and related appurtenances. The emergency generator set would require diesel fuel.

Virginia Power is the major producer and distributor of electrical power in the project area associated with this alternative component. Virginia Power owns and operates two steam-electric power plants in the York River basin. The North Anna Plant has an installed capacity of 1,720 megawatts (MW), and the Yorktown Plant has a capacity of 1,154 MW (SWCB, 1988).

TABLE 4-57

SUMMARY OF AFFECTED LAND USE IN ALTERNATIVE PROJECT AREAS

Alternative	Intake*			Reservoir**			Pipeline		Total		
	Acres Disturbed	AFD Land (acres)	Number of Houses	Acres Disturbed	AFD Land (acres)	Number of Houses	Acres Disturbed	Number of Houses	Acres Disturbed	AFD Land (acres)	Number of Houses
Ware Creek Reservoir	3	3	0	1,238	246	0	159	0	1,400	249	0
Black Creek Reservoir	3	3	0	1,146	376	14	123	0	1,272	379	14
King William Reservoir***	3	0	0	2,234	0	0	94	0	2,331	0	0
Fresh Groundwater Development	8	0	0	N/A	N/A	N/A	Minimal	0	8	0	0
Groundwater Desalination in Newport Waterworks Distribution Area	5	0	0	N/A	N/A	N/A	65	0	70	0	0

* Major river withdrawal of groundwater withdrawal points.
** Excludes reservoir buffer area.
*** King William County does not currently designate AFD lands.
N/A Not Applicable.

Navigation

By regulation, all tidal water bodies in the United States are considered to be "navigable waters of the United States" (33 CFR § 329.4). Based on past studies, it is assumed for administrative purposes that the Pamunkey River is navigable for its entire length (K. M. Kimidy, USCOE - Norfolk District, personal communication, 1993).

The proposed river intake structure would be located at Northbury in tidal and navigable waters. The mean tidal range is 3.3 feet at Northbury (USDC, 1989). USGS topographic maps show a mid-channel depth at mean low water of 18 feet at Northbury. Water depths of 17 feet, taken at 80, 100, and 120 feet from the south shore (i.e., New Kent County), were recorded during a recent field inspection (Malcolm Pirnie, 1990). The Pamunkey River is approximately 260 feet wide at Northbury.

The proposed Ware Creek Reservoir dam site is located in tidal and navigable waters 4.7 river miles upstream of the confluence of Ware Creek and the York River. The Ware Creek channel is approximately 75 feet wide at the dam site (Wilber et al., 1987). Approximate channel depths of 4 to 5 feet have been observed in the vicinity of the dam site in an October 1992 field inspection by Malcolm Pirnie scientists. The Ware Creek channel is free from manmade obstructions from the proposed dam site to its confluence with the York River.

The tide is primarily semi-diurnal on Ware Creek. The mean tidal range has been measured at 2.8 feet (0.86 meters) at the mouth of Ware Creek and approximately 1.4 feet (0.42 meters) at or just upstream of the proposed dam site (Wilber et al., 1987). Based on field observations in 1992 by Malcolm Pirnie, tidal influence on Ware Creek extends to a point approximately 1,700 feet east of the State Route 600 crossing of Ware Creek at Richardson Millpond. A large beaver dam blocks tidal influence upstream of this point; however, tidal influence may extend farther upstream during extremely high spring tides or storm surges.

In the ***Final Environmental Impact Statement - James City County's Water Supply Reservoir on Ware Creek***, the USCOE pointed out that "recreational navigation is limited to small powerboats and canoes because of the shallow depth of the creek" (USCOE, 1987). Commercial navigation may also occur in Ware Creek since a leased shellfish area extends from the mouth of Ware Creek to a point approximately 1.6 river miles upstream of the mouth (VMRC, 1992). Any shellfish beds in Ware Creek have been closed by the Virginia Department of Health due to high coliform bacteria levels in the creek (J. C. Dawson, James City County, personal communication, November 1992).

Other Socioeconomic Impacts

The proposed Ware Creek Reservoir would be located within James City and New Kent counties, near the metropolitan areas of Newport News, Hampton, Williamsburg, and Richmond. Both counties have experienced substantial growth over the past decade. In 1980, the estimated population of James City County was 22,763, based on 1980 Census data. This population has increased by 53 percent during the last decade to 34,859 persons in 1990 (USDC, 1992). Within New Kent County, the 1980 Census estimated the County population to be 8,781. The population increased by 19 percent by 1990, to 10,445 persons (USDC, 1992).

Since the 1970s, great changes in land use in James City County have occurred. The County, which has historically been rural in nature, has transformed to a more urban and suburban environment. This expansion is expected to continue through the 1990s (JCC, 1991). While much growth has occurred within New Kent County in the past two decades, the County remains primarily rural in nature.

Median household income in James City County in 1989, as estimated by the 1990 Census, was $39,785 per year, as compared to $27,337 in 1982 (T. Funkhouser, JCC, personal communication, 1992). This represents a 45.5 percent increase in median household income in the County in those years. In New Kent County, the estimated median household income in 1989, according to the 1990 Census, was $38,403 per year. This is a 106 percent increase over the 1979 estimated median household income in New Kent County of $18,629 per year (RRPDC, 1991).

Within James City County, all categories of housing types have increased within the past decade, and single family homes have increased as a percentage of the total. Recently, the County has been experiencing extensive new upscale housing development. As of January 1993, real estate within the County was taxed at a rate of $0.73 per $100 assessed value.

Census data indicate that the majority of housing units within New Kent County are single-family dwellings. In the past two decades, the trend has been that the number of new single-family dwellings has decreased, while the number of duplex and multi-family dwellings has increased (RRPDC, 1991). As of November 1992, the County real estate tax rate was $0.82 per $100 assessed value (N. Hahn, New Kent County, personal communication, 1992).

The economy of James City County is supported by an estimated 17,537 persons, 16 years of age or older, who are employed within the County (USDC, 1992). The type of industries which employ these people vary greatly. Based on employment data for the County (based on the 1990 Census), the greatest number of persons in the work force within the County are employed by the retail trade industry (20 percent). The next largest percentage (13 percent) work in the field of educational services.

Within James City County there are several large businesses which employ many people. Owens-Brockway Glass Container reported employing 240 persons when surveyed in 1990 as part of this study. Anheuser-Busch employed an additional 1,100 persons in 1990. Ball Metal and The Williamsburg Pottery are also large employers in the County (JCC, 1991).

Within New Kent County, the total number of persons 16 years of age or older who are employed is 5,326 (USDC, 1992). As in James City County, the largest employer category in the County is retail trade (14 percent). The next largest employer categories within the County are public administration (11 percent) and construction (11 percent). The largest employers are Cumberland Hospital, which employs over 200 persons, and the County.

4.5.2 Black Creek Reservoir with Pumpover from Pamunkey River

Municipal and Private Water Supplies

Intake

Municipal and private water supply withdrawals in the Pamunkey River basin are discussed in Section 4.5.1.

Reservoir

Many individual homeowners in the vicinity of the proposed Black Creek Reservoir site have their own wells. No municipal or private surface water supplies were identified in the immediate vicinity of the proposed reservoir site.

Pipeline

A 40-mgd capacity raw water outfall would be located on Diascund Creek upstream of Newport News Waterworks' Diascund Creek Reservoir. There are no known municipal or private water supplies along Diascund Creek upstream of the existing reservoir. However, Diascund Creek Reservoir itself is part of a municipal water supply system (i.e., Newport News Waterworks).

Recreational and Commercial Fisheries

Intake

Existing recreational and commercial fisheries at the proposed Pamunkey River intake site are described in Section 4.5.1.

Reservoir

Fish species present in the Black Creek Reservoir impoundment area are discussed in Section 4.3.2.

Because of their small size and limited access, the streams within the impoundment area have limited potential for commercial and recreational fishing. Crumps Millpond has not been surveyed by the VDGIF and is not currently stocked; however, it most likely is used for recreational fishing (D. C. Dowling, VDGIF, personal communication, 1992).

Invertebrate species of commercial importance would not be abundant in the proposed impoundment site due to the low salinity at and upstream of the proposed dam site.

Pipeline

Based on review of USGS topographic maps and color-infrared aerial photography of the pipeline route, most of the route traverses forested lands.

The new pipeline would cross 10 perennial and 14 intermittent streams, as well as an arm of Little Creek Reservoir.

Other Water-Related Recreation

Intake

Existing recreational uses of the proposed Pamunkey River intake site area are described in Section 4.5.1.

Reservoir

The primary water-related recreational activity in the proposed Black Creek Reservoir watershed is hunting. The basin supports many bird and mammal species sought by hunters. Several private hunt clubs and duck blinds are located in the basin (J. Taylor, VDGIF, personal communication, 1992).

Pipelines

Based on review of USGS topographic maps and color-infrared aerial photography of the pipeline route, most of the 20.3-mile route traverses forested lands. It is likely that portions of this area are leased to private hunt clubs.

Aesthetics

Intake

Existing aesthetic characteristics of the proposed Pamunkey River intake site area are described in Section 4.5.1.

Reservoir

The Black Creek watershed is remotely located within a rural area of New Kent County composed mainly of forested areas and scattered residential and agricultural areas. The aesthetic value of the proposed reservoir area is its natural beauty, composed of hardwood swamps, emergent vegetation, and wildlife. However, Black Creek has limited and seasonally variable visibility from public roads, so its aesthetic appeal is present but not apparent to the casual observer. Eleven houses were identified within the proposed pool area and three houses are located within 500 feet of the proposed dam. A total of 38 additional houses were identified within 500 feet of the proposed reservoir pool area (see Table 4-52).

Pipeline

The pipeline route would traverse mostly rural areas; however, 62 houses were identified within 300 feet of the proposed pipeline route (see Table 4-52).

Parks and Preserves

Intake

Parks and preserves in the vicinity of the proposed Northbury intake on the Pamunkey River are discussed in Section 4.5.1.

Reservoir

There are no existing designated parks or preserves located within the proposed Black Creek Reservoir drainage area (RRPDC, 1991; VDCR, 1989).

Pipeline

No existing parks or preserves are located along the proposed pipeline route for this alternative component (VDCR, 1989, RRPDC, 1991; JCC, 1991).

Land Use

Intake

Existing land uses at the proposed Pamunkey River intake site are described in Section 4.5.1.

Reservoir

High altitude aerial photographs and New Kent County planning maps were used to identify existing land uses within the proposed normal pool elevation of the reservoir and the reservoir watershed. Table 4-58 identifies existing land uses within the reservoir drainage area, which includes the normal pool area, while Table 4-59 identifies land uses within the normal pool area only.

Each of the land use categories, with the exception of forests, were measured directly from color-infrared aerial photographs using planimetry. Residential acreage includes all subdivisions, groups of homes, and individual homes which are not associated with agricultural operations. New Kent County planning maps were also used to identify residential acreage. The agricultural/rural residential acreage includes all agricultural lands and houses or structures associated with these lands. Wetland and open water acreage was determined through interpretation of aerial photographs and field inspections. Existing land uses within New Kent County are presented in Table 4-54 to provide an indication of the relative abundance of specific land use types within the region.

The majority of the watershed is currently forested (79 percent). Approximately 12 percent of the watershed supports the agricultural/rural residential land use and an additional 1 percent supports residential land use. The remaining 8 percent of the watershed is comprised of roads, open water, and wetlands.

Forested lands also comprise the majority of the reservoir pool area (66 percent), with wetlands and open water comprising the next largest land area (25 percent). Residential land uses are also located within the reservoir pool area, constituting approximately 8 percent of total existing land use within the pool area.

Considerable residential growth has occurred and continues to occur in portions of the proposed 5.5-square mile reservoir watershed. For example, the Clopton Forest residential subdivision borders the western edge of the Southern Branch Black Creek impoundment site. Based on review of New Kent County House Numbering Maps in conjunction with color-infrared aerial photography and USGS topographic mapping, there appear to be 14 existing houses which are at or below the proposed reservoir normal pool elevation of 100 feet msl or that would be displaced by the dams. At least three additional houses would be within the proposed reservoir buffer zones. The buffer zones are defined as the 100-foot buffer from the pool areas, or the 110-foot contour elevation, whichever is a greater distance from the proposed reservoir pool areas. As of January 1993, an additional five building permits for houses had been issued within the reservoir pool and buffer areas.

Anticipated future land uses within the vicinity of the reservoir drainage area are identified primarily as agriculture and conservation areas (RRPDC, 1991; New Kent County, 1991). Conservation lands are designated by New Kent County to protect environmentally sensitive lands. Within the watershed, these areas are expected to be concentrated along the Southern Branch Black Creek. Some medium density residential areas are expected to be located in the southwestern portion of the drainage area. The remainder of the watershed, and the majority, is designated for agricultural use.

CBPAs and AFDs are located within the reservoir drainage area. As described previously, CBPAs have not been comprehensively mapped in New Kent County. Rather, site surveys are required to identify CBPAs in regions along river or streams depicted on USGS maps which are proposed for development (N. Hahn, New Kent County, personal communication, 1992). Black Creek, its tributaries, and adjacent areas are likely candidates for inclusion in a CBPA.

Approximately 1,905 acres of the Pamunkey River Valley AFD are located within the northeast section of the watershed in New Kent County. Of this area, approximately 376 acres would be located within the proposed normal pool area of the reservoir (N. Hahn, New Kent County, personal communication, 1992).

It is anticipated that a buffer area around the normal pool area of the reservoir would be acquired by the RRWSWG to regulate adjacent land uses to protect reservoir water quality. Existing land uses within this buffer area would include those land use types listed in Table 4-57 as occurring within the watershed.

Pipeline

The proposed pipeline, with a length of 20.3 miles and an assumed ROW width of 50 feet, would disturb approximately 123 acres of land (excluding Little Creek Reservoir crossing). Existing land uses along the proposed pipeline were identified through review of USGS topographic mapping and color-infrared aerial photography. Based on review of these sources, a portion of the pipeline route (4.3 miles) follows existing rights-of-way through New Kent and James City counties. For the remainder of the route, which encompasses approximately 16 miles, the pipeline would primarily traverse forested and agricultural land.

A summary a affected land use in project areas for this alternative is included in Table 4-57.

<u>Noise</u>

Estimated construction time of the Black Creek Reservoir alternative is approximately 3 years. This alternative component would include an intake and pumping station at the

TABLE 4-58

BLACK CREEK RESERVOIR WATERSHED LAND USE (1989)

Land Use Category	Acreage	% of Total [1]
Residential [2]	49	1.4
Agricultural/Rural Residential [3]	409	11.6
Roads	1	0.036
Wetlands and Open Water	289	8.2
Forest	2,772	78.8
TOTAL	**3,520**	**100**

[1] Percent of total column may not sum to 100 percent due to rounding associated with the individual percentages presented for each land use category.

[2] Residential acreage includes all subdivisions, groups of homes, and individual homes not associated with agricultural operations.

[3] Agricultural/Rural Residential acreage includes all agricultural lands and houses or structures associated with these lands.

Source: Planimetry of identified land use boundaries on NAPP color-infrared aerial photography taken on March 11, 1989 (approximate scale 1"=836') and field investigations of wetland areas.

TABLE 4-59

BLACK CREEK RESERVOIR NORMAL POOL AREA LAND USE (1989)

Land Use Category	Acreage	% of Total [1]
Residential [2]	95	8.3
Agricultural/Rural Residential [3]	13	1.1
Wetlands and Open Water	285	24.9
Forest	752	65.6
Roads	1	0.1
TOTAL	**1,146**	**100**

1 Percent of total column may not sum to 100 percent due to rounding associated with the individual percentages presented for each land use category.

2 Residential acreage includes all subdivisions, groups of homes, and individual homes not associated with agricultural operations.

3 Agricultural/Rural Residential acreage includes all agricultural lands and houses or structures associated with these lands.

Source: Planimetry of identified land use boundaries on NAPP color-infrared aerial photography taken on March 11, 1989 (approximate scale 1"=836') and field inspections of wetland areas.

Pamunkey River, a pumping station at Black Creek Reservoir, and a pumping station at Diascund Creek Reservoir. Six 20 mgd pumps would be needed at the proposed Pamunkey River pumping station and four 10 mgd pumps would be required at both the Black Creek and Diascund Creek reservoir pumping stations. There are very few residences within 500 feet of the Pamunkey River intake and pumping station site, and some near the Black Creek and Diascund Creek reservoir pumping stations, which might be sensitive to elevated noise levels associated with the alternative. Background noise levels in the vicinity of the pumping stations would be those typical of a rural environment.

Infrastructure

Transportation

The principal transportation route through the immediate vicinity of the proposed impoundment area is State Route 249. There are numerous other lower order state routes throughout the reservoir area. Route 249 is the only existing highway which would be inundated by construction of the reservoir.

The Southern Railway crosses Black Creek just north of the proposed dam sites. No rail lines fall within the proposed impoundment areas.

The proposed pipeline route would parallel and/or cross several existing roadways and rail lines located in New Kent County (NKC) and James City County (JCC). These roadways and rail lines include U.S. Route 60 (JCC), State Routes 607 (NKC), 606 (NKC), 612 (NKC), 609 (NKC), 642 (NKC), 249 (NKC), 608 (NKC), 603 (JCC), 621 (JCC), 601 (JCC), 657 (JCC), and 610 (JCC), and the Southern Railway (NKC) and Chesapeake & Ohio Railway (JCC).

Utilities

Short-term energy requirements for this alternative would be related to fuel and electricity needed for construction activities. Diesel fuel would be necessary for the operation of land clearing, excavation, and construction equipment. Electricity would be needed from the local utility to support construction activities unless diesel generators were utilized to generate electricity at the project site. Long-term operation of the pumping stations would require a source of electricity for the pump motors and related appurtenances. The emergency generator set would require diesel fuel.

Virginia Power is the major producer and distributor of electrical power in the project area associated with this alternative component. Virginia Power owns and operates two steam-electric power plants in the York River basin. The North Anna Plant has an installed capacity of 1,720 megawatts (MW), and the Yorktown Plant has a capacity of 1,154 MW (SWCB, 1988).

Navigation

Navigational characteristics of the Pamunkey River at Northbury are described in Section 4.5.1.

The proposed Black Creek Reservoir dam sites are located in non-tidal waters upstream of the confluence of Black Creek and the Pamunkey River. No known commercial navigation currently occurs on Black Creek. Recreational navigation is unknown within the proposed impoundment sites. Limited recreational navigation may occur in the lowest reaches of Black Creek, well downstream of the proposed dam sites and downstream of the manmade obstructions which are described below.

Based on May 1992 field inspections by Malcolm Pirnie scientists, the Black Creek channel has at least three important manmade obstructions downstream of the proposed dam sites. The obstruction identified farthest downstream is the State Route 608 Bridge which spans a section of Black Creek approximately 40 feet wide. Four 9-foot wide, round culverts are situated under the bridge. There has also been some indication that downstream of the Route 608 Bridge is an old, submerged roadbed which may represent an additional obstacle to potential navigation.

The elevated Southern Railway Bridge is located south and upstream of the State Route 608 Bridge and spans a 20-foot wide section of Black Creek. The railroad bridge abutments are constructed of tar-covered wood timbers. The channel upstream of the Southern Railway Bridge narrows to an average width of approximately 12 feet. An additional obstruction to potential navigation is the State Route 606 Bridge which spans a 25-foot wide section of Black Creek. Three 6-foot by 6-foot box culverts are situated under the Route 606 Bridge.

<u>Other Socioeconomic Impacts</u>

The proposed Black Creek Reservoir would be located entirely within New Kent County, near the metropolitan areas of Newport News, Hampton, Williamsburg, and Richmond. The County has experienced substantial growth over the past decade. Within New Kent County, the 1980 Census estimated the County population to be 8,781 persons. The population increased by 19 percent by 1990, to 10,445 persons (USDC, 1992).

While much growth has occurred within New Kent County in the past two decades, the County remains primarily rural in nature. In New Kent County, the estimated median household income in 1989, according to the 1990 Census, was $38,403 per year. This is a 106 percent increase over the 1979 estimated median household income in New Kent County of $18,629 per year (RRPDC, 1991).

Census data indicate that the majority of housing units within New Kent County are single-family dwellings. In the past two decades, the trend has been that the number of new single-family dwellings has decreased, while the number of duplex and multi-family dwellings has increased (RRPDC, 1991). As of November 1992, the County real estate tax rate was $0.82 per $100 assessed value (N. Hahn, New Kent County, personal communication, 1992).

Within New Kent County, the total number of persons 16 years of age or older who are employed is 5,326 (USDC, 1992). The largest employer category in the County is retail trade (14 percent). The next largest employer categories within the County are public administration (11 percent) and construction (11 percent). The largest employers are Cumberland Hospital, which employs over 200 persons, and the County.

4.5.3 King William Reservoir with Pumpover from Mattaponi River

Municipal and Private Water Supplies

Intake

An analysis of existing water use and cumulative streamflow reduction in the Mattaponi River basin was conducted. Total reported surface and groundwater withdrawals within the entire Mattaponi River basin, exclusive of Chesapeake Corporation, averaged 3.66 mgd in the Year 1990 (P. E. Herman, SWCB, personal communication, 1993). This total withdrawal excludes 18.3 mgd of groundwater withdrawals made in 1990 by Chesapeake Corporation at West Point since these withdrawals are from very deep aquifers which are not included in this cumulative streamflow reduction analysis. An estimated 22 percent of the groundwater withdrawals made by Chesapeake Corporation are consumed (SWCB, 1988).

In December 1991 the SWCB approved a groundwater withdrawal permit that allows Chesapeake Corporation to withdraw up to 700.6 million gallons per month (23.0 mgd). Recharge zones, with direct interconnection between surface water and the lower aquifers, are located within the area immediately east of the Fall Line where major tributaries have incised through the quaternary sediments. Therefore, large groundwater withdrawals from the lower aquifers, such as those made by Chesapeake Corporation, do have the potential to deplete surface water sources in the Mattaponi and Pamunkey river basins to some unquantified degree. However, an estimated 78 percent of Chesapeake Corporation's groundwater withdrawal is ultimately discharged to surface waters and augments river flows to that extent.

There are also irrigators in the Mattaponi River basin whose total estimated annual withdrawals in the Year 1985 were 179 million gallons (or 0.98 mgd assuming all irrigation occurs between April and September) (G. S. Anderson, USGS, personal communication, 1991). Adding this irrigation withdrawal to reported Year 1990 withdrawals results in an estimated current average water withdrawal of 4.64 mgd within the Mattaponi River basin (exclusive of Chesapeake Corporation). Of this current estimated water demand in the basin (exclusive of Chesapeake Corporation), approximately 71 percent is for domestic, commercial, and institutional use; 21 percent is for irrigation; and 8 percent is for industrial, manufacturing, and mining purposes.

Actual net streamflow reductions would be less than total Mattaponi basin withdrawals since the 4.64-mgd figure includes some reported groundwater withdrawals and ignores surface water return flows such as wastewater treatment plant effluent and crop irrigation return flows (i.e., non-consumptive surface water withdrawals). Consumptive use is the portion of water withdrawn that is not returned to the resource because it has been evaporated, transpired, incorporated into products or crops, consumed by man or livestock, or otherwise removed from the water environment. The portion of the withdrawal that is not consumed is returned to the resource.

The ***York Water Supply Plan*** (SWCB, 1988) contains an estimated consumptive use factor of 0.66 for the Mattaponi River basin which is based on published USGS data (Solley et al., 1983). Applying this factor to average Year 1990 withdrawals results in an estimated consumptive use of 3.1 mgd within the entire Mattaponi River basin (exclusive of Chesapeake Corporation).

Total freshwater discharge at the mouth of the Mattaponi River is estimated at 585.5 mgd. Estimated Year 1990 consumptive water use in the basin represents 0.5 percent of the average discharge. A list and location map of major reservoirs, stream intakes and groundwater withdrawals within the Mattaponi River basin are presented in Table 4-60 and Figure 4-7.

One private water supply system was identified in the vicinity of the proposed Mattaponi River intake site. Walkerton Water System, Inc. owns two deep wells located in the community of Walkerton in King and Queen County. One of these wells is not in service at this time. The second well was drilled in 1984 and is screened at depths of 282 to 292 feet and 363 to 383 feet. This water system is permitted by the VDH for 50 connections (S. Shaw, VDH, personal communication, 1993). Walkerton is located adjacent to the State Route 629 Bridge across the Mattaponi River which is approximately 4.8 river miles upstream of Scotland Landing.

Reservoir

Individual homeowners in the vicinity of the proposed King William Reservoir site have their own wells. No municipal or private surface water supplies were identified in the immediate vicinity of the proposed reservoir site.

Pipeline

A 40 mgd capacity raw water outfall would be located on Beaverdam Creek upstream of Diascund Creek Reservoir. There are no known municipal or private water supplies along Beaverdam Creek upstream of the existing reservoir. However, Diascund Creek Reservoir itself is part of a municipal water supply system (i.e., Newport News Waterworks).

<u>Recreational and Commercial Fisheries</u>

Intake

The Mattaponi River and its banks are utilized for recreational fishing, although no public boat landings are located in the immediate vicinity of Scotland Landing (Delorme Mapping Company, 1989). There is a privately-owned boat ramp to the Mattaponi River in King and Queen County, adjacent to the State Route 629 Bridge at Walkerton. However, public use of this boat ramp currently takes place and the VDCR and VDGIF have expressed an interest in acquiring this boating access (VDOT and FHA, 1992). The Walkerton Bridge is approximately 4.8 river miles upstream of Scotland Landing.

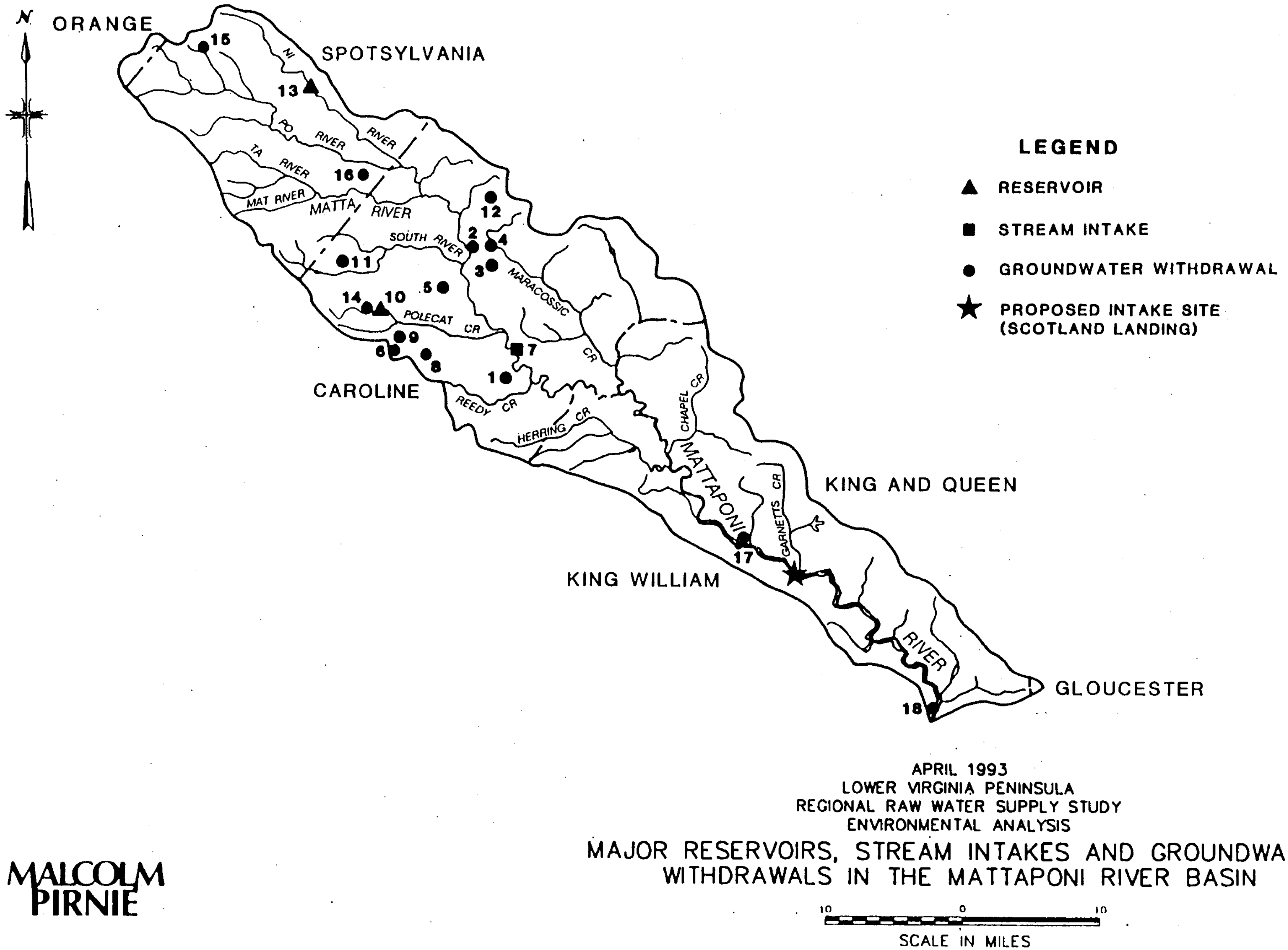
Commercially important fish species harvested in the Mattaponi River during 1990 and 1991 include Striped Bass and American Shad. Blue Crab are also harvested from the Mattaponi River (VMRC, 1992).

TABLE 4-60

MAJOR RESERVOIRS, STREAM INTAKES, AND GROUNDWATER WITHDRAWALS IN THE MATTAPONI RIVER BASIN

Map Number (a)	Description	1990 Withdrawal (b) (mgd)
1	Groundwater Withdrawal 1 Well Alpha Water Corporation (Elsinore)	0.015
2	Groundwater Withdrawal 4 Wells Town of Bowling Green	0.135
3	Groundwater Withdrawal 1 Well Caroline County (Caroline High School)	0.005
4	Groundwater Withdrawal 1 Well Foreign & Domestic Woods, Inc. (Bowling Green Plant)	0.017
5	Groundwater Withdrawal 2 Wells Caroline County (Milford Sanitary District)	0.033
6	Groundwater Withdrawal 3 Wells Caroline County Utility System	0.156
7	Stream Intake Mattaponi River Smith Sand & Gravel, Inc. (Ruther Glen Plant)	0.349
8	Groundwater Withdrawal 1 Well Days Inn	0.026 (d)
9	Groundwater Withdrawal 3 Wells VA Dept. of Transportation (I-95 Bowling Green Rest Area)	0.048
10	Reservoir (Lake Caroline) Lake Caroline Water Company	0.395
11	Groundwater Withdrawal 2 Wells Sydnor Hydrodynamics,Inc. (Campbell's Creek)	0.037
12	Groundwater Withdrawal 26 Wells U.S. Army (Fort AP Hill)	0.015 (c)
13	Reservoir (Ni) Spotsylvania County (Ni River WTP)	2.319
14	Groundwater Withdrawal 1 Well Lake Land 'or Utility Company	0.053
15	Groundwater Withdrawal 2 Wells Spotsylvania County (Winewood Estates)	0.011
16	Groundwater Withdrawal 3 Wells Po River Water & Sewer Company (Indian Acres Club of Thornburg)	0.063
17	Groundwater Withdrawal 2 Wells Walkerton Water System, Inc.	0.015
18	Groundwater Withdrawal 14 Wells Chesapeake Corporation (West Point Facility)	18.295

a) See Figure 4-7.
b) Reported 1990 withdrawals retrieved from the Virginia Water Use Data System (P.E. Herman, SWCB, personal communication, 1993).
c) 1984 withdrawal as reported in York Water Supply Plan (SWCB, 1988).
d) 1986 withdrawal as reported in Virginia Water Withdrawals 1986 (SWCB, 1987).



APRIL 1993
LOWER VIRGINIA PENINSULA
REGIONAL RAW WATER SUPPLY STUDY
ENVIRONMENTAL ANALYSIS

MAJOR RESERVOIRS, STREAM INTAKES AND GROUNDWATER WITHDRAWALS IN THE MATTAPONI RIVER BASIN

FIGURE 4-7

MALCOLM PIRNIE

Reservoir

Within the proposed impoundment area, Cohoke Mill Creek is shallow and has limited access. The creek is also isolated from navigable waters downstream by the existing Cohoke Millpond Dam. Therefore, the proposed impoundment area currently has limited potential for commercial fisheries since it would not accommodate larger commercial vessels.

The majority of the recreational fishing in the vicinity of the proposed impoundment area occurs downstream in Cohoke Millpond. Cohoke Millpond is a private 15-acre fishing pond owned by the Cohoke Club, Inc. The Cohoke Club has a small boathouse on the pond and a private fishing dock immediately downstream of the Cohoke Millpond Dam.

Invertebrates of commercial importance would not be abundant in the proposed impoundment site given the low salinity at and upstream of the proposed dam site. This would likely be the case with or without the existing Cohoke Millpond Dam which is located downstream of the proposed impoundment site.

Pipeline

Based on review of USGS topographic maps and color-infrared aerial photography of the pipeline route, 9 perennial and 17 intermittent streams would be crossed by the new pipeline. The pipeline would also cross the Pamunkey River and an arm of Little Creek Reservoir. No commercial fishing occurs at Little Creek Reservoir. Commercial fishing in the Pamunkey River is discussed in Section 4.5.1.

<u>Other Water-Related Recreation</u>

Intake

The Mattaponi River and its banks in the proposed project area are utilized for various recreational activities including fishing, hunting, and boating. There is a privately-owned boat ramp on the Mattaponi River in King and Queen County, adjacent to the State Route 629 Bridge at Walkerton. However, public use of this boat ramp currently takes place, and the VDCR and VDGIF have expressed an interest in acquiring this boating access (VDOT and FHA, 1992). The Walkerton Bridge is approximately 4.9 river miles upstream of Scotland Landing.

The Mattaponi River is tidal at the proposed intake location and is well-suited for year-round recreational boat activity. Several privately owned duck blinds and hunt clubs are located in the vicinity of Scotland Landing (H. Garner, VDGIF, personal communication, 1992).

Reservoir

The primary water-related recreation within the proposed King William Reservoir watershed is hunting. The basin supports several bird and mammal species sought by hunters. Hunt clubs within the watershed include the West Point Stillhunters Club which leases land adjacent to State Routes 626, 630, and 631 and the Holly Grove Hunt Club which leases land adjacent to State Routes 626, 632, and 651. Several other private hunt clubs and duck blinds are also located in the basin (H. Garner, VDGIF, personal communication, 1992).

The Cohoke Club, Inc. owns the Cohoke Millpond and some of the land near the existing millpond dam. The Cohoke Club has a small boathouse and a private fishing dock immediately downstream of the Cohoke Millpond dam.

Pipeline

Based on review of USGS topographic maps and color-infrared aerial photography of the pipeline route, most of the 17.0-mile route traverses forested lands. It is likely that portions of this area are leased to private hunt clubs. The pipeline also crosses the Pamunkey River which may support hunting, fishing, and boating, although the nearest public boat landing, Brickhouse Landing, is located approximately 3,000 feet downstream of the proposed pipeline crossing.

Aesthetics

Intake

The aesthetic value of the proposed river intake area is its predominantly natural, scenic beauty. The shoreline surrounding the Mattaponi River in the vicinity of the proposed intake is a sloping, forested terrain which is relatively undeveloped in the immediate vicinity. No houses were identified within 500 feet of the proposed Mattaponi River pump station. However, there is a new, large-lot residential subdivision on the south shore of the Mattaponi River, with the nearest house located approximately 1,000 feet downstream of the proposed pump station building site. Some site work at the pump station site could be within 600 feet of the nearest house within this new subdivision (see Table 4-52).

Reservoir

The King William watershed is mostly rural with residential areas scattered along roads and highways. The aesthetic value of the proposed reservoir area is its scenic beauty, a product of its hardwood swamps, emergent vegetation, and wildlife. However, the proposed impoundment area on Cohoke Mill Creek has limited and seasonally variable visibility from public roads, so its aesthetic appeal is present but not highly apparent to the causal observer. No existing houses were identified within the proposed reservoir pool area or in the vicinity of the proposed dam. A total of 28 houses were identified within 500 feet of the proposed reservoir pool area, with the nearest house located at least 50 feet from the pool area.

Pipeline

The pipeline route would traverse mostly rural areas; however, 45 houses were identified within 300 feet of the proposed pipeline route (see Table 4-52).

The *Comprehensive Plan for King William County, Virginia* (KWCPD, 1991) identifies the intake site as being located within a designated CBPA. Due to the proximity of the site adjacent to the Pamunkey River, the area would be designated as an RPA.

As of July 1992, the provisions of the Virginia Agricultural and Forestal Districts Act of 1977 had been repealed in King William County. Therefore, no AFDs were in effect within the County (D. W. Carney, King William County, personal communication, 1992).

Reservoir

Color-infrared aerial photographs were used to identify existing land uses within the proposed normal pool elevation of the reservoir and the reservoir watershed. Existing land uses within the reservoir drainage area, including the pool area, are identified in Table 4-61. Land uses within the normal pool area are identified in Table 4-62. The data presented in these tables are based on 1993 aerial photography of the region. Development within this region has not been great within the past decade (KWCPD, 1991).

All categories, with the exception of wetlands and forests, were identified and measured on the aerial photographs using planimetry. Residential acreage includes all subdivisions, groups of homes, and individual homes not associated with agricultural operations. The agricultural/rural residential category includes all agricultural lands and houses or structures associated with these lands. Wetland and open water acreage in the drainage area was determined through interpretation of aerial photography and field inspections. Existing land uses within King William County are presented in Table 4-63 to provide an indication of the relative abundance of specific land use types within the region.

The majority of the reservoir watershed is currently forested (76 percent). Approximately 17 percent of the watershed is in agricultural/rural residential land use. Aside from homes associated with agricultural operations, only limited residential land use was identified within the watershed. No existing homes were identified at or below 100 feet msl. The remainder of the watershed is comprised of open water, wetlands, and roads.

Forested lands also comprise the majority of the proposed reservoir pool area (77 percent), with wetlands comprising the next largest land area (21 percent). Approximately 29 acres of agricultural/rural residential land is also located at or below the proposed normal pool elevation of 90 feet msl.

No existing houses were identified that would be displaced by the proposed reservoir or dam. This determination was made based on review of USGS topographic maps, recent color-infrared aerial photography, and discussions with King William County planning and building officials.

The King William Reservoir drainage area is designated as a CBPA in accordance with the Chesapeake Bay Preservation Act (KWCPD, 1991). Cohoke Mill Creek and immediately adjacent areas are designated as RPAs. The remainder of the watershed is designated as an RMA. Residential, light commercial, and planned unit developments are anticipated to be located along the perimeter of the watershed in the future.

Parks and Preserves

Intake

The Mattaponi River is not currently designated as part of the Virginia Scenic Rivers System (VSRS). While it is currently not afforded protection under this system, it is designated in the ***1989 Virginia Outdoors Plan*** as a potential component which is worthy of future evaluation (VDCR, 1989). No existing parks or preserves are located in the vicinity of the proposed Mattaponi River intake at Scotland Landing (VDCR, 1991; KWCPD, 1991).

The Nature Conservancy currently holds a conservation easement on the Mattaponi River in King & Queen County. The easement protects 50 acres of marshland on the Mattaponi River, which includes an island marsh, at and immediately upstream of the State Route 629 Bridge at Walkerton (VCOE, 1987; Paust, 1988; VDOT and FHA, 1992). This easement is located approximately 5 river miles upstream of the proposed Scotland Landing intake site.

Reservoir

There are no parks or preserves located within the drainage area of the proposed King William Reservoir (VDCR, 1989; KWCPD, 1991).

Pipeline

The Sweet Hall Marsh component of the Chesapeake Bay National Estuary Research Reserve System (CBNERRS) is located approximately 2.7 river miles downstream of the proposed pipeline crossing of the Pamunkey River.

No other existing parks or preserves are located along the proposed pipeline route for this alternative component (VDCR, 1989; KWCPD, 1991; JCC, 1991).

Land Use

Intake

It is assumed that construction of a pump station at Scotland Landing on the Mattaponi River would required disturbance of approximately 3 acres of land. In addition, a small amount of land would be required for construction of an access road to the pump station and for placement of electrical transmission lines to power the pump station. Field studies of the proposed intake site at Scotland Landing were conducted by Malcolm Pirnie during the spring of 1990 to determine the feasibility of the site as a potential raw water intake location. These studies identified the site as being located on a large tract of land (i.e., 188 acres) which can be subdivided, if necessary, for the pumping station.

To further characterize existing land uses at the site, USGS topographic mapping and color-infrared aerial photography were also reviewed. Based on inspection of these resources, the pump station building would be located on forested land.

TABLE 4-61

KING WILLIAM RESERVOIR WATERSHED LAND USE (1993)

Land Use Category	Acreage	% of Total [1]
Agricultural/Rural Residential [2]	1,441	17.1
Roads		
Primary Roads	62	0.7
Secondary Roads	67	0.8
Subtotal	129	1.5
Wetlands and Open Water	479	5.7
Forest	6,380	75.7
TOTAL	**8,429**	**100**

1 Percent of total column may not sum to 100 percent due to rounding associated with the individual percentages presented for each land use category.

2 Agricultural/Rural Residential acreage includes all agricultural lands and house or structures associated with these lands.

Source: Planimetry of identified land use boundaries on color-infrared aerial photography taken by Air Survey Corporation on March 7, 1993 (approximate scale 1" = 1,000') and field inspections of wetland areas.

TABLE 4-62

KING WILLIAM RESERVOIR NORMAL POOL AREA LAND USE (1993)

Land Use Category	Acreage	% of Total [1]
Agricultural/Rural Residential [2]	29	1.3
Wetlands and Open Water	479	21.4
Forest	1,719	76.9
Roads	7	0.3
TOTAL	**2,234**	**100**

[1] Percent of total column may not sum to 100 percent due to rounding associated with the individual percentages presented for each land use category.

[2] Agricultural/Rural Residential acreage includes all agricultural lands and house or structures associated with these lands.

Source: Planimetry of identified land use boundaries on color-infrared aerial photography taken by Air Survey Corporation on March 7, 1993 (approximate scale 1" = 1,000') and field inspections of wetland areas.

TABLE 4-63

KING WILLIAM COUNTY LAND USE (1988)

Land Use Category	Acreage	Percent of Total
Urban	1,587	0.8
Agricultural	38,201	20.9
Forest and Other [1]	137,978	75.5
Water [2]	5,056	2.8
TOTAL	**182,822**	**100**

[1] Includes recreational and wildlife areas.

[2] Does not include ponds less than 40 acres in size or streams.

Source: *York Water Supply Plan* (SWCB, 1988).

As of July 1992, no AFDs were in effect within King William County (D. W. Carney, King William County, personal communication, 1992).

As described in the ***King William Reservoir Project Development Agreement*** (King William County and City of Newport News, 1990), for water quality protection purposes. King William County would acquire and lease to the City of Newport News sufficient land to create a buffer zone around the reservoir. This buffer zone would extend a minimum of 100 feet horizontally from the water's edge at spillway elevation and a minimum of 7 feet vertically above spillway elevation. Existing land uses within this buffer area would include those land use types listed in Table 4-61 as occurring within the watershed.

Pipeline

The proposed pipeline, with a length of 17.0 miles and an assumed ROW width of 50 feet, would disturb approximately 94 acres of land (excluding Pamunkey River and Little Creek Reservoir crossing and directional drill segment below high ground). Existing land uses along the proposed pipeline were identified through review of USGS topographic mapping and color-infrared aerial photography. A portion of the pipeline route (4.3 miles) follows existing rights-of-way through King William, New Kent, and James City counties. For the remainder of the route, which encompasses approximately 12.7 miles, the pipeline would primarily traverse forested and agricultural land.

A summary of affected land use in project areas for this alternative is included in Table 4-57.

Noise

Estimated construction time of the King William Reservoir alternative is approximately 3 years. This alternative component would include an intake and pumping station at the Mattaponi River and a pumping station at Diascund Creek Reservoir. Five 15 mgd pumps would be needed at the Mattaponi River pumping station and four 10 mgd pumps would be required at the Diascund Creek Reservoir pumping station. There are no residences within 500 feet of the proposed Mattaponi River intake and pumping station site, and some near the Diascund Creek Reservoir pumping station, which might be sensitive to elevated noise levels associated with the project. Background noise levels in the vicinity of the pumping stations would be those typical of a rural atmosphere.

Infrastructure

Transportation

The principal transportation route through the immediate vicinity of the proposed impoundment area is State Route 30. There are numerous other lower order state routes throughout the reservoir area. State Route 626 is the only existing highway which would be inundated by construction of the reservoir.

The Southern Railway crosses Cohoke Millpond just south of the proposed dam site. No rail lines fall within the proposed impoundment area.

The proposed pipeline route would parallel and/or cross several existing roadways and rail lines located in King William County (KWC), New Kent County (NKC), and James City County (JCC). These roadways and rail lines include U.S. Route 60 (JCC), State Routes 620 (KWC), 30 (KWC), 632 (KWC), 630 (KWC), 624 (NKC), 623 (NKC), 249 (NKC), 33 (NKC), 603 (JCC), 621 (JCC), 601 (JCC), 657 (JCC), and 610 (JCC), and the Southern Railway (KWC) and Chesapeake & Ohio Railway (JCC).

Utilities

Short-term energy requirements for this alternative would be related to fuel and electricity needed for construction activities. Diesel fuel would be necessary for the operation of land clearing, excavation, and construction equipment. Electricity would be needed from the local utility to support construction activities unless diesel generators were utilized to generate electricity at the project site. Long-term operation of the pumping stations would require a source of electricity for the pump motors and related appurtenances. The emergency generator set would require diesel fuel.

Virginia Power is the major producer and distributor of electrical power in the project area associated with this alternative component. Virginia Power owns and operates two steam-electric power plants in the York River basin. The North Anna Plant has an installed capacity of 1,720 megawatts (MW), and the Yorktown Plant has a capacity of 1,154 MW (SWCB, 1988).

Navigation

Based on past studies, it is assumed for administrative purposes that the Mattaponi River is navigable from its confluence with the York River to as far upstream as Guinea Bridge in Caroline County (K. M. Kimidy, USCOE - Norfolk District, personal communication, 1993).

The proposed river intake structure would be located at Scotland Landing in tidal and navigable waters. The mean tidal range is 3.9 feet at Walkerton, approximately 5 river miles upstream of Scotland Landing (USDC, 1989). USGS topographic maps show mid-channel depths at mean low water ranging from 19 to 25 feet in the immediate vicinity of Scotland Landing. Water depths of 21 to 25 feet were measured at the proposed intake structure footprint during field inspections conducted by Malcolm Pirnie in April 1993. The Mattaponi River is approximately 450 feet wide at Scotland Landing.

The proposed King William Reservoir dam site is located in non-tidal waters on Cohoke Mill Creek. Cohoke Mill Creek flows in a southerly direction into Cohoke Millpond, which is an existing impoundment downstream of the proposed dam site, and tributary to the Pamunkey River. The upstream end of Cohoke Millpond and the Cohoke Millpond Dam itself are located approximately 0.4 river miles and 1.8 river miles, respectively, downstream of the proposed King William Reservoir dam site.

No known commercial navigation currently occurs on Cohoke Mill Creek. Within the proposed impoundment site, recreational navigation is unknown and the main channel of Cohoke Mill Creek is obstructed by a triple 10-foot by 10-foot box culvert underneath State Route 626. Recreational navigation does occur below the proposed dam site in Cohoke

Millpond. Limited recreational navigation may also occur in the short tidal reach of Cohoke Mill Creek downstream of the Cohoke Millpond Dam (i.e., State Route 632 Bridge crossing).

Other Socioeconomic Impacts

The proposed King William Reservoir would be located entirely within King William County, near the metropolitan areas of Newport News, Hampton, Williamsburg, and Richmond. The County has experienced substantial growth over the past decade. Within King William County, the 1980 Census estimated the County population to be 9,334. Population increased by 17 percent by 1990, to 10,913 persons (USDC, 1992).

While some growth has occurred within King William County in the past two decades, the County remains primarily rural in nature. Most of the population growth is attributable to an influx of new residents, particularly in the southwest portion of the County (U. S. Route 360 corridor) closest to Richmond.

In King William County, the estimated median household income in 1989, according to the 1990 Census, was $33,676 per year. This is a 73 percent increase over the 1979 estimated median household income in King William County of $19,446 per year (RRPDC, 1991).

The number of households within King William County has increased greatly in the past two decades. The majority of these units are single-family and multi-family homes. There are currently no mobile/manufactured home parks or subdivisions in the County (KWCPD, 1991). As of November 1992, the County real estate tax rate was $1.17 per $100 assessed value (G. Baka, KWCPD, personal communication, 1992).

Within King William County, the total number of persons 16 years of age or older who are employed is 5,504 (USDC, 1992). The largest employer category in the County is retail trade (15 percent). The next largest employer category is manufacturing of nondurable goods (14 percent).

4.5.4 Fresh Groundwater Development

Municipal and Private Water Supplies

This alternative component would involve fresh groundwater withdrawals made from new well fields in western James City County and/or New Kent County. These groundwater withdrawals would be used to augment Diascund Creek and Little Creek reservoirs when Newport News Waterworks system reservoir volume is below 75 percent of total capacity. These withdrawals would be made from the Middle Potomac Aquifer. However, the potential exists for impacts (via leakage) to the multi-aquifer system.

In 1983 the total estimated withdrawal from the Potomac aquifers on the York-James Peninsula was 33.6 mgd. These estimated Potomac aquifer withdrawals represent approximately 86 percent of the total estimated groundwater withdrawals on the York-James Peninsula (38.9 mgd). The largest groundwater withdrawal is made by Chesapeake Corporation (West Point Facility) and was reported as 18.295 mgd for 1990 (P. E. Herman, SWCB, personal communication, 1993). In December 1991 the SWCB approved a groundwater withdrawal permit that allows Chesapeake Corporation to withdraw up to 700.6 million gallons per month (23.0 mgd). Table 4-64 lists the 1983 estimated groundwater withdrawals from the York-James Peninsula by aquifer. Approximate locations of permitted or certified wells in the region surrounding the proposed well fields are shown in Figure 4-8.

Recreational and Commercial Fisheries

Diascund Creek and Little Creek reservoirs are currently monitored by a fishery management program in cooperation with the VDGIF. Recreational and commercial fisheries exist in both reservoirs.

Other Water-Related Recreation

No recreational facilities are located in the vicinity of proposed groundwater wells or associated pipelines at Diascund Creek or Little Creek reservoirs (VDRC, 1989; James City County, 1991).

Aesthetics

Potential aesthetic impacts from this alternative were evaluated by identifying houses within 300 feet of the proposed pipelines and 500 feet of the proposed groundwater withdrawal facilities. No houses were identified within 300 feet of the pipeline routes. A total of nine houses were identified within 500 feet of the proposed groundwater withdrawal points (see Table 4-52).

Parks and Preserves

There are no existing parks or preserves in the vicinity of proposed groundwater well locations at Diascund Creek or Little Creek reservoirs (VDCR, 1989; JCC, 1991; RRPDC, 1991).

Land Use

Existing land uses in the vicinity of proposed groundwater well locations along the perimeter of Diascund Creek and Little Creek reservoirs were identified based on review of USGS topographic maps and color-infrared aerial photography taken in March 1982. The predominant land use which would be impacted by the wells and pipelines is forested land.

A summary of affected land use in project areas for this alternative is included in Table 4-57.

Noise

Estimated construction time of the proposed fresh groundwater wells and pipelines is approximately 6 months. Eight 1.3 mgd pumps would be installed in James City and New Kent counties. There are some residences near the proposed well sites and pipeline routes which might be sensitive to elevated noise levels anticipated with the alternative. Background noise levels in the vicinity of the pumping stations would be those typical of a rural environment.

TABLE 4-64

ESTIMATED GROUNDWATER WITHDRAWALS FROM YORK-JAMES PENINSULA BY AQUIFER (1983) *

Aquifer	Withdrawal (mgd)	Percentage of Total
Columbia	0.100	0.3
Yorktown-Eastover	1.373	3.5
Chickahominy-Piney Point	2.939	7.6
Aquia	0.903	2.3
Upper Potomac	14.168	36.4
Middle Potomac	15.873	40.8
Lower Potomac	3.560	9.1
Total	**38.916**	**100.0**

* Adapted from: Groundwater Resources of the York-James Peninsula of Virginia (Laczniak and Meng, 1988).

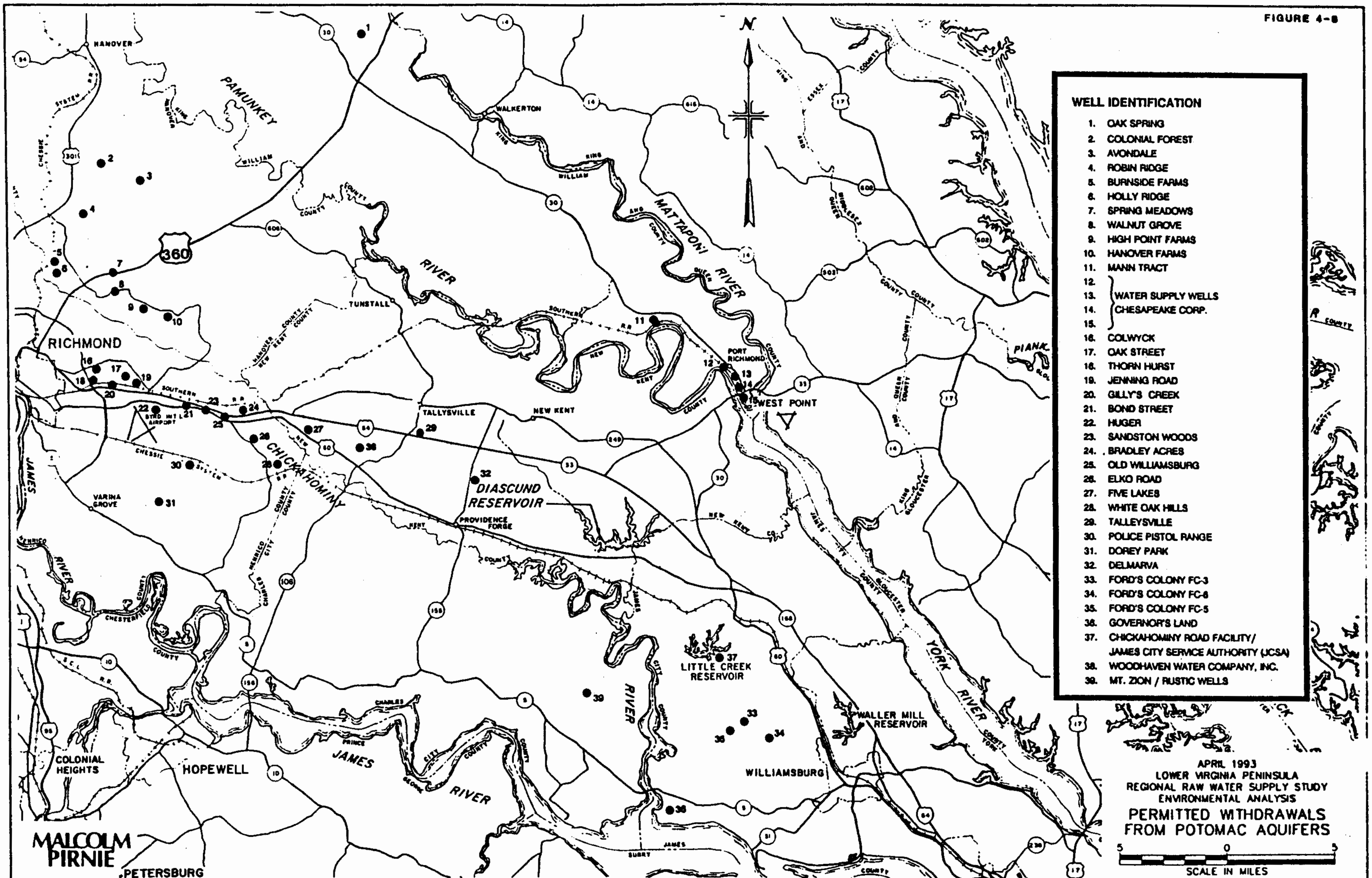


FIGURE 4-8
WELL IDENTIFICATION
1. OAK SPRING
2. COLONIAL FOREST
3. AVONDALE
4. ROBIN RIDGE
5. BURNSIDE FARMS
6. HOLLY RIDGE
7. SPRING MEADOWS
8. WALNUT GROVE
9. HIGH POINT FARMS
10. HANOVER FARMS
11. MANN TRACT
12.
13. WATER SUPPLY WELLS
14. CHESAPEAKE CORP.
15.
16. COLWYCK
17. OAK STREET
18. THORN HURST
19. JENNING ROAD
20. GILLY'S CREEK
21. BOND STREET
22. HUGER
23. SANDSTON WOODS
24. BRADLEY ACRES
25. OLD WILLIAMSBURG
26. ELKO ROAD
27. FIVE LAKES
28. WHITE OAK HILLS
29. TALLEYSVILLE
30. POLICE PISTOL RANGE
31. DOREY PARK
32. DELMARVA
33. FORD'S COLONY FC-3
34. FORD'S COLONY FC-6
35. FORD'S COLONY FC-5
36. GOVERNOR'S LAND
37. CHICKAHOMINY ROAD FACILITY/
JAMES CITY SERVICE AUTHORITY (JCSA)
38. WOODHAVEN WATER COMPANY, INC.
39. MT. ZION / RUSTIC WELLS
N
HANOVER
PAMUNKEY
RIVER
MATTAPONI
RIVER
WALKERTON
RICHMOND
TUNSTALL
PORT RICHMOND
WEST POINT
TALLYSVILLE
NEW KENT
BYRD INT'L AIRPORT
CHICKAHOMINY
DIASCUND
RESERVOIR
PROVIDENCE FORGE
VARINA GROVE
JAMES
RIVER
LITTLE CREEK
RESERVOIR
WALLER MILL
RESERVOIR
YORK RIVER
WILLIAMSBURG
COLONIAL HEIGHTS
HOPEWELL
JAMES
RIVER
PETERSBURG
MALCOLM PIRNIE
APRIL 1993
LOWER VIRGINIA PENINSULA
REGIONAL RAW WATER SUPPLY STUDY
ENVIRONMENTAL ANALYSIS
PERMITTED WITHDRAWALS
FROM POTOMAC AQUIFERS
5 0 5
SCALE IN MILES

Infrastructure

Transportation

Any transportation impacts as a result of this alternative should be temporary and negligible.

Utilities

Short-term energy requirements for this alternative would be related to fuel and electricity needed for construction activities. Diesel fuel would be necessary for the minor operation of land clearing, excavation, construction, and well drilling equipment. Long-term operation of the pumping stations would require a source of electricity for the pump motors and related appurtenances. However, energy demands would be relatively low since the well pumps would only be operated when Newport News Waterworks system reservoir volume is below 75 percent of total capacity.

At full project utilization, the wells would require an average of approximately 2,400 MWH per year of electrical power. To supply power to all eight well sites, approximately 17 miles of new or upgraded electrical transmission lines would be required for connections to suitable existing Virginia Power lines along U.S. Route 60.

Navigation

Fresh Groundwater Withdrawals would have no effect on navigation.

Other Socioeconomic Impacts

Potential socioeconomic effects would occur with this alternative in the form of increased water rates to consumers.

4.5.5 Groundwater Desalination in Newport News Waterworks Distribution Area

Municipal and Private Supplies

This alternative component would involve the development of up to 10 mgd of deep brackish groundwater supply from wells screened in the Middle and Lower Potomac aquifers in eastern portions of the York-James Peninsula.

Due to the potential for impacts (via leakage) to the multi-aquifer system, descriptions of the confined aquifers in the project area are discussed in Section 4.2.5. A discussion of current groundwater withdrawals on the York-James Peninsula is presented in Section 4.5.4.

Recreational and Commercial Fisheries

The concentrate pipeline for Site 1 (Copeland Industrial Park Ground Storage Tank) would not cross any streams before discharging into Hampton Roads.

The concentrate pipeline for Site 2 (Upper York County Ground Storage Tank) would cross one intermittent and one perennial tributary of Jones Millpond. The perennial tributary may be utilized for recreational fishing; however, due to its small size, this water body would not be commercially important. The proposed concentrate pipeline would discharge into Queens Creek, a tributary of the York River which is utilized for recreational fishing (York County, 1991).

The concentrate pipeline for Site 3 (Harwood's Mill WTP Clearwell) would cross one perennial and one intermittent stream before discharging into the Poquoson River. The perennial stream crossing is a tributary of the Poquoson River.

The concentrate pipeline for Site 4 (Lee Hall WTP Clearwell) would not cross any streams before discharging into Skiffe's Creek.

Fish species typical of the water bodies that would receive concentrate discharges are discussed in Section 4.3.5.

Other Water-Related Recreation

One groundwater well and associated RO treatment facility would be located within a recreational area. The Site 4 facilities (Lee Hall WTP Clearwell) would be located within the boundaries of Newport News Park which encompasses the drainage area of Lee Hall Reservoir. Current recreational uses of the park include boating, fishing, canoeing, sailing, and picnicking.

A portion of the concentrate discharge pipeline for Site 2 (Upper York County Ground Storage Tank) would traverse the York County New Quarter Park located adjacent to Queens Lake and the Colonial Parkway in York County. Existing recreational facilities in the park include a floating fishing pier, horse shoe courts, picnic areas, hiking trails, softball fields, and volleyball courts (York County, 1991).

Aesthetics

At Site 1 (Copeland Industrial Park Ground Storage Tank), there would be impacts to the visual surroundings that exist for the five buildings identified within 500 feet of the proposed RO treatment facility. The proposed concentrate discharge pipeline route would pass within 300 feet of five buildings, two churches, and one school (see Table 4-52).

At Site 2 (Upper York County Ground Storage Tank), 12 houses and one school were identified within 500 feet of the proposed RO treatment facility. A total of 38 houses and one building were identified within 300 feet of the proposed concentrate discharge pipeline route (see Table 4-52). The pipeline route would also cross York County New Quarter Park and the Colonial Parkway of the Colonial National Historic Park.

At Site 3 (Harwood's Mill WTP Clearwell), no houses were identified within 500 feet of the proposed RO treatment facility, but 142 houses, 11 buildings, one school, and the Harwood's Mill Filtration Plant are within 300 feet of the proposed concentrate discharge pipeline route (see Table 4-52).

At Site 4 (Lee Hall WTP Clearwell), the Lee Hall Filtration Plant is located within 500 feet of the proposed RO treatment facility. Three buildings were identified within 300 feet of the proposed concentrate discharge pipeline route (see Table 4-52). Also, the proposed RO treatment facilities would be located within the boundaries of Newport News Park.

Parks and Preserves

Only one of the groundwater wells and associated RO treatment facilities would be located within a designated park or preserve. The Site 4 facilities (Lee Hall WTP Clearwell) would be located within the boundaries of Newport News Park. This City of Newport News park encompasses the drainage area of the Lee Hall Reservoir. A section of the concentrate discharge pipeline for this alternative would also be located within the park boundaries.

A portion of the concentrate discharge pipeline for the Site 2 facilities (Upper York County Ground Storage Tank) would traverse the York County New Quarter Park. This park is located adjacent to Queens Lake and the Colonial Parkway in York County. The park contains 545 acres and is designated primarily for passive recreation (York County Department of Planning and Community Development, 1991). This pipeline would also cross the Colonial National Historical Parkway in York County.

Land Use

Existing land uses in the vicinity of proposed groundwater well locations, associated RO treatment plants, and concentrate discharge lines for this alternative were identified based on review of USGS topographic maps of the region. Approximately 13.4 miles of concentrate discharge pipeline would be required for this alternative. Land uses in the vicinity of the concentrate discharge pipeline routes include commercial, residential, forested, and some industrial areas.

A summary of affected land use in project areas for this alternative is included in Table 4-57.

Noise

Estimated construction time of the proposed groundwater wells, RO plants, and concentrate discharge pipelines is approximately 1 year. Three 3.8 mgd pumps would be installed in the City of Newport News and two in York County. There are several residences near the well sites and pipeline routes which might be sensitive to elevated noise levels anticipated with the project. Background noise levels in the vicinity of the pumping stations would be those typical of a moderately urban environment.

Infrastructure

Transportation

Any transportation impacts as a result of the Groundwater Desalination alternative should be temporary and negligible.

Utilities

Short-term energy requirements for this alternative would be related to fuel and electricity needed for construction activities. Diesel fuel would be necessary for the minor operation of land clearing, excavation, construction, and well drilling equipment. Long-term operation of the pumping stations would require a source of electricity for the pump motors and related appurtenances.

At full project utilization, the wells and RO treatment facilities would require an average of approximately 17,500 MWH per year of electrical power. To supply power to all the well and treatment sites, only minor upgrades of electrical transmission lines would be required.

Wastewater (i.e., concentrate) generated at the four RO treatment plants would be pumped through four dedicated concentrate pipelines to discharge points in nearby tidal waters.

Other Socioeconomic Impacts
The potential socioeconomic effect of increased water rates to the consumer could also occur if this alternative component is implemented.

4.5.6 Use Restrictions

Municipal and Private Water Supplies

Based on safe yield modeling results, this alternative would allow Lower Peninsula water systems to provide an additional 1.5 mgd of treated water safe yield. This safe yield benefit represents 5 percent of the Lower Peninsula's projected Year 2040 treated water supply deficit of 30.2 mgd.

Recreation and Commercial Fisheries
Use Restrictions would have no adverse impacts on fish species of recreational or commercial importance.

Other Water-Related Recreation
Recreational activities within project areas are described in Sections 4.5.1 through 4.5.5.

Aesthetics
The aesthetic values of project areas are described in Sections 4.5.1 through 4.5.5.

Parks and Preserves
Use Restrictions would be likely to restrict irrigation of parks within the area. Park resources within project areas are described in Sections 4.5.1 through 4.5.5.

Land Use
Existing land uses within project areas are described in Sections 4.5.1 through 4.5.5.

Noise
Use Restrictions would have no effect on ambient noise levels.

Infrastructure
Use Restrictions should have no effect on existing infrastructure.

Other Socioeconomic Impacts
The socioeconomic setting of the project areas is presented in Sections 4.5.1 through 4.5.5.

4.5.7 No Action

Municipal and Private Water Supplies
Municipal and private water supplies in the region are described in Sections 4.5.1 through 4.5.5.

Recreational and Commercial Fisheries
Recreational and commercial fisheries within project areas are described in Sections 4.5.1 through 4.5.5.

Other Water-Related Recreation
Recreational activities within project areas are described in Sections 4.5.1 through 4.5.5.

Aesthetics
The aesthetic values of project areas are described in Sections 4.5.1 through 4.5.5.

Parks and Preserves
Existing parks and preserves within the region are described in Sections 4.5.1 through 4.5.5.

Land Use
Existing land uses in project areas are described in Sections 4.5.1 through 4.5.5.

Noise
If no action was taken, there would be no adverse impact on ambient noise levels.

Infrastructure
Existing infrastructure in project areas is described in Sections 4.5.1 through 4.5.5.

Other Socioeconomic Impacts
The socioeconomic setting of project areas is described in Sections 4.5.1 through 4.5.5.

4.6 SUMMARY OF AFFECTED ENVIRONMENT

The affected environment for each of the seven alternatives is summarized in Table 4-65.

5.0 ENVIRONMENTAL CONSEQUENCES

5.1 INTRODUCTION

This section is devoted to the probable direct, indirect, and cumulative impacts of the practicable project alternatives and the No Action alternative; and is the scientific and analytic basis for the comparison of alternatives in this document. A general description of the effects of each practicable alternative is presented, but only in as much detail as needed to make meaningful comparisons among them. A more detailed evaluation of potential impacts is contained in ***Alternatives Assessment (Volume II - Environmental Analysis)*** (Malcolm Pirnie, 1993). This report is incorporated herein by reference and is an appendix to this document.

The environmental effects of each alternative are summarized for each of the following general categories:

- Physical Resources: Describes impacts on substrate, water quality, hydrology, groundwater resources, soil and mineral resources, and air quality. Riffle and pool complexes were also evaluated, but none of these features were identified within the project areas. Therefore, no impacts to these complexes are anticipated.

- Biological Resources: Describes impacts on endangered, threatened or sensitive species; fish and invertebrates; other wildlife; sanctuaries and refuges; wetlands and vegetated shallows; and mud flats.

- Cultural Resources: Describes impacts on archeological and historical sites.

- Socioeconomic Resources: Describes impacts on municipal and private water supplies, recreational and commercial fisheries, other water-related recreation, aesthetics, parks and preserves, land use, noise, infrastructure, and other socioeconomic impacts.

- Unavoidable and Adverse Environmental Impacts.

- Irreversible and Irretrievable Commitments of Resources.

- Relationship Between Short-Term Uses of Man's Environment and the Maintenance and Enhancement of Long-Term Productivity.

A comparative summary of the environmental consequences associated with each alternative is presented in Section 3.6.

5.2 PHYSICAL RESOURCES

This section provides a general description of how the physical environment would be impacted by each of the seven alternatives evaluated. Physical resource categories evaluated are described below.

Substrate

This section addresses the potential impacts of each alternative on aquatic ecosystem substrate. Impacts are assessed according to the acreage of aquatic ecosystem substrate disturbed.

Water Quality

This section evaluates the potential impacts to surface water quality from the seven alternative components. Water quality impacts to groundwater are addressed in Groundwater Resources. In evaluating the water quality impacts to these surface waters, existing water quality conditions were characterized and potential long-term and short-term water quality changes resulting from implementation of each alternative was assessed. Some factors which were used in evaluating the impacts were quality of the existing surface waters, severity of any impacts, magnitude of any water quality changes, and relative probability that there would be an impact (based on available information). Because the amount of surface water quality information for each alternative varies widely, and the types of impacts differ, a quantitative analysis of each alternative was not appropriate. Rather, a more qualitative analysis which considered relative trends and changes was used to evaluate each alternative. In this manner, the assessment between alternative components would not be biased by the amount of information available for each alternative.

Hydrology

Hydrologic impact analyses were conducted to evaluate the potential environmental consequences of each alternative component on surface water or groundwater hydrology. For surface water withdrawals, key hydrologic impact assessment criteria include streamflow duration curves, average annual, average monthly and cumulative withdrawal rates as a fraction of available flow, and flow contravention frequencies. Impacts to affected streams at proposed impoundment sites and pipeline discharge points are also quantified. For groundwater withdrawals, the magnitude of potential aquifer drawdown is evaluated.

Groundwater Resources

This section evaluates the proposed alternatives based on the relative severity of their potential impacts to the respective environmental criteria. Potential impacts to groundwater resources are divided into two broad categories:

- Impacts to Groundwater Quantity
- Impacts to Groundwater Quality

Most of the above impact criteria were developed by the Virginia State Water Control Board (SWCB) in response to the Groundwater Management Act of 1973 (which was repealed and replaced by the Groundwater Management Act of 1992 (Virginia Code § 62.1 - 254 through § 62.1 - 270)).

Soil and Mineral Resources

This section describes the potential impacts on soils and mineral resources from each alternative component. Impacts to these resources resulting from implementation of practicable alternatives are addressed in terms of the acreage of disturbance to these resources.

Air Quality

This section discusses the potential impacts of each alternative component on air quality. Impacts are addressed in terms of construction and operation impacts.

5.2.1 Ware Creek Reservoir with Pumpover from Pamunkey River

Substrate

The Ware Creek Reservoir alternative would impact approximately 1.54 acres of substrate. In greater detail, 0.16 acres of substrate would be removed during construction of the intake pipeline at the proposed Northbury intake site, 1.2 acres of substrate would be temporarily disturbed by pipeline construction, and 0.18 acres of substrate would be disturbed, removed or permanently covered by construction of the outfall structures.

In addition, filling the proposed reservoir area to 35 feet msl would result in the inundation of approximately 1,238 acres, of which 54 acres are currently open water and perennial stream areas containing substrate. Because substrates in these areas are presently inundated, adverse effects from further inundation of these perennially wet areas are considered minimal.

Water Quality

Surface waters involved in this alternative are the Pamunkey River, Diascund Creek Reservoir, Ware Creek, and 5 perennial and 16 intermittent streams.

The water quality characteristic for the Pamunkey River which is of greatest concern relative to the proposed withdrawal is salinity. Changes in the distribution of salinity in the river are controlling factors in tidal wetland community structure and some anadromous fish spawning grounds. For use as drinking water, the concentration of chlorides, and secondarily sodium, is of concern. An analysis was conducted to estimate the impact of the proposed withdrawal on existing salinity concentrations in the Pamunkey River. Based on this analysis, salinity changes in the Pamunkey River resulting from the proposed withdrawal are not expected to impact existing tidal freshwater vegetative communities.

From a drinking water treatment perspective, another concern associated with Pamunkey River water quality is possible intrusion of salinity, and associated chlorides and sodium, as far upstream as the proposed intake site at Northbury. However, based on review of available salinity data, and based on the proposed MIF policy which precludes withdrawals during drought conditions, Pamunkey River withdrawals would be avoided or prevented during any periods of detectable salinity near the intake.

The primary long-term impact to the water quality of Diascund Creek Reservoir is the addition of flow from the Pamunkey River. Phosphorus concentrations tend to be higher in the Pamunkey River. Therefore, increased phosphorus loading to the reservoir may result in water quality problems associated with eutrophic conditions. However, the increased flow through the reservoir, as well as its natural assimilative capacity, should help mitigate the higher phosphorus concentrations.

The most noteworthy long-term impacts to Ware Creek water quality would occur in the tidal portions of the creek, primarily downstream of the proposed dam. One impact would be a considerable change in downstream water quality conditions, eliminating the tidal freshwater section and reducing or eliminating oligohaline portions of Ware Creek.

The runoff control measures planned for Stonehouse should afford some degree of water quality protection for Ware Creek. However, given the magnitude of the Stonehouse project, there would still be a severe risk of long-term reservoir water quality deterioration due to the extensive nature of planned residential and commercial development in the watershed. For example, this development has the potential to impact reservoir water quality by contributing non-point source runoff from roads, sediment loads from home and road construction activities, and nutrient loads from lawn fertilizer runoff. One of James City County's environmental consultants has also predicted that the proposed Ware Creek Reservoir would be upper mesotrophic/lower eutrophic immediately after construction and ultimately would become eutrophic (James R. Reed & Associates, 1986).

Another impact would be an increase in the phosphorus loading by the pumpover from Diascund Creek which may result in eutrophic conditions in the proposed reservoir.

Short-term water quality impacts are also expected from dam and outfall construction, and clearing associated with preparation of the reservoir. These impacts would primarily consist of increased turbidity resulting from increased erosion. Sediment control measures would be maintained during construction of the dam to minimize impacts to downstream water quality.

In addition to the impacts resulting from reservoir development, accidental spills directly into the reservoir could have a great short-term impact on reservoir water quality. This potential impact is important for the Ware Creek project, since Interstate 64 directly crosses over three arms of France Swamp and one arm of Bird Swamp within the normal pool area of the reservoir.

At Outfall Site 1 on Diascund Creek, the existing water quality conditions would be changed to that of the Pamunkey River. Short-term impacts would also occur as a result of increasing the flow in the channel. However, these impacts should dissipate since the channel would reestablish itself.

At Outfall Site 2, the water quality impact would be a change in the existing water quality to a blend of Diascund Creek water and Pamunkey River water in the vicinity of the outfall. Because the Pamunkey River has a higher phosphorus concentration than Diascund Creek Reservoir, this could result in an increased phosphorus loading to the reservoir.

Water quality impacts to streams crossed during pipeline construction would be limited to the period of construction. Therefore, these impacts are considered minimal.

<u>Hydrology</u>

To identify the potential hydrologic impacts of a 120 mgd Pamunkey River withdrawal capacity at Northbury, the results of the safe yield modeling (see Section 3.4.11) for this withdrawal scenario were used to simulate post-withdrawal flow conditions. For each month of the 696-month safe yield analysis, the simulated pre-withdrawal flow, withdrawal volume, and flow past the intake site were tabulated and analyzed.

Figure 5-1 depicts the percentages of time in which simulated flows past the proposed intake occurred under pre- and post-withdrawal conditions. Decreases in flow past the intake under post-withdrawal flow conditions is relatively small at given frequencies of occurrence.

An analysis of annual average withdrawals and flows past the proposed intake site under pre- and post-withdrawal conditions was conducted. The average withdrawal is simulated to be 63.4 mgd. This represents an 8.2 percent decrease in the estimated average flow past the intake. However, it is estimated that an average Pamunkey River withdrawal of only 25 mgd would be required to provide desired safe yield benefits. This represents a 3.3 percent decrease in estimated average flow past the intake.

Monthly average flows past the proposed intake were simulated for pre-withdrawal conditions (see Figure 5-2). Under the assumed Pamunkey River MIF policy, the proposed maximum withdrawal of 120 mgd could represent a maximum of 40 percent of the total freshwater flow at Northbury. This could occur during the month of October (Assumed MIF for October equals 180 mgd) if flow past the intake was 300 mgd and the maximum proposed withdrawal of 120 mgd was made.

An analysis of contraventions, or periods when flows are less than given threshold levels, was also performed. There is only a small increase in flow contraventions under post-withdrawal conditions.

A cumulative streamflow analysis was conducted to estimate the impact of any future streamflow reductions in addition to the proposed project on streamflow in the Pamunkey River. It is estimated that by the Year 2040, with all currently identified potential uses taken into account, and an estimated average withdrawal of 25 mgd for this alternative, average Pamunkey River streamflow would be reduced by 8.8 percent.

Construction of a dam on Ware Creek would inundate 37.1 miles of tidal and non-tidal perennial and intermittent streams. Streamflows would be restricted to 3.6 percent to 14.4 percent of existing average flow. The net reduction in freshwater discharge at the proposed dam site would be 9.5 to 10.7 mgd.

Water depth in the Pamunkey River would not be measurably impacted by this alternative since the proposed intake site is located in tidal waters.

The new pipeline for this alternative would cross 5 perennial and 16 intermittent streams. Impacts to the hydrology of these streams would be temporary in nature, and are deemed minimal.

Based on field measurements and flow calculations, the channels at the proposed outfall sites appear capable of accommodating maximum flows during pumpover operations.

The two proposed outfalls on Diascund Creek have the potential to cause physical, chemical and biological changes in the Creek. With a combined maximum raw water discharge capacity of 120 mgd, these outfalls could cause greater meandering of the stream channel and substantially increased erosion rates. The higher flow regime would result in increased flow velocities, higher dissolved oxygen levels and higher nutrient flushing rates. These latter changes are expected to be beneficial to aquatic life.

<u>Groundwater Resources</u>

A discussion of the potential impacts to groundwater resources related to the operation of a similar freshwater river intake is presented in Section 5.2.3.

An analysis of annual average withdrawals and flows past the proposed intake site under pre- and post-withdrawal conditions was conducted. The average withdrawal is simulated to be 63.4 mgd. This represents an 8.2 percent decrease in the estimated average flow past the intake. However, it is estimated that an average Pamunkey River withdrawal of only 25 mgd would be required to provide desired safe yield benefits. This represents a 3.3 percent decrease in estimated average flow past the intake.

Monthly average flows past the proposed intake were simulated for pre-withdrawal conditions (see Figure 5-2). Under the assumed Pamunkey River MIF policy, the proposed maximum withdrawal of 120 mgd could represent a maximum of 40 percent of the total freshwater flow at Northbury. This could occur during the month of October (Assumed MIF for October equals 180 mgd) if flow past the intake was 300 mgd and the maximum proposed withdrawal of 120 mgd was made.

An analysis of contraventions, or periods when flows are less than given threshold levels, was also performed. There is only a small increase in flow contraventions under post-withdrawal conditions.

A cumulative streamflow analysis was conducted to estimate the impact of any future streamflow reductions in addition to the proposed project on streamflow in the Pamunkey River. It is estimated that by the Year 2040, with all currently identified potential uses taken into account, and an estimated average withdrawal of 25 mgd for this alternative, average Pamunkey River streamflow would be reduced by 8.8 percent.

Construction of a dam on Ware Creek would inundate 37.1 miles of tidal and non-tidal perennial and intermittent streams. Streamflows would be restricted to 3.6 percent to 14.4 percent of existing average flow. The net reduction in freshwater discharge at the proposed dam site would be 9.5 to 10.7 mgd.

Water depth in the Pamunkey River would not be measurably impacted by this alternative since the proposed intake site is located in tidal waters.

The new pipeline for this alternative would cross 5 perennial and 16 intermittent streams. Impacts to the hydrology of these streams would be temporary in nature, and are deemed minimal.

Based on field measurements and flow calculations, the channels at the proposed outfall sites appear capable of accommodating maximum flows during pumpover operations.

The two proposed outfalls on Diascund Creek have the potential to cause physical, chemical and biological changes in the Creek. With a combined maximum raw water discharge capacity of 120 mgd, these outfalls could cause greater meandering of the stream channel and substantially increased erosion rates. The higher flow regime would result in increased flow velocities, higher dissolved oxygen levels and higher nutrient flushing rates. These latter changes are expected to be beneficial to aquatic life.

Groundwater Resources

A discussion of the potential impacts to groundwater resources related to the operation of a similar freshwater river intake is presented in Section 5.2.3.

When the reservoir becomes operational, changes in the groundwater flow and quality of the Columbia Aquifer may result. An approximate increase of 15 to 30 feet in some areas of the groundwater level, and the resulting increased horizontal flow rate, and an increase in the number of springs located on the valley walls in the watersheds bordering Ware Creek watershed is expected. During construction and operation of the reservoir, the Columbia and Yorktown Aquifers would be afforded recharge by direct and indirect seepage from the reservoir. This would generally be considered a beneficial impact. However, if the water quality in Ware Creek Reservoir deteriorates over the long-term, as expected, then reservoir seepage could have some detrimental impact on groundwater quality.

Impacts to the shallow groundwater system by the Stonehouse planned community is expected to be minimal due to the use of sewer systems. Indirect pumpover from the Pamunkey River to Ware Creek Reservoir via Diascund Creek Reservoir would also not be expected to affect the overall groundwater quality in either watershed.

Implementation of a drinking water reservoir alternative would directly (via recharge) and indirectly (via alternative supply) benefit the groundwater resources of the region.

In general, construction activities related to the reservoir and dam should have little effect on groundwater quality and quantity within the watershed.

Soil and Mineral Resources

Construction of an intake facility at the proposed Northbury intake site would cause the disturbance of approximately 3 acres of Nevarc-Remlik complex and the Pamunkey Fine Sandy Loam; the latter is considered a prime agricultural soil (Hodges et al., 1985).

Construction of Ware Creek Reservoir dam and subsequently filling of the proposed Ware Creek Reservoir would result in the inundation of approximately 1,238 acres of land. However, open water and perennial streams already inundate an estimated 54 acres of this area. Therefore, 1,184 acres of wetlands would be inundated by the reservoir.

Prime agricultural soils account for 20 of the 1,238 acres to be inundated by the reservoir. However, adverse effects due to the inundation of these soils and dam construction would be minimal since steep side slopes and low land flooding presently make the majority of these soils unsuitable for farming.

Effects to soil due to the construction of the raw water pipelines associated with this alternative would be minimal. After construction, the disturbed soils would be returned to a natural state. A total of 159 acres of soils within the pipeline ROW would be temporarily disturbed.

Air Quality

Although a sizeable portion of this alternative falls within the boundaries of an ozone non-attainment area, the type and amount of pollutants emitted from this operation is minimal and would not prevent reasonable further progress toward attaining the ambient ozone air quality standard.

During the construction phase of the project, it is likely that burning of some unusable cleared vegetation would be conducted on site. Due to the short-term nature of this activity, only a minimal effect on air quality would be expected. In addition, it is expected that

Pamunkey River Monthly Flows

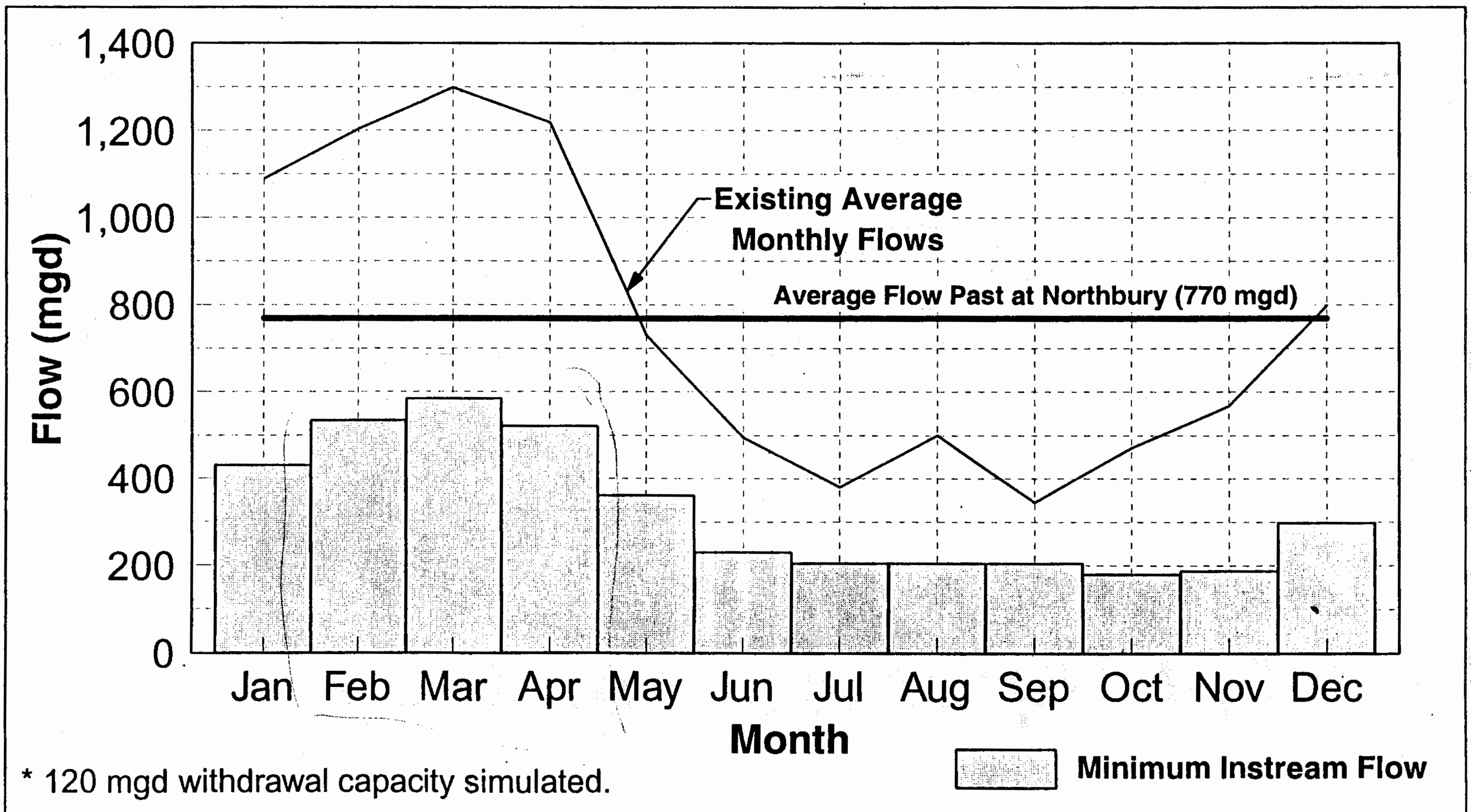


Figure 5-2

clearing, excavation and construction activities would produce fugitive dust emissions in and around the site.

Fuel burning emissions from the use of construction equipment would be released during construction activities. A minimal effect on air quality would be expected due to the small amount of emissions relative to other sources of air pollution in the region and since these activities would be temporary.

5.2.2 Black Creek Reservoir with Pumpover from Pamunkey River

Substrate

The Black Creek Reservoir alternative would impact, at a minimum, an estimated 1.61 acres of existing substrate. This would consist of approximately 0.16 acres of substrate surface area removed at the Northbury intake site, 1.4 acres of substrate being temporarily affected by pipeline construction, and 0.05 acres of substrate at the outfall locations being disturbed, removed, or permanently covered by construction of the outfall structures. An additional 0.6 acres of substrate could be disturbed if conventional cut and fill techniques are used for the Little Creek Reservoir crossing. As with the Ware Creek Reservoir alternative, the majority of affected substrate would only be temporarily impacted.

In addition, filling the proposed reservoir area to 100 feet msl would result in the inundation of approximately 1,146 acres, of which 21 acres are currently open water and perennial stream areas containing substrate. Because substrates in these areas are presently inundated, adverse effects from further inundation of these perennially wet areas are considered minimal.

Water Quality

Surface waters involved in this alternative are the Pamunkey River, Black Creek, Diascund Creek Reservoir, Little Creek Reservoir, and 10 perennial and 14 intermittent streams. Impacts to Pamunkey River water quality are discussed in Section 5.2.1, and are expected to be negligible.

For the purpose of this review, the assumption has been made that Black Creek water quality is similar to Crump Creek and Matadequin Creek water quality. There are only minor differences in the water quality between Crump Creek, Matadequin Creek and the Pamunkey River, including concentrations of nutrients such as phosphorus.

The most notable change at the proposed reservoir site would result from increasing the depth of the surface water to maximums of 87 feet in the eastern branch of Black Creek impoundment and 77 feet in the Southern Branch Black Creek impoundment. With these depths, stratification would be expected to occur, principally in the summer months, with possible anoxic conditions and low temperatures in the hypolimnion. If water released from the dam is only from the bottom of the reservoir, downstream water quality problems would be expected. Mitigative measures, such as multi-level releases could be used to regulate the water quality released from the reservoir. Long-term water quality characteristics for Black Creek downstream from the two dams are not expected to be adversely impacted from the change in flow resulting from the impoundment.

Short-term water quality impacts to Black Creek would occur from dam and outfall construction, and clearing associated with preparation for reservoir filling. These impacts would consist largely of increased turbidity as a result of increased erosion in cleared areas.

Water from the Pamunkey River would sometimes be pumped directly to Diascund Creek Reservoir headwaters. The impact on water quality for the outfall on the headwaters of Diascund Creek would be a change in the existing water quality conditions to that of the Pamunkey River. In general, the water quality of the Pamunkey River is better than the existing water quality in Diascund Creek Reservoir, with the notable exception of phosphorus concentrations. Therefore, there could be periods when eutrophication impacts could occur in Diascund Creek Reservoir due to increased nutrient loading.

Water quality impacts to streams crossed during pipeline construction would be limited to the period of construction.

Hydrology

Potential hydrologic impacts associated with withdrawals at the proposed intake site are presented in Section 5.2.1. However, one difference for this alternative would be the slightly greater degree of potential cumulative streamflow reductions in the Pamunkey River basin. This difference occurs because Black Creek Reservoir would impound a tributary of the Pamunkey River, whereas Ware Creek Reservoir would impound a tributary of the York River. In addition, the Black Creek Reservoir alternative would require an estimated average Pamunkey River withdrawal of 29 mgd to provide desired safe yield benefits. This would represent a 3.8 percent reduction in estimated average flow past the intake site. In comparison, the Ware Creek Reservoir alternative would require an estimated average Pamunkey River withdrawal of 25 mgd to provide desired safe yield benefits.

It is estimated for this alternative that by the Year 2040, with all currently identified potential users taken into account, and a simulated average withdrawal of 29 mgd, average Pamunkey River streamflow would be reduced by 9.5 percent.

Construction of dams on the Southern Branch Black Creek and the eastern branch of Black Creek would inundate 13.7 miles of free-flowing perennial and intermittent streams. Streamflows would be restricted to 32 percent of existing average flows. The net reduction in average combined freshwater discharge at the two proposed Black Creek dam sites would be 2.6 mgd.

The new pipeline for this alternative would cross 10 perennial and 14 intermittent streams. Any impacts to the hydrology of these stream would be temporary in nature, and are deemed minimal.

The proposed outfall on Diascund Creek has the potential to create physical, chemical, and biological changes in the creek. With a maximum raw water discharge capacity of 40 mgd, this outfall could cause greater meandering of the stream channel and increased erosion rates. The higher flow regime would result in increased flow velocities, higher dissolved oxygen levels, and higher nutrient flushing rates. These latter changes are expected to be beneficial to aquatic life.

Groundwater Resources

A discussion of the potential impacts to groundwater resources related to operation of a similar freshwater river intake is presented in Section 5.2.3.

A maximum increase in the water table elevation of 40 feet is predicted in those areas directly adjacent to the reservoir. This would result in increased horizontal flow velocity and an increase in the number of seeps and springs in adjacent watersheds.

During construction and operation of the reservoir, the Yorktown Aquifer would be afforded recharge by direct seepage from the reservoir. Black Creek Reservoir seepage losses were estimated at 2 mgd.

Implementation of a drinking water reservoir alternative would directly (via recharge) and indirectly (via alternative supply) benefit the groundwater resources of the region.

In general, construction activities related to the reservoir and dam should have little effect on groundwater quality and quantity within the watershed.

Soil and Mineral Resources

Potential effects to soils due to construction of a raw water intake facility at the Northbury site on the Pamunkey River are discussed in Section 5.2.1.

Filling the proposed Black Creek Reservoir would result in the inundation of approximately 1,146 acres of land. However, open water and perennial streams already inundate an estimated 21 acres of this area. Therefore, 1,125 acres of soil would be inundated by the reservoir. Prime agricultural soils account for 17 of the 1,146 acres. However, adverse effects due to the inundation of these soils and dam construction would be minimal since steep side slopes and lowland flooding presently make the majority of these soils unsuitable for farming.

Construction of four reservoir outfall structures would disturb a combined total of 10,500 square feet of soil. In addition, the construction of a pump station on the eastern branch of the proposed reservoir would disturb approximately 4 acres of soil. After construction, the two dams would cover a combined total area of 26 acres, of which 12 acres would be located below the normal pool elevation of the reservoir. The two emergency spillways would require a total of 4 acres of soils to be cleared, graded, and mowed. It is estimated that approximately 2.8 acres would be covered by an impervious layer of concrete or asphalt as a result of this project. This estimate includes the emergency spillways, access roads, and intake/discharge structures associated with the two dams.

Effects to soil due to the construction of the raw water pipelines associated with this alternative would be minimal. After construction, the disturbed soils would be restored to a more natural state. A total of 123 acres of soils within the pipeline ROW would be temporarily disturbed.

Air Quality

Only a small portion of this alternative falls within the boundaries of an ozone non-attainment area. Based on the preliminary layout, none of the air emissions resulting from this operation occur in the non-attainment area and therefore would not affect ambient ozone air quality levels.

During the construction phase of the project, it is likely that burning of some cleared unusable vegetation would be conducted on site. Due to the short-term nature of this activity, only a minimal effect on air quality would be expected. In addition, it is expected that clearing, excavation and construction activities would produce fugitive dust emissions in and around the site.

Fuel burning emissions from the use of construction equipment would be released during construction activities. A minimal effect on air quality would be expected due to the small amount of emissions relative to other sources of air pollution in the region and since these activities would be temporary.

5.2.3 King William Reservoir with Pumpover from Mattaponi River

Substrate

The King William Reservoir alternative would impact, at a minimum, an estimated 1.71 acres of aquatic ecosystem substrate. Approximately 0.16 acres of substrate would be disturbed at the Scotland Landing intake site, 1.5 acres of substrate would be disturbed as a result of pipeline construction, and 0.05 acres of substrate would be disturbed, removed, or permanently covered by construction of outfall structures. An additional 0.6 acres of substrate could be disturbed if conventional cut and fill techniques are used for the Little Creek Reservoir crossing. The majority of the impacts would be temporary.

In addition, filling the proposed reservoir area to 90 feet msl would result in the inundation of approximately 2,234 acres, of which 106 acres are currently open water and perennial stream areas containing substrate. Because substrates in these areas are presently inundated, adverse effects from further inundation of these perennially wet areas are considered minimal.

Water Quality

Surface waters involved in this alternative are the Mattaponi River, Cohoke Mill Creek, the Pamunkey River, Diascund Creek Reservoir, Little Creek Reservoir, and 9 perennial and 17 intermittent streams.

As with the Pamunkey River, the water quality characteristic for the Mattaponi River which is of greatest concern relative to the proposed withdrawal is salinity. An analysis was conducted to estimate the impact of the proposed withdrawal on existing salinity concentrations in the Mattaponi River. Based on this analysis, salinity changes in the Mattaponi River resulting from the proposed withdrawal and other existing and projected consumptive Mattaponi basin water use are not expected to greatly impact existing tidal freshwater vegetative communities. Natural Mattaponi River salinity fluctuations greatly exceed any salinity changes that are predicted due to withdrawals.

From a drinking water treatment perspective, a concern associated with Mattaponi River water quality is the possible intrusion of salinity, and associated chloride and sodium, as far upstream as the proposed intake site on Scotland Landing. However, based on review of available Mattaponi River salinity data, and based on the proposed MIF policy which precludes withdrawals during drought conditions, Mattaponi River withdrawals would be avoided or prevented during any periods of detectable salinity near the intake.

Long-term water quality changes to Cohoke Mill Creek would occur from filling the impoundment area of the proposed reservoir with water from the Mattaponi River. For the purpose of this review, the assumption has been made that Cohoke Mill Creek water quality is similar to Crump Creek and Matadequin Creek water quality. The most notable differences in water quality between Crump Creek, Matedequin Creek, and the Mattaponi River are the concentrations of phosphorus and chlorides, which are higher in the Mattaponi River. It is likely that the discharge of water from the Mattaponi River into the proposed King William Reservoir would result in increases in the phosphorus and chloride concentrations that would not occur if there were no pumpover.

Once the reservoir is filled, the normal pool elevation would be at 90 feet msl and maximum depth in the reservoir would be approximately 82 feet. With these depths, stratification would be expected to occur, principally in the summer months, with possible anoxic conditions and low temperatures in the hypolimnion. If water released from the dam is only from the bottom of the reservoir, downstream water quality problems resulting from the temperature variations, the low dissolved oxygen, and nutrient enriched water would be expected. Mitigative measures, such as multi-level releases could be used to regulate the water quality released from the reservoir. Long-term water quality characteristics for Cohoke Mill Creek downstream from the two dams are not expected to be adversely impacted from the change in flow resulting from the impoundment.

Short-term water quality impacts to Cohoke Mill Creek and Cohoke Millpond would occur from dam and outfall construction, and clearing associated with preparation for reservoir filling. These impacts would consist largely of increased turbidity as a result of increased erosion in cleared areas.

Impacts from the proposed King William Reservoir pumpover to Diascund Creek Reservoir are expected to be similar to impacts at the proposed Black Creek Reservoir. The only additional factor is that the higher phosphorus concentration increases the chance for developing eutrophic conditions in Diascund Creek Reservoir. It is likely that the average water quality pumped from King William Reservoir would not be appreciably different than that which would reach Diascund Creek Reservoir for the proposed Black Creek Reservoir alternative.

Water quality impacts to streams crossed during pipeline construction would be limited to the period of construction. The pipeline crossing of the Pamunkey River would be completed using directional drilling techniques. Therefore, impacts to Pamunkey River water quality should not occur.

The Little Creek Reservoir crossing would be accomplished using conventional cut and fill techniques, directional drilling techniques, or an elevated crossing. Regardless of the crossing technique, environmental controls would be used so that any impacts would be minimal and temporary.

<u>Hydrology</u>

To identify the potential hydrologic impacts of a 75 mgd Mattaponi River withdrawal capacity at Scotland Landing, the results of the safe yield modeling (see Section 3.4.15) for this withdrawal scenario were used to simulate post-withdrawal flow conditions. For each month of the 696-month safe yield analysis, the simulated pre-withdrawal flow, withdrawal volume, and flow past the intake site were tabulated and analyzed.

Figure 5-3 depicts the percentages of time in which simulated flows past the proposed intake occurred under pre- and post-withdrawal conditions. Decreases in flow past the intake under post-withdrawal flow conditions is relatively small at given frequencies of occurrence.

An analysis of annual average withdrawals and flows past the proposed intake site under pre- and post-withdrawal conditions was conducted. The average withdrawal is simulated to be 49.4 mgd. This represents a 9.9 percent decrease in the estimated average flow past the intake. However, it is estimated that an average Mattaponi River withdrawal of only 35 mgd would be required to provide desired safe yield benefits. This represents a 7.0 percent decrease in estimated average flow past the intake.

Monthly average flows past the proposed intake were simulated for pre-withdrawal conditions (see Figure 5-4). Under the assumed Mattaponi River MIF policy, the proposed maximum withdrawal of 75 mgd could represent a maximum of 41 percent of the total freshwater flow at Scotland Landing. This could occur during the months of June through November if flow past the intake was 181 mgd and the maximum proposed withdrawal of 75 mgd was made.

An analysis of contraventions, or periods when flows are less than given threshold levels, was also performed. There is only a small increase in flow contraventions under post-withdrawal conditions.

A cumulative streamflow analysis was conducted to estimate the impact of any future streamflow reductions in addition to the proposed project on streamflow in the Mattaponi River. It is estimated that by the Year 2040, with all currently identified potential uses taken into account, and an estimated average withdrawal of 35 mgd for this alternative, average Mattaponi River streamflow would be reduced by 6.9 percent.

Construction of a dam on Cohoke Mill Creek would inundate 28.3 miles of free-flowing perennial and intermittent streams. Streamflows would be restricted to 32 percent of existing average flow. The net reduction in freshwater discharge at the proposed dam site would be 6.3 mgd.

Water depth in the Mattaponi River would not be measurably impacted by this alternative since the proposed intake site is located in tidal waters.

The new pipeline for this alternative would cross 9 perennial and 17 intermittent streams. Impacts to the hydrology of these streams would be temporary in nature, and are deemed minimal.

The pipeline would also require crossing the Pamunkey River and an arm of Little Creek Reservoir. The Pamunkey River crossing would be accomplished using directional drilling techniques, which should not affect the hydrology of the river. The Little Creek Reservoir crossing would be accomplished using conventional cut and fill techniques, directional drilling techniques, or an elevated crossing.

The proposed outfall on Beaverdam Creek would have the potential to create physical, chemical, and biological changes in the creek. With a maximum raw water discharge capacity of 40 mgd, this outfall could cause greater meandering of the stream channel and substantially increased erosion rates. The higher flow regime would result in increased flow velocities, higher dissolved oxygen levels and higher nutrient flushing rates, which are expected to be beneficial to aquatic life.

Groundwater Resources

A possible concern exists over direct freshwater withdrawals from the Mattaponi River of up to 75 mgd, and the possible encroachment of salinity into tidal freshwater reaches of the Mattaponi Watershed. If this were to occur, the potential for saltwater encroachment into the shallow aquifers would be high. However, based on the proposed MIF policy which precludes withdrawals during drought conditions, and based on salinity

MATTAPONI RIVER FLOW DURATION CURVES

(SIMULATED FLOWS PAST SCOTLAND LANDING FOR 10/29 - 9/87)

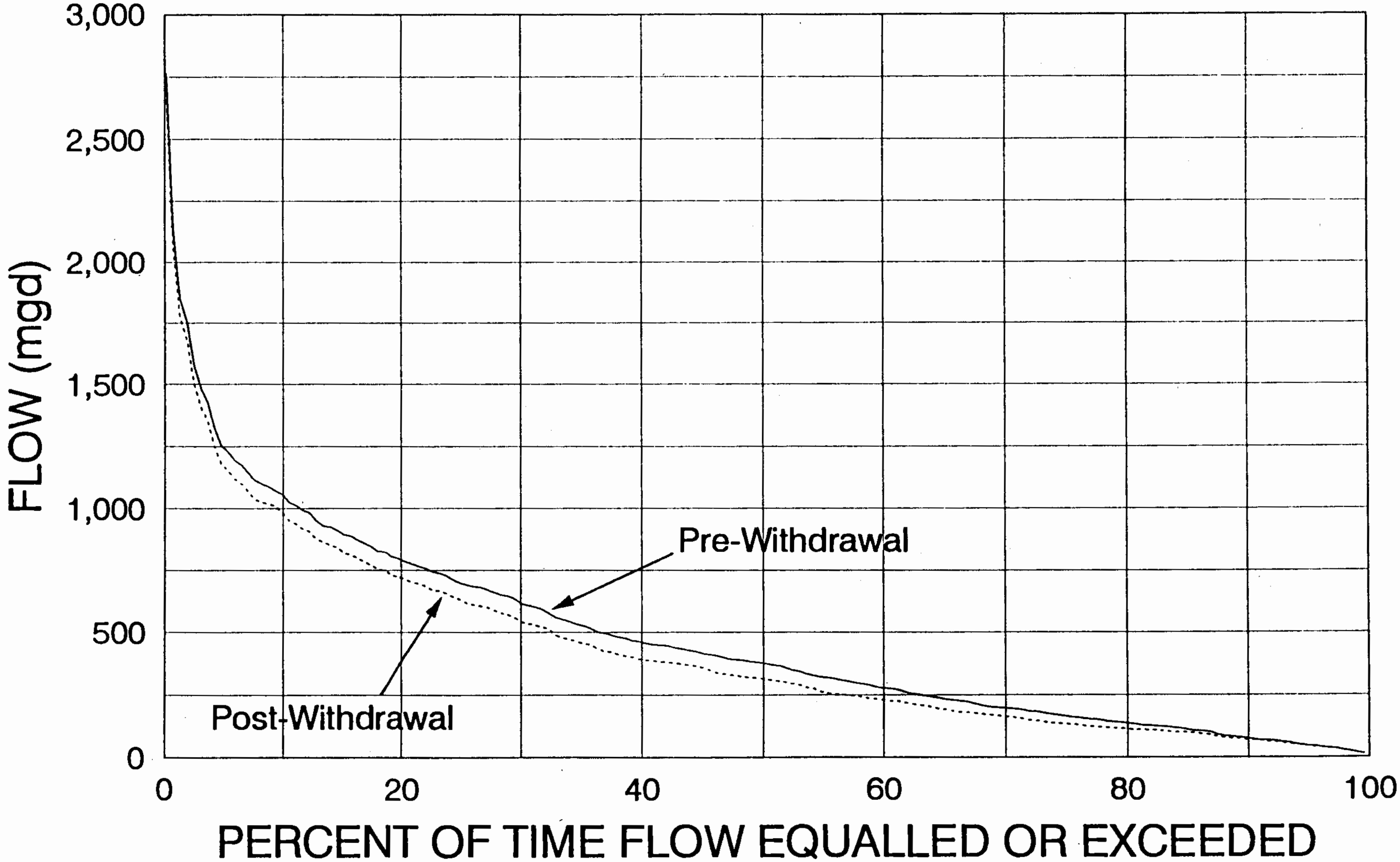


Figure 5-3

Mattaponi River Monthly Flows

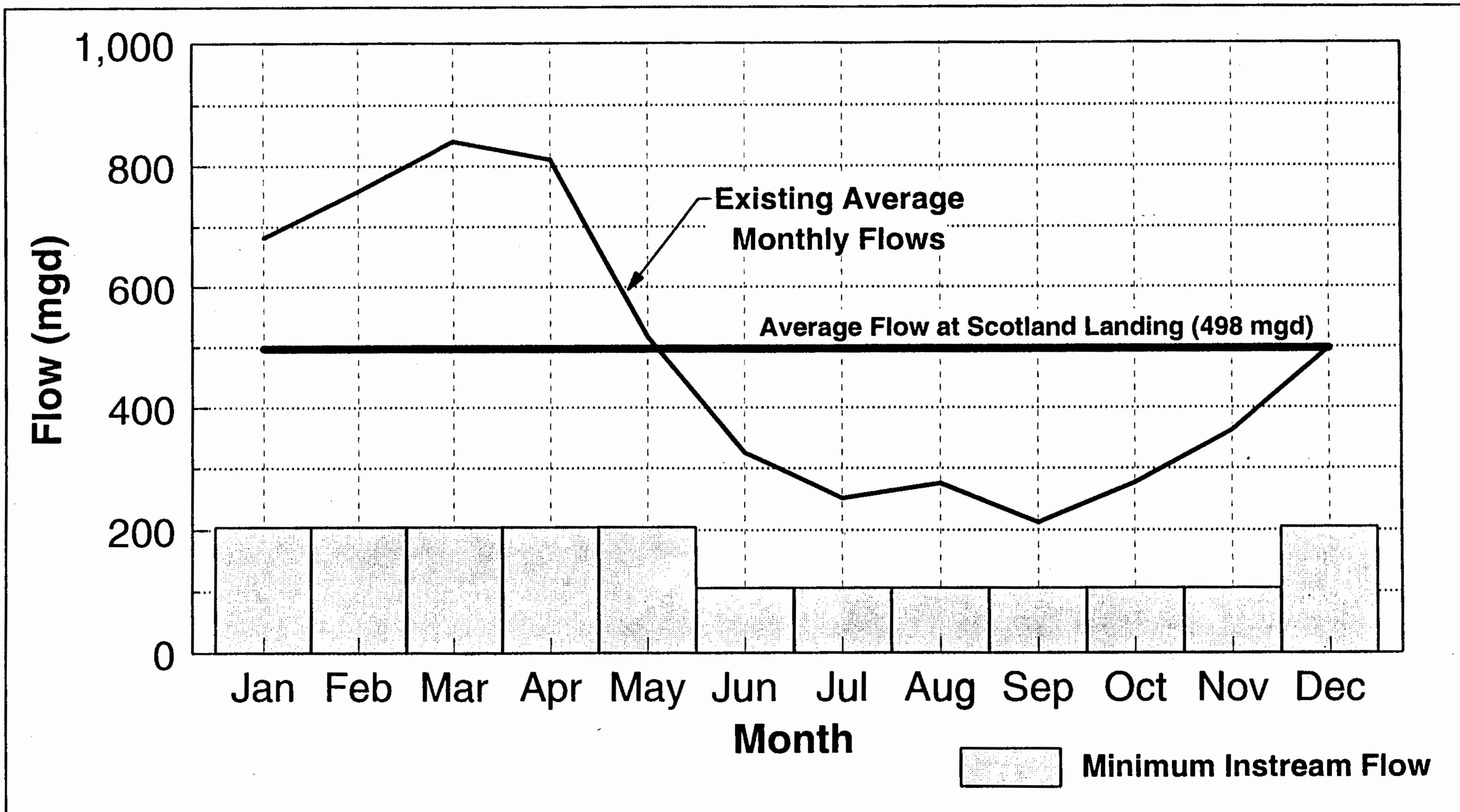


Figure 5-4

intrusion modeling, little change in the water quality of the shallow aquifers beneath and bordering the river is expected.

Alteration of the existing groundwater flow velocity patterns is expected in the Cohoke Mill Creek and adjacent watersheds. A corresponding increase in lateral seepage due to the rise in water table elevation and relationship to the Pamunkey and Mattaponi Rivers has been estimated at 1.5 mgd. Underseepage below the dam has been estimated at 0.5 mgd.

Based on water quality data for the Mattaponi River compiled by Malcolm Pirnie, an initial screening of the proposed King William Reservoir watershed, and a salinity intrusion impact study (Hershner et al., 1991), there should be little effect to overall water quality of the shallow aquifer system.

Implementation of a drinking water reservoir alternative would directly (via recharge) and indirectly (via alternative supply) benefit the groundwater resources of the region.

In general, construction activities related to the reservoir and dam should have little effect on groundwater quality and quantity within the watershed.

Soil and Mineral Resources

Construction of an intake facility at the proposed Scotland Landing intake site would cause the disturbance of approximately 3 acres of Tetotum, Bojac, and Tarboro soils which are considered prime agricultural soils (Hodges et al., 1985). Construction of the access road would cause the disturbance of approximately 10 acres of these soils.

Filling the proposed King William Reservoir would result in the inundation of approximately 2,234 acres of land. However, open water and perennial streams already inundate an estimated 106 acres of this area. Therefore, 2,128 acres of soil would be inundated by the reservoir. Prime agricultural soils account for 342 acres and would be inundated. Presently, approximately 9 acres of the prime agricultural land is being used for farming purposes while the remaining land is either wetland or forested land.

Temporary disturbances to approximately 100 acres of soil would occur during the construction of the earthen dam and emergency spillway associated with this alternative. A total of approximately 38 acres of soil would be either removed or covered by the dam, emergency spillway, access roads and associated structures.

Effects to soil due to the construction of the raw water pipeline are expected to be temporary. A total of 94 acres of soils within the pipeline ROW would be temporarily disturbed. After construction, the disturbed soils would be restored to pre-construction conditions.

Air Quality

Only a small portion of this alternative falls within the boundaries of an ozone non-attainment area. Based on the preliminary layout, none of the air emissions resulting from this operation occur in the non-attainment area and therefore would not affect ambient ozone air quality levels.

During the construction phase of the project, it is likely that burning of some unusable cleared vegetation would be conducted on site. Due to the short-term nature of this activity, only a minimal effect on air quality would be expected. In addition, it is expected that clearing, excavation and construction activities would produce fugitive dust emissions in and around the site. Special attention would be given to ensure effective implementation of dust suppression measures, particularly given the close proximity of recreational uses in Cohoke Millpond.

Fuel burning emissions from the use of construction equipment would be released during construction activities. A minimal effect on air quality would be expected due to the small amount of emissions relative to other sources of air pollution in the region and since these activities would be temporary.

5.2.4 Fresh Groundwater Development

Substrate
This alternative would involve the excavation and removal of an estimated 0.18 acres of substrate during construction of the eight pipeline outfalls.

Water Quality
Surface waters involved in this alternative are Diascund Creek Reservoir and Little Creek Reservoir. The principal impact would be to increase chloride, bicarbonate, sodium, sulfate, fluoride, and possibly phosphorus concentration in the two reservoirs. With the exception of phosphorus, water quality conditions for Little Creek Reservoir would be impacted the most. Phosphorus concentrations in the groundwater near Diascund Creek Reservoir are expected to be higher than at Little Creek Reservoir. Concentrations over short periods of time may be sufficient to impact aquatic life in the two reservoirs, and increase treatment requirements at the terminal reservoirs.

Hydrology
A discussion of the potential hydrologic impacts from the Fresh Groundwater Withdrawals alternative is presented below in the description of Groundwater Resources.

Groundwater Resources
In 1988, two test wells were installed by the City of Newport News to evaluate the water quality and yield of the Middle Potomac Aquifer in the vicinity of Diascund Creek and Little Creek Reservoirs. The report, prepared by Geraghty & Miller concluded that development of a 10 mgd supply of fresh groundwater from the Middle Potomac Aquifer was feasible with well yields between 1 and 1.5 mgd (Geraghty & Miller, 1988). Transmissivities reported for the aquifer appeared to be low compared to USGS publications and the USGS Coastal Plain Regional Model, and the predicted drawdown may, therefore, be exaggerated.

In 1992, Malcolm Pirnie conducted several modeling studies using a three-dimensional groundwater flow model developed by the USGS. In these studies, fresh groundwater withdrawals were simulated in James City and New Kent counties at rates ranging from 2.1 to 10.3 mgd (Malcolm Pirnie, 1992 and 1992). There was no simulation done for this specific 10 mgd alternative; however, the results of the previous modeling provides insight into the approximate drawdowns anticipated from the two proposed well fields.

Based on the results of the 1988 test well program and recent regional modeling, the anticipated drawdown from the two proposed well fields should not create drawdown exceeding 5 feet in the Yorktown, Chickahominy-Piney Point, and Aquia Aquifers. These aquifers are used for domestic, agriculture, and light industrial use throughout the Lower and Middle Peninsulas.

Based on the previous studies conducted by Malcolm Pirnie and projected future withdrawals based on groundwater use data, a new 10 mgd withdrawal is not likely to dewater any portion of the Middle Potomac Aquifer.

Anticipated changes in the potentiometric surface of the Middle Potomac Aquifer could induce east to west flow in limited areas. This condition indicates that a potential for increased east to west encroachment of saline groundwater would exist.

Soil and Mineral Resources

Each well site would require the clearing of approximately 0.5 acres to accommodate the well, well pumphouse, and security fence. Construction activities required would temporarily disturb the soils. In addition, approximately 2 acres of soils would be disturbed for the pipeline ROW for all eight wells. After construction, disturbed soils would be restored to a more natural state.

Air Quality

This alternative would not cause a detrimental impact on air quality. Construction of new pipelines would involve only a minimal amount of land clearing and excavation. As a result, operation of construction equipment and vehicles and the release of combustion emissions would be reduced.

5.2.5 Groundwater Desalination in Newport News Waterworks Distribution Area

Substrate

This alternative would involve the removal of 0.09 acres of substrate at the concentrate discharge pipeline outfalls. An additional 0.18 acres of substrate would be temporarily disturbed at the four minor stream crossings.

Water Quality

Surface waters involved in this alternative are the outfalls for the concentrate discharges. There are four proposed outfall locations under this alternative, three of which are in waters which would be classified as polyhaline and one is in waters which would be classified as mesohaline to oligohaline. The principal impact of the concentrate discharges would be from salinity, metal concentrations, and possibly nutrients. For the one outfall discharging to mesohaline waters, the increase in salinity in the vicinity of the discharge could be substantial. Because the concentration of metals and nutrients in the brackish groundwater are uncertain, the magnitude of this impact cannot be assessed at this time.

Hydrology

A discussion of the potential hydrologic impacts associated with deep brackish groundwater withdrawals is presented in the following discussion of Groundwater Resources.

Two perennial and two intermittent stream crossings would be required along the pipeline routes for this alternative. Any impacts to the hydrology of these streams from pipeline crossings would be temporary in nature, and are deemed minimal.

Due to the relatively small volume of concentrate which would be discharged per day, and the locations of the outfalls in tidal systems, it is expected that the discharges will have only very minimal, localized impacts on the hydrology of the receiving waters.

Groundwater Resources

Drawdown

Due to the location and depths of the proposed well system, no drawdown would be expected in the overlying shallow aquifers used by homeowners in surrounding areas for outdoor watering. Due to the depths of the anticipated withdrawals, the amount being withdrawn, and based on recent experience with similar withdrawals using the USGS groundwater flow model, no dewatering of the aquifer is anticipated during the project period.

Regional drawdown in the Middle Potomac Aquifer may be 9 to 10 feet at a distance of 10 miles from the center of the well system. The majority of current wells in the Middle and/or Lower Potomac Aquifer is southeastern Virginia should not experience drawdowns from the proposed desalination well system in excess of 5 to 10 feet. Water level declines of 5 to 10 feet are not normally considered severe unless pumping appurtenances are subsequently dewatered.

Water Quality

The area west of the pumping center may experience less brackish groundwater conditions as brackish water encroachment to the west is reversed. Concurrent with this process, existing brackish areas of the aquifer east of the well system may experience an increased brackish condition as groundwater from the eastern portions of the aquifer are encouraged to move toward the pumping center.

Soil and Mineral Resources

The five wells associated with this alternative would be installed in urban and suburban areas in which many major improvements have already been made. Therefore, disturbances to soils during construction would be minimal when compared to existing improvements in the vicinity of the proposed project site

Soils would be disturbed within the estimated 65 acres of pipeline ROW required for this alternative. After construction, the soils would be restored to a natural state.

Air Quality

This alternative has the potential to affect short-term air quality due to the additional automobiles and machinery in the area and traffic delays during construction. However, the impacts are not expected to be noticeable in relation to the far more adverse traffic congestion typical of the region.

5.2.6 Use Restrictions

Substrate

Implementation of the this alternative would have no impact on aquatic ecosystem substrate.

Water Quality

Implementation of use restrictions is not expected to impact existing water quality conditions.

Hydrology

This alternative component could stimulate the installation of new shallow wells to provide water for nonessential uses. However, the imposition of use restrictions on customers currently serviced by Lower Peninsula water purveyors would be expected to have a negligible effect on surface and subsurface hydrology.

Groundwater Resources

Implementation of use restrictions on individuals currently serviced by a municipal water purveyor would be expected to have a negligible impact on groundwater resources.

Soil and Mineral Resources

The implementation of the Use Restrictions alternative would have no impact on soil and mineral resources.

Air Quality

The implementation of the Use Restrictions alternative would have no adverse impact on ambient air quality.

5.2.7 No Action

Substrate

This alternative would have no impact on aquatic ecosystem substrate.

Water Quality

Existing reservoirs would be drawn down more severely and for more prolonged periods. This would likely result in the degradation of existing water quality in the reservoirs. Diascund Creek Reservoir storage was reduced to 20 to 25 percent of its total capacity for an 8-month period in 1983 and 1984. During this period, hypereutrophic conditions developed in the reservoir, on the basis of a mean total phosphorus concentration of 0.09 mg/l. Concentrations of phosphorus are higher during reservoir drawdown because of: 1) Decreased settling time for tributary inflows of phosphorus, 2) Increased exposure of fine-grained, phosphorus-rich bottom sediments to resuspending forces, and 3) Increased algae uptake of phosphorus directly from bottom sediments (Lynch, 1992). Under the No Action alternative, the reservoirs would be increasingly drawn down to extremely low levels for extended periods of time. Eutrophic conditions could occur during similar periods and would impact all the existing reservoirs in the Lower Peninsula.

Hydrology

The No Action alternative would have an adverse impact due to further stress of already limited surface water and groundwater sources.

Groundwater Resources

If no action is taken, existing sources will be relied upon more heavily, and cumulative impacts on the regional aquifer system may result. As reservoirs are drawn down further, and groundwater use increases to maximum permit limits, some undesirable impacts on groundwater resources would be expected. The USGS has simulated the withdrawal of groundwater at permitted maximums and found that dewatering of limited western portions of some aquifers, and an increase in the potential for salt water encroachment, could occur (Laczniak and Meng, 1988).

Soil and Mineral Resources
The No Action alternative would have no impact on soil and mineral resources.

Air Quality
The No Action alternative would have no adverse impact on ambient air quality.

5.3 BIOLOGICAL RESOURCES

This section provides a general description of how the biological environment would be impacted by each of the seven alternatives evaluated. Biological resource categories evaluated are described below.

Endangered, Threatened, or Sensitive Species
This category addresses the potential for impacts to state or federally listed endangered or threatened species, or sensitive species (any candidates for state or federal listing) which may occur as a result of project implementation.

Fish and Invertebrates
This category addresses the potential for impacts to fish and invertebrates and other aquatic organisms in the food web.

Other Wildlife
This category addresses potential impacts to wildlife species which are not addressed in the Endangered, Threatened, and Sensitive Species and Fish and Invertebrates sections.

Sanctuaries and Refuges
This category evaluates the potential impacts to sanctuaries and refuges which could result from implementation of the evaluated alternatives.

Wetlands and Vegetated Shallows
In this category, wetlands and vegetated shallows are evaluated for any potential impacts due to the implementation of each of the seven alternatives. Overall impacts to wetlands and vegetated shallows are evaluated based on a combination of impact acreage, permanence of impacts, and wetland values impacted.

Mud Flats
In this section, mud flats identified in the vicinity of each of alternatives are evaluated for potential impacts.

5.3.1 Ware Creek Reservoir with Pumpover from Pamunkey River

Endangered, Threatened or Sensitive Species
Due to the distance between the proposed intake and the Bald Eagle nests in the vicinity, no consequential adverse impacts to the nest sites are anticipated as a result of intake placement and operation. In addition, no measurable impacts to transient individuals are expected due to the small area of disturbance required in relation to the large area of remaining habitat available to the species in the region.

No appreciable impacts to Pamunkey River tidal freshwater vegetative communities are expected as a result of salinity changes due to the proposed withdrawal. No known populations of the Sensitive Joint-vetch are located in the vicinity of the proposed intake site on the Pamunkey River (Perry, 1993).

No known populations of designated endangered or threatened species would be directly impacted by construction of a reservoir on Ware Creek. However, the following sensitive species are, or may be, located in the vicinity of the reservoir site: Small Whorled Pogonia, Bald Eagle, Sensitive Joint-vetch, and Mat-forming Water-hyssop.

A site survey for the Sensitive Joint-vetch resulted in the identification of no extant populations of the species within Ware Creek tidal wetlands (Perry, 1993). Impacts to approximately 12 acres of potential habitat of *Aeschynomene virginica* could occur during construction activities at the proposed reservoir site. Impacts to approximately 2.5 acres of downstream habitat could also occur through construction activities. Downstream impacts could be minimized by locating work staging areas away from these areas, and by implementing sediment control measures at all times. The potential for loss of propagule source due to construction activities is unknown (Perry, 1993). Additional impacts to Sensitive Joint-vetch habitat could occur due to the anticipated loss of tidal freshwater conditions in Ware Creek below the proposed dam site.

Because the RRWSG was denied access to the proposed Ware Creek Reservoir site to perform the Small Whorled Pogonia survey within the peak flowering period (May-July), a Small Whorled Pogonia survey could not be performed in time for this document. Consequently, a site survey for the Small Whorled Pogonia in the proposed Ware Creek Reservoir area is currently planned for June 1994 by the RRWSG. The results of this survey will be included in the Final Environmental Impact Statement for public review. Ninety acres of prime habitat for the Small Whorled Pogonia have been identified within the proposed reservoir area.

Due to the modification of the freshwater flow of the Ware Creek system following construction of the dam, it is likely that the freshwater tidal marsh in Ware Creek would become brackish. This rapid salinity change could threaten ecologically important community types and their component species.

The principal impacts of reservoir construction on downstream salinities were anticipated to include loss of the tidal freshwater vegetation and reduction or elimination of the oligohaline assemblage.

No direct impacts to Bald Eagles are anticipated as a result of reservoir construction. The presence of an open water system and food source may enhance the potential for eagles to inhabit the area.

The proposed pipeline which would carry raw water from the Northbury intake site to Ware Creek Reservoir may be far enough away from the Bald Eagle nest to preclude direct impacts. However, the VDCR recommended consultation with the USFWS and the VDGIF to ensure that potential impacts are minimized (T. J. O'Connell, VDCR, personal communication, 1992).

Fish and Invertebrates

Potential impacts from intake structures include entrainment and impingement of fish eggs and larvae. Alewife and Blueback Herring could be susceptible to greater impacts than other anadromous fish species because their eggs are distributed throughout the water column. The NMFS generally recommends that through-screen velocities at raw water intakes not exceed 0.5 feet per second (fps), for the protection of anadromous fish larvae. To meet this requirement, approximately 10 wedge-wire profile submerged intake screens would be used. These screens would be approximately 5 feet in diameter and 5.3 feet in length. Screens would require a water depth of at least 15 feet and would be placed midway between the river bottom and average water surface.

With wedge-wire screens having very low entrance velocities (i.e., ≤0.5 fps) and very small openings (i.e., 1 millimeter slots), it is unlikely that severe impingement and entrainment impacts would occur. Some small fraction of eggs could potentially be damaged while attached to the screens. However, it is expected that eggs which float on the surface over the intake, or roll on the bottom would safely pass the intake structures. Because American Shad, Hickory Shad, and Striped Bass eggs are slightly heavier than water, it is likely that the majority of these eggs would be located below the intake entrance and would not be affected.

An additional consideration is that while eggs are unable to move away from the intakes, larvae are capable of propelling themselves away from the pull of the intakes. This natural mechanism would help minimize larvae impingement on the intake screens.

Anadromous fish species should not be greatly affected by any potential changes in Pamunkey River salinity conditions.

Major impacts to fish and invertebrate species in Ware Creek would result from dam construction and inundation. These impacts would include conversion of current Striped Bass nursery habitat to a reservoir habitat. Once completed, the Ware Creek Reservoir would provide 1,238 acres of valuable open water habitat for freshwater fish and invertebrates. Some stream species could be eliminated by the change from a stream to a lake habitat. The loss of benthic food organisms and vegetation for spawning, nursery, and shelter could also eliminate some species. However, a fisheries management program would also be implemented and would include supplementary stocking of forage and game species to augment the natural population.

The dam and operation of the reservoir would also affect the nature of the estuarine community in Ware Creek due to reduced freshwater flow rates below the proposed dam. The proposed minimum reservoir release, which ranges from 0.4 to 1.6 mgd, would reduce flow below the dam to between 3.6 and 14.4 percent of average estimated flow at the proposed dam site.

A study conducted by VIMS concluded that predicted changes in the salinity distribution in Ware Creek would result in the elimination of the tidal freshwater vegetation and reduction or elimination of the oligohaline assemblage (Hershner and Perry, 1987). Reduction of freshwater flows would result in the expansion of the type of fish and invertebrate habitat associated with greater salinity. This would be most pronounced in the existing tidal freshwater sections of Ware Creek near the proposed impoundment site.

A HEP analysis has also been conducted for the proposed Ware Creek Reservoir (USFWS, 1987). The study concluded that lacustrine open water habitat value for the reservoir area is projected to increase by 1,416 average annual habitat units or 1,298 percent. The HEP analysis also indicated that the impact on estuarine finfish would be minimal and temporary.

Impacts associated with reservoir construction could include an increase in levels of suspended sediment. These impacts would be temporary and could be minimized by sediment control measures. Unplanned impacts such as oil spills from machinery could also have adverse impacts on benthic species. The degree of impact and recovery would be dependent on the magnitude of the spill (USCOE, 1987).

Impacts to fish and invertebrates associated with pipeline construction would be minimal and temporary.

The two proposed pipeline discharges to Diascund Creek would create a higher flow regime in the Creek. Increased flow velocities, higher dissolved oxygen levels, and higher nutrient flushing rates would also occur. These changes are expected to be beneficial to fish and invertebrates.

Other Wildlife

Impacts associated with the construction of the intake site would be limited to the disturbance of approximately 3 acres of forested and agricultural lands. Reptiles, amphibians, and small mammals would be the most affected by construction. Other wildlife would be displaced to adjacent habitats.

Approximately 625 acres of forested land would be lost through clearing and grubbing operations and subsequent inundation. Reptiles, amphibians, and small mammals which are less mobile would be the most affected by construction. Birds in the area are the most mobile of the vertebrate fauna and, as a result, fewer impacts would occur. Because areas adjacent to the reservoir are most likely fully occupied, most migrating individuals will not find room, or will displace others (USCOE, 1984).

The USFWS conducted a HEP study for the Ware Creek drainage area (USFWS, 1987). Based on cover typing of the study area, it was concluded that reservoir development would markedly affect habitat values in the following existing cover types: upland mixed forest, upland deciduous forest, forested wetland, scrub-shrub wetland, herbaceous wetland, open water and estuarine wetland (USCOE, 1987).

It is expected that the Great Blue Heron rookery would be threatened by inundation of the reservoir area (T. J. O'Connell, VDCR, personal communication, 1992; USEPA, 1992; USCOE, 1984; USCOE, 1987).

Although a large acreage of upland mixed forest would be converted to residential development, the absence of continued timber harvesting in the remaining mixed forested stands is projected to result in an increase in habitat value for this cover type.

Lacustrine habitat values would increase dramatically. All other cover types would suffer a loss of habitat value. The greatest habitat value losses would occur in forested and herbaceous wetland cover-types which would be inundated (USCOE, 1987).

Impacts to species currently utilizing palustrine and estuarine wetlands would occur due to changes in the source of primary productivity.

Dabbling ducks such as the Black Duck would be negatively affected by the reservoir. Their food sources would be mostly destroyed by the removal and flooding of vegetation.

Negative impacts are anticipated on amphibians requiring specific habitats for breeding and egg laying, such as specific water flow velocities or certain vegetation sizes.

Species utilizing community types along the pipeline route would be temporarily displaced. Due to the relatively small area of land requiring disturbance along the route, and the restoration, where possible, of affected land, the development of the underground pipeline should not substantially impact vertebrate species. Once revegetation (excluding reforestation) is complete, the pipeline ROW would provide valuable open field/shrub habitat adjacent to existing forested areas.

Sanctuaries and Refuges

No impacts to existing designated sanctuaries or refuges are anticipated as a result of intake placement in the vicinity of Northbury on the Pamunkey River, as a result of construction of the proposed Ware Creek Reservoir, or as a result of pipeline construction.

Wetlands and Vegetated Shallows

A minor amount of fringe wetlands located on the southern bank of the Pamunkey River would be affected by construction of the proposed installation trench required between the intake structure and the pump station.

Potential secondary impacts would include:

- Increased sedimentation and wetland loss downstream due to intake structure construction; and

- Changes in tidal freshwater plant communities resulting from salinity increases in the Pamunkey River.

Assuming that the water quality of the Pamunkey River does not deteriorate due to other factors, such as increased wastewater discharges or dramatically increased irrigation withdrawals, the vegetative species composition of the tidal freshwater wetland should not change appreciably as a result of freshwater withdrawals.

The major impact on wetlands by construction of the Ware Creek Reservoir would be direct loss through filling, removal or inundation. A total of approximately 590 acres of tidal and non-tidal wetlands would be affected by construction of the reservoir.

The 590 acres of wetlands affected by the Ware Creek Reservoir project represents approximately 2.7 percent of the 21,889.6 acres of tidal and non-tidal wetlands found in New Kent County and about 1.8 percent of the 32,957.2 acres found in James City County.

Secondary impacts would be related to short-term construction effects and long-term changes in flow regime in downstream wetlands. To indicate the degree of impact to Ware Creek, the percent restriction of flow which would be caused by the dam was estimated. Assuming an estimated average streamflow at the dam site of 11.1 mgd and a minimum reservoir release ranging from 0.4 mgd to 1.6 mgd, streamflow at the dam site would be reduced to 3.6 percent to 14.4 percent of existing average flow.

A VIMS study (Hershner and Perry, 1987) indicated that under average flow conditions, with the dam in place, those tidal freshwater wetlands which remained downstream of the dam initially after its construction would be eliminated and replaced by an oligohaline vegetational community. The study also indicated that existing oligohaline zones below the proposed dam site would be greatly reduced or eliminated.

Some limited areas of wetlands would be temporarily disturbed by pipeline stream crossings. As discussed in Section 5.2.1, an estimated 1.2 acres of substrate would be affected by the 21 minor stream crossings required for pipeline construction. The area of wetland disturbance along the route would likely be similar.

Mud Flats

No mud flats would be directly impacted in project areas for this alternative. Use of a turbidity curtain during construction of the intake structure would decrease sediment flow, thereby minimizing any potential impacts to downstream mud flats.

5.3.2 Black Creek Reservoir with Pumpover from the Pamunkey River

Endangered, Threatened or Sensitive Species

Potential impacts to endangered, threatened and other sensitive species resulting from the proposed Pamunkey River withdrawal are discussed in Section 5.3.1.

No known populations of designated endangered or threatened species would be directly impacted by construction of a reservoir on Black Creek Reservoir. However, the following sensitive species are, or may be, located in the vicinity of the reservoir site: Mabee's Salamander, Bald Eagle, Northern Diamondback Terrapin, and Small Whorled Pogonia.

A survey of potential suitable habitat for the Small Whorled Pogonia was conducted in the proposed reservoir area in July 1993. No individuals of Small Whorled Pogonia were identified within suitable habitat in the reservoir area. Therefore, it is not anticipated that the project would negatively impact individuals of the species. A detailed description of the survey methodology and results are presented in Report E.

Once the reservoir is constructed, it would provide valuable open water habitat. This would provide important foraging habitat for the Bald Eagle.

The proposed minimum combined release of 1.2 mgd represents 32 percent of the estimated combined average flow at the two dam sites. This release is expected to preserve the quality of downstream habitat in Black Creek that sensitive species may use.

The proposed pipeline which would carry raw water from the Northbury Black Creek Reservoir may be far enough away from the Bald Eagle nest to preclude direct impacts. However, the VDCR recommended consultation with the USFWS and the VDGIF to ensure that potential impacts are minimized (T. J. O'Connell, VDCR, personal communication, 1992).

Fish and Invertebrates

Potential impacts to fish and invertebrates at the Pamunkey River intake site are described in Section 5.3.1.

The major impact to fish and invertebrate species in Black Creek would result from dam construction and inundation. Once completed, the Black Creek Reservoir would provide 1,146 acres of valuable open water habitat for freshwater fish and invertebrates.

Some stream species could be eliminated by the change from a stream to a lake habitat. The loss of benthic food organisms and vegetation for spawning, nursery, and shelter could ~~also~~ eliminate some species. However, a fisheries management program would also be implemented and would include supplementary stocking of forage and game species to augment the natural population.

The dams and operation of the reservoir would also affect the nature of the tidal freshwater community in the lower reaches of Black Creek due to reduced freshwater flow rates below the proposed dams. However, the proposed minimum reservoir release of 1.2 mgd represents 32 percent of the estimated combined average streamflow of 3.8 mgd at the two dam sites, and is expected to be sufficient to maintain good habitat quality below the dams for fish and invertebrates.

Impacts associated with reservoir construction could include an increase in suspended sediment. These impacts would be temporary and could be minimized by sediment control measures. Unplanned impacts such as oil spills from machinery could also have adverse impacts on benthic species. The degree of impact and recovery would be dependent on the magnitude of the spill.

Impacts to fish and invertebrates associated with pipeline construction would be minimal and temporary.

The proposed pipeline discharge to Diascund Creek would create a higher flow regime in the Creek. Increased flow velocities, higher dissolved oxygen levels, and higher nutrient flushing rates would also occur. These changes are expected to be beneficial to fish and invertebrates.

Other Wildlife

Potential impacts to other wildlife at the proposed Pamunkey River intake site are discussed in Section 5.3.1.

Within the proposed reservoir pool area, approximately 752 acres of forested land (66 percent of the normal pool area) would be converted to open water. Approximately 25 percent (285 acres) of the pool area supports palustrine and emergent wetlands which would be inundated. Approximately 13 acres of agricultural/rural residential land would be lost. Acreage of open water would be increased substantially.

Reptiles, amphibians, and small mammals which are less mobile would be the most affected by construction. Birds in the area are the most mobile of the vertebrate fauna and, as a result, are least likely to be affected. Because areas adjacent to the reservoir are most likely fully occupied, most migrating individuals will not find room, or will displace others (USCOE, 1984).

Indirect impacts to heron rookeries could occur as a result of reservoir construction and modification of the flow regime of the Black Creek system. However, adverse indirect impacts to these resources are not anticipated.

Species utilizing community types along the pipeline route would be temporarily displaced. Due to the relatively small area of land disturbance along the route, and the restoration, where possible, of affected land, the development of the underground pipeline should not severely impact vertebrate species. Once revegetation (excluding reforestation) is complete, the pipeline ROW would provide valuable open field/shrub habitat adjacent to existing forested areas.

Sanctuaries and Refuges

No impacts to existing designated sanctuaries or refuges are anticipated as a result of intake placement in the vicinity of Northbury on the Pamunkey River, as a result of construction of the proposed Black Creek Reservoir, or are anticipated as a result of pipeline construction for this alternative component.

Wetlands and Vegetated Shallows

Project impacts in the vicinity of the Northbury site are described in Section 5.3.1.

A total of approximately 285 acres of non-tidal wetlands would be inundated, filled, or removed by construction of the Black Creek impoundment. Further verification of this estimate will be conducted in 1994 and will be included in the Final Environmental Impact Statement for public review. Based on previous wetland delineation analyses, the estimate of wetlands within the proposed Black Creek Reservoir pool is not expected to change more than 10 - 15 percent from the current estimate.

Impact acreages for the Black Creek Reservoir were compared with wetland acreages for New Kent County contained in ***The Virginia Non-Tidal Wetlands Inventory*** (VDCR, 1990). The 285 acres of wetlands affected by the Black Creek Reservoir project represent approximately 1.3 percent of the 21,889.6 acres of tidal and non-tidal wetlands found in New Kent County.

Secondary impacts would be related to short-term construction effects and long-term changes in flow regime in downstream wetlands. To indicate the degree of impact to the existing hydrology of the Black Creek system, the percent restriction of flow from the watershed which would be caused by the dams was estimated. Assuming an estimated average streamflow from the watershed of 3.8 mgd and a minimum reservoir release of 1.2 mgd, combined streamflow at the dam sites would be reduced to 32 percent of existing average flows.

It is reasonable to conclude that wetlands downgradient from the two dam sites may be affected by reductions in average water levels. There are approximately 212 acres of vegetated wetlands from eight cover types located between the two dam sites and the Pamunkey River. These vegetated wetlands below the Black Creek dam sites have very high functional values.

Flood peaks would also be greatly reduced downstream of the dam sties due to moderation of flows via storage in the impoundment. As a result, floodplain wetlands hydrology would be severely limited and impacts to this type of wetland may occur.

Some limited areas of wetlands would be temporarily disturbed by pipeline stream crossings. As discussed in Section 5.2.2, an estimated 1.4 acres of substrate would be affected by the 24 minor stream crossings required for pipeline construction. The area of wetland disturbance along the route would likely be similar. Pipeline construction across an arm of Little Creek Reservoir would affect a deep open water area approximately 500 feet wide.

Mud Flats

No mud flats would be directly impacted in project areas for this alternative. Use of a turbidity curtain during construction of the intake structure would decrease sediment flow, thereby minimizing any potential impacts to downstream mud flats.

5.3.3 King William Reservoir with Pumpover from the Mattaponi River

Endangered, Threatened or Sensitive Species

No known populations of species with special federal and/or state status in the tidal region of the Mattaponi River are anticipated to be directly impacted by intake construction and operation.

Impacts to approximately 2.5 acres of potential habitat of *Aeschynomene virginica* could occur during construction activities at the site (Perry, 1993). No information on the seed bank availability of the species is available. Therefore, the potential for the loss of propagule source due to construction activities is unknown. Potential propagule loss and damage to species habitat could be minimized by:

- Locating work staging areas away from wetland areas.
- Implementing sediment control measures at all times.
- Avoiding compaction and disturbance of wetland soils.

It is not anticipated that the predicted minute incremental salinity changes due to the river withdrawals would affect the plant.

No great adverse impacts to transient Bald Eagles are anticipated as a result of intake placement and operation due to the small area of disturbance in relation to the large area of remaining habitat available to the species in the region.

No known populations of designated endangered, threatened or sensitive species would be directly impacted by construction of King William Reservoir. However, the following federal and state protected species are located in the vicinity of the project area: Mabee's Salamander, Bald Eagle, Northern Diamondback Terrapin and Small Whorled Pogonia.

A biological assessment of the Bald Eagle and the Small Whorled Pogonia was undertaken to identify potential impacts to these species in the reservoir area. The detailed results of this assessment are presented in the report ***Biological Assessment For Practicable Reservoir Alternatives*** (Malcolm Pirnie, 1994) which is appended to this document as Report E.

The tree containing the Cohoke Mill Creek eagle nest would not be directly affected by the King William Reservoir Project. However, as outlined below, construction of some project features would occur within a relatively short distance of the eagle nest.

- King William Dam: The toe of the dam would approach as close as approximately 375 feet from the nest. Excavation area work limits for the dam could approach as close as 275 feet from the nest.

- Emergency Spillway: The emergency spillway would be constructed on the west abutment of the dam. This spillway would approach as close as approximately 2,200 feet of the nest. Channel improvements downstream of the spillway would be minimized as much as possible in consideration of the low probability of spillway use.

- Gravity Pipeline: A 60-inch diameter gravity pipeline would follow the hillside to the east of Cohoke Mill Creek, generally near 50 feet above mean sea level (msl) in the vicinity of the eagle nest. The pipeline would be buried and would approach as close as approximately 375 feet of the nest.

- Roadway over King William Dam: The travelway associated with the proposed roadway across the top of the dam would approach as close as approximately 675 feet of the nest.

The primary threat to Bald Eagles using the nest on Cohoke Mill Creek is considered to be the short-term noise and disruption which would result from dam construction (M. A. Byrd, The College of William and Mary, personal communication, 1993). One possible effect from the project would be to cause the eagles to abandon their nest as a result of short-term disturbances during reservoir construction. However, if this were to occur, it could be viewed as a temporary impact since eagles often use alternate nest sites in different years (USFWS, 1987).

Recreational boat traffic on the proposed reservoir was also considered as a potential disturbance to the Bald Eagle. A comprehensive study entitled ***Ecology, Habitat and Management of Bald Eagles at B. Everett Jordan Lake and Falls Lake, North Carolina*** was recently conducted (Luukkonen et al., 1989). Sixty-three intentional disturbances by motorized boats flushed eagles with a mean flush distance of 450 feet. Most (92 percent) of the eagles were flushed when the approaching boat was within 820 feet from shore. As part of this study, eagles were observed to flush at greater distances when approached by walking observers than when approached by motor boats.

For the King William Reservoir Project, boat traffic on the reservoir would be limited to areas upstream of the intake structure. This intake structure would be located approximately 900 feet from the bald eagle nest and, therefore, is outside of the normal range of observed eagle flushing distances at other reservoirs. In addition, the ***King William Reservoir Project Development Agreement*** would only permit the use of electric motors on motorized boats using the reservoir (King William County and City of Newport News, 1990). Electric motors are much quieter than gasoline powered engines and would, therefore, be less disturbing to eagles at the nest or eagles foraging on the reservoir.

Once the reservoir is constructed, it would provide valuable open water habitat. This would provide important habitat for the Bald Eagle. A discussion of the potential for the creation of Bald Eagle habitat at the reservoir site is presented in Report E. With appropriate management efforts, Bald Eagle foraging and nesting habitat could be successfully created at the proposed King William Reservoir site, especially given the following factors:

- Once the reservoir is filled, extensive undeveloped shoreline with large diameter trees would exist around the reservoir. The mature forests adjacent to the open water would greatly expand local bald eagle habitat by providing nesting, roosting, and perching sites.

- Extensive shallow water areas and freshwater fisheries would exist within the reservoir, thus greatly expanding the bald eagle's local foraging habitat and potential food supply.

- Large numbers of active bald eagle nesting sites already exist in the region and the population could expand at the King William Reservoir site.

- The proposed King William Reservoir would provide an environment much more suited to bald eagle establishment than under existing land use conditions in which the site is used for timbering and hunting.

To minimize impacts to the Bald Eagle nest, the following potential management measures may be useful:

- To the maximum extent possible, avoid construction activities in areas closest to the Bald Eagle nest during the entire eagle breeding season.

- Protect any new bald eagle nesting sites by establishing buffer zones around the nests. Cooperative agreements should be pursued with landowners to protect such nesting habitat.

- Promote eagle roosting site creation by establishing buffer zones around selected large open areas containing large trees (i.e., greater than 1.6-foot diameter) at low densities. Selective timbering of areas may be necessary to create suitable roost stands.

- Promote eagle perching site creation by establishing buffer zones around selected large trees (i.e., greater than 1.6-foot diameter) along the reservoir shore which have more open crowns than other trees along the shore.

- Install buoys to keep boats from approaching too close to eagle nest sites which are established around the King William Reservoir.

- Develop educational materials such as posters and leaflets to place in public locations close to established eagle roosting, nesting, and foraging areas. Such materials should educate the general public on the effects of land development, shooting, and other human activity on bald eagles.

One individual of Small Whorled Pogonia was identified near the proposed King William Reservoir project area during field surveys for the species conducted in June 1993. If reservoir construction proceeds, the individual would be located within a watershed protection area which would not be harvested. The proposed normal pool elevation of the reservoir is 90 feet msl. The plant is located between the 90-foot and the 100-foot contour elevations, which should protect it from inundation effects associated with reservoir construction.

Because only one individual was found in this area, in habitat which is less than ideal for the species, it is unlikely that this population will maintain itself into the future.

However, during reservoir construction and operation, management techniques would be applied to protect this individual. These would include the establishment of a 100-foot buffer zone around the individual and the prohibition of any construction or recreation activities within this zone. By limiting all activities within this area, the impacts of reservoir construction and operation on this individual plant would be minimized.

The proposed minimum reservoir release of 3 mgd is expected to preserve the quality of downstream habitat in Cohoke Millpond and Cohoke Mill Creek that sensitive species may use.

No known populations of endangered, threatened or sensitive species would be directly impacted by construction of pipeline associated with this alternative.

Fish and Invertebrates

Potential impacts as a result of intake operation include entrainment and impingement of fish eggs and larvae. Alewife and Blueback Herring could be susceptible to greater impacts than other anadromous fish species because their eggs are disturbed throughout the water column. The NMFS generally recommends that through-screen velocities at raw water intakes not exceed 0.5 fps, for the protection of anadromous fish larvae. To meet this requirement, approximately 6 wedge-wire profile submerged intake screens would be used. These screens would be approximately 5 feet in diameter and 5.5 feet in length. Screens would require a water depth of at least 15 feet and would be placed midway between the river bottom and average water surface.

With wedge-wire screens, having very low entrance velocities (i.e., ≤ 0.5 fps) and very small openings (i.e., 1 millimeter slots), it is unlikely that appreciable impingement and entrainment impacts would occur. Some small fraction of eggs could potentially be damaged while attached to the screens. However, it is expected that eggs which float on the surface over the intake, or roll on the bottom, would safely pass the intake structures. Also because American Shad, Hickory Shad, and Striped Bass eggs are slightly heavier than water, it is likely that the majority of the eggs would be located below the intake entrance and would not be affected.

An additional consideration is that while eggs are unable to move away from the intakes, larvae can propel themselves away from the pull of the intakes. This natural mechanism would help minimize larvae impingement of the intake screens.

Anadromous fish species should not be substantially affected by any potential changes in Mattaponi River salinity conditions.

The major impact to fish and invertebrate species in Cohoke Mill Creek would result from dam construction and inundation. Once completed, the King William Reservoir would provide 2,234 acres of valuable open water habitat for freshwater fish and invertebrates. Some stream species could be eliminated by the change from a stream to a lake habitat. The loss of benthic food organisms and vegetation for spawning, nursery, and shelter could also eliminate some species. However, a fisheries management program would also be implemented and would include supplementary stocking of forage and game species to augment the natural population.

The dam and operation of the reservoir could affect the nature of Cohoke Mill Creek due to reduced freshwater flow rates below the proposed dam. However, the proposed minimum reservoir release of 3 mgd represents 32 percent of the estimated average streamflow of 9.3 mgd at the dam site, and is expected to be sufficient to maintain good habitat quality below the dam for fish and invertebrates.

Impacts associated with reservoir construction could include an increase in levels of suspended sediment. These impacts would be temporary and could be minimized by sediment control measures. Unplanned impacts such as oil spills from machinery could also have adverse impacts on benthic species. The degree of impact and recovery would be dependent on the magnitude of the spill.

Impacts to fish and invertebrates associated with pipeline construction would be minimal and temporary. Impacts to fish and invertebrates in the Pamunkey River should not occur due to pipeline construction.

The proposed pipeline discharge to Beaverdam Creek would create a higher flow regime in the creek. Increased flow velocities, higher dissolved oxygen levels, and higher nutrient flushing rates would also occur. These changes are expected to be beneficial to fish and invertebrates.

Other Wildlife

Impacts resulting from the placement of a pump station at Scotland Landing would result in the disturbance of approximately 3 acres of forested land. Reptiles, amphibians, and small mammals would be the most impacted by construction. Other wildlife would be displaced to adjacent habitats.

The proposed reservoir pool area is comprised primarily of forested land (76 percent). Approximately 1,719 acres of upland forest would be converted to open water. 479 acres of wetlands would be converted to open water. A loss of 29 acres of agricultural/rural residential land would occur. The acreage of open water would increase considerably.

Reptiles, amphibians, and small mammals which are less mobile would be the most affected by construction. Birds in the area are the most mobile of the vertebrate fauna and, as a result, are least likely to be affected. Additional wetlands would be created from reservoir development, providing habitat for wetland species; however, because adjacent forested areas are most likely fully occupied, most migrating individuals would not find room, or would displace others.

Species utilizing community types along the pipeline route would be temporarily displaced. Due to the relatively small area of land disturbance along the route and the restoration, where possible, of the affected land, the development of the underground pipeline should not greatly impact vertebrate species. Once revegetation (excluding reforestation) is complete, the pipeline ROW would provide valuable open field/shrub habitat adjacent to existing forested areas.

Sanctuaries and Refuges

No impacts to existing sanctuaries or refuges are anticipated as a result of intake placement in the vicinity of Scotland Landing on the Mattaponi River, as a result of construction of the proposed King William Reservoir, or are anticipated as a result of pipeline construction for this alternative component.

Wetlands and Vegetated Shallows
No direct impacts to wetlands at the intake site are anticipated.

Potential secondary impacts would include:

- Increased sedimentation due to intake structure construction; and

- Changes in tidal freshwater plant communities resulting from salinity increases in the Mattaponi River.

Assuming that the water quality of the Mattaponi River does not deteriorate due to other factors, the vegetative species composition of the tidal freshwater and oligohaline wetlands should not change appreciably as a result of freshwater withdrawals.

The major impact on wetlands by construction of the King William Reservoir would be direct loss through filling, removal or inundation. A total of approximately 479 acres of wetlands would be affected by construction of the reservoir. Further verification of this estimate will be conducted in 1994 and included in the Final Environmental Impact Statement for public review.

The 479 acres of wetlands affected by the King William Reservoir project represents approximately 1.8 percent of the 26,767.7 acres of tidal and non-tidal wetlands found in King William County.

Secondary impacts would be related to short-term construction effects and long-term changes in flow regime in downstream wetlands. Based on USFWS National Wetland Inventory maps, there are approximately 55.3 acres of vegetated wetlands from three cover types located between the proposed King William Reservoir dam site and the Pamunkey River. The percent reduction of flow which would be caused by the dam was estimated to indicate the degree of impact to the existing hydrology of the Cohoke Mill Creek system. Based on an estimated average streamflow at the dam site of 9.3 mgd and a minimum reservoir release of 3 mgd, streamflow at the dam site would be reduced to 32 percent of existing average flows.

The existing Cohoke Millpond has already provided a sizeable degree of flow moderation in the lower reaches of Cohoke Mill Creek. Consequently flow reductions due to the proposed reservoir should not cause dramatic changes in average water levels or floodplain hydrology in vegetated wetland areas below the dam site.

Some limited areas of wetlands would be temporarily disturbed by pipeline stream crossings. As discussed in Section 5.2.3, an estimated 1.5 acres of substrate would be affected by the 26 minor stream crossings required for pipeline construction. The area of wetland disturbance along the route would likely be similar.

Pipeline construction across an arm of Little Creek Reservoir would affect a deep open water area approximately 500 feet wide. The Pamunkey River crossing would be accomplished using directional drilling techniques which would not disturb river bottom substrate or adjacent wetlands in Cousaic Marsh.

Mud Flats

No mud flats would be directly impacted in project areas for this alternative. Use of a turbidity curtain during construction of the intake structure would minimize any potential impacts to downstream mud flats. Potential sediment flow created by intake construction would be carried downstream; therefore, mud flats located upstream would not be impacted.

5.3.4 Fresh Groundwater Development

Endangered, Threatened or Sensitive Species

No endangered, threatened or sensitive species would be adversely impacted from development of this alternative.

Fish and Invertebrates

Disturbance of a combined 6,000 square feet at Diascund Creek and Little Creek reservoirs for placement of pipelines may impact invertebrate species inhabiting wetlands adjacent to the reservoirs.

Because groundwater withdrawals would occur when the reservoir drop to 75 percent of capacity, this alternative would prevent more severe reservoir drawdowns than would otherwise occur. This would be beneficial to fish and invertebrates.

Other Wildlife

The development of eight wells along the perimeter of Diascund Creek and Little Creek Reservoirs would impact a relatively small area of forested land. Construction activities would require a maximum disturbance of approximately 8 acres. Pipeline impact is expected to be minimal due to well proximity to the reservoirs. Species would be temporarily displaced to adjacent areas.

Sanctuaries and Refuges

No impacts to sanctuaries or refuges are anticipated as a result of implementation of this alternative component.

Wetlands and Vegetated Shallows

It is anticipated that deep aquifer freshwater withdrawals would not have any measurable impacts on wetlands in the area, which are maintained by surface water and shallow groundwater hydrology.

Impacts to wetlands would result from the construction of outfall structures and associated placement of stone rip-rap in the Diascund Creek Reservoir proper, and in tributaries leading to Little Creek Reservoir. Assuming that each outfall structure and associated rip-rap would cover an area 20 feet wide by 50 feet long, this project component would impact 1,000 square feet of lacustrine limnetic, open water wetlands (L1OWU) at each of the four Diascund Creek Reservoir discharge points and 1,000 square feet of palustrine forested, broad-leaved deciduous, temporary wetlands (PFO1A) at two of the four Little Creek Reservoir discharge points.

Mud Flats

No mud flats are located in the vicinity of proposed groundwater wells or associated pipelines and outfall structures; therefore, no impacts to mud flats would occur.

5.3.5 Groundwater Desalination in Newport News Waterworks Distribution Area

Endangered, Threatened or Sensitive Species

No adverse impacts to known threatened, endangered or sensitive species are anticipated as a result of this alternative.

Fish and Invertebrates

Stream impacts due to concentrate discharge pipelines would be minor and transient. The four stream crossings required would be accomplished by cut and fill techniques, with stream contours restored following construction.

Concentrate discharge pipeline outfalls would be placed in areas where polyhaline or mesohaline conditions already occur to avoid any potential impacts to existing fish and invertebrate species.

Other Wildlife

Groundwater development at five well locations and RO treatment plant construction would disturb approximately 5 acres. The proposed locations of the wells and RO plants are within urbanized areas. Impacts to vegetation communities and their associated wildlife species would be minimal.

Construction of concentrate discharge pipelines would disturb approximately 65 acres along the proposed pipeline routes. Wildlife species inhabiting these areas would be temporarily displaced. Due to the relatively small area of land disturbance at any one area along the routes, and the restoration, where possible, of the affected land development of the underground pipeline should not greatly impact vertebrate species.

Sanctuaries and Refuges

No impacts to sanctuaries or refuges are anticipated as a result of implementation of this alternative.

Wetlands and Vegetated Shallows

Impacts to wetlands would include the construction of outfall structures and placement of approximately 4,000 square feet of rip-rap in wetlands associated with discharge points. The total wetlands acreage disturbed would be 0.9 acres.

Mud Flats

For Site 1, the concentrate outfall structure would temporarily or permanently impact 4,000 square feet of mud flats in Hampton Roads Harbor. No sizeable impacts to mud flats would be anticipated for the other well sites.

5.3.6 Use Restrictions

Endangered, Threatened or Sensitive Species

The implementation of the Use Restrictions alternative would have no impact on endangered, threatened or sensitive species on the Lower Peninsula.

Fish and Invertebrates

The implementation of the Use Restrictions alternative would have no impact on fish and invertebrate species in the Lower Peninsula.

Other Wildlife

Implementation of the Use Restrictions alternative should have no impact on existing wildlife resources in the Lower Peninsula.

Sanctuaries and Refuges

The implementation of the Use Restrictions alternative on the Lower Peninsula would have no impact on sanctuaries and refuges in the region.

Wetlands and Vegetated Shallows

There would be no impacts to wetlands as a result of implementing the Use Restrictions alternative

Mud Flats

No impacts to mud flats would occur with implementation of the Use Restrictions alternative.

5.3.7 No Action

Endangered, Threatened or Sensitive Species

If no action were taken by local water purveyors to develop additional water supplies, there could be negative impacts to wetland species due to the increased frequency and severity of drawdowns in existing reservoirs. Increasingly, existing reservoirs would be drawn down to levels which could negatively impact adjacent wetland communities. The largest impacts would be expected at Diascund Creek and Little Creek as these reservoirs experience the most frequent and severe drawdowns.

No endangered, threatened or sensitive species are known to occur in areas surrounding Diascund and Little Creek reservoirs. Bald Eagles are documented as occurring in the project vicinity. Foraging habitat of this species may be affected if increased water demands result in more severe reservoir drawdowns.

Fish and Invertebrates

If no action were taken by local water purveyors to develop additional water supplies, there could be negative impacts to fish and invertebrate species due to the increased frequency and severity of drawdowns in existing reservoirs. Increasingly, existing reservoirs would be drawn down to levels which could negatively impact adjacent wetland communities. Species inhabiting shallow streams within these wetland communities would be most impacted.

Other Wildlife

If no action were taken by local water purveyors to develop additional water supplies, there could be negative impacts to wildlife species due to the increased frequency and severity of drawdowns in existing reservoirs. Increasingly, existing reservoirs would be drawn down to levels which could negatively impact adjacent wetland communities. Wildlife species depending on these communities could be affected.

Sanctuaries and Refuges

If no action is taken to augment the existing water supplies on the Lower Peninsula, there will be no impact to existing sanctuaries and refuges in the region.

Wetlands and Vegetated Shallows

The No Action alternative would require increasing reliance on existing reservoirs to satisfy growing water demands. As a result, these reservoirs would be increasingly drawn down to levels that could negatively impact adjacent wetland communities.

In addition, there would be an increasing dependence on shallow groundwater sources. This, in turn, could result in a potential negative impact to wetlands supplied by shallow groundwater.

Mud Flats

The No Action alternative would result in more frequent and severe drawdowns in existing water supply reservoirs serving the Lower Peninsula. Mud flats along the peripheral areas of reservoirs would, therefore, be more exposed to the atmosphere. Adverse impacts from such exposure could include some dewatering during extended periods of reservoir drawdown.

5.4 CULTURAL RESOURCES

Potential impacts to known cultural resources within project areas are discussed in this section. Direct impacts resulting from disturbance of cultural resources are discussed.

5.4.1 Ware Creek Reservoir with Pumpover from Pamunkey River Intake

One known prehistoric site identified during field studies of the proposed intake site in conjunction with the ***Phase IA Cultural Resource Survey for the Proposed King William Reservoir, King William County, Virginia and the Proposed Black Creek Reservoir, New Kent County, Virginia*** (MAAR Associates, 1994) would be affected by construction of the proposed intake and pump station. Impacts to "Chericoke", which is located in the vicinity of the Northbury withdrawal site, would not be anticipated since the resource is well separated from the intake site.

Due to the high potential for cultural resources in the area, the USCOE (1984) has indicated that a site survey would be necessary to identify the extent of any resources in the vicinity of the intake site. The site was examined during field studies for the ***Phase IA Cultural Resource Survey of the Proposed King William Reservoir, King William County, Virginia and the Proposed Black Creek Reservoir, New Kent County, Virginia*** conducted by MAAR Associates (1994). However, the Phase IA survey concentrated on the reservoir area with limited research conducted at the intake site.

Reservoir

The USCOE (1984) stated that the Stonehouse archaeological site could be damaged if reservoir construction is not carefully executed. At the time of the study, the existence of other cultural resources in the reservoir area was unknown, but it was expected that several other sites existed. The USCOE suggested that further archaeological survey work be conducted to determine the degree of resources within the reservoir area.

The 45 prehistoric and historic period sites which were identified as being at or below the 35-foot contour elevation would be directly impacted by reservoir construction. In addition, 16 historic-period sites could be impacted. In April 1993, the VDHR reported that James City County had hired a consultant to perform Phase II archaeological studies for the proposed Ware Creek Reservoir (E. R. Eaton, VDHR, personal communication, 1993). Due to the identification of numerous archaeological resources within the reservoir pool area, this additional survey work is required to identify the archaeological potential of these sites and locate additional resources.

Pipeline

One known historic site (44NK81) could be impacted from pipeline construction for this alternative component. Two additional archaeological sites (44JC269 and 44JC297) are located adjacent to the pipeline route. Impacts to these sites would be avoided to the maximum extent possible during construction.

The pipeline route would also transect the registered acreage of Saint Peter's Church (63NK27), a National Historic site. Any impacts to the grounds would be minimal and temporary in nature. The actual church structure would be located approximately 550 feet north of the pipeline. Consequently, no impacts to this structure are anticipated.

The Slater House (47JC19) is located adjacent to the pipeline route. Assuming a 50-foot wide right-of-way for pipeline construction, impacts to this resource could be avoided. However, Burnt Ordinary (47JC63) is located in close proximity to the proposed pipeline route. A site survey would be conducted prior to construction to assure that impacts to the resources would be minimized.

Due to several known locations of archaeological resources along the pipeline route, additional survey work would likely be required to identify any other cultural resources which could be impacted.

5.4.2 Black Creek Reservoir with Pumpover from Pamunkey River Intake

Potential impacts to cultural resources resulting from construction and operation of an intake and pumping station at Northbury are discussed in Section 5.4.1.

Reservoir

Based on the results of a Phase IA Cultural Resource Survey (MAAR Associates, 1994) conducted at the reservoir site, construction of the reservoir would directly impact Crump's Mill (63NK70). This resource would be inundated with a reservoir normal pool elevation of 100 feet msl. One or two additional historic sites identified by the New Kent County Historical Society may also be located within the proposed reservoir pool area.

The predictive model used to estimate the potential for cultural resources at the Black Creek site indicated that there are few, if any, prehistoric sites located within the impoundment area. As a result, it is suggested that impacts to prehistoric cultural resources within the impoundment area would be relatively small (MAAR Associates, 1994).

As indicated by the VDHR in its review of the Phase IA Cultural Resource Survey for the reservoir area, four properties would require further evaluation to determine the potential effects of the project on the resources. These include Crump's Mill (VDHR 63-

70), Iden (VDHR 63-41; MAAR 2), VDHR 63-203 (MAAR 13), and VDHR 63-178 (MAAR 70). The inundation of Crump's Mill would almost certainly constitute an adverse effect. The VDHR has indicated that the effects on the other three properties may possibly be limited to visual effects and that the potential effects might not be adverse (H. B. Mitchell, VDHR, personal communication, 1993).

Pipeline

It is anticipated that some impacts to cultural resources would result along the pipeline route, primarily to yet unidentified archaeological sites. Two previously recorded sites may be impacted by pipeline construction. It is unlikely that the two National Register sites (St. Peter's Church and Marl Hill) in the vicinity of the pipeline route would be impacted by the project (MAAR Associates, 1994). Any impacts to the grounds of St. Peter's Church would be minimal and temporary in nature. The actual church structure is located approximately 550 feet north of the proposed pipeline route. Consequently, no impacts to this structure are anticipated.

Based on review of VDHR records, two additional known sites (44JC642 and 44JC644) would be directly impacted by pipeline construction for this alternative component. These sites are identified in VDHR's records as having been recently surveyed and have been described as being badly eroded. As a result, no further work was recommended. It is unlikely that additional survey work would be required at these sites, and precautions would be taken during pipeline construction to minimize impacts to existing resources.

5.4.3 King William Reservoir with Pumpover from Mattaponi River Intake

No known cultural resources would be impacted as a result of construction and operation of an intake and pumping station at Scotland Landing. However, the area was identified as having a high potential for cultural resources (MAAR Associates, 1994) based on limited research conducted on the intake site during the Phase IA survey.

Reservoir

No previously recorded cultural resources would be directly impacted by construction of the reservoir. However, the VDHR has identified three historic sites (50KW11, 50KW15, and 50KW40) located above the 110-foot contour elevation which could potentially be impacted from reservoir construction. Two of these properties were reviewed by the VDHR in the Fall of 1993 (H. B. Mitchell, VDHR, personal communication, 1993). At this time, it was determined that Colosse Baptist Church (VDHR 50-15) and Malbourne (VDHR 50-40) would not be affected by the proposed project (H. B. Mitchell, VDHR, personal communication, 1993). Historic site 50KW11 (Canton) has never been formally evaluated for its eligibility for the National Register of Historic Places (B. J. Larson, VDHR, personal communication, 1992). As a result, additional survey work at this site may be required to identify its cultural significance.

Based on the results of a Phase IA Cultural Resources Survey conducted at the reservoir site (MAAR Associates, 1994), it is anticipated that there will be a relatively large number of prehistoric sites within the impoundment area that would be impacted by inundation. Sites identified in the survey which would be impacted include an earthen dam, an ice house and a total of six prehistoric sites.

Pipeline

It is anticipated that some impacts to cultural resources would result along the pipeline route, primarily to unidentified archaeological sites. One previously recorded site may be impacted by pipeline construction (MAAR Associates, 1994). It is expected that the pipeline route which traverses stream valleys would impact cultural resources in these areas.

Three archaeological sites identified from VDHR records (44NK101, 44JC642, and 44JC644) would be directly impacted by construction of the proposed pipeline. It is anticipated that further survey work of the Hechler Quarry site (44NK101) would be required to determine its cultural significance. The 44JC642 and 44JC644 sites have recently been surveyed and have been described as being badly eroded. It is unlikely that additional survey work would be required at these sites, and precautions would be taken during pipeline construction to minimize the impacts to the existing resources.

These observations are based on limited research conducted on the pipeline routes during the Phase IA survey.

5.4.4 Fresh Groundwater Development

The VDHR conducted a search of its cultural resource site inventory for the project areas encompassed by the Fresh Groundwater Withdrawals alternative and identified two previously recorded archaeological sites in the vicinity of the Diascund Creek Reservoir well sites. However, VDHR indicated that impacts to these sites should not occur given the great distances which separate these sites from the project areas.

Additional survey work may be required at the Little Creek Reservoir project area to verify the location of potential resources and to identify any additional resources which could be affected.

5.4.5 Groundwater Desalination in Newport News Waterworks Distribution Area

No known archaeological sites are located in the vicinity of Site 1. The VDHR believes that since concentrate discharge pipeline construction would take place in already disturbed rights-of-way, this project area has a low potential for containing intact archaeological resources. Therefore, minimal impacts are expected.

Forty-seven archaeological sites are known to be located in close proximity to the Site 2 project area. It is likely that additional survey work would be required.

Five archaeological sites are known to be located in close proximity to the Site 3 area. However, most of the facilities for Site 3 would be constructed in existing rights-of-way which have already been disturbed. Therefore, minimal impacts are expected.

Eighteen archaeological sites are known to be located in close proximity to the Site 4 project area. Of the 4 groundwater desalting project areas, VDHR believes that Site 4 has the greatest potential to affect previously unidentified archaeological sites.

5.4.6 Use Restrictions

Implementation of the Use Restrictions alternative would not impact cultural resources.

5.4.7 No Action

If no action is taken by local purveyors to augment existing water supplies, there would be no impacts to cultural resources within the region.

5.5 SOCIOECONOMIC RESOURCES

This section provides a general description of how the socioeconomic environment would be impacted by each of the seven alternatives evaluated. Socioeconomic resource categories evaluated are described below.

Municipal and Private Water Supplies

Alternative components may have the potential to impact the quality of water supplies in such a way as to render them unpalatable or require communities to incur higher treatment costs. Alternatives also may alter the quantity of water which is available for municipal and private water supplies.

Important evaluation factors in this category include treated water safe yield benefits for RRWSG jurisdictions, potential water supply benefits for non-RRWSG jurisdictions, magnitude of existing withdrawals from water sources, changes in surface water or groundwater availability for other existing or potential future water users, and potential changes in the quality of surface water or groundwater used for municipal or private water supply.

Recreational and Commercial Fisheries

This category addresses the potential impacts to recreational and commercial fisheries which may occur as a result of project implementation.

Other Water-Related Recreation

This category describes the potential positive and negative impacts to water-related recreation which may occur as a result of project implementation.

Aesthetics

The magnitude of aesthetics alterations is determined by such factors as the relative uniqueness of aesthetic characteristics that are altered or created, distance that the structures are visible, their height, the materials used in construction, the extent and magnitude of changes in vegetation along shorelines, and the extent of other physical/chemical alterations that may, for example, cause algal blooms and/or odor problems. Aesthetic impacts may also result from changes in air quality and noise levels; however, these impacts have been evaluated separately. Therefore, the primary focus of this aesthetic impact category is on the degree of potential visual impact from each of the alternative components. This analysis is based on impacts within the project viewsheds, which are the estimated areas from which observers are likely to see the construction activities and structures associated with each alternative.

Parks and Preserves

This category identifies the potential impacts to parks and preserves which could result from implementation of the evaluated alternatives.

Land Use

This category addresses potential impacts to existing land use and impacts to proposed future land use.

Noise

This category discusses the noise impacts of each alternative component. A specific discussion of noise impacts attributable to each alternative component is included.

Infrastructure

This category identifies the impacts each alternative component would have on elements of infrastructure including transportation, utilities, and navigation. Evaluation of impacts involved describing the direct impacts on existing roads and traffic patterns, comparing anticipated power needs and wastewater generation to available utility capacities, and describing potential navigational impacts on affected navigable waterways.

Direct, Indirect, and Cumulative Socioeconomic Impacts

Potential socioeconomic impacts which could result from implementation of alternative components are addressed in this section. This section focuses on potential socioeconomic impacts resulting from the proposed reservoirs. Potential impacts resulting from other physical features of alternatives, such as pipelines, pump stations, and wells, are not specifically addressed in this section. It is likely that the preferred alternative will include construction of a water supply reservoir, and it is assumed that the construction of any reservoir would result in the greatest socioeconomic impacts, as compared to other physical features of an alternative (i.e., pipelines, pump station, wells, etc.). Therefore, for this analysis, the degree of socioeconomic impact which could result from reservoir development is deemed indicative of the degree of impact of the entire alternative component.

5.5.1 Ware Creek Reservoir with Pumpover from the Pamunkey River

Municipal and Private Water Supplies

River withdrawals associated with this alternative should not cause any appreciable water quality changes in the Pamunkey River.

It is possible that the large (120 mgd capacity) municipal water supply withdrawal associated with this alternative could limit the availability of the Pamunkey River as part of Hanover County's proposed Crump Creek Reservoir Project. Hanover County's project would include a 25- to 40-mgd pumpover from the Pamunkey River. This potential withdrawal site is located approximately 30 river miles upstream of Northbury. In May 1991, the County submitted a permit application for the project to the USCOE. This application was still pending as of March 1993 (Perritt, 1993).

Hanover County has recently studied an alternative to the Crump Creek Reservoir Project that would also involve off-stream storage of Pamunkey River withdrawals. It is expected that Pamunkey River withdrawals for Lower Peninsula use would increase the magnitude of permitting obstacles for Hanover County on either of its potential Pamunkey River water supply projects.

Owing to conditions set forth in a December 1983 Agreement between James City and New Kent counties, New Kent County has the option to purchase an ownership interest of up to 30 percent of the Ware Creek Reservoir capacity. Based on safe yield analysis for this alternative, this equates to as much as 2.2 mgd of the raw water safe yield being available to New Kent County. This water allocation represents an important potential benefit for New Kent County which is not a current member of the RRWSG.

The Columbia and Yorktown Aquifers would be afforded recharge by direct and indirect seepage from the reservoir. This would be a beneficial impact, assuming that the water stored in the reservoir remains of good quality. However, if the water quality of the Ware Creek Reservoir deteriorates as a result of intense development in the watershed then reservoir seepage could have some detrimental impact on groundwater quality.

Substantial municipal water supply benefits would be derived from interconnecting the new Pamunkey River withdrawal and Ware Creek Reservoir with the existing Lower Peninsula water systems.

Recreational and Commercial Fisheries

Potential impacts from intake structures include the entrainment and impingement of fish eggs and larvae. Use of wedge-wire screens with very low entrance velocities and very small openings would greatly reduce these potential impacts.

Potential impacts due to reduced Pamunkey River flows should be inconsequential.

The loss of coastal marshes, such as those within the reservoir area, would result in the decrease in nursery and feeding grounds for young fish and juveniles of commercial importance (USEPA, 1992).

The semi-anadromous White Perch would lose valuable spawning habitat since the dam would block this estuarine perch from freshwater spawning areas above the dam site (USEPA, 1992). The decline of this species may impact higher trophic levels.

The anadromous Striped Bass would also suffer impacts due to conversion of current Striped Bass nursery habitat to a reservoir impoundment.

Once completed, Ware Creek Reservoir would provide 1,238 acres of valuable open water habitat for freshwater fish. Species currently present in the drainage area would populate the reservoir. Some stream species could be eliminated by the change from a stream to a lake habitat. The loss of benthic food organisms and vegetation for spawning, nursery, and shelter could also eliminate some species. However, a fisheries management program in cooperation with the VDGIF would include supplementary stocking of forage and game species to augment natural populations.

Direct impacts to invertebrate species of commercial importance are not anticipated. However, adverse indirect effects to invertebrate species through greatly reduced freshwater flow and increased salinities in Ware Creek would be possible.

Any impacts to recreational or commercial fisheries resulting from pipeline construction should be minimal and temporary.

Other Water-Related Recreation

Intake

Potential impacts to water-related recreation are anticipated to be minimal due to the small acreage of impact to forested lands at the intake site (approximately 3 acres) and the vast area remaining in the Pamunkey River basin which can be used for recreation. Water depth in the Pamunkey River, which is important for recreational uses, would not be measurably impacted by withdrawals since the proposed intake is located in tidal waters. Hunting in the area may be disturbed during construction of the pump station and noise generated from operation of the pump station may cause localized disturbance of waterfowl.

Reservoir

Upon construction of the reservoir, 350 acres of recreational facilities are planned for development in the watershed, in association with the Stonehouse Community. Planned recreational facilities include: two golf courses; nine park systems including: playgrounds, five swimming pool complexes, and six tennis court complexes; a tennis center; a recreational vehicle storage area; and a community center (Stonehouse, Inc., 1991).

New open water area created by the reservoir could be used for several recreational activities including boating, fishing, sailing, swimming, and hunting; however, certain restrictions may be applied to hunting in the vicinity of the reservoir by James City and New Kent counties. Reservoir development would result in reduced land area for hunting; however, the open water created by the reservoir may increase the number of game and waterfowl species which use the area.

Land adjacent to the reservoir could be used as picnic areas, camping sites, and nature trails. Anticipated recreational needs for this area, as identified in the ***Virginia Outdoors Plan*** (VDRC, 1989), include canoeing areas, outdoor swimming areas, camp sites, and hiking trails, which the watershed could be designed to provide. The reservoir would be stocked with fish and a fisheries management plan would be implemented to provide long-term sport fishing benefits. Fishing may decline after the early years of the reservoir due to nutrient decline in the system (USCOE, 1987).

Pipeline

No recreational facilities would be impacted by the pipeline route. The pipeline could result in temporary disturbances to hunting in forested areas along the pipeline route. However, lands affected by pipeline construction would be restored, where possible, following construction.

Aesthetics

Intake

Construction and operation of the proposed Pamunkey River pumping station would create minor aesthetic impacts since houses are located as close as 300 feet from the project area. However, architectural and landscaping treatment would be designed to minimize visual impacts, as well as to minimize the propagation of sound.

The pumping station would also be visible to boats passing up and down the Pamunkey River in the vicinity of the intake. Vegetation cleared for construction of the intake line may also disrupt the visual continuity of the shoreline. However, much of the land in the immediate vicinity of the proposed pumping station site has already been cleared for agricultural use and structures exist nearby. For the most part, the pumping station would modify an already disturbed visual environment and, with appropriate landscaping and architectural treatment, should not overly detract from the scenic beauty of the river near the intake.

Reservoir

A dramatic shift in the scenic character of the area would occur from replacement of the hardwood swamp and emergent wetlands with an open lake. Short-term impacts to residents in the area would result from landscaping, air quality, and noise. However, once construction is completed, long-term noise or air quality impacts would be of a greatly reduced magnitude. Odor is not expected to be a problem since the proposed river pumpover would be used to keep the reservoir full and thus minimize periods when the reservoir would be severely drawn down and more likely to develop odor problems.

The proposed dam location could cause the delisting of Ware Creek from the Nationwide Rivers Inventory (USCOE, 1987). Therefore, this alteration could preclude a waterway on the Inventory from eventually being listed as a Wild and Scenic River.

New open water created by the reservoir would create an aesthetic resource for residents and visitors to the proposed Stonehouse Community.

Special design and landscaping of the dam area would be used to minimize the impact to the surrounding visual beauty. Where possible, the buffer strip required by James City County's watershed protection ordinance would be left uncleared to reduce visual impacts and ensure slope stability.

Pipeline

A total of 107 houses were identified within 300 feet of the proposed pipeline route. Pipeline installation would require a right-of-way to be cleared, and then restored, where possible, to a natural condition. Disruption of the aesthetic amenities along the transmission route would be greatest during construction.

Parks and Preserves

No impacts to existing parks or preserves are anticipated as a result of intake, reservoir, or pipeline construction associated with this alternative.

If the reservoir is constructed, nine parks are currently planned to be created throughout the reservoir drainage area in association with the planned Stonehouse Community.

Land Use

Due to the remoteness of the proposed Pamunkey River intake site from development, the placement of a pumping station would cause only limited impacts on existing land uses. Impacts would be limited to the disturbance of approximately 1.5 acres of forested land and 1.5 acres of agricultural land.

Additional land uses may be disturbed by construction of an access road to the proposed intake site. It is anticipated that impacts associated with these activities would be minor.

New electrical transmission lines may be required to power the pump station, which could require the dedication of new rights-of-way. Land uses within these areas would also be impacted.

While the construction of an intake at Northbury is not consistent with existing plans for future use of the area, development at the site is not precluded. Due to the designation of the site as a CBPA, development would be required to be conducted in compliance with the provisions of the Act.

The 3-acre pump site is also located within an AFD. While intake construction would preclude use of this small area for agriculture or forestry, this area represents only 0.01 percent of the 25,066 acres of AFD land in New Kent County.

Although approximately 625 acres of forest would be lost through clearing and grubbing operations and subsequent inundation, this represents less than 1 percent of the forested land within James City and New Kent counties.

All development at the reservoir site would be required to comply with the provisions of the Chesapeake Bay Preservation Act.

Approximately 126 acres of the York River AFD in New Kent County would be impacted by clearing and grubbing operations and subsequent inundation. This represents 0.5 percent of the total 25,066 acres of AFD land in New Kent County. While reservoir construction would preclude use of this acreage for agriculture or forestry, the area of impact is small in relation to the remaining AFD land in the county. In addition, the open water reservoir area would still provide a valuable natural and ecological resource, which would fulfill part of the purpose of an AFD. Approximately 120 acres of the Barnes Swamp AFD would be impacted in the reservoir area. This represents 0.68 percent of the approximately 17,597 acres of AFD land in James City County.

Existing and future land uses within a reservoir buffer area may also be impacted by implementation of this project. These areas would be maintained in their natural state to protect the water quality of the reservoir. Therefore, it is likely that future development within these areas would be precluded.

The total land area encompassed by the pipeline ROW would be approximately 159 acres. Use of this strip would temporarily remove agricultural land within that area from its current land use. Forested areas along the pipeline route would be cleared, and reforestation would be precluded in order to maintain the pipeline ROW. Due to the relatively small area of land disturbance in any one area along the route, and the restoration, where possible, of affected land, pipeline construction should not cause unacceptable impacts to existing or future land use.

<u>Noise</u>

Construction activities such as clearing, excavation, and building operations would increase noise levels at the project site. Noise would also be generated from the transportation of workers and materials to the sites. Total noise levels during construction of the Ware Creek Reservoir could be excessive since highway traffic from Interstate 64 crossing this site would increases typical background noise levels. Long-term impacts on ambient noise levels would result from the operation of pumping stations.

Infrastructure

The Ware Creek Reservoir alternative would inundate three existing state routes and require potential abandonment of a fourth state route. The estimated 100-year flood pool elevation of Ware Creek Reservoir would also come within ½ to 1 foot of flooding a low point on Interstate 64. In addition, based on the extent of planned development associated with the Stonehouse community, there would be an increase in long-term traffic volumes around the Ware Creek Reservoir.

The Ware Creek Reservoir would require 13 miles of new or upgraded electrical transmission lines for connection of new pump stations to suitable existing power sources and use considerable electric power. Secondary energy impacts in the Ware Creek Basin, as a result of the planned development associated with the Stonehouse community, would also be noticeable.

The Ware Creek Reservoir intake and dam construction would have potential impacts on recreational navigation within the Ware Creek basin.

Other Socioeconomic Impacts

No families would be displaced by construction of the proposed Ware Creek Reservoir. Growth-inducing impacts of the proposed reservoir are already evident in the northern portion of James City County, where the Stonehouse Community is being planned. Increased business and employment activity associated with reservoir construction would have a beneficial impact on the local economy.

5.5.2 Black Creek Reservoir with Pumpover from the Pamunkey River

Municipal and Private Water Supplies

Potential impacts to municipal and private water supplies from the proposed Pamunkey River withdrawal are discussed in Section 5.5.1.

The Black Creek Reservoir drainage area lies entirely within New Kent County. As such, New Kent County may acquire an option to purchase a portion of the Black Creek Reservoir capacity. For purposes of the safe yield analysis for this alternative, a host jurisdiction allowance of 3 mgd was assumed. This water allocation represents a considerable potential benefit for New Kent County which is not a current member of the RRWSG.

There would also be a beneficial impact to local groundwater users as a result of the proposed reservoir. The Yorktown Aquifer would be afforded recharge by direct and indirect seepage from the reservoir.

Tremendous municipal water supply benefits would be derived from interconnecting the new Pamunkey River withdrawal and Black Creek Reservoir with the existing Lower Peninsula water systems.

Recreational and Commercial Fisheries

Potential impacts to recreational and commercial fisheries at the Pamunkey River intake site are described in Section 5.5.1.

Once completed, Black Creek Reservoir would provide 1,146 acres of valuable open water habitat for freshwater fish. Species currently present in the drainage area would populate the reservoir. Some stream species could be eliminated by the change from a stream to a lake habitat. The loss of benthic food organisms and vegetation for spawning, nursery, and shelter could also eliminate some species. However, a fisheries management program in cooperation with the VDGIF would include supplementary stocking of forage and game species to augment natural populations.

The proposed minimum reservoir release of 1.2 mgd represents 32 percent of the estimated combined average streamflow at the two dam sits, and is expected to be sufficient to maintain good quality fishery habitat in the lower reaches of Black Creek.

Any impacts to recreational or commercial fisheries resulting from pipeline construction should be minimal and temporary.

Other Water-Related Recreation

Intake

Potential impacts to water-related recreation in the vicinity of the proposed intake site at Northbury on the Pamunkey River are identified in Section 5.6.1.

Reservoir

Upon construction of the reservoir, new open water areas could provide water-related recreation in the basin including boating, fishing, canoeing, swimming, sailing, and hunting. However, hunting in the vicinity of the reservoir may be regulated by New Kent County. Reservoir development would result in reduced land area for hunting; however, the open water created by the reservoir may increase the number of game and waterfowl species which use the area. The reservoir would be stocked with fish and a fisheries management plan would be implemented to provide long-term sport fishing benefits. Anticipated future recreational needs for this area, as identified in the ***Virginia Outdoors Plan*** (VDRC, 1989), include hunting areas, camping sites, outdoor swimming areas, and picnic areas, which the watershed could be designed to provide.

If the reservoir is constructed, New Kent County may designate portions of the watershed as public parks, which would likely include recreational facilities.

Pipeline

Impacts to forested areas along the pipeline route could result in temporary disturbances to hunting in the area. However, lands affected by pipeline construction would be restored, where possible, following construction.

Aesthetics

Intake

Aesthetic impacts due to construction and operation of the proposed Pamunkey River intake and pumping station are discussed in Section 5.6.1.

Reservoir

A dramatic shift in the scenic character of the area would occur from the replacement of hardwood swamp and emergent wetlands with an open lake. However, this new open water habitat would create an aesthetic resource for residents. Short-term impacts to residents in the area would result from landscaping, air quality, and noise. However, once construction is completed, long-term noise or air quality impacts would be of a greatly reduced magnitude. Odor is not expected to be a problem since the proposed river pumpover would be used to keep the reservoir full and thus minimize periods when the reservoir would be severely drawn down and more likely to develop odor problems.

The dams would be specially designed and landscaped to minimize impacts to the surrounding visual features. Wherever possible, a buffer strip would be left uncleared to reduce visual impacts and ensure slope stability.

Pipeline

A total of 62 houses were identified within 300 feet of the proposed pipeline route. Pipeline installation would require a right-of-way to be cleared, and then restored, where possible, to a natural condition. Disruption of the aesthetic amenities along the transmission route would be greatest during construction.

Parks and Preserves

No negative impacts to parks or preserves are anticipated as a result of intake, reservoir, or pipeline construction associated with this alternative.

If the Black Creek Reservoir is constructed, it is possible that New Kent County may designate portions of the watershed as public parks.

Land Use

Potential land use impacts anticipated at the proposed Pamunkey River intake site are described in Section 5.5.1.

Although there would be a loss of approximately 752 acres of forest through clearing and grubbing operations and subsequent inundation, this represents less than 1 percent of the forested land in New Kent County. The most important land use impacts anticipated as a result of reservoir construction are associated with the inundation of 95 acres of residential land. Within these areas, at least 14 existing houses would be displaced by reservoir construction. At least three additional houses within the proposed reservoir buffer areas could also be displaced. As of January 1993, an additional five building permits had been issued for houses within the proposed pool areas and buffer zones.

In general, construction of the reservoir is consistent with local land use plans for the area, which designate the region as remaining rural in nature in the future.

All development at the reservoir site would be required to comply with the provisions of the Chesapeake Bay Preservation Act.

Approximately 376 acres of the Pamunkey River AFD would be impacted by clearing and grubbing operations and subsequent inundation. This represents only 1.5 percent of the total 25,066 acres of AFD land within New Kent County. While reservoir construction would preclude use of this acreage for agriculture or forestry, the area of impact is small in relation to the remaining AFD land in the county. In addition, the open water reservoir area would still provide a valuable natural and ecological resource, which would fulfill part of the purpose of an AFD.

Existing and future land uses within a reservoir buffer area may also be impacted by implementation of this project. These areas would be maintained in their natural state to protect the water quality of the reservoir. Therefore, it is likely that future development within these areas would be precluded.

The total land area encompassed by the pipeline ROW would be approximately 123 acres. Use of this strip would temporarily remove agricultural land within that area from its current land use. Forested areas along the pipeline route would be cleared, and reforestation would be precluded in order to maintain the pipeline ROW. Due to the relatively small area of land disturbance in any one area along the route, and restoration, where possible, of affected land, pipeline construction should not cause unacceptable impacts to existing or future land use.

Noise

Construction activities such as clearing, excavation, and building operations would increase noise levels at the project site. Noise would also be generated from the transportation of workers and materials to the sites. Long-term impacts on ambient noise levels would result from the operation of pumping stations.

Infrastructure

The Black Creek Reservoir alternative would inundate portions of one state route. It would require 15 miles of new or upgraded electrical transmission lines for connection of new pump stations to suitable existing power sources.

The intake structure on the Pamunkey River would have a potential impact on commercial and/or recreational navigation due to the shallow and narrow river conditions at Northbury. The dam site, however, would not have a substantial impact on navigation.

Other Socioeconomic Impacts

The Black Creek Reservoir alternative would displace several families and result in potential lifestyle changes. This alternative could also result in many positive socioeconomic impacts during construction by increasing business in the area, and by inducing growth. However, this alternative would also result in decreased property tax revenue for the county from the removal of the project area from private ownership. It is estimated, as a worst-case scenario, that the yearly tax base foregone by reservoir construction is $83,267.

5.5.3 King William Reservoir with Pumpover from the Mattaponi River

Municipal and Private Water Supplies

River withdrawals associated with this alternative should not cause any great water quality changes in the Mattaponi River.

Mattaponi River basin waters are not used to a substantial degree at this time. To Malcolm Pirnie's knowledge, the only recent proposal for sizeable additional withdrawals from the Mattaponi River basin has been by Spotsylvania County. The County submitted a permit application to the USCOE for a proposed reservoir on the Po River which is a tributary to the Mattaponi River. If constructed, operation of the reservoir could eventually reduce mean flow downstream of the dam by up to 8.4 mgd (Hayes, Seay, Matter & Mattern, 1989). Federal agencies indicated a strong opposition to this project based on its environmental impacts (R. Poeske, USEPA-Region III, personal communication, 1992). Now other water supply alternatives, in the Rappahannock River basin, are being considered.

Mattaponi River withdrawals for Lower Peninsula use could increase the magnitude of water supply permitting obstacles for Spotsylvania County. However, it is expected that this would occur only if the County resumes pursuit of its original Po River Reservoir proposal.

Owing to conditions set forth in the ***King William Reservoir Project Development Agreement*** (King William County and City of Newport News, 1990), the County has an option to reserve up to 3 mgd of the King William Reservoir capacity. This allowance represents a considerable potential benefit for King William County which is not a current member of the RRWSG.

There would also be some beneficial impact to local groundwater users as a result of the proposed reservoir. The Yorktown Aquifer would be afforded recharge by direct and indirect seepage from the reservoir.

Substantial municipal water supply benefits would be derived from interconnecting the new Mattaponi River withdrawal and King William Reservoir with the existing Lower Peninsula water systems.

Recreational and Commercial Fisheries

Potential impacts from the intake structures include the entrainment and impingement of fish eggs and larvae. Use of wedge-wire screens with very low entrance velocities and very small openings would greatly reduce these potential impacts.

Potential impacts due to reduced Mattaponi River flows should be inconsequential.

Once completed, King William Reservoir would provide 2,234 acres of valuable open water habitat for freshwater fish. Species currently present in the drainage area would populate the reservoir. Some stream species could be eliminated by the change from a stream to a lake habitat. The loss of benthic food organisms and vegetation for spawning, nursery, and shelter could also eliminate some species. However, a fisheries management program in cooperation with the VDGIF would include supplementary stocking of forage and game species to augment natural populations.

Temporary construction-related impacts to fisheries in Cohoke Millpond could be minimized by the use of turbidity curtains surrounding areas of construction. This would appreciably reduce potential impacts due to sedimentation during dam construction and reservoir clearing and grubbing operations.

The proposed minimum reservoir release of 3 mgd represents 32 percent of average estimated flow at the dam site and is expected to be sufficient to maintain good quality fishery habitat in Cohoke Millpond and the lower reaches of Cohoke Mill Creek.

Any impacts to recreational or commercial fisheries resulting from pipeline construction should be minimal and temporary. Impacts to recreational or commercial fisheries in the Pamunkey River should not occur due to pipeline construction (directional drilling techniques will be used).

Other Water-Related Recreation

Intake

Water depth in the Mattaponi River, which is important for recreational uses, would not be measurably impacted by withdrawals since the proposed intake is located in tidal waters. Due to the remoteness of the proposed Mattaponi River intake site from development, the only disturbances to recreation from the pump station would be a disruption to hunting during construction. Also, noise generated from operation of the pump station may cause localized disturbance of waterfowl.

If the reservoir is constructed, King William County may develop a recreational area located in the vicinity of the intake structure (King William County and City of Newport News, 1990).

Reservoir

Upon implementation of this alternative, King William County may develop up to five sites as recreational areas adjacent to, and with access to, the reservoir. These sites would allow swimming, fishing, and boating (excluding the use of internal combustion engines) in the reservoir (King William County and City of Newport News, 1990). Other water-related activities, such as canoeing, sailing, and hunting, could also be included in the reservoir recreation plan; however, certain restrictions may be placed on hunting in the vicinity of the reservoir by King William County. Reservoir development would result in reduced land area for hunting; however, the open water created by the reservoir may increase the number of game and waterfowl species which use the area. The reservoir would be stocked with fish and a fisheries management plan would be implemented to provide long-term sport fishing benefits.

Land adjacent to the reservoir could be used for picnic areas, camping sites, and nature trails. Projected water-related recreational needs for this area, as identified in the ***Virginia Outdoors Plan*** (VDRC, 1989), include hunting areas, swimming areas, and picnic and camping sites, which the watershed could be designed to provide.

Impacts to Cohoke Millpond could include siltation during reservoir construction. This could cause temporary impacts on fishing in the pond. However, environmental controls would be used during construction to minimize any impacts to Cohoke Millpond from increased turbidity in Cohoke Mill Creek.

Pipeline

Impacts to forested areas along the pipeline route may temporarily disturb hunting in the area. However, lands affected by pipeline construction would be restored, where possible, following construction.

The Pamunkey River crossing would be accomplished using directional drilling techniques. These drilling techniques can be accomplished from the shore and should not affect fishing in the Pamunkey River. Noise generated during construction could temporarily disturb waterfowl in the vicinity of the river crossing.

Aesthetics

Intake

No houses were identified in the immediate vicinity of the proposed Mattaponi River intake and pumping station site at Scotland Landing. Nevertheless, these proposed facilities would include architectural and landscaping treatment designed to minimize visual impacts, as well as to minimize the propagation of sound.

The pumping station would be visible to boats passing up and down the Mattaponi River in the vicinity of the intake. Any vegetation cleared for construction of the intake line could also disrupt the visual continuity of the shoreline. Most of the land in the immediate vicinity of the proposed pumping station site is forested and no structures were identified within 500 feet of the site. Therefore, the area appears quite pristine as viewed from the river. In view of these potential visual impacts, appropriate landscaping and architectural treatment would be used to help minimize any detraction from the scenic beauty of the river near the intake.

Reservoir

A dramatic shift in the scenic character of the area would occur from the replacement of hardwood swamp and emergent wetlands with an open lake. However, this new open water habitat would create an aesthetic resource for residents. Short-term impacts to residents in the area would result from landscaping, air quality, and noise. However, once construction is completed, long-term noise or air quality impacts would be of greatly reduced magnitude. Odor is not expected to be a problem since the proposed river pumpover would be used to keep the reservoir full and thus minimize periods when the reservoir would be severely drawn down and more likely to develop odor problems.

The dam area would be specially designed and landscaped to minimize impacts to the surrounding visual features. According to watershed protection provisions of the ***King William Reservoir Project Development Agreement*** (King William County and City of Newport News, 1990), building, land disturbing activity, and clearing or vegetation removal would be severely restricted within the reservoir buffer areas. These provisions would help enhance and preserve the positive aesthetic values associated with the new reservoir.

Pipeline

A total of 45 houses were identified within 300 feet of the proposed pipeline route. Pipeline installation would require a right-of-way to be cleared, and then restored, where possible, to a natural condition. Disruption of the aesthetics along the transmission route would be greatest during construction.

Parks and Preserves

No negative impacts to existing parks or preserves are anticipated as a result of intake, reservoir, or pipeline construction associated with this alternative.

If the reservoir is constructed, it is possible that King William County may designate portions of the watershed as public parks. The County may develop up to five recreational sites adjacent to, and with access to, the reservoir.

Land Use

Due to the remoteness of the proposed Mattaponi River intake site from development, the placement of a pumping station would cause only limited impacts on existing land uses. Impacts would be limited to the disturbance of approximately 3 acres of forested land.

Additional land uses may be disturbed by construction of an access road to the proposed intake site. It is anticipated that impacts associated with these activities would be minor.

New electrical transmission lines may be required to power the pump station, which could require the dedication of new rights-of-way. Land uses within these areas would also be impacted.

While the construction of an intake and pump station at Scotland Landing is not consistent with existing plans for future use of the area, development at the site is not precluded. Due to the designation of the site as a CBPA, development would be required to be conducted in compliance with the provisions of the Act.

Although approximately 1,719 acres of forest would be lost through clearing and grubbing operations and subsequent inundation, this represents only 1.7 percent of the 111,832 acres of forested land within King William County.

Reservoir construction at the King William County site would be consistent with local land use plans for the region. These plans designate the area as remaining primarily rural in nature and protected as a conservation area through the Chesapeake Bay Preservation Act. All development at the reservoir site would be required to comply with the provisions of the Act.

Existing and future land uses within a reservoir buffer area may also be impacted by implementation of this project. These areas would be maintained in their natural state to protect the water quality of the reservoir. Therefore, it is likely that future development within these areas would be precluded.

The total land area encompassed by the pipeline ROW would be approximately 94 acres. Use of this strip would temporarily remove agricultural land within that area from its current land use. Forested areas along the pipeline route would be cleared, and reforestation would be precluded in order to maintain the pipeline ROW. Due to the relatively small area of land disturbance in any one area along the route and the restoration, where possible, of affected land, pipeline construction should not cause unacceptable impacts to existing or future land use.

Noise

Construction activities such as clearing, excavation, and building operations would increase noise levels at the project site. Noise would also be generated from the transportation of workers and materials to the sites. Long-term impacts on ambient noise levels would result from the operation of pumping stations.

Infrastructure

The King William Reservoir alternative would inundate portions of one state route. Energy requirements would only require 2.5 miles of new or upgraded electrical transmission lines.

The reservoir intake structures would not interfere with navigation due to the depth of the Mattaponi River at Scotland Landing. The associated dam would also not interfere with navigation on the river.

Other Socioeconomic Impacts

No families would be displaced by the proposed King William Reservoir. However, substantial positive benefits associated with new growth are not anticipated because the site is not readily accessible to the interstate road system and lacks the necessary factors which are important in attracting residential, commercial, or industrial development to the area. King William County is likely to benefit during reservoir construction from increased employment and business activity. However, this alternative would also result in decreased property tax revenue for the county from the removal of the project area from private ownership. It is estimated, as a worst-case scenario, that the tax base foregone by reservoir construction is $147,280.

5.5.4 Fresh Groundwater Development

Municipal and Private Water Supplies

This alternative would provide a moderate treated water safe yield benefit. This alternative could provide 15 percent of the Lower Peninsula's projected Year 2040 treated water supply deficit of 30.2 mgd. However, this alternative would also cause groundwater drawdown and groundwater quality impacts.

Recreational and Commercial Fisheries

The small land disturbances associated with this alternative should not negatively impact recreational fisheries at Diascund and Little Creek reservoirs if proper sedimentation and erosion control measures are followed. Because groundwater withdrawals would occur when reservoir drop to 75 percent of capacity, this alternative would have some limited beneficial impacts on recreational fisheries by preventing more severe reservoir drawdowns than would otherwise occur.

Other Water-Related Recreation

No impacts to recreation are anticipated as a result of implementation of this alternative.

Aesthetics

Any negative aesthetic impacts associated with this alternative component would likely be associated with construction and would thus be minor and temporary. In addition, the proposed groundwater withdrawal and transmission facilities would include architectural and landscaping treatment to minimize the impact to visual surroundings, as well as to minimize the propagation of sound.

Parks and Preserves

No impacts to parks or preserves are anticipated as a result of implementation of this alternative.

Land Use

The area of impact for well placement and placement of transmission pipeline to the reservoir would be minimal.

Noise

Construction activities such as clearing, excavation, and building operations would increase noise levels at the project site. Noise would also be generated from the transportation of workers and materials to the sites. Long-term impacts on ambient noise levels would result from the operation of groundwater wells.

Infrastructure

Transportation and navigation impacts as a result of the Fresh Groundwater alternative are expected to be negligible, and only limited impacts on energy resources would occur. However, approximately 17 miles of new or upgraded electrical transmission lines would be required for connections to suitable existing power sources.

Other Socioeconomic Impacts

Potential socioeconomic impacts could occur with this alterative in the form of increased water rates to consumers. These impacts could result form the costs incurred by the water purveyor in developing the additional supply. For the 4.4-mgd treated water safe yield benefit calculated for this alternative component, the Year 1992 present value of life cycle costs is $9.9 million. This is equivalent to $2.2 million per mgd of treated water safe yield benefit for this alternative.

While this alternative has been identified as being practicable with respect to cost, it is likely that the cost of water supply development to the purveyors will be passed on to the consumer in the form of increased rates.

5.5.5 Groundwater Desalination in Newport News Waterworks Distribution Area

Municipal and Private Water Supplies

This alternative would provide a moderate treated water safe yield benefit. This alternative could provide 21 percent of the Lower Peninsula's projected Year 2040 treated water supply deficit of 30.2 mgd. However, this alternative would also cause groundwater drawdown and groundwater quality impacts.

Recreational and Commercial Fisheries

The proposed groundwater withdrawal locations are spread evenly across the Lower Peninsula. Therefore, any local groundwater impacts to the Coastal Plain aquifer system and the surface water bodies which recharge the aquifer would be minimized. As a result, impacts to recreational and commercial fisheries should be negligible.

All concentrate discharges would occur in areas where elevated salinity levels (i.e., polyhaline and mesohaline conditions) already exist; therefore, impacts to species of recreational or commercial value are not anticipated due to potential changes in salinity levels.

Disturbances due to stream crossings would be temporary and minimal.

Other Water-Related Recreation

Development of the Site 4 facilities would be in an area of Newport News Park which is not subject to recreational policies; therefore, construction in the area would not affect existing recreation in the park.

Assuming a maximum right-of-way disturbance width of 40 feet, approximately 6.9 acres of the York County New Quarter Park would be affected by construction of the concentrate discharge pipeline for Site 2. Recreational facilities in this area could be temporarily affected during pipeline construction, but would be restored to their previous state. As a result, impacts to recreation at this park are anticipated to be minimal and temporary in nature.

Although the concentrate discharge pipeline for Site 2 would also cross the Colonial National Historic Parkway, no impacts to recreation are anticipated. The pipeline would be bored under the roadway to avoid traffic and no access to the site would exist from the parkway.

Aesthetics

The RO treatment facilities would be designed to minimize objectionable visual impact to houses and buildings located in close proximity to the project area. After construction is completed, long-term visual impacts would likely be offset to some degree by architectural design and landscaping features incorporated into the facilities.

Construction of the concentrate discharge pipelines would temporarily affect many houses in close proximity to the pipeline routes. However, after construction is completed, the cleared pipeline right-of-way would be restored, where possible, to a natural condition.

Any aesthetic impacts to the Colonial Parkway, York County New Quarter Park, or Newport News Park are anticipated to be minimal and temporary in nature.

Parks and Preserves

Development of the Site 4 facilities would affect areas within Newport News Park. Affected areas within this park would include a maximum of 1 acre for well development and RO facility construction, and approximately 2.3 acres of temporary disturbance for construction of the concentrate discharge pipeline (2,500 feet of pipeline within the park; assumed maximum right-of-way width of 40 feet). While these areas are located within the park, they are not subject to recreational policies set forth by the City of Newport News Department of Parks and Recreation (NNDPR, 1992). As a result, development of the well and associated facilities would not have any impact on the operation of the park for its intended purposes.

Assuming a 40-foot maximum right-of-way width, approximately 6.9 acres (7,500 linear feet) of the York County New Quarter Park would be affected by concentrate discharge pipeline constructed for the Site 2 facilities. This area would be temporarily disturbed for pipeline construction and then restored, where possible, to a more natural condition. As a result, the impacts to the park are anticipated to be minimal and temporary in nature.

Although the concentrate discharge pipeline for the Site 2 facilities would cross the Colonial National Historical Parkway, impacts to the resource are not anticipated. The pipeline would be bored under the Parkway, to minimize the potential for impacts to the resource.

Land Use

Groundwater development would require a total disturbance of 5 acres for well development and construction of the associated RO treatment plans. Because of the proposed location of the wells and RO plants at existing finished water storage and distribution locations within urbanized areas, and the minimal area of disturbance, the impacts to existing land uses at those sites are deemed minimal.

The total land area encompassed by the pipeline ROW would be approximately 65 acres. Reforestation of cleared areas would be precluded in order to maintain the pipeline ROW. Due to the relatively small area of land requiring disturbance in any one area along the route; no impacts to existing structures; and the restoration, where possible, of affected land construction should not cause unacceptable impacts to existing or future land uses.

Noise

Construction activities such as clearing, excavation, and building operations would increase noise levels at the project site. Noise would also be generated from the transportation of workers and materials to the sites. Total noise levels during construction of the concentrate discharge pipelines could be excessive since traffic tie-ups in highly populated residential areas could increase typical background noise levels. Long-term impacts on ambient noise levels would result from the operation of groundwater wells.

Infrastructure

Transportation and navigation impacts as a result of the groundwater Desalination Alternative are expected to be negligible. Potential impacts on energy resources would also be minor.

Other Socioeconomic Impacts

The potential socioeconomic impacts of increased water rates to consumer could also occur if this alternative is implemented. These increased water rates are likely to result due to the additional costs incurred by the water purveyor in developing additional supply. For the 6.4-mgd treated water safe yield benefit calculated for this alternative component, the Year 1992 present value of life cycle costs is $34.2 million. This is equivalent to $5.4 million per mgd of treated water safe yield benefit for this alternative.

While this alternative has been identified as being practicable with respect to cost, it is likely that the cost of water supply development to the purveyors will be passed on to the consumer in the form of increased rates.

5.5.6 Use Restrictions

Municipal and Private Water Supplies

No existing municipal or private water supplies would be affected as a result of this alternative component.

Recreational and Commercial Fisheries

The implementation of use restrictions should have no adverse impacts on fish species of recreational or commercial importance.

Other Water-Related Recreation

The implementation of use restrictions on the Lower Virginia Peninsula could result in negative impacts to recreation at existing reservoirs. Irrigation in the reservoirs' watersheds may be halted which would impair the physical appearance of the watersheds and lower their aesthetic value. Private and public recreational facilities reliant on non-essential water use; such as swimming pools, golf courses, parks, and fields for sporting events; could also be adversely affected.

Aesthetics

Implementation of the Use Restrictions alternative on the Lower Virginia Peninsula could result in negative aesthetic impacts at existing reservoirs. For example, irrigation in the reservoirs' watersheds would likely be discontinued and could impair the physical appearance of the watersheds, thus lowering visual aesthetic values. Aesthetic benefits derived from private and public recreational facilities reliant on non-essential water use; such as swimming pools, golf courses, parks, and fields for sporting events; could also be negatively impacted.

Parks and Preserves

Implementation of the Use Restrictions alternative on the Lower Peninsula could result in negative impacts to parks preserves. It is likely that irrigation of parks within the area would be limited. This would result in negative impacts to the physical appearance of parks.

Land Use

The implementation of use restrictions would limit outdoor usage for parks and residential areas. Commercial and industrial facilities could also be adversely affected by use restrictions. In particular, businesses which rely on large quantities of treated water (e.g., car washes and beverage manufacturers) might have to reduce production or otherwise limit their operations. However, these potential impacts would only occur during extended drought periods when use restrictions are in effect.

Noise

The implementation of the Use Restrictions alternative would have no adverse impact on ambient noise levels.

Infrastructure

The implementation of the Use Restrictions alternative would not cause impacts to infrastructure.

Other Socioeconomic Impacts

Implementation of the Use Restrictions alternative could result in varying degrees of socioeconomic impacts, depending on the degree of use restrictions which are implemented. Under Tier 1, which would involve voluntary restrictions on water use, there would be very few socioeconomic impacts. Because the restrictions are voluntary, those water users which would suffer appreciable socioeconomic impacts by restricting water use would not be likely to minimize their usage. The water purveyor, however, would be impacted, as the decrease in regional water usage would represent decreased revenues to the water purveyor.

With Tier 2 use restrictions in effect, there would be greater socioeconomic impacts. This tier focuses on the elimination of nonessential uses of water, such as outdoor watering, and can result in socioeconomic impacts to some users. Landowners who irrigate their real estate might be affected if the restrictions are in place long enough to detract from the appearance of their land. This could in turn, result in fewer sales of their property. Owners of golf courses and other recreational areas might suffer from decreased revenues as a result of mandatory use restrictions because they would not be able to keep their facilities maintained as necessary to promote their use. The water purveyor would also be impacted to a greater degree by reduced revenues under this tier.

Tier 3 use restrictions would result in the greatest socioeconomic impacts. Water rationing would result in socioeconomic impacts to all water users. Not only would businesses associated with outdoor water uses be impacted, as in Tier 2, but other businesses which depend on water would be affected. Car washes, for example, might not be able to operate. Under this scenario, the business owner would be measurably impacted as his economic well-being would be affected. The water purveyor would also be markedly affected by decreased revenues resulting from water rationing.

5.5.7 No Action

Municipal and Private Water Supplies

If the No Action alternative were taken, there would be severe adverse impacts on municipal and private water supplies. Cumulative impacts would result from existing water supply sources being relied on more and more heavily to meet increasing demand. Surface water reservoirs would be drawn down more severely and for more prolonged periods. It is likely that more frequent and more severe water quality problems would also be experienced in the reservoirs. In the event of a drought as severe as the controlling drought modeled for safe yield analyses, existing surface water supplies could be completely depleted under demand conditions projected for the mid-1990s.

Some existing groundwater users are not currently withdrawing the maximum amount allowed by their permits. Wells owned or operated by the James City Service Authority, York County, New Kent County, Stonehouse, Inc., Ford's Colony, Governor's Land, BASF, and others could be relied on more heavily if no action is taken to increase available water supplies. The USGS has simulated the withdrawal of groundwater at permitted maximums and found that cumulative impacts could include dewatering of limited western portions of some aquifers and an increase in the potential for salt water encroachment (Laczniak and Meng, 1988).

Recreational and Commercial Fisheries

If no action were taken by local water purveyors to develop additional water supplies, there could be negative impacts to fish species of recreational importance due to the increased frequency and severity of drawdowns in existing reservoirs. Also, lower water levels may limit access to existing boat docks, boat ramps, and fishing docks, thereby reducing recreational fishing opportunities.

This alternative should not impact commercial fisheries since the major impact would be to species inhabiting existing water supply reservoirs, and these reservoirs are not used for commercial fishing.

Other Water-Related Recreation

If no action is taken to increase the Lower Virginia Peninsula's water supply, water-related recreation within the region would be negatively impacted. Continued drawdown of the reservoirs would reduce open water space available for recreational activities and detract from the aesthetic value of the reservoirs. Reducing the water levels substantially could also adversely affect recreational fish species that inhabit the reservoirs. It is possible that some existing boat docks, boat ramps, and fishing docks could become less usable for recreational purposes.

Aesthetics

If no action is taken to increase the Lower Virginia Peninsula's water supply, aesthetic attributes of the existing reservoirs could be adversely impacted. For example, continued and more severe drawdown of the reservoirs would reduce open water space, expose lake bottoms, and detract from the visual appearance of the reservoirs. In addition, there would be longer periods when the reservoirs would be severely drawn down and more susceptible to developing odor problems.

Parks and Preserves

If no action were taken to augment the existing water supply on the Lower Peninsula, existing parks within the region could be negatively impacted. Increasingly severe reservoir drawdowns would negatively impact local parks such as Newport News Park (adjacent to Lee Hall Reservoir) and Waller Mill Park (adjacent to the City of Williamsburg's Waller Mill Reservoir). Reservoir bottoms that are inundated under normal conditions would be exposed at greater frequencies, which would negatively affect the use of the parks for their intended purposes.

No impacts to existing preserves in the region are anticipated as a result of the No Action alternative.

Land Use

If no action is taken by local purveyors to develop additional water supplies, there would be no negative impacts to existing land uses as a result of water supply development. However, new land use development and associated economic benefits could be precluded as a result of insufficient water supplies.

Noise

If no action was taken, there would be no adverse effect on ambient noise levels.

Infrastructure

If the No Action alternative was taken, resulting impacts on infrastructure would be negligible.

Other Socioeconomic Impacts

If no action were taken to provide additional sources of raw water supply to the Lower Peninsula, considerable socioeconomic impacts would occur. It is possible that growth-limiting measures would be implemented to conserve the existing water supply. For example, water purveyors could place moratoriums on new hook-ups. This would result in the cessation of new industries and other water users locating in the region due to a lack of treated water supply to meet their needs. The curtailment of new development would also take away potential new sources of revenue for the region which is generated by development (e.g., state and local income taxes, state sales taxes, municipal and county property taxes, and water user charges). While new sources of this revenue would be eliminated, government expenditures for public services would continue to rise, leading to fiscal problems in the local government. These fiscal impacts could be mitigated by the government either by increasing tax rates, or through cutbacks in services (e.g., police and fire protection, schools, etc.).

Each of the solutions which government may implement to minimize their financial burdens is likely to result in its own adverse impacts. An increase in taxes could result in increased reliance on public assistance, out-migration, delinquent payment of property taxes, and real estate foreclosures. Secondary impacts from public service reductions could include an increase in crime, lower quality education, and unemployment. Future water shortages would jeopardize the health and safety of customers when supplies become inadequate to meet the demands of sanitary facilities and fire protection.

5.6 UNAVOIDABLE ADVERSE ENVIRONMENTAL IMPACTS

The majority of potential adverse impacts resulting from the seven alternatives could be mitigated or minimized. However, some impacts could not be avoided. Unavoidable adverse impacts to environmental resources are listed below in general terms, for each of the seven evaluated alternatives.

Ware Creek Reservoir with Pumpover from Pamunkey River

- Removal of substrate at the intake and outfall locations.
- Increased phosphorus loading to Diascund Creek Reservoir and the proposed Ware Creek Reservoir.
- Elimination of tidal freshwater zone on of Ware Creek.
- An estimated 25 mgd average Year 2040 Pamunkey River withdrawal for this alternative, which is equivalent to 3.3 percent of average Pamunkey River flow at the intake site. Cumulative streamflow reduction in the Year 2040 of 8.8 percent.
- Impoundment of 37.1 miles of stream channels.
- Changes in the groundwater flow and quality.
- Permanent loss of soils within the reservoir area.

- Elimination of some fish and invertebrates currently inhabiting the Ware Creek system.

- Inundation of 590 acres of wetlands and open water habitat.

- Loss of existing habitat and land use at the pump station sites and in the reservoir area.

- Loss of Great Blue Heron rookery at Ware Creek.

- Cultural resources within project areas would be directly impacted.

- Closure of Ware Creek to anadromous fisheries including Striped Bass.

- Aesthetics in the vicinity of the pump station would be affected.

- Increase in noise levels at the pump station sites.

- Inundation of three existing state routes and potential abandonment of a fourth state route.

- Impacts to recreational navigation at the Pamunkey River intake site and within the Ware Creek basin.

Black Creek Reservoir with Pumpover from Pamunkey River

- Removal of substrate at the intake and outfall locations.

- Increased phosphorus loading to Diascund Creek Reservoir during the Black Creek Reservoir bypass operation.

- An estimated 29 mgd average Year 2040 Pamunkey River withdrawal alternative, which is equivalent to 3.8 percent of average Pamunkey River flow at the intake site. Cumulative streamflow reduction in the Year 2040 of 9.5 percent.

- Impoundment of 13.7 miles of stream channels.

- Changes in the groundwater flow and quality.

- Permanent loss of soils within the reservoir area.

- Elimination of some fish and invertebrates currently existing in the Black Creek system.

- Inundation of 285 acres of wetlands and open water habitat.

- Loss of existing habitat and land use at the pump station sites and in the reservoir area.

- Cultural resources within project areas would be directly impacted.

- Aesthetics in the vicinity of the pump station would be affected.
- Increase in noise levels at the pump station sites.
- Displacement of 14 homes, at least eight others may be affected.
- Inundation of one state route.
- Impacts to recreational navigation at the Pamunkey River intake site.

King William Reservoir with Pumpover from Mattaponi River

- Removal of substrate at the intake and outfall locations.
- Increased phosphorus loading to Diascund Creek Reservoir and Cohoke Mill Creek.
- An estimated 35 mgd average Year 2040 Mattaponi River withdrawal, which is equivalent to 7.0 percent of average Mattaponi River flow at the intake site. Cumulative streamflow reduction in the Year 2040 of 6.9 percent.
- Impoundment of 28.3 miles of stream channels.
- Changes in the groundwater flow and quality.
- Permanent loss of soils within the reservoir area.
- Elimination of some fish and invertebrates currently existing in the Cohoke Mill Creek system.
- Inundation of 479 acres of wetlands and open water habitat.
- Loss of existing habitat and land use at the pump station sites and in the reservoir area.
- Cultural resources within project areas would be directly impacted.
- Aesthetics in the vicinity of the pump station would be affected.
- Increase in noise levels at the pump station sites.
- Inundation of portions of one state route.

Fresh Groundwater Development

- Removal of substrate at the pipeline outfall locations.
- Increased levels of chloride, bicarbonate, sodium, sulfate, fluoride, and possibly phosphorus in Diascund Creek and Little Creek reservoirs.

- Reduced groundwater availability and potential for reduced yield of wells in the vicinity.
- Permanent loss of soils at the well sites.
- Impacts to wetlands located at outfall structures.
- Cultural resources within project areas would be directly impacted.
- Loss of existing habitat and land use at the well locations.

<u>Groundwater Desalination in Newport News Waterworks Distribution Area</u>

- Removal of substrate at the concentrate discharge pipeline outfalls.
- Addition of concentrate to polyhaline and meso/oligohaline water bodies.
- Middle and Potomac Aquifers may experience slight drawdown.
- Changes in groundwater quality.
- Minor impacts to wetlands at outfall locations.
- Impacts to mud flats in vicinity of concentrate discharge outfalls.
- Cultural resources within project areas would be directly impacted.
- Aesthetics in the vicinity of the well locations would be affected.
- Minor impacts to Newport News Park and York County New Quarter Park.
- Loss of existing habitat and land uses at the RO facility locations.

<u>Use Restrictions</u>

- Increased reliance on groundwater may result in aquifer drawdown.

<u>No Action</u>

- Eutrophication of existing reservoirs.
- Dewatering of limited western portions of some surface aquifers.
- Wetland habitat along existing reservoirs adversely affected by reservoir drawdown. Could impact species using these areas.
- Severe adverse impacts on existing municipal water supplies.
- Parks and preserves in the vicinity of existing reservoirs negatively affected.
- Aesthetics in the vicinity of existing reservoirs would be negatively impacted.

- Severe limitations on future land use development.
- Constraints on future growth.

5.7 IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES

This section describes impacts which would result from each of the evaluated alternatives which cannot be mitigated or replaced in the future. These irreversible and irretrievable impacts are listed below in general terms.

Ware Creek Reservoir with Pumpover from Pamunkey River

- Substrate areas at the proposed intake site and outfall locations would be committed to the project.
- Land areas and wildlife habitat (excluding wetlands) at the proposed pump station sites and within the reservoir pool area would be committed to the project. Areas along the pipeline route would be restored a natural state following pipeline construction, and would not be irretrievably committed.
- Average Year 2040 river withdrawals of 25 mgd (3.3 percent of Pamunkey River flow) would be irretrievably committed to the project.
- Capital resources and labor required for the construction of the project would be irretrievably lost through project implementation. However the overall benefit of the project to the Lower Peninsula is expected to outweigh these losses.

Black Creek Reservoir with Pumpover from Pamunkey River

- Substrate areas at the proposed intake site and outfall locations would be committed to the project.
- Land areas and wildlife habitat (excluding wetlands) at the proposed pump station sites and within the reservoir pool area would be committed to the project. Areas along the pipeline route would be restored a natural state following pipeline construction, and would not be irretrievably committed.
- Average Year 2040 river withdrawals of 29 mgd (3.8 percent of Pamunkey River flow) would be irretrievably committed to the project.
- Capital resources and labor required for the construction of the project would be irretrievably lost through project implementation. However the overall benefit of the project to the Lower Peninsula is expected to outweigh these losses.

King William Reservoir with Pumpover from Mattaponi River

- Substrate areas at the proposed intake site and outfall locations would be committed to the project.

- Land areas and wildlife habitat (excluding wetlands) at the proposed pump station sites and within the reservoir pool area would be committed to the project. Areas along the pipeline route would be restored a natural state following pipeline construction, and would not be irretrievably committed.

- Average Year 2040 river withdrawals of 35 mgd (7.0 percent of Mattaponi River flow) would be irretrievably committed to the project.

- Capital resources and labor required for the construction of the project would be irretrievably lost through project implementation. However the overall benefit of the project to the Lower Peninsula is expected to outweigh these losses.

Fresh Groundwater Development

- Substrate areas at the pipeline outfall locations would be committed to the project.

- Land areas and wildlife habitat (excluding wetlands) at the proposed well locations would be committed to the project.

- Groundwater withdrawals would be irretrievably committed to the project.

- Capital resources and labor required for the construction of the project would be irretrievably lost through project implementation. However the overall benefit of the project to the Lower Peninsula is expected to outweigh these losses.

Groundwater Desalination in Newport News Waterworks Distribution Area

- Substrate areas at the concentrate discharge pipeline outfall locations would be committed to the project.

- Land areas and wildlife habitat (excluding wetlands) at the proposed well locations would be committed to the project.

- Groundwater withdrawals would be irretrievably committed to the project.

- Capital resources and labor required for the construction of the project would be irretrievably lost through project implementation. However the overall benefit of the project to the Lower Peninsula is expected to outweigh these losses.

Use Restrictions

- No resources would be irreversibly or irretrievably committed for this project.

No Action

- No resources would be irreversibly or irretrievable committed for this project.

5.8 RELATIONSHIP BETWEEN SHORT-TERM USES OF MAN'S ENVIRONMENT AND THE MAINTENANCE AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY

Short-term impacts are associated with the evaluated alternatives. These impacts primarily occur during the construction phase of the projects and then are dissipated following construction. The short-term impacts associated with the alternatives are listed below. In comparison to these short-term impacts, the most evident long-term benefit of these projects would be the availability of additional water supply for the Lower Virginia Peninsula.

<u>Ware Creek Reservoir with Pumpover from Pamunkey River</u>

- Disturbance of substrate would occur during pipeline and reservoir construction.
- Dam construction would result in increased erosion and turbidity within the Ware Creek system. Streams crossed by the pipeline would also be affected by increased turbidity during construction.
- Increased flow at the two outfall locations on Diascund Creek would temporarily affect the stream channel. The channel would reestablish itself.
- Streams crossed by the pipeline would experience changes in hydrology during construction.
- Soils along the pipeline route would be temporarily disturbed during construction.
- Elevated fugitive dust emissions, fuel combustion from construction equipment, and burning activities are anticipated during construction.
- Existing land uses and habitat for wildlife along the pipeline route would be temporarily disturbed.
- Limited areas of wetlands would be temporarily disturbed by pipeline stream crossings.
- Increased noise levels due to construction machinery are anticipated.
- Aesthetics in the project area would be affected during construction.

<u>Black Creek Reservoir with Pumpover from Pamunkey River</u>

- Disturbance of substrate would occur during pipeline and reservoir construction.
- Dam construction would result in increased erosion and turbidity within the Black Creek system. Streams crossed by the pipeline would also be affected by increased turbidity during construction.

- Increased flow at the outfall location on Diascund Creek would temporarily affect the stream channel. The channel would reestablish itself.

- Streams crossed by the pipeline would experience changes in hydrology during construction.

- Soils along the pipeline route would be temporarily disturbed during construction.

- Elevated fugitive dust emissions, fuel combustion from construction equipment, and burning activities are anticipated during construction.

- Existing land uses and habitat for wildlife along the pipeline route would be temporarily disturbed.

- Limited areas of wetlands would be temporarily disturbed by pipeline stream crossings.

- Increased noise levels due to construction machinery are anticipated.

- Aesthetics in the project area would be affected during construction.

King William Reservoir with Pumpover from Mattaponi River

- Disturbance of substrate would occur during pipeline and reservoir construction.

- Dam construction would result in increased erosion and turbidity within the Cohoke Mill Creek system. Streams crossed by the pipeline would also be affected by increased turbidity during construction.

- Increased flow at the outfall location on Beaverdam Creek would temporarily affect the stream channel. The channel would reestablish itself.

- Streams crossed by the pipeline would experience changes in hydrology during construction.

- Soils along the pipeline route would be temporarily disturbed during construction.

- Elevated fugitive dust emissions, fuel combustion from construction equipment, and burning activities are anticipated during construction.

- The existing Bald Eagle nest downstream of the proposed dam would be temporarily disturbed by noise and disruption associated with construction.

- Existing land uses and habitat for wildlife along the pipeline route would be temporarily disturbed.

- Limited areas of wetlands would be temporarily disturbed by pipeline stream crossings.

- Increased noise levels due to construction machinery are anticipated.
- Aesthetics in the project area would be affected during construction.

Fresh Groundwater Development

- Soils along the pipeline route would be temporarily disturbed during construction.
- Fugitive dust emissions and fuel combustion from construction equipment are anticipated during construction.
- Existing land uses and habitat for wildlife along the pipeline route would be temporarily disturbed.
- Aesthetics in the project area would be affected during construction.
- Increased noise levels due to construction machinery are anticipated.

Groundwater Desalination in Newport News Waterworks Distribution Area

- Disturbance of substrate would occur during pipeline construction.
- Streams crossed by the pipeline would experience changes in hydrology during construction.
- Soils along the pipeline route would be temporarily disturbed during construction.
- Elevated air pollution expected from increased traffic flow during construction.
- Existing land uses and habitat for wildlife along the pipeline route would be temporarily disturbed.
- Aesthetics in the project area would be affected during construction.
- New Quarter park in York County would be temporarily impacted by pipeline construction.
- Increased noise levels due to construction machinery are anticipated.

Use Restrictions

Impacts anticipated as a result of use restrictions are not expected to be short-term in nature.

No Action

Impacts anticipated as a result of no action are not expected to be short-term in nature.

6.0 LIST OF PREPARERS

Study investigations were conducted by Malcolm Pirnie scientists and engineers and subcontractors with a wide variety of academic and professional training and experience. The following USCOE personnel, Malcolm Pirnie personnel, and subcontractor staff were primarily responsible for the preparation of this document and its appendices:

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Donna Ware, Ph.D.	The College of William & Mary	Small Whorled Pogonia Surveys
William Saunders, Ph.D.	The College of William & Mary	Small Whorled Pogonia Surveys
Virginia Crouch	The Nature Conservancy	Small Whorled Pogonia Surveys
Allen Plocher, Ph.D.	Old Dominion University	Wetland Delineations

7.0 PUBLIC INVOLVEMENT

Throughout the project planning process, the USCOE was consulted. The USCOE required that the federal advisory agencies be involved in the identification of practicable alternatives and, further, with the evaluation of practicable alternatives relative to environmental impact. Throughout the study process, there has also been an active exchange of information and ideas between involved regulatory agencies, environmental organizations, and the RRWSG. This exchange has included single- and multi-agency briefing meetings, distribution of project briefing materials, and numerous written and oral communications.

Prior to August 1, 1990, this information exchange was considered a "pre-scoping" activity, since the USCOE had not yet issued a formal Public Notice to solicit public comment on the scope of the Environmental Impact Statement (EIS) which would be required. It was agreed by the USCOE, USEPA, and USFWS that a detailed assessment of the project, in the form of an EIS, would be required because of the scale and complexity of the projects proposed.

The USCOE issued a Public Notice on August 1, 1990 requesting public comments on the scope of study for a draft EIS. This Public Notice initiated the official "scoping" process. A Notice of Intent to prepare a draft EIS was also issued by the USCOE and appeared in the Federal Register on July 30, 1990.

Pre-scoping and scoping comments were provided by the agencies, organizations, and individuals listed below. These comments are included as an appendix to the ***Phase I Summary Report*** (Malcolm Pirnie, 1991).

- U.S. Army Corps of Engineers
- U.S. Environmental Protection Agency
- U.S. Fish and Wildlife Service
- Virginia Deputy Secretary of Natural Resources
- Virginia Council on the Environment
- Virginia Department of Conservation and Recreation - Division of Natural Heritage
- Virginia Department of Conservation and Recreation - Division of Planning and Recreation Resources
- Virginia Department of Game and Inland Fisheries
- Virginia Department of Health

- Virginia Department of Transportation
- Virginia Institute of Marine Science
- Virginia State Water Control Board
- Chesapeake Bay Estuarine Research Reserve System
- Environmental Defense Fund
- National Wildlife Federation
- Southern Environmental Law Center
- Pamunkey Indian Reservation
- Mr. George A. Beadles, Jr.

In December 1990 the USCOE issued a summary of the scoping process and a ***Conceptual Scoping Outline for the Lower Peninsula's Raw Water Supply Draft EIS*** (W. H. Poore, Jr., USCOE - Norfolk District, personal communication, 1990). The 31 alternatives evaluated in this report were identified during the EIS scoping process as having the potential of providing a source of raw or treated water, or reducing the need for future water supplies.

The following is a list of Agencies and Organizations to which the Draft EIS has been sent:

U. S. Environmental Protection Agency
U. S. Department of Commerce
U. S. Department of Interior
U. S. Fish and Wildlife Service
U. S. Department of Energy
U. S. Department of Agriculture
U. S. Department of Transportation
National Marine Fisheries Service
Advisory Council of Historic Preservation
Virginia Department of Agriculture and Consumer Services
Virginia Marine Resources Commission
Virginia Department of Health
Virginia Department of Environmental Quality - Waste Division
Virginia Department of Environmental Quality - Water Division
Virginia Department of Environmental Quality - Air Division
Virginia Department of Environmental Quality - Division of Intergovernmental Coordination
Virginia Department of Mines, Minerals and Energy
Virginia Department of Forestry
Virginia Department of Transportation
Virginia Institute of Marine Science

Virginia Department of Game and Inland Fisheries
Virginia Department of Conservation and Recreation - Division of Natural Heritage
Virginia Department of Conservation and Recreation - Division of Planning and Recreation Resources
Virginia Department of Historic Resources
Chesapeake Bay Foundation
Chesapeake Bay Local Assistance Department
Hampton Roads Planning District Commission
Mattaponi Tribe
Upper Mattaponi Tribe
Pamunkey Tribe
Chesapeake Bay Estuarine Research Reserve System
Southern Environmental Law Center
National Wildlife Federation
National Audubon Society
Nature Conservancy
Environmental Defense Fund
Sierra Club
Alliance for the Chesapeake Bay
City of Hampton
City of Newport News
City of Poquoson
City of Williamsburg
James City County
King and Queen County
King William County
New Kent County
York County
Hampton Public Library
Heritage Library
James City County Public Library
Newport News Public Library
Pamunkey Regional Library
Poquoson Public Library
Williamsburg Regional Library
York County Public Library

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