8. ADAPTIVE MANAGEMENT AND MONITORING COMPONENTS

Currently, the PIERP is managed by a multi-component management framework, as described in the PIERP project management plan (PMP) (EA, 2004d). The PMP incorporates two approaches: adaptive management for tasks related to the habitat restoration goal, and task management for general design, construction, and maintenance tasks. This chapter summarizes the key components of the PIERP adaptive management plan, identifies key lessons learned from the construction and operation of the PIERP, and summarizes the existing monitoring components for PIERP. Ultimately, the existing PIERP and the lateral expansion will function and be managed as one operational unit. Specific project components related to the expansion of the PIERP will be added to the existing PMP, adaptive management plan (AMP) and monitoring framework.

The goals of the PIERP, as stated in the PMP, are to

- Restore remote island habitat in the mid-Chesapeake Bay using clean dredged material from the Chesapeake Bay approach channels to the Port of Baltimore,
- Optimize site capacity for clean dredged material while meeting the environmental restoration purpose of the project, and
- Protect the environment around the restoration site.

In accordance with the PCA, management responsibility for the PIERP lies with the ERPCT. Daily management of the project is coordinated through the Site Development Team, the Site Operations Team, and the Adaptive Management Team (Figure 8-1). The ERPCT is advised by the Poplar Island Working Group, which is composed of representatives of Federal, State, and local agencies, environmental groups, educational institutions, and commercial interests with an interest in the success of the project. Through regularly scheduled project updates from the management teams and reviews of key planning documents and reports, the Working Group provides recommendations to the ERPCT on regulatory compliance, habitat development and management, and resource monitoring.

Subcommittees of the Poplar Island Working Group were established to advise the management teams on restoration planning and operations and on environmental monitoring activities. The Habitat Subgroup provides recommendations on habitat development and resource management to the Working Group or the Adaptive Management Team. Specific responsibilities of the Habitat Subgroup include review and comment on the Habitat Development Framework, Adaptive Management Plan, Wildlife Management Plan, and individual cell development plans.

The Monitoring Subgroup provides recommendations on the monitoring program to the Working Group or the Adaptive Management Team. Its specific responsibilities include:

- Annual review of the Monitoring Framework;
- Review of specific sampling plans, including QA/QC requirements;
- Review of monitoring data and reports; and
- Recommendations for updating the monitoring program as project conditions require.

To supplement the Poplar Island Working Group and its subgroups, the management teams may appoint other ad hoc groups to provide independent review of specific technical or management issues.

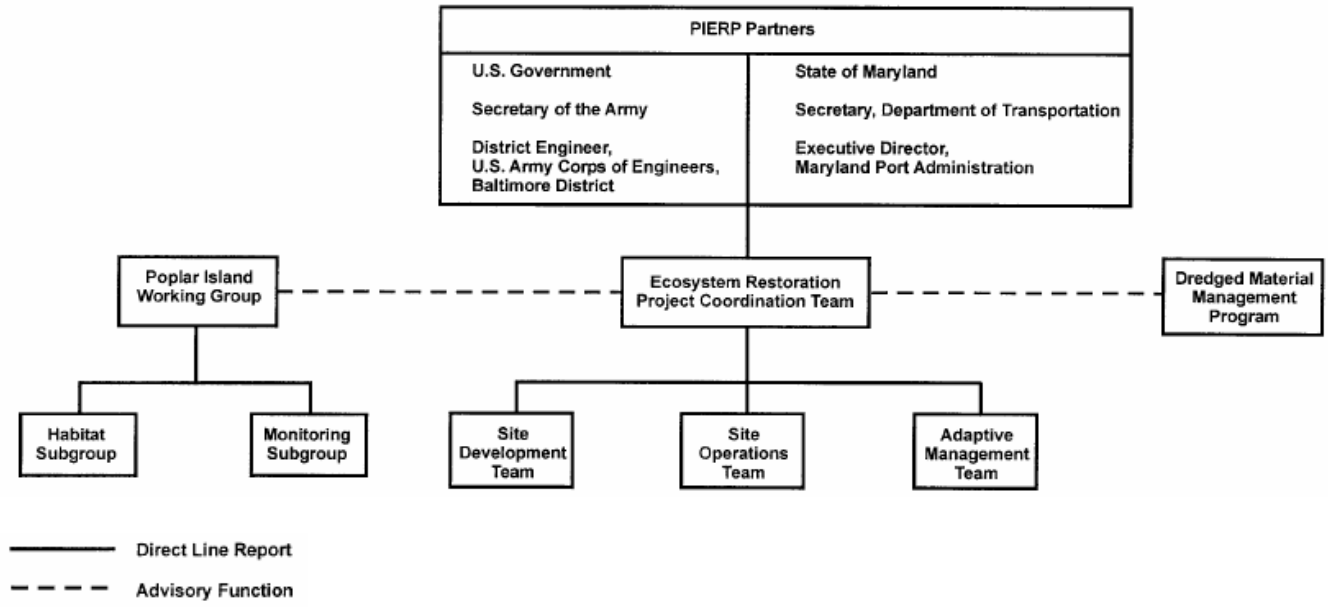

Figure 8-1. PIERP Management Teams

8.1 ADAPTIVE MANAGEMENT

The Adaptive Management Plan (EA, 2004e) provides the framework for managing the habitat restoration goal of the PIERP. Adaptive management is the process of outlining a management plan, periodically reviewing progress toward executing that plan, and revising the plan, if necessary, to reflect actual experience gained in the implementation. Adaptive management is particularly appropriate for ecological restoration projects because initial project expectations often prove unrealistic in the actual implementation or because it may not be possible to define specific objectives at the initiation of the project and further testing is needed to make such definition possible.

Adaptive management plans include the following key elements:

- Goals and objectives for the final project outcome,
- Measurable end points to evaluate progress toward those goals, including acceptable bounds of success around those endpoints,
- Methods for measuring progress toward those end points,
- A schedule for reviewing the measurements and assessing progress,
- A mechanism for developing corrective actions when progress is outside of the acceptable bounds,
- A mechanism for implementing those corrections, and

- A mechanism for incorporating the lessons learned from those assessments into a revised management plan, which could include revising the goals, objectives and/or end points.

As illustrated in Figure 8-2, adaptive management is an iterative process—set initial goals, measure progress, assess progress, and revise the goals if necessary—and then repeat the process over again and again until the project is complete.

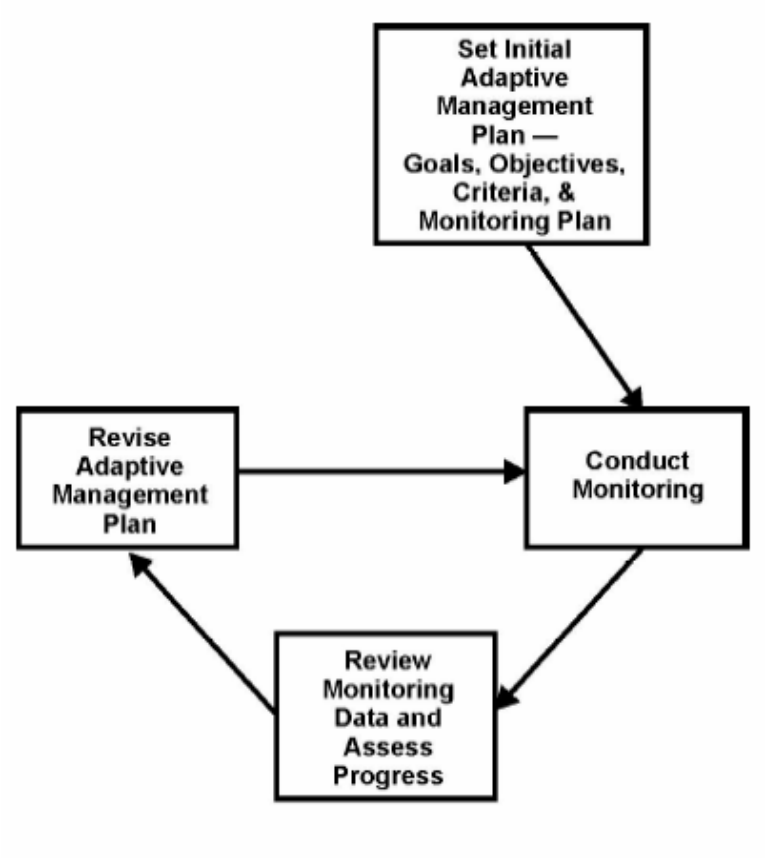

Figure 8-2. Adaptive Management Process

8.1.1 PIERP Adaptive Management Components

The PIERP Adaptive Management Plan has two components: Habitat Restoration and Cell Development.

HABITAT RESTORATION	CELL DEVELOPMENT
• The Restoration Component relates to the final creation of habitat, i.e., what the habitat is expected to be once development has been completed and sufficient time has elapsed for the habitat to reach a more or less mature state.	• The Cell Development Component pertains to the ongoing activities related to habitat development, such as the process of developing an individual cell from the beginning of dredged material placement through the final planting of vegetation.

HABITAT RESTORATION	CELL DEVELOPMENT
• The Restoration Component creates the long-term habitat objectives for assessing ultimate success of the restoration effort.	• The Cell Development Component creates interim objectives for annual assessment of project progress toward those long-term objectives.
• Monitoring of the goals and objectives of the Restoration Component generally begins after a habitat type has been completed, which could be several years into the project, or in some cases, after the project has been completely developed.	• Assessment of the goals and objectives of the Cell Development Component is done on an annual basis throughout construction of the island.

In general, the long-term goals and objectives of the Restoration Component are used to establish the more-detailed, short-term goals and objectives of the Cell Development Component. Experience gained from monitoring and assessing the objectives in the Cell Development Component is used, as necessary, to adjust the goals or objectives in the Restoration Component.

Restoration Component The habitat restoration goal for PIERP is to create approximately 1,140 acres of remote island habitat, half uplands and half tidal marsh. For the Restoration Component of the Adaptive Management Plan, this goal is divided into seven subgoals:

- Create island nesting habitat for ground-nesting colonial water birds (i.e., terns),
- Create island nesting habitat for colonial wading birds (i.e., herons, egrets),
- Create tidal marsh habitat,
- Create upland habitat,
- Create a diversity of habitats,
- Create quiescent conditions for SAV recovery, and
- Minimize and offset loss of benthic habitat.

Six of these goals are restoration objectives developed by the USACE-Baltimore District, MPA, and State and Federal resource agencies for the 1996 EIS (USACE/MPA, 1996). A seventh goal to address upland habitat was added to the Restoration Component by the Adaptive Management Team.

The objectives in the Restoration Component primarily relate to habitat creation. The criteria for these habitat objectives are typically specific numeric targets based on original project design drawings, design objectives described in the EIS, and habitat development guidelines in the Habitat Development Framework. Several subgoals also have an objective related to use of the habitat by wildlife. The criteria for these wildlife objectives are more qualitative, focusing on the presence or absence of species present in the mid-Bay area that would use the type of habitat being created.

Cell Development Component The cell development goal is to develop cells to meet dredging needs and achieve habitat requirements. The subgoals are:

- Meet dredging needs,
- Operate site to optimize dewatering and consolidation of placed material and to support habitat requirements,
- Develop cells to achieve habitat requirements (i.e., elevation, hydrology, vegetation),
- Manage undesirable species as cells develop, and
- Conduct habitat monitoring in support of long-term habitat goals.

These objectives relate to annual operating goals, such as the quantity and rate of placement of dredged material, consolidation of dredged material, and construction of individual cells, including criteria for substrate, hydrology, and vegetation.

8.1.2 PIERP Adaptive Management Review Process

The Adaptive Management Team will review and update the Cell Development Component of the Adaptive Management Plan annually. The project partners may review specific components of the plan on a more frequent basis, as necessitated by emergency situations or to meet project needs for design, construction, or operation before the annual reassessment.

During the review process, data collected for each criterion are reviewed, and progress toward achieving each objective is assessed. If progress is determined to be satisfactory, it may be decided to make no changes to the Adaptive Management Plan. However, if progress is not satisfactory any one or more of several corrective actions may be taken:

- Revise the Adaptive Management Plan at some level (subgoal, objective, attribute, criterion) to make it more realistic,
- Revise the monitoring plan to determine why progress is not occurring,
- Revise the design and/or operation of PIERP to try to recover or redirect progress toward the goal or objective,
- Revise the design and/or operation of PIERP to reflect a new or revised goal or objective,
- Revise the Habitat Development Framework,
- Revise the Monitoring Framework, or
- Revise individual cell development plans.

During the early years of island development (i.e., before any habitat areas are completely developed and monitoring of completed habitat has begun), the Restoration Component of the Adaptive Management Plan will be revised only when review of the Cell Development Component indicates that a long-term goal or objective is unachievable and needs to be revised. Once habitat development is completed in a cell, the monitoring for the long-term restoration goals will begin, and the Restoration Component will be reviewed every 1-3 years, depending on the monitoring schedule.

Throughout the adaptive management process, a historical record is maintained to document the evaluations and changes made in each annual assessment. The records include (1) data used in the assessment (i.e., current conditions at the time of the assessment), (2) evaluations of those data versus the criteria, (3) recommended changes, and (4) implemented changes or reasons for not implementing specific recommended changes. Through these records, the Adaptive Management Team will document revisions to objectives, attributes, and criteria, and the reasons those revisions were made.

8.2 LESSONS LEARNED FROM PIERP

Based on the experience gained from the design, construction, and operations at PIERP, several key 'lessons learned' have been incorporated into the existing AMP and habitat development framework, and the plan formulation and design phases of PIES. An important consideration throughout the planning process for PIES has been building in the flexibility and procedures to quickly respond to unanticipated occurrences during the life of the project, such as specific cell development and design constraints, controlling nuisance species, changing/moving the locations of habitat islands, and impacts from storm events. The AMP provides a vehicle and a structure for submitting and gaining approval from the project stakeholders for proposed changes. Key issues and the way in which they were incorporated into the planning process and design for PIES are outlined below.

8.2.1 Engineering Considerations

1) ***Define the extent of the sand borrow areas, and include the excavation of the sand in the impacts analysis.*** The sand borrow areas were identified and delineated early in the study process to accurately determine the sand quantities necessary for the development of the recommended plan (Appendix A), and the effects associated with excavation were included in the impacts analysis. Sand borrow areas not included within the lateral expansion footprint were incorporated into the existing conditions surveys and impact analysis.

2) ***Do not design wetland cells on top of sand borrow areas because filling in the excavated sand borrow areas makes it difficult to achieve the necessary final design elevations for the wetland cells.*** For the expansion study, the upland cells were designed on top of the sand borrow area located within the proposed project footprint, resulting in a conceptual lateral configuration that has upland cells located on the eastern side of the proposed expansion, closest to the shoreline.

3) ***For the impacts analysis, include a defined area outside the extent of the toe dike needed for barge/equipment access and operations/maintenance activities related to the project.*** A Study Area that included a footprint for the lateral expansion was evaluated in the expansion study, rather than a specific alignment. The footprint evaluated included the proposed access channel and enough 'buffer-area' to allow for design adjustments so the exterior dike can be constructed in its optimal configuration in the final design stage.

4) ***For the impacts analysis, differentiate between the final dike height and the temporary construction height. There will be an additional 5-ft of dike necessary for the construction phase of the upland cells.*** The difference between the temporary dike height during construction and the final dike height of the project were discussed in the project description (Chapter 1). The impacts analysis for the visual assessment evaluated the impacts of raising the height of the existing upland cells to the final design height of 25 ft, not to the temporary dike height of 30 ft.

5) ***The existing upland dikes need to be temporarily raised to five ft above the final design height during dredged material placement, dewatering, and crust management to achieve targeted upland elevations.*** For the proposed vertical expansion, a temporary dike height of +30 ft MLLW for a duration of approximately 10 years has been assumed in the impacts evaluation. The dikes will be lowered to a final dike height of +25 ft MLLW after placement and dewatering have ceased.

6) ***Develop a procedure to submit and approve cell design changes and maintenance adjustments throughout the life of the project.*** Changes to the specific cell and subcells for PIERP are achieved through the adaptive management process and coordination with members of the Poplar Island Working Group. Construction activities, operations, maintenance, and monitoring of the lateral and vertical expansion components will be incorporated into this process.

7) ***Final elevations of dredged material within the upland cells will require uneven relief features to achieve the drainage necessary for proper dewatering and run-off to the wetland cells.*** Although the final dikes will be set to a specific elevation, the dredged material will have some relief to accommodate water run-off through the wetland cells. Consequently, the final dredged material surface will not be completely level or flat.

8.2.2 Environmental Considerations

1) ***More completely define the upland habitat goals for the project.*** Upland habitat goals are discussed in the habitat development framework for PIERP, and the upland habitat restoration targets are under development, to be implemented once the upland cells are completed for PIERP. Decisions made for the PIERP upland cells will be incorporated into the upland cells planned for the lateral expansion.

2) ***Allow for flexibility of habitat criteria target acreages.*** The habitat restoration goals for the proposed lateral expansion include ranges for the uplands to wetlands ratio. The final proportions of uplands and wetlands, and the final proportions of wetland types (high marsh to low marsh) will be based on environmental and engineering design constraints, and adjustments to the ratio may be refined by the Habitat Sub-Group throughout the life of the project.

3) ***Define the habitat expectations for the transitional area from wetland to upland, understanding that the transition will not be immediate.*** Habitat design and implementation strategies for the wetland to upland transition are currently under development for PIERP, and will be included in the Habitat Development Framework. Decisions will be incorporated in planning and design phases for PIES as design details of the project become available.

4) ***Include the underwater habitat that has been, and would be created, on the exterior face of the armor stone as an environmental benefit.*** Epibenthic colonization on the exterior armor stone dikes has been evaluated and monitored for PIERP (Section 3.1.6.d). The perimeter dike habitat was included as an interim benefit throughout the life of the project in the calculation of the environmental benefits (ICU) for both the existing PIERP and for the expansion project.

5) ***When describing habitat creation goals, discuss targeted community types of wildlife instead of identifying specific target species.*** The habitat goals specified in the PIERP EIS have been refined through the adaptive management process and the development of the Habitat Framework. The concept of revising the habitat development goals to plan for community types/guilds, such as colonial nesting waterbirds, or general flora types rather than individual target species is currently under review by the Poplar Island Habitat Work Group. The ICU methodology used to calculate the environmental benefits of PIERP and of the lateral/vertical expansion was based on habitat use by community groups. Habitat created through the proposed lateral expansion would be incorporated into both the adaptive management process and the habitat framework.

6) ***Update the time of year restrictions to aid in the planning for site operations activities.*** Time of year restrictions have been updated, and are applied to the footprint of the lateral expansion in the impacts to wildlife section (Section 5.4.7). An updated table of the time of year restrictions is located in Appendix C, Table C-3.

7) ***Incorporate a wildlife management plan that includes the control of nuisance species, in addition to the monitoring and protection of species of interest such as terrapins and terns.*** Some components of the wildlife management plan are being implemented, such as the lethal control of nuisance species including gulls, Canada geese, and foxes; maintenance of the habitat islands; and monitoring of diamondback terrapin habitat. Procedures in place for the existing PIERP will be extended to lateral expansion cells. Additional components of the wildlife management plan are currently under development, and other will be developed as needed as part of the adaptive management process.

8) ***Establish procedures for monitoring discharge through the spillways and develop a plan to respond to unanticipated events in a timely manner, including specific contingencies.*** A monitoring plan for discharge through the exterior spillways is in place for PIERP (Table 3-2) and will be extended to include exterior spillways and the tidal gut discharge location for the lateral expansion. The spillway monitoring

program was developed by MES in conjunction with MDE and is periodically revised to reflect changes to operational status.

9) ***Consider planting native grasses on the dike.*** The seed mixture used to plant the dike was formulated to provide stability and erosion control to the slopes. The seed mixture used on the dikes is described in the Habitat Development Framework, and included a variety of native grass species, but also included non-native species. The same specification will be considered for the lateral expansion dikes.

10) ***Continue to implement the goals of the SAV restoration and protection***. Because more quiescent conditions have been created in Poplar Harbor, a specific plan to monitor SAV recovery has been established. The goals of the SAV restoration will be determined in conjunction with USFWS, based on the results of the SAV studies. However, the goals of SAV restoration and protection have not yet been met, and will continue to be implemented as part of the expansion study.

11) ***Establish a monitoring program that quantifies and evaluates sedimentation on NOBs.*** Construction of the proposed lateral alignment would be close to NOB 8-11, east of the proposed project. Procedures will be put into place that will minimize NOB impacts during construction, and sedimentation monitoring will take place before, during, and after construction, as prescribed in the Monitoring Framework.

8.3 SITE OPERATIONS MONITORING

Inspection and monitoring of the structural stability and integrity of the facilities at the PIERP is an on-going component of the site operations. On-site personnel from USACE and MES frequently conduct informal inspections of the perimeter and interior dikes, armor stone, roadway surfaces, and spillways. Following any significant storm event, a thorough visual inspection is conducted to identify obvious signs of distress (like major dike erosion or road surface failures)

An Operations and Maintenance plan for the PIERP, which will include a formal inspection program to be conducted annually following a detailed inspection checklist and documented with a formal report, is under development. Also to be included in the Operations and Maintenance plan is a specific monitoring plan for the armor stone that will involve detailed aerial surveys and specific monitoring plots of the perimeter dike surface. The monitoring plots of the perimeter dike surface will be carefully monitored (probably annually or bi-annually) to detect subtle armor stone deterioration from weathering (such as freeze-thaw deterioration).

8.4 ENVIROMENTAL MONITORING FRAMEWORK

Monitoring needs for the existing PIERP have been identified by a multi-disciplinary group of State and Federal regulatory and resource agencies. Goals, objectives, and general monitoring approaches are outlined in the Monitoring Framework (MES, 2003d), and specific monitoring details are provided in the PIERP Annual Monitoring Study Plan, prepared each year by

MES. Monitoring is performed to ensure regulatory compliance, to document the creation of beneficial habitat, to confirm the expected findings of no negative impacts, and to provide operational input on the success of habitat creation and potential changes which will increase the habitat value and utilization.

As of 2005, the PIERP Monitoring Framework consists of thirteen monitoring components:

1. Turbidity Monitoring
2. Shellfish bed sedimentation
3. Sediment quality
4. Wetland vegetation
5. Water quality
6. Benthic and Epibenthic community
7. Fisheries use of exterior proximal waters
8. Wetlands use by fish
9. Wetlands use by wildlife
10. Bird utilization
11. Interior water quality/algae
12. Terrapin monitoring
13. SAV monitoring in Poplar Harbor

Agencies providing expertise and information on monitoring elements include the NMFS, USFWS, the National Biological Survey, MDNR (including MGS), MDE, MES, USEPA and USACE-Baltimore District. A collaborative, multi-disciplinary team developed the framework to contain costs, to ensure comprehensive monitoring and to provide concurrent peer review of the monitoring effort. All changes in the monitoring framework will continue to be presented to the team of resource and regulatory agencies for their review and comment. The framework is intended to be flexible to meet the needs of the project and the resource agencies over time. Each element will be evaluated at the end of each monitoring year and the monitoring team will decide upon appropriate changes as necessary.

The existing monitoring framework would be expanded to include any lateral and vertical expansion of PIERP. The location and number of additional monitoring locations and the frequency of monitoring events for each component would be determined based on consultation with the appropriate agency representatives, and approved by members of the Monitoring Subgroup. Changes and updates to the monitoring framework will be evaluated as part of Adaptive Management Process. Components of the PIERP Monitoring Framework are summarized in the following sections, and specific information about the frequency and duration of each monitoring component is located in Table 8-1 and the Monitoring Framework (MES 2003d).

8.4.1 Turbidity Monitoring

The objective of the turbidity monitoring is to comply with Water Quality Certification turbidity monitoring requirements during construction. The turbidity monitoring program will

test the hypothesis that turbidity levels outside of a defined mixing zone will remain in compliance with the Water Quality Certification limitations during construction activities.

During the Phase I and Phase II perimeter dike construction for PIERP, turbidity monitoring was required, and was conducted according to the following sampling plan. Specific monitoring locations and frequency for the perimeter dike construction of the lateral expansion will be developed through consultation with MDE.

The limits for compliance were 50 NTU (monthly average) and 150 NTU (daily maximum) outside of an established mixing zone as prescribed in COMAR and the Water Quality Certification for PIERP. The initial monitoring frequency was for two out of every three days of construction at fifteen locations, for the first thirty days of construction. When compliance with the Water Quality Certification was achieved for the first thirty days, monitoring dropped to one out of every three days of construction at ten locations for the next six months of construction. When compliance was still achieved, monitoring continued at a frequency of once per week at five locations until construction had ended. Sampling occurred on either flood or ebb tides, and not during a slack tide. Sample locations were located on the edge of a mixing zone established using the location of the day's construction activities as the center of an ellipse. This ellipse's axis was parallel to the direction of tidal flow. The length of the ellipse was 9000 ft, and the width of the ellipse was 3000 ft. The daily monitoring locations were at the edge of the ellipse, on the side of prevailing tidal flow. Monitoring locations encompassed the side of the ellipse being sampled, but were concentrated at the end, where tidal transport of turbidity was most likely to occur.

Additional Monitoring for Expansion Project – Turbidity monitoring will be required during construction of the lateral expansion. The turbidity monitoring program will be developed with, and approved by, MDE. No additional monitoring will be required for the vertical raising of the existing upland cells.

8.4.2 Shellfish Bed Sedimentation

The objective of the shellfish bed sedimentation monitoring is to provide information on the change in sedimentation rates on nearby charted oyster bars as a result of construction activity. The shellfish bed sedimentation monitoring will test the hypothesis that there is no increase in sedimentation rates on the charted oyster bars during construction of the exterior dikes at PIERP when compared to sedimentation rates in reference areas unaffected by dike construction.

Shellfish bed sedimentation monitoring was conducted for the construction of PIERP according to the following protocol. Additional monitoring required during the construction of the lateral expansion will be developed in consultation with MDNR and MGS. At each of three sites within the limits of oyster bar NOB 8-10, a marker horizon of colored fine sand will be spread in a staked area. Three staked reference sites will also be established with a colored sand horizon in an area outside of the potential influence of Poplar construction. Sediment cores will be collected monthly from all six sites to determine if sedimentation is occurring and to what degree. In addition, divers will visually examine the sites and measure

the sediment accumulation if possible. This will be performed one month prior to and once a month during the estimated construction period when dike construction is closest to the oyster bars.

Additional Monitoring for Expansion Project - Monitoring of the sedimentation along the oyster bars adjacent to the expansion footprint (NOBs 8-11 and 8-7) will be required during construction, and will be developed through consultation with MDNR and MGS. No additional monitoring will be required for the vertical raising of the existing upland cells.

8.4.3 Sediment Quality

The objectives of the sediment quality monitoring are:

- To monitor the physical parameters and concentrations of metals and other target analytes in sediment that could be indicators of accompanying effects to benthic infauna and potential bioaccumulation through the food chain.
- To provide operational input on wetlands function and the need for soil conditioning to increase pH and reduce metals mobilization in the uplands.

The sediment quality monitoring program will test the hypothesis that project conditions will not change the metals behavior in PIERP wetlands or Poplar Harbor when compared to regional background sediments.

Surface sediments are currently sampled at twelve locations (the same locations as the benthic monitoring and water quality monitoring locations). Sediment samples are analyzed for ITM target analytes, with the exception of organophosphorus pesticides, VOCs, and SVOCs (EA, 2004f). An additional 16 locations are sampled each year and analyzed only for grain size, trace metals, and C/N/S (MES, 2003d).

Additional Monitoring for Expansion Project - Monitoring of the exterior sediment quality will continue using the established methods and protocols. Additional sampling locations outside of the dikes will be chosen to accurately assess potential changes in the exterior environment. The number and location of additional sampling locations will be based on the final design and determined through consultation with MDE and MGS. No additional monitoring will be required for the vertical raising of the existing upland cells.

8.4.4 Wetland Vegetation

The objectives for the wetland vegetation monitoring are:

- To measure and evaluate differences in plant community species composition, densities or production among the PIERP restored marshes, those of the remnant islands and nearby reference marshes;
- To measure and evaluate differences in plant community species composition, densities or production associated with age of the restored marshes;

Table 8-1. Poplar Island Monitoring Schedule (as of May 2005)

	BASELINE AND PRE-PLACEMENT STUDIES					OPERATIONS MONITORING AND POST PLACEMENT STUDIES														
						4/01 - 1/31/02*	2/1/02 - 1/31/03	2/1/03 - 1/31/04	2/1/04 - 1/31/05	2/1/05 - 1/31/06	2/1/06- 1/31/07									
	1995/1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
	(BASELINE)		CONSTRUCTION																		
Sediment Quality	X					X	X	X	X	X	X	X	X								
ITM Analysis						x		x													
Wetland Vegetation (see note 3)	X					X	X	X	X	X	(X)	(X)	(X)	(X)	(X)	(X)	(X)	(X)	(X)	(X)	(X)
Exterior Water Quality Monitoring	X					X	X	X		X			X			X				X	X
ITM Analysis						x		x													
Turbidity (Construction)			X	X	X	X															
Discharge Monitoring						X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Benthics, Community & Tissue	X				X		X			X			X			X				X	X
ITM Tissue Analysis					x		x														
Fisheries Use of Exterior Proximal Waters	X					X	X	X	X	X	X	(X)		X			X			X	X
Wetlands Use by Fish	X					X	X	X	X	X	X	(X)		X			X			X	X
Wetlands Use by Wildlife	X						X	X	X	X			X			X					
Bird Utilization Counts							X	X	X	X											
Submerged Aquatic Vegetation						X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Shellfish Bed Sedimentation		X	X	X	X	X	X	X													
Interior Water Quality / Algae Monitoring							X	X	X	X											
Diamondback Terrapin Monitoring							X	X	X	X											
	(X) - MONITORING PLANNED, could be adjusted based on wetland development schedule																				

NOTES: 1. All monitoring elements will be evaluated annually to determine if continued monitoring is necessary. Some elements may be added or deleted as conditions change.

2. Initiation of wetlands monitoring is contingent on completion of the wetlands plantings for the first cell.

3. Wetland Vegetation monitoring will be staggered based on when the new wetland cells come on-line.

- To measure and evaluate differences in plant species composition or zonation associated with age or topographic changes of restored marshes; and
- To provide operational input on survival of plant species and methods to increase planting success.

The wetland vegetation monitoring program will test the following hypotheses:

1. There are no differences in plant community species composition, densities or production among the PIERP restored wetlands, those of the remnant islands and nearby reference wetlands.

2. There are no differences in plant community species composition, densities or production associated with age (seral stage) of the restored wetlands.

3. There are no differences in plant species composition or zonation associated with age or topographic changes of restored wetlands.

Vegetation surveys and collections will be performed at the end of the growing season during the baseline year. Up to six permanently marked plots of known size will be selected in a reference wetlands and at existing vegetated areas on the remnant islands. Five transects 10 meters apart on each of six plots will be established through each plot and will be permanently marked. Plant shoot densities, plant survival, above and below ground biomass survival and large scale vegetation delineation and survival estimates will be performed. Sediment movement and vegetation zonation will also be examined through topographic measurement along transects, aerial photography and comparison of surveys.

Additional Monitoring for Expansion Project - Monitoring of the wetland vegetation will continue using the established methods and protocols, and wetland cells within the lateral expansion will be added to monitoring program as they are developed. No additional monitoring will be required for the vertical raising of the existing upland cells.

8.4.5 Water Quality

The objectives for the water quality monitoring is to characterize water quality in the project area and to evaluate whether long term water quality changes have resulted from the project.

The water quality monitoring program will test the hypothesis that there will be no significant long term change in water quality at PIERP. (A short term change is expected.)

Water quality samples are collected from the same twelve locations as the benthic monitoring and the sediment quality monitoring stations. Samples are analyzed for ITM target analytes, except organophosphorus pesticides, VOCs, and SVOCs and nutrient parameters included in the Chesapeake Bay Program.

Additional Monitoring for Expansion Project - Monitoring of the exterior water quality will continue using the established methods and protocols. Additional sampling locations outside of the perimeter dikes will be chosen to accurately assess potential changes in the exterior

environment resulting from spillway discharge and discharge from the tidal gut into Poplar Harbor. The number and location of additional sampling locations will be based on the final design and determined through consultation with MDE. No additional exterior monitoring will be required for the vertical raising of the existing upland cells.

8.4.6 Benthic and Epibenthic Community

The objectives of the benthic and epibenthic community monitoring are:

- To characterize the benthic community in the project area,
- To verify re-establishment of the community,
- To provide information on epibenthic colonization on the dike, and
- To assure there is no accumulation of contaminants in the tissue of benthic organisms in and around PIERP from project conditions.

The benthic and epibenthic monitoring program will test the following hypotheses:

1. There will be achievement of the benthic restoration goal (an abundance and diversity goal for benthic systems developed as part of the Chesapeake Bay Program) in Poplar Harbor within two years of exterior dike construction.

2. There will be no accumulation of contaminants in benthic tissue as a result of project conditions.

3. The project will promote an epibenthic community on the exterior dikes and finger dikes. This will enhance the habitat restoration impacts of the project and may offset the loss of the snag field to the recreational fishery.

Sampling locations for the benthic community are at the same twelve locations as the water quality and the sediment quality monitoring locations. Three locations along the exterior dike are sampled for the epibenthic community analysis. Three replicate samples per location will be collected. Community composition, abundance and diversity will be measured and recorded.

Benthic tissue samples will be collected when the benthic community sampling occurs. Three species of clams - soft-shelled clams, baltic clams *(Macoma balthica*), and razor clams are targeted for collection at five locations. The tissue samples are analyzed for ITM target analytes, except organophosphorus pesticides, SVOCs, and VOCs.

Additional Monitoring for Expansion Project - Monitoring of the benthic and epibenthic community will continue using the established methods and protocols. Additional sampling locations outside of the dikes for the benthic community and benthic tissue and on the dikes for the epibenthic community will be chosen to accurately assess potential changes in the exterior environment. The number and location of additional sampling locations will be based on the final design and determined through consultation with MDE. No additional monitoring will be required for the vertical raising of the existing upland cells.

8.4.7 Fisheries Use of Exterior Proximal Waters

The objective of the exterior fisheries monitoring is to measure and evaluate differences in fish and decapod populations and densities before and after the project.

The exterior fisheries monitoring will test the following hypotheses:

1. There is no difference in fish or decapod species composition or density within the Poplar Harbor area prior to island construction compared to after island construction.

2. There is no difference in faunal species composition or density in areas immediately adjacent to the outside of the dike prior to construction compared to after construction.

Poplar Harbor and areas on the reference islands east of the island footprint are sampled using trawls, gill nets, throw traps and crab pots. Gill nets are also used in the snag area on the western side of the remnant islands. Species composition, abundance and size will be recorded. Trawling will be performed in early spring, summer and fall; gill netting during spring and fall; crab pots will be set in early summer; throw trap sampling will be done during early fall.

Additional Monitoring for Expansion Project - Monitoring of the fisheries use of proximal waters will continue as described, but will be expanded to include areas adjacent to the dikes constructed for the lateral expansion. No additional monitoring will be required for the vertical raising of the existing upland cells.

8.4.8 Wetlands Use by Fish

The objective of the use of the wetlands by fish monitoring is to measure and evaluate differences in decapod and fish densities and community species composition over time in the restored marshes, the reference marshes and the remnant marshes at PIERP.

The wetlands use by fish monitoring will test the following hypotheses:

1. There are no differences between decapod or fish densities, or community species composition among the PIERP restored wetlands compared to those prior to restoration.

2. There are no differences between decapod, or fish densities or community species composition among restored PIERP wetlands compared to nearby reference wetlands.

3. There are no differences in decapod, or fish densities or community species composition associated with age of restored PIERP wetlands.

Fish, shrimp and crab use of the wetlands will be sampled in reference marshes, created marshes and remnant marshes. Replicate fyke nets will be used, with two replicate transects per location where possible. Sampling for fauna will be performed during early spring,

summer and fall, and environmental parameters will also be analyzed. Species, size and abundance data will be recorded.

Additional Monitoring for Expansion Project - Monitoring of wetlands use by fish will continue as described, but will be expanded to include wetlands within the expansion footprint once they are developed. No additional monitoring will be required for the vertical raising of the existing upland cells.

8.4.9 Wetlands Use by Wildlife

The objectives of the wildlife use of the wetlands monitoring are:

- To measure and evaluate species and numbers of migratory waterbirds nesting on the island;
- To compare densities and species composition of migratory waterbirds on the restored marshes the remnant marshes and nearby reference marshes;
- To evaluate differences in wildlife utilization with the seral age of the marsh; and
- To evaluate use of the island by terrapin.

The wetlands use by wildlife monitoring will test the following hypotheses:

1. The species and numbers of migratory waterbirds nesting on the islands in the Poplar group show no numerical change or site relocation comparing pre- vs. post-restoration of PIERP.

2. Densities and species composition of migratory waterbirds using (feeding, roosting) the wetlands do not differ among restored wetlands on Poplar, remaining island reference wetlands or nearby mainland reference wetlands.

3. Age (or seral stage) or restored sites has no influence on their relative attractiveness as nesting sites (uplands) or feeding sites (wetlands to migratory waterbirds).

4. Use of restored upland sites by nesting terrapins is not different from use at either remnant island or mainland reference wetlands.

The number of species and species densities of migratory waterbirds and terrapins on the remnant island marshes and in nearby reference marshes will be quantified. Nest counts will be conducted in the spring. Key indicator species will be used. Wetlands plots in reference wetlands, created wetlands and remnant wetlands will also be used to evaluate bird use in each plot. Upland transects will also be established for terrapin searches. Indicator species are Bald Eagles, Black Ducks, Little Blue Herons, Least and Common Terns, Snowy Egrets, migrant shorebirds, and terrapins.

Additional Monitoring for Expansion Project - Monitoring of wetlands use by wildlife will continue as described, but will be expanded to include wetlands within the expansion footprint once they are developed. No additional monitoring will be required for the vertical raising of the existing upland cells.

8.4.10 Bird Utilization

The objective of the bird utilization is to monitor and evaluate bird utilization on and around PIERP.

Hypotheses—Bird utilization by desirable species on and around PIERP will increase as the habitat restoration goals are completed.

Brief Description – Bird identification and activity within the cells and offshore of PIERP will be monitored and recorded throughout the year, concentrating on those periods when utilization is highest. During regular site visits, the avian investigator will observe bird activity in each cell and inventory the type and quantity of each species present. Similar documentation will be made for bird species observed offshore in the vicinity of PIERP.

Additional Monitoring for Expansion Project - Monitoring of bird utilization will continue as described, but will be expanded to include areas within the expansion footprint. No additional bird utilization monitoring will be required for the vertical raising of the existing upland cells.

8.4.11 Interior Water Quality/Algae Monitoring

Purpose – To characterize water quality inside the cells of PIERP and evaluate potential trends in water quality changes that may result from the conditions produced by dredged material placement.

Hypotheses- Water quality within the cells of PIERP will remain safe for discharge, use by birds and other wildlife.

Brief Description – From April through October, bi-weekly samples will be collected and analyzed for algae content. The water quality parameters of turbidity, pH, temperature, salinity, dissolved oxygen, and conductivity will be measured in each cell at the time the sampling. Nutrient samples will be taken at the same time for ammonium and phosphate analysis. Water samples will be analyzed for algae down to the lowest practical taxonomic level.

Additional Monitoring for Expansion Project - A water quality monitoring program for the lateral expansion will be developed through consultation with MDE based on project design features, including additional spillways and the tidal gut discharges to Poplar Harbor. No additional monitoring will be required for the vertical raising of the existing upland cells.

8.4.12 Terrapin Monitoring

Purpose - To quantify the use of nesting and juvenile habitat by diamondback terrapins on PIERP, including the responses to change in habitat availability throughout the progression of the project. To determine hatchling viability, recruitment rates, sex ratio to evaluate the suitability of the island for terrapin nesting. To determine if the project is affecting terrapin population dynamics by increasing the amount of juvenile and nesting habitat on the island.

Hypotheses

1. There will be no decrease in the number of terrapin nests or the habitat used from year to year.

2. Nest and hatchling survivorship and sex ratio will not be different on PIERP than on reference sites.

3. There will be no change in terrapin population size on PIERP, particularly within cells from the time the cells are filled, throughout wetland development, and after completion and breach of the retaining dike.

Brief Description - Terrapin nesting habitat on PIERP will be monitored daily during the nesting season. Nests location will be documented using global positioning systems (GPS). Nests will be excavated to determine clutch size, monitored daily for nest survivorship and all resulting hatchlings will be marked and released on the island. Nest temperatures will be recorded using miniature temperature loggers placed in a subset of the nests to determine hatchling sex ratio. Terrapin population size will be determined using mark-recapture release techniques. Hatchlings will be marked using binary coded wire tags. All juvenile and adult turtles captured will be marked with an externally visible, numbered, monel tag and passive integrated transponder (PIT) tag. Body size measurement will be used to determine population structure and to evaluate the impact of the project on population dynamics.

Additional Monitoring for Expansion Project - Monitoring of terrapin nests will continue as described during any construction activities. Once construction is complete, additional areas located in the expansion footprint would be incorporated into the existing monitoring program. No additional terrapin monitoring will be required for the vertical raising of the existing upland cells.

8.4.13 SAV Monitoring in Poplar Harbor

Purpose- To evaluate the location and health of SAV in Poplar Harbor.

Hypothesis- SAV growth in Poplar Harbor will increase because of improved environmental conditions in Poplar Harbor.

Brief Description- Annual SAV surveys will be conducted in Poplar Harbor to determine density, location, and species of SAV beds, using the grid system developed by USFWS. Results of the SAV surveys in Poplar Harbor will be compared to Eastern Shore reference sites. Monitoring frequencies will be evaluated annually.

Additional Monitoring for Expansion Project - Since the footprint of the lateral expansion is not located within Poplar Harbor, SAV monitoring will continue following the sampling methodology developed by USFWS. No additional SAV monitoring will be required for the vertical raising of the existing upland cells.