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Acronyms and Abbreviations

CBRFA	Chesapeake Bay Restoration Fund Act
CPF	Consolidated Property File
CSSP	Comprehensive Sewer Strategic Plan
DNR	Maryland Department of Natural Resources
EDU	equivalent dwelling unit
ENR	enhanced nutrient removal
EPA	U.S. Environmental Protection Agency
EUAC	equivalent uniform annual cost
GDP	General Development Plan
GIS	geographic information system
gpd	gallons per day
HB	House Bill
HDPA	Health Department problem area
lb	pound
MA	management area
MBR	membrane bioreactor
MDE	Maryland Department of the Environment
mg/L	milligrams per liter
O&M	operation and maintenance
OSDS	onsite sewage disposal systems
SBR	sequencing batch reactor
SSA	sewer service area
TM	Technical Memorandum
TMDL	total maximum daily load
TN	total nitrogen
WRE	water resources element
WRF	water reclamation facility

SECTION 1

Executive Summary

1.1 Project Background and Objectives

Anne Arundel County, Maryland, is conducting a countywide evaluation of service options for properties with onsite sewage disposal systems (OSDS, commonly referred to as septic systems). The overall goal of the OSDS Evaluation Study is to develop an OSDS Strategic Plan for implementing the Chesapeake Bay Watershed Restoration Fund (the "Flush Fee"). The focus of the Strategic Plan is to develop the most cost-effective approach to reducing nitrogen loads from OSDS systems that is consistent with County goals.

The County has recently updated a database containing the number and location of properties with OSDS throughout the county that were subject to the Flush Fee starting in early 2006. There are about 40,700 properties with OSDS, according the most recent County database, out of more than 193,300 properties countywide.

Significant objectives for the OSDS Evaluation Study include the following:

- Identify and categorize OSDS by assembling a GIS database of all OSDS countywide
- Develop a prioritization based on potential for nitrogen contamination, i.e., which OSDS should be treated first
- Evaluate and develop the cost of treatment, based on four categories of alternatives:
  - Extending sewer service, with assumed treatment at water reclamation facilities (WRFs) that are upgraded for enhanced nutrient removal (ENR)
  - Cluster type of community sewer service
  - OSDS upgrades with enhanced nitrogen removal
  - No action: maintain existing septic system
- Develop an implementation strategy that identifies treatment approaches and priorities for OSDS countywide. The implementation strategy includes developing database tools and mapping for the recommended priorities. In addition, the strategy identifies policy, regulatory, and fiscal issues and action items that support implementation of the recommended OSDS treatment alternatives.

1.2 Cost Effectiveness of Treatment Alternatives

Planning-level cost estimates were developed for enhanced OSDS, for potential sewer extension projects to connect areas with existing septic systems to existing sewer service areas (SSAs), and for potential cluster community wastewater systems. These treatment approaches were evaluated with respect to their life-cycle costs and removal efficiency and to provide baseline planning information for developing a countywide treatment strategy.

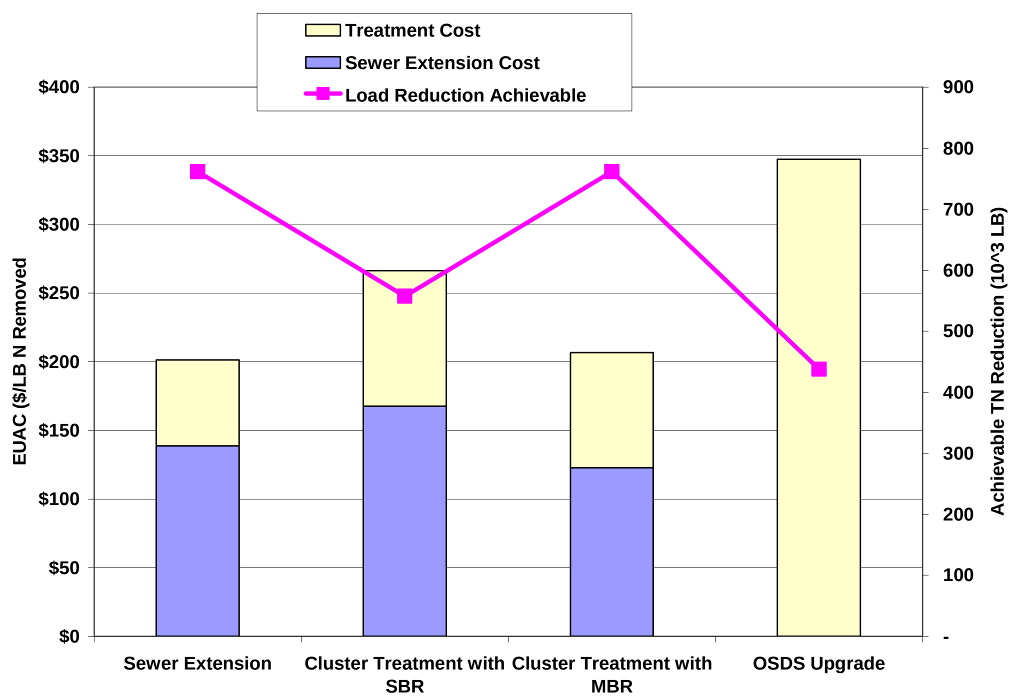
Detailed schematic designs were completed for 10 study areas representing 5,654 acres of Anne Arundel County that are served by onsite systems. With one exception, these areas were all significantly larger than the communities that the County periodically evaluates for sewer extension on a petition basis. In order to extend the data set to examine sewer extension costs for small communities, the output of 14 petition studies that have been conducted for the County by various consultants since January of 1998 was reviewed. The petition areas generally represent areas that are smaller than 200 acres and about 50 acres on average.

Based on these 10 case studies and 14 petition studies, the unit costs of each treatment approach were developed—both as an initial capital cost and an equivalent uniform annual cost (EUAC). The EUACs are life-cycle costs that factor in the initial capital costs, operation and maintenance (O&M) costs, and capital renewal costs, based on the service life of each component. Cost data and assumptions were reviewed and revised based on input from MDE and the County Health Department.

The analysis of unit costs indicated that OSDS system upgrades are the least costly from an initial capital investment standpoint, but are similar in cost over the long term when O&M, service life, inflation, and energy costs are accounted for.

Furthermore, when nitrogen removal effectiveness is considered, the analysis indicated that on a per-unit removal basis, sewer extensions and cluster treatment approaches are more cost-effective and are capable of obtaining a higher level of total nitrogen (TN) removal than OSDS upgrades, as shown in Figure 1-1.

FIGURE 1-1
Estimated Nitrogen Load Reduction Achievable by Treatment Technology and Equivalent Uniform Annual Cost per Pound of Nitrogen Removed



The overall cost effectiveness of each treatment approach in reducing TN loads delivered to area receiving waters was analyzed on a unit cost per-pound removal basis. During the course of the OSDS Evaluation Study, Maryland Department of the Environment (MDE) provided guidance that delivery ratios should be set as follows:

- 80 percent for OSDS within the Critical Area
- 50 percent for OSDS outside the Critical Area and within 1,000 feet of nontidal waters
- 30 percent for all other OSDS

The MDE 80/50/30 delivery ratio approach was applied to the effluent concentration for each treatment approach and applied to each OSDS in the county. The effluent concentrations were assumed to be 3 milligrams per liter (mg/L) for the sewer extension alternative to reflect upgrading the WRFs to ENR. The membrane bioreactor (MBR)-based cluster treatment facilities used in the cost analysis were designed provide an effluent with 3 mg/L TN. The sequencing batch reactor (SBR) cluster systems would provide 8 mg/L to be consistent with MDE requirements for all treatment facilities with flows above 5,000 gallons per day (gpd). The OSDS denitrification upgrades were estimated to provide 20 mg/L TN per MDE policy.

1.3 Prioritization and Strategic Plan for Reducing OSDS Nitrogen Loads

OSDS were grouped into management areas (MAs) with like characteristics that would allow the same treatment technology to be assigned to all OSDS in the bin. The following criteria were used to group the OSDS into MAs:

- Planned sewer service (existing, planned, future, no service)
- OSDS density
- Nitrogen delivery ratio
- Subwatershed divides in rural SSAs with no planned sewer service
- Proximity to sewer
- Health Department-identified problem area

Each MA was assigned a treatment approach, as shown in Figure 1-2.

The MAs were split into high-, medium-, and low-priority groups based on cost effectiveness ($ per pound of nitrogen removed). High-priority MAs are the first 15 percent, based on cost effectiveness. Medium-priority MAs are from 15 to 60 percent, and low-priority are the last 40 percent. Figure 1-3 shows a countywide overview of those priority MAs. Attachments A and B of Appendix D contain a complete list of all MAs, ranked in alphabetical order and in order of cost effectiveness, respectively. Attachment B of Appendix D also contains an index map of the location of MAs, showing the three priority groups based on cost effectiveness. A geographic information system (GIS) database containing this information has been provided to the County to facilitate further analysis and prioritization by watershed or other planning unit.

Table 1-1 summarizes the total costs and load reductions of the recommended strategy, by priority group and in total.

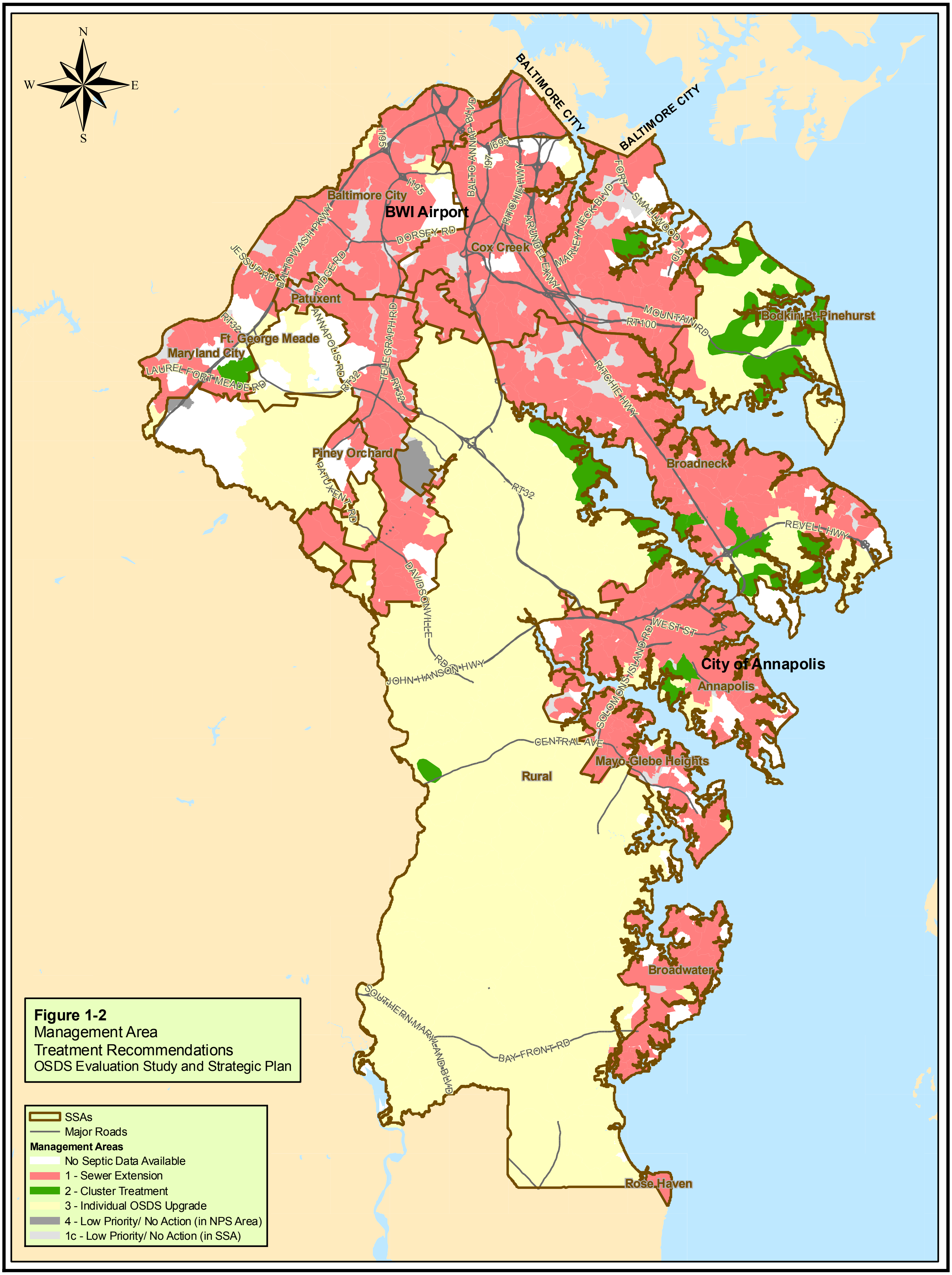


Figure 1-2
Management Area
Treatment Recommendations
OSDS Evaluation Study and Strategic Plan

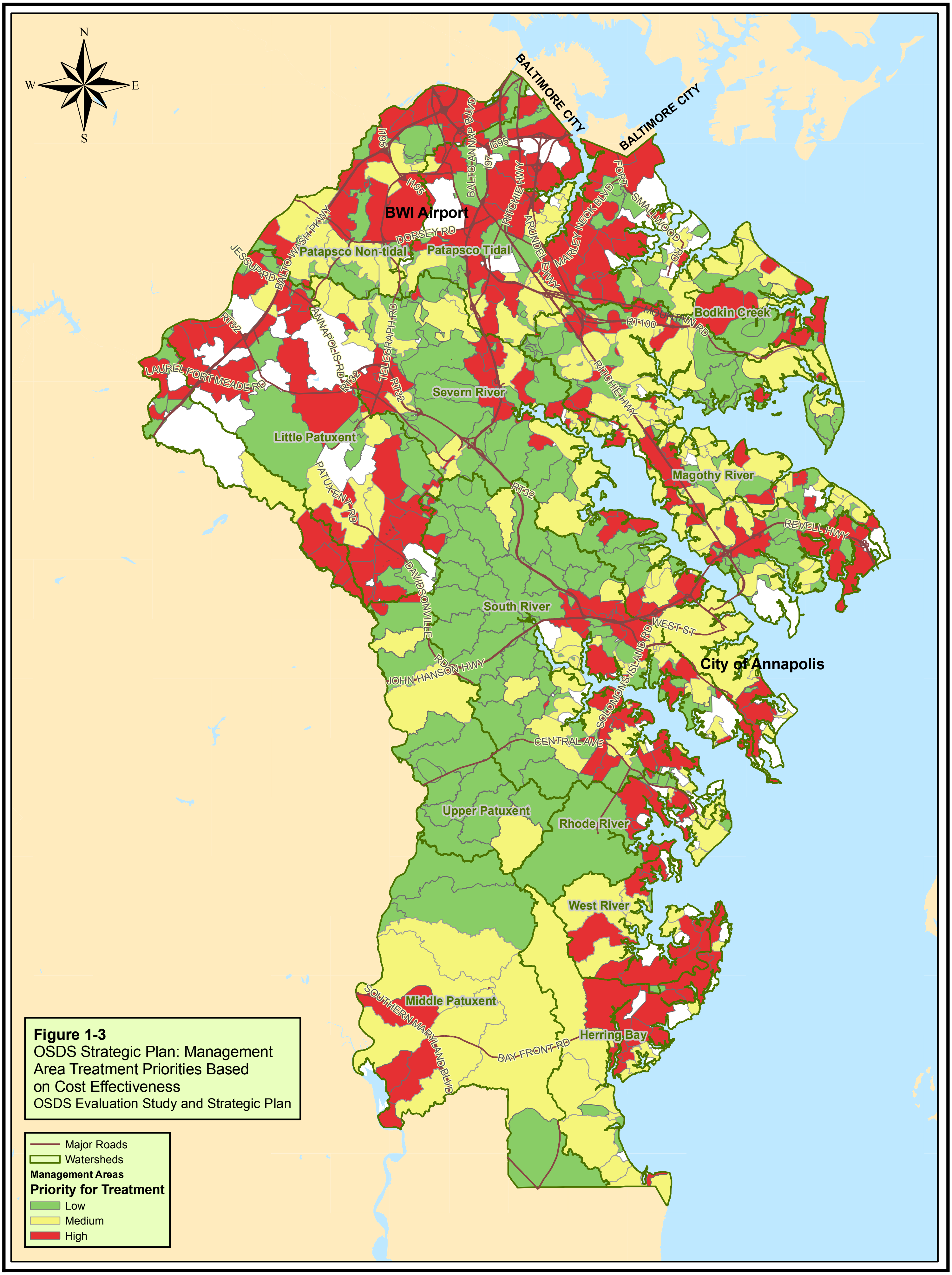


Figure 1-3
OSDS Strategic Plan: Management Area Treatment Priorities Based on Cost Effectiveness
OSDS Evaluation Study and Strategic Plan

TABLE 1-1
Summary of Costs and Loads by Priority Group

Management Area Priority	Percentage of OSDS treated	EUAC (Millions)	Initial Capital Cost (Millions)	Existing Load (Lbs of TN)	Load after OSDS Strategy Applied (Lbs of TN)	Total Reduction (Lbs of TN)	EUAC ($/Lbs of TN Reduction)	Initial Capital Cost ($/Lbs of TN Reduction)
High	15%	$23	$211	212,324	39,907	172,417	$133	$1,224
Medium	45%	$68	$600	388,208	88,019	300,189	$227	$1,999
Low	40%	$54	$303	280,468	132,004	148,464	$364	$2,041
Total	**100%**	**$145**	**$1,114**	**881,000**	**259,930**	**621,070**		

Figures 1-4 and 1-5 show the existing load and the load after treatment on a per area basis (pounds per acre per year). For comparison purposes, Figure 1-6 shows the load reduction that would occur if all OSDS were upgraded individually, assuming a resulting effluent concentration of 20 mg/L plus the delivery ratio of each system to receiving waters.

In effect, Figure 1-6 shows the loads that would result if the County implemented the Tributary Strategy recommendation of OSDS upgrades. Table 1-2 summarizes the TN reduction of the recommended OSDS strategy, compared to the Tributary Strategy recommendation of countywide OSDS upgrades.

TABLE 1-2
OSDS Strategic Plan versus Tributary Strategy (Individual OSDS Upgrades)

Load Reduction, Pounds per Year		
	Strategic Plan	**Tributary Strategy**
Current Load	881,000	881,000
Load Reduction	627,080	440,500
Net Load	253,920	440,500
Equivalent Uniform Annual Cost		
Total	$145,000,000	$152,000,000
Per Pound of Load Reduction	$231	$345

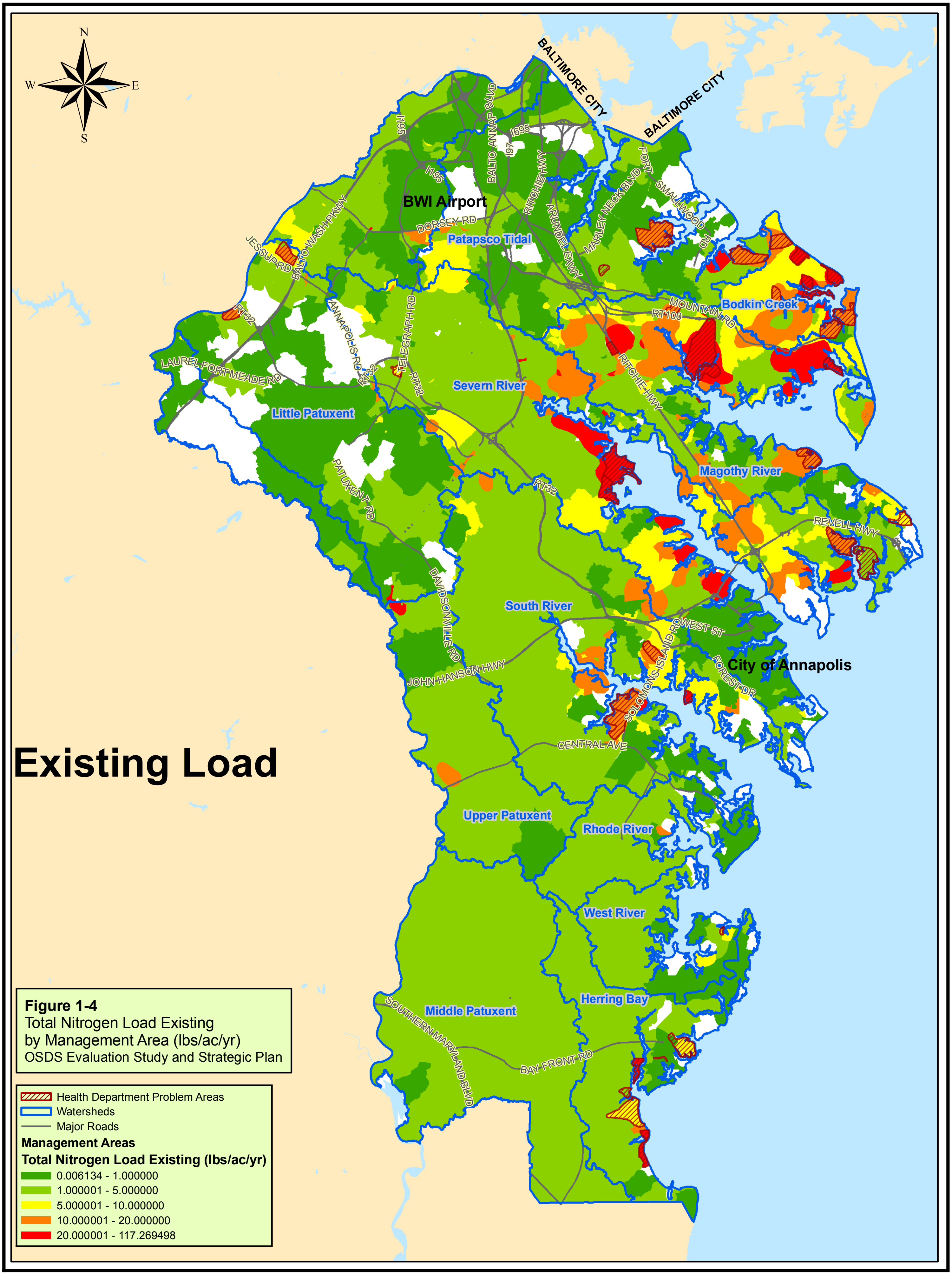


Figure 1-4
Total Nitrogen Load Existing
by Management Area (lbs/ac/yr)
OSDS Evaluation Study and Strategic Plan

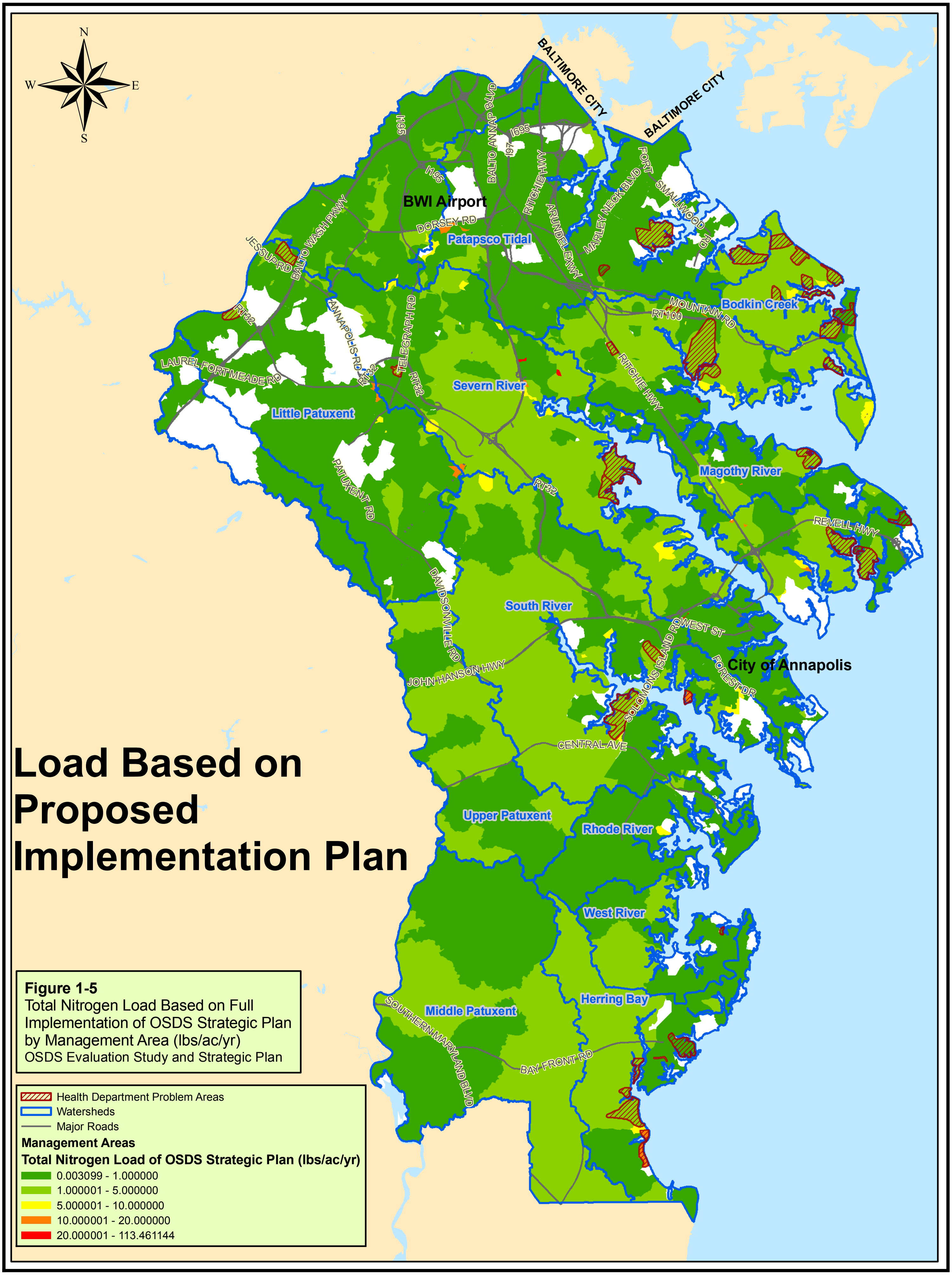
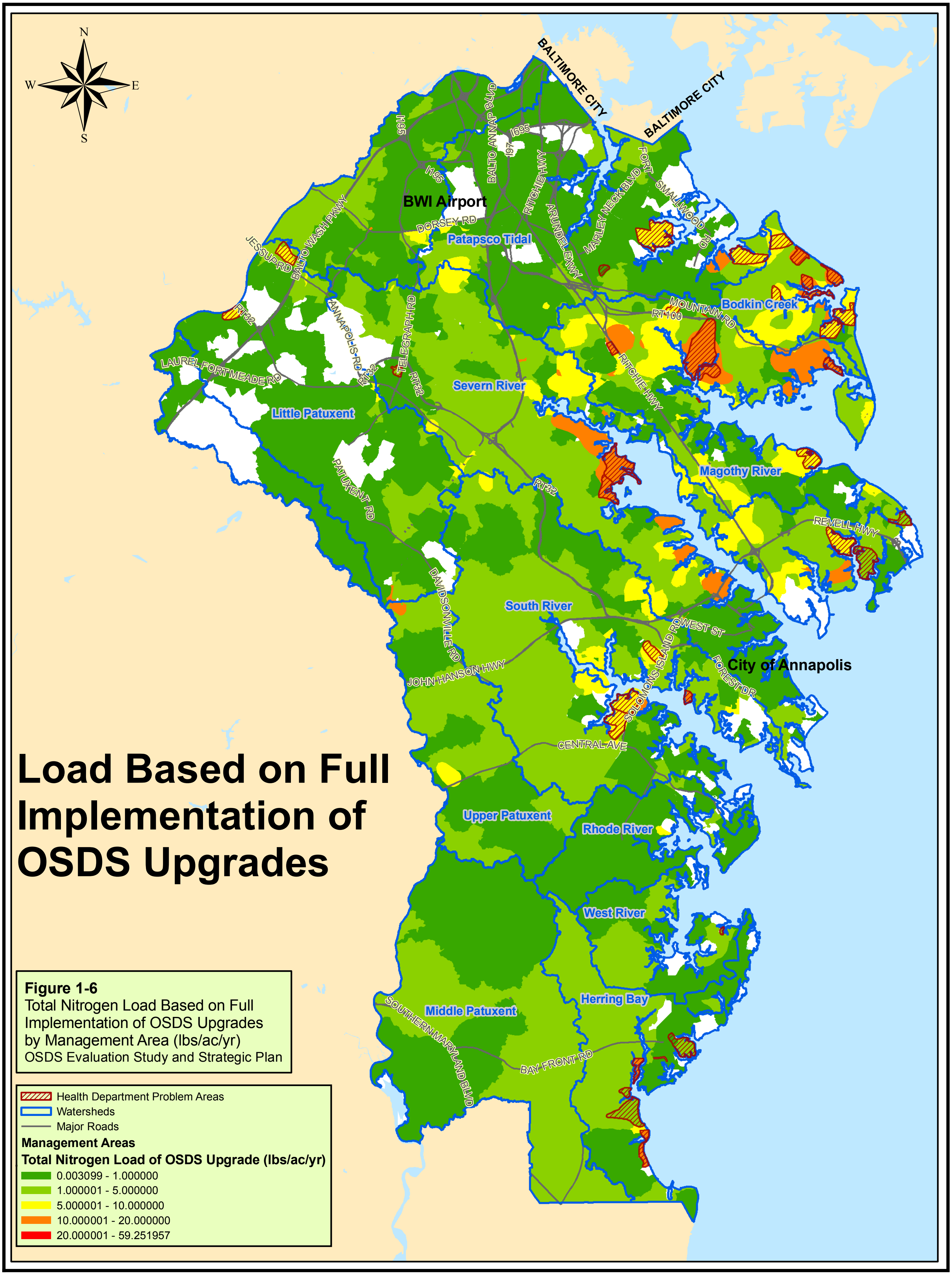


Figure 1-5
Total Nitrogen Load Based on Full Implementation of OSDS Strategic Plan by Management Area (lbs/ac/yr)
OSDS Evaluation Study and Strategic Plan



Load Based on Full Implementation of OSDS Upgrades

Figure 1-6
Total Nitrogen Load Based on Full Implementation of OSDS Upgrades by Management Area (lbs/ac/yr)
OSDS Evaluation Study and Strategic Plan

1.4 Implementation Strategy to Address Technical, Policy, Regulatory, and Statutory Issues

This OSDS Evaluation Study identified a number of technical, policy, regulatory, and statutory issues that the County should address before implementing the recommended treatment approaches for OSDS. Details of these issues are presented in Section 5 and in Appendix D. The list of recommended County actions is provided below:

1. Meet with MDE and the Maryland Department of Natural Resources (DNR) to articulate County OSDS Strategy
2. Work with MDE, DNR, and state legislators to revise Chesapeake Bay Restoration Fund Act (CBRFA) language
3. Partner with MDE, DNR, and others to update the science of OSDS load estimates (concentration, delivery ratios) and Chesapeake Bay model
4. Partner with MDE and DNR to evaluate alternatives for new OSDS cluster treatment systems (new land application/reuse options, new outfall options in shellfish areas)
5. Partner with MDE and DNR to develop OSDS load credit mechanism for WRF load caps
6. Develop OSDS Environmental Fee Study and Ordinance
7. Develop OSDS Maintenance Ordinance
8. Make revisions to General Development Plan: identify changes in areas of planned sewer service (additions and deletions); identify priorities; identify areas designated for limited sewer service for managing areas of existing OSDS targeted either for sewer extension or cluster systems

Implications for House Bill (HB) 1141 – Water Resources Element (WRE). Summarize how this study can be used to address the septic system component of WRE.

SECTION 2

Introduction

2.1 Project Background and Objectives

Anne Arundel County, Maryland, is conducting a countywide evaluation of service options for properties with onsite sewage disposal systems (OSDS, commonly referred to as septic systems). The overall goal of the OSDS Evaluation Study[1] is to develop an OSDS Strategic Plan for implementing the Chesapeake Bay Watershed Restoration Fund (the "Flush Fee"). The focus of the Strategic Plan is to develop the most cost-effective approach to reducing nitrogen loads from OSDS systems that is consistent with County goals.

The County has recently updated a database containing the number and location of properties with OSDS throughout the county that were subject to the Flush Fee starting in early 2006. There are about 40,700 properties with OSDS, according the most recent County database, out of more than 193,300 properties countywide. Figure 2-1 shows the location of OSDS countywide.

The County recently completed a Comprehensive Sewer Strategic Plan (CSSP) for seven of the County's sewer service areas (SSAs): Annapolis, Baltimore City, Broadneck, Broadwater, Cox Creek, Maryland City, and Patuxent. The OSDS Evaluation Study leverages geographic information system (GIS) data and related wastewater flow forecasting tasks from that project by looking at OSDS within those seven SSAs, and by extending the analysis and information used to cover the unserved rural areas and the unserved areas within the remaining SSAs, which include:

- Mayo–Glebe Heights
- Rose Haven
- Bodkin Pt.–Pinehurst
- Ft. George Meade
- Piney Orchard

2.2 Purpose of the Study

Significant objectives for the OSDS Evaluation Study include the following:

- Identify and categorize OSDS by assembling a GIS database of all OSDS countywide
- Develop a prioritization based on potential for nitrogen contamination i.e., which OSDS should be treated first

[1] The original study name, the Septic System Evaluation Study, was changed to Onsite Sewage Disposal System (OSDS) Evaluation Study to be consistent with EPA and MDE formal terminology for septic systems.

- Evaluate and develop the cost of treatment, based on four categories of alternatives:
  - Extending sewer service, with assumed treatment at WRFs that are upgraded for enhanced nutrient removal (ENR)
  - Cluster type of community sewer service
  - OSDS upgrades with enhanced nitrogen removal
  - No action: maintain existing septic system
- Develop an implementation strategy that identifies treatment approaches and priorities for OSDS countywide. The implementation strategy includes developing database tools and mapping for the recommended priorities. In addition, the strategy identifies policy, regulatory, and fiscal issues and action items that support implementation of the recommended OSDS treatment alternatives.

The categorization of OSDS into possible treatment alternatives includes categorization of OSDS in rural SSAs, as well as the possibility of extending sewer service from existing water reclamation facilities (WRFs).

2.3 Approach to the Study

The OSDS Evaluation Study includes the following four tasks:

- **Task 1**—Identifying, Categorizing, and Prioritizing OSDS
- **Task 2**—Preliminary Cost Analysis of Onsite Septic System Upgrades and Cluster Community Wastewater Systems
- **Task 3**—Preliminary Cost Analysis of Sewer System Extensions
- **Task 4**—Implementation Plan and Final Report

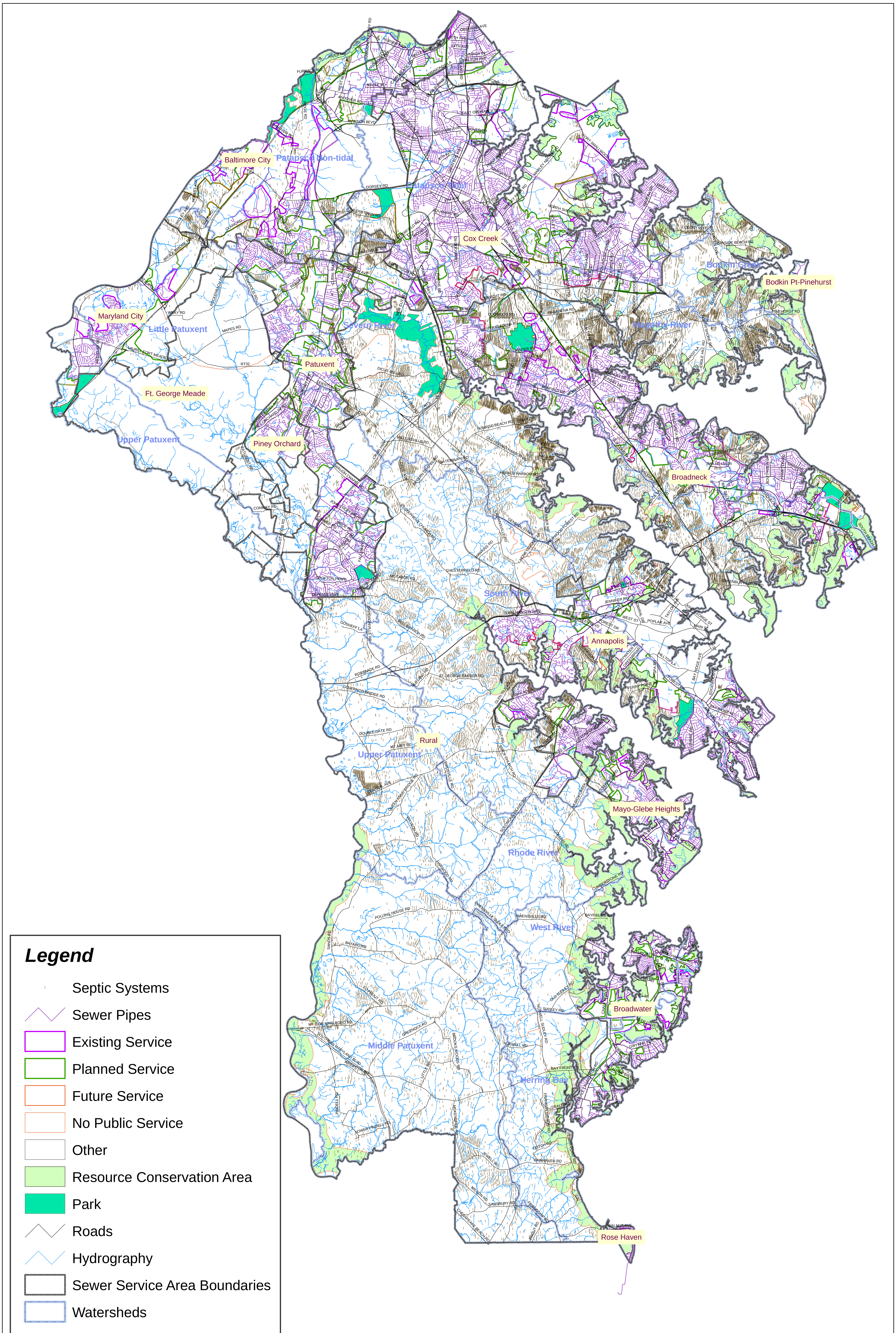
The overall approach to the study was to conduct a literature search to determine important evaluation criteria to be considered in determining risk of nitrogen migration from OSDS to surface waters. Then the location and prioritization of OSDS was conducted in Task 1 using GIS data and workshops with County staff. This included initial estimates of total nitrogen load delivered to receiving waters. In Task 2, detailed schematic designs were completed for 10 study areas that represent 5,654 acres of Anne Arundel County that were served by onsite systems. From these designs, detailed capital and operation and maintenance (O&M) cost estimates were prepared using a life-cycle cost module. This module was applied in Tasks 2 and 3 to provide a uniform evaluation of the effectiveness of the treatment approaches. Finally, in Task 4 the unit cost and OSDS nitrogen load delivery information were combined to develop site-specific recommendations for OSDS treatment. These recommendations also included an analysis of policy, regulatory and financial issues that would need to be addressed. Task 4 culminated in a strategic plan for OSDS treatment recommendations and policy initiatives.

2.4 Report Overview

Technical Memoranda (TM) were prepared at the end of each task of this study. This report summarizes the key findings of those TMs, and the final TMs are included as appendices. The report is organized as follows:

- Section 1: Executive Summary
- Section 2: Introduction
- Section 3: Location and Characteristics of OSDS in Anne Arundel County
- Section 4: Treatment Alternative Unit Costs and Cost Effectiveness
- Section 5: Technical, Policy, Regulatory and Statutory Issues
- Section 6: Prioritization and Strategic Plan for Reducing OSDS Nitrogen Loads
- Appendix A: Literature Review—Septic System Performance Criteria, Technologies, and Cost Factors (Technical Memorandum, CH2M HILL, July 12, 2006)
- Appendix B: Onsite Sewage Disposal Systems: Identification, Categorization and Prioritization (Technical Memorandum for Task 1)
- Appendix C: Onsite Sewage Disposal Systems: Evaluation of Treatment Alternatives and Costs (Technical Memorandum for Tasks 2 and 3)
- Appendix D: Onsite Sewage Disposal System Evaluation Study: Management Strategy and Implementation Plan (Technical Memorandum for Task 4)

In addition to the preparation of this report, a key outcome of this project is the development of a complete database and GIS mapping system that will allow the County to zoom into priority areas, by watershed or SSA, to display and analyze OSDS management areas as implementation and policy issues are further elaborated. The OSDS database and GIS spatial information and analysis capabilities are illustrated throughout this report. A detailed list of the digital files provided to the County is provided on the CD for the OSDS Evaluation Study (delivered separately from this report).



0 2 4 Miles

Figure 2-1. Septic System Location
Anne Arundel County
Maryland

CH2MHILL

August 14, 2006

SECTION 3

Location and Characteristics of OSDS in Anne Arundel County

3.1 Methodology for Identifying and Mapping OSDS Locations

Anne Arundel County has developed a database of the location of properties with OSDS in the county. The process started with the County's Consolidated Property File (CPF), which is a database the County maintains that is initially derived from property records maintained by the State Department of Assessment and Taxation, to which the County adds additional information such as water and sewer billing records. The first pass of OSDS identification was based on known locations from other County databases. The next step was to determine where development has occurred on the remainder of the properties on a case-by-case basis. Properties were judged to be developed based on assessed value of the improvements, using a cutoff of $10,000. For developed properties, the next step was to determine if the area had water and wastewater service. County Health Department personnel made site visits to all of the developed properties that were identified as without water and wastewater service.

As a result of this process, a GIS layer or point coverage could be created that indicates whether the property is developed or undeveloped, adjacent to wastewater service, and either on septic or sewer. The point coverage is limited to a generalized point representing each parcel and does not include any location information of OSDS within that parcel polygon.

The OSDS GIS database also does not contain site-specific information on the type of OSDS or its operation and maintenance status. However, the land use on each property is available from the CPF, thus allowing residential and nonresidential properties to be distinguished.

Using County GIS information, spatial analyses were conducted with the OSDS layer to summarize the number of OSDS by watershed, sewer service category, and Health Department problem areas. In addition, GIS analyses were used to characterize OSDS density, proximity to Chesapeake Bay Critical Areas, and surface water, slope, and soil characteristics. Finally, GIS analyses were used to develop estimates of nitrogen loads by OSDS. Results of these analyses are summarized below and presented in more detail in Appendix B. Section 6 summarizes the prioritization of OSDS based on nutrient reduction cost effectiveness and County prioritization criteria.

3.2 Number of OSDS by Watershed

Table 3-1 summarizes the number of OSDS by watershed. In addition, Table 3-1 lists the total number of developed properties with the percentage that are served by OSDS versus public sewer. Figure -2-1 in Section 2 shows the location of OSDS countywide with watershed boundaries.

TABLE 3-1
Inventory of OSDS by Watershed
Anne Arundel County OSDS Evaluation Study

Watershed	Number of OSDS	Percent of Countywide OSDS	Number of Developed Accounts	Percent Served by OSDS
Bodkin Creek	3,093	7.6%	3,214	96.2%
Herring Bay	1,041	2.6%	4,008	26.0%
Little Patuxent	793	1.9%	19,336	4.1%
Magothy River	9,626	23.7%	25,744	37.4%
Middle Patuxent	2,206	5.4%	2,266	97.4%
Patapsco Non-tidal	1,120	2.8%	9,056	12.4%
Patapsco Tidal	2,163	5.3%	41,914	5.2%
Rhode River	430	1.1%	1,890	22.8%
Severn River	11,926	29.3%	31,251	38.2%
South River	6,084	15.0%	17,696	34.4%
Upper Patuxent	1,715	4.2%	3,446	49.8%
West River	351	0.9%	2,406	14.6%
(blank)	136	0.3%	762	17.8%
Grand Total	40,684	100.0%	162,989	25.0%

Note: (blank) watershed means the OSDS mapping location in the GIS data layer is in the water. This happens for some properties on the water's edge.

3.3 Number of OSDS by SSA

Table 3-2 summarizes the number of OSDS by SSA. In addition, Table 3-2 lists the total number of developed properties with the percentage that are served by OSDS versus public sewer. Figure 2-1 in Section 2 shows the location of OSDS countywide with SSA boundaries.

TABLE 3-2
Inventory of OSDS by SSA
Anne Arundel County OSDS Evaluation Study

Sewer Service Area	Number of OSDS	Percent of Countywide OSDS	Number of Developed Accounts	Percent Served by OSDS
Annapolis	3,201	7.9%	16,601	19.3%
Baltimore City	1,446	3.6%	11,777	12.3%
Bodkin Pt-Pinehurst	140	0.3%	160	87.5%
Broadneck	9,957	24.5%	30,302	32.9%
Broadwater	291	0.7%	4,887	6.0%
Cox Creek	2,513	6.2%	42,037	6.0%
Ft. George Meade	2	0.0%	10	20.0%
Maryland City	160	0.4%	4,336	3.7%

TABLE 3-2
Inventory of OSDS by SSA
Anne Arundel County OSDS Evaluation Study

Sewer Service Area	Number of OSDS	Percent of Countywide OSDS	Number of Developed Accounts	Percent Served by OSDS
Mayo-Glebe Heights	104	0.3%	3,192	3.3%
Patuxent	892	2.2%	22,902	3.9%
Piney Orchard	17	0.0%	3,629	0.5%
Rose Haven	4	0.0%	378	1.1%
Rural	21,815	53.6%	22,189	98.3%
(blank)	142	0.3%	589	24.1%
Grand Total	40,684	100.0%	162,989	25.0%

Note: (blank) Sewer Service Area means the OSDS mapping location in the GIS data layer is in the water. This happens for some properties on the water's edge.

3.4 Number of OSDS by Planned Sewer Service Type

Table 3-3 summarizes the number of OSDS by planned sewer service type. In addition, Table 3-3 lists the total number of developed properties with the percentage that are served by OSDS versus public sewer. Figure 2-1 in Section 2 shows the location of OSDS countywide with Sewer Service Type boundaries.

TABLE 3-3
Inventory of OSDS by Planned Sewer Service Type
Anne Arundel County OSDS Evaluation Study

Planned Sewer Service Type	Number of OSDS	Percent of Countywide OSDS	Number of Developed Accounts	Percent Served by OSDS
Existing Service	1,881	4.6%	118,181	1.6%
Future Service	8,322	20.5%	8,674	95.9%
No Public Service	23,041	56.6%	23,449	98.3%
Other	18	0.0%	38	47.4%
Park	22	0.1%	45	48.9%
Planned Service	5,676	14.0%	9,792	58.0%
Resource Conservation Area	1,584	3.9%	2,165	73.2%
(blank)	140	0.3%	587	23.9%
Grand Total	40,684	100.0%	162,931	25.0%

Note: (blank) Planned Sewer Service Type means the OSDS mapping location in the GIS data layer is in the water. This happens for some properties on the water's edge.

3.5 Number of OSDS by Land Use Type

Table 3-4 summarizes the number of OSDS by land use type. In addition, Table 3-4 lists the total number of developed properties with the percentage that are served by OSDS versus public sewer. There are 36,120 (89 percent) OSDS that serve residential properties and 4,440 (11 percent) that serve nonresidential properties.

TABLE 3-4
Inventory of OSDS by Land Use of Property Served
Anne Arundel County OSDS Evaluation Study

Land Use Type	Number of OSDS	Percent of Countywide OSDS	Number of Developed Accounts	Percent Served by OSDS
Agricultural	673	1.7%	873	77.1%
City of Annapolis	3	0.0%	3	100.0%
Government/Institutional	219	0.5%	745	29.4%
Industrial	299	0.7%	643	46.5%
Multiple Family Dwelling	5	0.0%	5,834	0.1%
Natural Open Space	449	1.1%	2,171	20.7%
Office	224	0.6%	794	28.2%
Recreation and Parks	131	0.3%	1,369	9.6%
Retail	623	1.5%	2,966	21.0%
Single Family Dwelling	36,102	88.7%	116,412	31.0%
Townhouse	13	0.0%	24,159	0.1%
Transportation/Utility	92	0.2%	498	18.5%
Vacant	1,708	4.2%	5,749	29.7%
Water	19	0.0%	74	25.7%
(blank)	124	0.3%	700	17.7%
Grand Total	40,684	100.0%	162,989	25.0%

Note: (blank) Land Use Type means the OSDS mapping location in the GIS data layer is off shore. This happens for some properties on the water's edge.

3.6 Number of OSDS in Health Department Problem Areas

The County Health Department manages a GIS layer in the County's database containing 37 OSDS problem areas, referred to in previous County Water and Sewer Master Plan as wastewater management problem areas. These were classified as problem areas based on the following factors:

- High water table
- Steep slopes
- Poor percolation tests
- Lot size
- Historical use of alternative OSDS technologies

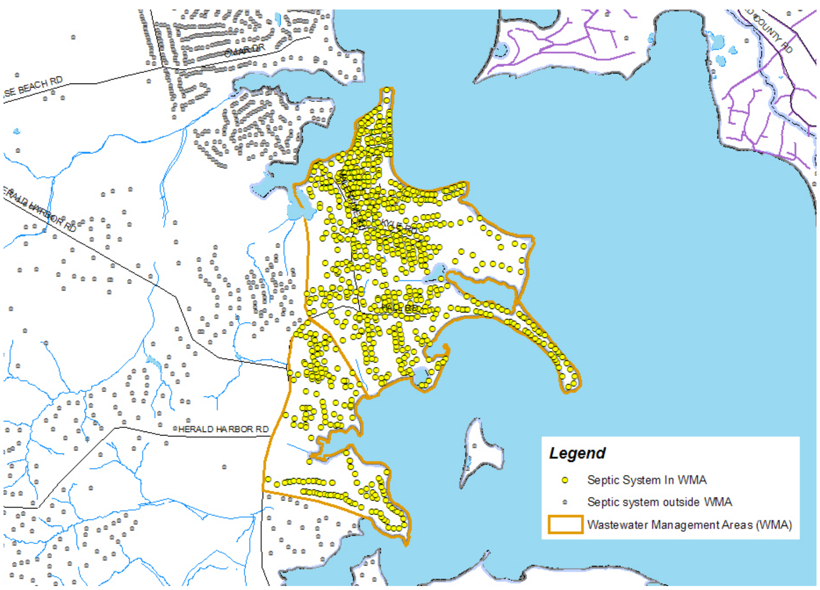
County personnel ranked the location of an OSDS inside the Health Department OSDS problem areas as the most significant criterion in terms of potential environmental benefit.

Table 3-5 lists the frequency distribution of OSDS inside and outside of problem areas: 14.2 percent of all OSDS are in problem areas. Figure 3-1 shows an example view of OSDS concentrated in a problem area.

TABLE 3-5
Frequency Distribution of OSDS
Anne Arundel County OSDS Evaluation Study

Inside or Outside Health Dept. Problem Areas	Number	Percentage of total
Inside	5,773	14.2
Outside	34,910	85.8

FIGURE 3-1
OSDS Inside Health Department Problem Areas (Sample Data)



3.7 OSDS Density

Figure 3-2 shows the distribution of OSDS based on density. Figure 3-3 shows a countywide view of OSDS density, with the same density categories as shown in Figure 3-2. Table 3-6 tabulates the data shown in Figure 3-2—17 percent of all OSDS are in areas with a density of at least 1 OSDS per acre, and an additional 31 percent are in areas with a density of between 0.5 and 1 OSDS per acre.

FIGURE 3-2
Frequency Distribution of OSDS by Density

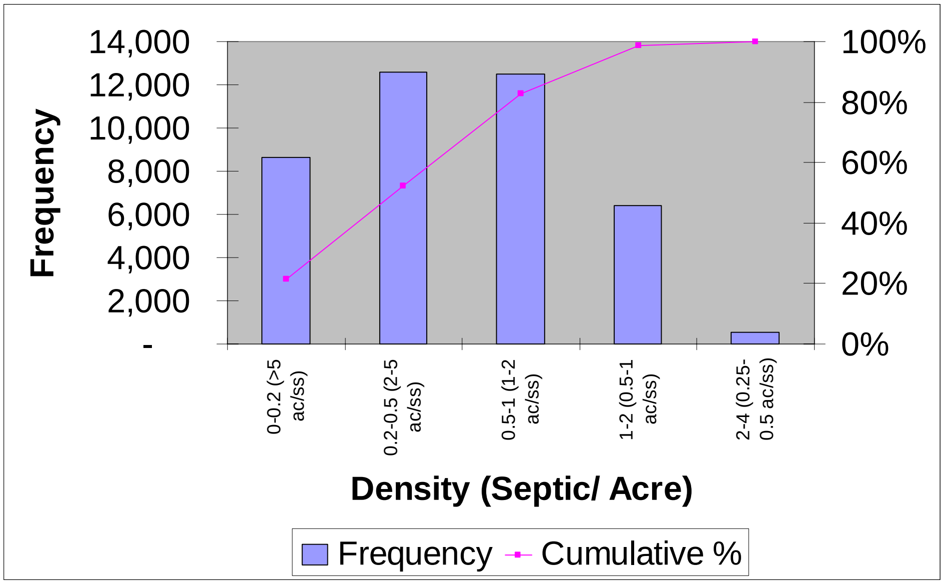


TABLE 3-6
Frequency Distribution of OSDS Density
Anne Arundel County OSDS Evaluation Study

Density (Septic/ Acre)	Density (Acres/Septic System)	Frequency	Cumulative %
-	-	-	0%
0-0.2	>5	8,656	21%
0.2-0.5	2-5	12,571	52%
0.5-1	1-2	12,495	83%
1-2	0.5-1	6,429	99%
2-4	0.25-0.5	532	100%

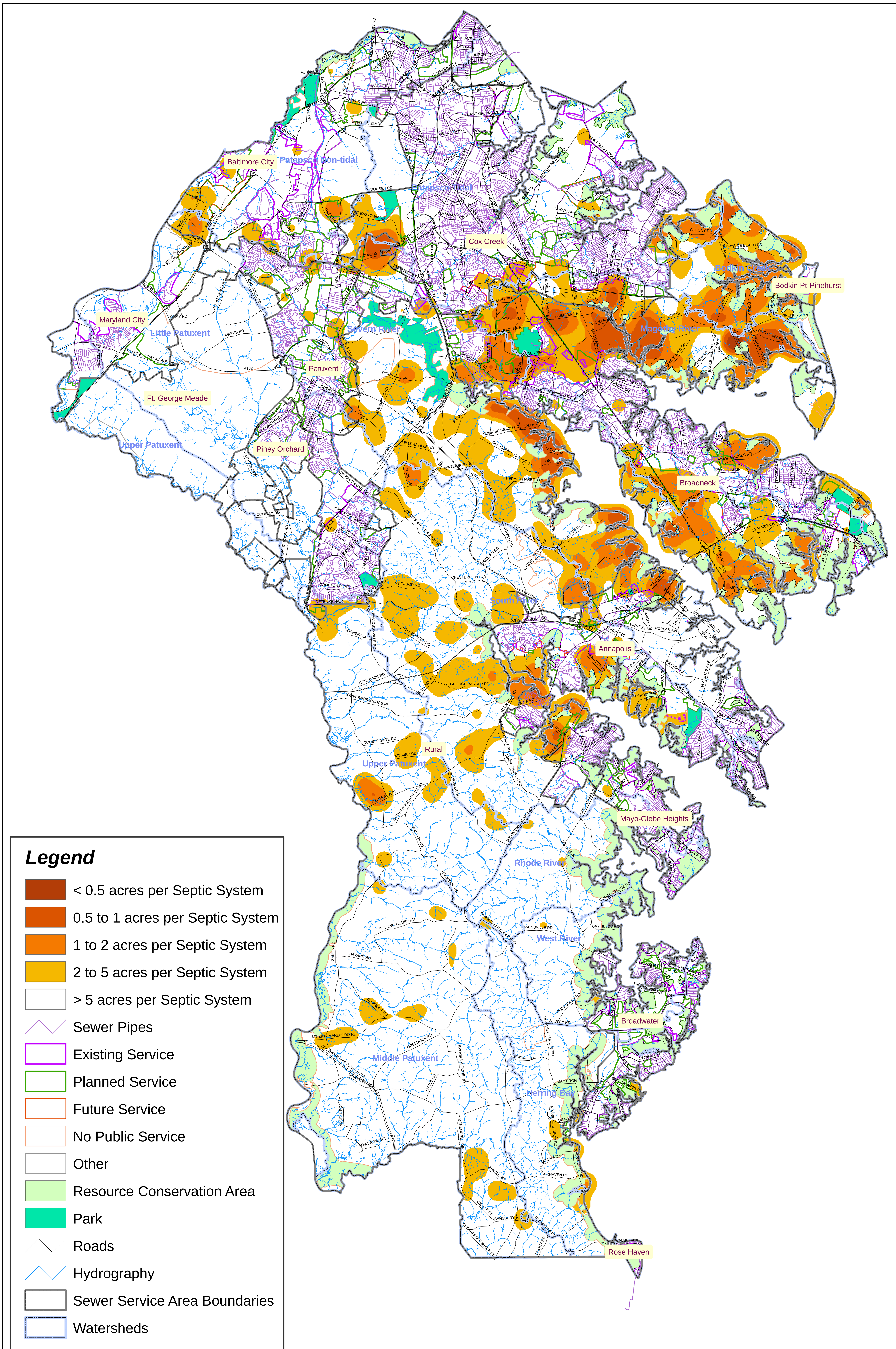


Figure 3-3. Septic System Density
Anne Arundel County
Maryland

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August 15, 2006

3.8 OSDS in Chesapeake Bay Critical Area

Table 3-7 shows the number of OSDS within the Chesapeake Bay Critical Area. Thirty-two percent of all OSDS are within the Critical Area.

TABLE 3-7
OSDS in the Critical Area
Anne Arundel County OSDS Evaluation Study

Inside or Outside Chesapeake Critical Area	Frequency	Cumulative %
RCA (Resource Conservation Area)	1,393	3%
LDA (Less Developed Area)	10,785	30%
IDA (Intensely Developed Area)	1,007	32%
Outside	27,498	100%

3.9 OSDS as a Function of Distance to Surface Water

Table 3-8 shows the frequency distribution of OSDS as a function of distance to surface water. Eighty-six percent of all OSDS are within 1,000 feet of surface water, which includes the 32 percent within the Critical Area (1,000 feet from tidal surface water) and the remainder within 1,000 feet of non-tidal surface water.

TABLE 3-8
OSDS as a Function of Distance from Surface Water
Anne Arundel County OSDS Evaluation Study

Distance to Water (ft)	Frequency	Cumulative %
0	0	0.00%
100	3,517	8.64%
200	5,207	21.44%
300	4,732	33.08%
400	4,906	45.13%
500	3,986	54.93%
600	3,643	63.89%
700	2,977	71.20%
800	2,334	76.94%
900	2,206	82.36%
1000	1,679	86.49%
5000	5,494	100.00%

3.10 Nitrogen Loads of OSDS

3.10.1 Methodology and Assumptions

Total nitrogen (TN) loads were estimated for all OSDS in the county. The following variables were used in the computations:

- TN load per person from septic leach field (pounds [lbs.]/day)
- Persons per equivalent dwelling unit (persons/EDU)
- Nonresidential flow rate (gallons per day per account [gpd/acct])
- TN from nonresidential septic leach field (milligrams per liter [mg/L])
- TN for denitrifying OSDS (mg/L)
- TN for sewer connection (mg/L)
- Delivery ratio, as a function of distance from the OSDS to the water's edge (%)

Several different scenarios were developed to show the sensitivity of the pollutant load to different assumptions for the input variables (see Appendix B). The estimated TN load per year ranges from 459,000 to 1,241,000 lbs. based on the different scenarios. The total load using delivery ratio assumptions recommended by MDE is 881,000 lbs. Even with the most conservative assumptions, the TN load from OSDS is similar to the total load from the County's nine wastewater plants at ENR limits: 609,000 lbs/year.

The TN load per person from conventional OSDS, 9.5 pounds per year, is the value suggested by MDE in *Maryland's 2006 TMDL* [total maximum daily load] *Implementation Guidance for Local Governments* (MDE, 2006). This equates to a concentration of 40 mg/L at a flow rate of 78 gallons per person per day. Residential flow rates were not used in the computations; instead, total loads per person were used, as suggested by MDE during a meeting on August 3, 2006.

Persons per household numbers, 2.60, were derived from the census data for Anne Arundel County.

Nonresidential flow rates were assumed to be 1,300 gpd per account, based on County recommended flow factors.

The TN load per capita for denitrifying systems was derived by assuming a concentration of 20 mg/L, as recommended by MDE.

The TN load per capita for hooking up to sewer was derived by assuming a concentration of 3 mg/L, as recommended by MDE for ENR level of wastewater treatment.

Delivery ratios reflect the fraction of TN that is delivered to receiving waters. These are influenced by many variables, including complexities of different soils, distances of systems to the nearest water body, plant uptake, and depth to the saturation zone. Most nitrogen from OSDS moves through the groundwater in the form of nitrate. MDE's TMDL guidance suggests an average delivery ratio of 60 percent. The Chesapeake Bay Program model reportedly used an average delivery ratio of 40 percent. The U.S. Environmental Protection Agency's Chesapeake Bay Program has summarized the literature on nitrate removal from shallow groundwater in *Water Quality Functions of Riparian Forest Buffer Systems in the Chesapeake Bay Watershed* (EPA, 1995). Studies show delivery ratios ranging from 75 to

10 percent. Therefore, some scenarios were run with delivery ratios varying from 100 percent at the water's edge to 40 percent for systems 5,000 feet away.

During the course of the OSDS Evaluation Study, MDE provided guidance that delivery ratios should be set as follows:

- 80 percent for OSDS within the Critical Area
- 50 percent for OSDS outside the Critical Area and within 1,000 feet of nontidal waters
- 30 percent for all other OSDS

These 80/50/30 MDE delivery ratio assumptions were used to summarize the estimated current TN loads by watershed, by SSA, and by sewer service planning category.

Figure 3-4 shows the location where each delivery ratio assumption applies. Note that 32 percent of all OSDS are within the Chesapeake Bay Critical Area (see Table 3-7) and 86 percent of all OSDS are within 1000 ft of either tidal and non-tidal surface water (see Table 3-8).

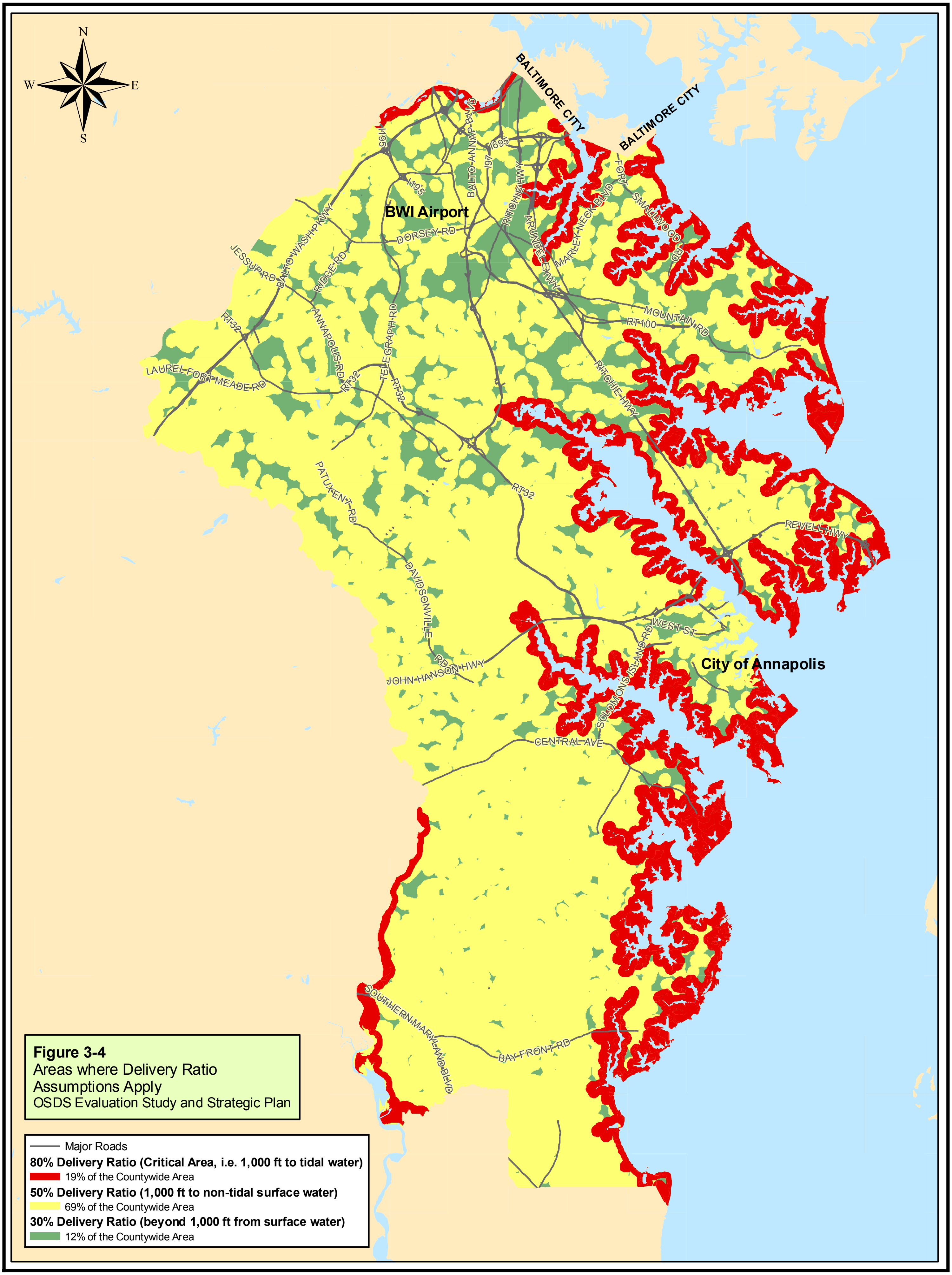


Figure 3-4
Areas where Delivery Ratio Assumptions Apply
OSDS Evaluation Study and Strategic Plan

3.10.2 TN Loads by Watershed

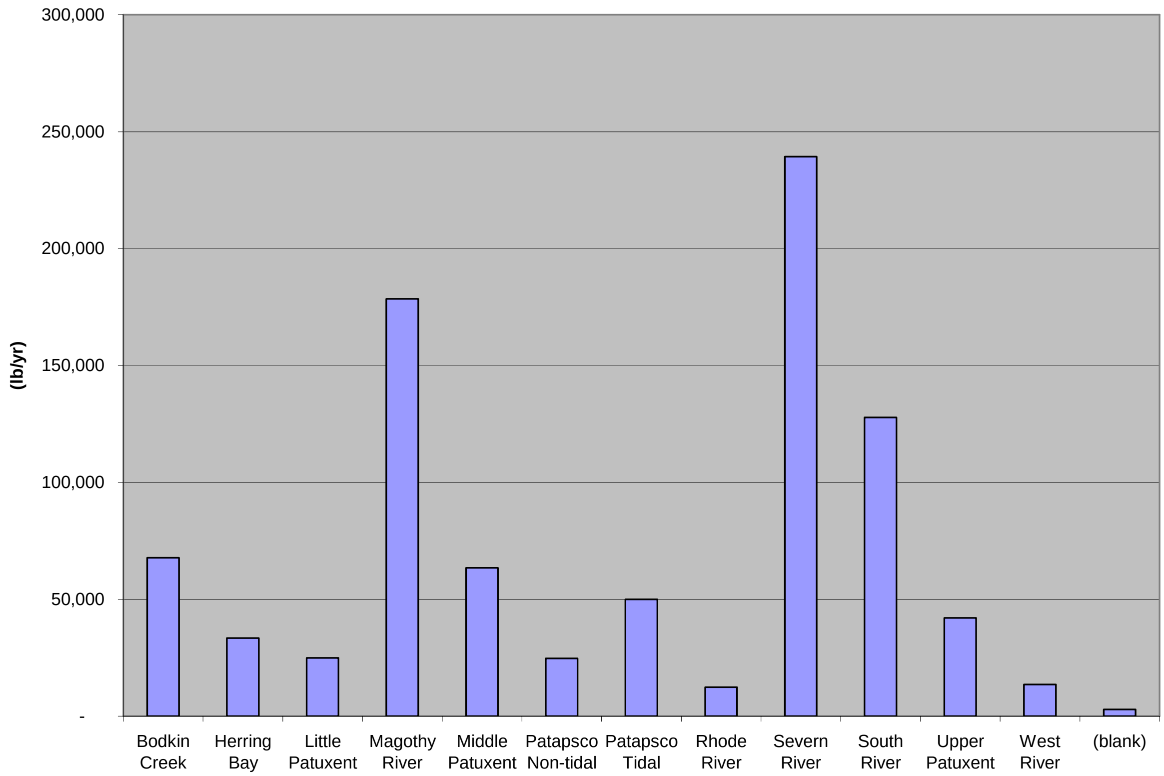
Table 3-9 shows the estimated current TN loads by watershed. Figure 3-5 shows a bar chart of the estimated TN load.

TABLE 3-9
TN Delivered from OSDS to Receiving Waters, by Watershed
Anne Arundel County OSDS Evaluation Study

Watershed	Total (lbs.)	Percentage
Bodkin Creek	67,815	7.7
Herring Bay	33,406	3.8
Little Patuxent	24,899	2.8
Magothy River	178,517	20.3
Middle Patuxent	63,439	7.2
Patapsco Non-tidal	24,770	2.8
Patapsco Tidal	49,959	5.7
Rhode River	12,457	1.4
Severn River	239,348	27.2
South River	127,840	14.5
Upper Patuxent	42,067	4.8
West River	13,630	1.5
(blank)	2,853	0.3
Grand Total	881,000	100.0

Note: Assumes nitrogen delivery ratio of 80% in Critical Areas, 50% within 1,000 feet of non-tidal waters, and 30% elsewhere, per MDE guidance.

FIGURE 3-5
TN Delivered from OSDS to Receiving Waters, by Watershed



3.10.3 TN Loads by SSA

Table 3-10 shows the estimated current TN loads by SSA.

TABLE 3-10
TN Delivered from OSDS to Receiving Waters, by SSA
Anne Arundel County OSDS Evaluation Study

SSA	Total (lbs.)	Percentage
Annapolis	81,556	9.3
Baltimore City	30,593	3.5
Bodkin Pt.-Pinehurst	3,408	0.4
Broadneck	174,209	19.8
Broadwater	10,826	1.2
Cox Creek	58,096	6.6
Ft. George Meade	127	0.0
Maryland City	6,047	0.7
Mayo-Glebe Heights	3,246	0.4
Patuxent	24,886	2.8
Piney Orchard	426	0.0
Rose Haven	186	0.0
Rural	484,449	55.0
(blank)	2,947	0.3
Grand Total	881,000	100.0

Note: Assumes nitrogen delivery ratio of 80% in Critical Areas, 50% within 1,000 feet of non-tidal waters, and 30% elsewhere, per MDE guidance.

3.10.4 TN Loads by Sewer Service Planning Category

Table 3-11 shows the estimated current TN loads by sewer planning category.

TABLE 3-11
TN Delivered from OSDS to Receiving Waters, by Planned Sewer Service Type
Anne Arundel County OSDS Evaluation Study

Sewer Type	Total (lbs.)	Percentage
Existing Service	50,973	5.8
Planned Service	109,661	12.4
Future Service	161,468	18.3
No Public Service	487,732	55.4
Resource Conservation Area	66,417	7.5
Other	1,059	0.1
Park	775	0.1
(blank)	2,915	0.3
Grand Total	881,000	100.0

Note: Assumes nitrogen delivery ratio of 80% in Critical Areas, 50% within 1,000 feet of non-tidal waters, and 30% elsewhere, per MDE guidance.

3.11 References

EPA. 1995. *Water Quality Functions of Riparian Forest Buffer Systems in the Chesapeake Bay Watershed.*

MDE. 2006. *Maryland's 2006 TMDL Implementation Guidance for Local Governments*.

SECTION 4

Treatment Alternative Unit Costs and Cost Effectiveness

4.1 Approach to Unit Cost Estimates - Pilot Area Case Studies

Planning-level cost estimates were developed for enhanced onsite septic systems, for potential sewer extension projects to connect existing areas with septic systems to existing SSAs, and for potential cluster community wastewater systems. These treatment approaches were evaluated with respect to their life-cycle costs and removal efficiency and to provide baseline planning information for developing a countywide treatment strategy.

Detailed schematic designs were completed for 10 study areas that represent 5,654 acres of Anne Arundel County that are served by onsite systems. With one exception, these areas were all significantly larger than the communities that the County periodically evaluates for sewer extension on a petition basis. In order to extend the data set to examine sewer extension costs for small communities, the output of 14 petition studies that have been conducted for the County by various consultants since January of 1998 was reviewed. The petition areas generally represent areas that are smaller than 200 acres and about 50 acres on average.

Figure 4-1 shows the locations of the 10 study areas relative to a density map of OSDS in the county. From these designs, detailed capital and operation and maintenance (O&M) cost estimates were prepared using a life-cycle cost module (see Appendix C for details). This module was applied to provide a uniform evaluation of the effectiveness of three treatment approaches:

1. Extension of the County collection system to serve the OSDS communities
2. Provision of a local collection system and a cluster treatment facility for each community
3. Upgrading the existing OSDS to provided enhanced nitrogen removal

Cost data and assumptions were reviewed and revised based on input from MDE and the County Health Department.

Based on analysis of capital costs per EDU in the study areas and the 14 smaller petition study areas, there does not appear to be a strong relationship between distance to existing sewers and capital costs as shown in Appendix C and contrary to previous studies in the literature (Appendix A). Similarly, for the larger case study areas a strong relationship did not exist for the unit cost of sewer extension in relation to distance from the existing facilities. However, in several cases the cost of sewer extension was significantly lower than individual upgrades when OSDS density was high, and distance to existing sewer was relatively lower.

When investigating the potential for economies of scale that could result when applying each alternative to communities of increasing size, again the relationships were not very strong suggesting that several site specific factors would influence the costs more than distance to sewer or community size alone. OSDS density was a much stronger factor in the cost to provide treatment to a given community onsite system. The data revealed that it became generally more cost-effective to provide a local collection system when OSDS density exceeded 0.68 systems per acre.

Based on these analyses it was decided that rather than select a cost relationship that varies with distance, average capital and EUAC cost numbers were used per EDU, as shown in Table 4-1.

TABLE 4-1
Unit Cost per Equivalent Dwelling Unit (EDU) for Initial Capital Costs and Life Cycle Costs (Equivalent Uniform Annual Costs) of Treatment Alternatives

	Unit Cost per EDU		
	Sewer Extension	**Cluster Treatment**	**OSDS Upgrade**
Initial Capital	$38,000	$36,203	$13,000
Equivalent Uniform Annual Cost	$3,780	$3,550	$3,750

4.2 Initial Capital Costs and Life Cycle Costs per EDU

The unit costs of each treatment approach are presented in Figures 4-2 and 4-3 as an initial capital cost and an Equivalent Uniform Annual Cost (EUAC), respectively. The EUACs are life cycle costs that factor in the initial capital costs, O&M costs, and capital renewal costs, based on the service life of each component. The EUACs were computed using a 5 percent discount rate and a 4 percent inflation factor.

Figures 4-2 and 4-3 indicate that OSDS system upgrades are the least costly from an initial capital investment standpoint, but are similar in cost over the long term when O&M, service life, inflation, and energy costs are accounted for. It should also be noted that the OSDS upgrade alternative assumed that drain field replacement or rehabilitation costs would not be incurred in the initial capital cost of the upgrade, but only after a service life of 50 years.

Figure 4-4 provides a breakdown of the individual components of the EUAC costs. These costs incorporate the recent Maryland energy cost increases as of May 2007.

Figure 4-1. Onsite Sewage Disposal System (OSDS) Density and Study Areas

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May 14, 2006

FIGURE 4-2
Initial Capital Cost per EDU for Each Treatment Alternative

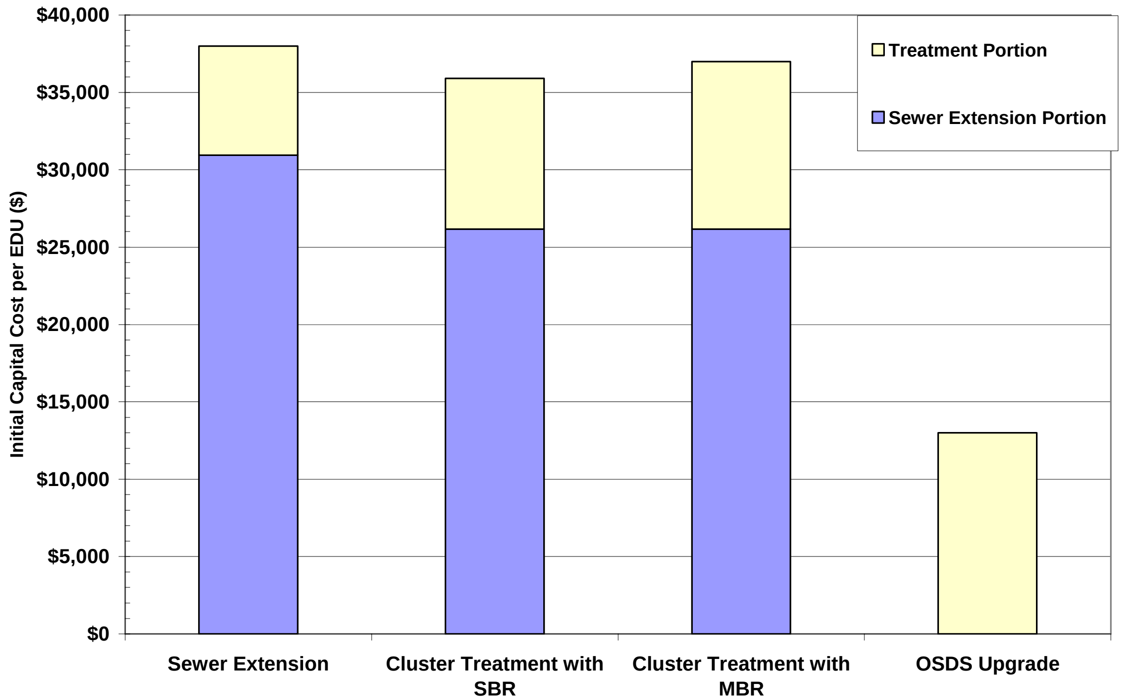


FIGURE 4-3
EUAC per EDU for Each Treatment Alternative

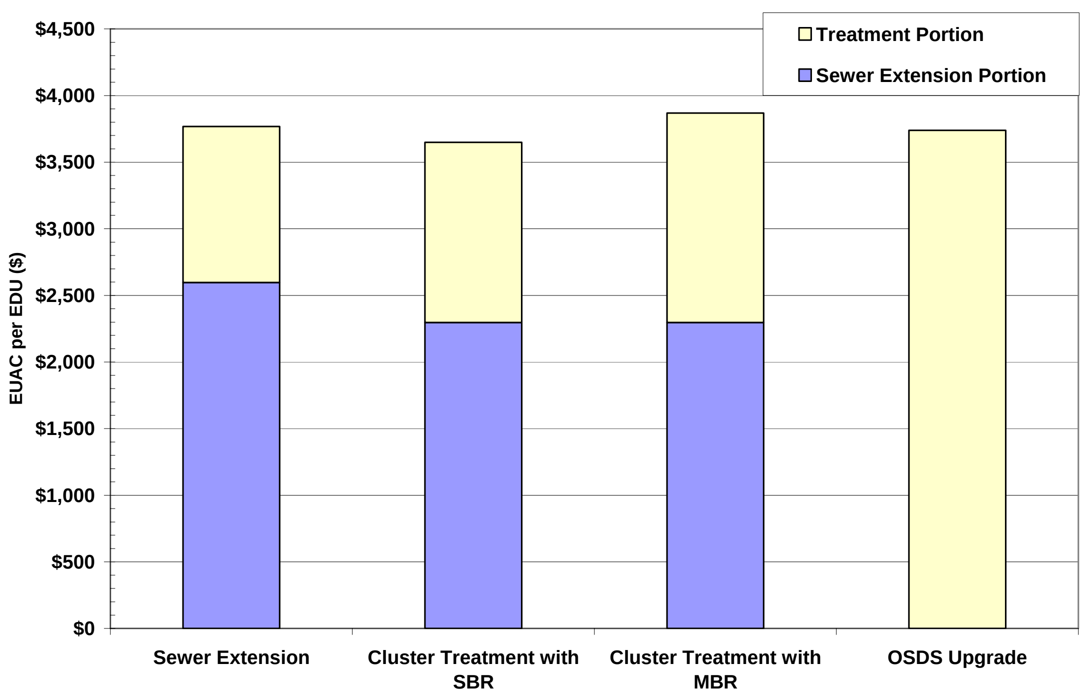
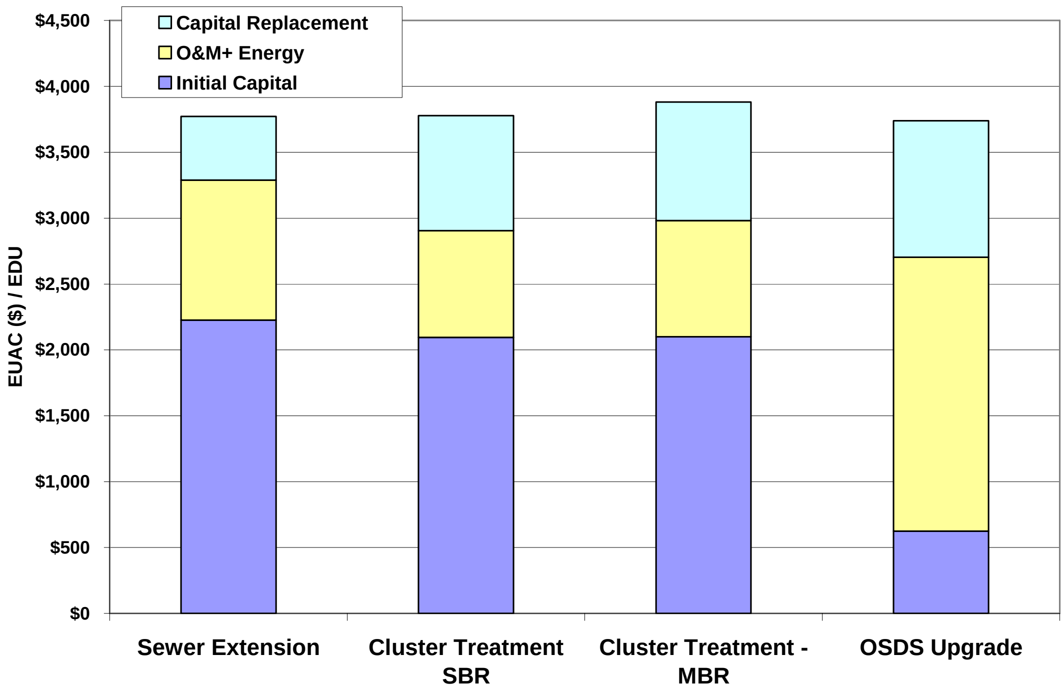


FIGURE 4-4
EUAC per EDU for Each Treatment Alternative with Component Cost Breakdown



Tables 4-2 and 4-3 summarize the costs to provide treatment to all OSDS in the county. The unit costs of treatment were extrapolated on a countywide basis, using the average of the costs of each treatment alternative for the 10 representative communities. These tables indicate that the total program cost for the OSDS upgrades over the long term could range from $527million to $1.6 billion. Although it is unrealistic for every OSDS to require a treatment upgrade, these cost figures underscore the importance of selecting a long-term treatment method that will provide sustainable TN reductions. The recommended strategy for managing OSDS, presented in Section 6, is a combination of the most cost-effective measures appropriate to each local situation of OSDS density, nitrogen delivery ratios, and proximity to sewer.

TABLE 4-2
Countywide Initial Capital Costs of Treatment Alternatives

Initial Capital ($millions)			
Sewer Extension	Sewer Extension w/ addt'l treatment	Cluster Treatment	OSDS Upgrade
$1,134	$1,541	$1,468	$527

Note: Assumes countywide implementation at unit costs from case studies, as shown in Figure 4-2.

TABLE 4-3
Countywide EUAC of Treatment Alternatives

EUAC ($millions)			
Sewer Extension	**Sewer Extension w/ addt'l treatment**	**Cluster Treatment**	**OSDS Upgrade**
$106	$153	$144	$152

Note: Assumes countywide implementation at unit costs from case studies, as shown in Figure 4-3.

4.3 Cost Effectiveness of Denitrifying OSDS Upgrades versus Hookup to Sewer

The overall cost effectiveness of each treatment approach in reducing TN loads delivered to area receiving waters was analyzed on a unit cost per pound removal basis. The MDE 80/50/30 delivery ratio approach was applied to the effluent concentration for each treatment approach and applied to each OSDS in the county. The effluent concentrations were assumed to be 3 mg/L for the sewer extension alternative to reflect upgrading the WRFs to ENR. The membrane bioreactor (MBR)-based cluster treatment facilities used in the cost analysis were designed provide an effluent with 3 mg/L TN. The sequencing batch reactor (SBR) cluster systems would provide 8 mg/L to be consistent with MDE requirements for all treatment facilities with flows above 5,000 gpd. The OSDS denitrification upgrades were estimated to provide 20 mg/L TN per MDE policy. The total cumulative delivered load and the total load reduction achievable are summarized in Table 4-4. The achievable reductions from this table were used to translate the average treatment cost for each alternative to a cost per pound removed. This is illustrated in Figures 4-5 and 4-6, along with the total achievable TN reduction.

This analysis indicated that on a per-unit removal basis, sewer extensions and cluster treatment approaches are more cost effective and are capable of obtaining a higher level of TN removal than OSDS upgrades. It is important to recognize that the cost and load reduction numbers in Table 4-4 assume hypothetically that all OSDS receive a given form a treatment. In practice, each treatment approach is not feasible everywhere, given varying OSDS densities and distance from existing sewer and other factors. In the next step, OSDS were grouped into Management Areas where a given treatment approach could be applied based on sewer planning category, proximity to sewer, and OSDS density.

TABLE 4-4
Comparison of Treatment Alternatives by Effluent Concentration, Delivered Load, and Achievable Countywide Reduction

	Sewer Extension and WRF	Cluster Treatment with SBR and Land Application	Cluster Treatment with MBR and Direct Discharge	OSDS Upgrade
Effluent N Concentration (mg/L)	3	8	3	20
Delivered TN	119,640	323,581	119,640	443,221
Achievable TN Reduction	761,360	557,419	761,360	437,779
Initial Capital Cost $/LB TN Removed	$ 2,030	$ 2,621	$ 1,977	$ 1,208
EUAC $/LB TN Removed	$ 201	$ 266	$ 207	$ 347

Note: Load estimates based on current MDE delivery ratio assumption - 80% for OSDS in Critical Area, 50% for OSDS within 1,000 feet of receiving water, 30% for all other OSDS.

FIGURE 4-5
Estimated Nitrogen Load Reduction Achievable by Treatment Technology and Total Initial Capital Cost per lb. of Nitrogen Removed

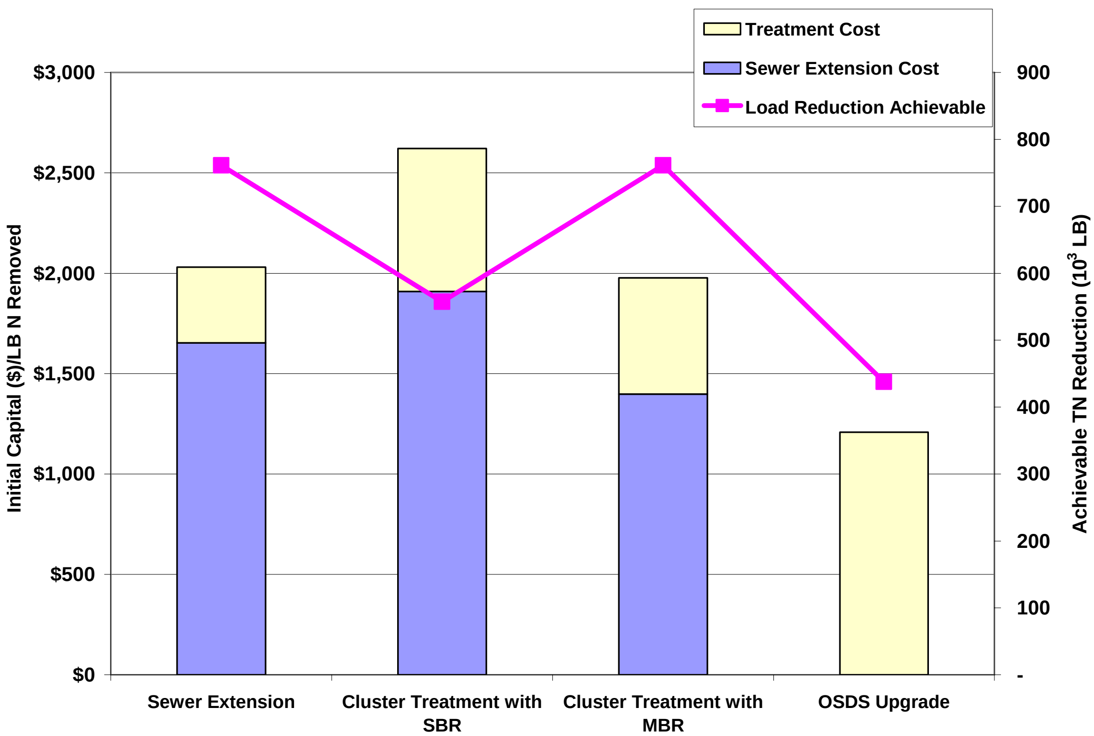
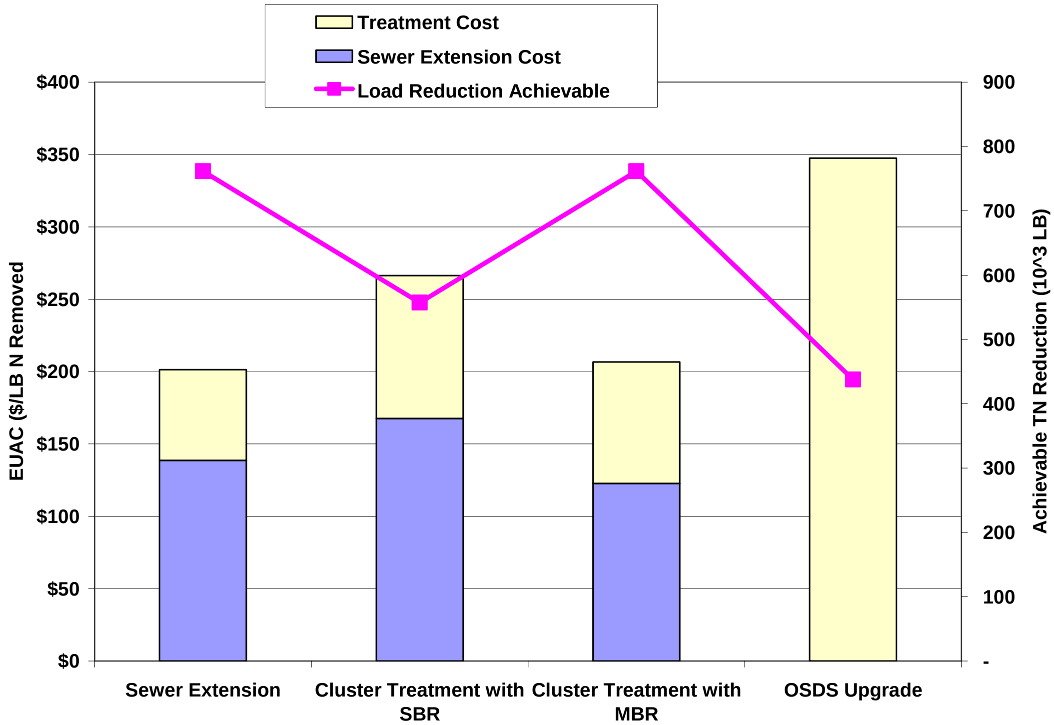


FIGURE 4-6
Estimated Nitrogen Load Reduction Achievable by Treatment Technology and Equivalent Uniform Annual Cost per lb. of Nitrogen Removed



SECTION 5

Technical, Policy, Regulatory, and Statutory Issues

5.1 Technical Issues

In addition to establishing the most cost effective nitrogen reduction approach for the onsite systems from a technical perspective, numerous policy issues were considered that would need to be addressed in order to implement the management strategy. These would require some level of federal, state, and local action. The issues can be categorized into technical, county-level policy and regulatory issues, and state-level policy and regulatory issues, as outlined below and explained in further detail in Appendix D. Section 6 contains specific recommended actions to address these issues as part of the overall OSDS Strategic Plan.

Technical issues addressed include need for research to better understand OSDS effluent nitrogen concentration and delivery ratios.

5.1.1 Need to Improve the Understanding of Existing OSDS Effluent Nitrogen Loads and Delivery Ratios

Key parameters in this study included the TN concentration in OSDS effluent at the edge of the drain field, and the percentage of this nitrogen that enters the nearest surface water. This study undertook no new research on these parameters and relied on the assumptions about OSDS performance and the delivery ratios that MDE was applying as part of its OSDS management policy and EPA's Chesapeake Bay Program office. An extensive literature review was performed, in addition to the study documented in Appendix A, and no additional sources were found that could substantiate or refute the present numbers adopted by MDE. As a result, the principle of increasing nitrogen delivery with distance to receiving water is sensible; however, these assumptions suffer from a relatively high degree of uncertainty, and there is scant scientific data to support the present assumptions. Therefore, the strategic plan includes recommendations for collaboration on research into OSDS effluent nitrogen loads and delivery ratios.

5.1.2 OSDS Effluent Nitrogen Concentration

MDE has indicated, based on its literature review and experience, that the effluent nitrogen concentration at the edge of the drain field of a properly functioning OSDS ranges from 40 to 50 mg/L. The low end of this range, 40 mg/L, was used in the study. However, a recent comprehensive literature review (WERF #04DEC1a) found that the median septic effluent nitrogen concentration of a large number of studies was 55.4 mg/L for single-source domestic OSDS, and 84.0 mg/L for non-medical commercial systems. Therefore, the 40 mg/L used in the study may be low.

5.1.3 Delivery Ratios

The Chesapeake Bay Program's watershed model assumes a nitrogen delivery ratio of 40 percent for all septic systems regardless of location. This study evaluated applying delivery ratios ranging from 40 to 100 percent, depending on distance from the nearest surface water. During the course of the study, MDE adopted a set of delivery ratio assumptions based on location and distance to surface water. These delivery ratios are 80 percent for OSDS within the Critical Area, 50 percent for systems outside of the Critical Area but within 1,000 feet of non-tidal surface waters, and 30 percent everywhere else. These four sets of assumptions produce substantially different results for estimating existing nitrogen loads to surface waters, expected load reductions, and the OSDS hookup credits. Table 5-1 illustrates the wide range in estimated annual TN loads produced by the four sets of assumptions.

TABLE 5-1
Impact of Delivery Ratio Assumptions on Estimated Total Annual OSDS Nitrogen Delivered to Surface Waters in Anne Arundel County

Delivery Ratio Assumption	Annual Load, lbs
40 Percent	640,000
80/50/30	880,000
60 Percent	960,000
40 to 100 Percent Scale, varying with distance from surface water	1,240,000

As noted above, there are little or no data underlying any of these assumptions. Additional research on delivery ratios would be extremely valuable in improving the accuracy of OSDS load and load reduction estimations, and would result in more reliable and efficient OSDS plans. It would also facilitate additional refinements to the OSDS hookup credits. It is strongly recommended that the Chesapeake Bay Program and MDE initiate and support research on OSDS delivery ratios as part of the Tributary Strategy implementation.

5.2 County-level Policy and Regulatory Issues

County-level policy and regulatory issues addressed include need for coordination of the recommended OSDS Strategic Plan with the County's update to the General Development Plan, including the need for better understanding of ways to mitigate unintended consequences of extending sewer service on development growth; need for an impact fee for OSDS; and need for programs and regulations to promote the reliability and sustainability of individual OSDS upgrades.

5.2.1 Coordination with the General Development Plan

The recommendations of this study, presented in Section 6, have implications for land use planning, zoning, and sewer service category decisions; therefore, the adoption of a septics strategic plan must be coordinated with the County's General Development Plan (GDP). Likewise, the GDP should be consistent with the adopted OSDS Strategic Plan.

In some cases, the OSDS Strategic Plan makes recommendations regarding the extension of the existing sewer system into areas currently without sewer service. Future sewer service may be planned for some of these areas, or none may be planned. The total number of OSDS proposed for sewer extension is 12,205 in areas currently planned or designated by the County for future sewer service, and 1,529 in areas designated as No Public Service. Corresponding flows in these areas is 4.16 mgd for sewer extension in planned or future sewer service areas, and 0.49 mgd for sewer extension in designated no public service areas, respectively. Similar data are presented in Appendix D for proposed cluster systems. The proposed sewer extension or cluster systems creates the potential for additional growth demands in these areas simply because of the proximity of sewers, which would be inconsistent with the GDP. It is recommended that the County include provisions in the GDP, such as the creation of special SSAs with restrictions on the provision of sewer service within the SSA, or designating sewer mains built for the primary purpose of OSDS retirement as limited access sewers, with connections limited to OSDS retirement and new development that is consistent with the existing GDP, zoning, and sewer service category. No matter what measures are adopted, however, the only certain barrier to unintended growth is the political will to resist pressure to allow additional development simply because a sewer is present in an area with no planned growth.

Anne Arundel County is currently revising the GDP, with a target date of August 2008 for the Final Draft. The development of the preliminary drafts should incorporate the findings and recommendations of the septics study that the County wants to implement. The schedule for development of the GDP drafts is such that these recommendations can be easily incorporated in the initial drafts. This will also provide the benefit of public review of the OSDS Evaluation Study findings and recommendations.

The GDP must also address the requirements of House Bill (HB) 1141, the *Land Use – Local Government Planning Act* of 2006. HB 1141 requires jurisdictions to include a water resources element (WRE) in their comprehensive plans The purpose of the WRE is to ensure that planned land use does not exceed the carrying capacity of the watersheds, defined as water supplies and wastewater treatment capacity adequate to support the planned land uses, and control of stormwater-related pollutant loads. A TMDL-like analysis is required for each watershed. For each watershed, pollutant loads for existing and proposed land uses are calculated, and the total is compared to the "assimilative capacity" of the watershed. If the analysis indicates that the planned land use would result in violations of water quality standards, then it must be revised or other ways found to reduce the pollutant loadings. Analysis of OSDS nutrient loads is required as part of this analysis.

All of Anne Arundel County's 8-digit watersheds are included on Maryland's 303(d) list of impaired waters requiring TMDLs. The analysis required by HB 1141 should be coordinated with TMDL development.

5.2.2 Impact Fee for New OSDS

The County and the State will spend significant amounts of money in the future to reduce OSDS nitrogen loads. To help offset this, one alternative is to assess a fee on new OSDS installations, the proceeds of which would be used for OSDS conversions, cluster treatment facilities, or sewer extensions to connect OSDS. The principal justification for the fee is that new OSDS nitrogen sources should be required to offset their loads by funding OSDS nitrogen load reductions elsewhere through the imposition of the fee.

Unit cost data that could support development of an impact fee are presented in Section 4 and Appendix C. An analysis of possible fee structures should consider the following questions in assessing an OSDS impact fee.

1. What loads should new OSDS development be required to offset?
   - OSDS effluent nitrogen loads
   - OSDS effluent nitrogen loads and stormwater loads
   - OSDS effluent nitrogen loads, stormwater loads, and all other indirectly generated loads (e.g., transportation-related)
2. What mechanisms should be considered for making the offsets available?
   - Developer/builder acquires offsets directly through the Maryland trading and offsets program
   - Developer/builder acquires offsets by purchasing them from the County, with the revenue being dedicated to implementation of the OSDS Strategic Plan
3. What are the possible bases for the fee?
   - Cost to treat the same flow volume at a WRF
   - Cost to achieve equivalent reduction through OSDS conversion or hookup to sewer
   - Cost to acquire the offsets from lowest cost sources under Maryland's trading and offsets policy (e.g., credit/offset generators, payment to State funds)
4. How much cost should be recovered?
   - Full
   - Actual cost to achieve required load reduction elsewhere
   - A portion of the full or actual cost
   - Maximize revenue

Properly structuring and setting the fee would require financial modeling of the expected revenue and expense, as well as assessment of financial impact on the community. It is recommended that the County initiate a separate study to assess the OSDS impact fee.

5.2.3 OSDS Reliability and Sustainability of Individual Upgrades

This study assessed OSDS nitrogen loadings and calculated present worth and EUACs to reduce loadings, as discussed in Section 3 and presented in detail in Appendix C. The cost estimating framework used a 100-year life-cycle so the complete service life of all major treatment system components could be represented. Adequate O&M costs to ensure proper operation of the facilities over the full planning period were included in the analysis. However, the three technologies considered in the study—upgrading conventional OSDS to achieve nitrogen removal, local cluster treatment facilities, and connection to public sewer—

differ significantly in the assurance they provide that proper O&M would be carried out and the projected load reduction actually achieved over the full planning period. Connection to an existing water reclamation or new cluster facility would mean County ownership and operation of the facilities, while OSDS upgrades would involve contracts between the State and/or County and individual homeowners.

Currently, there is nothing in the State-homeowner contract that would provide assurances that proper O&M would be provided beyond the initial 5-year period covered by the contract. In addition, beyond the initial 5 years, there would be nothing to prevent homeowners from shutting off the power to the OSDS to avoid the significantly higher electricity costs they would incur as a result of the upgrade, as the County Health Department staff has reportedly observed in some instances.

Given the need for long-term reliability, the adequacy of the State contract with homeowners should be evaluated. It is possible that additional contractual requirements are needed. It is also possible that this issue should be addressed through additional State or County regulation.

5.3 State-Level Policy and Regulatory Issues

State-level policy and regulatory issues addressed include the need for guidance on how to translate tributary strategy goals to the County-level; the need to change the Chesapeake Bay Restoration Fund Act law to make funds eligible for treatment approaches other than OSDS upgrades, including sewer extension and cluster treatment systems; and the need for permitting guidance and flexibility to address new cluster treatment systems, OSDS hookup credits and bubble permits.

5.3.1 Translating and Applying Tributary Strategy Goals

This study addressed the question, "What are the Tributary Strategy requirements for septic load reductions?" The Tributary Strategy, however, takes a programmatic approach calling for conversion of all septic systems to denitrifying ones. The strategy has no nitrogen load reduction requirements per se. Even though not required for the preparation of the basin implementation plans, this study evaluated whether the septic load goals for the Lower Western Shore, Patapsco/Back River and Patuxent basins could be divided into jurisdictional or watershed allocations. It was found that it would take major land-use database enhancements to incorporate political boundaries in the Chesapeake Bay watershed model. Hence, at this time, any political sub-allocation of the Tributary Strategy load goals would be mathematically arbitrary, so its use should be restricted to generalized planning purposes.

Given this, the study made no attempt to translate the Tributary Strategy septic load goals to numeric County goals. There is little doubt however, that the County's strategy, if implemented, would be more cost-effective and result in greater nitrogen load reductions than the approach taken in the Tributary Strategy.

5.3.2 Chesapeake Bay Restoration Fund Act Eligibility

The Chesapeake Bay Restoration Fund Act (CBRFA) currently allows the use of septic fund monies only for upgrading OSDS. Given the increased cost effectiveness on a per pound of nitrogen basis of the sewer connection and cluster treatment options, as shown by this study and the recommended plan, strong consideration should be given to amending the statute to allow Bay Restoration Funds to be used for sewer extensions and hookups, as well as community collection systems and cluster treatment facilities, as long as the primary purpose is to reduce nitrogen loads to surface waters and the Chesapeake Bay.

5.3.3 Permitting Issues

Three National Pollution Discharge Elimination System permitting issues must be addressed—nitrogen wasteload allocations for new cluster treatment facilities, management options for cluster facility effluent given the restriction on discharges to shellfish waters, and the handling of OSDS hookup credits under the County's bubble permit.

5.3.3.1 Wasteload Allocation for New Cluster Treatment Facilities

New cluster treatment facilities built for the primary purpose of retiring OSDS and reducing nitrogen loads to surface waters should be exempt from MDE's current point source policy, which grants no nitrogen or phosphorus load allocation to new wastewater treatment facilities built to accommodate growth.

5.3.3.2 Management of Cluster System Effluent

The discharge of wastewater effluent into surface waters designated as shellfish waters is prohibited. In some cases, this restricts the available OSDS options in some areas; cluster treatment facilities may not be selected where such restrictions exist. In these cases, alternate management options for the effluent may provide the answer. Such technologies could include spray irrigation or natural wetland flow augmentation. Both the State and local jurisdictions would benefit from the development of additional management options for cluster system effluent. The County should encourage MDE to support efforts to develop additional management options for high-quality cluster treatment effluent. A detailed description of the types of the effluent treatment, disposal, and reuse options that were considered for cluster systems is described in Appendix C.

5.3.3.3 OSDS Hookup Credits and the Bubble Permit

When the County obtains OSDS hookup nitrogen credits, they presumably will be added to the aggregate point source nitrogen allocation established by the bubble permit, regardless of where in the County the hookup occurred. The County should obtain MDE concurrence in this interpretation and ensure that the bubble permit, when issued, is consistent with this interpretation. A potential framework for establishing the OSDS hookup credit is provided below.

5.3.4 Establishing the OSDS Hookup Credit

The idea of an OSDS nitrogen allocation hookup credit has been under discussion in Maryland for several years. MDE's draft nutrient trading policy, not yet released, proposes credits based on loads calculated using the 80/50/30 percent delivery ratios, depending on location. The policy also states that the proposed credits of 12.2, 7.5, and 4.6 pounds per year are for hookup to a treatment facility discharging at 4 mg/L TN, and that non-residential systems should be treated on a case-by-case basis.

Refinement to the OSDS hookup credit is needed, and discussions with MDE should continue. The credit is directly dependent on the assumed delivery ratios which are, as noted above, themselves in need of additional research. In addition, the reasons for basing the credits on the assumption that WRFs would be discharging nitrogen at 4 mg/L are not clear. The CBRFA requires that facilities "optimize" their performance, meaning discharging as close to 3 mg/L as possible. There are other questions as to exactly how the credits would be applied as well.

Whatever the ultimate magnitude of the OSDS hookup credit, it could be a smart growth tool for the County. Table 5-2 illustrates this by using Management Area SV421 as an example. MDE's currently proposed methodology for calculating credits is used. If all 332 OSD systems in Management Area SV421 were retired and connected to a WRF or cluster treatment facility discharging at 4.0 mg/L nitrogen, up to 1,772 new domestic hookups could be accommodated under the County's point source bubble permit. The credits could also be used to offset urban stormwater or other nonpoint source loads as well. Under a nutrient trading program, such credits could become valuable commodities as Maryland experiences continuing growth pressure. MDE should continue to work with local jurisdictions and the wastewater community to refine the development and implementation of the OSDS hookup credits.

TABLE 5-2
OSDS Hookup Credit Calculation for Management Area SV421

	Residential			Non-residential			
Delivery Ratio	**No. OSDS**	**Credit/OSDS Pounds/Yr**	**Total Credit Pounds/Yr**	**No. OSDS**	**Credit/OSDS Pounds/Yr**	**Total Credit Pounds/Yr**	**Total Credit Pounds/Yr**
0.8	255	9.6	2,448	3	50	150	2,598
0.5	77	4.5	347	101	23	2,363	2,710
0.3	-	1.6	-	1	8	8	8
Total	**332**		**2,795**	**105**		**2,521**	**5,316**

Could support 1,772 new hookups to ENR facility, at 3.0 lbs per hookup (250 gpd x 4 mg/L).
Credit per OSDS is based on MDE's draft trading policy, which assumes 9.5 lb/person/yr, 3.2 person/OSDS, and the given delivery ratio. Nonresidential credits per OSDS were estimated based on the residential credit multiplied by the ratio of flow factors 1300/250.

SECTION 6

Prioritization and Strategic Plan for Reducing OSDS Nitrogen Loads

6.1 Purpose and Overview

This section summarizes the strategy for countywide implementation of the recommended alternatives for treating OSDS. This strategy is based on the organization of the onsite systems into logical MAs and a recommended treatment technology for each area that is based on the most cost-effective approach to nitrogen removal. The MAs were assigned a treatment technology based on the cost-effectiveness analysis presented in Section 4 (and Appendix C) and the nitrogen delivery ratio, as defined by MDE as part of its nutrient management policies. A prioritization was also developed that applied the criteria developed in Task 1 (Appendix B) and on a nitrogen load reduction basis per guidance provided by MDE.[2]

This section describes the approach and results of placing OSDS into MAs, the prioritization of MAs based on nitrogen reduction cost effectiveness, and the overall OSDS Strategic Plan.

6.2 OSDS MAs and Recommended Treatment Approach

The methodology for grouping OSDS into MAs with common treatment approach recommendations is presented below, followed by a summary of the recommended treatment approach and a description of the GIS database.

6.2.1 Purpose and Overview of MA Delineation Procedure

The purpose of using MAs was to provide logical groups of OSDS sites that are assigned the most cost-effective and environmentally beneficial treatment technology for each area. The overall procedure consisted of three steps:

1. Characterize OSDS by density and delivery ratio and place into bins representing a preliminary treatment approach for each individual OSDS
2. Group OSDS into MAs
3. Assign a treatment approach to each MA

In other words, each MA comprised a group of OSDS with like characteristics that would allow the same treatment technology to be assigned to all OSDS in the bin. This process is illustrated in Figure 6-1. The following criteria were used to group the OSDS into MAs:

[2] MDE provided verbal guidance to the Anne Arundel County OSDS project team at a June 2007 meeting, at which it recommended that nitrogen delivery from OSDS leach fields to receiving waters be estimated as 80 percent in the Critical Area (within 1000 ft of tidal waters), 50 percent within 1000 ft of nontidal waters, and 30 percent everywhere else. This guidance represents a change from previous MDE policy assuming a constant 60 percent delivery, regardless of location. MDE has since incorporated this new policy into draft nutrient trading policy, not yet published.

- Planned sewer service (existing, planned, future, no service)
- OSDS density
- Nitrogen delivery ratio
- Subwatershed divides in rural SSAs with no planned sewer service
- Proximity to sewer
- Health Department-identified problem area

The three-step procedure for MA delineation and treatment approach definition is presented in additional detail in Attachment C.

6.2.2 MA Treatment Recommendations

The results of the MA treatment recommendations are shown in Figure 6-2. Table 6-1 shows the distribution of OSDS by treatment approach (bin) and watershed.

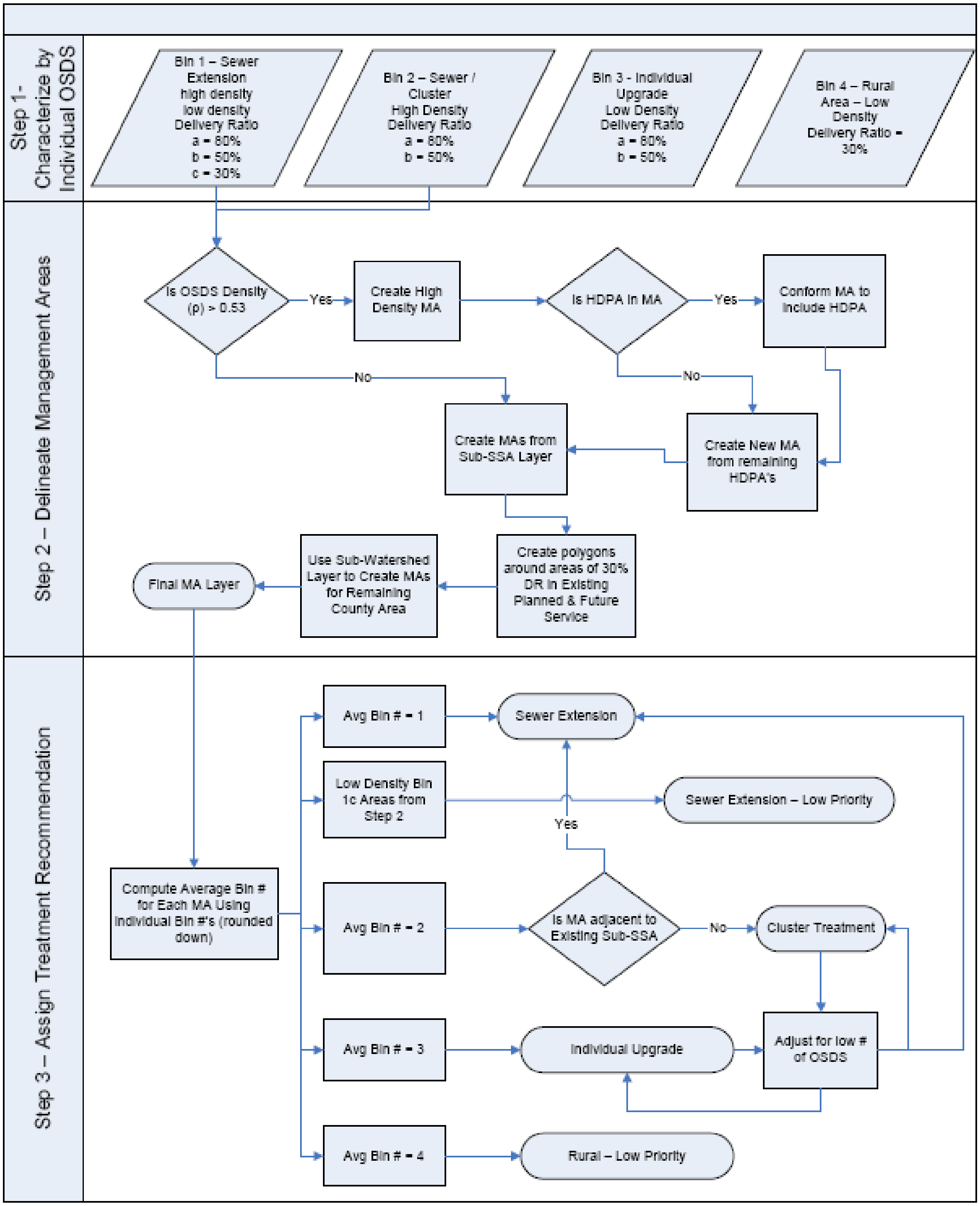
Note that the recommended treatment approach includes two categories of MAs, designated as (1) low-priority/no-action, including MAs in County-designated rural areas not designated for public sewer service (bin 4); and (2) existing, planned, or future SSAs with density below the 0.68 OSDS /acre cost-effectiveness threshold and with a low delivery ratio of 30 percent (bin 1c). These areas are called out as areas of low priority for OSDS upgrades or no action, or possible re-designation as areas of no public sewer service. In cost and load reduction analyses, no action was assumed for these MAs. Figure 3 in Appendix D shows these low- priority/no-action OSDS MAs.

At the other end of the spectrum, Figure 3 in Appendix D also shows areas recommended for sewer extension (bin 1) that extend into areas that are not currently recommended for sewer service. These areas are recommended for service as a result of high density of OSDS systems in areas of high nitrogen delivery ratio that are adjacent to areas of current sewer service.

6.2.3 GIS Database Description

A key outcome of this project is the development of a complete database and GIS mapping system that will allow the County to zoom into priority areas, by watershed or by SSA, to display and analyze OSDS MAs as implementation and policy issues are further elaborated. That database and the mapping system are summarized in Appendix D. A complete list of MAs and database information is contained in Attachments A, B and C of Appendix D, along with a map index of the location of MAs. Attachment A of Appendix D explains the MA naming convention and includes a list in alphabetical order by MA. The list in Attachment B of Appendix D is prioritized based on cost effectiveness (cost per pound of nitrogen reduction). Attachment C of Appendix D contains the same list of MAs, but sorted in order of priority scores from the priority criteria developed in Task 1 of this study (*Identification, Categorization and Prioritization,* see TM-1 in Appendix B of this report). Summary maps based on the database and GIS mapping system are displayed throughout this report.

FIGURE 6-1
OSDS Management Area Delineation Procedure



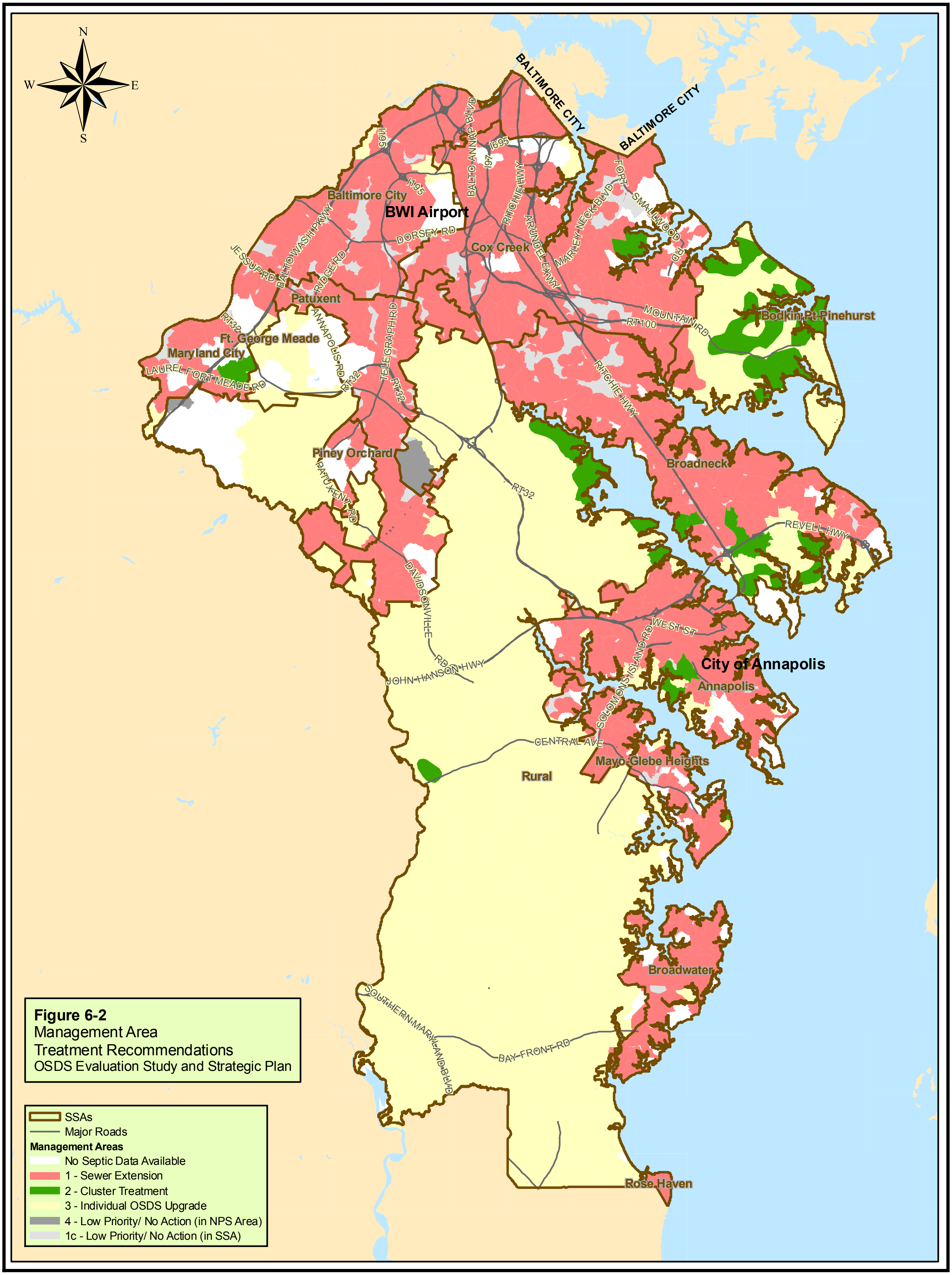


Figure 6-2
Management Area
Treatment Recommendations
OSDS Evaluation Study and Strategic Plan

TABLE 6-1
Distribution of Treatment Recommendations by Watershed

	Bin						
Watershed	1 Sewer Extension	2 Cluster Treatment	3 Individual OSDS Upgrade	4 Low Priority / No Action (in NPS Area)	1c Low Priority / No Action (in SSA)	# OSDS	% OSDS
Bodkin Creek	10	2379	704	0	0	3093	7.6%
Herring Bay	166	0	875	0	0	1041	2.6%
Little Patuxent	496	6	141	13	137	793	1.9%
Magothy River	6335	1900	808	0	583	9626	23.7%
Middle Patuxent	0	0	2206	0	0	2206	5.4%
Patapsco Non-tidal	862	0	27	0	231	1120	2.8%
Patapsco Tidal	1310	482	122	0	249	2163	5.3%
Rhode River	15	1	399	0	15	430	1.1%
Severn River	4375	3662	3552	0	337	11926	29.3%
South River	2179	126	3727	0	52	6084	15.0%
Upper Patuxent	105	281	1321	1	7	1715	4.2%
West River	96	0	249	0	6	351	0.9%
Blank	76	41	17	0	0	134	0.3%
Total	16025	8878	14148	14	1617	40682	
%	39.4%	21.8%	34.8%	0.0%	4.0%		

NPS is No Public Service areas, not designated for sewer service, largely in the rural area.
SSA is the Sewer Service Areas designated for existing, planned or future sewer service.

Attachment A of Appendix D contains a complete list of MAs, with nitrogen load and cost information as follows:

- Area (Acres)
- Number of OSDS in MA
- Assigned Bin # (Treatment Technology)
- SSA for Sewer Extension (Bin 1)
- Existing Load (LB/YR)
- Load After Treatment (LB/YR)
- Load Reduction (LB/YR)
- Total EUAC ($/YR)
- Total Initial Capital Cost ($)
- $EUAC/LB Reduced
- $IC/LB Reduced

- Priority Rank
- N reduction per OSDS (lb/OSDS/yr)

6.3 OSDS Strategic Plan

Given the primary goal of managing nitrogen discharges from OSDS to the Chesapeake Bay, the recommended overall OSDS Strategic Plan consists of two components:

- A prioritization of OSDS MAs in order of cost effectiveness. OSDS are grouped into areas of similar treatment recommendations and then prioritized in declining order of costs per pound of nitrogen removed.
- A list of regulatory, policy, and research actions that are recommended to support implementation of the OSDS treatment approaches, based on the issues presented in Section 5.

6.3.1 Strategic Plan: OSDS Management Area Priorities

Approach to Prioritization

Two approaches were taken to prioritizing MAs:

- Prioritization based on ranking scores reflecting County evaluation criteria, not tied directly to nitrogen load reduction
- Prioritization based on the cost effectiveness of each MA's nitrogen load reduction.

In the first approach, the OSDS priority rank was based on the aggregate score of the following criteria: proximity to surface water, location in Chesapeake Critical Areas, location in Health Department problem areas (HDPAs), and slope. Appendix B explains how these criteria were scored. The ranking scores for each OSDS in the database were averaged within each MA to arrive at an aggregate priority rank for each MA. The scores for the MAs are shown in Figures 6 and 7 in Appendix D relative to watershed boundaries and sewer service boundaries, respectively. Appendix D also tabulates priority scores based on County evaluation criteria by treatment bin and sewer planning category.

The second prioritization approach used in this study ensured that the most cost-effective treatment approach was applied to areas of highest nitrogen delivery and density first. Given the limited resources of the County and State, prioritizing OSDS treatment based on cost-effectiveness is the recommended approach.

The overall cost-effectiveness of each treatment approach in reducing nitrogen loads delivered to area receiving waters was analyzed on a unit cost per-pound removal basis in TM-2 (Appendix C). The MDE 80/50/30 delivery ratio approach was applied to the effluent concentration for each treatment approach and applied to each OSDS in the county. The effluent concentrations were assumed to be 3 mg/L for the sewer extension alternative, to reflect upgrading the WRFs to ENR. The MBR-based cluster treatment facilities used in the cost analysis were designed to provide an effluent with 3 mg/L TN. The SBR cluster systems would provide 8 mg/L, to be consistent with MDE requirements for all treatment facilities above 5,000 gpd. The OSDS denitrification upgrades were estimated to have an effluent concentration of 20 mg/L TN at the drainfield, per MDE policy.

TN Reduction by Watershed

For the recommended OSDS treatment approaches, Tables 6-2, 6-3, and 6-4 present the existing TN load, load after treatment, and load reduction due to treatment, broken down by treatment approach and watershed. The TN load was based on the MDE recommended delivery ratio of 80/50/30 percent according to OSDS location.

TABLE 6-2
Existing TN Load (lb/yr) by Treatment Approach (Bin) and Watershed

	Treatment Bin						
Watershed	**1 Sewer Extension**	**2 Cluster Treatment**	**3 Individual OSDS Upgrade**	**4 Low Priority / No Action (in NPS Area)**	**1c Low Priority / No Action (in SSA)**	**Total**	**Percent**
Bodkin Creek	79	45337	22399	0	0	67815	7.7
Herring Bay	6503	0	26903	0	0	33406	3.8
Little Patuxent	16296	475	4851	417	2860	24899	2.8
Magothy River	117796	34064	20012	0	6646	178517	20.3
Middle Patuxent	0	0	63439	0	0	63439	7.2
Patapsco Non-tidal	21438	0	457	0	2875	24770	2.8
Patapsco Tidal	28505	12859	4504	0	4091	49959	5.7
Rhode River	630	127	11348	0	352	12457	1.4
Severn River	87220	74618	73328	0	4181	239348	27.2
South River	50562	3176	73356	0	746	127840	14.5
Upper Patuxent	6510	3716	31621	48	172	42067	4.8
West River	3396	0	10189	0	44	13630	1.5
Blank	1659	843	351	0	0	2853	0.3
Total	**340,594**	**175,215**	**342,760**	**465**	**21,967**	**881,000**	
Percent	38.7	19.9	38.9	0.1	2.5		

NPS is No Public Service areas, not designated for sewer service, largely in the rural area.
SSA is the Sewer Service Areas designated for existing, planned or future sewer service.

TABLE 6-3
TN Load (lb/yr) After Treatment by Treatment Approach (Bin) and Watershed

	Treatment Bin						
Watershed	**1 Sewer Extension**	**2 Cluster Treatment**	**3 Individual OSDS Upgrade**	**4 Low Priority / No Action (in NPS Area)**	**1c Low Priority / No Action (in SSA)**	**Total**	**Percent**
Bodkin Creek	18	4943	11240	0	0	16202	6.2
Herring Bay	617	0	13508	0	0	14125	5.4
Little Patuxent	2471	71	2431	417	2860	8250	3.2
Magothy River	15356	4190	10070	0	6646	36262	14.0
Middle Patuxent	0	0	31830	0	0	31830	12.2
Patapsco Non-tidal	3176	0	230	0	2875	6281	2.4
Patapsco Tidal	3993	1532	2260	0	4091	11876	4.6
Rhode River	68	12	5695	0	352	6126	2.4
Severn River	12280	7894	36880	0	4181	61234	23.6
South River	6069	303	36909	0	746	44027	16.9
Upper Patuxent	976	579	15879	48	172	17654	6.8
West River	358	0	5108	0	44	5511	2.1
Blank	241	116	177	0	0	533	0.2
Total	**45,623**	**19,639**	**172,218**	**465**	**21,967**	**259,911**	
Percent	17.6	7.6	66.3	0.2	8.5		

NPS is No Public Service areas, not designated for sewer service, largely in the Rural area.
SSA is the Sewer Service Areas designated for existing, planned or future sewer service.

TABLE 6-4
TN Load (lb/yr) Reduction by Treatment Approach (Bin) and Watershed

	Treatment Bin						
Watershed	1 Sewer Extension	2 Cluster Treatment	3 Individual OSDS Upgrade	4 Low Priority / No Action (in NPS Area)	1c Low Priority / No Action (in SSA)	Total	Percent
Bodkin Creek	61	40393	11159	0	0	51613	19.9
Herring Bay	5886	0	13394	0	0	19280	7.4
Little Patuxent	13826	404	2420	0	0	16650	6.4
Magothy River	102440	29874	9942	0	0	142256	54.7
Middle Patuxent	0	0	31609	0	0	31609	12.2
Patapsco Non-tidal	18262	0	227	0	0	18489	7.1
Patapsco Tidal	24512	11328	2244	0	0	38083	14.7
Rhode River	562	115	5654	0	0	6330	2.4
Severn River	74941	66725	36449	0	0	178114	68.5
South River	44494	2873	36446	0	0	83813	32.2
Upper Patuxent	5534	3137	15742	0	0	24413	9.4
West River	3038	0	5081	0	0	8119	3.1
Blank	1418	728	175	0	0	2320	0.9
Total	**294,971**	**155,576**	**170,542**	**0**	**0**	**621,089**	
Percent	113.5	59.9	65.6	0.0	0.0		

NPS is No Public Service areas, not designated for sewer service, largely in the Rural area.
SSA is the Sewer Service Areas designated for existing, planned or future sewer service.

Figures 6-3 and 6-4 show the existing load and the load after treatment on a per-area basis (pounds per acre per year). For comparison purposes, Figure 6-5 shows the load after treatment that would occur if all OSDS were upgraded individually, assuming a resulting effluent concentration of 20 mg/L plus the delivery ratio of each system to receiving waters. In effect, Figure 6-5 shows the loads that would result if the County implemented the Tributary Strategy recommendation of OSDS upgrades.

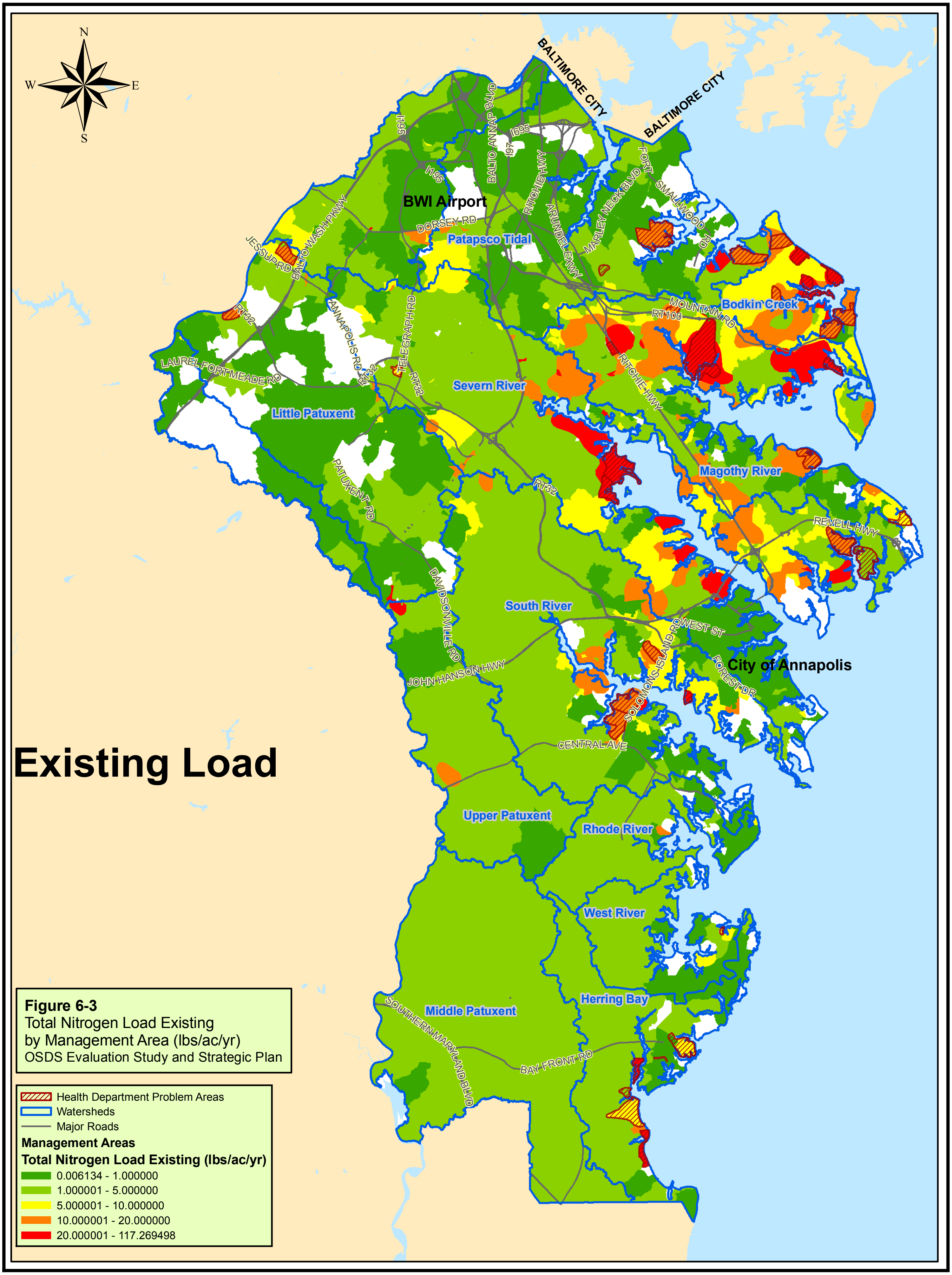
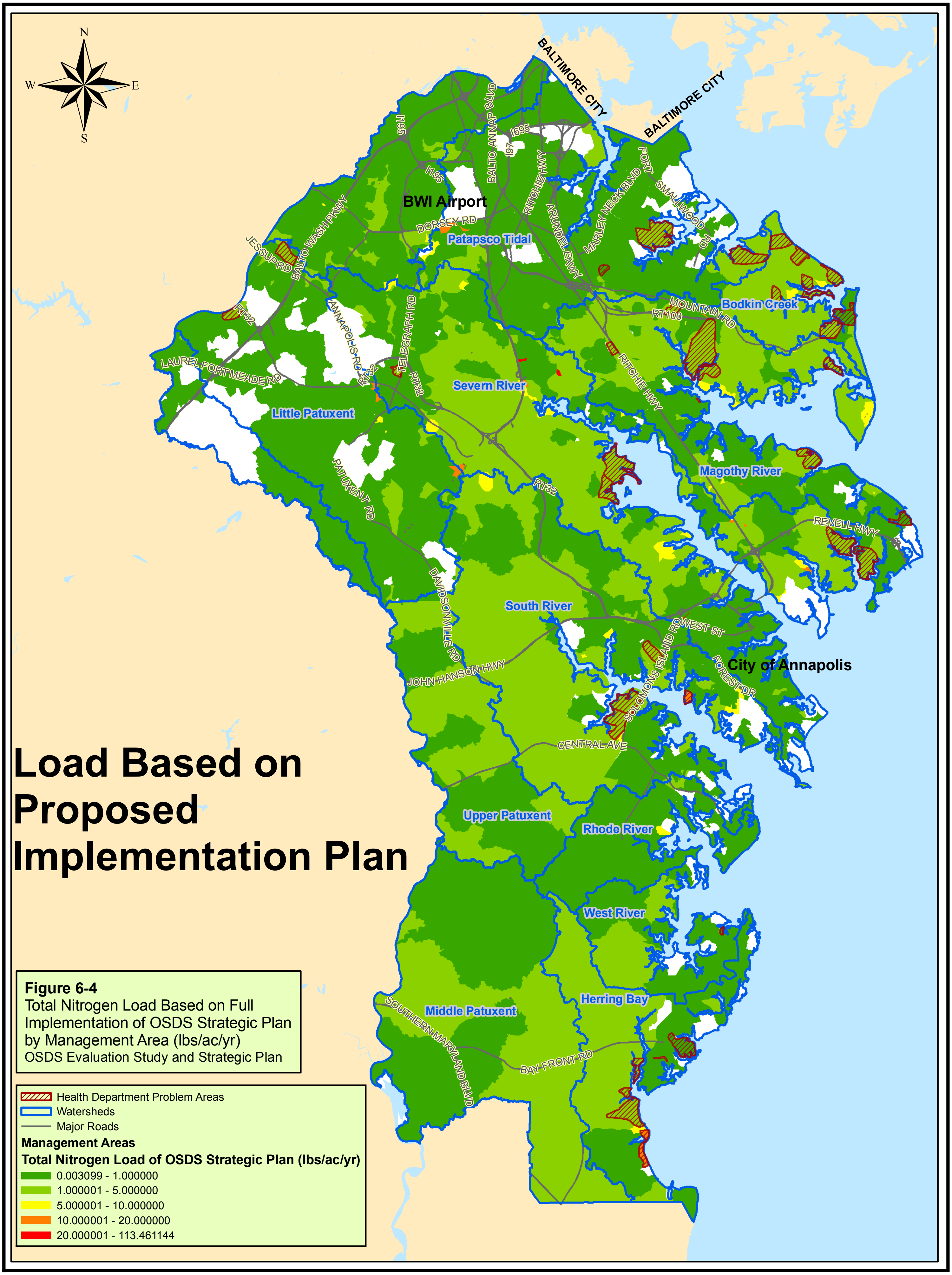


Figure 6-3
Total Nitrogen Load Existing by Management Area (lbs/ac/yr)
OSDS Evaluation Study and Strategic Plan



Load Based on Proposed Implementation Plan

Figure 6-4
Total Nitrogen Load Based on Full Implementation of OSDS Strategic Plan by Management Area (lbs/ac/yr)
OSDS Evaluation Study and Strategic Plan

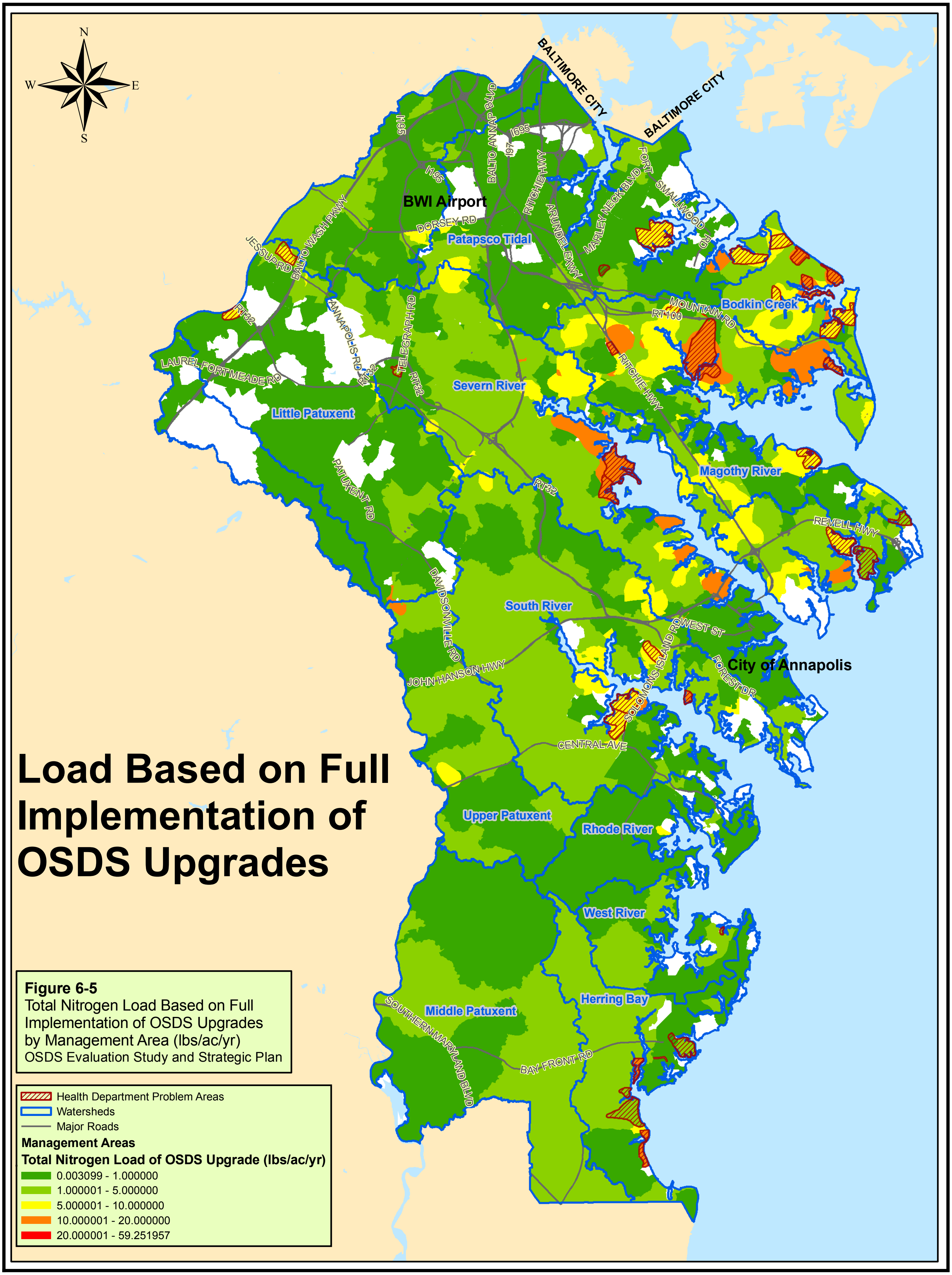


Figure 6-5
Total Nitrogen Load Based on Full Implementation of OSDS Upgrades by Management Area (lbs/ac/yr)
OSDS Evaluation Study and Strategic Plan

The list in Attachment A of Appendix D is prioritized based on cost-effectiveness (cost per pound of nitrogen reduction). Attachment B of Appendix D also contains an index map of the location of MAs, showing three priority groups based on cost-effectiveness. High-priority MAs are the first 15 percent, based on cost effectiveness. Medium-priority MAs are from 15 to 60 percent, and low-priority MAs are the last 40 percent. Figure 6-6 shows a countywide overview of those priority MAs. Figure 6-7 shows the three priority groups with a comparison of the cumulative nitrogen reduced, for all management areas sorted in declining order of removal effectiveness (pounds nitrogen removed per OSDS), compared to the cost effectiveness of removal (EUAC per pound removed).

Note that this prioritization scheme is based on average cost-effectiveness per OSDS within an MA, which may not reflect total load reduction or load per unit area. Figures 4a and 4b in Appendix D compare the load reductions of the recommended OSDS strategy on a per-OSDS basis and on a per-area basis. The load reduction per OSDS correlates best with the recommended prioritization of OSDS MAs. Some MAs in the high- priority group contain a small number of OSDS, but these are usually high load delivered because they are in high delivery ratio areas and may be non-residential systems. It is recommended that additional prioritization criteria be considered in the final ranking of OSDS projects, such as watershed priority, total load reduced, and other factors.

Figure 6-8 shows the load reduction for each treatment recommendation on a per area basis; that is the load after treatment subtracted from the current load, for areas recommended for sewer extension, for cluster treatment, and for OSDS upgrade, respectively.

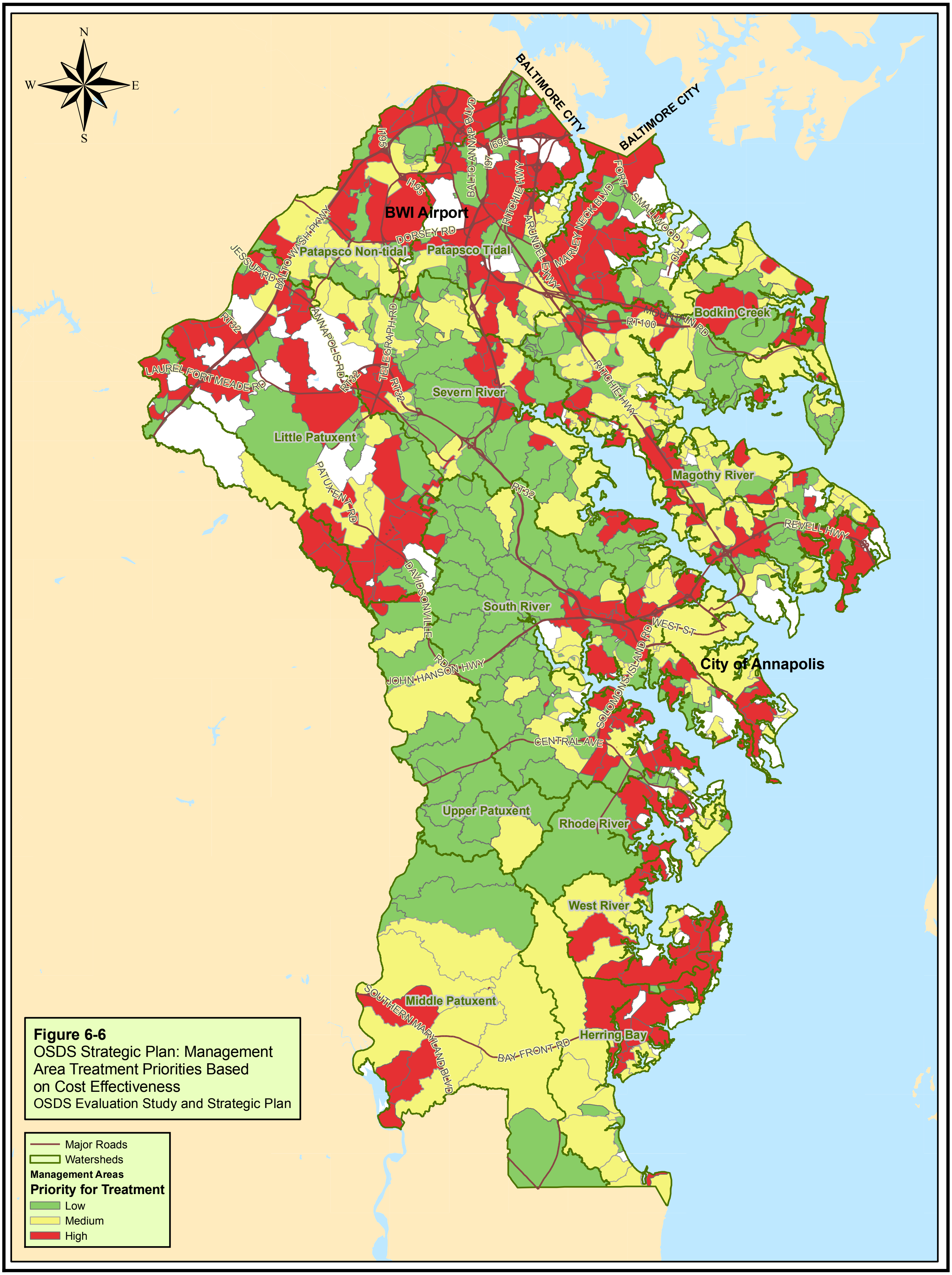
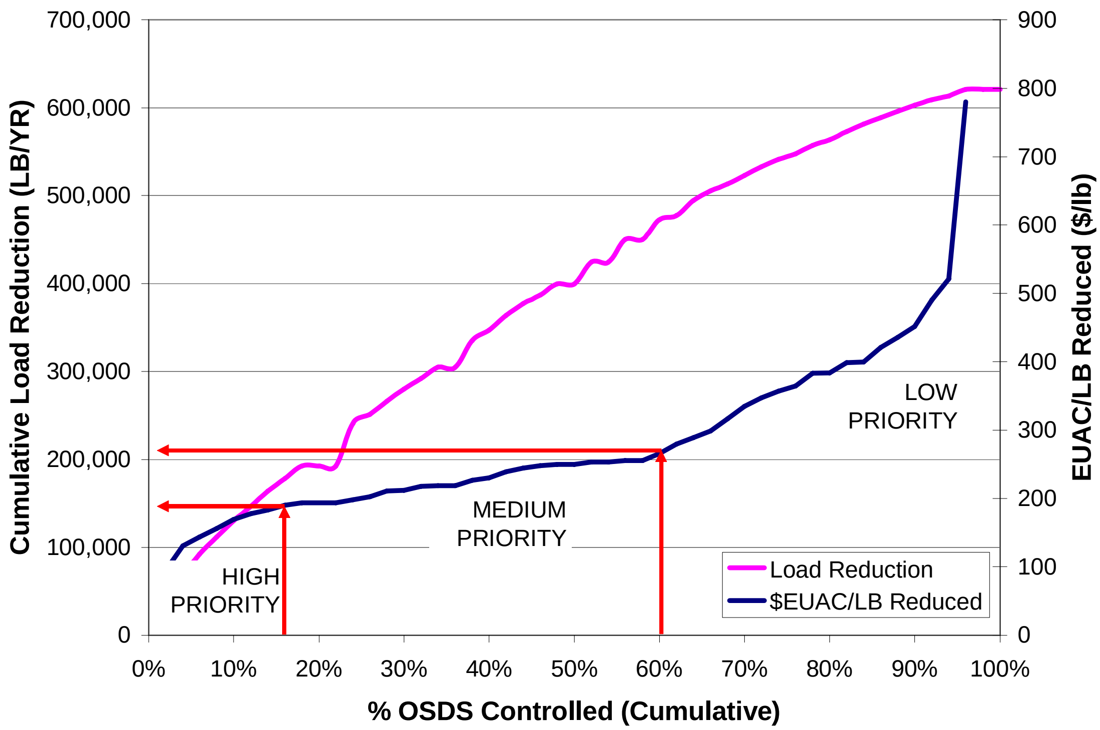


Figure 6-6
OSDS Strategic Plan: Management Area Treatment Priorities Based on Cost Effectiveness
OSDS Evaluation Study and Strategic Plan

FIGURE 6-7
Cumulative Total Nitrogen Reduction vs. Cumulative Number of OSDS Treated, Ranked by Management Area Unit Load Reduction (lbs/OSDS/yr), Compared to Cost Efficiency (EUAC $ Per Pound Nitrogen Reduced)



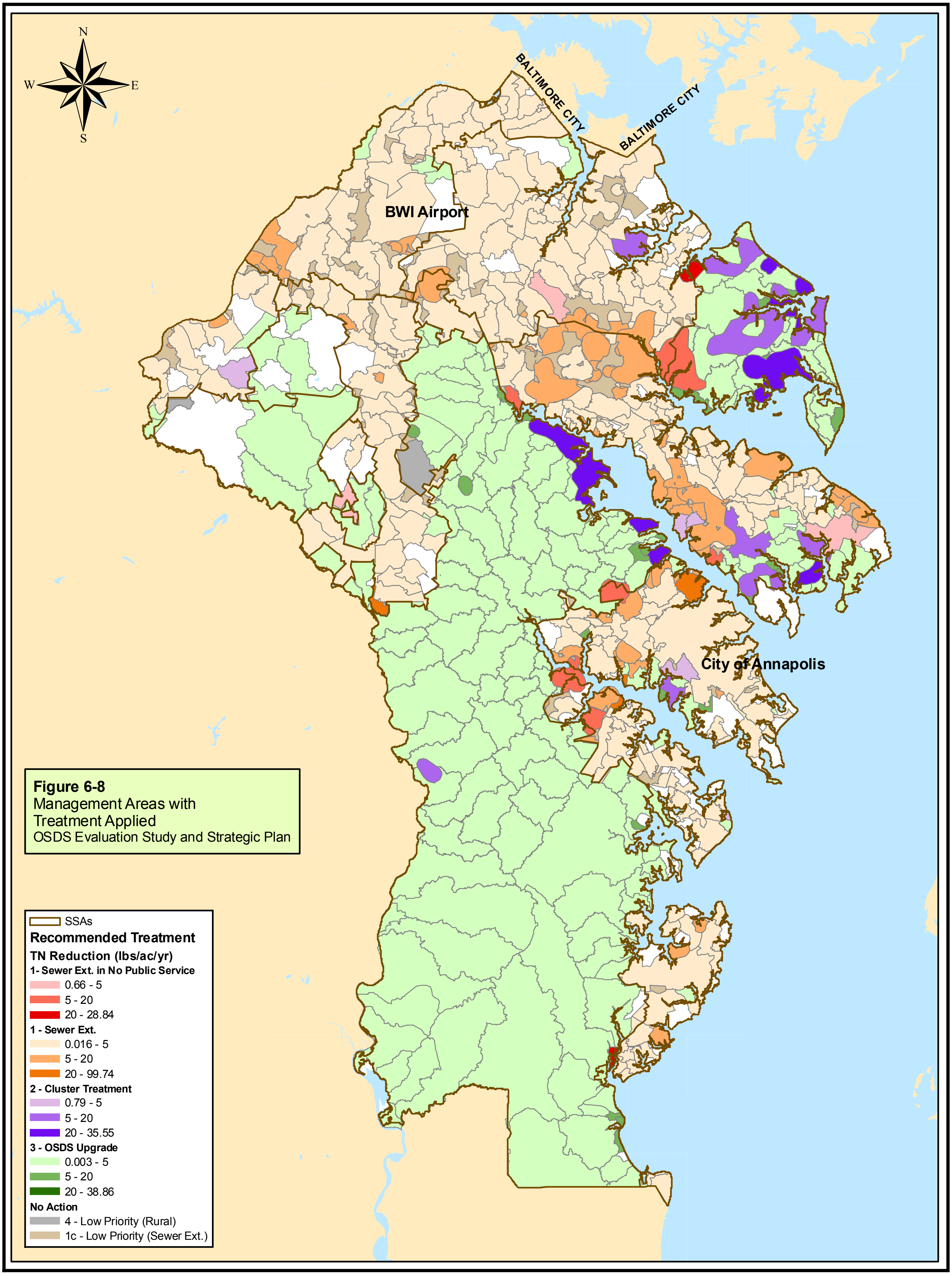


Figure 6-8
Management Areas with
Treatment Applied
OSDS Evaluation Study and Strategic Plan

Summary of Nitrogen Reduction and Costs by Watershed

Table 6-5 summarizes the number of OSDS, load reductions, treatment costs, and costs per pound for the recommended treatment approaches for each watershed. Appendix D contains a more-detailed breakdown of costs by watershed, by sewer service planning type, and by treatment approach.

TABLE 6-5
Summary of Treatment Costs and Nutrient Removal Efficiency by Watershed

Watershed	Number of OSDS	Total Initial Capital Cost ($M)	EUAC ($M)	TN Load Reduction (LB/yr)	Avg Initial Capital $/LB Removal	Avg EUAC $/LB Removal	Avg OSDS Priority
Bodkin Creek	3093	95.66	11.12	51,613	3,075	357	1.94
Herring Bay	1041	17.68	3.91	19,280	960	176	2.94
Little Patuxent	793	20.90	2.42	16,650	886	136	1.58
Magothy River	9626	320.02	33.72	142,256	1,903	255	2.07
Middle Patuxent	2206	28.68	8.27	31,609	907	262	2.08
Patapsco Non-tidal	1120	33.11	3.36	18,489	1,670	312	1.53
Patapsco Tidal	2163	68.82	7.12	38,083	1,426	186	2.12
Rhode River	430	5.79	1.56	6,330	749	132	2.35
Severn River	11926	345.00	42.86	178,114	1,824	260	2.06
South River	6084	135.81	22.66	83,813	1,593	241	2.24
Upper Patuxent	1715	31.34	6.35	24,413	1,685	235	1.53
West River	351	6.89	1.30	8,119	919	152	2.14
Blank	134	4.59	0.50	2,320	1,781	256	2.84
Total	**40,682**	**1,114.28**	**145.15**	**621,089**			

Summary of Nitrogen Reduction and Costs by HDPA

The Anne Arundel County Health Department has identified areas in the county that have OSDS that are either substandard or require alternative systems to avoid failure due to poor soil conditions, high groundwater, small lot size or steep slopes. The locations of these HDPAs are shown on Figures 6-3, 6-4 and 6-5. Table 6-6 summarizes the number of OSDS, load reductions, treatment costs, and costs per pound for the recommended treatment approaches for each MA that overlaps with an HDPA.

TABLE 6-6
Summary of Treatment Costs and Nutrient Removal Efficiency for OSDS MAs that Intersect HDPAs

Management Area ID	Number of OSDS	Cost Effectiveness Priority	Treatment Recommended (BIN)	Existing Load (lb/yr)	Load After Treatment (lb/yr)	Load After OSDS Upgrade (lb/yr)	Total Initial Capital Cost ($)	Total EUAC ($/yr)	Avg Initial Capital $/LB Removal	Avg EUAC $/LB Removal	Avg OSDS Priority
SV62	61	HIGH	1	2,881	303	24	2,318,000	230,580			
PT135	147	HIGH	2	6,830	863	1,445	5,321,913	521,850	892	87	2.83
HB137	51	HIGH	1	2,383	225	7	1,938,000	192,780	898	89	3.20
LP138	19	HIGH	1	1,103	165	7	722,000	71,820	770	77	1.67
BC173	139	HIGH	2	2,987	307	186	5,032,285	493,450	1,878	184	3.15
BC178	96	HIGH	2	2,124	207	3,423	3,475,535	340,800	1,813	178	3.38
BC258	140	HIGH	2	3,408	319	39	5,068,488	497,000	1,641	161	3.33
SO425	240	HIGH	1	5,960	614	1,195	9,120,000	907,200	1,706	170	3.12
HB472	6	HIGH	1	332	31	552	228,000	22,680	757	75	3.11
SV482	183	HIGH	2	3,907	368	1,506	6,625,238	649,650	1,872	184	3.32
WR501	8	HIGH	1	578	55	160	304,000	30,240	581	58	2.65
BC565	149	HIGH	2	3,689	375	1,071	5,394,320	528,950	1,628	160	2.66
BC567	224	HIGH	2	5,068	474	12,551	8,109,581	795,200	1,765	173	3.10
SV582	14	HIGH	3	597	300	1,551	182,000	52,500	612	176	3.46
SV583	16	HIGH	1	465	70	1,244	608,000	60,480	1,538	153	1.56
MR584	29	HIGH	1	847	84	1,718	1,102,000	109,620	1,444	144	3.17
HB585	60	HIGH	1	1,827	171	1,710	2,280,000	226,800	1,377	137	3.29
MR177	16	MEDIUM	1	316	30	2,557	608,000	60,480	2,121	211	3.51
MR179	1448	MEDIUM	1	24,873	3024	4,555	55,024,000	5,473,440	2,518	251	2.32
BC180	150	MEDIUM	2	3,071	287	13,694	5,430,523	532,500	1,951	191	3.55
BC181	121	MEDIUM	2	2,464	243	14,524	4,380,622	429,550	1,973	193	2.62

TABLE 6-6
Summary of Treatment Costs and Nutrient Removal Efficiency for OSDS MAs that Intersect HDPAs

Management Area ID	Number of OSDS	Cost Effectiveness Priority	Treatment Recommended (BIN)	Existing Load (lb/yr)	Load After Treatment (lb/yr)	Load After OSDS Upgrade (lb/yr)	Total Initial Capital Cost ($)	Total EUAC ($/yr)	Avg Initial Capital $/LB Removal	Avg EUAC $/LB Removal	Avg OSDS Priority
SO426	280	MEDIUM	1	5,688	697	6,057	10,640,000	1,058,400	2,132	212	2.28
PT566	613	MEDIUM	2	11,175	1202	19,536	22,192,738	2,176,150	2,225	218	2.56
MR569	495	MEDIUM	1	9,052	1365	569	18,810,000	1,871,100	2,447	243	1.73
MR570	1596	MEDIUM	1	27,150	3388	1,045	60,648,000	6,032,880	2,552	254	2.25
MR572	1584	MEDIUM	2	28,796	3416	300	57,346,325	5,623,200	2,259	222	2.37
MR575	643	MEDIUM	1	12,002	1307	233	24,434,000	2,430,540	2,285	227	2.72
SV577	1896	MEDIUM	2	38,734	4092	426	68,641,813	6,730,800	1,981	194	2.75
HB581	66	MEDIUM	3	2,078	1045	919	858,000	247,500	831	240	3.13
HB601	7	MEDIUM	1	138	13	70	266,000	26,460	2,121	211	3.32
HB623	323	MEDIUM	3	10,480	5256	5,256	4,199,000	1,211,250	804	232	2.35
SV675	7	MEDIUM	2	138	13	70	253,424	24,850	2,021	198	3.45
SO4	1	LOW	5	48	48	3,002	-	-			
MR81	2	LOW	5	15	15	2,866	-	-			
LP101	2	LOW	5	15	15	1,538	-	-	-	-	1.00
LP110	23	LOW	5	371	371	167	-	-	-	-	1.09
PT136	7	LOW	1	77	13	1,972	266,000	26,460	4,179	416	1.41
SO423	227	LOW	1	3,393	509	290	8,626,000	858,060	2,992	298	1.75
HB429	154	LOW	3	3,043	1538	749	2,002,000	577,500	1,330	384	3.33
LP564	120	LOW	1	1,482	222	1,858	4,560,000	453,600	3,618	360	1.83
SO580	57	LOW	3	1,126	569	5,643	741,000	213,750	1,330	384	3.28
Total	**11,420**			**230,713**	**33,609**	**116,283**	**407,756,806**	**41,790,070**			

6.3.2 Implementation Strategy to Address Technical, Policy, Regulatory, and Statutory Issues

This OSDS Evaluation Study identified a number of technical, policy, regulatory, and statutory issues that the County should address before implementing the recommended treatment approaches for OSDS. Details of these issues are presented in Section 5 and in Appendix D. The list of recommended County actions is provided below:

1 Meet with MDE and DNR to articulate County OSDS Strategy

2 Work with MDE, DNR, and state legislators to revise CBRFA language

3 Partner with MDE, DNR, and others to update the science of OSDS load estimates (concentration, delivery ratios) and Chesapeake Bay model

4 Partner with MDE and DNR to evaluate alternatives for new OSDS cluster treatment systems (new land application/reuse options, new outfall options in shellfish areas)

5 Partner with MDE and DNR to develop OSDS load credit mechanism for WRF load caps

6 Develop OSDS Environmental Fee Study and Ordinance

7 Develop OSDS Maintenance Ordinance

8 Make revisions to General Development Plan: identify changes in areas of planned sewer service (additions and deletions); identify priorities; identify areas designated for limited sewer service for managing areas of existing OSDS targeted either for sewer extension or cluster systems

9 Implications for HB 1141 –WRE. Summarize how this study can be used to address septic system component of WRE.