Executive Summary

In May 2003, the U.S. Environmental Protection Agency (EPA) Region III issued guidance entitled *Ambient Water Quality Criteria for Dissolved Oxygen, Water Clarity and Chlorophyll* a *for the Chesapeake Bay and Its Tidal Tributaries* (*Regional Criteria Guidance*). The EPA developed this guidance to achieve and maintain the water quality conditions necessary to protect aquatic living resources of the Chesapeake Bay and its tidal tributaries. The *Regional Criteria Guidance* is intended to assist the Chesapeake Bay jurisdictions–Maryland, Virginia, Delaware and the District of Columbia–in adopting revised water quality standards to address nutrient and sediment-based pollution in the Chesapeake Bay and its tidal tributaries. Part of the jurisdictions' water quality standards development process may be to conduct use attainability analyses (UAAs). The EPA developed the *Technical Support Document for Identifying Chesapeake Bay Designated Uses and Attainability* (*Technical Support Document*) to assist states in developing their individual UAAs.

The UAA process is traditionally conducted by individual states. However, the multi-stakeholder body that guided the development of the water quality criteria for the Chesapeake Bay, the Water Quality Steering Committee, determined that providing UAA-related information on a watershed-wide scale would help promote coordination and consistency across all jurisdictions. To that end, the *Technical Support Document* provides a compilation of the basinwide analyses assimilated collaboratively by the affected jurisdictions. The *Technical Support Document* is not a regulation or a mandatory requirement. Rather, the EPA encourages the jurisdictions to use the information in this document and, when appropriate, to perform additional analyses tailored to each jurisdiction during their respective water quality standards development processes.

In providing technical background information for the Bay jurisdictions to use in their own UAAs, the *Technical Support Document* explains and documents why it appears that the current designated uses for aquatic life protection cannot be attained in all parts of the Chesapeake Bay and its tidal tributaries. The *Technical Support Document* provides scientific data showing that natural and human-caused conditions that cannot be remedied are the basis for the nonattainment and proposes refined designated uses for the states to consider during their upcoming water quality standards development and adoption processes. The document also provides scientific data indicating that the refined designated uses are viable in many areas of the Chesapeake Bay and its tidal tributaries and documents that the refined designated uses protect existing aquatic life uses. Finally, the document briefly summarizes economic analyses performed by the Chesapeake Bay Program, including estimates of the cost of implementing three of the four levels of control scenarios.

REGULATORY BACKGROUND

The Water Quality Standards Regulation (40 CFR 131.3) defines a UAA as "...a structured scientific assessment of the factors affecting the attainment of a use which may include physical,

chemical, biological, and economic factors...." (40 CFR 131.10[g]). The Water Quality Standards Regulation requires a state to conduct a UAA when it designates uses that do not include those specified in Section 101(1)(2) of the Federal Water Pollution Control Act .[1] A state must also conduct a UAA when it wishes to remove a specified designated use of the Federal Water Pollution Control Act or adopt subcategories of those specified uses that require less stringent criteria.

When conducting a UAA, a state must demonstrate that attaining the designated use is not feasible due to one or more of six factors specified in Section 131.10(g) of the Water Quality Standards Regulation. These factors are:

1. Naturally occurring pollutant concentrations prevent the attainment of the use;

2. Natural, ephemeral, intermittent, or low-flow conditions or water levels prevent the attainment of the use, unless these conditions may be compensated for by the discharge of a sufficient volume of effluent without violating state water conservation requirements to enable uses to be met;

3. Human-caused conditions or sources of pollution prevent the attainment of the use and cannot be remedied or would cause more environmental damage to correct than to leave in place;

4. Dams, diversions or other types of hydrologic modifications preclude the attainment of the use, and it is not feasible to restore the water body to its original condition or to operate such modifications in a way that would result in the attainment of the use;

5. Physical conditions related to the natural features of the water body, such as the lack of a proper substrate, cover, flow, depth, pools, riffles and the like, unrelated to chemical water quality, preclude attainment of aquatic life protection uses; and

6. Controls more stringent than those required by sections 301(b)(1)(A) and (B) and 306 of the Act would result in substantial and widespread economic and social impacts.

The Water Quality Standards Regulation also specifies that any change in designated uses must show that the existing uses are still being protected. The EPA's 1983 *Water Quality Standards Handbook* provides two definitions for an existing use. First, an existing use can be defined as fishing, swimming or other uses that have actually occurred since November 28, 1975. The second definition of an existing use is that the water quality of a water body is suitable to allow

[1] Section 101(a)(2) of the Federal Water Pollution Control Act states that "...it is the national goal that wherever attainable, an interim goal of water quality which provides for the protection and propagation of fish, shellfish, and wildlife and provides for recreation in and on the water be achieved by July 1, 1983."

the use to be attained–unless there are physical problems, such as substrate or flow, that prevent use attainment. The Water Quality Standards Regulation, in turn, requires state anti-degradation policies to protect existing water quality. Therefore, any recommendations regarding refined designated uses for the Chesapeake Bay and its tidal tributaries must ensure that existing aquatic life uses continue to be protected.

DOCUMENTING WHY CURRENT DESIGNATED USES MAY NOT BE ATTAINABLE

The determination documented in the *Technical Support Document* that current designated uses in the Chesapeake Bay and its tidal tributaries may not be attainable is based on two of the six factors noted above–natural and human-caused conditions that cannot be remedied. Output from model-simulated scenarios as well the paleoecological record of the Chesapeake Bay ecosystem both provide evidence that these two conditions prevent attainment of current designated uses.

To understand the feasibility of attaining current designated uses in the Chesapeake Bay and its tidal tributaries, the Chesapeake Bay Program developed three watershed modeling scenarios: 'all-forest,' 'pristine' and 'everything, everywhere by everyone,' or the E3 scenario. The 'all-forest' and 'pristine' scenarios represent the Chesapeake Bay Program's best effort to simulate water quality conditions prior to European settlement and, in so doing, help characterize existing, naturally occurring pollutant concentrations that prevent attainment of current designated uses. To represent human-caused conditions that cannot be remedied and to determine the upper boundaries of the watershed's technological capability for reducing nutrient and sediment pollution, the Chesapeake Bay Program also developed the E3 scenario, which the watershed partners consider physically implausible.

Figure 1 illustrates the results of these three model scenarios, which show that significant portions of the deep channel and deep waters of the Chesapeake Bay and its tidal tributaries cannot meet a dissolved oxygen concentration of 5 mg/l. For the pristine scenario, on a baywide basis for all tidal-water segments that have deep-channel and deep-water areas, attainment is not achieved for portions (i.e., approximately 3 percent and 1 percent, respectively) of these areas during the summer months. For the E3 scenario, 59 percent, 23 percent and 2 percent non-attainment are exhibited in the deep-channel, deep-water and open-water areas, respectively, even after implementation of nutrient reduction measures that represent limits of technology.

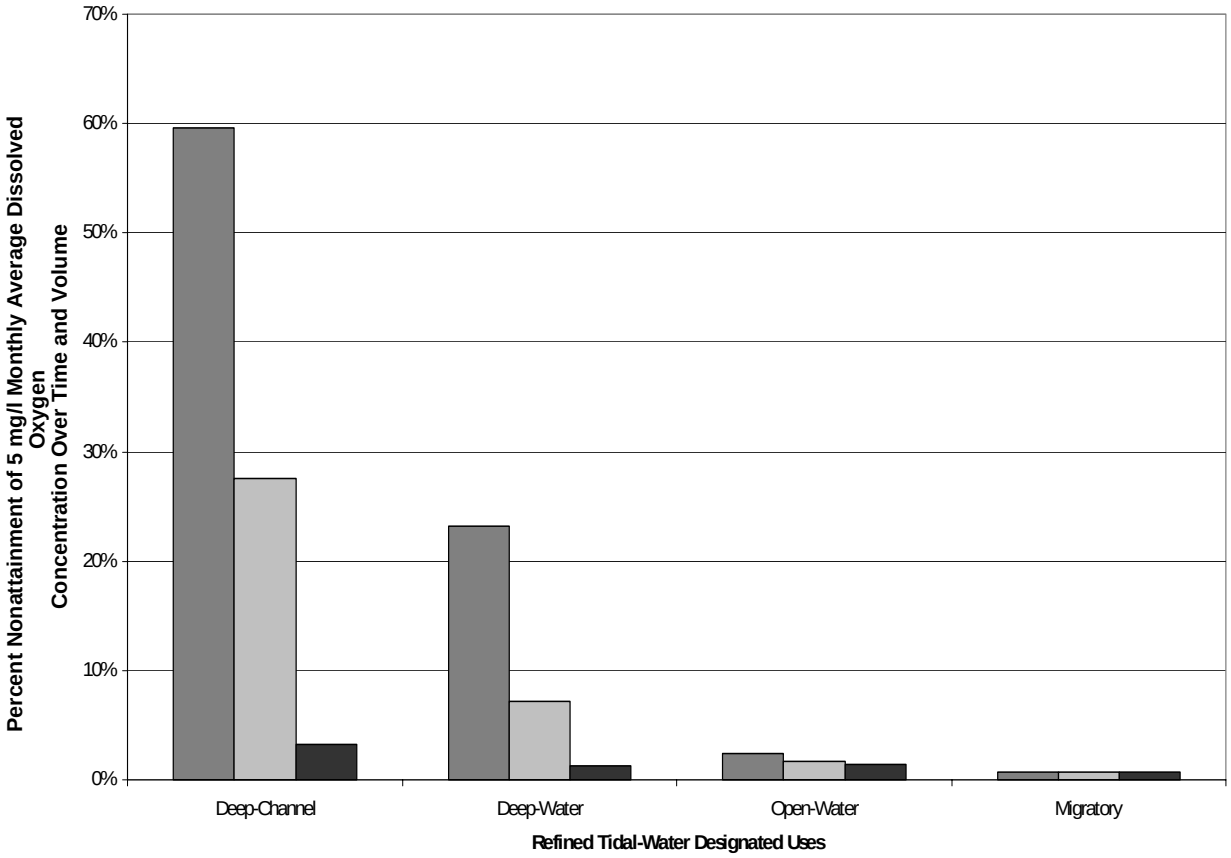

Figure 1. Percent nonattainment of a 5 mg/l monthly average dissolved oxygen concentration over the June through September period for the E3 (physically implausible) (dark grey bars), all-forest (light grey bars) and pristine (black bars) model scenarios by the refined tidal-water designated uses.

In addition to modeled information, the Chesapeake Bay Program has evidence from the paleoecological record of the Chesapeake Bay ecosystem to support the concept that natural conditions prevent attainment of current designated uses. An evaluation of this information suggests that the main channel of the Chesapeake Bay most likely experienced oxygen depletion before large-scale post-colonial land clearance took place, due to natural factors such as climate-driven variability in freshwater inflow.

DEVELOPMENT OF THE REFINED DESIGNATED USES

Current designated uses for the Chesapeake Bay and its tidal tributaries do not fully reflect natural conditions and are too broad in their definition of use to support the adoption of more habitat-specific aquatic life water quality criteria. The current uses also change across jurisdictional borders within the same water body. Therefore, in refining the tidal-water designated uses, the six Bay watershed states and the District of Columbia considered five principal factors:

- Habitats used in common by sets of species and during particular life stages should be delineated as separate designated uses;
- Natural variations in water quality should be accounted for by the designated uses;
- Seasonal uses of different habitats should be factored into the designated uses;
- The Chesapeake Bay criteria for dissolved oxygen, water clarity and chlorophyll *a* should be tailored to support each designated use; and
- The refined designated uses applied to the Chesapeake Bay and its tidal tributary waters will support the federal Clean Water Act goals and state goals for uses existing in these waters since 1975.

The five refined designated uses reflect the habitats of an array of recreationally, commercially and ecologically important species and biological communities. The vertical and horizontal breadth of the designated use boundaries are based on a combination of natural factors, historical records, physical features, hydrology, bathymetry and other scientific considerations (Figure 2).

The *migratory fish spawning and nursery designated use* protects migratory and resident tidal freshwater fish during the late winter to late spring spawning and nursery season in tidal freshwater to low-salinity habitats. Located primarily in the upper reaches of many Bay tidal rivers and creeks and the upper mainstem Chesapeake Bay, this use will benefit several species including striped bass, perch, shad, herring, sturgeon and largemouth bass.

The *shallow-water bay grass designated use* protects underwater bay grasses and the many fish and crab species that depend on the vegetated shallow-water habitat provided by underwater grass beds.

The *open-water fish and shellfish designated use* focuses on surface water habitats in tidal creeks, rivers, embayments and the mainstem Chesapeake Bay and protects diverse populations of sport fish, including striped bass, bluefish, mackerel and sea trout, as well as important bait fish such as menhaden and silversides.

The *deep-water seasonal fish and shellfish designated use* protects animals inhabiting the deeper

transitional water-column and bottom habitats between the well-mixed surface waters and the very deep channels. This use protects many bottom-feeding fish, crabs and oysters, and other important species such as the bay anchovy.

The *deep-channel seasonal refuge designated use* protects bottom sediment-dwelling worms and small clams that bottom-feeding fish and crabs consume. Low to occasional no dissolved oxygen conditions occur in this habitat zone during the summer.

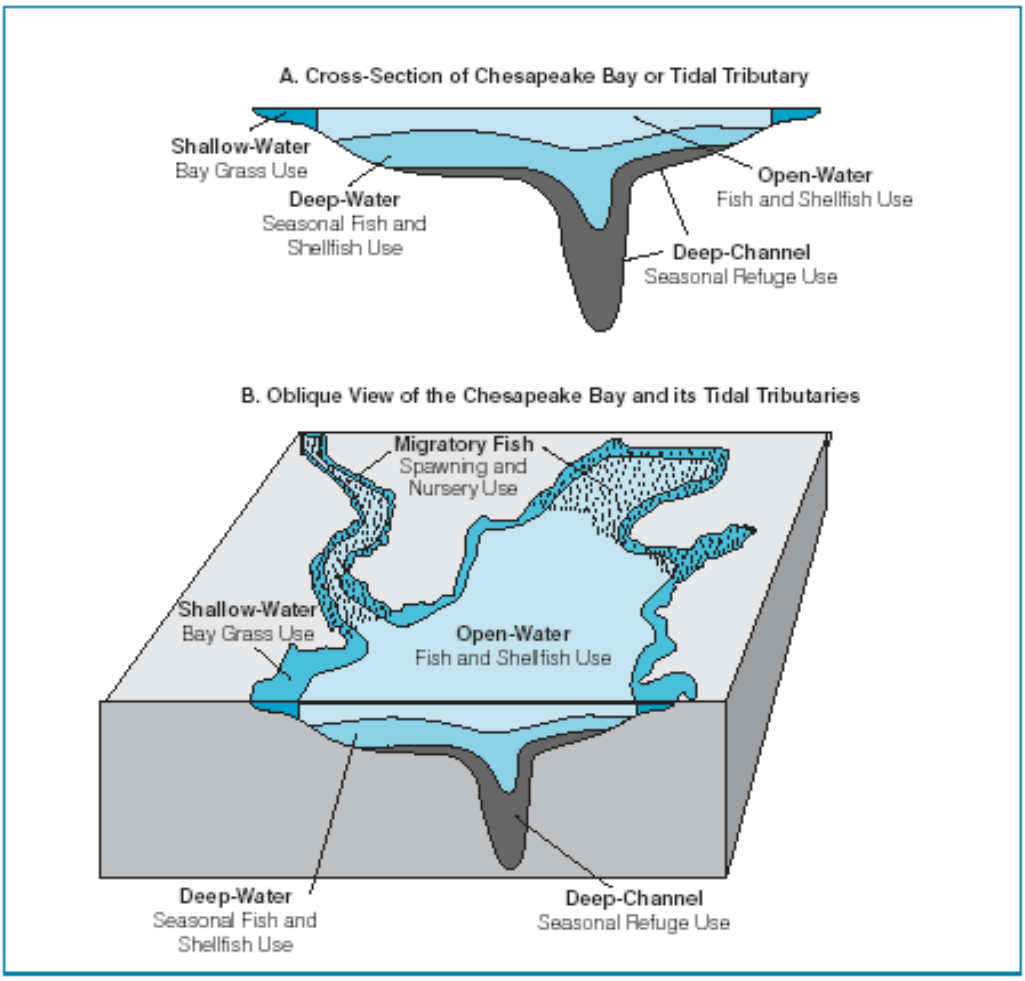

Figure 2. Conceptual illustration of the five Chesapeake Bay tidal-water designated use zones.

ATTAINABILITY OF REFINED DESIGNATED USES

The Chesapeake Bay Program assessed attainability for the refined designated uses based on dissolved oxygen for the migratory and spawning, open-water, deep-water and deep-channel designated uses. Attainability for the shallow-water designated use was assessed based on historic and recent data on the existence of underwater bay grass acreage. The Chesapeake Bay Program did not assess attainability for the chlorophyll *a* criteria, which applies to the open-water designated use, because this criteria is expressed in narrative terms and does not provide a numeric value around which to perform attainability analyses.

For the refined designated uses to which the dissolved oxygen criteria applies, the Chesapeake Bay Program evaluated attainability by comparing the modeled water quality response to a series of technology-based nutrient reduction scenarios. This series of scenarios was developed to represent the watershed's nutrient and sediment reduction potential in terms of the types, extent of implementation and performance of best management practices (BMPs), wastewater treatment technologies and storm water controls.[2] These scenarios range from Tier 1, which represents the current level of implementation plus regulatory requirements implemented through 2010, to a theoretical limit-of-technology scenario referred to as the E3 scenario ('everything, everywhere by everybody'). Tier 2 and Tier 3 are intermediate scenarios between Tier 1 and the E3 scenario. It is important to note that these tiers are artificial constructs of technological levels of effort and do not represent actual programs that the jurisdictions will eventually implement to meet the water quality standards. Rather, the Chesapeake Bay Program developed the tiers as an assessment tool to determine potential load reductions achievable by various levels of technological effort, and to model water quality responses to controls.

The Chesapeake Bay Program used the Chesapeake Bay Watershed and Water Quality Models to determine the water quality response to the pollutant reductions in each scenario (Table 1) and then compared these modeled water quality observations within the five refined designated uses to determine the spatial and temporal extent of nonattainment with the respective dissolved oxygen criteria. Specifically, comparison of model results for dissolved oxygen were made to a monthly average dissolved oxygen concentration of 6 mg/l for the migratory and spawning use, 5 mg/l for the open-water use, 3 mg/l for the deep-water use and 1 mg/l for the deep-channel use.

[2] Sediment reduction is only reflected in the scenarios as that incidental to nutrient removal.

Table 1. Summary of pollutant loadings that result from applying the load reductions associated with each scenario across all nutrient and sediment sources (except shoreline erosion) in the watershed.

Pollutant	2000 Progress	2010 Tier 1	2010 Tier 2	2010 Tier 3	2010 E3
Nitrogen	284.8	260.9	221.3	180.8	116.4
Phosphorus	19.12	18.96	16.41	13.38	10.10
Sediment	5.044	4.644	4.144	3.625	2.953

Migratory and Spawning Designated Use

Current monitoring data and Chesapeake Bay Water Quality Model outputs indicate that the migratory and spawning designated use is essentially being attained in the Chesapeake Bay and its tidal tributaries for dissolved oxygen. The few segments that are not fully attaining the dissolved oxygen criterion would fully attain this use in the Tier 1 scenario (lowest level of control technologies).

Open-Water, Deep-Water and Deep-Channel Designated Uses

Table 2 provides the results of the attainability analysis for dissolved oxygen for the open-water (including shallow-water)[3], deep-water and deep-channel designated uses, by Chesapeake Bay Program segment. As Table 2 illustrates, current monitoring data (presented under the 'observed' column) indicate that the open-water designated use is seldom fully attained. However, at Tier 3, attainment for about 60 percent of the segments is achieved for this refined designated use. In most cases where nonattainment is indicated for open-water at Tier 3, it is less than 2 percent nonattainment, and often, less than 1 percent. For the deep-water designated use for dissolved oxygen criteria, almost no attainment is achieved based on current monitoring data and only some degree of attainment is seen at reduction levels equivalent to Tier 2. At the reduction levels represented by the E3 scenario, attainment is achieved for all segments of the Chesapeake Bay except for one (middle central Chesapeake Bay, CB4MH). Table 2 illustrates that, under observed conditions, the proposed dissolved oxygen criteria are not attained for the deep-channel designated use. With increasing load reductions, however, 100 percent attainment is achieved at the E3 scenario, and, at the levels of reduction represented by Tier 3, percent nonattainment is primarily less than 2 percent.

[3] Because the dissolved oxygen criteria is the same for the open-water as for the shallow-water use, attainability for the shallow-water designated use is presented under the open-water designated use in Table 2.

Table 2. Percent nonattainment of monthly averaged 5, 3 and 1 mg/l dissolved oxygen concentrations applied to open-water, deep-water and deep-channel designated uses, respectively.

Chesapeake Bay Program Segment	Model Scenarios					
	DU	Observed	Tier1	Tier2	Tier3	E3
Northern Chesapeake Bay (CB1TF)	OW	A	A	A	A	A
Upper Chesapeake Bay (CB2OH)	OW	1.92	0.68	0.43	0.17	A
Upper Central Chesapeake Bay (CB3MH)	OW	A	A	A	A	A
	DW	4.18	2.24	1.61	0.73	A
	DC	13.52	7.21	5.03	1.84	A
Middle Central Chesapeake Bay (CB4MH)	OW	0.05	A	A	A	A
	DW	19.64	14.28	12.05	8.51	0.69
	DC	45.19	28.94	18.81	3.93	A
Lower Central Chesapeake Bay (CB5MH)	OW	A	A	A	A	A
	DW	6.16	3.75	2.58	1.08	A
	DC	13.79	6.00	2.59	0.15	A
Western Lower Chesapeake Bay (CB6PH)	OW	5.87	3.68	2.71	1.30	0.01
	DW	0.36	A	A	A	A
Eastern Lower Chesapeake Bay (CB7PH)	OW	4.55	2.81	1.82	0.74	A
	DW	A	A	A	A	A
Mouth of Chesapeake Bay (CB8PH)	OW	A	A	A	A	A
Upper Patuxent River (PAXTF)	OW	A	A	A	A	0.38
Middle Patuxent River (PAXOH)	OW	9.79	1.84	1.62	0.86	A
Lower Patuxent River (PAXMH)	OW	7.40	1.69	1.04	0.01	A
	DW	5.52	0.82	0.50	0.07	A
Upper Potomac River (POTTF)	OW	A	A	A	A	A
Middle Potomac (POTOH)	OW	2.10	1.08	0.63	0.31	0.01
Lower Potomac (POTMH)	OW	0.78	A	A	A	A
	DW	6.90	4.53	3.11	1.12	A
	DC	18.89	8.64	5.07	0.19	A
Upper Rappahannock River (RPPTF)	OW	A	A	A	A	A

Chesapeake Bay Program Segment	Model Scenarios					
	DU	Observed	Tier1	Tier2	Tier3	E3
Middle Rappahannock River (RPPOH)	OW	A	A	A	A	A
Lower Rappahannock River (RPPOH)	OW	0.44	0.10	A	A	A
	DW	5.58	1.09	0.01	A	A
	DC	6.39	3.38	1.65	A	A
Piankatank River (PIAMH)	OW	0.12	A	A	A	A
Upper Mattaponi River (MPNTF)	OW	33.26	25.87	27.23	33.73	52.14
Lower Mattaponi River (MPNOH)	OW	46.88	28.95	31.86	28.99	48.11
Upper Pamunkey River (PMKTF)	OW	62.25	42.07	30.35	32.94	54.50
Lower Pamunkey (PMKOH)	OW	42.15	12.66	13.86	10.32	11.39
Middle York River (YRKMH)	OW	18.08	3.31	2.32	0.42	A
Lower York River (YRKPH)	OW	1.48	A	A	A	A
	DW	0.01	A	A	A	A
Mobjack Bay (MOBPH)	OW	2.30	1.60	1.10	0.34	A
Upper James River (JMSTF)	OW	0.66	A	A	A	A
Middle James River (JMSOH)	OW	A	A	A	A	A
Lower James River (JMSMH)	OW	A	A	A	A	A
Mouth of the James River (JMSPH)	OW	A	A	A	A	A
Eastern Bay (EASMH)	OW	A	A	A	A	A
	DW	3.26	2.00	0.90	0.36	A
	DC	20.23	11.26	6.49	0.67	A
Middle Choptank River (CHOOH)	OW	0.14	A	A	A	A
Lower Choptank River (CHOMH1)	OW	2.27	1.78	1.51	1.08	0.43
Mouth of the Choptank River (CHOMH2)	OW	0.33	A	A	A	A
Tangier Sound (TANMH)	OW	0.15	0.06	0.05	0.36	0.22
Lower Pocomoke River (POCMH)	OW	A	A	A	A	A

A = Applicable dissolved oxygen criteria fully attained; analysis based on monthly averaged dissolved oxygen concentrations 5 mg/l, 3 mg/l and 1 mg/l for open-water, deep-water and deep-channel designated uses.
DU = designated use; OW–open-water; DW–deep-water; DC–deep-channel.

Shallow-Water Bay Grass Designated Use

Attainability for the shallow-water bay grass designated use is based on historic and recent data on the distribution of underwater bay grasses. Detailed analyses using this data–including historical aerial photographs–were undertaken to map the distribution and depth of historical underwater bay grass beds in the Chesapeake Bay and its tidal tributaries. These analyses led to the adoption of the single best year method that considers historical underwater bay grass distributions from the 1930s through the early 1970s as well as more recent distributions since 1978 to present. Using this method, the Chesapeake Bay Program and its watershed partners established a baywide underwater bay grass restoration goal of 185,000 acres. Because of limitations associated with mapping underwater bay grasses using historical photography, the estimate of past underwater bay grass distributions is conservative. Therefore, the restoration goal is conservative as well and considered attainable.

CONFIRMATION THAT EXISTING USES ARE MET

In establishing the refined designated uses, the Chesapeake Bay Program took explicit steps in developing the requirements and boundaries to ensure that existing aquatic life uses would continue to be protected as the EPA Water Quality Standards Regulation require. For some refined designated uses–the migratory fish spawning and nursery, the deep-water and the deep-channel–the application of new dissolved oxygen criteria will result in improvements to existing water quality conditions. The refined open-water fish and shellfish designated use dissolved oxygen criteria will provide an equal level of protection as the current state water quality standards afford to the same tidal waters. Likewise, the refined shallow-water bay grass designated use also ensures protection of existing underwater bay grass-related uses because the single best year method is based on historical (1930s through the early 1970s) and more recent (1978 - present) underwater bay grass distributions.

ECONOMIC ANALYSES

The *Technical Support Document* summarizes three types of economic analyses that the Chesapeake Bay Program performed in conjunction with developing revised water quality criteria, designated uses and boundaries for those uses in the Chesapeake Bay and its tidal waters. One analysis was undertaken to estimate the costs of implementing the hypothetical control scenarios (represented by the Tier 1-3 scenarios). Screening-level analyses are the second type of analysis summarized. These analyses were conducted to rule out areas that would not experience substantial and widespread economic and social impacts if states implemented controls more stringent than those required by sections 301 and 306 of the Clean Water Act. The results of analyses to model regional economic impacts is the third type of analysis summarized in the *Technical Support Document.*

A separate document entitled *Economic Analyses and Impacts of Nutrient and Sediment*

Reduction Actions in the Chesapeake Bay Watershed (*Economic Analyses*) presents detailed descriptions of these three types of analysis and the attendant findings.

Table 3 summarizes the results of the cost analyses described in detail in the *Economic Analyses* document. Captured in the table are the total capital and annual costs (annualized capital plus annual operation and maintenance [O&M] costs) associated with the tier scenarios. The cost analysis and other economic analyses provide information related to evaluating impacts from the implementation of the nutrient reduction measures defined in the tier scenarios. However, the Chesapeake Bay Program did not use these analyses to delineate boundaries for the refined designated uses. Although this information may be useful to them in developing their own UAAs, states will need to conduct more rigorous economic analyses than the analyses performed by the Chesapeake Bay Program.

Table 3. Estimated cumulative costs and pollutant loading reductions associated with the Tier 1-3 scenarios and the E3 scenario.

Tier	Total Nitrogen Reduction from Levels in 2000 (millions pounds per year)[1]	Total Capital Costs (in millions of 2001 dollars)[2]	Total Annual Costs (in millions of 2001 dollars)[2]
Tier 1	23.9	$1,391	$196
Tier 2	63.5	$3,593	$553
Tier 3	104.0	$7,713	$1,125
E3[3]	168.4	Not estimated	Not estimated

1. Loadings based on Phase 4.3 of the Chesapeake Bay Program's Watershed Model.
2. Costs include those paid by private-sector businesses and households in addition to those paid by public entities that provide cost-share funding for nutrient reduction controls and BMPs.
3. The E3 scenario represents a theoretical limit-of-technology control scenario that provides a maximum loadings reduction estimate.