property. The reasonableness determinations for non-residential properties such as schools and churches are made on a case-by-case basis. The determinations are based not only on the barrier cost, but also on the type and duration of the activity taking place, the size of the affected area, the severity of the impact, and the amount of noise reduction provided.

Table 4.9-2 provides a summary of the barriers with each of the three CBAs. Included are the number of barriers, the total length and surface area, and a very preliminary total cost for barrier materials and installation. CBA 3, which is predicted to impact the largest number of noise-sensitive properties, would require the largest number and square footage of noise barriers to provide noise protection to impacted properties. CBA 2, with the least number of impacted properties, would require the least number and square footage of barriers to protect impacted properties.

Table 4.9-2
SUMMARY NOISE BARRIER TOTALS

CBA	Number of Barriers	Total Linear Feet	Total Square Feet	Total Cost	Sites Protected	Feasible Barriers	Cost-Effective Barriers
CBA 1	51 Barriers	103,150	1,451,550	$30,482,550	156 Residences 1 Church 1 School	All	None
CBA 2	40 Barriers	37,650	562,100	$11,804,100	83 Residences 1 Church 1 School 8 Sites Not Protected	All (8 sites not protected)	None
CBA 3	63 Barriers	110,250	1,628,490	$34,198,290	182 Residences 2 Churches	All	None

Note: All results in this table have been based on preliminary noise analysis and design, and may change upon detailed analyses. The cost-effectiveness of barriers protecting churches and schools are based on cost and other factors as discussed in Section 4.9.3.

4.10 WATER QUALITY AND WATER RESOURCES

4.10.1 Surface Water Resources

Stormwater runoff from highways and associated rights-of-way typically contains a specific suite of pollutants which can occur in widely varying concentrations. Pollutants of concern associated with highway construction and use include a variety of substances from common organic materials to toxic metals. Some pollutants, such as herbicides, road salts, and fertilizers, are intentionally placed in the environment to promote safety or roadside vegetation. Other pollutants, such as the incidental release of small amounts of petroleum products and metals from trucks and cars, are the indirect effect of roadway utilization. A major factor that determines concentrations of pollutants in highway stormwater runoff is the volume of traffic carried by a particular segment of roadway.

4.10.1.1 Non-Point Source Effects

The magnitude of stormwater pollutant loading attributed to a particular construction activity along with the proximity of that activity to sensitive waters (such as public water supplies and special aquatic habitat) can factor into water quality. Should a build alternative be selected, the effects of pollutant loadings will vary along the corridor. Primary factors that will influence the effect of highway runoff pollutant loading within any particular surface water body include the type and size of the receiving water body, the potential for dispersion, the size of the catchment area, the biological diversity of the receiving water body, and relative effectiveness of proposed mitigation measures.

Construction of a CBA would result in an increase in impervious surfaces – a situation which, without stormwater management, could increase peak rates of runoff within a given drainage area. To varying degrees, construction of a CBA would also result in the introduction of certain pollutants normally associated with vehicular traffic (a function of vehicle miles traveled or VMT). With respect to highway projects, stormwater pollution loading is the quantity of pollutants that are transported off the road surface before they reach a stormwater management facility. If not addressed through appropriate stormwater management, the combination of these factors could contribute to degradation of water quality through increases in nonpoint pollutant loading. Stormwater runoff pollution loadings for the No-Build Alternative and the CBAs are presented in Table 4.10-1. These quantities do not reflect overall reductions which can be expected to occur following implementation of best management practices identified in section 4.10.1.4. For purposes of comparison, the severity of effects with respect to water quality is expressed in terms of percent increase over 2004 base year conditions. Compared to 2004 baseline conditions, CBA 2 would result in the smallest percent increase of stormwater runoff pollutant loading (at 9.59 percent) relative to the other two CBAs. Compared to 2004 baseline conditions, CBA 1 and CBA 3 would result in relatively higher yet comparable percent increase of stormwater runoff pollutant loading (at 23.23 percent and 23.18 percent, respectively).

With respect to short-term effects, clearing and grubbing, earth moving and grading, and other construction-related activities can lead to erosion of soils. If unchecked, these activities can lead to the deposition of eroded sediments within nearby waterways and water bodies. Without implementation of appropriate mitigation measures, short-term effects to surface waters (i.e., during and immediately following construction) would include (1) a temporary increase in turbidity and sedimentation during and immediately following nearby land disturbances and (2) an increase risk of contamination associated with the presence of heavy equipment fluids (fuels, lubricants, etc.) and construction-related chemicals (paints, concrete additives, etc.).

With implementation of appropriate mitigation measures and BMPs (as discussed below), construction or operation of a CBA would not result in measurable degradation of water quality or affect changes to regional water quality trends (as presented in section 3.10.1.1).

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TABLE 4.10-1
STORMWATER RUNOFF POLLUTION LOADINGS

Pollutant	Daily Production Rate of Pollutant (mg/vehicle mile)[2]	Annual Pollutant Loadings (kg)							
		2004 - Base Year	No Build	CBA 1		CBA 2		CBA 3	
				Loading at 2026	Build/No Build Difference	Loading at 2026	Build/No Build Difference	Loading at 2026	Build/No Build Difference
Chemical Oxygen Demand	63.5	66,398.09	91,062.36	112,219.99	21,157.63	99,795.92	8,733.56	112,172.98	21,110.62
Suspended Solids	120	125,476.71	172,086.35	212,069.26	39,982.92	188,590.71	16,504.37	211,980.44	39,894.09
Floatable Solids	3.93	4,109.36	5,635.83	6,945.27	1,309.44	6,176.35	540.52	6,942.36	1,306.53
Settleable Solids	43.5	45,485.31	62,381.30	76,875.11	14,493.81	68,364.13	5,982.83	76,842.91	14,461.61
Oil	9.67	10,111.33	13,867.29	17,089.25	3,221.96	15,197.27	1,329.98	17,082.09	3,214.80
Chromium	0.0077	8.05	11.04	13.61	2.57	12.10	1.06	13.60	2.56
Copper	0.0696	72.78	99.81	123.00	23.19	109.38	9.57	122.95	23.14
Zinc	0.735	768.54	1,054.03	1,298.92	244.90	1,155.12	101.09	1,298.38	244.35
Lead	1.82	1,903.06	2,609.98	3,216.38	606.41	2,860.29	250.32	3,215.04	605.06
Nickel	0.062	64.83	88.91	109.57	20.66	97.44	8.53	109.52	20.61
Total Phosphorus	0.097	101.43	139.10	171.42	32.32	152.44	13.34	171.35	32.25
Total Nitrogen	3.4	3,555.17	4,875.78	6,008.63	1,132.85	5,343.40	467.62	6,006.11	1,130.33
TOTAL		258,054.66	353,911.77	436,140.41	82,228.64	387,854.56	33,942.78	435,957.73	82,045.96
% Increase Compared to No-Build					23.23		9.59		23.18
Vehicle Miles Traveled (millions of vehicles per day)		2,864,765	3,928,912		4,841,764		4,305,724		4,839,736

[1] Projected loading does not reflect reductions that would occur following implementation of best management practices.
[2] Reference: Sylvester and DeWalle, December 1972.

4.10.1.2 Impaired Waters

Figure 4.10-1 shows impaired waters (stream segments) that would be crossed by CBAs. Table 4.10-2 lists these impaired waters, sources of impairment, and those highway-related pollutants which could exacerbate or contribute to the existing impairment.

Relatively large portions of the Blackwater River watershed and a number of surface waters within the study area are classified as impaired on the basis of fecal coliform, sediments, and low dissolved oxygen. As set forth in the "305(b)/303(d) 2002 Integrated List of Assessed Waters in Virginia" (VDEQ, 2002), these impairments are related to agricultural runoff, concentrated livestock operations, and non-highway sanitation-related issues (such as failing septic systems). The major parameter of impairment in regional streams is fecal coliform – a parameter that would not be affected by highway construction. Another major parameter of impairment is dissolved oxygen. Since dissolved oxygen concentrations can become adversely low following algal blooms (typically a function of nutrient loading), VDOT would consider minimizing or restricting the use of nutrient-bearing fertilizers or would make use of stormwater management facilities that effectively prohibit nutrient loading of receiving waters for CBA crossings in the vicinity of streams heavily impaired due to low dissolved oxygen. Any increase in highway pollutant loading in the vicinity of Spring Branch is of particular concern due to the fact that Spring Branch currently fails to meet general benthic standards as a result of existing urban and industrial discharges. Any CBA crossing in the vicinity of Spring Branch would likely include stormwater management plans designed specifically to address these particular conditions.

Table 4.10-2
IMPAIRED WATERS CROSSED BY CBAS

Alternative	Impaired Waters Crossed	Sources(s) of Impairment	Highway-Related Pollutant(s) Which Could Contribute to Impairment
CBA 1	Eley Swamp	pH (natural conditions)	none
	Blackwater River between Route 460 and the state line	fish tissue - mercury	none
	Coppahaunk Swamp between headwaters & Blackwater River	fecal coliform	none
	Black Swamp between headwaters & Assamoosick Swamp	fecal coliform	none
	Warwick Swamp between headwaters & Blackwater River	dissolved oxygen, pH, fecal coliform	total phosphorus & total nitrogen loading effects upon dissolved oxygen
	Second Swamp between headwaters & Blackwater River	dissolved oxygen, fecal coliform	total phosphorus & total nitrogen loading effects upon dissolved oxygen
CBA 2	Eley Swamp	pH (natural conditions)	none
	Blackwater River between Route 620 & Antioch Swamp	dissolved oxygen, fecal coliform	total phosphorus & total nitrogen loading effects upon dissolved oxygen
	Coppahaunk Swamp between headwaters & Blackwater River	fecal coliform	none
	Spring Branch between Borden Chemical Plant discharge & Blackwater River (2 crossings)	general standard (benthic)	all
	Warwick Swamp between headwaters & Blackwater River	dissolved oxygen, pH, fecal coliform	total phosphorus & total nitrogen loading effects upon dissolved oxygen
	Second Swamp between headwaters & Blackwater River	dissolved oxygen, fecal coliform	none

Alternative	Impaired Waters Crossed	Sources(s) of Impairment	Highway-Related Pollutant(s) Which Could Contribute to Impairment
CBA 3	Eley Swamp	pH (natural conditions)	none
	Blackwater River between Route 620 & Antioch Swamp	dissolved oxygen, fecal coliform	total phosphorus & total nitrogen loading effects upon dissolved oxygen
	Coppahaunk Swamp between headwaters & Blackwater River	fecal coliform	none
	Spring Branch between Borden Chemical Plant discharge & Blackwater River	general standard (benthic)	all
	Blackwater River between Warwick Swamp & Cypress Swamp	dissolved oxygen, pH, fecal coliform	total phosphorus & total nitrogen loading effects upon dissolved oxygen
	Otterdam Swamp between headwaters & Blackwater River	dissolved oxygen, pH	total phosphorus & total nitrogen loading effects upon dissolved oxygen
	Blackwater Swamp between headwaters & Blackwater River	dissolved oxygen, pH, fecal coliform	total phosphorus & total nitrogen loading effects upon dissolved oxygen

4.10.1.3 Surface Drinking Water Supplies

Portions of watersheds deemed by the Virginia Department of Health to be important to public water supplies along with intakes for public drinking water supplies are shown in Figure 4.10-2. The easternmost 3.5 miles of each of the three CBAs would traverse a portion of the Lake Meade watershed which has been deemed by the Virginia Department of Health to be important to public water supplies owned by the City of Suffolk and the City of Portsmouth. Based on construction of a limited access highway on new alignment and a total pavement width of 76 feet (38 feet each direction), this 3.5-mile segment translates to 32.2 acres of impervious surface (2.7 percent of the 1,186-acre Lake Meade watershed). In addition, approximately 1.5 miles of CBA 2 and CBA 3 would traverse a portion of the Lake Prince watershed which has deemed by the Virginia Department of Health to be important to public water supplies owned by the City of Suffolk. This 1.5-mile segment translates to 13.8 acres of impervious surface (1.4 percent of the 1,011-acre Lake Prince watershed).

Intakes for public drinking water supplies located downstream of a CBA are listed in Table 4.10-3. Norfolk's Lake Prince intake is located 5.5 stream miles downstream of CBA 2 and CBA 3. Norfolk's Western Branch Reservoir intake is located 8.0 stream miles downstream of CBA 2 and CBA 3. Neither CBA would be located within the five-mile stream segment which the Virginia Department of Health generally considers critical to protection of intakes. On a long-term basis, construction of a CBA in the vicinity of a public water supply would increase the probability of contamination should pollutants be released as a result of traffic accidents or should pollutants typically carried as constituents of highway stormwater runoff be introduced via runoff. Considering (1) the relatively small increase of impervious surface with respect to total watershed acreage, (2) the distance of CBAs from nearest drinking water intakes, (3) the pollutant-lowering effects of natural attenuation and dilution that would occur over these distances, and (4) implementation of those mitigation measures discussed in section 4.10.1.4, the construction or operation of a CBA would not result in measurable degradation of surface water drinking supplies.

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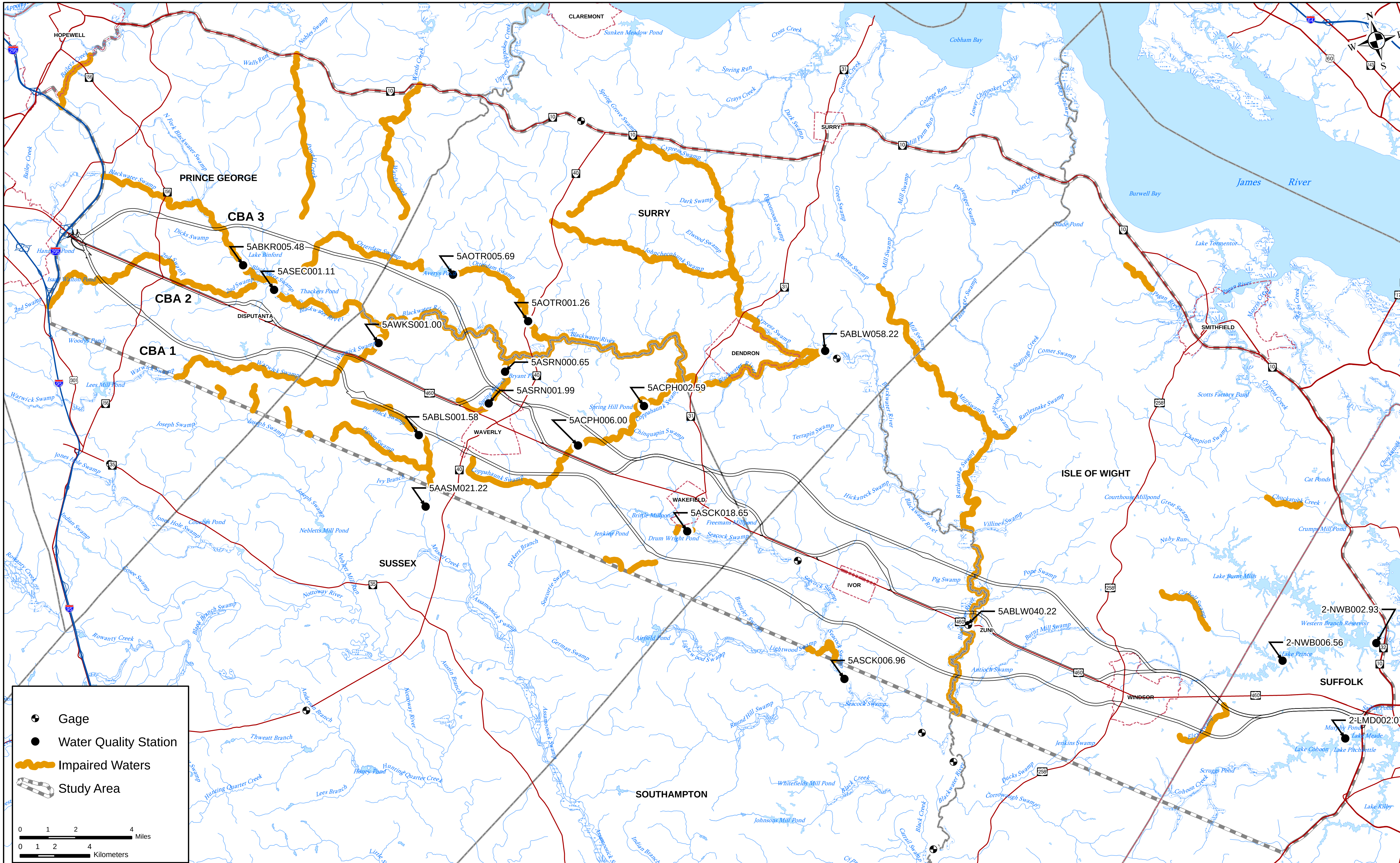
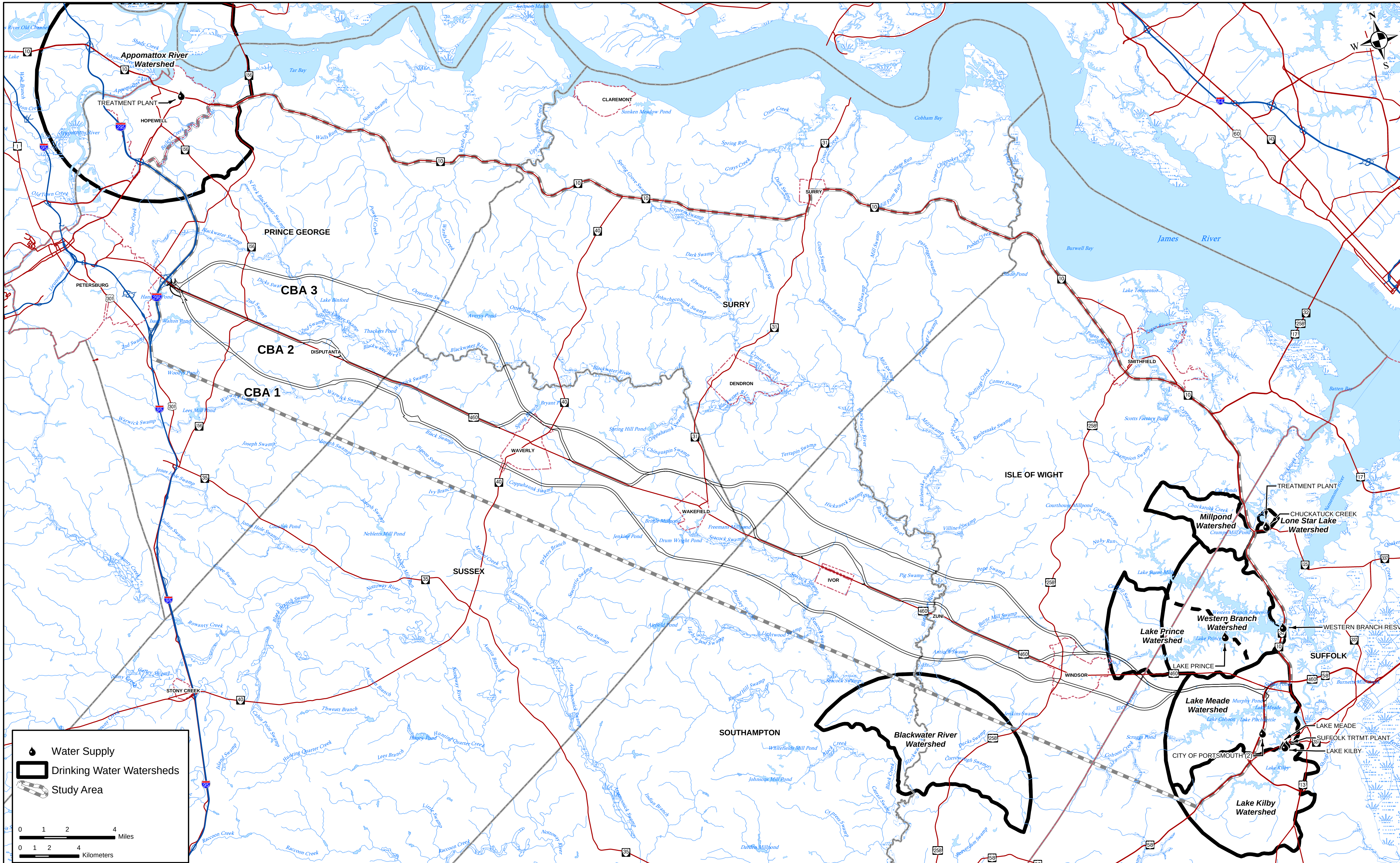


FIGURE 4.10-1
IMPAIRED WATERS AND
WATER QUALITY MONITORING STATIONS



ROUTE 460 Location Study

FIGURE 4.10-2
SURFACE WATER RESOURCES

TABLE 4.10-3
POTENTIALLY AFFECTED PUBLIC SURFACE WATER SUPPLIES

Alternative	Facility Name / Facility Ownership	Distance Downstream to Nearest Intake
CBA 1	Lake Meade / City of Portsmouth	Not applicable – intake is upstream of receiving waters.
	Lake Cahoon / City of Portsmouth	Not applicable – no present intake
CBA 2	Lake Meade / City of Portsmouth	Not applicable – intake is upstream of receiving waters.
	Lake Cahoon / City of Portsmouth	Not applicable – no present intake
	Lake Prince / City of Norfolk	5.5 stream miles
	Western Branch Reservoir / City of Norfolk	8.0 stream miles
CBA 3	Lake Meade / City of Portsmouth	Not applicable – intake is upstream of receiving waters.
	Lake Cahoon / City of Portsmouth	Not applicable – no present intake
	Lake Prince / City of Norfolk	5.5 stream miles
	Western Branch Reservoir / City of Norfolk	8.0 stream miles

4.10.1.4 Mitigation Measures

Stormwater management facilities will be designed in accordance with specifications set forth in Section 3.14 of the Virginia Erosion and Sediment Control Handbook (1992) and VDOT's Annual Erosion and Sediment Control and Stormwater Management Standards and Specifications, as approved by VDCR. Detention/retention basins would be designed to function as temporary basins for sediment and erosion control during the construction of the CBA. After construction is complete, the basins would be restored to their original depth and converted into permanent stormwater management facilities. The number, locations, and abatement capacities of stormwater management facilities will be determined during later phases of project design. Pollutant removal efficiencies set forth in Table 4.10-4 will be used as a factor in determining the location and design of stormwater management facilities.

TABLE 4.10-4
EXPECTED POLLUTANT REMOVAL EFFICIENCY FOR STRUCTURAL BMPS

BMP Type	Typical Pollutant Removal (%)				
	Sediments	Nitrogen	Phosphorus	COD/BOD	Metals
Wet Ponds	90	48	65	30/*	*
Water Quality Inlets	20 - 40	< 10	< 10	< 10/< 10	< 10
Constructed Wetlands	50 - 80	< 30	15 – 45	*/*	50 - 80
Bioretention Facilities	90	68 – 80	70 – 83	*/*	93 - 98
Grassed Swales	70	25	30	25/*	50- 90
Extended Detention Ponds	68 - 90	28 -40	42 – 50	42 - 50/*	42 - 90
Infiltration Trenches	75 – 99	45 – 70	50 – 75	*/70 – 90	75 - 99
Hydrodynamic Separators	50 – 90	*	*	*/*	*
Infiltration Basins	75 – 99	45 – 70	50 – 70	*/70 – 90	50 - 90
Porous Pavement	82 – 95	80 – 85	65	*	*

* Insufficient data
Source: FHWA, 1996.

Certain components of the CBAs could be located near enough to public surface water supplies as to require special mitigation measures, both during and following construction. The exact nature of these measures are dependent on the distance between the facility and nearest pathways to a surface water critical to a public drinking water supply and the future assessment of the pollutant-lowering effects of natural attenuation and dilution that would occur over these distances. Stormwater management basins located near public water supplies would likely be designed with adequate detention time to allow spilled contaminants to be pumped out before they can enter the water supply. Although a spill consisting of the entire contents of a tanker truck would be unlikely, runoff entering stormwater management basins could be routed from the inlet pipe to a dry sump area sized to capture the volume of a tanker truck (1,100 cubic feet). In the event of a spill, local spill response personnel would initiate a Level II response to contain the spill and prevent its spread through the use of absorbent booms and pads. Heavy trucks, such as those carrying hazardous materials, need longer highway stopping sight distances, particularly on crest vertical curves and horizontal curves. VDOT will consider enhanced design options along critical portions of a CBA - including shoulders on horizontal curves, both on the roadway and on ramps, which are common sites of accidents. VDOT will consider geometric design in environmentally sensitive areas based on higher-than-minimum standards to enhance truck safety, thereby further reducing the probability of a truck running off the road.

All CBAs will require a Stormwater Management Program Permit from VDCR for construction activities affecting greater than one acre and an approved erosion and sediment control plan. During and immediately following construction, multiple measures (such as erosion and sediment controls, a phased plan to limit the amount of exposed soil, and oversight by a full-time erosion and sediment control inspector) would likely be implemented in the vicinity of surface waters critical to public water supplies or special aquatic habitat. Erosion and sediment controls considered would consist of temporary filter barriers, temporary silt fences, temporary sediment traps, jute mesh and EC-3 mat erosion control ditches, Type II rock check dams, culvert inlet protections, diversion dikes, block and gravel sediment filter curb inlet protection, block and gravel sediment filter drop inlet protection, stone outlet protection, and Type II turbidity curtains. Design components intended to avoid, minimize, and mitigate adverse water quality effects will be considered for implementation during later phases of project design and development.

With implementation of appropriate mitigation measures and BMPs, the long-term operation and maintenance of a CBA would not result in measurably adverse impacts to public water supplies, water-related recreational opportunities, or aquatic habitat values due to degradation of water quality.

4.10.2 Groundwater Resources

Highway runoff can have a measurable effect on groundwater, including changes in water quality within the vadose zone and the saturated zone. Highway runoff effects on groundwater are often spatially limited, however, due to local hydrological conditions as well as pollutant sorption processes within and above the aquifer (Barrett, et al, 1993). For example, studies have demonstrated that the impact of deicing on the surrounding soil is limited to a distance of approximately 50 feet (15 meters) from the edge of pavement (California Department of Transportation, 1992). Roadway projects result in the introduction of pollutants normally associated with vehicular traffic. If not addressed through appropriate stormwater management, this situation can lead to water quality problems (an increase in nonpoint pollutant loading). If unabated, roadway runoff and other nonpoint source pollution can adversely impact water quality of nearby water supply wells or groundwater recharge areas. Infiltration could introduce contaminants typically carried in stormwater runoff (primarily salts and heavy metals) unless adequate BMPs are employed.

No sole source aquifers, as defined under Section 1424(e) of the Safe Drinking Water Act, have been designated in Virginia (EPA, 1999). The Commonwealth of Virginia currently has no approved wellhead protection program (EPA, 1999).

4.10.2.1 Effects

CBAs were assessed to determine whether they would be located within the currently recommended (i.e., non-regulatory) 1,000-foot (305-meter) wellhead protection radius set forth in the Virginia model ordinance (Virginia Ground Water Protection Steering Committee, 1998) or the 100-foot (30.5-meter) wellhead setback zone specified in Virginia Waterworks Regulations (VR 355-18-000) for public groundwater supply wells. Public groundwater resources (i.e., public water supply wells and associated 1,000-foot wellhead protection radius) within the study area, are shown in Figure 4.10-3. As shown in Figure 4.10-3, CBA 2 would encroach upon the non-regulatory 1,000-foot wellhead protection radius at three well locations. CBA 2 would also encroach upon the 100-foot wellhead setback zone (specified in Virginia Waterworks Regulations) at one of the three aforementioned well locations. Neither CBA 1 nor CBA 3 would encroach upon a 1,000-foot wellhead protection radius or a 100-foot wellhead setback zone.

Effects on public groundwater supplies in the vicinity of the aforementioned CBA 2 encroachments could include potentially measurable increases in dissolved metals and chloride along with increased risk of spills during construction. In these areas, special mitigation measures, both during and following construction may be required. Similar to the situation with surface water supplies, construction of a CBA in the vicinity of a public groundwater supply well would increase the probability of contamination should contaminants be suddenly released as a result of a traffic accident.

4.10.2.2 Mitigation

Measures evaluated by VDOT during later design phases to avoid or minimize effects to groundwater supplies would include (1) pollution prevention plans implemented during critical phases of construction and (2) design of stormwater drainage systems to prevent the infiltration of liquid contaminants or contaminated runoff. Measures that VDOT will consider to protect nearby groundwater supply wells would include (1) routing of runoff laden with deicing agents away from well recharge zones, (2) stormwater management facilities developed during later design phases to optimize free ion retention through use of organic soil linings, etc., and (3) development of SPCC plans. Plans will likely be developed in accordance with Virginia Waterworks Regulations and any wellhead protection ordinances subsequently developed by local governments and service authorities. During later design phases, VDOT will evaluate the use of stormwater management facilities designed to intercept and retain spilled materials before they can reach a water supply well aquifer (through possible use of detention/ retention basins and stormwater conveyance routes which avoid direct infiltration to aquifer recharge areas and wellhead protection zones). VDOT will consider the use of stormwater facilities designed with adequate detention times to allow recovery of spilled contaminants before such contaminants can reach a critical groundwater supply area. The exact nature of these facilities are dependent on the distance between a CBA and the nearest pathways to recharge zones critical to a public drinking water supply and the future assessment of the pollutant-lowering effects of natural attenuation and dilution that would occur over these distances. To mitigate temporary construction impacts, an erosion and sediment control plan developed in accordance with the Virginia Sediment and Erosion Handbook and VDOT's Annual Erosion and Sediment Control and Stormwater Management Standards and Specifications (as approved by VDCR) will be implemented.

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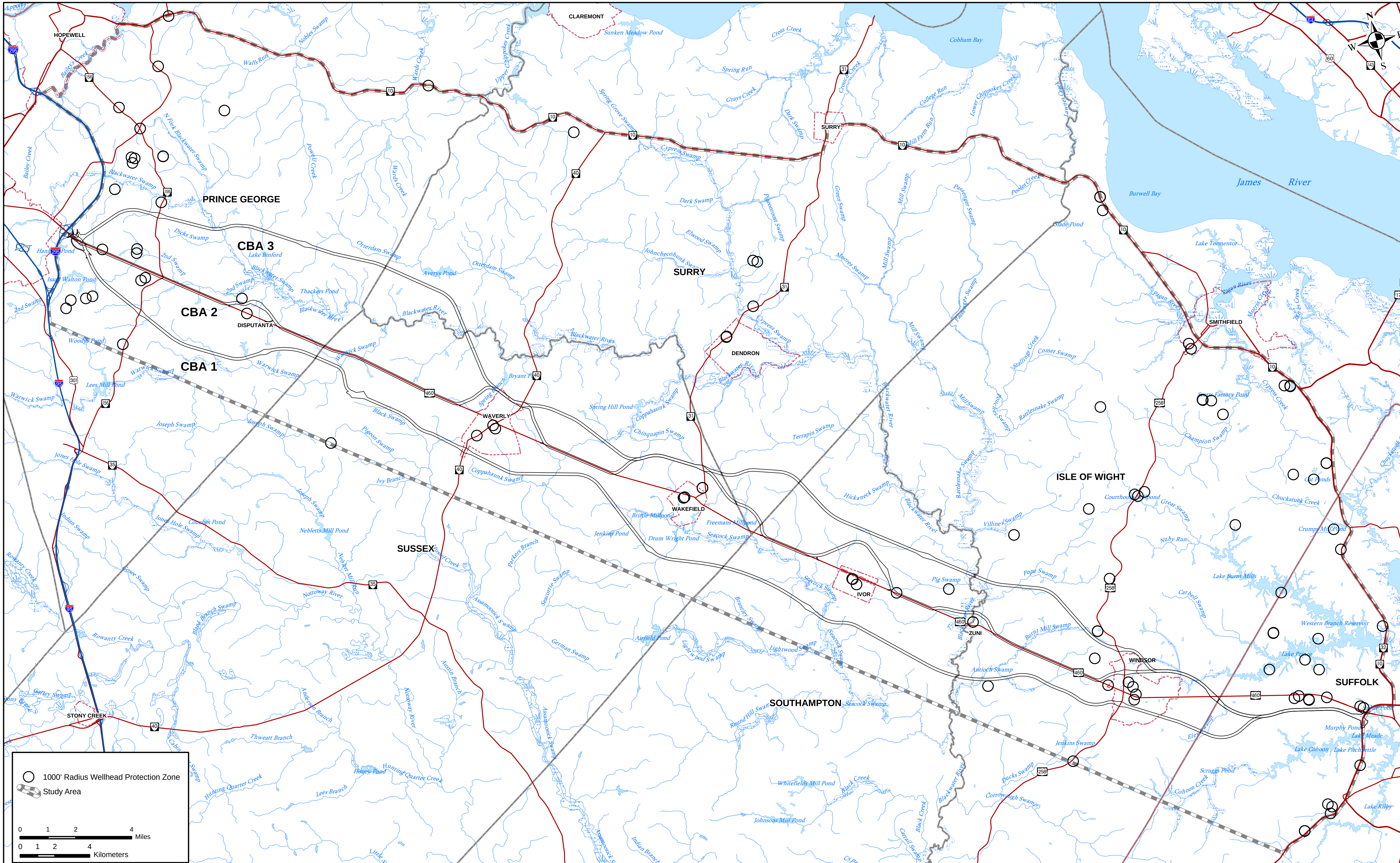

FIGURE 4.10-3
PUBLIC GROUNDWATER SUPPLIES