UPPER OHIO NAVIGATION STUDY, PENNSYLVANIA
ENVIRONMENTAL APPENDIX

Cumulative Effects Assessment

Note to Reader:

The National Environmental Policy Act requires consideration of three categories of impacts: direct, indirect and cumulative. A cumulative impact is "the impact on the environment which results from the incremental impact of the action when added to other past, present and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time." (40 CRF 1508.7)

The cumulative effects of Ohio River Navigation System, as a whole, were addressed in the Ohio River Mainstem Systems Study System Investment Plan/Programmatic Environmental Impact Statement, published in draft, May 2006. A separate cumulative effects assessment was undertaken for the Upper Ohio Navigation Study to address in sufficient detail the resources and foreseeable future actions within the relatively small study area (Ohio River miles 0 – 40) comparative to the entire 981-mile length of the Ohio River.

The following report is the complete cumulative effects assessment study. The essential elements of this report are summarized in the body of the Environmental Impact Statement.

Chapter 1

INTRODUCTION TO THE UPPER OHIO NAVIGATION STUDY CUMULATIVE EFFECTS ASSESSMENT

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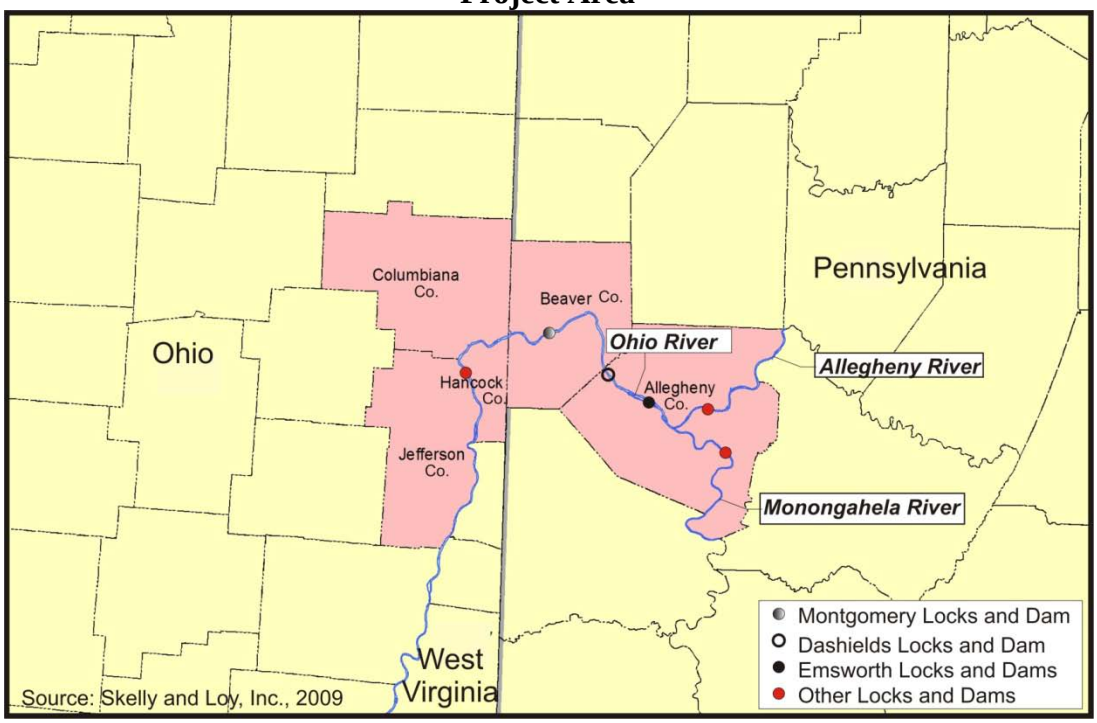
1.1 CHAPTER OVERVIEW

The Pittsburgh District, United States Army Corps of Engineers (USACE) is preparing this Cumulative Effects Assessment (CEA) in support of the Upper Ohio Navigation Study pursuant to the *National Environmental Policy Act of 1969*, as amended (NEPA). This chapter of the CEA provides background information on the Upper Ohio Navigation Study and serves as an introduction to the process used for assessing its cumulative effects. It includes a brief description of the study, the context for conducting environmental studies, the goals and activities associated with the CEA, and an overview of the contents of the CEA.

1.2 THE UPPER OHIO NAVIGATION STUDY

The Upper Ohio Navigation Study, Pennsylvania, is a congressionally directed feasibility study to investigate opportunities for maintaining and improving commercial navigation**,** consistent with protection of the environment, on the upper Ohio River. The study area, including the counties (shaded) that comprise it, is shown on Figure 1-1. Although the navigation facilities involved in the study are in Pennsylvania alone, the study area for certain natural, cultural and socioeconomic resources influencing or influenced by these facilities extends downriver into Ohio and West Virginia.

FIGURE 1-1
Project Area



The congressional authorization for studying the navigation system on the upper Ohio River is contained in resolutions adopted by the Committee on Public Works of the United States Senate dated May 16, 1955 and March 20, 1982, and by the United States House of Representatives Committee on Public Works and Transportation dated March 11, 1982. The study will consider engineering, economic, and environmental factors in evaluating long-term navigation needs, and in investigating opportunities for integrating ecosystem restoration features into long-range plans for this reach of the river.

Three facilities, the Emsworth, Dashields, and Montgomery (EDM) locks and dams, maintain navigation on the upper Ohio River in Allegheny and Beaver counties, Pennsylvania. These facilities have been in place since 1922, 1929, and 1936, respectively. For the purposes of this study, the upper Ohio is defined as the pools formed by EDM. It is comprised of the upper 31.7 river miles on the Ohio River, 11.2 miles on the lower Monongahela River, and 6.7 miles on the Allegheny River. Inclusion of the New Cumberland Pool, immediately downstream of Montgomery Dam, extends the study area to river mile (RM) 54.4. These EDM facilities are the oldest locks and dams on the Ohio River that are not currently authorized for modernization. In addition to the EDM projects, there will be 16 modernized lock and dams along the Ohio River by 2014. The modernized Ohio River facilities are configured with double lock chambers having typical dimensions of 110 foot x 1,200 foot main chambers and auxiliary chambers of either 110 foot x 1200 foot (from Olmstead to RC Byrd) or 110 foot by 600 foot (From Racine to New Cumberland). By contrast, the EDM main chambers are the size of the smaller auxiliary chambers (110 foot x 600 foot) and their auxiliary chambers are very small at 56 foot x 360 foot. Two major

problems associated with the EDM projects are deteriorated structural condition and traffic delays during main lock closure due to insufficient auxiliary lock capacity.

The EDM locks and dams are the uppermost three facilities on the Ohio River. They are situated between the tributary navigation systems of the Monongahela and Allegheny rivers and the remainder of the Ohio River Navigation System. The Ohio River Navigation System includes the mainstem Ohio River and its main navigable tributaries, the Allegheny, Monongahela, Kanawha, Green, Tennessee, and Cumberland rivers, along with smaller navigable tributaries, the Little Kanawha, Big Sandy, and Kentucky rivers. The Ohio River Navigation System is a major component of the Mississippi River System, which provides links to ocean-going trade at New Orleans and Great Lakes trade by way of the Illinois River and its connectors to Lake Michigan in and near Chicago.

The upper Ohio River locks and dams are authorized for navigation although the raised pools created by the dams allow for water supply and recreation. Because of the navigation system, large quantities of cargo are moved into and through the Pittsburgh area at relatively low cost and with minimal effects on land-based passenger and freight transportation. Coal and aggregate (stone, sand, and gravel) firms are the primary producers of the upper Ohio River freight. Electric utilities and steel mills are the primary consumers of commodities that move through EDM. There are dozens of terminals and fleeting areas along the banks of the upper Ohio to accommodate commercial navigation, docks, boat ramps, and marinas for recreational boating; water intake structures for industry; and outfalls that serve numerous communities in the area.

USACE planning regulations require identification of a National Economic Development (NED) plan. The NED plan is generally defined as a plan that reasonably maximizes economic development benefits consistent with protecting the environment. Plans will be formulated and evaluated that include both navigation and National Ecosystem Restoration (NER) benefits in accordance with current USACE guidance. The best combined plan, justified in terms of NED and NER, will be identified and compared strictly to the NED plan. Either the NED plan or the combined plan will be recommended for implementation.

Concurrent with the analysis of the EDM projects in terms of NED/NER, the USACE Pittsburgh District prepared an Environmental Impact Statement (EIS) for the Upper Ohio Navigation Feasibility Study. Preparation of a feasibility study is a recommendation of the USACE's 2006 draft *Ohio River Mainstem Systems Study, System Investment Plan/Programmatic Environmental Impact Statement* (ORMSS). Following guidance in Council on Environmental Quality (CEQ) Regulations, 40 Code of Federal Regulations (CFR) 1500 – 1508, USACE will tier from ORMSS in addressing potential impacts of alternatives considered in the Upper Ohio study. By following a tiered approach, consideration of major environmental factors can be incorporated into the planning process at an early stage.

Several earlier USACE efforts focused on concerns over the physical condition and capacity limitations at EDM. A *Preliminary Report on Proposed Plan of Improvement,*

prepared in 1962, was followed by a feasibility-level report in 1971, the *Report on Replacement - Emsworth, Dashields and Montgomery Locks and Dams - Ohio River, Pennsylvania*. At that time, a plan that reduced the number of projects in this reach of the river by eliminating Dashields (a "two-for-three" plan) was found to have the highest net benefits. The recommended plan at that time, however, was a "three-for-three" plan that included new 110 foot x 1,200 foot and 110 foot x 600 foot locks at each site, and new gated dams at Emsworth and Montgomery. Although no action was taken on the recommended plan, rehabilitations of the EDM lock and dam facilities were undertaken in the 1980s to extend their useful life.

As already noted, the Great Lakes and Ohio River Division released the draft ORMSS in May 2006. The goal of ORMSS was to identify the best long-term comprehensive program for maintaining a viable navigation system on the main stem of the Ohio River while striving to achieve environmental sustainability. This system study looked at all 19 navigation facilities for the period 2010-2070 in an effort to develop a System Investment Plan (SIP). The SIP concluded that physical improvements to EDM were economically justified in the near term and provided rationale for timely completion of this Upper Ohio Navigation Feasibility Study.

In October 2006, the USACE Pittsburgh District conducted public scoping meetings, in accordance with NEPA regulations and policies, and undertook preliminary work in preparation of a CEA. The USACE also developed work plans for individual valued environmental components (VECs) and reasonably foreseeable future actions (RFFAs) for each individual valued environmental component (VEC). Additional information on the VECs and RFFAs is found later in this CEA.

1.3 CONTEXT FOR ENVIRONMENTAL STUDIES

Guidance was issued by the Council on Environmental Quality (CEQ, 1997), United States Environmental Protection Agency (USEPA) (1999), and USACE (2002) regarding the evaluation of cumulative impacts. This CEA is guided by those regulations and policies. Not only will this CEA consider impacts to important resources, it will incorporate the concept of environmental sustainability. While the CEA primarily focuses on environmental impacts, it recognizes that actions must also be evaluated comprehensively within the context of economic and engineering issues.

Because cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time, cumulative effects have been defined by the CEQ as the result of "the incremental impact of an action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other actions." Furthermore, the CEQ suggests that cumulative effects can be identified through a series of questions, including the following:

- Is the project one of similar past, present, or future actions in the area?
- Will other activities in the area have similar environmental effects?

- Will the project in combination with other projects have an effect beyond its direct impacts?

- Has the project been considered during other CEAs?

- What is the value of the potentially impacted resource?

- Is the resource protected by legislation?

- Is the resource ecologically, culturally, or economically important?

- Is the resource important to a human community?

The policy of the USACE relative to addressing cumulative effects is an outgrowth of NEPA and the subsequent guidance developed by the CEQ. As stated in Engineer Pamphlet (EP) 1165-2-1 (USACE 1999):

> Each proposed water resource development activity is but a piece of a large-scale program. The combined beneficial and adverse economic, environmental and social impacts of individual projects, each of which may be relatively minor, can have a significant regional or national impact. At each level of the evaluation and review process it is necessary to assess the cumulative beneficial and adverse effects of individual project impacts.

Consequently, this CEA provides a review of the past, current, and anticipated environmental impacts from multiple actions and programs of the USACE; other federal, state, and local governmental agencies; and private entities. By concentrating on the resource under investigation, the environmental sustainability of that resource can be the *ultimate test* for determining the significance of cumulative effects. Thus, the impact to a resource is significant if the cumulative effects exceed the sustainability of that resource.

1.3.1 Environmental Operating Principles

On March 26, 2002, General Robert Flowers, then Chief of Engineers of the USACE, announced seven Environmental Operating Principles (EOPs) for planning and decision-making. The EOPs have been incorporated into Engineer Circular (EC) 1105-2-404 (2003a) and Engineer Regulation (ER) 200-1-5 (2003b). Three of the principles are directly related to the Upper Ohio Navigation Study and have been incorporated into this CEA. Those principals are:

- Strive to achieve environmental sustainability. An environment maintained in a healthy, diverse, and sustainable condition is necessary to support life *(Principle 1)*;

- Recognize the interdependence of life and the physical environment. Proactively consider environmental consequences of programs and act accordingly in all appropriate circumstances *(Principle 2)*; and

- Seek ways and means to assess and mitigate cumulative impacts to the environment; bring systems approaches to the full life cycle of our processes and work *(Principle 5)*.

1.3.2 Context for Environmental Sustainability

Sustainable development and environmental sustainability are the foundations for this CEA. Sustainable development has been defined as meeting the needs of the present without compromising the ability of future generations to meet their own needs (World Commission on Environment and Development 1987). Sustainable development also involves the search for economic progress that does not impair the welfare nor destroy the environmental and natural resources of future generations (Pearce *et. al* 1989).

Environmental sustainability is further defined by the USACE as "a synergistic process whereby environmental and economic considerations are effectively balanced through the life cycle of project planning, design, construction, operation and maintenance to improve the quality of life for present and future generations" (USACE 2002). The process of using environmental sustainability as an indicator of cumulative effects was used during the analytical studies found within ORMSS and the subsequent studies for the Upper Ohio Navigation Study that tiered from ORMSS.

1.4 GOALS AND ACTIVITIES OF THIS STUDY

The goal of this CEA is to assess the potential incremental cumulative impact of further modernization of the Upper Ohio Navigation System on resources, ecosystems, and human communities of concern. The analysis addresses the accumulation of meaningful impacts to environmental resources from the modernization of the navigation system in concert with impacts from other past, present, and reasonably foreseeable future actions by USACE and others. The emphasis of the technical analyses associated with the CEA is on the environmental sustainability of each resource under investigation.

As noted previously, the Upper Ohio Navigation Study was initiated in October 2006 with a series of public scoping meetings. Approximately 40 people attended three public meetings held throughout the Pittsburgh area. Press releases, legal ads, and invitation letters were distributed prior to each meeting. Comments were received during the meetings on project costs, barge traffic, riverfront development, pool elevation, economic benefits, safety and recreation, threatened and endangered species, and the environmental process. Related public scoping also occurred during ORMSS.

Additionally, an interagency working group (IWG) was formed during the preparation of ORMSS. A more regional IWG was formed to continue to guide the development of planning and research methodologies associated with this CEA. Comprised

of representatives from natural resource agencies, planning bodies, and academia, as well as USACE personnel, the IWG has provided background information, reviewed technical reports, and offered comments throughout the process. The IWG has served as a forum for continuous scoping throughout the project. Representatives from the United States Fish and Wildlife Service, United States Environmental Protection Agency, United States Coast Guard, Pennsylvania Fish and Boat Commission, Pennsylvania Department of Environmental Protection, Southwest Pennsylvania Commission, Port of Pittsburgh Commission, Western Pennsylvania Conservancy, the Nature Conservancy, the Ohio River Valley Water Sanitation Commission, California University of Pennsylvania, Marshall University, and Pennsylvania State University have participated in the IWG.

A considerable amount of existing data and a large number of reports were reviewed throughout the process. Much of the information found in that data and those reports was extracted for use in this CEA. New data were also gathered during recent field surveys and by contact with local planning agencies. A major activity involved the integrated analysis of the assembled information and data related to past, present, and potential future cumulative effects on key resources, ecosystems, and human communities of concern. Key environmental resources analyzed included water quality, sediment quality, fish, mussels, and riparian areas. Human uses related to river-based recreation, transportation and traffic, air quality, health and safety, socioeconomics, and cultural resources were also analyzed. Individual chapters have been prepared on these resources, ecosystems, and human communities of concern. Internal and external reviews were incorporated in the preparation of each chapter.

1.5 CONTENTS OF THIS CEA

This CEA is organized into 14 chapters. References are listed, as appropriate, at the end of each chapter or exhibit. Following this introductory chapter, Chapter 2 summarizes the overall project approach, methodology, VECs, and RFFAs. Chapters 3 through 13 present individual analyses for each VEC, including definitions, issues, related laws/regulations, past to current baseline conditions, interaction with other VECS, indicators of environmental sustainability, relevant actions affecting the VEC under investigation, and the analysis of and conclusions on environmental sustainability. The final chapter discusses the conclusions related to this study.

1.6 REFERENCES

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Chapter 2

CEA PROCEDURE AND METHODS

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2.1. Overview

2.2 Scoping

2.3 Matrices for Reasonably Foreseeable Future Actions

2.4 Analysis of Environmental Sustainability

2.5 References

2.1. OVERVIEW

This analysis addresses the cumulative effects of past, present, and reasonably foreseeable future actions (RFFAs) within the study area of the Upper Ohio Navigation System. This Cumulative Effects Assessment (CEA), an important component of the Upper Ohio Navigation Study's Environmental Impact Statement (EIS), identifies the incremental impact of the study alternatives on specific valued environmental components (VECs). The EIS is tiered off of the Ohio River Mainstem Study's (ORMSS) Programmatic EIS.

Procedures recommended by the Council on Environmental Quality (CEQ) were used for this CEA. These procedures include the use of questions/interviews/panels, checklists, matrices, networks/systems diagrams, modeling, trends analysis, overlay mapping/GIS, carrying capacity, ecosystem analysis, economic impact analysis, and social impact analysis. Although the CEQ guidance provides distinct steps and different methods for analyzing cumulative effects, those steps can be modified or combined to provide a better picture of past, present, and reasonably foreseeable effects. Depending on the resource examined, some methods are more appropriate than others. To some degree, this CEA and the ORMSS CEA combined elements of all the suggested procedures, which is not unusual when examining the potential for cumulative effects associated with larger projects. Table 2-1 provides a definition of each procedure and identifies its importance to the Upper Ohio River CEA.

TABLE 2-1
CEA Procedures and Methods

Procedure/Method	Definition/Description	Extent Utilized in Upper Ohio River CEA
Matrices	Two-dimensional checklists that are often able to quantify interactions between human activities and resources, assesses both magnitude and importance	Used as the primary method of analyzing RFFAs, also were very valuable in determining levels of sustainability
Trends Analysis	Assesses the status of resources, ecosystems, and human communities over time	Used as the primary method of analyzing past and current conditions, as well as making predictions on future sustainability
Questions, Interviews, Panels	Applicable to social and environmental effects, used primarily during scoping, can help characterize spatial and cause and effect relationships	Used during initial scoping, but also continued throughout the study, were especially important in defining VECs and gathering information from the Interagency Working Group (IWG)
Overlay Mapping/ GIS	Provides locational information, helps set boundaries for other analytical efforts	Used to identify geographic areas for each VEC, also used in many of the efforts that supported the study
Networks and Systems Diagrams	Link components of environmental or social systems, allow user to trace cause and effect through a series of links	Used to some degree in identifying interactions between VECs and drawing overall conclusions
Checklists	Primarily applicable to environmental effects, can provide a list of common or likely effects, but often simplifies things too much	Used to some extent during development of RFFAs and determining sustainability, but used more as a means for maintaining consistency through the process than for analysis
Carrying Capacity	Analyzes the limits and thresholds inherent in many environmental and socioeconomic systems	Used to help identify sustainability of resources
Modeling	Quantifies cause and effect relationships, can compute effect of project scenarios	Not used in this CEA, but modeled data prepared by other agencies or groups were examined during the research on past, current, and possible future conditions

TABLE 2-1 (continued)
CEA Procedures and Methods

Procedure/Method	Definition/Description	Extent Utilized in Upper Ohio CEA
Ecosystem Analysis	Examines a full range of ecological resources and their interactions with the environment, requires focusing on the resource, not the alternatives	Used throughout the study, formed the most important guiding principle for the study
Economic Impact Analysis	Identifies changes in business activity, employment, income, and population	Used throughout the study, but was particularly important while examining socioeconomics, recreation, transportation, traffic, health, and safety
Social Impact Analysis	Examines population characteristics, community structure, and community resources	Used to develop RFFAs, very important while examining socioeconomics, recreation, transportation, traffic, air quality, health, and safety

The Upper Ohio River CEA mirrors the ORMSS CEA. In effect, the Upper Ohio River CEA used information from ORMSS as a framework, but tightened the geographic scope to the Upper Ohio study area, used updated data, and provided more detail on the local setting and resources. As expected, some conclusions on environmental sustainability were different than those found in ORMSS.

2.2 SCOPING

2.2.1 Background on Scoping

Scoping is an important part of determining whether resources, ecosystems, or human communities of concern have already been impacted by other projects or will be impacted by a proposed project. Scoping was first incorporated in the environmental process by the CEQ in 1978 as an "early and open process for determining the scope of the impact study and the significant issues to be addressed in an environmental impact statement or environmental assessment" (CEQ 1978). Scoping typically occurs during the initial stages of planning an impact study, often with public and agency meetings. Scoping meetings introduce proposed projects and serve as a mechanism to solicit preliminary comments. These early meetings can set the direction for future studies and often identify preliminary community concerns. They can also help identify whether other agencies have plans that may impact resources in the future.

As an open process, scoping provides an opportunity for federal agencies, state and local governments, Indian tribes, environmental organizations, planning and development entities, and the public to participate fully in the study. It is the principal vehicle for assuring that all stakeholders have sufficient opportunity to be involved in the study outcome.

The CEQ calls scoping an iterative process, one that should be used in both the planning and development stage (CEQ 1997). As such, scoping during this CEA was a continuous process.

The CEQ identifies the following four steps for scoping cumulative effects analyses:

- Step 1 – Identify the significant cumulative effects issues associated with the proposed action and define the assessment goals;
- Step 2 – Establish the geographic scope for the process;
- Step 3 – Establish the time frame for the analysis; and
- Step 4 – Identify other actions affecting the resources, ecosystems, human communities of concern.

As a result, the USACE has completed the following:

- Invited the participation of affected federal, state, and local agencies, any affected Indian tribe, the proponent of the action, and other interested persons (including those who might not be in accord with the action on environmental grounds);
- Determined the scope and the significant issues to be analyzed in depth in the impact study;
- Identified and eliminated from detailed study issues that are not significant or have been covered by prior environmental review, narrowing the discussion of these issues to a brief presentation of why they will not have a significant effect on the human environment or providing a reference to their coverage elsewhere;
- Identified public environmental assessments and other environmental impact statements that are being, or will be, prepared that are related to, but are not part of, the scope of the impact study under consideration;
- Identified other environmental review and consultation requirements so the lead agency may prepare other required analyses and studies concurrently with, and integrated with, the impact study; and
- Indicated the relationship between the timing of the preparation of environmental analyses and the agency's tentative planning and decision making schedule.

2.2.2 Components of the Upper Ohio River Scoping Process

Several activities were associated with the scoping process for the Upper Ohio River CEA. A multi-discipline team of USACE staff and consultants periodically conferred to plan, discuss, review, and synthesize information. A working group of public agencies and interested parties was consulted to help determine the magnitude of the CEA, identify issues

of concern, provide background information and data, and suggest RFFAs. Table 2-2 provides an overview of the components of the scoping process.

TABLE 2-2
Components of the Scoping Process

Component	Key Functions
USACE	Provided leadership to the entire scoping process; included educational features related to the CEA; interacted with participating agencies; developed initial list of VECs, RFFAs, methods, and environmental sustainability; analyzed data, reports, and other information
Interagency Working Group	Provided scientific and/or policy advice; aided in identifying research needs; participated in the completion of RFFA matrices, the identification of indicators for environmental sustainability; reviewed various study documents
Other Agencies	Helped determine the scope of the CEA study, including the identification of cumulative effects concerns and contributory actions to these concerns; provided data and background data for completion of the CEA
Public Scoping Meetings	Helped determine the scope of the CEA study, including the identification of cumulative effects concerns and contributory actions to these concerns

2.2.3 USACE

During the planning stage for the study, the USACE identified preliminary VECs, data needs, information sources, roles, and schedules. Because the project tiered from ORMSS, the earlier CEA was used as a scoping model, but since the Upper Ohio Navigation Study was site-specific, some components were modified. Subsequently, the USACE met with participating agencies to present the Upper Ohio River CEA project and obtain information on agency priorities, VECs, and RFFAs. The USACE also sought suggestions for conducting the study. The CEA structure was further modified in response to agency suggestions.

To complete the scoping phase of the study, the USACE:

- Developed a study plan based on CEA procedure described by the CEQ (1997);
- Conducted information gathering activities;
- Undertook technical studies that would provide additional information for the CEA;
- Identified eleven VECs; and

- Continued coordination efforts with participating agencies, primarily through the IWG.

2.2.4 Participating Agencies

Agencies and interested parties participating in the IWG in addition to the USACE included the United States Fish and Wildlife Service, United States Environmental Protection Agency, United States Coast Guard, Ohio River Valley Water Sanitation Commission, Pennsylvania Fish and Boat Commission, Pennsylvania Department of Environmental Protection, Port of Pittsburgh Commission, Southwest Pennsylvania Commission, Western Pennsylvania Conservancy, the Nature Conservancy, California University of Pennsylvania, Marshall University, and Pennsylvania State University.

Agency coordination has:

- Aided in identifying key issues and cumulative effects;
- Identified key research needs relative to environmental issues and natural resources;
- Provided a forum for reviewing USACE findings;
- Allowed full agency participation in the completion of RFFA matrices for all VECs; and
- Resulted in the separation of a Water/Sediment Quality VEC to two chapters addressing Water Quality and Sediment Quality.

2.2.5 Public Scoping

A series of National Environmental Policy Act (NEPA) public scoping meetings was held for the study at three different locations in the Pittsburgh area in late October 2006. Approximately 40 people attended the meetings.

Press releases, legal ads, and invitation letters were distributed prior to each meeting. Comments were received during the meetings on project costs, barge traffic, riverfront development, pool elevation, economic benefits, safety and recreation, threatened and endangered species, and the environmental process. Specific comments are discussed in other chapters of this CEA. Related public scoping also occurred during ORMSS.

2.3 MATRICES FOR REASONABLY FORESEEABLE FUTURE ACTIONS

Direct effects are caused by an action and occur at the same time and place as that action. Indirect effects are induced by the action and generally occur later in time or are farther removed in distance. Cumulative effects, however, are a result of the incremental impact of an action when added to other past, present, and reasonably foreseeable actions.

Thus, the analysis of RFFAs is crucial in determining cumulative effects. Cumulative effects can be difficult to understand because they are not clear cut. They can accrue from similar impacts, from multiple actions, or be the product of unrelated impacts from a variety of actions. In addition, some actions may offset the effects of other actions, lessening the overall impact. Finally, cumulative effects arise from actions which may only be connected by their common impacts on similar resources, ecosystems, or human communities.

The identification and analysis of RFFAs present many challenges. Proponents of future actions may be reluctant to reveal information for a number of reasons. Plans may be uncertain and project sponsors, both private and public, may not see a benefit in disclosing them. Furthermore, project sponsors may not completely understand the importance of their plans on other projects, or understand the potential impact inherent in those plans on others. Detailed design and operational information is generally not available for proposed projects. At the preliminary stage of project development, locations may not be set. Project size and magnitude may not have been determined. Usage estimates or projections may not be sufficiently rigorous.

Many factors affect the timing, location, and design of future actions. If programming and funding requirements have not been finalized, future actions may be delayed, downsized, or modified significantly over time. If definitions of future actions are too liberal, future impacts may be predicted as being too high. If definitions are too conservative, future impacts may be underestimated.

The methodology used for this CEA employed a series of matrices that connected RFFAs and the anticipated effects on VECs. This method was originally developed in the ORMSS CEA study. That CEA addressed the Ohio River mainstem from Pittsburgh to the Mississippi River (a distance of 981 miles). The Pittsburgh District also successfully used this CEA methodology for their Locks and Dams 2, 3 and 4, Monongahela River Project, a tributary to the upper Ohio River.

The RFFA matrix approach was originally developed for the ORMSS CEA and later modified for projects on the Lower Mon. Adjustments were made for this CEA as well. Through all three projects, the fundamental principle remained the same: *focus on the resource*. In adapting the RFFA matrix method to the Upper Ohio River study, the findings of the ORMSS CEA and scoping information from both ORMSS and the Upper Ohio Navigation Study were used to determine RFFAs, VECS, timeframes, and geographic scopes. This resulted in the identification of 73 RFFAs and 11 VECS. The timeframe for each VEC was consistent throughout, from 1885 to 2070, but the geographic scopes varied from the river itself (e.g., for aquatic resources) to the five-county region surrounding the upper Ohio River (e.g., for socioeconomic resources).

RFFAs were divided into two primary categories: USACE actions and actions by others. These two categories were further subdivided into other categories associated with navigation, ecosystem restoration, development, resource protection, transportation systems, natural events, and the regulatory environment. A complete list of the RFFAs is shown in Table 2-3.

TABLE 2-3
Reasonably Foreseeable Future Actions (RFFAs)

USACE Actions		
Type	**Specific Action**	**Description**
Navigation Investments	Replacement locks at Emsworth, Dashields, and Montgomery Dams (EDM)	New replacement main chamber locks would be constructed to provide reliable operation. These new locks may or may not be larger than the existing main chambers.
	Rehabilitation of EDM	Rehabilitations would include the dams at their present locations and possibly the existing main chambers.
	Navigation aids - lock & dam (L/D) signage	Approach warnings, distance buoys at dams; rules & guidance at lock approaches
	Non-structural navigation improvements	Vessel scheduling & coordination, expanded mooring facilities, n-up/n-down during closures, reduced movement of empties, stockpiling of materials
	L/D operation and maintenance	Lock maintenance, repair, and rehabilitation (requires temporary closure of lock chamber)
	Approach & channel dredging / disposal	Routine removal & disposal of sand, gravel, or other deposits to maintain a 9-foot depth
	Environmental design	
	environmental sustainability operation actions	Modifications to achieve environmental sustainability objectives
	Pool maintenance	Maintaining "run of the river" pool as opposed to uncontrolled river or other types of pools
	Sec 107 port development and maintenance dredging	Small river & harbor improvement projects not specifically authorized by Congress
Ecosystem Restoration	Fish passage at EDM	Structural elements to facilitate fish movements

TABLE 2-3 (continued)
Reasonably Foreseeable Future Actions (RFFAs)

Actions by Others		
Type	**Specific Action**	**Description**
Navigation System Dependent - "But For"	*Commercial Navigation*	
	barge queuing	Lining up tows waiting to go though locks
	fleeting areas/barge storage	Areas where barge tows are assembled, dissembled & reassembled; temporary instream storage of barges
	terminals & multi-modal sites	Facilities where materials are unloaded, loaded or temporarily stored; intermediate ports for fleeting
	barge/tow tech/green design	Operations & maintenance (O&M) practices, technology & design for improving environmental quality related to commercial navigation
	accidents/spills	Barge traffic accidents; shipping materials spillage during transit or storage
	USCG nav. aids - const., O&M	Positioning & operation of buoys, channel markers, fixed lights & other navigation devices by USCG
	Energy	
	hydropower on dams	Power generation facilities at dams; future facilities licensed by Federal Electric Regulatory Commission
	continued operation of coal-fired power plants	O&M or expansion at existing power generation plants
	Water-based recreation	
	marina development & operation	Commercial docking facilities
	commercial boating	Commercial party or excursion boats; rented watercraft
	personal boating	Motorized or nonmotorized watercraft used for recreation
River Dependent	*Water supply / discharge*	
	municipal	Public drinking water intakes
	industrial	Industrial water intakes & discharges
	Waste water treatment discharges (WWTP)	
	onsite systems	Conventional septic systems, alternative systems & other options for unsewered smaller communities
	stormwater discharges; CSOs; SSOs	Surface runoff; non-point source discharges; separate stormwater collection systems; combined sanitary & stormwater collection systems
	Marcellus shale gas extraction (water impacts)	Wastewater discharges
	Resource extraction	
	instream sand and gravel mining	Commercial extraction of sand & gravel from the river
	Acid mine discharge (AMD)	Discharge of acidic waters from abandoned mines

TABLE 2-3 (continued)
Reasonably Foreseeable Future Actions (RFFAs)

Actions by Others		
Type	**Specific Action**	**Description**
Riverfront / Flood Plain Development	*Downtown Pittsburgh*	
	ongoing Point State Park improvements	Recreation & aesthetic improvements along riverfront
	Convention Center riverfront park	Recreation & aesthetic improvements along riverfront
	residential development/ conversions	Conversion of commercial facilities to residential facilities
	North Shore development	Casino, hotel, office construction, entertainment & shopping complexes; recreation & aesthetic improvements along riverfront
	Pittsburgh South Side	
	continued riverfront development	Recreation & aesthetic improvements along riverfront
	continued South Side Works development	Entertainment, shopping, & office complex; recreation & aesthetic improvements along riverfront
	Riverfront trails	
	Pittsburgh riverfront trail system	Construction of new trails
	Beaver County trail system	Construction of new trails
	Brownfields redevelopment	
	Neville Island	Reuse of industrial site
	PL&E, McKees Rocks	Reuse of industrial site
	M&B Development	Reuse of industrial site
	Fab Tech & Buckeye Pipline	Reuse of industrial site
	J&L site in Aliquippa	Reuse of industrial site
	Leetsdale Industrial Park	Reuse of industrial site
Resource Protection / Restoration	Ohio River Islands Widlife Refuge System	Refuge extends 362 miles with 22 islands and 3 mainland properties; protects native wildlife & habitats; includes Phillis and Georgetown islands
	Nationwide Rivers Inventory	Ohio River from PA state line to Wellsville, WV; exhibits significant national values
	Ecosystem restoration	Restoration of riparian areas & river by non-federal agencies
	Cultural resources	Historic & archaeological resources

TABLE 2-3 (continued)
Reasonably Foreseeable Future Actions (RFFAs)

Actions by Others		
Type	**Specific Action**	**Description**
Bridges and Roadways	*Bridge renovations*	
	Ambridge/ Aliquippa Bridge	Bridge renovation
	Shippingport Bridge	Bridge renovation
	Rochester Bridge	Bridge renovation
	McKess Rocks Bridge	Bridge renovation
	Birmingham Bridge	Bridge renovation
	Rankin Bridge	Bridge renovation
	New crossings	
	Maglev	Magnetic levitation train from Pittsburgh International Airport to Greensburg, PA, via downtown Pittsburgh
	North Shore connector	Transit subway from downtown Pittsburgh, currently under construction under the Allegheny River
	Roadways	
	Mon/Fayette Expressway	New expressway into downtown Pittsburgh
	SR 28 widening/ railroad relocation	Major roadway improvements along Allegheny River
	CSX double stack upgrades (National Gateway)	Railroad corridor improvements to allow double-stack shipments
Natural Events	Floods	Potential occurrence during the planning period
	Droughts	Potential occurrence during the planning period
	Invasive species	Non-native plant and animal species

TABLE 2-3 (continued)
Reasonably Foreseeable Future Actions (RFFAs)

Actions by Others		
Type	**Specific Action**	**Description**
Regulatory Environment	Phase I & 2 NPDES	National Pollutant Discharge Elimination System (NPDES) stormwater permits developed in response to Clean Water Act; adoption of best management practices (BMPs) to control nonpoint sources of pollution
	TMDLs	Maximum pollutants waterbody can receive; sum of allowable loads of single pollutant from all contributing point, nonpoint, & natural sources
	ALCOSAN & other consent decrees	Consent decrees with EPA to address CSO and SSO issues and related wet weather concerns
	Adaptive management in Sand & Gravel EIS	Commitments from Final Environmental Impact Statement
	Pollution prevention	Reduction or elimination of pollutants through increased efficiency & use of raw materials, energy, water or other resources; protection of resources by conservation
	USACE permitting programs	Programs address excavations, fills & discharges in navigable waters; regulated activities associated with physical obstructions, water quality standards, dredged and fill materials, water resources projects, infrastructure development, and conversion of wetlands to industrial or urban land uses
	Boating safety regulations	Legislation & rules related to recreational watercraft operation
	Monitoring programs - PA/ORSANCO	Monitoring of river water quality & aquatic ecology; research programs; repository for information on water quality
	Environmental awareness education	Wide range of societal educational programs currently exist, more are likely to be developed in the future
	Clean Air Act (CAA) standards	Current and future standards related to CAA
	Clean Water Act (CWA)	Current and future standards related to CWA
	Endangered Species Act (ESA)	ESA provides means for protecting endangered & threatened plant or animal species & the critical habitats
	Environmental sustainability practices	Practices that meet present needs without compromising ability of future generations to meet their own needs

Analysis of the matrices was based on several things, best illustrated by a series of questions. During what time period will the action occur or how frequently will the RFFA take place? Four time periods were used, including 1 = within 10 years, 2 = between 10 and 20 years from now, 3 = between 25 and 60 years from now, or A = during all time periods.

What is the probability of occurrence of the RFFA? Three rankings were used for occurrence probability, including H = high probability, M = medium probability, and L = low probability. What is the anticipated location of the RFFA along the river or what is the anticipated "area of occurrence" of the effects? Two rankings were used, including E = along entire length of the river or S = specific location. What is the importance, or impact, of the action on the VEC? Three rankings were used to determine importance, including H = high, M = medium, and L = low. And finally, what are the anticipated effects of the RFFA on the VEC? Three rankings were used, including "+" = positive, "-" = negative, and "+/-" = mixed effects, both positive and negative could occur.

Several additional questions helped formulate answers to the first set of questions. Those questions included the following: What is the duration of the RFFA and the related effects? What is the recoverability or reversibility of the effects on the VEC or subcomponent of the VEC? What regulatory standards or policies apply to the effects? What are the anticipated effects of the RFFA on other VECs?

As answers were developed for each question and the matrices completed, the matrix for each VEC was compared to other VECs. In this way, the interaction between VECs could be compared and the analysis of sustainability could be integrated into the process.

2.4 ANALYSIS OF ENVIRONMENTAL SUSTAINABILITY

Environmental sustainability balances environmental and economic considerations through the life cycle of project planning, design, construction, operation, and maintenance to improve the quality of life for present and future generations. For the Upper Ohio River CEA and similar CEAs, it represents a test of significance of potential cumulative effects. By addressing measurable factors (for the most part quantifiable factors, but in some cases, qualitative), known as indicators of sustainability, a determination on whether or not a resource is currently sustainable, was sustainable in the past, or will be sustainable in the future can be developed.

Consequently, the results of this CEA address what current environmental sustainability is and whether or not it is expected to improve or decline in the future. Three definitions of environmental sustainability were used for the analysis:

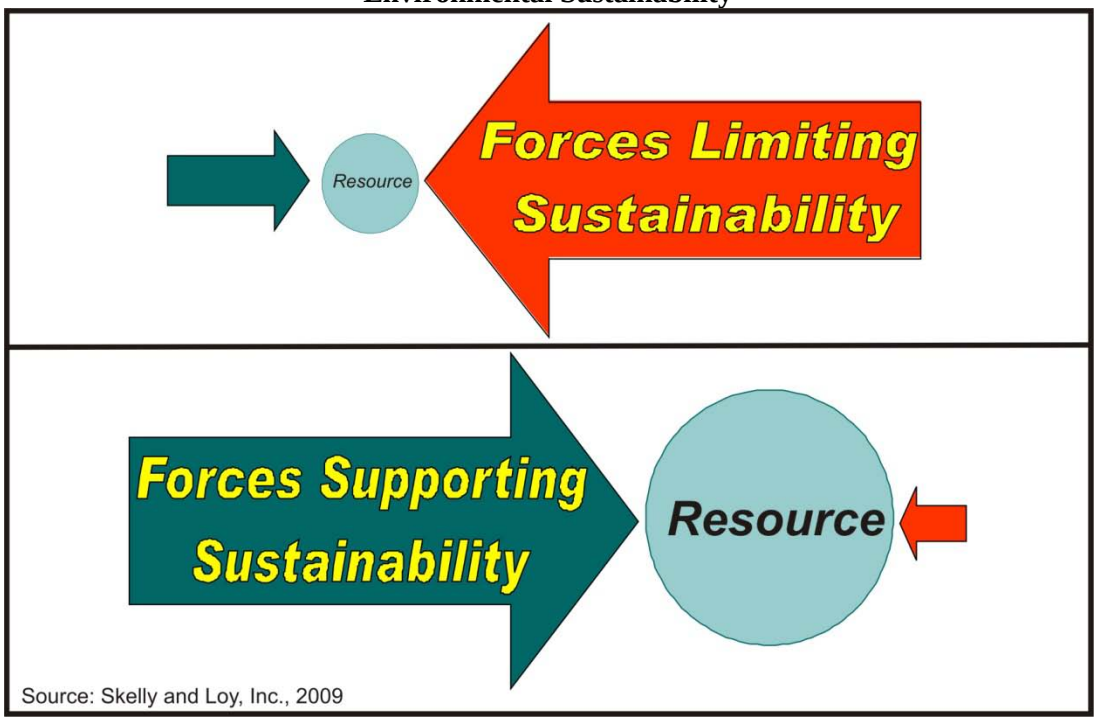
- Not sustainable – conditions for the selected indicators do not reflect conditions that would facilitate attainment of acceptable standards or would not maintain existing standards in concert with collective impacts of proposed activities.

- Marginally sustainable – conditions for the selected indicators are such that attainment of acceptable living conditions and quality of life are accomplished for the majority, but not all, of the potentially affected populations. However, the conditions of indicators are somewhat tenuous both in location and likelihood of occurrences (in other words, the conditions are borderline for environmental sustainability, and there are uncertainties regarding specific quantitative measures).

- Sustainable – conditions for the selected indicators are such that attainment of acceptable living conditions and quality of life are accomplished for essentially all of the potentially affected populations in the project area, and such standards are maintained in concert with foreseeable future activity. Further, conditions of the indicators exceed regulatory thresholds, and various governmental programs are in place to respond to any potential erosion of values related to the resource.

Figure 2-1 illustrates the concept of sustainability. When the forces supporting sustainability are strong, the health of the resource is strong. When those forces are weak or being diminished, then the health of the resource decreases and its existence is threatened.

FIGURE 2-1
Environmental Sustainability



Indicators or groups of indicators of environmental sustainability were identified, and relevant information presented. If all thresholds established by the indicators were met, then the resource was considered to be sustainable. If none of the thresholds were met, then it was unsustainable. If some of the thresholds were met – or all were met, but only partially in time or space – the resource was judged to be marginally sustainable.

2.5 REFERENCES

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Chapter 3

WATER QUALITY

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3.1 DEFINITION

Water quality is defined as the integration of physical, chemical, and certain biological parameters of the aquatic environment and their evaluation in relation to human health and aquatic ecological resources. Water quality standards and designated use attainment will be examined to assess the levels at which the upper Ohio River is being protected. Specific water quality parameters to be evaluated are listed among the indicators of environmental sustainability. Phytoplankton, zooplankton, and benthic macroinvertebrate populations also reflect water quality.

3.2 OBJECTIVES/SCOPE

3.2.1 Objectives

This chapter provides an overview of water quality throughout the upper Ohio River. Additionally, this chapter assesses the system-wide cumulative impacts to water quality of all

likely major navigation improvements along the river from 1885 to 2070. Impacts that are directly or indirectly attributable to modernization of the navigation system are evaluated in concert with impacts from other past, present, and reasonably foreseeable future actions (RFFAs) by the United States Army Corps of Engineers (USACE) and others.

Assessments of past and present actions and current conditions are the basis for identifying and interpreting the potential impacts of reasonably foreseeable future actions (RFFAs). These future actions include the major navigation improvements identified for the Emsworth, Dashields, and Montgomery locks and dams (EDM); other routine or potential actions by the USACE; projected actions by other federal, state, or local agencies, and non-governmental entities; predictions of general economic expansion and development; and regulatory changes.

The results of the cumulative effects assessment are intended to determine past, present, and future environmental sustainability and identify needed actions to improve long term sustainability within the upper Ohio River.

3.2.2 Geographic Scope

The geographic focus for water quality includes that portion of the Upper Ohio River Navigation System that is most directly affected by the existing and possible future modifications to the system. This includes the Allegheny and Monongahela tributaries of the Ohio River to the first upstream dam on each river. The downstream geographic limit is defined as the New Cumberland Lock and Dam (L/D). The geographic scope includes the following pools: Emsworth, Dashields, Montgomery, and New Cumberland. Also included are the floodplains along either bank of the four pools. This floodplain zone is defined as the meander channel of the upper Ohio River and includes the 100- and 500-year floodplains as well as terraces of level land lying above floodplains. Floodplain lands are considered in this assessment because water quality is affected by siltation and contaminants associated with construction, industry, urban storm water, and other land-based activities and because streams and floodplains normally interact as a complex ecosystem.

3.2.3 Time Frame

The established time frame for this assessment is 1885 to 2070. The earlier date is associated with the initial lock and dam construction on the Ohio River. Thus, it approximates the beginning of the modern lock and dam system. The latter date approximates the economic life of anticipated improvements on the Ohio River and is considered the planning horizon for the project. Earlier relevant data about water quality are included when available to provide a more comprehensive overview of cumulative effects which may have occurred over decades or longer.

3.3 ISSUES FROM SCOPING

Scoping has occurred as part of the Ohio River Mainstem Study (ORMSS) and for the Upper Ohio Navigation Study. A series of 12 public scoping meetings was held for ORMSS

during the summer of 2001. Subsequently, a series of three public scoping meetings was held for the Upper Ohio Navigation Study in October 2006. Approximately 185 people attended the ORMSS meetings and approximately 40 people attended the Upper Ohio Navigation Study meetings.

Several comments related to water quality were made during the ORMSS meetings, but none specifically during the public scoping meetings for the Upper Ohio Navigation study. Comments that were directly or indirectly associated with water quality are shown in Table 3-1. Data from ORMSS have been aggregated in the table below, and as a result may not tie directly into individual comments presented in the larger study.

TABLE 3-1
Comments on Water Quality from Public Scoping Meetings

Comment	Number of Similar Comments	Scoping Meeting
Loss of shoreline trees and river property caused by barge activity	7	ORMSS
Bank undercutting and failure caused by increased barge traffic, queuing, and wave action	7	ORMSS
Loss of green space and wildlife habitat with development of marina facilities	5	ORMSS
Cumulative effect of discharges on river may offset water quality improvements	4	ORMSS
Development of floodplains and wetlands resulting in increased runoff and habitat loss	4	ORMSS
Need for ongoing coordination and cooperation with concerned agencies and groups	3	ORMSS
Bank erosion caused by USACE-controlled pool fluctuations	3	ORMSS
Loss of significant farmland to urban development along river corridor	3	ORMSS
Need to develop comprehensive plans for development along river	3	ORMSS
Methods to be used for assessing water quality	2	ORMSS
Challenges to water quality presented by combined sewer overflows (CSOs) and sanitary sewer overflows (SSOs)	2	ORMSS
Need for more stringent discharge permitting procedures or moratorium on permits	2	ORMSS
Impaired water quality and bioaccumulation in fish tissue of harmful substances stirred up by dredging	2	ORMSS
Importance of including commercial dredging and associated permitting process in CEA	2	ORMSS
Importance of coordination of resources agencies in determining baseline conditions	2	ORMSS
Loss of unique, sensitive species due to water quality problems and habitat modifications	2	ORMSS

Comment	Number of Similar Comments	Scoping Meeting
Need to consider 404 application approvals and resultant actions as direct USACE actions	1	ORMSS
Increased spills and accidents potentially affecting aquatic life and impairing water quality	1	ORMSS
High levels of mercury, arsenic, fecal coliform bacteria, and agri-chemicals in surface water	1	ORMSS
Possibility of implementing mechanical aeration in mainstem pools	1	ORMSS
Importance of continued water quality improvements as a high priority	1	ORMSS
Overall effects of navigation structures and activities on groundwater levels	1	ORMSS
Need to protect public groundwater supplies	1	ORMSS
Need to improve sediment and erosion control from public and private developments	1	ORMSS
Need for long-term plan to address silt removal and prevent future sedimentation	1	ORMSS
Development of ongoing program to reevaluate cumulative effects every 5 years	1	ORMSS
Effects of Greenup L/D improvements on barge queuing	1	ORMSS
Importance of coordination between USACE and Ohio River public water suppliers	1	ORMSS
Prolonged bureaucratic procedures in obtaining discharge permits	1	ORMSS
Note: There were no comments specifically on water quality issues during the public scoping meetings for the Upper Ohio Navigation Study.		

In addition to the public scoping meetings, comments were solicited from members of an Interagency Working Group (IWG) specifically established for this study. These members included representatives from the United States Coast Guard (USCG), United States Environmental Protection Agency (USEPA), United States Fish and Wildlife Service (USFWS), Pennsylvania Department of Environmental Protection (PADEP), Pennsylvania Fish and Boat Commission (PFBC), Ohio River Valley Water Sanitation Commission (ORSANCO), Port of Pittsburgh Commission, Southwest Pennsylvania Commission, Western Pennsylvania Conservancy, California University of Pennsylvania, Marshall University, the Pennsylvania State University, and USACE consultants. A summary of the comments received regarding water quality is provided in Table 3-2.

TABLE 3-2
Summary of Interagency Working Group Comments on Water Quality

Area of Concern	Additional Input
Environmental Sustainability Indicators	Plankton levels/food availability, water velocities, endocrine disrupting compounds (EDCs), and indicators of Marcellus Shale brine water
Special Concerns	Marcellus Shale impacts, water allocation, wastewater discharge, overland runoff, point and non-point sources of pollution, sedimentation, Mon River mine pool, dredging impacts, streambank stabilization, and impacts to wetlands
Is ORMSS Still Valid	Not all in agreement
Geographic Nuances	Major tributaries, islands, and backwaters

3.4 LAWS, REGULATIONS, ORDINANCES, AND PROGRAMS

A pivotal regulatory event for the Ohio River Valley was the signing of an interstate compact in 1948 that created the Ohio River Valley Water Sanitation Commission. The principal mission of ORSANCO was to abate existing pollution and control future pollution of waters in the Ohio River basin (ORSANCO 1998). Somewhat later, the Federal Clean Water Act of 1972 (CWA) and other governmental regulations and programs were key in reversing the poor state of water quality. Such environmental regulations have been critical to the control and treatment of acid mine drainage, municipal sewage, and industrial effluents that had polluted the river for decades.

Because less than one percent of sewered communities along the Ohio River treated their wastewater in 1948, one of ORSANCO's first actions was to adopt and promote standards for sewage treatment. Another milestone occurred in 1970 when ORSANCO adopted its first Pollution Control Standards, which required all municipal treatment plants along the Ohio River to provide at least secondary treatment of wastewater. These standards were adopted two years before secondary treatment became mandatory under the CWA.

Every three years since 1970, ORSANCO has revised its Pollution Control Standards for all municipal and industrial discharges to the Ohio River, as changing conditions require. These standards are enforced by ORSANCO's member states, primarily through permits issued under the National Pollutant Discharge Elimination System (NPDES) in Section 402 of the CWA. Provisions of the ORSANCO compact require state standards for discharges to the Ohio River to be at least as stringent as the commission's Pollution Control Standards. Over the decades since its creation, ORSANCO's programs have broadened to include a spectrum of monitoring activities that help track changes in biological communities and provide a database for environmental decision making.

In addition to ORSANCO's standards, several key governmental regulations and related initiatives influence water quality in the study area. Table 3-3 presents information on important federal regulations and established programs, which directly or indirectly influence water quality of the Ohio River.

TABLE 3-3
Laws, Regulations, Ordinances, and Programs Relevant to Water Quality

Law/Program (Lead Agency)	Key Components	Relevance to Water Quality
Water Resources Development Act (WRDA) (U.S. Army Corps of Engineers)	• Authorizes USACE port development, navigation, flood control, and erosion control projects through the 1986 act and subsequent amendments	Contains provisions for environmental assessment and mitigation
USACE Permitting Statutes (U.S. Army Corps of Engineers)	• Section 10 of Rivers and Harbors Act (1899) prohibits the unauthorized obstruction or alteration of any navigable water of the United States. • Section 404 of CWA authorizes the USACE to issue permits for the discharge of dredged and fill materials into waters of the U.S.	Permits require assessment of impacts on water quality and aquatic ecological resources and mandate mitigation of adverse impacts
Small Navigation Projects (U.S. Army Corps of Engineers)	• Section 107 of Rivers and Harbor Act (1960) authorizes USACE to develop and construct small navigation projects for harbor protection.	Includes impacts of such actions on water quality
Spill Response (U.S. Coast Guard & ORSANCO)	• Includes emergency response activities for river-related spills and accidental discharges and is related to the Oil Pollution Act and Section 301 of the CWA	Minimizes adverse impacts of spills and discharges on mussels and other aquatic life and on water quality
Clean Water Act (U.S. Environmental Protection Agency)	• Establishes structure for regulating pollution discharges into U.S. waters (NPDES permits) • Gives USEPA authority to implement pollution control programs • Requires establishment of water quality standards • Recognizes need to address nonpoint source pollution	Provides a comprehensive framework for water quality improvement and protection applicable to all waters of the United States
Safe Drinking Water Act (SDWA) (U.S. Environmental Protection Agency)	• Provides for establishment of primary regulations for the protection of public health and secondary regulations related to taste, odor, and appearance of drinking water	Helps protect public water supplies for approximately three million people who use Ohio River as their source of drinking water
Site Remediation Statutes (U.S. Environmental Protection Agency)	• Includes CERCLA, RCRA, SARA, and related state programs that focus on cleanup and restoration of contaminated sites	Potentially reduces groundwater and soil pollution sources and contributions to pollution loads in the Ohio River
Oil Pollution Act (U.S. Environmental Protection Agency)	• Strengthened USEPA's ability to prevent & respond to catastrophic oil spills	Provides protection from pollution & damage from oil spills

Law/Program (Lead Agency)	Key Components	Relevance to Water Quality
TMDL Program (U.S. Environmental Protection Agency)	• Section 303 of CWA regulates maximum pollutant load a water body can receive and still attain water quality standards	Presents a more holistic option to water quality management than traditional "command and control" approaches
Phase 1 & 2 NPDES Program (U.S. Environmental Protection Agency)	• Also within the CWA, requires municipalities and certain industrial and construction sites to adopt best management practices to control point sources of pollution	Should reduce pollution characteristics of stormwater discharges from urban and industrial zones along the Ohio River
National CSO Control Policy (U.S. Environmental Protection Agency)	• Published by USEPA, calls for communities to implement long-term plan for CSOs to comply with the CWA • Administered through each state's NPDES permit program	Should reduce pollution from a major urban source
ORSANCO Monitoring	• Encompasses ongoing water quality and aquatic ecology monitoring programs by ORSANCO	Tracks trends in water quality and biological communities and provides database that can inform environmental decision making
State Water Quality Certification (Appropriate state or interstate pollution control agencies)	• Section 401 of the CWA requires certification from state or interstate water control agencies that a project is in compliance with established effluent limits and water quality standards.	Provides opportunity for state or interstate scrutiny of such actions on fish and other aquatic resources
PA Sewage Facilities Act	• All municipalities must develop and implement an official sewage plan that addresses their present and future sewage disposal needs.	Helps prevent/document sewage discharge in state waterways
PA Storm Water Management Act	• PADEP provides financial and technical assistance to counties for development and to municipalities for implementation of watershed-based storm water management plans under the Storm Water Management Act of 1978 (Act 167).	Has the potential to prevent major runoff from storm events that could increase the rate of sedimentation and other pollutants into the state's waterways
PA Act 67 & 68	• Encourages sound land-use planning at the local level and requires state agencies to consider local land use ordinances and comprehensive plans in making certain permit and funding decisions.	Helps prevent poor land use decisions that could result in adverse effects to water quality

3.5 PAST TO CURRENT BASELINE CONDITIONS

Water quality in the upper Ohio River declined between 1820 to the 1940s in proportion to population growth and industrial development (Pearson 1992). Pearson noted that overall mean turbidity, dissolved solids, chlorides, nitrates, and sulfates of the Ohio River increased up to the 1940s, while dissolved oxygen levels declined. Acid mine drainage in the upper Ohio River before 1950 contributed to depressed pH values of less than 4.0 in some reaches. Mean monthly counts of total fecal coliform bacteria often exceeded 20,000/100 ml during the same period.

3.5.1 Measures of Key Water Quality Parameters

Several physical, chemical, and certain biological parameters determine the level of water quality. The parameters used for this analysis included dissolved oxygen content, pH/acidity/alkalinity levels, amount of turbidity and suspended solids present, and the nitrogen and phosphorous content. Each of these parameters is discussed in more detail in the following sections.

3.5.1.1 Dissolved Oxygen

Stream ecosystems produce and consume oxygen. The atmosphere and plants provide the oxygen that becomes dissolved in streams. Running water, because of its churning, dissolves more oxygen than still water such as that found in a reservoir behind a dam. Respiration by aquatic animals, decomposition, and various chemical reactions consume oxygen. Wastewater from sewage treatment plants often contains organic materials that are decomposed by microorganisms, which use oxygen in the process. The amount of oxygen consumed by these organisms in breaking down the waste is known as the biochemical oxygen demand (BOD).

Oxygen is measured in its dissolved form as milligrams per liter of dissolved oxygen (DO). If more oxygen is consumed than is produced, DO levels decline and some sensitive animals may migrate, become ill, or die. DO levels vary by season and day. Water temperature and altitude both have effects on DO. Cold water holds more oxygen than warm water and water holds less oxygen at higher altitudes. Thermal discharges, such as water used for industrial cooling, raise the water temperature and lower its oxygen content. Aquatic animals are most vulnerable to lowered DO levels in the early morning on hot summer days when stream flows are low, water temperatures are high, and aquatic plants have not been producing oxygen since sunset.

BOD measures the amount of oxygen consumed by microorganisms to decompose organic matter in stream water. BOD also measures the chemical oxidation of inorganic matter. The rate of oxygen consumption in a stream is affected by a number of variables: temperature, pH, the presence of certain kinds of microorganisms, and the type of organic and inorganic material in the water. BOD directly affects the amount of dissolved oxygen in rivers and streams. The greater the BOD, the more rapidly oxygen is depleted in the stream. This means less oxygen is available to higher forms of aquatic life. The consequences of high BOD are the same as those for low dissolved oxygen: aquatic organisms become stressed,

suffocate, and die. Sources of BOD include leaves and woody debris; dead plants and animals; animal manure; industrial effluents, wastewater treatment plants, feedlots, and food-processing plants; failing septic systems; and urban stormwater runoff.

DO is an essential indicator when assessing the health of aquatic ecosystems. Most aquatic ecosystems require 5 to 6 milligrams per liter (mg/l) of DO to support diverse populations of aquatic life. ORSANCO's current minimum DO standard for the protection of aquatic life is an average of at least 5.0 mg/l for each calendar day with the minimum concentration not less than 4.0 mg/l. During the April 15 - June 15 fish spawning season, a minimum DO concentration of 5.0 mg/l must be maintained (ORSANCO 2003). Sufficient DO levels are especially crucial to fish spawning success. These ORSANCO DO standards are consistent with standards of the states along the Ohio River. This is true for both Pennsylvania and Ohio water quality standards. However, DO standards enforced by the states were generally designed to reflect the needs of aquatic life as reviewed by a National Technical Advisory Committee in the late 1960s and the National Academy of Sciences/National Academy of Engineering in the early 1970s. Most state standards still reflect scientific judgment as of those dates. A classic study of DO concentrations and aquatic life conducted in the Ohio River established the notion that 5 mg/l DO was the boundary condition between little fish life and a reasonably productive community of mixed warmwater fish species (Brinley 1944, as cited in USEPA 1986). It is not an unreasonable expectation that DO goals greater than minimum boundary conditions might be established before the year 2070, the end of the Upper Ohio River CEA study period (USACE 2006).

CWA antidegradation guidance (USEPA 1983) has already been applied to management of minimum DO concentrations along the upper Ohio River. Antidegradation guidance assists in determining nonpoint discharges, cost effective alternatives to such discharges, and the social and economic benefits that may justify any degradation of water quality. Specifically, antidegradation policy guidance has been applied for the protection of aquatic life to hydropower development in the Ohio River basin portion of USEPA Region III (Federal Energy Regulatory Commission [FERC] 1988). Based primarily on USEPA review of numerous studies of DO effects on the survival of sensitive embryonic and larval life stages of non-salmonid fishes (USEPA 1986), minimum DO concentrations of 5.0 mg/l daily and 6.0 mg/l weekly mean were established as a lower boundary for no significant adverse impacts to warmwater fishes in early life stages.

Monitoring and research on this parameter in the Ohio River date back to the DO surveys and model development of Streeter and Phelps (1925). DO concentrations in the upper Ohio River are influenced by multiple factors, including water temperatures, biochemical oxygen demand, photosynthesis, algae, travel and mixing times of pollutants, and the existing navigation system (Wellner and Dinger 1989). Historically, DO levels within the upper Ohio River were mostly influenced by the BOD of domestic and industrial sewage discharges. This effect was most prominent in the waters surrounding the City of Pittsburgh. For the first quarter or so of the 1900s, the city and region enjoyed a booming industrial economy. This industrial growth came at a high environmental cost to the water quality of the three surrounding rivers, however. The problems associated with the domestic and industrial sources of pollution continued to plague the surrounding waterways. In 1936, Congressman Brent Spence testified at a congressional hearing on the pollution of navigable

waters that "the Ohio River is a cesspool." At that same hearing the State Health Commissioner of Kentucky added that "the Ohio River, from Pittsburgh to Cairo, is an open sewer" (USEPA 2000).

The Allegheny County Sanitary Authority (ALCOSAN) was formed in March of 1946 to solve the issues at hand. At this time, 65 million gallons of wastewater were being discharged daily from Allegheny County into the surrounding waterways. While the formation of ALCOSAN took place in 1946, financial and political issues delayed the opening of the waste treatment plant until October of 1959. The goal of ALCOSAN was to reduce the BOD generated by these wastes by 50 percent, thereby complying with or exceeding the discharge standards (Tarr and Yosie 2003).

Following the 1948 signing of the ORSANCO compact, water quality conditions in the Ohio River began to improve. ORSANCO adopted stream water quality recommendations following the 1965 Federal Water Quality Act. In 1970, ORSANCO Pollution Control Standard I-70 made secondary level treatment the minimum requirement for wastewater treatment plants. As a result, BOD decreased significantly, even as influent loading continued to increase with population increases. Massive federal cost sharing construction grants to local authorities from 1972 to 1995 helped support planning design and construction of wastewater plants to meet minimum treatment requirements. Corresponding to decreasing levels of pollutant loading, DO available in the river to support aquatic life increased substantially (USEPA 2000, as cited in USACE 2006).

Prior to effective wastewater treatment, low DO values were typically recorded downstream from Pittsburgh. Substantial DO sags occurred downstream until the late 1960s and mid 1970s. As recently as 1978, DO concentrations as low as 4.0 mg/l were occasionally reported from nearly all ORSANCO monitoring stations during June through September, when temperatures are generally highest and flows lowest. Koryak (1976), studying the upper 130 miles of the Ohio River, found development of DO stratification in navigation pools during low summer flow. Better reaeration occurred at low flows when navigation dams released water through fewer gates with larger openings to create greater turbulence (USACE 2006).

Since the completion of secondary sewage treatment facilities at most major cities in the late 1970s, few low oxygen events occur unless wastewater treatment facilities are temporarily shut down for repairs, maintenance, or emergencies (Pearson and Krumholz 1984). By 1987, Wellner and Dinger actually found elevated DO concentrations up to a mile downstream from major wastewater treatment plants, indicating the general effectiveness of wastewater treatment re-aeration on DO.

DO levels were measured during recent biological studies within the Emsworth, Dashields, and New Cumberland pools (ORSANCO 2004, 2007, 2008). These studies were conducted during stable, low-flow conditions typical of the Ohio River during the summer and early fall. The mean DO level within the New Cumberland Pool was 9.34 mg/l and measurements ranged from 8.00 to 11.20 mg/l. The mean DO level within the Emsworth Pool was 8.96 mg/l and measurements ranged from 8.00 to 10.55 mg/l. The mean DO level

within the Dashields Pool was 8.53 mg/l and measurements ranged from 7.71 to 9.46 mg/l. These DO levels are well above the minimum DO level of 5.0 mg/l required during spawning season, the most critical time to fish throughout the year. These results can be found in Table 3-4.

TABLE 3-4
Dissolved Oxygen (DO) Levels Measured within the Emsworth, Dashields, and New Cumberland Pools

Emsworth		Dashields		New Cumberland	
River Mile	**DO (mg/l)**	**River Mile**	**DO (mg/l)**	**River Mile**	**DO (mg/l)**
2.2 (A)	9.00	6.7	8.00	32.8	9.29
5.0 (A)	9.00	7.7	8.29	36	11.20
5.7 (A)	8.00	8.1	7.71	36.5	N/A
2.6 (M)	8.85	8.4	8.09	37.2	11.20
4.5 (M)	9.02	8.4	9.21	39.9	9.40
4.8 (M)	9.00	9.1	9.44	40.2	9.00
5.7 (M)	9.00	9.4	9.28	41.4	9.00
6.3 (M)	8.90	9.8	8.89	42.5	8.90
9.1 (M)	8.79	10.0	9.46	44.2	8.90
10.8 (M)	8.71	10.6	9.08	45.3	N/A
0.2 (O)	10.55	10.8	9.01	46.4	9.70
1.9 (O)	9.36	11.3	7.89	46.8	8.10
4.0 (O)	9.25	11.6	7.89	48.3	9.00
4.3 (O)	9.00	12.0	7.89	51.6	9.70
5.1 (O)	8.00	12.5	7.89	53.4	8.00
Mean DO	8.96	Mean DO	8.53	Mean DO	9.34
A = Allegheny, M = Monongahela, O = Ohio Rivers					
Sources: ORSANCO, 2004, 2007, and 2008					

The potential for hydropower development at Ohio River navigation dams could also affect DO levels in the river. There are six currently operating hydropower facilities along the Ohio River mainstem. However, increasing energy costs and favorable public policy could in the future create incentives for additional hydropower development. During the late 1980s, when such conditions occurred, nearly every navigation dam on the Ohio River and its tributaries, as well as most federal storage reservoirs in the basin, were permitted or licensed by FERC for hydropower development (USACE 2006).

Potential hydropower generation at the Emsworth and Montgomery dams could particularly affect DO levels in the river, because diversion of river flows through turbines can interfere with the rapid introduction of oxygen which occurs when water passes over a dam. Since the 1970s, the USACE has operated these dams to manage the energy of their discharges to promote efficient gas exchange and reaeration of discharged waters. These operations principally involve schedules of gate operations designed to promote tailwater turbulence and air entrainment during low flow periods. These operations have been very successful and have eliminated serious summer DO depressions along this reach. An

additional benefit to water quality from these operations to maximize gas exchange, achieved perhaps at somewhat of a cost to local air quality, is the stripping of volatile organic compounds (VOCs) from the water discharged (FERC 1988; Koryak 1988; Kincaid *et al*. 1988; USACE 2006)

The Federal Energy Regulatory Commission analyzed the potential cumulative impacts from stacked retrofit hydropower development at navigation dams along the upper 350-mile-long reach of the Ohio River (FERC 1988). The results of FERC model studies demonstrated that there would be substantial declines in dissolved oxygen concentrations from stacked hydropower projects then licensed or permitted along the upper 150-mile reach of the Ohio River during both low and moderate summer season flow periods. Essentially, this entire reach, which at present generally exceeds the minimum warmwater antidegradation DO criteria, would fail to meet this standard. FERC also coupled a bioenergetics model to their hydraulic/water quality model, which showed a very substantial adverse impact to fish growth in the Ohio River from the losses in DO. Again, this impact was most severe along the upper 150-mile reach of the river. DO concentrations along the longer and deeper pools downstream of Willow Island Dam (RM 161.7) do not appear to be influenced as strongly by operations at the navigation dams, and are generally not as well aerated at low summer flows as the pools in the upper river (USACE 2006).

At present, there are no hydropower facilities operational on the Ohio River upstream of Hannibal Dam (RM 126.4). However, electrical energy costs and public policy changes between now and the year 2070 may again encourage additional hydropower development along the Ohio River which could influence future DO concentrations and fish growth in the river (USACE 2006).

ORSANCO policies require hydropower developers to:

1) Conduct studies to determine the level of aeration provided by the dam prior to hydropower construction;

2) Replace the aeration capacity when needed to maintain river DO conditions; and

3) Continuously monitor DO levels above and below the facility, with results made available to ORSANCO.

3.5.1.2 pH/Acidity/Alkalinity

The measure of the acidic or alkaline (basic) nature of a solution as ranked on a logarithmic scale to 1 to 14 is pH. It affects many chemical and biological processes in water. Below a pH of 7.0, water is acidic; above 7.0, water is alkaline or basic. Because the pH scale is logarithmic, a drop in pH by one unit is equivalent to a ten-fold increase in acidity. Therefore, a water sample with a pH of 5.0 is ten times as acidic as a sample with a pH of 6.0. ORSANCO's current pH standard to protect aquatic life is between 6.0 and 9.0 standard units (2003). Significant environmental impacts of pH involve synergistic effects with other substances (e.g., iron, aluminum, ammonia, and mercury) (USACE 2006).

The upper Ohio River system, especially the lower Monongahela, has historically experienced extreme variations in pH. While pH values in excess of pH 9.0 maximum criteria have been observed, values depressed below pH 6.0 minimum criteria were most typical. Also, although massive dumps of acid metal pickling liquors and other episodic events have been documented, chronic acid mine drainage (AMD) from high-sulfur bituminous coal mines has been primarily responsible for low pH conditions in the river (USACE 2006).

Within the upper Ohio River watershed, mining has had a greater influence on water quality than any other human activity. Coal has been mined within the upper Ohio River watershed for more than 200 years. Coal mining activities were first recorded in the United States in 1761. This occurred in the Pittsburgh coal seam mine located in Coal Hill (Edmunds and Koppe 1968). Coal Hill is currently known as Mount Washington. Mount Washington is situated above the left descending bank of the lower Monongahela River, overlooking its confluence with the Allegheny River to form the Ohio River. The Pittsburgh coal seam has been described as the world's single most valuable mineral deposit (Edmunds 1999). It was the principal source of coal in the United States until the 1970s (Pennsylvania Coal Association 1999, as cited in USACE 2001). The Pittsburgh coal seam fired an enormous industrial engine that contributed to the winning of two World Wars, played a prominent role in the development of a regional and national economy, and, directly and indirectly, profoundly influenced the water quality history of the Monongahela, Allegheny, and Ohio rivers.

Acid mine drainage is the result of the oxidation of iron sulfides (pyrite and marcasite) that naturally occur in coal and in the overburden rock. The major source of acid mine drainage in the eastern United States is pyrite. In the process of mining, these reduced minerals are uncovered and exposed to the oxidizing actions of air and water. Autotrophic sulfur and iron-oxidizing bacteria are major process catalysts of reactions that form sulfuric acid and metal hydroxides. Acid mine drainage is characteristically accompanied by mineralization of waters and heavy metal pollution, mostly dissolved, suspended, and/or deposited iron hydroxides and other associated absorbed and/or co-precipitated metals (USGS 2000). Severely AMD impacted streams are typically devoid of fish and most other aquatic life because of low pH levels and the smothering effects of deposited iron hydroxides and other associated metal ions (Koryak *et al.* 2004).

Pennsylvania coal production peaked in 1917 when 329,000 miners produced 278 million tons of coal (Edmunds and Koppe 1968). Generations of mining activity also incidentally produced a tremendous volume of acid mine drainage. As early as 1912, the Pittsburgh Flood Commission identified AMD as a severe economic problem responsible for the corrosion of pipes, pumps, boilers, and navigation structures (Pittsburgh Flood Commission 1912). Around the same time, Ortmann (1909) documented the destruction of aquatic life resources in the Monongahela River and other local streams as the result of acid mine drainage, discharges from primary metal manufacturing industries fueled by coal, and other types of water pollution. In 1914, the U.S. Public Health Service documented acidification of the entire 128-mile length of the Monongahela River, and episodic

acidification of the Ohio River as far as 160 miles downstream of the confluence of the Monongahela and Allegheny Rivers. By the 1920s, when an estimated 2.5 million tons of sulfur acid annually flowed into the Ohio River at Pittsburgh, the problem threatened not only the natural environment of the region, but also the very industrial economy coal had created (Crichton 1927). Many other accounts of pollution of the Monongahela River have been documented. However, when compared to the terrible degree and extent of the acid mine drainage degradation of the river, all other types of pollution experienced could be considered subordinate (USACE 2002, 2006).

Data collected by the USGS and the Pennsylvania Department of Forests and Waters (White 1951) provide a record of conditions between October 1947 and September 1949. The pH of the Ohio River ranged from 3.65 to 6.6 and averaged 5.3. Between 1940 and 1965 pH measurements of less than 5.0 (often less than 4.0) were commonly recorded in the upper 100 miles of the Ohio River. During this same period, unusually high pH records of between 9.0 and 10.0 were occasionally seen in all reaches of the river, probably due to undocumented industrial discharges. During the 1960s and 1970s, much progress was achieved in reducing acid mine drainage pollution in the upper Ohio River Basin. The success of these efforts can be seen in the annual reports of ORSANCO for the period 1974-1980. In most of these years 100 percent compliance with established standards for pH were achieved at all monitoring stations in the Ohio River (Pearson and Krumholz 1984, as cited in USACE 2006).

During biological studies conducted within the Emsworth, Dashields, Montgomery, and New Cumberland pools (ORSANCO 2007, 2008, 2006, and 2004), pH levels were measured. These studies were conducted during stable, low-flow conditions typical of the Ohio River during the summer and early fall. The mean pH level within Emsworth Pool was 7.2 and measurements ranged from 5.2 to 8.1. The mean pH level within Dashields Pool was 7.8 and measurements ranged from 6.97 to 8.56. The mean pH level within the Montgomery Pool was 7.6 and measurements ranged from 7.4 to 8.0. The mean pH level within the New Cumberland Pool was 7.41 and measurements ranged from 7.2 to 7.8. The pH range defined by ORSANCO's and PADEP's water quality standards is from 6.0 to 9.0. All but one (Emsworth River Mile [RM] 4.3) of the pH measurements were within this acceptable range. These results are shown in Table 3-5.

TABLE 3-5
pH levels measured within the Emsworth, Dashields, Montgomery, and New Cumberland Pools

Emsworth		Dashields		Montgomery		New Cumberland	
River Mile	pH	River Mile	pH	River Mile	pH	River Mile	pH
2.2 (A)	6.4	6.7	8.08	13.7	7.4	32.8	7.36
5.0 (A)	6.4	7.7	8.38	14.1	7.4	36	7.20
5.7 (A)	7.6	8.1	7.97	15.8	7.4	36.5	7.36
2.6 (M)	7.9	8.4	8.34	16.6	7.7	37.2	7.20
4.5 (M)	7.7	8.4	6.97	19.3	7.7	39.9	7.42
4.8 (M)	6.7	9.1	6.97	22.0	7.6	40.2	7.38
5.7 (M)	6.7	9.4	6.97	23.1	7.5	41.4	7.50

Emsworth		Dashields		Montgomery		New Cumberland	
River Mile	**pH**	**River Mile**	**pH**	**River Mile**	**pH**	**River Mile**	**pH**
6.3 (M)	7.1	9.8	8.56	26.0	8.0	42.5	7.40
9.1 (M)	7.6	10.0	7.65	27.0	7.7	44.2	7.40
10.8 (M)	7.6	10.6	7.65	27.1	N/A	45.3	N/A
0.2 (O)	8.1	10.8	7.65	27.3	N/A	46.4	7.38
1.9 (O)	8.0	11.3	7.95	27.6	N/A	46.8	7.32
4.0 (O)	8.0	11.6	7.95	28.7	N/A	48.3	7.47
4.3 (O)	5.2	12.0	7.95	30.1	N/A	51.6	7.80
5.1 (O)	7.5	12.5	7.95	30.4	N/A	53.4	7.58
Mean pH	7.2	Mean pH	7.80	Mean pH	7.6	Mean pH	7.41

A = Allegheny, M = Monongahela, O = Ohio Rivers

Sources: ORSANCO, 2004, 2006, 2007, and 2008

Unusually high pH and alkalinity values are typical of runoff from urban centers in the basin. Sewage is typically alkaline, as is runoff from paved urban surfaces. Alkaline steel mill slag leachates significantly influence the pH and alkalinity of runoff in the upper Ohio River (Koryak *et al.* 2002). Algal blooms during summer season low flow periods can also increase pH and alkalinity.

There are several causes for the observed decline in acidity in the upper Ohio River. These causes include: widespread mine roof collapses introducing alkaline overburden drainage; mine flooding; elimination of atmospheric oxygen in older mines that would diminish pyrite oxidation; legislation and regulation resulting in less damaging mineral extraction methods; declining local high sulfur coal production triggered by higher demands for low sulfur fuels; geochemical weathering processes gradually reducing qualities of exposed pyritic materials in older mines; AMD remediation initiatives; hydrologic stream flow modifications; and operator treatment of active mine effluents.

While it would appear that acid mine drainage problems in the Ohio River have been under control for the past several decades, much of the progress in the abatement of acid mine drainage has been achieved by mandatory treatment, required by the CWA and related regulations, of the effluents of active coal mines. Although acid mine drainage pollution problems have declined dramatically, the legacy of past pollution continues to pose problems to the upper Ohio River. Pennsylvania not only has more miles of acid mine drainage degraded streams than any other state (approximately 3,400 miles), but more miles of acid mine drainage degraded streams than all other states combined (USEPA and Office of Surface Mining [OSM] 1995). West Virginia follows Pennsylvania with about 1,100 miles of acid mine drainage degraded streams. A high percentage of West Virginia's acid mine drainage problems are concentrated in the upper Monongahela River drainage basin and flow downstream into Pennsylvania and the Ohio River.

Although a substantial decline in acidity of the three rivers surrounding Pittsburgh has been evident from the chemical data for considerably more than half a century, the chemical data trends generally have had little impact on public or political awareness until certain critical and visible threshold levels are achieved at specific sites, such as local survival of even highly stressed populations of fish in long dead streams. From this viewpoint, the

recovery of fishes and other aquatic organisms examined in other sections of this report provide considerable insight into the water quality recovery process (Koryak *et al.* 2004).

Although there has been a major improvement to the acidity of the upper Ohio River, potential problems from primarily old Pittsburgh coal seam mines are now developing along the Monongahela River. Many coal operations previously committed to pumping and treating of their acid mine drainage discharges have declared bankruptcy. This had resulted in abandoned or orphan mines. Deep mining operations in the Monongahela River Basin over a period of more than a hundred years have left massive voids currently filled or filling with water. Orphan mines that are located below surface drainage level are actively being flooded, creating an immense aquifer of mine water and resulting in new acid mine drainage discharges. It is projected that in 2015 all orphan mines located below the surface drainage level will have reached their maximum capacity to hold water. The Monongahela River Mine Pool has been described as having a giant football shape, stretching from Fairmont, WV in the south to Pittsburgh, PA in the north, and from Wheeling, WV in the west to Uniontown, PA in the east. The aquifer created by the flooding of orphan mines in the Pittsburgh Coal Basin will create the second largest spatially-continuous high-yield aquifer in the Northern Appalachian Region (Donovan and Leavitt 2004).

The West Virginia University Center for Coal Mining Research conducted an extensive study to map the underground mining and water quality of this mine pool (Ziemkiewicz and Vandivort 2004, as cited in Lorson and Smith 2004). They have documented extremely acidic water with gross heavy metal loads within the mine pool. The mine pool has several points that are at a level where they may discharge their acid load to the Monongahela River in the near future. Ten Mile Creek (Mon RM 65.5) and Dunkard Creek (Mon RM 87.2) have been identified as primary discharge points. All marine life in Dunkard Creek was killed in September 2009. Preliminary analysis has suggested an algae bloom as the cause of that loss, but other factors may have contributed to the extensive devastation, including mine waste discharges. Several resource agencies are involved in investigations of the recent incident. A collaboration of natural resource agencies are also involved in aggressive efforts to fully document other fishery resources which may be damaged or lost if an adequate solution to the mine pool flooding problem is not found in the near future.

3.5.1.3 Fecal Coliform Bacteria

The occurrence of fecal coliform bacteria in aquatic environments indicates water has been contaminated with fecal matter of humans or other animals, generally from the overflow of domestic sewage or nonpoint sources of waste. Fecal coliform indicates the presence of organisms caused by the fecal matter of warm-blood animals that may cause gastrointestinal illness (Knauer 2001). Consequently, the presence of fecal coliforms is an indicator of a potential health risk for humans exposed to such water (USACE 2006).

Historically, bacteriological water quality has been and still is a serious issue within the upper Ohio River. Typhoid fever statistics presented by Drake (1931) for the period between 1873 and 1930 show that, historically, human health in the Ohio River Valley was

severely threatened by fecal pollution. In 1907, for example, Pittsburgh typhoid fever cases and death rates were 1,119.2 and 125.2 per 100,000 inhabitants per year, respectively. This was the highest death rate from typhoid of the nation's largest cities. As a result of the construction of water filtration systems for public water supplies from the rivers between 1907 and 1914, typhoid cases and death rates dropped dramatically to 64.5 and 15.4 per 100,000 by 1914, respectively. By 1930, typhoid cases and death rates had further declined to 11.2 and 1.5 per 100,000, respectively.

Since the late 1950s, the development of sewage treatment plants throughout the region has alleviated pollution from domestic and industrial waste that previously discharged directly to local waterways. The largest plant was constructed in 1958 and is operated by the ALCOSAN. Efficiency and environmental improvements accrued as ALCOSAN gradually extended its services to more local communities. It now serves the City of Pittsburgh and 82 other communities in Allegheny County. In 1970, ORSANCO began to require all municipal wastewater treatment facilities to provide secondary level treatment, and ALCOSAN upgraded from primary to secondary level treatment in 1974. Better treatment of wastewaters has resulted in improved bacteriological water quality in the upper Ohio River.

Although the construction of water treatment plants has helped reduce the amount of sewage released into the upper Ohio River, releases of untreated sewage continue to degrade local water quality and impair the value of habitat, recreation, and public water supplies. The main sources of this untreated sewage are from combined sewer overflows (CSOs), sanitary sewer overflows (SSOs), and failing sewers during storm events when high flows are diverted away from treatment plants and go directly into the river. The City of Pittsburgh, ALCOSAN, and other communities in the region face extensive and costly regulatory actions under the Clean Water Act for both CSO and SSO wet weather discharges. Annually, an estimated 16 billion gallons of mixed rainwater and raw sewage are discharged into the region's waterways from CSOs and SSOs during wet weather in the ALCOSAN service area. The ALCOSAN service area alone has 259 CSO and 53 SSO structures from which untreated sewage is discharged into local streams during wet weather, more than any other similar authority in the nation (ALCOSAN 2008; National Research Council [NRC] 2005). Cost estimates to fix these sewer infrastructure problems vary; one recent projected estimate of the cost of regional combined sewer separation by conventional methods was 11 billion dollars.

The enormity and complexity of CSO/SSO problems in the Pittsburgh region, accompanied by regulatory pressures by the Allegheny County Health Department (ACHD), the PADEP, and the USEPA, has led to innovative demonstration initiatives and numerous recent and highly detailed studies. While any thorough examination of these studies is beyond the scope of this assessment, notable examples include the Three Rivers Wet Weather Demonstration Project (TRWW), established in 1997 to assist communities in the ALCOSAN service area under regulatory scrutiny to eliminate combined sewer overflows. The National Research Council of the National Academy of Sciences published a study of the problem in 2005, titled *Regional Cooperation for Water Quality Improvement in Southwestern Pennsylvania*. Similarly, the Allegheny County Health Department and the United States Geological Survey are quantifying fecal indicator bacteria levels in the Allegheny, Monongahela and Ohio rivers near Pittsburgh (Fulton and Buckwalter 2004) and

studies of fecal bacteria were an important component of the Three Rivers/Second Nature initiative (Knauer 2001).

As of 1988, the Clean Water Act was amended by Congress to prohibit SSOs and to reduce CSOs. This resulted in an agreement between ALCOSAN, USEPA, PADEP, and ACHD for ALCOSAN to comply with the Clean Water Act during periods of wet weather. A Consent Decree was the result of this agreement. It was officially filed with the U.S. Department of Justice in May 2007. Some of the major requirements of the Consent Decree were the elimination of all SSO and dry weather discharges; regulation of CSOs to meet compliance requirements; construction and operation of conveyance, storage, and treatment facilities to accommodate additional flow; development and implementation of a Wet Weather Plan; development of partnerships with service municipalities; and expansion of public outreach efforts. The Wet Weather Plan must propose technical alternatives to eliminate SSOs, control CSOs to meet water quality standards, and provide conveyance and treatment capacity for municipal flows within the regional collection system. The Wet Weather Plan must be submitted to the regulatory agencies by September 30, 2012 (ALCOSAN 2009).

PADEP (25 PA Code #93.7) has established the following water quality standards (WQS) for bacteria: from May 1 through September 30 and from October 1 through April 30, fecal coliform bacteria shall not exceed a geometric mean of 200 coliforms (col)/100 milliliters (mL) and 2,000 col/100 mL from five consecutive samples in a 30-day period, respectively. Pennsylvania presently lacks recreational water contact criteria for *Escherichia coli* (*E. coli*) and *enterococci*. The USEPA has issued recommended criteria for *E. coli* of 126 col/100 mL, and for *enterococci* of 33 col/100 mL in recreational waters. Both are represented as a geometric mean based on no less than five samples equally spaced over a 30-day period.

Today, primary water born gastrointestinal human diseases of concern include giardiasis, cryptosporidiosis, *Giardia lamblia* and *Cryptosporidium parvum* (Fulton and Buckwalter 2004). Though outbreaks of diseases from these organisms have occurred in other parts of the nation, and there were serious incidents and concerns with giardiasis from the City of McKeesport's Monongahela/Youghiogheny River water supply several decades ago, and a serious apparently waterborne disease epidemic limited to persons connected to the Sewickley water supply system during the 1970s, there is no recent evidence that southwestern Pennsylvania has experienced any waterborne disease outbreak that could link impaired source water quality with human health effects. Also, amoebic meningoencephalitis from thermophilic *Naegleria fowleri* is a unique potential health problem in the thermal discharges, recipient waters, and cooling towers of the numerous power plants along the Ohio River. Data developed by Sykora *et al*. (1983) suggests that the

optimum water temperature for pathogenic *Naegleria* strains in artificially heated effluents is between 27° and 35°C. While the probability that heated effluents might contaminate large bodies of generally cooler water is limited, swimming and other water contact activities are not advisable in the heated effluents and in sections of recipient waters affected by elevated water temperatures. Pearson (1992) notes that direct effects of coliform bacteria on fishes are negligible, but that sewage contamination affects fishes by altering nutrient levels, biochemical oxygen demand, DO, and suspended sediments and by adding organic compounds.

Total coliform bacteria data for the Ohio River go back more than 60 years. The Ohio River Committee, reporting on the condition of the river from 1939-1943, found mean total coliform counts exceeding 20,000/100 mL for 31 to 61 percent of the time at monitoring stations (Pearson 1992). When the ORSANCO compact was signed in 1948, only one percent of all domestic sewage was treated before being dumped into the Ohio River. In 1951, ORSANCO established its first bacterial water quality standards of <5,000 total coliform bacteria per 100 mL for drinking water and <2,000/100 mL for contact recreation. By 1964, when 97 percent of the population along the Ohio River was served by primary sewage treatment, concentrations of the coliform bacteria in the upper 100 miles of the Ohio River had dramatically declined. The mean at Wheeling, WV, for example, was 62,000/100 mL in 1952, but only 950/100 mL in 1964.

In 1970, ORSANCO began to require all municipal wastewater treatment facilities to provide secondary treatment (ORSANCO 1984). Subsequently, coliform bacteria levels in the Ohio River were expected to decline. This decline did not occur in the river overall, although decreases did occur in the upper 100 miles. Complicating matters somewhat during the 1970s, ORSANCO began reporting only fecal coliform levels as a better indicator of sewage contamination. In 1976, ORSANCO adopted the new federal drinking water standard of 2,000 col/100 mL, a standard that has remained to date. By 1978-79, ORSANCO reported nearly 100 percent compliance in the lower two-thirds of the river and compliance about 75 percent of the time in the upper 100 miles, where problems had previously been most acute (Pearson and Krumholz 1984).

After reviewing bacterial data through the 1980s, Pearson (1992) noted that the largest decreases in coliform bacteria in the Ohio River mainstem apparently occurred after primary sewage treatment facilities became operational, with the most dramatic declines reported in the upper 100 miles. Nevertheless, most violations of the drinking water standard occurred in the upper river throughout the 1980s. The primary contact recreation standard of ≤200/100 mL, established for full-body exposure recreation (e.g., swimming and water skiing), also was violated frequently (Pearson 1992).

ORSANCO fecal coliform bacteria monthly sampling data (May 1992/2001 – October 2008) downstream from Pittsburgh along the river is presented in Table 3-6. These data indicated that the number of exceedances has not improved over the past 16 years and that this is still an issue for the upper Ohio River. This will continue to be an issue until SSOs are eliminated and the effects of CSOs are managed properly. The lower percentage of exceedances observed in 2007 is most likely due to fewer wet events throughout the summer months.

TABLE 3-6
ORSANCO Fecal Coliform Sampling Exceedances in Pittsburgh
May 1992/2001 – October 2008

	River Mile 1.4				River Mile 4.3			
	1992-2005	2006	2007	2008	2001-2005	2006	2007	2008
Total Samples	397	27	29	30	381	81	87	90
Number Exceeding Standard	194	15	9	16	196	41	29	51
Percent Exceeding Standard	**49**	**56**	**31**	**53**	**51**	**51**	**33**	**57**
Source: ORSANCO, 2009a								

Federal regulations require public notice when sewer overflows and runoff increase the likelihood of river contamination. Since 1995, the Allegheny County Health Department has issued river water advisories to warn of possible contamination and to caution people to limit contact with river water when boating, fishing, water skiing, swimming, or engaging in other river recreational activities. An advisory does not prohibit nor discourage river recreational activities; instead, it is intended to inform the public when river water may be contaminated so that precautions can be taken to minimize water contact. Advisories are issued during the summer river-recreation season, from May 15 to September 30, when sewer overflows and storm runoff increase the likelihood of river contamination. During the summer of 2000, when precipitation was above normal, 13 advisories were issued and included 71 of a total of 138 days (Fulton and Buckwalter 2004).

The results of wet and dry weather cross-sectional surveys of the pool of Emsworth Dam near Pittsburgh by Knauer (2001) demonstrated some impacts of precipitation and CSOs on bacteriologic conditions in the river near urban areas. During dry weather in the 2001 recreation season (May 15 - September 30), fecal coliform concentrations generally met target goals for recreational use ($\leq$ 200 col/100 ml). Storms with precipitation intensities of less than 0.7 inch had little lasting impacts on fecal coliform concentrations. However, more significant and persistent fecal coliform contamination occurred following storms with greater than 1.2 inches of precipitation. Areas near the river banks tended to have higher fecal coliform concentrations, and to recover less quickly than mid-channel locations. Unfortunately, most contact recreation occurs near shore. Also, local small urban stream tributaries to the navigation system, while not large enough to measurably affect the mainstem, tended to be contaminated with fecal coliforms even during dry weather. Shallow bars at the mouths of these streams were observed to be fishing and recreation concentration points along the river, as were actual CSO discharge locations. The exact number of CSOs along the mainstem Ohio River in this area is probably less important than the fact that there are a total of 420 CSOs in urban Allegheny County near Pittsburgh which impact the Ohio River.

3.5.1.4 Turbidity and Total Suspended Solids

Turbidity and total suspended solids (TSS) both indicate the amount of solids suspended in the water column. These parameters take into account both mineral (e.g., soil particles) and organic (e.g., algae) solids. TSS is measured by weight of material per volume of water (mg/L) while turbidity is measured as the amount of light scattered by a water sample, with more suspended particles causing greater light scattering. Turbidity, the amount of particulate matter suspended in the water, is reported as nephalometric or Jackson turbidity units (NTUs or JTUs), depending on the measuring instrumentation. ORSANCO has no specific standard for TSS or turbidity. Turbidity and TSS are closely related to stream flow and velocity.

Although elevated turbidity is aesthetically unappealing, it is also detrimental to the health of aquatic ecosystems and humans. High concentrations of particulate matter in a water body can cause increased sedimentation and siltation, which, in turn, can damage habitats for fish and other aquatic life. Further, suspended particles provide attachment sites for other pollutants such as heavy metals and bacteria. Turbidity can also provide nourishment and shelter for pathogens. Several studies have shown a strong relationship between turbidity and pathogens in drinking water (USEPA 1999). Turbidity and TSS of the Ohio River are influenced by erosion characteristics of native soils and geology, but dredging for channel maintenance and land use are probably greater factors. Soil loss and runoff to waterways are accelerated by human activities such as clearing of forests, draining of wetlands, agriculture, and development. Current agricultural practices, reforestation, and runoff controls from construction sites help minimize sediment losses. Simultaneously, increased nutrient loads and runoff from impervious surfaces stimulate algal productivity and increase pollutants attached to soil particles (USACE 2006).

Qualitative reports from the 19th century describe the Ohio River as naturally clear except for the higher turbidities associated with spring flooding. Pearson and Krumholz (1984) noted that Mark Twain and others described the Ohio as naturally the clearest of the three major arms of the Mississippi River system. ORSANCO reported mean turbidity values from 2 to 576 JTU for 43 Ohio River stations monitored between 1952 and 1955 and 2 to 1301 JTU monitored in 1962-63. From 1953-1985, ORSANCO observed a decreasing trend in turbidity, coinciding with the construction of numerous flood control reservoirs on major Ohio River tributaries. These impoundments trap sediments and release clearer water. According to Pearson (1992), the range of turbidities to which Ohio River fish are exposed in modern times is probably not significantly greater than in prehistoric times, but the mean turbidities are higher now. Higher mean turbidities have influenced the fish community more indirectly (e.g., by reducing favored food supplies, visibility of food organisms, and spawning areas) than directly (e.g., clogging gills, smothering eggs or larvae). Higher turbidities and concomitant siltation also have contributed to the decline of native mussels in the Ohio, Allegheny, and Monongahela rivers.

The Allegheny River is naturally the clearest of the three rivers surrounding Pittsburgh. The Allegheny's substrate is unique due to its close vicinity to the ice margin in the time of the glaciers. Because of these glaciers, the substrate of the Allegheny River

consists of well-rounded, unweathered pebbles; sharp, angular sand; small amounts of silt and clay; and boulders. As the glaciers melted, much of the fine material was washed into the Ohio River and then into the Mississippi River. The Monongahela is much more dominated by finer substrates. This is due to much of its bed being composed of sedimentary rocks. The Ohio River substrate is a mixture of the material carried by the Allegheny and Monongahela rivers. Therefore, the substrate of the Ohio River tends to be coarser than the Monongahela River, but finer than the Allegheny River. Since finer substrates are more easily suspended within the water column, the Monongahela River is typically the most affected by high levels of turbidity while the Allegheny River is typically the least affected. In addition to the substrate compositions of these rivers, certain activities also influence the turbidity levels. The two most influential human activities include barge traffic and dredging. Additionally, turbidity levels are increased where large tributaries enter these rivers (USACE 2006).

ORSANCO's 2000 Pollution Control Standards include no specific turbidity or TSS standard for protection of aquatic life, but generally state that waters discharged to receiving waters be free from materials that will settle to form objectionable sludge deposits or suspended materials that will be unsightly or deleterious. Sewage must be treated so as not to exceed the TSS arithmetic mean in monthly samples of 30 mg/L or a weekly arithmetic mean of 45 mg/L.

3.5.1.5 Nitrogen and Phosphorus

Less information exists for nitrogen and phosphorus than for the other water quality metrics discussed previously. Nitrogen and phosphorus are nutrients that stimulate growth of algae and aquatic plants that provide food for fish. Major sources of nitrogen and phosphorus entering rivers include municipal and industrial wastewater, septic systems, agricultural runoff, and atmospheric deposition. Nitrate and phosphate are the forms of these elements most readily available for plant growth. Hynes (1970) notes normal concentrations of nitrate and phosphate in river water are low because plants rapidly take up both ions.

Nitrate is the fully oxidized form of nitrogen and, except under polluted conditions, is the form normally occurring in streams. Ammonia (NH_3) is the most common form of nitrogen in sewage and is toxic to aquatic life in relatively low concentrations. In flowing water, bacteria convert ammonia to nitrites and nitrates. An ORSANCO study of long-term water quality trends from 1977 through 1987 indicated a strongly decreasing trend in ammonia nitrogen and a decreasing trend in total nitrogen, primarily related to wastewater treatment plant improvements and stringent discharge permit requirements (ORSANCO 1990).

ORSANCO water quality criteria to protect human health are 10 mg/L for nitrite + nitrate nitrogen and 1.0 mg/L for nitrite nitrogen. Recent data from 17 sampling stations between New Cumberland L/D (RM 54.4) and Paducah (RM 935) indicated nitrogen levels well below the standards (ORSANCO 2000).

ORSANCO has not established a standard for total phosphorus, although USEPA recommends a maximum limit of 1.0 mg/L for flowing waters. A strongly decreasing trend in total phosphorus observed basin-wide during ORSANCO's 1977-1987 long-term study was attributed to the switch to phosphate-free detergents. More recent phosphorus data were collected at 17 navigation dams for 17 dates between November 1996 and September 1999. No samples exceeded 1.0 mg/L from Hannibal L/D (RM 126.4) upstream and only a few samples exceeded that level downstream to Markland L/D. Total phosphorus is more commonly an issue in areas highly affected by agriculture. Therefore, this is not of great concern for the upper Ohio River.

Concerns about the effects of algal blooms on aquatic life and drinking water quality have led USEPA to direct states to adopt water quality criteria for nutrients. Algal blooms have not harmed aquatic life in the Ohio River, but drinking water suppliers have reported increased algal activity, which may result in taste and odor problems. Data from ongoing algal and nutrient analyses of Ohio River water supplies should assist in the development of appropriate nutrient criteria (ORSANCO 2001).

3.5.2 Development of Total Maximum Daily Loads

Total maximum daily load refers to the maximum amount of a pollutant that a water body can receive and still meet water quality standards. Consequently, a TMDL represents the sum of allowable loads of a single pollutant from all contributing point, nonpoint, and natural sources. The TMDL program originated from Section 303(d) of the Clean Water Act, which requires the development of TMDLs for all waters in which beneficial uses are impaired. During the 1970s and 1980s, however, TMDLs were largely overlooked as states focused on controlling point sources of pollution through NPDES permits. The present emphasis on TMDL program implementation has been driven by: 1) the realization that point source controls alone are insufficient to attain the nation's water quality goals and 2) citizen lawsuits forcing the USEPA to develop guidance for the TMDL program (Commission on Geosciences, Environment and Resources [CGER] 2001).

Under USEPA regulations promulgated in 1992, states are required to identify water bodies that are not meeting water quality criteria established for specific designated uses. For each impaired water body, a state must determine the amount by which sources of point and nonpoint pollution must be reduced to meet stated water quality standards. Further, TMDL plan implementation should encompass water body restoration practices, such as habitat restoration and channel modification. Given the huge number of potential TMDLs for impaired river segments, lakes, and estuaries nationwide and budget constraints, the National Research Council's Commission on Geosciences, Environment and Resources recently recommended changes to move the TMDL process forward (CGER 2001). TMDLs undergo technical review and public comment, and then are submitted to USEPA for final approval.

Within this complex regulatory and scientific context, TMDLs currently are being developed for the Ohio, Allegheny, and Monongahela rivers. The Pennsylvania Department of Environmental Protection has developed TMDLs for polychlorinated biphenyls (PCBs)

and chlordane for sections of rivers included within the geographic scope of this project. The TMDL for PCBs in the Ohio, Allegheny, and Monongahela rivers are 0.00442, 0.0022730, and 0.000508 lbs/day, respectively. The TMDL for chlordane in each river is 0.05525, 0.0284122, and 0.00635 lbs/day, respectively (PADEP 2009). These TMDLs are accurate only for the reaches of these rivers within the geographic scope of this project. In addition to these TMDLs, the PADEP is currently proposing a combined sewer overflow TMDL and an abandoned mine drainage TMDL for the Ohio and Allegheny rivers, respectively (PADEP 2006).

The configuration of the listed streams (primarily the Allegheny, Monongahela, and Ohio rivers) consists of a series of locks and dams. Any PCB contaminated sediments tend to stay in the river pools rather than being washed out as they would be on free flowing streams. All known point source discharges of PCBs or chlordane have been required to obtain a NPDES permit with water quality based effluent limits and a requirement of "not detectable" for limits lower than detection.

Because the use of both PCBs and chlordane has been banned in the United States, there should be no new point sources to which controls can be applied. There are no known current sources of PCBs and chlordane to the lower Monongahela or upper Ohio rivers, although potential past sources were identified during TMDL development. There is however one known NPDES permitted discharge of PCBs to a tributary to the lower Allegheny River. The TMDLs for these rivers state that PCBs and chlordane present are believed to reside primarily in the sediments due to historical use and improper disposal practices. Generally, the levels of PCBs and chlordane are expected to decline over time through natural attenuation due to the bans on use. Examples of processes in natural attenuation are covering of contaminated sediments with newer, less contaminated materials, and flushing of sediments during periods of high stream flow. Natural attenuation may be the best implementation method because it involves less habitat disturbance/destruction than active removal of contaminated sediments. Mechanical or vacuum dredging, for example, removes the habitat needed by certain benthic macroinvertebrates. In addition, some organisms will be killed during the dredging process. Suspension of sediments during dredging may also cause abrasive damage to the gills and/or sensory organs of benthic macroinvertebrates or fish. Suspended sediments can also affect the prey gathering ability of sight-feeding fish. In addition, active removal may cause resuspension of contaminated materials, thus making PCBs and chlordane available for additional uptake. The natural attenuation alternative is also the least costly option. Consequently, the TMDLs state that long-term natural attenuation is the best alternative and provides reasonable assurance that the TMDL will be implemented (USEPA 2001).

3.5.3 Effectiveness of Specific Point and Non-Point Source Control Programs

The success of polluting control programs are individually documented in summary articles found on the USEPA website (http://www.epa.gov/owow/nps/Success319/). Although none of them are on the Upper Ohio River, they illustrate the effectiveness of pollution control programs. The improved water quality observed on the upper Ohio River

further demonstrates the success of similar point and non-point source pollution control programs occurring locally.

A dam modification project on the Middle Cuyahoga River is described. A TMDL study was conducted by the Ohio Environmental Protection Agency (Ohio EPA) in 1999 on the Middle Cuyahoga River. As a result of this study, it was determined that this river was partially attaining goals for its designated use – warmwater habitat (WWH). This stream was entered into Ohio's 303(d) list as "impaired by nutrients, siltation, low dissolved oxygen, flow alteration, and other habitat alteration." Further evaluation of the stream by the Ohio EPA determined that the Kent Dam was a significant contributing factor to the impairment of the Middle Cuyahoga River. "Prior to the project, the Index of Biological Integrity (IBI) – an objective measurement of the diversity of the fish community – indicated that fish life within the river failed to meet WWH standards." Physical habitat conditions were also evaluated. The Qualitative Habitat Evaluation Index (QHEI) was utilized to evaluate the habitat. The existing habitat features did not meet WWH standards either. Following completion of the project, the IBI scores increased by 57 percent and the QHEI increased by 56 percent. Due to the improvements, the Cuyohoga River fully attained its WWH aquatic live use designation and was expected to be removed from the 303(d) list (USEPA 2005).

A Pennsylvania project on Semiconon Run, a tributary to Connoquenessing Creek, was highlighted. This stream was determined to be significantly impaired by an acidic abandoned mine discharge that provided iron and to a lesser extent aluminum and manganese to the stream. This led to an impairment of the biological habitat provided by Semiconon Run. As a result, this stream was added to Pennsylvania's 303(d) list of impaired waters for metals. To remediate this problem a passive treatment facility was constructed which included a settling basin, treatment wetland, and limestone spillway. Data collected during a stream survey three years following completion of the project determined that the stream habitat was no longer impaired. As a result of the project, the stream was removed from Pennsylvania's 303(d) list (USEPA 2008).

West Virginia's Morris Creek is a stream that is severely degraded in several areas by acid mine drainage. Morris Creek is a tributary to the Kanawha River. This stream was first added to the state's 303(d) list in 1996 for metals and then again in 1998, 2000, 2002, and 2004 for pH and metals. To remediate these problems the Morris Creek Watershed Association identified four priority treatment sites. By 2006 the treatment systems were in operation and improved water quality conditions were realized immediately. It is anticipated that Morris Creek will be removed from the 303(d) list by 2010 if conditions remain improved (USEPA 2008).

3.5.4 Biological Indicators of Water Quality

All aquatic organisms, from minute microscopic plankton to the largest fish, reflect the water quality of their environment and, thus, potentially can serve as biological indicators of water quality conditions and trends. Smaller organisms, especially algae and macroinvertebrates, have most often been studied in this regard, in part, because of their relative ease in field collection and laboratory processing. Characterization of water quality

has been the primary motivation for the biological surveys (or biosurveys), which have been conducted along the river by ORSANCO since 1957.

Bioassessments in general may be used within a planning and management framework to prioritize water quality problems for more stringent assessments and to document environmental recovery following control action. Some advantages of using biosurveys identified by the Ohio EPA (1988) follow:

1) Biological communities reflect overall ecological integrity (i.e., chemical, physical, and biological integrity). Therefore, biosurvey results directly assess the status of a water body relative to the primary goal of the CWA (i.e., fishable, swimmable waters).

2) Biological communities integrate the effects of different pollutant stressors and thus provide a holistic measure of their aggregate impact. Communities also integrate stresses over time and provide an ecological measure of fluctuating environmental conditions. Assessing integrated variable pollutant inputs offers a particularly useful approach for monitoring non-point source impacts and the effectiveness of certain best management practices (BMPs).

3) Routine monitoring of biological communities can be relatively inexpensive, particularly when compared to the cost of assessing toxic pollutants, either chemically or with toxicity tests.

4) The status of biological communities is of direct interest to the public as a measure of a pollution free environment, while reductions in chemical pollutant loadings are not as readily understood by the layman as positive environmental results.

5) Where criteria for specific ambient impacts do not exist, biological communities may be the only practical means of evaluation.

3.5.4.1 Algae of the Ohio River Mainstem

Fish and mussel species have been studied and documented for the Ohio River since the 19th century; however, very few studies have focused on phytoplankton and zooplankton specifically. Phytoplankton (algae and cyanobacteria) are tiny organisms that occur naturally in freshwater. Zooplankton are the animal constituent of plankton, and consist mainly of small crustaceans and fish larvae.

Phytoplankton populations are environmentally regulated by light, temperature, nutrients, and predation by zooplankton. Local and temporary adverse effects on phytoplankton populations can be caused by toxic levels of contaminants.

High algal densities (algal blooms) normally indicate high levels of nutrients in the water. Algae form a basis of the food chain and are a foundational component of the Ohio

River ecosystem. Not only are algae an important food source for zooplankton, mussels, and other invertebrates, but also for several species of fish which are extremely important to river ecosystems. Some shiners (*Notropis* sp.), catostomids (suckers), carpsuckers (*Carpiodes* sp.) and, perhaps most critically, gizzard shad (*Dorosoma cepedianum*) are reported to feed directly and largely on algae (Hynes 1970). Algae in running waters may occur as attached forms on all types of solid objects, including macrophytes, and as films on mud and silt surfaces. Algae also occur as free floating or planktonic forms. Until relatively recent years, a debate ensued over whether or not apparently planktonic algae found in streams and rivers could be considered to be "truly" plankton. Hynes (1970) reviewed the literature and concluded that large rivers do support phytoplankton.

Researchers have also confirmed that phytoplankton communities are very important in the upper Ohio River. Subsequent monitoring has to a large degree been motivated by a history of water supply taste and odor problems and public health concerns. In recent years these concerns have expanded to include control of cryptosporidious disease by filtration of the oocysts of the protozoan *Cryptosporidium parvum* during algae blooms (USACE 1994).

The algae currently being sampled by ORSANCO within the Upper Ohio River include blue-green/cyanobacteria, chrysophyte, diatoms, euglenoid, green, pyrrophyte/dinoflagellate, and chryptophyte algae. Within the Upper Ohio River, algae causing taste and odor issues, clogging filters, and those which are pollution tolerant are mostly comprised of blue-green/cyanobacteria, diatoms, euglenoid, and green algae. Blue-green/cyanobacteria are also responsible for producing toxins. It is important to note, however, that not all genera within these algal groups have these effects.

3.5.4.2 Ohio River Plankton Studies - 1957 to 1960

Between October 1957 and January 1960, Jackson and Weise (1962) collected 210 plankton samples along the Ohio River. Over the length of the river, they concluded that diatoms generally dominated the phytoplankton community. In particular, they found that filamentous diatoms of the genus *Melosira* were abundant, nearly ubiquitous, and a significant component of most Ohio River algae blooms. While species composition was similar along the length of the river, there were quantitative longitudinal variations, with generally depressed concentrations of phytoplankton in the polluted upper portion of the river. They suggested that acid mine drainage pollution contributed by the Monongahela River depressed phytoplankton abundance in the upper river.

3.5.4.3 Ohio River Plankton Studies - 1974 to 1975

The USACE sampled phytoplankton along the upper Ohio River between RM 1.0 and RM 129.2 in 1974. Similar to the findings of Jackson and Weise (1962), they observed that the microflora of the Ohio River was dominated by diatoms and green algae, particularly the centric diatoms *Melosira* and *Cyctotella*, and the green algae *Ankistrodesmus*. Except for a few occasional filaments of *Oscillatoria* and *Anabaena*, blue-green algae were conspicuously absent from the upper Ohio River, even during late summer. Since blue-green algae are very

sensitive to acid conditions, it was speculated that the influence of acid mine drainage may have limited blue-green algae growth in the upper river at that time (USACE 1975).

Algae concentrations at a 2 to 3 foot depth ranged from a low of 116 cells/mL in the Emsworth Pool in June to 9,700 cells/mL in the Hannibal Pool in September. The average for all navigation pools from June to November was more than 3,000 cells/mL. The lowest chlorophyll measurements occurred during the highest flow conditions. During a 50,000 to 70,000 cubic feet/second (cfs) flow survey, total cell counts along the river were typically less than 1,000 cells/mL. During a 10,000 to 13,000 cfs low flow survey, phytoplankton total cell counts ranged from 2,000 to 9,700 cells/mL. Cell counts and chlorophyll concentrations were intermediate during moderate flow conditions. It was suggested that abundant phytoplankton in the upper Ohio River was probably related to vertical DO stratification patterns observed in the river during summer season low flow periods. The photosynthetic activity of large phytoplankton populations generates high amounts of oxygen. Light is necessary for photosynthesis and large rivers tend to carry heavy loads of suspended matter that restrict light penetration. During a July 1974 low flow survey, 50 percent to 80 percent of total incident surface light was extinct at a depth of 2 feet along the upper Ohio River. Penetration of one percent of surface light never reached 12 feet during that survey and the one percent level was only around 6 feet during a November survey. Photosynthesis, therefore, with subsequent oxygen production, is limited by light penetration to a relatively thin surface layer in the Ohio River (USACE 1975).

Phytoplankton concentrations in near-surface samples were generally elevated in the lower sections of navigation pools where velocities are low, and were reduced downstream of navigation dams. Other studies conducted by the USACE (1976 and 1991) confirm this impact of navigation dams on phytoplankton distribution. Ten surveys were conducted between 1975 and 1988 along the Monongahela River navigation system that included phytoplankton samples collected immediately upstream and downstream of navigation dams. On average, algae cell volumes decreased by 55.2 percent below Maxwell Locks and Dam. The mean decreases downstream of Locks and Dams No. 4, 3, and 2 were 13.5 percent, 20.1 percent, and 26.8 percent, respectively. These localized declines were likely the result of mixing at the dams of higher surface water algae concentrations with the lower algae concentrations of deeper waters. A potential impact of such mixing is making fine organic materials more available to filter-feeding benthic invertebrates in the tailwaters of navigation dams than along other reaches of the navigation systems.

Another observation from long term monitoring along the Monongahela River navigation system was that blue-green algae, formerly suppressed by acid mine drainage pollution, were becoming increasingly abundant as acid mine drainage pollution was abated. Blue-green algae concentrations in the Monongahela had become particularly high during summer low flow periods in the shallow, nutrient enriched, coal-fired electrical power generation thermal plumes and in the river. Blue-green algal concentrations created seasonal taste and odor nuisance problems for a major water supply utility downstream. It was suggested that thermal discharges to this lower reach of the river would be expected to generally stimulate algae growth, and selectively encourage the more thermophilic and problematic blue-green algae.

3.5.4.4 Distribution and Abundance of Phytoplankton along the Ohio River

Phytoplankton is an important component of ecosystems in rivers, making them a valuable indicator of water quality. Phytoplankton provides a food source for invertebrates and small fish and plays a crucial role in nutrient and energy cycling. Phytoplankton also has a strong influence on the dissolved oxygen levels though the physiological functions of photosynthesis and respiration. Additionally, phytoplankton is highly sensitive to a range of environmental stressors such as nutrient enrichment, changes in pH, and increased concentrations of some dissolved chemicals and contaminants. Since phytoplankton have rapid growth rates and respond quickly to changes in their habitat, they often provide an early warning of changing environmental conditions which may not be detected by other methods. This makes phytoplankton valuable indicators of water quality (MDEP 2005).

While phytoplankton naturally occur in surface waters, when conditions are ideal both algae and cyanobacteria can undergo a phenomenon known as a bloom. Under these conditions, the phytoplankton reproduces rapidly forming clumps that can overtake water bodies. Large blooms can clog intake pipes and filter lines. When blooms die, the dead cells often produce objectionable odors as a result of oxygen depletion in the surrounding waters. In addition to these adverse effects, cyanobacteria produce highly toxic substances. These toxic substances, known as cyanotoxins, are capable of causing serious illness or even death if consumed. Algae do not produce toxic substances (AAFC 2007).

Data for phytoplankton within the geographic scope of this project in the 1980s and 90s is very scarce. However, in July 1999, ORSANCO, in cooperation with the University of Cincinnati, Northern Kentucky University, and ten major public water supply utilities, initiated an ambitious program to monitor algae and chlorophyll along the Ohio River. This year round sampling study initiative is by far the most comprehensive attempt to monitor and characterize the algae community of the Ohio River. Organisms are identified at the genus level from samples collected twice per month, year round, at each of the ten water supply intakes along the Ohio River. These genera were then categorized by their indicator status(s): taste and odor causing, toxin producing, filter clogging, and pollution tolerant. Within the Upper Ohio River, algae causing taste and odor issues, clogging filters, and those which are pollution tolerant are mostly comprised of blue-green/cyanobacteria, diatoms, euglenoid, and green algae. Blue-green/cyanobacteria are responsible for producing toxins.

Data collected from 2000 to 2006 Ohio River Miles 5 (West View) and 40 (East Liverpool) are displayed in Table 3-7. This table displays the percentage of the yearly samples each indicator status comprises. It is important to note that an individual genus may belong to more than one indicator status or none at all. Therefore, the sum of the yearly percentages may be greater than or less than 100.

TABLE 3-7
ORSANCO Algae Sampling in the Upper Ohio River at
ORM 5 (West View) and ORM 40 (East Liverpool)
Percentage of Samples by Indicator Status

	Taste & Odor Causing		Toxin Producing		Filter Clogging		Pollution Tolerant	
	West View	East Liverpool	West View	East Liverpool	West View	East Liverpool	West View	East Liverpool
2000	20.28	13.15	6.91	16.29	25.99	13.04	19.90	22.18
2001	18.94	17.06	2.71	3.64	23.28	20.06	11.20	15.74
2002	19.27	23.63	1.18	4.97	27.74	31.68	19.75	25.83
2003	30.88	21.09	8.26	14.47	39.06	19.92	22.40	20.14
2004	21.84	22.78	4.72	4.85	36.39	35.92	28.14	31.40
2005	37.94	33.26	20.55	22.13	24.22	16.72	33.64	28.32
2006	38.02	39.34	20.16	17.57	33.50	40.79	35.32	34.29
Source: ORSANCO, 2009a								

It is difficult to draw any distinct conclusions from the data collected. This is due to the fact that acceptable ranges for these indicators have not yet been determined. However, in general it appears these problematic algae have been increasing proportionally. This appears to be particularly true for the taste and odor causing and pollution tolerant algae. Continued monitoring will allow for verification of potential trends. Additionally, continued monitoring will allow for the development of acceptable ranges for each indicator and possibly an index of biotic integrity for algae.

3.5.4.5 Aquatic Macroinvertebrates of the Ohio River Mainstem

In addition to their intrinsic values and importance as food for fish and other forms of aquatic life and often non-aquatic life, benthic macroinvertebrate communities are also highly responsive indices of water quality. According to the Ohio EPA (1988), the advantages of using benthic macroinvertebrates for bioassessments are:

1) Macroinvertebrate communities are good indicators of localized conditions. Because many benthic macroinvertebrates have limited migration patterns or a sessile mode of life, they are particularly well suited for assessing site-specific impacts (upstream-downstream studies).

2) Macroinvertebrate communities integrate the effects of short-term environmental variations. Most species have a complex life cycle of approximately one year or

more. Sensitive life stages will respond quickly to stress; the overall community will respond more slowly.

3) Benthic macroinvertebrates serve as a primary food source for many recreational and commercially important fish.

4) Most state water quality agencies routinely collect biosurvey data that focus on macroinvertebrates. Many states already have background macroinvertebrate data.

Macroinvertebrate quality evaluations are based on the principle that invertebrate communities of non-degraded streams are composed of many different types of organisms, including pollution intolerant taxa such as mayflies, stoneflies, and caddisflies (*Ephemeroptera*, *Plecoptera*, and *Trichoptera*, or EPT organisms). The invertebrate communities of polluted streams, on the other hand, are dominated by a small number of pollution tolerant taxa such as sludge worms and bloodworms (*Annelida* and *Chironomidae*). Between the extremes are numerous organisms with intermediate tolerances.

3.5.4.6 Ohio River Macroinvertebrate Studies - 1957 to 1960

Between October 1957 and January 1960, ORSANCO (Jackson and Weise 1962) collected Petersen, orange-peel, and Eckman dredge invertebrate samples along the length of the Ohio River. They found the invertebrate communities of rocky substrates along the main channel of the Ohio River to then consist primarily of the coelenterate *Hydra americana*, the bryozoan *Urnatella gracilis*, the dipteran *Chironomus* sp., the copepod *Canthocamptus* sp., and the protozoans *Vorticella* sp. and *Epistylis* sp., none of which are sensitive species. The invertebrate communities of soft substrates nearer to shore were even more depauperate, consisting only of very pollution tolerant tubificid worms and a few specimens of the bloodworm chironomid *Tendipes* sp.

Ephemeroptera are generally considered to be indices of good water quality, and burrowing species of the genera *Ephemera* and *Hexagenia* are indices of both good water quality and sediment quality. They may be present in huge numbers in large unpolluted rivers where they are important components of the aquatic ecosystem and can be major sources of forage for fishes and other aquatic life. Jackson and Weiss commented that Ephemeroptera were very sparse at that time in the Ohio River compared to the large numbers then present in the Mississippi River.

Due to water quality improvements over the more than four decades since completion of the Jackson and Weise survey, burrowing mayflies have gradually returned to the entire Ohio River. Huge, newsworthy, emergences of burrowing mayflies finally returned to the Pittsburgh reach of the Ohio River only in 2002/2003.

3.5.4.7 Ohio River Macroinvertebrate Studies - 1963 to 1967

The results of an intensive Ohio River cooperative aquatic macroinvertebrate monitoring effort, conducted between 1963 and 1967, were published by the U.S. Environmental Protection Agency in 1971 (Mason *et al*.). Important conclusions developed by Mason *et al.* were that artificial substrate sampling techniques tended to collect more diverse samples than dredge samples, and that during the five year study period the abundance and diversity of macroinvertebrates increased at stations along the lower and middle reaches of the Ohio River, but not yet in the upper reach of the river near Pittsburgh.

Throughout 1963-67, dredge samples from the upper part of the river contained only pollution-tolerant sludgeworms and a few bloodworms. Occasionally damselflies and midges were collected from the artificial substrate samplers. Caddisflies first appeared at Toronto, Ohio (RM 58); mayflies were first present at RM 260 near Addison, Ohio; and stoneflies occurred at Huntington, West Virginia (RM 301). The invertebrate taxa found to be nearly ubiquitous along the Ohio River were the midges *Dicrotendipes nevosus*, *Procladuis* sp., *Coelotanypus* sp., *Cricotopus* spp., *Ablabesmyia* spp., *Crytochironomus* spp., and *Psectrocladius* spp. Also present at most stations were the caddisfly *Cyrnellus fraternus*, the damselfly *Argia*, the mayfly *Stenonema*, and the coelenterate *Cordylophora lacustris*. Taxa limited in distribution to the upper Ohio River included the midge *Chironomus riparius* and the crayfish *Orconectes obscurus*.

3.5.4.8 Invertebrate Community Condition Scores - Patterns and Trends

Including the Mason study data, ORSANCO has Ohio River rock basket sampler aquatic macroinvertebrate data from 1964 to 1974, and Hester-Dendy multiple-plate artificial substrate sampler data from 1975 to 2001. The older rock basket data predates the CWA of 1972 and numerous other landmark national and local environmental initiatives, including, for instance, the 1974 initiation of secondary level sewage treatment by the Allegheny County Sanitary Authority at Pittsburgh. Of this baseline historical data, 1967 is a particularly interesting year because triplicate rock basket samples were collected at ten stations spaced along the entire length of the Ohio River between RM 6.2 and 980.4. Going back to the raw 1967 data and applying subsequently developed Rapid Biological Assessment (RBA) condition score rating analysis methodologies developed by the USEPA (Plafkin *et al*. 1989) and the Ohio EPA (1988) would allow for a comparison of relative invertebrate community impairment along the length of the river.

Unfortunately, most of the world's large rivers have scarcely been examined from an ecological perspective (Thorp 1992). Lotic research has rather focused on smaller and medium sized unregulated streams and rivers, and indeed only about 4 percent of the publications on running water have dealt with large rivers (Hynes 1989, as cited in Thorp 1992). Therefore, there has been little research and there is a lack of scientific consensus on appropriate metrics to use for rating impairment of large rivers. Currently, a draft index is being refined that uses benthic macroinvertebrates to assess biotic integrity in the Ohio River (Emery 2003). However, until such research is completed and consensus is reached, the

following expedited attempt at rating the degree of impairment of the Ohio River invertebrate community must be considered highly tentative.

Table 3-8 shows the tentative condition scores developed from the 1967 data for ten rock basket sample collection stations along the Ohio River, as well as the metrics used to compute these scores. Only one sampling site was located within the geographic scope of this project. What is clear from this table is the poor condition of the macroinvertebrate community in the upper Ohio River during this time period. At Ohio River Mile 6.2, the expedited condition score was 26.5 compared to an average of 52.2 at the other nine sampling locations. This is likely related to the mix of historic pollution sources to the upper Ohio River, which have included not only domestic wastes, but also gross heavy industrial and chemical manufacturing wastes, and massive loads of acid mine drainage from bituminous coal mines. While organic waste and nutrient pollution typically result in large numbers of only a few tolerant taxa, acid mine drainage and other types of pollution can result in both drastically reduced species richness and standing crops (Koryak *et al*. 1972; Koryak *et al.* 1998).

TABLE 3-8
Ohio River Macroinvertebrate Metrics and Expedited Condition Scores from Triplicate Rock Basket Sample Data Collected in 1967

Station Location (Ohio River Mile)	Mean # Taxa as % Reference Station (17.7)	Mean Total # Organisms	Mean % EPT Taxa	Mean % EPT Organisms	Mean % Not AC Organisms	Mean % EPT Organisms *Cyrnellus fraternus**	Expedited Condition Score
6.2	32.2	100.0	20.1	0.3	20.1	100.0	26.5
57.5	32.2	20.0	0.0	0.0	8.7	0	12.2
167.5	62.1	40.0	6.1	5.3	31.3	50.0	29.0
260.0	45.2	40.0	40.0	49.1	54.4	50.3	45.7
301.4	69.5	100.0	35.0	46.3	51.6	97.8	60.5
341.0	35.6	20.0	20.6	45.5	54.0	95.3	35.1
462.0	73.4	100.0	33.3	76.6	78.0	88.2	72.3
600.5	75.1	80.0	27.8	42.8	50.8	87.1	55.3
787.5	100.0	100.0	45.2	85.5	86.1	11.5	83.4
980.4	81.9	100.0	51.7	70.5	76.0	0.8	76.0

According to common usage of this scoring technique, an invertebrate condition score greater than 80 percent indicates that a stream is non-impaired, 60-79 percent slightly impaired, 40-59 percent moderately impaired, and less than 40 percent severely impaired (Ohio EPA 1988). Consistent with the historical chemical water quality data, and also generally the fish data, the 1967 invertebrate condition scores ranged from an extremely depressed low of only 12.2 percent in the upper river to a high of 83.4 percent in the lower river. The upper river was definitely severely degraded.

Re-initiation in 2002 of rock basket sampling by ORSANCO at 23 stations between river miles 6.2 and 436.2 provides an opportunity to assess changes in the Ohio River during

the past environmentally proactive 35-year period. Condition scores and metrics for the 2002 ORSANCO data are shown in Table 3-9. Twenty-two of the 2002 stations were located upstream and downstream of eleven dams on the Ohio River. For trend analysis and impairment pattern identification, these upstream and downstream of dam data sets are merged, though they will be discussed separately in subsequent paragraphs. The metrics used to develop condition scores from the 2002 data are identical to those used for the 1967 data with two exceptions. Zebra mussels (*Dreissena polymorpha*) infested the entire length of the Ohio River in the interim between collection of the 1967 and 2002 samples. They were present sporadically in sometimes enormous numbers at stations sampled in 2002. Therefore, to make the 2002 data more consistent with pre-infestation data, the number of zebra mussels was subtracted from the 2002 total number of organism metric. Also, there are some variations in taxonomic identification definition apparent in the two data sets, especially for oligochaetes, which make using the 1967 taxa richness reference problematic for analysis of the 2002 data. Therefore, the percentage of the mean number of taxa present per sample (21.3 taxa) was substituted as a reference station metric for the 2002 data. A comparison of the 1967 and 2002 data shows dramatic improvements along the upper river.

TABLE 3-9
Ohio River Macroinvertebrate Metrics and Expedited Condition Scores Developed from Rock Basket Sample Data Collected by ORSANCO in 2002

Station Location (Ohio River Mile)	Mean # Taxa as % Ref. Station (21.3)	Mean Total # Organisms Score (excluding zebra mussels)	Mean % EPT Taxa	Mean % EPT Organ-isms	Mean % Not AC Organ-isms	Mean % EPT Organ-isms Cyrnellus fraternus *	Expedited Condition Score	Mean Combined Condition Score
Emsworth Dam								
Above RM 6.2	100.00	100.00	13.6	1.0	78.4	64.3	58.6	54.1
Below RM 6.2	100.00	100.00	29.2	4.9	13.9	17.5	49.6	
Dashields Dam								
Above RM 13.3	94.0	100.0	20.0	10.7	68.1	75.4	58.6	58.6
Missing Sample	-	-	-	-	-	-	-	
Montgomery Dam								
Above RM 31.7	100.0	80.0	13.6	1.0	85.4	50.0	56.0	42.8
Below RM 31.7	65.7	40.0	21.4	3.9	17.5	0.0	29.7	
New Cumberland Dam								
Above RM 54.4	89.2	20.0	15.7	9.3	41.2	0.0	35.1	38.4
Below RM 54.4	100.0	80.0	15.4	2.5	10.8	62.5	41.7	

* Not used as a condition score metric

3.5.4.9 Influence of Navigation Dams on Invertebrate Communities

Characteristics of invertebrate rock basket communities from samples collected by ORSANCO upstream and downstream of Ohio River navigation dams in 2002 are summarized in Table 3-9. These data show that taxa richness was somewhat higher downstream of the dams, a mean of 22.4 compared to 20.2 taxa per sample. Also the mean condition score (48.3 percent versus 46.9 percent) and mean percentage EPT taxa per sample (22.5 versus 17.8) was higher downstream of the dams. However, all other parameters demonstrated slightly more negative values downstream of dams and the data are probably inconclusive. If there are more diverse and healthier invertebrate macroinvertebrate communities in the tailwaters of the dams than within their pools, the composition of these communities is probably correlated with natural substrate. The artificial substrate sampling techniques used would not reflect such natural variations in the substrate of the river.

3.5.5 Attainment of Ohio River Designated Uses

Section 305(b) of the CWA requires biennial water quality assessment of the degree to which surface waters are attaining their designated uses. The Ohio River has four designated uses: 1) warm water aquatic life, 2) public water supply, 3) contact recreation, and, 4) fish consumption. Table 3-10 summarizes the three classifications ORSANCO has developed to describe attainment of these uses.

TABLE 3-10
Assessment Criteria for Ohio River Designated Uses

Aquatic Life Support
Fully supporting: No pollutant exceeds criteria in as much as ten percent of the samples collected. Ohio River Fish Index (ORFIn) scores do not indicate aquatic life impairment.
Partially supporting: One or more pollutants exceed criteria in as much as ten percent of the samples collected. OR ORFIn scores indicate aquatic life impairment.
Not Supporting: One or more pollutants exceed criteria in greater than 25 percent of the samples collected. OR ORFIn scores indicate severe aquatic life impairment.
Public Water Supply Use
Fully supporting: No pollutant exceeds criteria in as much as10% of the samples collected.
Partially supporting: One or more pollutants exceed human health criteria in 11-25 % of samples collected. OR Frequent intake closures are necessary to protect water supplies due to instream concentrations exceeding finished water maximum contamination levels (MCLs) OR Frequent non-routine additional treatment is necessary to protect water supplies due to instream concentrations exceeding finished water MCLs.
Not supporting: One or more pollutants exceed human health criteria in greater than 25 % of samples collected. OR Source water quality causes MCL violations which result in noncompliance with provisions of the Safe Drinking Water Act.
Contact Recreation Use
Fully supporting: Monthly average or instantaneous maximum bacteria criteria are exceeded during fewer than 10% of the recreation season months (May – October).
Partially supporting: Monthly average or instantaneous maximum bacteria criteria are exceeded during 11-25% of the recreation season months.
Not supporting: Monthly average or instantaneous maximum bacteria criteria are exceeded during more than 25% of the recreation season months.

TABLE 3-10 (continued)
Assessment Criteria for Ohio River Designated Uses

Fish Consumption Use
Fully supporting: No fish consumption advisories are in effect.
Partially supporting: Restricted fish consumption advisories are in effect or dioxin or mercury data indicate impairment.
Not supporting: "No Consumption" advisories are in effect for all commonly consumed species.
Source: ORSANCO, 2002

ORSANCO's most recent biennial assessments were reviewed to gain perspective on the current status of the Ohio River's designated uses. While comparisons of biennial assessments are generally indicative of trends, some variations between assessments may occur due to modifications in sampling procedures from year to year, including the number of Ohio River miles tested.

Table 3-11 shows the results of the ORSANCO's biennial assessments. The data displayed are for the portion of the Ohio River that is within the boundaries of Pennsylvania (River Miles 0 to 40.2). The data are reported for those portions of the river located in specific geographic sections (i.e., all of Pennsylvania, all of Ohio/West Virginia). Consequently, only the Pennsylvania results are shown here because most of the project area is covered.

TABLE 3-11
Impaired Ohio River Miles in Pennsylvania According to Attainment Use Designations Set by ORSANCO (Ohio River Miles 0 – 40.2)

Biennial Sampling Years	Aquatic Life Use	Contact Recreation Use	Public Water Supply Use	Fish Consumption Use
2006 & 2007	0	40.2	4.0	40.2
2004 & 2005	N/A	N/A	N/A	N/A
2002 & 2003	0	40.2	4.0	40.2
2000 & 2001	0	6.2	0	40.2
1998 & 1999	0	25.4	0	40.2
Source: ORSANCO, 2009b				

Aquatic Life Use was the only designation to meet its criteria throughout Pennsylvania for all four biennial reports. *Fish Consumption Use* was the only designation to be impaired throughout Pennsylvania for all four biennial reports. This was the result of high levels of PCBs and dioxins. This result was consistent throughout the entire Ohio River mainstem. Results for *Contact Recreation Use* changed over the time period of the four reports. While in 2000 and 2001 only 6.2 miles were listed as impaired, in 2002 and 2003 and 2006 and 2007 all 40.2 miles were listed as impaired. This was due to high levels of bacteria throughout this reach of stream. CSOs are one of the biggest contributing factors to the high levels of bacteria. The results for *Public Water Supply Use* were very good overall. Although there has been an increase in impaired miles since the 2000 and 2001 biennial report, only 4.0 miles have been listed as impaired in the last two biennial reports referenced. These miles were found to be impaired due to high levels of fecal coliform. This was the case for approximately half of the Ohio River mainstem.

3.6 INTERACTIONS WITH OTHER VALUED ENVIRONMENTAL COMPONENTS (VECs)

The history and public perception of water quality conditions in the Ohio River mainstem, in large measure, illustrate the complex interplay between water quality and many other VECs, including those concerning human communities. During the mid-20th century when the Ohio River was perceived almost as an open sewer, fish, mussels, and other aquatic organisms declined, recreation suffered, and public health and safety were compromised.

Species composition and abundance of aquatic organisms are excellent indicators of overall water and sediment quality. Many fish species that took refuge in the lower Ohio River and in the tributaries of the Ohio during the worst decades of pollution have recovered and moved upstream. Densities, biomass, and fish community diversity have increased dramatically as water quality has improved. Sport fishing has improved and increased in popularity as fish populations have increased and taste and odor problems have generally declined. Fish consumption advisories, however, are still issued for certain species along specific river segments. Increased sport fishing has enhanced the perception of the river's recreational value and, in turn, has benefited local economies.

While most fish species have increased in the Ohio River mainstem, several species requiring clean, gravel substrates for spawning have declined. Freshwater mussels, the most conspicuous component of the bottom fauna, suffered significant declines both in numbers and species diversity in the mid nineteenth century although there has been some modest repopulation in recent years in the Montgomery pool.

Improved water quality and associated monitoring systems (e.g., ORSANCO's early-warning spill detection system) have combined with regulatory actions to ensure safer drinking water for more than three million people that rely on the river as their primary drinking water source. Improved water quality also has led to increases in boating and contact recreation, including water skiing and personal watercraft use.

Water quality also is related to aesthetics, especially with regard to appearance and odor. The improved aesthetics of water in the upper Ohio River have helped attract people to the riverbanks for recreation and special events. Increased public interest in the river has, in turn, stimulated land use changes with potential impacts on historical and archaeological resources, as the demand for more parks, restaurants, bike trails, and other public facilities along the Ohio River has increased.

3.7 INDICATORS OF ENVIRONMENTAL SUSTAINABILITY FOR WATER QUALITY

Indicators of environmental sustainability provide benchmarks for measuring cumulative effects on a given resource or valued environmental component (VEC). Indicators for water quality include:

- Measures of key water quality parameters, including dissolved oxygen, pH, fecal coliforms, turbidity, total suspended solids and nutrients;

- Level of conformance with state and federal water quality standards, including attainment of permissible use designations;

- TMDL (total maximum daily load) determination and implementation;

- Effectiveness of specific point source control and nonpoint source control programs;

- Ability to sustain diverse, healthy populations of aquatic organisms; and

- Effectiveness of spill response, monitoring programs, and related precautionary measures.

3.8 RELEVANT FUTURE ACTIONS AFFECTING WATER QUALITY

Reasonably Foreseeable Future Actions (RFFAs) for water quality were evaluated utilizing a matrix prepared during the scoping process. The matrix was an outgrowth of a similar matrix developed during the preparation of ORMSS. Results of the RFFA evaluation for water quality resources are summarized in Table 3-12.

TABLE 3-12
RFFA Cumulative Effects Matrix for Water Quality

RFFA[1]	Time Period[2]	Occurrence Probability[3]	Location on River[4]	Importance[5]	Effects[6]
USACE Actions					
Navigation Investments					
Replacement locks at Emsworth, Dashields, and Montgomery Dams (EDM)	1	H	S	L	+/-
Rehabilitation of EDM dams	1	H	S	L	-
Navigation aids - lock & dam signage	A	H	S	L	-
Non-structural navigation improvements	A	H	S	L	-
L&D operation and maintenance	A	H	S	L	-
Approach & channel dredging/disposal	A	H	E	M	-
Environmental design					
environmental sustainability operation actions	A	H	S	L	+
Pool maintenance	A	H	E	L	-

RFFA[1]	Time Period[2]	Occurrence Probability[3]	Location on River[4]	Importance[5]	Effects[6]
Sec 107 port development and maintenance dredging	2	L	S	M	-
Ecosystem Restoration					
Fish passage at EDM	1	H	S	L	+/-
Actions by Others					
Navigation System Dependent - "But For"					
Commercial navigation					
barge queuing	1	M	E	L	+/-
fleeting areas/barge storage	1	M	E	L	+/-
terminals & multi-modal sites	2	L	S	M	-
barge/tow tech/"green" design	A	M	E	L	+/-
accidents/spills	A	M	E	H	-
Coast Guard navigation aids - const., O&M	A	H	E	L	+
Energy					
hydropower on dams	2	M	S	M	-
continued operation of coal-fired power plants	A	M	S	M	-
Water-based recreation					
marina development & operation	A	M	S	M	-
commercial boating	A	H	E	M	-
personal boating	A	H	E	L	-
River Dependent					
Water supply/discharge					
municipal	A	M	S	H	-
industrial	A	M	S	H	-
Waste water treatment discharges (WWTP)					
onsite systems	A	H	E	H	-
stormwater discharges; CSOs; SSOs	A	H	S	H	-
Marcellus shale gas extraction (water impacts)	A	H	E	H	-
Resource extraction					
instream sand and gravel mining	A	H	E	H	-
Acid mine discharge (AMD)	A	M	E	H	-

RFFA[1]	Time Period[2]	Occurrence Probability[3]	Location on River[4]	Importance[5]	Effects[6]
Riverfront/Flood Plain Development					
Downtown Pittsburgh					
Ongoing Point State Park improvements	1	H	S	L	+/-
Convention Center riverfront park	1	H	S	L	+/-
residential development/conversions	A	H	S	L	+/-
North Shore development	1	H	S	L	+/-
Pittsburgh South Side					
continued riverfront development	A	H	S	L	+/-
continued South Side Works development	1	H	S	L	+/-
Riverfront trails					
Pittsburgh riverfront trail system	A	H	E	L	+/-
Beaver County trail system	A	M	E	L	+/-
Brownfields redevelopment					
Neville Island	1	H	S	M	+
PL&E, McKees Rocks	2	M	S	M	+
M&B Development	2	M	S	M	+
Fab Tech & Buckeye Pipeline	1	M	S	M	+
J&L site in Aliquippa	1	M	S	M	+
Leetsdale Industrial Park	1	H	S	M	+
Resource Protection/Restoration					
Ohio River Islands Wildlife Refuge System	A	H	S	M	+
Nationwide Rivers Inventory	A	M	S	M	+
Ecosystem restoration	A	M	E	M	+
Cultural resources	A	M	E	L	+/-
Bridges and Roadways					
Bridge renovations					
Ambridge/Aliquippa Bridge	1	H	S	L	+/-
Shippingport Bridge	1	H	S	L	+/-
Rochester Bridge	1	H	S	L	+/-
McKees Rocks Bridge	1	H	S	L	+/-
Birmingham Bridge	1	H	S	L	+/-
Rankin Bridge	1	H	S	L	+/-
New crossings					
Maglev	2	L	S	L	-

RFFA[1]	Time Period[2]	Occurrence Probability[3]	Location on River[4]	Importance[5]	Effects[6]
North Shore Connector	1	H	S	L	-
Roadways					
Mon/Fayette Expressway	2	L	S	L	-
SR 28 widening/railroad relocation	1	H	S	L	-
CSX double stack upgrades (National Gateway)	1	M	S	L	-
Natural Events					
floods	A	M	E	M	-
droughts	A	L	E	L	-
invasive species	A	H	E	M	+/-
Regulatory Environment					
Phase I & 2 NPDES program	A	H	E	H	+
TMDLs	A	H	E	H	+
ALCOSAN & other consent decrees	A	H	E	H	+
Adaptive management in Sand & Gravel EIS	A	H	E	L	+
Pollution prevention	A	H	E	H	+
USACE permitting programs	A	H	E	H	+
Boating safety regulations	A	H	E	L	+
Monitoring programs - PA/ORSANCO	A	H	E	H	+
Environmental awareness education	A	H	E	M	+
Clean Air Act standards	A	H	E	L	+
Clean Water Act standards	A	H	E	H	+
Endangered Species Act (ESA)	A	H	E	H	+
Environmental sustainability practices	A	H	E	H	+

[1] Reasonably Foreseeable Future Actions

[2] Time period in which the RFFA may occur: A = all periods; 1 = within 10 years; 2 = in 10 - 25 years; 3 = in 25 - 60 years

[3] Occurrence probability or likelihood RFFA will happen: H = high; M = medium; L = low

[4] Location or setting on river where RFFA is expected to occur: E = along entire length of river; S = specific location

[5] Importance or impact of action on the VEC: H = high; M = medium; L = low

[6] Effects of action on the VEC: + = positive effect; - = negative effect; +/- = mixed effects

Impacts can be complex and occur in many ways. While impacts result from an action, those impacts are not always apparent from a straightforward analysis of cause and effect. Often, similar actions do not affect resources in the same manner. As a means of further explaining potential impacts to water quality, four vectors have been identified. The vectors have a specific relationship with one another and may influence the scope and magnitude of future impacts on water quality. Some actions will intercept with more than one vector. The four vectors are related to turbidity and sedimentation, point source pollution, nonpoint source pollution, and pollution reduction.

Actions that cause turbidity and sedimentation are the result of disturbance of bottom substrates, either temporarily or through permanent removal. In addition to causing increases in turbidity, sediments can be suspended or blanket portions of the river bottom. This can, in turn, reduce light penetration, interfere with the respiration and feeding of aquatic organisms, impair habitat or cause habitat loss, and agitate contaminants that have already settled in the sediment. RFFAs that fall into this vector and the other three vectors are noted in Table 3-13.

Actions that contribute to point source pollution are generally associated with industrial and residential settlement patterns that affect the river, but can be a result of other factors, such as dredging operations, accidents, and spills. Thermal pollution, chemical pollution, suspended solids and particles, heavy metals, and nutrient-rich constituents can all result from point sources. They affect key water quality parameters, such as DO and pH, and in turn impact aquatic life and habitat by introducing potentially harmful substances into the ecosystem, reducing light penetration, and inhibiting photosynthesis. Some point source pollutants have the potential to jeopardize public health, as well. RFFAs that fall into this vector are also noted in Table 3-13.

Actions that contribute to nonpoint source pollution can also introduce nutrient-rich constituents, solids, particles, chemicals, and toxic substances into the ecosystem. Nonpoint sources are more difficult to control, especially as they occur in the floodplain, but are being addressed by the regulatory system. RFFAs that fall into this vector are also noted in Table 3-13.

Actions that contribute to pollution reduction can serve as countermeasures to those RFFAs that have negative impacts. Though primarily regulatory or government-controlled in character, they also serve to raise environmental awareness of potential pollution problems throughout the community. RFFAs that fall into this vector are also noted in Table 3-13.

TABLE 3-13
RFFAs and Water Quality Impact Vectors

RFFA	Actions that Cause Turbidity and Sedimentation	Actions that Contribute to Point Source Pollution	Actions that Contribute to Nonpoint Source Pollution	Actions that Contribute to Pollution Reduction
USACE Actions				
Approach & channel dredging/disposal	X		X	
Actions by Others				
Terminals & multi-modal sites	X			
Accidents/spills		X		
Hydropower on dams	X	X		
Operation of coal-fired plants		X		
Marina development & operation	X		X	
Commercial boating	X			
Municipal water supply/discharge		X		
Industrial water supply/discharge		X		
WWTP - onsite systems		X	X	
WWTP – stormwater discharges, CSOs, SSOs		X	X	
Marcellus shale gas extraction		X		
Instream sand and gravel dredging/mining		X		
Acid mine discharge		X		
Brownfields redevelopment		X	X	
Ohio River Islands Wildlife Refuge System				X
Natural events	X		X	
Nationwide Rivers Inventory				X
Ecosystem restoration				X
Regulatory Environment				X

Discussions of the potential impacts of RFFAs with high and medium importance are presented in the remainder of this section. The discussions are organized around USACE actions and actions by others. Summaries of both permanent and temporary impacts are discussed.

3.8.1 USACE Actions

3.8.1.1 Navigation Investments

Although construction of longer locks at EDM will have temporary negative impacts associated with construction, the long term effect will be positive by moving barge traffic more efficiently through the system. To accomplish the improvements, however, major construction will be required. Construction activities would potentially generate temporary turbidity and sedimentation impacts.

Likewise, approach and channel dredging/disposal could result in negative impacts on water quality associated with turbidity and downstream sedimentation as well. These types of activities could potentially result in the release of legacy pollutants into the water column. Water quality impacts of dredging disposal is minimal as all disposal is taken upland.

3.8.2 Actions by Others

Actions by others that could cause turbidity and sedimentation impacts include terminals and multi-modal sites, hydropower on dams, marina development and operation, commercial boating, and natural events. Actions that contribute to point source pollution include accidents and spills, hydropower on dams, operation of coal-fired plants, municipal water supply and discharge, industrial water supply and discharge, wastewater treatment plants (onsite systems, stormwater discharges, CSOs and SSOs), Marcellus Shale gas extraction, instream sand and gravel dredging and mining, acid mine discharge, and brownfields development. Actions that contribute to nonpoint source pollution include adjacent development of the floodplain and natural events. Wastewater treatment in any manner is especially important, because if not functioning properly, fecal coliforms and suspended solids can be introduced into the river. Actions that contribute to pollution reduction include the Ohio River Islands Wildlife Refuge System, the Nationwide Rivers Inventory, ecosystem restoration, and the regulatory environment.

3.8.2.1 Navigation System Dependent – “But For”

Potential actions by others that may result in negative impacts on water quality include development of terminals and multi-modal sites; potential accidents or spills of toxic materials in the river; utilization of dams for hydropower; continued operation of coal-fired power plants; marina development and operation; and commercial boating. To varying degrees, some of these activities can cause turbidity and sedimentation. New terminals and

multi-modal sites provide potential pollutant sources through accidental spills when loading or unloading barges. Accidents or spills along the river associated with commercial boating can potentially contribute hazardous materials directly to the river. Utilizing the dams for hydropower could result in lower concentrations of DO. Wastewater discharges associated with operation of treatment plants are a potential source of water pollution, especially fecal coliforms, suspended solids, increased BOD and nutrients. Coal-fired power plants contribute thermal pollution to the river which negatively affects DO.

Marina development and operation could result in turbidity and stir up potentially polluted sediments in the river, in effect, re-suspending pollutants that may have already settled and pose less of a threat to the environment. Increased commercial boating would have similar impacts by potentially increasing turbidity and releasing contaminants that could settle in river sediment,

3.8.2.2 River Dependent

Some river dependent actions would likely result in negative effects on the water quality of the upper Ohio River. New municipal and industrial discharges as well as new discharges from onsite systems and stormwater systems constitute potential sources of fecal coliforms, suspended solids, and nutrients. Acid mine discharge would result in lower pH and possible introduction of metals. Although these discharges will be regulated by existing regulations, unregulated discharges are also a possibility. Fortunately, monitoring programs and precautionary measures have improved over the years, resulting in positive benefits for water quality.

Wastewater discharges to the river from Marcellus shale operations are a relatively new source of water pollutant – to what extent is only now being studied However, as noted above, these discharges will be regulated to some degree under existing and potentially future regulations to minimize environmental impacts. Existing CSO and SSO discharges are continued sources of pollution to the river. Instream sand and gravel mining or dredging also create turbidity and sedimentation by stirring up legacy pollutants.

3.8.2.3 Riverfront/Floodplain Development

Brownfields redevelopment is a category of riverfront/floodplain development that would provide a positive effect on the water quality of the river. Redevelopment of the existing brownfields along the upper Ohio River would result in the removal or isolation of potential contaminants from accessing river flows. There are several brownfields along the upper Ohio River that may be redeveloped. Those listed in Table 3-12 are the most likely to occur in the reasonably foreseeable future, but with an improving economy, there could be others, as well. While generally viewed as a positive socioeconomic force, riverfront development can contribute to both point and nonpoint pollution, especially when it occurs in the floodplain. However, because government agencies are usually involved, in terms of initiating plans or funding such redevelopment activities, the negative activities are minimized and mitigated through precautionary measures and monitoring programs.

3.8.2.4 Resource Protection/Restoration

The Ohio River Islands Wildlife Refuge System and Nationwide Rivers Inventory provide positive influences on water quality and contribute to pollution reduction as these activities provide protection to undeveloped habitats or environmentally significant features along the river. Ecosystem restoration would also provide a positive influence on water quality by restoring the riparian areas that help filter water running into the river.

3.8.2.5 Natural Events

Floods would likely have negative effects on water quality. Flooding could result in a major influx of point source and nonpoint source pollution through CSOs, SSOs, overland runoff, and other sources. Invasive species have the potential to have both positive and negative effects on water quality. For example, the zebra mussel has the ability to filter water to improve water quality, but if the water becomes too clear, the potential for blue-green algae to thrive increases. High numbers of these algae create taste and odor issues with drinking water.

3.8.2.6 Regulatory Environment

The existing regulatory environment provides protections for water quality both directly and indirectly and is the major contributor to pollution reduction. Programs under the Clean Water Act such as the NPDES and TMDL programs will provide for improved water quality through the permitting of discharges to the river. Consent decrees in place to remediate for CSO and SSO discharges should ultimately result in the elimination of such systems. Monitoring programs, such as ORSANCO's, will be continually testing the river and suggesting new regulations as land uses and industries along the river change over time. The Clean Air Act limits the amount of pollutants discharged to the atmosphere which can end up in water. The Endangered Species Act of 1973 provides protection for listed species, which would involve maintaining water quality standards. USACE permitting programs provide authority to review projects for impacts to natural resources and require measures to avoid, minimize, and mitigate for unavoidable impacts. Environmental sustainability practices and pollution prevention will improve the methods in which projects are planned and constructed. Finally, environmental awareness education will provide the opportunity to educate the public on the importance of water quality to healthy river ecosystems.

3.9 ANALYSIS OF ENVIRONMENTAL SUSTAINABILITY

Indicators of environmental sustainability provide benchmarks for measuring cumulative effects on a given resource. The indicators for water quality include measures of key water quality parameters, level of conformance with water quality standards, TMDL determination and implementation, effectiveness of specific control programs, ability to sustain diverse, healthy populations of aquatic organisms, and effectiveness of spill response, monitoring programs, and related precautionary measures.

Environmental sustainability is a synergistic process whereby environmental considerations to water quality are effectively balanced through the life cycle of project planning, design, construction, operation, and maintenance to maintain the quality of life for present and future generations. Accordingly, it represents a test of significance of potential cumulative effects.

3.9.1 Positive Forces Affecting Water Quality

The positive forces affecting water quality of the upper Ohio River are primarily related to existing environmental regulations, a shrinking population, and increasing public awareness of the importance of water quality. Nothing has been more vital to water quality improvements than the Clean Water Act and the ORSANCO Compact. These agreements have resulted in vast improvements to water quality and will continue to maintain and improve water quality throughout the upper Ohio River. The treatment of acid mine drainage and municipal and industrial wastes will continue to be important to maintaining and improving water quality. Future elimination of all CSOs/SSOs will also be critical to improve the water quality.

A shrinking population surrounding the upper Ohio River will be a minor positive force affecting water quality. A smaller population leads to less domestic waste and less pressure to develop the riparian and wetland habitats that act as filters for water flowing into the river.

With decreasing levels of pollutant loading, DO available in the river to support aquatic life has increased substantially. DO levels measured the past few years in the local pools have been well above the minimum DO level of 5.0 mg/l required during spawning season, the most critical time to fish throughout the year. Concurrently, pH levels were measured during the same period. All but one of the pH measurements were within this acceptable range.

Environmental sustainability practices will improve the methods in which projects are planned and constructed, and therefore limit the adverse effects such projects can have on water quality. The redevelopment of brownfields along the river provides a potential opportunity for the removal or isolation of potential contaminants from accessing river flows. The Endangered Species Act also provides a positive influence through protection of habitat for listed species. Ecosystem restoration efforts additionally provide a positive influence through various habitat restoration projects that may improve water quality conditions.

Industrial activities along the river have been waning over the years. This provides an additional positive influence on the water quality conditions of the river. Public awareness of water quality continues to improve. This is accomplished through development that increases the availability and value of the river to people. It is also accomplished through the establishment of the Ohio River Islands National Wildlife Refuge and Nationwide Rivers Inventory.

Recent biological studies conducted within the New Cumberland, Montgomery, Dashields, and Emsworth pools have shown mixed, but generally favorable results in terms

of habitat and reproductive viability. In the New Cumberland Pool, ORFIn scores average 9.9 points below what was expected. In the Montgomery Pool, approximately 87 percent of the sampled sites were in passing condition. In the Dashields Pool, 62 percent of the sites met their aquatic life designation. In the Emsworth Pool, all 15 sampled sites met their aquatic life designation. This would seem to indicate that as water quality improved – densities, biomass, and fish community diversity have increased measurably indicating improved water quality – fish species have re-colonized portions of the river that were once polluted and returned to former habitats from cleaner upstream tributaries.

ORSANCO has a spill monitoring system in place. The three states within the project area and related federal agencies with pertinent responsibilities have contingency plans in place to respond to spills or accidental discharges. Section 301 of the Clean Water Act (CWA) requires many industrial facilities to develop and maintain plans for preventing and responding to spills of oil and hazardous substances.

3.9.2 Negative Forces Affecting Water Quality

The negative forces affecting water quality in the upper Ohio River are primarily related to wastewater discharges to the river, CSOs/SSOs, existing and potential discharges of acid mine drainage, dredging operations, invasive species, and the development of riparian resources.

The Monongahela River Mine Pool is a potentially enormous problem that has not yet been adequately addressed by all entities. Of all issues facing the area that are related to the Ohio River environment, the Monongahela Mine Pool is the most uncertain, yet under certain circumstances – that is, if the pool would discharge into the river, as some fear – it could end up having the greatest negative impact on the river's ecosystem. Compounding the uncertainty of the situation, however, is not knowing where those discharges will occur. Most of the identified discharge points would flow into the Monongahela River. If they do reach the Ohio River, flows from the Allegheny River would neutralize the effects thereby minimizing impacts to the Ohio River.

The influence of wastewater discharges and dredging operations are buffered through existing regulations and permit conditions, but are still potential threats to water quality. Even though plans and a consent agreement with USEPA exist to eventually eliminate CSOs/SSOs and prevent municipal waste from reaching the river, bacteriological contamination will remain a serious problem until that work is complete. Specifically, recent ORSANCO fecal coliform bacteria monthly sampling data indicated that the number of exceedances has not improved over the past 16 years and that this is still an issue for the upper Ohio River. Additionally, TMDLS – and the potential improvements they represent – have not been finalized yet. There are also programs in place to remediate acid mine drainage that should limit the extent of its negative forces. Although the potential for development along the upper Ohio River is not considerably high, any development could lead to additional sources of pollution. These effects, however, should be minimized with advancements in environmental sustainability practices.

3.9.3 Incremental Impacts on EDM

Although there will be short term impacts associated with the construction of the lock chambers, the incremental impacts of EDM improvements on water quality will be limited and generally positive. The new lock chambers will provide added reliability to the navigation system, thereby reducing the need for the auxiliary chamber and the resulting queues. Tows in queue maintain position under power, and the resulting prop wash in a relatively localized position can significantly impact aquatic habitat through scour and sedimentation. By reducing the frequency and duration of queuing, the adverse aquatic habitat impacts will be reduced. Improvements at EDM also include using the existing 600-foot main chamber as the auxiliary when the new main chamber is complete. Increasing the auxiliary chamber from 56' x 360' to 110' x 600' will significantly reducing transit time and the length of the queue.

3.10 DETERMINATION OF SUSTAINABILITY

Three definitions of environmental sustainability were used for the analysis:

- Not sustainable – conditions for the selected indicators do not reflect conditions that would facilitate attainment of acceptable standards or would not maintain existing standards in concert with collective impacts of proposed activities.

- Marginally sustainable – conditions for selected indicators are such that attainment is accomplished for the majority, but not all, of the potentially affected area. However, the conditions are somewhat tenuous both in location and likelihood of occurrences. (In other words, the conditions are borderline for environmental sustainability, and there are uncertainties regarding specific quantitative measures.)

- Sustainable – conditions for selected indicators are such that attainment of acceptable conditions is accomplished for essentially all of the potentially affected area, and such standards are maintained in concert with foreseeable future activity. Further, conditions exceed regulatory thresholds, and various governmental programs are in place to respond to any potential erosion of values related to water quality.

Figure 3-1 illustrates environmental sustainability for past, present, and the reasonably foreseeable future. Based upon the previously described information and the actions and effects on the environmental sustainability of water quality, the sustainability can be characterized as follows:

- In the time period prior to 1920, and continuing up to about 1970, the water quality was in a degraded state characterized by low DO concentrations, low pH levels, high bacterial contamination, high nitrogen concentrations, and remobilization of potentially toxic chemicals that had become associated with river sediments. With the exception of the ORSANCO Compact, which ushered in the beginning of regulatory reform, no other pollution reduction, control, or regulatory programs were in place during this period. Further, poor aquatic populations were observed. It was

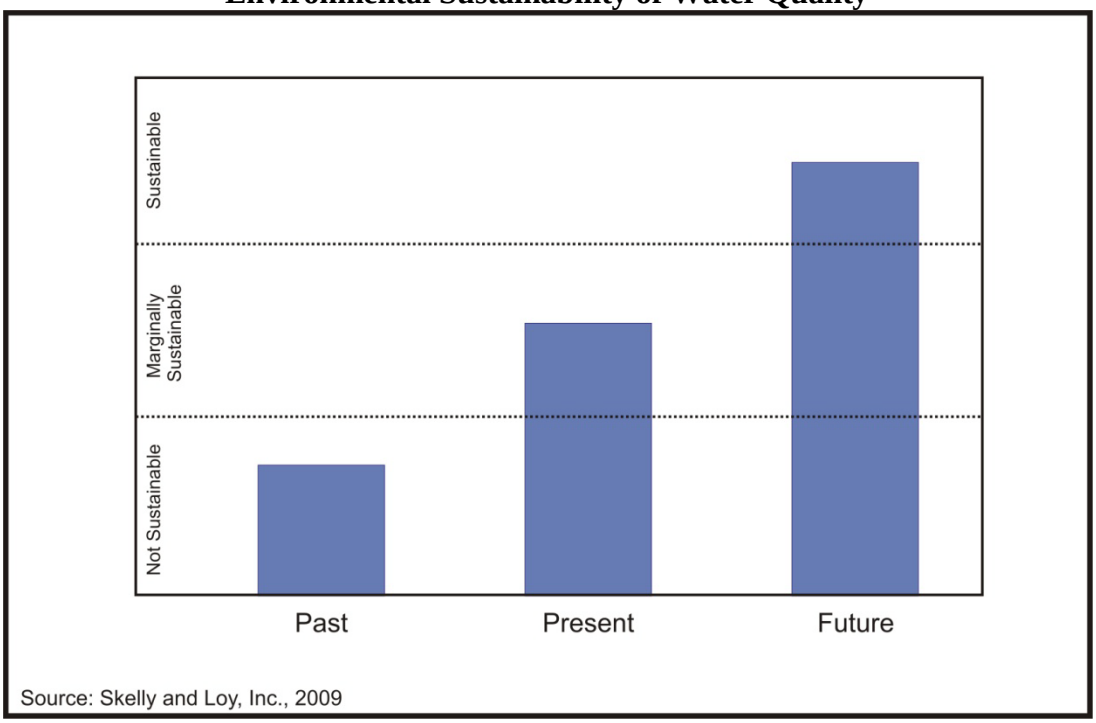
this poor water quality that was in large part the reason for these low populations. For these reasons, it can be assumed that the sustainability of water quality could be characterized as not sustainable.

- Implementation of the programs managed by ORSANCO and the requirements of the Clean Water Act resulted in steady improvements in water quality of the upper Ohio River in recent decades. Aside from the presence of legacy pollutants, significant water quality improvements have occurred. For example, DO concentrations are typically above the 5.0 mg/L standard, pH levels are between the 6.0 to 9.0 standard, and nitrogen concentrations meet current water quality criteria. However, bacterial contamination primarily associated with non-point source pollution is still an issue. Further, legacy-contaminated sediments are a concern in the upper river along with fish consumption advisories throughout the mainstem. In contrast, the results of algae (plankton) and aquatic macroinvertebrate biological surveys in the five most recent decades have demonstrated steady improvements in these aquatic ecological resources, with the improvements paralleling water quality improvements. Accordingly, at this time, the environmental sustainability of water quality is classified as marginally sustainable. The primary concerns in the present time are associated with bacterial contamination and chemical remobilization from legacy-contaminated sediments.

- In the future, the existing environmental regulations such as the Clean Water Act and water quality standards set by ORSANCO should further improve water quality, eventually achieving a sustainable condition. The improvements which have occurred in the past half century should be built upon as current and future technologies and infrastructure continue to become more advanced.

  Despite past improvements moving the area to full sustainability, however, the Monongahela River Mine Pool remains a major uncertainty and could prevent further improvements in the lower Monongahela River including the Monongahela River branch of Emsworth pool. The possibility is real that it could find its way into the regional river system with significant adverse effects. To date, there is no clear approach on how to address it. Fortunately, research is continuing. As a result, it is assumed that the resource agencies will soon develop a suitable response to prevent this from occurring. But until that happens, the threat of environmental degradation to the aquatic environment exists.

FIGURE 3-1
Environmental Sustainability of Water Quality



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Chapter 4

FISH

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4.1 DEFINITION

Freshwater fish are aquatic vertebrates that are ectothermic (or cold-blooded), covered with scales, and equipped with two sets of paired fins and several unpaired fins. This chapter will consider how cumulative effects of human use of the upper Ohio River have influenced fish communities and what impacts may be anticipated in the foreseeable future. Fish of the upper Ohio River represent a highly visible and important environmental component. Fish are excellent indicators of cumulative effects and environmental sustainability because:

- Their multi-year life spans and mobility facilitate interpretation of long-term effects and larger-scale habitat conditions.

- Fish communities include a wide range of species, trophic (feeding) levels, and reproductive conditions that can reflect varying degrees of environmental change.

- Some fish species are very sensitive to chemical and physical changes that may be caused by pollutants, changes in flow patterns, and other factors.

- Fish are easier to collect and identify and more information is available on their life histories than for small invertebrates.

- Fish are of interest and concern to society due to their potential for food and sport.

These aspects will be assessed during the cumulative effects assessment. Other topics of major concern include the status of the historic upper Ohio River fish fauna, connectivity between mainstem pools and between the mainstem and tributaries, fish host availability for dispersal of mussels, and potential acid mine drainage.

4.2 OBJECTIVES/SCOPE

4.2.1 Objectives

This chapter provides an overview of fish throughout the upper Ohio River. Additionally, this chapter assesses the system-wide cumulative impacts to fish of all likely major navigation improvements along the river from 1885 to 2070. Impacts that are directly or indirectly attributable to modernization of the navigation system are evaluated in concert with impacts from other past, present, and reasonably foreseeable future actions (RFFAs) by the United States Army Corps of Engineers (USACE) and others.

Assessment of past and present actions and current conditions is the basis for identifying and interpreting the potential impacts of RFFAs. These future actions include the major navigation improvements identified in this study; other routine or potential actions by the USACE; projected actions by other federal, state, or local agencies and non-governmental entities; and predictions of general economic expansion and development as well as regulatory changes. The results of the cumulative effects assessment are intended to determine past, present, and future environmental sustainability and identify needed actions to improve long term sustainability within the upper Ohio River.

4.2.2 Geographic Scope

The geographic focus for impacts on fish includes that portion of the upper Ohio River Navigation System that is most directly affected by the existing and possible future modifications to the system. This includes the Allegheny and Monongahela tributaries of the Ohio River to the first upstream dam on each river. The downstream geographic limit is defined as the New Cumberland Lock and Dam (L/D).

The geographic scope includes the following pools: Emsworth, Dashields, Montgomery, and New Cumberland. Also included are the floodplains along either bank of the four pools. This floodplain zone is defined as the meander channel of the Ohio River and includes the 100- and 500-year floodplains as well as terraces of level land lying above these floodplains. Floodplain lands are considered in this assessment because fish communities are

affected by siltation, runoff, and contaminants associated with construction, industry, agriculture, and other land-based activities, and because streams and floodplains normally interact as a complex ecosystem. The contribution of embayments and tributaries to recruitment of mainstem fish populations also will be considered.

4.2.3 Time Frame

The established time frame for this assessment is 1885 to 2070. The earlier date is associated with the initial lock and dam construction on the Ohio River. Thus, it approximates the beginning of the modern lock and dam system. The latter date approximates the economic life of improvements on the Ohio River and is considered the planning horizon for the project. Earlier relevant data about fishes are included when available to provide a more comprehensive overview of cumulative effects which may have occurred over decades or longer.

4.3 ISSUES FROM SCOPING

Scoping has occurred as part of the Ohio River Mainstem Study (ORMSS) and for the Upper Ohio Navigation Study. A series of 12 public scoping meetings was held for ORMSS during the summer of 2001. Subsequently, a series of three public scoping meetings was held for the Upper Ohio Navigation Study in October 2006. Approximately 185 people attended the ORMSS meetings and approximately 40 people attended the Upper Ohio Navigation Study meetings.

Several comments related to fish were made during both series of meetings. Comments associated with fish are shown in Table 4-1.

TABLE 4-1
Comments on Fish from Public Scoping Meetings

Comment	Number of Similar Comments	Scoping Meeting
Bank undercutting and failure caused by increased barge traffic, queuing, and wave action	7	ORMSS
Mouths of tributaries silted in, impairing fish habitat, limiting access, and damaging property	5	ORMSS
Loss of green space and wildlife habitat with development of marina facilities	5	ORMSS
Damage destruction of mussel beds and fish spawning areas	4	ORMSS
Cumulative effect of discharges on river may offset water quality improvements	4	ORMSS
Development of floodplains and wetlands resulting in increased runoff and habitat loss	4	ORMSS
Effects on fishing caused by water level fluctuations	3	ORMSS
Need for ongoing coordination and cooperation with concerned agencies and groups	3	ORMSS

Comment	Number of Similar Comments	Scoping Meeting
Importance to coordinate with resource agencies and conduct surveys to determine baseline conditions	3	ORMSS, Upper Ohio River Nav. Study
Need to develop comprehensive plans for development along river	3	ORMSS
Impaired water quality and bioaccumulation in fish tissue of harmful substances stirred up by dredging	2	ORMSS
Need for fish habitat improvements, including fish passage around locks and dams	2	ORMSS
Importance of including commercial dredging and associated permitting process in CEA	2	ORMSS
Challenges to water quality presented by CSOs (combined sewer overflows) and SSOs (storm sewer overflows)	2	ORMSS
Need for more stringent discharge permitting procedures or moratorium on permits	2	ORMSS
Possible use of dredge spoils to improve riparian or island habitat or for upland filling	2	ORMSS
Loss of unique, sensitive species due to water quality problems and habitat modifications	2	ORMSS
Potential instability of Ohio River islands and futility of creating islands wildlife refuge	2	ORMSS
Increased spills and accidents potentially affecting aquatic life and impairing water quality	1	ORMSS
Possibility of implementing mechanical aeration in mainstem pools	1	ORMSS
Importance of continued water quality improvements as a high priority	1	ORMSS
Habitat damage caused by USACE permitted commercial sand and gravel operations	1	ORMSS
Under-representing of fishermen in ORMSS scoping process	1	ORMSS
Increase in barge loading/unloading facilities limiting fishing access from shore	1	ORMSS
USACE role when fish kills occur	1	ORMSS
Need to prevent distribution of exotic/invasive plants and animals through USACE actions	1	ORMSS
Development of ongoing program to reevaluate cumulative effects every 5 years	1	ORMSS
Need to consider 404 application approvals and resultant actions as direct USACE actions	1	ORMSS
High levels of mercury, arsenic, fecal coliform bacteria, and agrichemicals in surface water	1	ORMSS
Need to improve sediment and erosion control from public and private developments	1	ORMSS
Need for long-term plan to address silt removal and prevent future sedimentation	1	ORMSS

Comment	Number of Similar Comments	Scoping Meeting
Need for coordination with community floodplain coordinators along river	1	ORMSS
Need to determine T&E species within study area and potentially develop mitigation strategies	1	Upper Ohio River Nav. Study

In addition to the public scoping meetings, questionnaires were given to members of the Interagency Working Group (IWG). These members included representatives from the United States Coast Guard (USCG), United States Environmental Protection Agency (USEPA), United States Fish and Wildlife Service (USFWS), Pennsylvania Department of Environmental Protection (PADEP), Pennsylvania Fish and Boat Commission (PFBC), Ohio River Valley Water Sanitation Commission (ORSANCO), Port of Pittsburgh Commission, Southwest Pennsylvania Commission, Western Pennsylvania Conservancy, California University of Pennsylvania, Marshall University, the Pennsylvania State University, and USACE consultants. The first part of the survey asked the IWG members to determine the validity of the conclusions found in the ORMSS Cumulative Effects Assessment as they pertain to the Upper Ohio Navigation Study. All agreed the conclusions on fish for the past and present time periods were applicable to the Upper Ohio Navigation Study; however, the USFWS did not agree that the conclusions pertained to future. The USFWS stated that the upper Ohio River system is more depauperate of fish. According to the USFWS, fish passage through dams, heavier industrialization of floodplain and riparian habitats, acid mine drainage, and more serious CSO problems are of greater future concern for the Upper Ohio Navigation Study than ORMSS. A summary of the comments received regarding fish is provided in Table 4-2.

TABLE 4-2
Summary of Interagency Working Group Comments on Fish

Area of Concern	Additional Input
Environmental Sustainability Indicators	Fish tissue analysis, size distribution of population, Ohio River Fish Index (ORFIn) results, riparian habitat, plankton levels/food availability, endocrine disruptency compounds (EDCs), indicators of Marcellus Shale brine water
Special Concerns	Increase amount of nursery habitat, EDCs, fish tissue contamination, habitat improvement (especially spawning habitat), lack of sediment transportation
Is ORMSS Still Valid	Not all in agreement
Geographic Nuances	Extensive modification of floodplains precludes interaction with it, all exotic introductions should be considered

4.4 LAWS, REGULATIONS, ORDINANCES, AND PROGRAMS

A pivotal regulatory event for the upper Ohio River's water quality, fish, and other aquatic ecological resources was the signing of an interstate compact in 1948 that created ORSANCO. The principal mission of ORSANCO was to abate existing pollution and control future pollution of waters in the Ohio River basin (ORSANCO 1998). The marked improvements to upper Ohio River water quality made through ORSANCO and other governmental regulations and programs during the past half-century were key to reversing the declining state of upper Ohio River fishes in the mid-20th century.

Table 4-3 provides a list of regulations and established programs related to fish of the upper Ohio River. In many cases, protection of the fish community and fishery resources is a consequence of other environmental objectives, such as improving water quality or protecting wetlands.

TABLE 4-3
Laws, Regulations, Ordinances, and Programs Relevant to Fish

Law/Program (Lead Agency)	Key Components	Relevance to Fish
Farm Security and Rural Investment Act of 2002 (Farm Bill) (U.S. Dept. of Agriculture, Natural Resources Conservation Service)	• Includes various incentive programs to promote installation of riparian buffers • Swampbuster provisions withhold certain USDA benefits from farmers who convert or modify wetlands • Offers opportunities for wetlands mitigation	Helps improve and/or preserve environmental functions & value of riparian areas in the Ohio River floodplain, which also benefit fish and other aquatic resources
Water Resources Development Act (U.S. Army Corps of Engineers)	• Authorizes USACE port development, navigation, flood control and erosion control, projects through the 1986 act and subsequent amendments	Contains provisions for environmental assessment and mitigation that can affect fish
Small Navigation Projects (U.S. Army Corps of Engineers)	• Section 107 of Rivers and Harbor Act (1960) authorizes USACE to develop and construct small navigation projects for harbor protection.	Includes impacts of such actions on water quality, fish, and other aquatic resources
Rivers and Harbors Act (1899) (U.S. Army Corps of Engineers)	• Section 10 prohibits the unauthorized obstruction or alteration of any navigable water of the United States.	Helps maintain the environmental integrity of the waterway as an aquatic habitat
USACE Permitting Statutes (U.S. Army Corps of Engineers)	• Section 404 of the CWA authorizes the USACE to issue permits for the discharge of dredged or fill material into the waters of the United States.	Permits require assessment of impacts on water quality, fish, and other aquatic resources and mandate mitigation of adverse impacts and mandate

Law/Program (Lead Agency)	Key Components	Relevance to Fish
		mitigation of adverse impacts
Spill Response (U.S. Coast Guard & ORSANCO)	• Includes emergency response activities for river-related spills and accidental discharges and is related to the Oil Pollution Act and Section 301 of the CWA	Minimizes adverse impacts of spills and discharges on fish and other aquatic resources and on water quality
National Environmental Policy Act (NEPA) (Council on Environmental Quality and other resource agencies)	• Requires preparation of environmental impact statements for new construction projects by private and governmental agencies	Includes water quality & habitat impacts of new projects along the Ohio River such as power plants, USACE projects, and riverfront developments
Clean Water Act (CWA) (U.S. Environmental Protection Agency)	• Section 402 establishes National Pollution Discharge Elimination System (NPDES) for regulating pollution discharges into U.S. waters. • Section 316(b) requires cooling water intake structures to reflect best available technology to minimize adverse environmental effects. • Section 401 of CWA requires applicants proposing activity, which may result in discharge to U.S. waters, to obtain certification of compliance with state water quality standards. This section is administered by each individual state. • Gives USEPA authority to implement pollution control programs • Requires establishment of water quality standards • Recognizes need to address nonpoint source pollution	Protects fish within general context of water quality improvements and minimizes impacts from construction or other activities within state waters
Site Remediation Statutes (U.S. Environmental Protection Agency)	• Includes CERCLA, RCRA, SARA and related state programs that focus on cleanup and restoration of contaminated sites	Potentially reduces groundwater and soil pollution sources which may adversely impact fish and other aquatic resources in the Ohio River

Law/Program (Lead Agency)	Key Components	Relevance to Fish
Oil Pollution Act (U.S. Environmental Protection Agency)	• Strengthened EPA's ability to prevent & respond to catastrophic oil spills	Protects fish and other aquatic resources from pollution & damage from oil spills
TMDL Program (U.S. Environmental Protection Agency)	• Section 303 of CWA regulates maximum pollutant load a water body can receive and still attain water quality standards	Presents a more holistic option to water quality management than traditional approaches with potential benefits for fish and other aquatic resources
Phase 1 & 2 NPDES Program (U.S. Environmental Protection Agency)	• Also within the CWA, requires municipalities and certain industrial and construction sites to adopt BMPs to control point sources of pollution	Should reduce pollution characteristics of stormwater discharges from urban and industrial zones that may adversely affect fish and other aquatic resources in the Ohio River
National CSO Control Policy (U.S. Environmental Protection Agency)	• Published by USEPA, calls for communities to implement long-term plan for combined sewer overflows to comply with the CWA • Administered through each state's NPDES permit program	Should reduce pollution from major urban sources with potential benefits for fish and other aquatic resources
Executive Order 11988, Floodplain Management & Executive Order 11990 (Executive Branch)	• Prevents federal agencies from contributing to the adverse impacts of floodplain development & modification	Restricts federal development in Ohio River floodplain wherever there are practicable alternatives with potential benefits for fish and other aquatic and riparian resources
Executive Order 13112, Invasive Species (1999) (Executive Branch & multi-agency National Invasive Species Council)	• Requires federal agencies to prevent the introduction of invasive species and provide for their control and to minimize their economic, ecological, and human health impacts	Helps to maintain and/or restore the ecological integrity of aquatic and riparian ecosystems
Endangered Species Act (U.S. Fish & Wildlife Service)	• Authorizes determination & listing of threatened & endangered species • Prohibits unauthorized taking, possession, sale & transport of endangered species • Provides for land acquisition to protect endangered species	Establishes framework for protection of threatened & endangered species that are components of the aquatic ecosystem upon which fish rely
Fish & Wildlife Act (U.S. Fish & Wildlife Service)	• Section 7(a) requires U.S. Department of Interior to take steps required for management & protection of fish & wildlife resources through research,	Establishes a comprehensive national fish & wildlife policy applicable to fish and other aquatic and riparian resources

Law/Program (Lead Agency)	Key Components	Relevance to Fish
	acquisition of land & water & other means	
Fish & Wildlife Coordination Act (U.S. Fish & Wildlife Service)	• Requires that whenever water bodies are modified by a federal agency, that agency first shall consult with the USFWS and with appropriate state agencies with a view toward wildlife conservation	Provides for equal consideration and coordination of fish and wildlife conservation with other aspects of water resources development
National Wildlife Refuge System Administration Act & National Wildlife Refuge System Improvement Act (U.S. Fish & Wildlife Service)	• Provide guidance for management and public use of refuge system, including development of comprehensive conservation plan for each refuge	Guide management & public use of Ohio River Islands National Wildlife Refuge, including fish habitat
National Invasive Species Act (U.S. Department of Transportation and Aquatic Nuisance Species Task Force)	• Requires all vessels operating in U.S. waters that are equipped with ballast tanks to comply with guidelines designed to prevent and reduce the dispersal of aquatic nuisance species	Helps reduce the further introduction and dispersal of invasive species that can disrupt aquatic ecosystems
ORSANCO Monitoring (ORSANCO)	• Encompasses ongoing water quality and aquatic ecology monitoring programs by ORSANCO	Helps track trends in water quality and biological communities and provides database that can inform environmental decision making
State Water Quality Certification (Appropriate state or interstate pollution control agencies)	• Section 401 of the CWA requires certification from state or interstate water control agencies that a project is in compliance with established effluent limits and water quality standards.	Provides opportunity for state or interstate scrutiny of such actions on fish and other aquatic resources
State Fishing Regulations (Ohio River Fisheries Management Team & State resource agencies)	• Establish regulations that consider fish habitat and reproduction. • Ohio River state resource agencies are developing an Ohio River Fisheries Management Team to standardize fishing regulations for the entire river.	Has potential to enhance environmental sustainability of Ohio River fish communities through long-term collaborative fisheries management efforts
PA Sewage Facilities Act	• All municipalities must develop and implement an official sewage plan that addresses their present and future sewage disposal needs.	Helps prevent and document the discharge of sewage in state waterways
PA Storm Water Management Act	• PADEP provides financial and	Has the potential to prevent major runoff from storm

Law/Program (Lead Agency)	Key Components	Relevance to Fish
	technical assistance to counties for development and to municipalities for implementation of watershed-based storm water management plans under the Storm Water Management Act of 1978 (Act 167).	events that could increase the rate of sedimentation and other pollutants into the state's waterways
PA Act 67 & 68	• Encourage sound land-use planning at the local level and require state agencies to consider local land use ordinances and comprehensive plans in making certain permit and funding decisions.	Helps prevent poor land use decisions that could result in adverse effects to fish species

4.5 PAST TO CURRENT BASELINE CONDITIONS

The upper Ohio River has provided continuous habitat for fishes for over 200 million years. Because large-scale geologic events have shaped the Mississippi drainage, its fish community is exceptionally rich in species and represents the center for adaptive management of freshwater fishes in North America (Pearson and Pearson 1989). Adaptive management utilizes a range of strategies and techniques throughout the planning process that have been evolving for many years. Typically, such strategies and techniques represent "on-the-ground" approaches to environmental management.

Large floodplain rivers (sometimes called "Great Rivers"), particularly the Ohio and Mississippi, are inhabited by a distinctive assemblage of fishes. Paddlefish, skipjack herring, mooneye, emerald shiner, river shiner, and blue sucker are among the Great River species that occur in the upper Ohio River (Burr and Page 1986; Pearson and Pearson 1989).

4.5.1 Early Accounts of Ohio River Fishes

Accounts of fishes collected from the upper Ohio River are not reliable prior to 1920 in terms of relative abundance because such accounts are typically inconsistent, but they are useful in understanding changes that have occurred in the fish community since that time. Pearson and Krumholz (1984) noted that the works of early 19th century naturalists Rafinesque and Lesueur indicate the upper 100 miles of the Ohio River near Pittsburgh were inhabited by a number of fish species which were either very rare or absent 100 to 160 years later in that region. Constantine Rafinesque provided the earliest account of upper Ohio River fishes (Krumholz 1981). In *Ichthyologia Ohiensis* (1820), Rafinesque described and commented on the abundance of over 100 new species of fishes he had observed while traveling down the Ohio in the summer of 1818. Many of these species are no longer recognized, but careful consideration of Rafinesque's work led Pearson and Krumholz (1984) to conclude that Rafinesque had observed 52 species of fishes.

Records on upper Ohio River fishes from 1820 to 1920 are scarce, although many human actions affected the river's environment during that time. The clearing of forests and draining of wetlands with the arrival of settlers, coal mining discharges, industrial wastes, and raw municipal sewage from communities around Pittsburgh led to the demise of nearly all fish from the rivers in the region during the late 19th century and most of the 20th century. Within 80 years of Rafinesque's voyage in 1818, Richard E. Call (1896) was able to state that fish diversity had declined due to "sewage and similar decimating influences." Preston and White observed that after approximately 1900, fish populations were beginning to be taken over by pollution tolerant species (1978).

In 1885, the USACE began to install a series of wicket dams which were raised under low flow conditions and collapsed under higher flows, thus allowing tows and fish to pass upstream or downstream over the dams. From 1874 to 1929, the USACE installed a system of locks and dams from the Ohio River from Pittsburgh to its confluence with the Mississippi River in Cairo, Illinois to maintain a 9-foot navigation channel. In 1897, the United States government purchased the Monongahela Navigation Company. Under control of the USACE, improvements were made to the existing navigation system on the Monongahela River. Upon the completion of six additional dams in 1903, 131 miles of the Monongahela River were navigable year round. By the time the Allegheny River locks and dams were finished in 1938, the navigation channel extended 72 miles from Pittsburgh to East Brady, Pennsylvania (Moxley 2001).

4.5.2 Downward Spiral of Fish Communities

The present system of dams has altered aquatic habitats by converting the upper Ohio River system from a free-flowing waterway to one of relatively constant width and a minimum maintained channel depth of 9 feet. The most profound effects that these navigation systems, combined with land use and flood control practices, had on the fishes of the upper Ohio River system were the siltation and inundation of the clean, available river substrate. This substrate was critical to the spawning success of many fishes. The installation of dams also interfered with the upstream and downstream migration of fishes, which is vital to spawning and redistribution of fishes throughout the river system (Pearson and Pearson 1989). The range and population of such migratory fishes as the lake sturgeon, paddlefish, skipjack herring, and blue sucker have been greatly reduced in the last 80 years as the result (Burr and Page 1986). In addition to the loss of suitable habitat and limits to migration, other adverse effects to fishes caused by dams include injury or mortality of fish passing through spillways, loss of life-stage specific habitat due to monotonous flow regime modifications, altered fish fauna due to changes in water temperature and water quality, and increased mortality due to predation (Larinier 2000). Concurrently, the high-lift dams created embayments in creek mouths adjacent to the mainstem in the upper half of the river, which offer important habitat for basses and other sunfishes (Preston and White 1978), species more typical of lake-like conditions.

Even before completion of the navigation system, various human activities had caused several fish species to decline in abundance by the early 20th century. Rapid growth of the human population in the upper Ohio River Basin during the first half of the 20th

century led to larger inputs of domestic sewage, industrial effluents, and acid mine drainage. The combined effects of these pollutants led to a depleted fish fauna dominated by tolerant species. By 1950, the abundance of intolerant species such as lampreys, sturgeons, paddlefish, big eye chub, muskellunge, sauger, and blue sucker were greatly reduced, while tolerant species such as the gizzard shad, emerald shiner, freshwater drum, bullhead catfish, and introduced common carp had increased in abundance within the Upper Ohio and Lower Allegheny (Pearson and Krumholz 1984). Conditions within the Monongahela River were even worse than the other two rivers. In 1948, fish had almost entirely disappeared and the Monongahela ran red with acid mine drainage, steel mill effluent, and other pollutants (3 Rivers 2nd Nature 2008). Fishes reported in the upper Ohio prior to 1920, but not collected since that time, include the least brook lamprey, Alabama shad, hornyhead chub, Ozark minnow, and mud, longhead, crystal, and gilt darters (USFWS 2000). The crystal and gilt darters were already scarce species, which disappeared after their riffle habitats were inundated by the wicket dams (Pearson and Krumholz 1984).

The effects of acid mine drainage from coal mining discharges were most prevalent within the Monongahela River, which in turn had environmental consequences for the Ohio River. During the 20th century, pH readings of 3.8 were recorded within portions of the Monongahela River (ORSANCO 1962). The combination of acid mine drainage and industrial and municipal pollutants depleted the fish communities of the lower Mon by the mid-20th century. All that remained was an insignificant fish community dominated by tolerant species. A sampling at Lock and Dam 3 during this time resulted in the collection of only two small bluegills. Sauger, spotted bass, freshwater drum, mooneye, goldeneye, river carpsucker, silver chub, buffalofishes, sturgeons, and paddlefish are among some of the fish species extirpated from the Monongahela River due to the severe conditions. A sampling effort conducted above Pittsburgh in 1958 resulted in the collection of only seven species, most of which were tolerant species (USACE 2001).

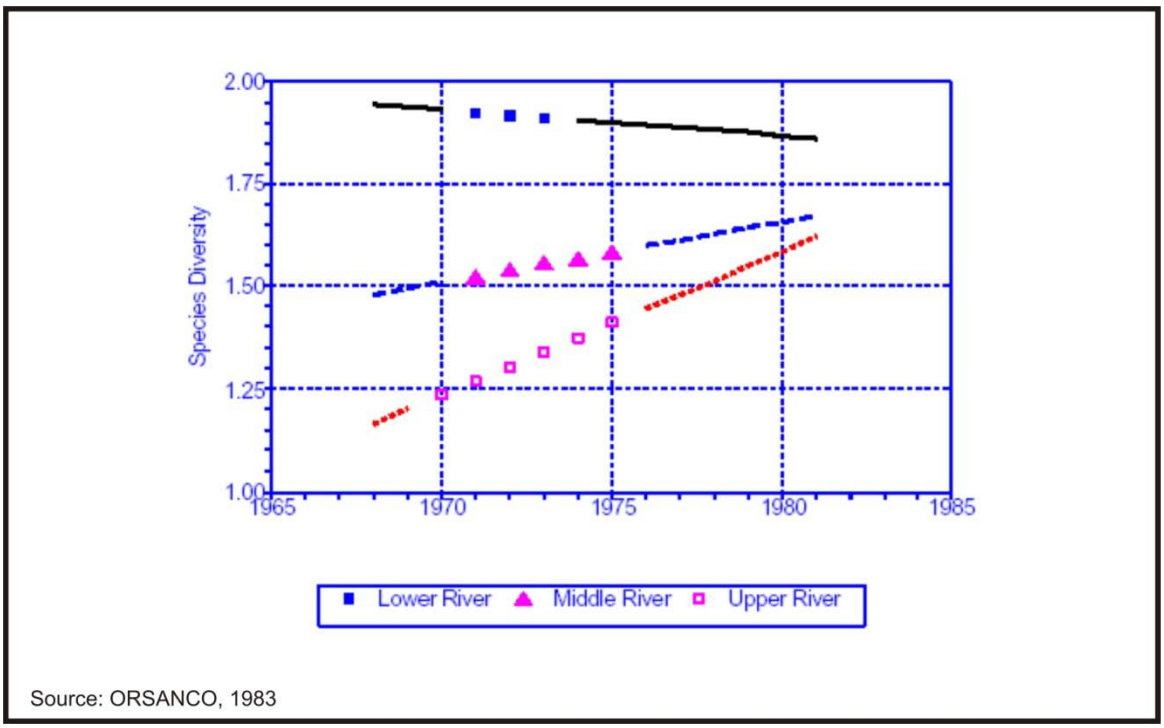
4.5.3 Improvements in Fish Populations

In the last half of the 20th century, actions of ORSANCO and implementation of the Clean Water Act of 1972 and its amendments led to considerable progress in reducing point source pollution, which helped in the subsequent recovery of many fish species. ORSANCO has worked with the states along the Ohio River to improve their awareness toward their responsibilities and roles regarding improving and preserving water quality. The Clean Water Act established regulations detailing strict requirements for pollution prevention and response measures to achieve improved water quality. Some of the measures taken to improve water quality throughout the upper Ohio River watershed include the regulation, reclamation, and treatment of acid mine drainage; the construction and upgrading of sewage treatment facilities; and the regulation and reduction of industrial effluents (Weller *et al.* 1991, as citied by Lorson and Smith 2004). As these measures were taken to improve water quality, fish species began to recolonize portions of the river that were once too polluted to inhabit. The first species to reappear were those that took refuge in upstream tributaries. Other large river species redistributed from the distant downstream areas of the river (Hoskin *et al.* 2003; Pearson and Krumholz 1984; USACE 2006a).

Numerous studies conducted since the introduction of the Clean Water Act in 1972 have demonstrated a positive trend in the abundance and diversity of fishes through the upper Ohio River system. To illustrate this trend, studies used in the ORMSS, Lower Mon EIS Appendix on Cumulative Effects Assessment, and the *Environmental Impact Statement on Commercial Sand and Gravel Dredging Operations in the Allegheny and Ohio Rivers, Pennsylvania* (SGEIS) (USACE 2002) are outlined below. Additional studies will also be incorporated to update the current status of fishes.

ORSANCO reviewed their rotenone fish sampling data from the late 1960s to the early 1980s (1983). This analysis identified a positive trend along the river during that time period. An increase in fish diversity as calculated by the Shannon-Weaver Index indicated improving water quality, with the greatest improvements seen in the upper Ohio River. Shannon-Weaver Index calculations range from three to zero, with three representing a perfectly diverse population. In the upper Ohio River, sport and commercially valuable fish species exhibited the greatest increase in diversity and abundance. These species tend to be more intolerant of pollution than other species. Fish diversity increased by 40 percent in the upper river compared to only 13 percent in the middle section. These improvements are credited to increased pH and dissolved oxygen concentrations, and to decreased levels of toxic materials in the river. As Figure 4-1 shows, higher diversity occurs in the lower river since it is larger in size and has a higher biomass. The upper Ohio River displayed more distinct changes in diversity since pollution was historically much more severe in this portion of the river (USACE 2006a).

Figure 4-1
Long-term Trends in Fish Diversity in the Ohio River



Pearson and Pearson confirmed that many species that were extirpated from the upper river during the worst decades of pollution have redistributed to portions of the river approximating their historical ranges (1989). Between 1984 and 1989, 18 fish species extended their range in an upstream direction, as shown in Table 4-4.

TABLE 4-4
Upstream Fish Range Extensions Reported Along the Ohio River

Fish Species	1970-1983 Distribution (Ohio River Mile)	1984-1988 Distribution (Ohio River Mile)
Paddlefish	427-981	341-981
Spotted Gar	846-981	560-981
Threadfin Shad	390-981	341-981
Mooneye	260-981	54-981
Grass Pickerel	597-981	54-981
River Carpsucker	54-981	35-981
Highfin Carpsucker	170-981	54-981
Northern Hogsucker	35-604	13-604
Smallmouth Buffalo	54-981	35-981
Silver Redhorse	35-981	13-981
Rosyface Shiner	35-981	13-981
Striped Bass	126-981	13-981
Silverjaw Minnow	54-287	35-605
River Chub	54-470	35-560
Striped Shiner	54-518	35-605
Fathead Minnow	161-279	77-560
Brook Silverside	54-260	35-981
Banded Darter	35-494	13-560
Source: Pearson and Pearson, 1989		

In addition to Pearson and Pearson's research, fish samples collected by Van Hassel *et al.* (1988) from 1973-1985 in the upper and middle river suggested that range extensions of such river species as the paddlefish, mooneye, spotted gar, river carpsucker, smallmouth buffalo, and white bass were most likely direct responses to improvements in water quality in the upper Ohio River.

As a part of the Sand and Gravel Dredging EIS (USACE 2006b), past and present fish data were correlated to produce a list of fish species that have historically been reported with the Ohio and Allegheny rivers surrounding the City of Pittsburgh. A total of 112 fish species were reported within the study area, including two hybrid species. Of the 112 species reported, 41 were not reported present in studies prior to 1980/81 while only two species that were previously present were not reported after this date. Of the 41 newly reported fish species, 11 are designated as intolerant species and only three as tolerant species. Again, it is assumed this change in species composition is due to better water quality.

Table 4-5 compares the ten most abundant fishes collected in the Ohio River for two different time periods and collection methods. Emerald shiner, gizzard shad, and freshwater drum are the three most abundant species on both lists. Species that occur on the 1991-2001 list that did not appear on the earlier list include the sauger, bluegill, temperate basses, and silver chub. Absent from the more recent list are the pollution-tolerant common carp and bullheads, as well as skipjack herring and white crappie (USACE 2006a).

TABLE 4-5
Ten Most Abundant Fish Species Collected from the Ohio River by Rotenone

Rank	Collected in Lock Chambers 1957-1980	Collected by Electrofishing 1991-2001
1	Emerald shiner	Gizzard shad
2	Gizzard shad	Emerald shiner
3	Freshwater drum	Freshwater drum
4	Mimic shiner	Sauger
5	Channel catfish	Mimic shiner
6	Common carp	Bluegill
7	Bullheads (all species)	Channel catfish
8	Skipjack herring	Morone spp. (temperate basses)
9	White crappie	Threadfin shad
10	Threadfin shad	Silver chub
Sources: Pearson and Krumholz, 1984; ORSANCO, 2002		

Preston (1974) summarized fish population studies that were conducted from 1967 to 1973 on the Monongahela River. This time frame is critical because it documents immediate effects of legislation and awareness toward water quality on one of the most degraded rivers in the country. Preston examined data available on both the upper and lower Mon. In 1967, only 20 fish were collected during a sampling conducted at the Braddock Locks and Dam. The number of fish collected increased in each sequential year. In 1973, 869 fish were collected during sampling. Although the data for the lower Mon did not show as significant an increase as observed in the upper Mon (0 fish in 1967 to 8,071 in 1973), it indicated a major improvement to the water quality and fish fauna of the lower Mon (USACE 2001).

ORSANCO has collected fish data at the Monongahela River locks since 1968. In 1968, ORSANCO data showed that only five fish species were collected at the Maxwell and Braddock locks and dams. Twenty years later, 20 fish species were collected. Fish biomass at these locations followed the same trend as it increased from just 5 kg in 1968 to 150 kg in 1988 (Lorson and Smith 2004). The Pennsylvania Fish and Boat Commission (PFBC) conducted electrofishing sampling in the early 1990s. High numbers of sport fish such as sauger, smallmouth bass, white bass, and channel catfish were collected during these samplings (Miko and Lorson 1994, as cited in Lorson and Smith 2004). By the mid-1990s, the PFBC had concluded the Monongahela River had once again become a fishable river (USACE 2001).

4.5.4 Current Status

4.5.4.1 CSOs/SSOs

Although the construction of water treatment plants has helped reduce the amount of sewage released into the upper Ohio River, releases of untreated sewage continue to degrade local water quality and impair the value of habitat, recreation, and public water supplies. The main sources of this untreated sewage are from combined sewer overflows, sanitary sewer overflows, and failing sewers. It has a critical effect on water quality, fish, mussels, and other wildlife habitat.

The City of Pittsburgh, the Allegheny County Sanitary Authority (ALCOSAN), and other communities in the region face extensive and costly regulatory actions under the Clean Water Act for both CSO and SSO wet weather discharges. Annually, an estimated 16 billion gallons of mixed rainwater and raw sewage are discharged into the region's waterways from CSOs and SSOs during wet weather in the ALCOSAN service area. There are 420 CSOs in Allegheny County. The ALCOSAN service area alone has 259 CSO structures from which untreated sewage is discharged into local streams during wet weather, more than any other similar authority in the nation (NRC 2005). Cost estimates to fix these sewer infrastructure problems vary; one recent projected estimate of the cost of regional combined sewer separation by conventional methods was 11 billion dollars. Due diligence requires the USACE to maintain a situational awareness of this important emerging issue in their planning and construction of water resource engineering projects along the upper Ohio River.

The enormity and complexity of CSO/SSO problems in the Pittsburgh region, accompanied by regulatory pressures by the Allegheny County Health Department, the PADEP, and USEPA, has led to innovative demonstration initiatives, and numerous recent and highly detailed studies. While any thorough examination of these studies is beyond the scope of this assessment, notable examples include the Three Rivers Wet Weather Demonstration Project (TRWW), established in 1997 to assist communities in the ALCOSAN service area under regulatory scrutiny to eliminate combined sewer overflows. The National Research Council of the National Academy of Sciences published an excellent study of the problem in 2005, titled *Regional Cooperation for Water Quality Improvement in Southwestern Pennsylvania*. In cooperation with the Allegheny County Health Department, the United States Geological Survey is quantifying fecal indicator bacteria levels in the Allegheny, Monongahela and Ohio rivers near Pittsburgh (Fulton and Buckwalter 2004). Further, both dry and wet weather, tributary and river mainstem, studies of fecal bacteria were an important component of the Three Rivers/Second Nature initiative (Knauer 2001).

4.5.4.2 ORSANCO Studies

Recent biological studies were conducted within the New Cumberland, Montgomery, Dashields and Emsworth pools in 2005, 2006, 2008, and 2007, respectively. These studies collected data on fish, habitat, water quality (temperature, DO, conductivity, and pH) and flow, and ORFIn metrics at 15 sites throughout each of the pools. The Ohio River Fish

Index, or ORFIn, is a method of measuring the health of fish communities in the Ohio River. The ORFIn includes 13 attributes, or metrics, of the fish community that when combined provide an accurate representation of the overall condition of the Ohio River fish community. These 13 metrics encompass several different features of the fish population, including diversity, abundance, feeding and reproductive guilds, pollution tolerance/intolerance, and fish health. (Additional information on ORFIn is found later in this chapter.)

Fish were collected at night utilizing the boat electrofishing technique at multiple sites throughout the pools. To determine if each pool supports its aquatic life designation, 15 sampling sites within each pool were assessed. Performance expectations for each site were based on habitat classes, which were determined by both depth and substrate of the site. For a pool to have met its aquatic life designation, more than 75 percent of the sites assessed had to surpass their performance expectations. The results of these surveys are outlined below:

- The New Cumberland Pool of the Ohio River extends from the Montgomery Lock and Dam (River Mile [RM] 31.7) to the New Cumberland Lock and Dam (RM 54.4). This pool signifies the downstream limit of the geographic scope. The fish survey resulted in 35 species of fish including one PA endangered species, the silver chub. The dominant species collected within this pool included the mimic shiner, emerald shiner, golden redhorse, and gizzard shad. These species comprised 22 percent, 14 percent, 13 percent, and 10 percent of the total catch. A total of 20 DELT (deformities, eroded fins, lesions, and tumors) anomalies were collected within this pool. At 9 of the 15 sampling locations, one or fewer DELT anomalies were collected. One or fewer DELT anomalies is considered optimal by the ORFIn.. Habitat surveys revealed that fines (38 percent) dominated the bottom substrate of the New Cumberland Pool. Other substrate included 23 percent gravel, 17 percent sand, 16 percent cobble, and 6 percent boulder. The average temperature, DO, conductivity, and pH were 25.1°C, 9.33 mg/L, 390 µS/cm, and 7.41, respectively. ORFIn results scored on average 9.9 points below what was expected at each site, with all but four sites failing. The poor ORFIn results were not fully understood. Fish metrics such as Great River Species, Percent Simple Lithophils, and Percent Piscivores were all lower than had been anticipated. It is expected these scores were the result of high flows and poor weather conditions during the survey. The poor conditions may have caused decreased capture efficiency of fish. The results of this study indicated the New Cumberland Pool did not meet its aquatic life designation (ORSANCO 2004).

- The Montgomery Pool of the Ohio River extends from the Dashields Locks and Dam (RM 13.2) to the Montgomery Locks and Dam (RM 31.7). This pool is located 13 miles downstream from the City of Pittsburgh and is heavily influenced by industry. The electrofishing survey resulted in the collection of 41 fish species. Five of these species are listed as either endangered, threatened, or of special concern in Pennsylvania. These species included the mooneye, silver chub, spotted sucker, longear sunfish, and warmouth. The dominant species were smallmouth buffalo (12.9 percent) and sauger (12.8 percent). It was unusual for

these species to outnumber shad and minnows. This was most likely due to high flow conditions during the surveys. A total of 27 DELT anomalies were collected within this pool. At 9 of the 15 sampling locations, one or fewer DELT anomalies were collected. Habitat surveys revealed the Montgomery Pool substrate was mostly sand (33 percent) and gravel (27 percent) with a small percentage of boulders. Water quality sampling did not show any poor or unusual water conditions throughout the pool. Of the 15 sites sampled, only two were in poor condition and did not meet their expected ORFIn scores. Approximately 87 percent of the sites were in passing condition. The results of this study indicated the Montgomery Pool did meet its aquatic life designation (ORSANCO 2006).

- The Dashields pool of the Ohio River extends from the Emsworth Locks and Dam (ORM 6.2) to the Dashields Locks and Dam (ORM 13.3). The electrofishing survey resulted in the collection of 31 fish species and one hybrid taxa. Five of the 31 species are listed as endangered, threatened, or of special concern in PA. These species were the silver chub, smallmouth buffalo, mooneye, river redhorse, and longnose gar. The three most dominant species were the sauger (15.6 percent), logperch (13.5 percent), and smallmouth bass (13.2 percent). A total of 5 DELT anomalies were collected within this pool. One or fewer DELT anomalies were collected at all 15 of the sampling locations. Habitat surveys revealed the substrate of the Emsworth pool was mostly composed of sand (30.0 percent) and gravel (29.6 percent), with a smaller percentage of cobble and fines. Water quality sampling did not show any poor or unusual water conditions throughout the pool. Utilizing a modified ORFIn (MORFIn) in the Dashields pool, five (38 percent) of the 13 sites assessed scored less than the minimum expected ORFIn scores and were assessed as either poor or very poor. The results of this study indicate the Dashields pool did meet its aquatic life designation (ORSANCE 2008).

- The Emsworth Pool defines the upstream limit of this study. It encompasses the three rivers surrounding Pittsburgh, from the most downstream dam on both the Allegheny and Monongahela rivers to the Emsworth Locks and Dam (RM 6.2). The electrofishing survey resulted in the collection of 42 fish species. Four of the 42 species are listed as endangered, threatened, or of special concern in PA. These species were the silver chub, river shiner, skipjack herring, and mooneye. The three most dominant species were the bluegill (14.5 percent), smallmouth bass (12.9 percent), and sauger (10.8 percent). A total of 8 DELT anomalies were collected within this pool. At 12 of the 15 sampling locations, one or fewer DELT anomalies were collected. Habitat surveys revealed the substrate of the Emsworth Pool was mostly composed of sand (37.4 percent) and gravel (30.2 percent), with a smaller percentage of cobble and fines. Water quality sampling did not show any poor or unusual water conditions throughout the pool. The ORFIn scores for all 15 sites were passing. The results of this study indicate the Emsworth Pool did meet its aquatic life designation (ORSANCO 2007).

These ORSANCO studies illustrate the current overall health of the upper Ohio River. A total of 62 fish species were collected from the three pools studied. Of these 62 species, seven are listed by Pennsylvania as threatened, endangered, or of special concern. Although the number of species collected is not as high as mentioned in previous sections, the fish communities sampled are still considered very diverse and abundant. The reason the numbers are not as high is due to the limited sampling. The previous sections were a collaboration of many studies throughout the history of the upper Ohio River system.

The ORSANCO studies also verify the improved water quality throughout the pools. Throughout history, water quality has been the biggest influence on the health of fishes within this region. The fact that no poor water quality was reported from any of the three pools is a significant sign that fish populations should only continue to diversify and the health of fishes improve into the future. The habitat quality and ORFIn scores are also very promising. Other than the New Cumberland Pool, fines only accounted for a small portion of the stream substrate. Fines can often have adverse effects on the breeding success of many fishes. Overall, these studies demonstrate a healthy population of fishes throughout the upper Ohio River.

4.5.4.3 Fishing Tournaments

In the summer of 2005, Pittsburgh hosted the CITGO Bassmaster Classic on the Ohio, Allegheny, and Monongahela rivers. The Bassmaster Classic is considered the most prestigious of all fishing tournaments. "Three Rivers is the perfect showcase for Pennsylvania bass fishing because it's a story of successful gamefish restoration," said Rick Lorson, a fisheries manager for the PFBC (Black 2005). Lorson was also quoted as saying, "There are healthy bass populations in the Monongahela, Allegheny and Ohio rivers, including the waters right in the heart of Pittsburgh. Thirty-five years ago, gamefish populations in Three Rivers had been suppressed due to poor water quality. The legacies of industry, mining and steel-making – as well as urban growth in the greater Pittsburgh area – had left the rivers so badly polluted that many people believed recovery was impossible." Lorson also stated that since 1991 the abundance of bass has been relatively stable with ups and downs that fluctuate with river conditions. The size is one big difference in the bass between now and 1991. "The great news is the number of bass over 12 inches and over 15 inches has increased," said Lorson. The ability of the bass to grow to such lengths indicates the conditions, such as water quality and food supply, have been consistent over a period of time (Black 2005).

Although the professional anglers had a rough time finding hungry bass during the 2005 Bassmaster Classic due to record high water temperatures (Weisberg 2006), Pittsburgh hosted the 2009 Forrest L. Wood Cup, a four-day bass fishing tournament that paid the winning angler $1 million and had a total purse of $2 million. Attracting national attention, the Forrest L. Wood Cup tournament is widely considered "bass fishing's crown jewel." Prior to the event, Ken Komoroski, member of the local organizing committee, was quoted as saying, "As a result of years of water quality improvement efforts, substantial populations of smallmouth, largemouth and spotted bass can now be found throughout the three rivers

(BASSBURGH.com 2009). Additionally, the largest flathead catfish caught in Pennsylvania during 2008 (over 37 pounds) was caught on the Ohio River (Pittsburgh Post-Gazette 2009).

These tournaments are an indication of the restoration of Pittsburgh's rivers and the current health of the fish communities. This dramatic turnaround displays the effectiveness of the Clean Water Act and actions by organizations such as ORSANCO. The upper Ohio River can once again be called home to many of the fishes that once roamed its waters in the 19th century.

4.5.4.4 Mining-Related Pollution Studies

In response to the past threat of the orphan mines, six different but coordinated efforts documented the fishery resources of the Monongahela River between 2002 and 2005. These studies were summarized in the Lower Mon CEA and represent good indicators for measuring the health of the Ohio River because of the Mon's influence on it. The reports found the following (more studies are expected as a result of the loss at Dunkard Creek):

- In 2003, Lorson and Smith (2004) of the PFBC conducted fish rotenone lock chamber surveys at Grays Landing, Maxwell, and Braddock locks and dams, as well as night electrofishing surveys in the tailwaters of these three structures. They collected a total of 40 species of fish using various sampling methods.

- Hedrick, O'Bara, and Jernejcic (2004) of the West Virginia Division of Natural Resources performed a lock chamber rotenone survey at Morgantown Locks and Dam (24 fish species) in 2003. In 2004, they assessed the tailwaters of Opekiska and Morgantown locks and dams by night electrofishing (20 and 24 fish species, respectively).

- ORSANCO performed night boat electrofishing along eight 500-meter long zones of the mainstem of the Monongahela River in the Maxwell Pool associated with Ten Mile Creek and eight 500-meter long zones in the Grays Landing Pool associated with Dunkard Creek (40 combined fish species).

- Kimmel and Argent (2005) of the California University of Pennsylvania, in 2005, used 239 sets of multi-mesh panel gill nets to sample the large-bodied riverine ichthyofauna assemblage of the Monongahela River. They collected 35 species or hybrids.

- Kimmel and Argent (2005) in 2003-2004 electrofished the mouths of 40 stream tributaries to the Monongahela River at their confluences with the river, including slackwater areas, upstream to the first hydraulic obstacle to fish passage. They collected 52 species or hybrids from 35 of these streams.

- Hoskin, Koryak, and Stafford (2003) electrofished the mouths of 17 tributaries of the lower Monongahela River in Allegheny County. They did not include slackwater embayment reaches of these streams or terminate sampling when

hydraulic obstacles to upstream fish passage were encountered. In 2002 they collected 16 species of fish from 15 of these streams.

The PADEP recently used benthic trawling to survey the nearby lower portion of the Allegheny River Navigation System. This new technique allowed the collection of an entire assemblage of darters that had not been detected by other fish sampling techniques. Darters are mostly intolerant of pollution, and recently had been limited to the more pristine streams of Pennsylvania. They have probably been able to expand their range from upstream refuge in response to improving water quality. The PADEP also conducted a benthic trawling survey in the lower Monongahela River later in 2006; however, these data were not in hand at the time this report was written. It is not unreasonable to expect that they might have found this same assemblage in the improved waters of the Monongahela River (Spears 2006 personal communication, as cited in USACE 2001).

In addition the mining related studies discussed above, other studies are showing the potential for a more historically natural fish assemblage to return to the Monongahela River despite its past conditions. These studies are discussed below.

Recolonization from the downstream reaches of the Ohio River will also likely continue. For example, the State Endangered river shiner was captured by Argent and Kimmel (2003, as cited in USACE 2001) from the nearby Allegheny River Navigation System and by Hoskin *et al.* (2003) at an Allegheny River tributary mouth in 2002. There is the potential that river shiners and other new species of fish will also be soon collected from the Monongahela River (USACE 2001).

Although the pollution-tolerant brown bullhead and white catfish were common among the fish community of the Monongahela River during some of its most polluted years (Preston 1974; ORSANCO 2004), ORSANCO (2004) has not collected any white catfish from the Ohio River since 1981. Catfishes now present in the system are channel catfish, flathead catfish, and occasionally a yellow bullhead or stonecat madtom (USACE 2001). Although catfish are considered an intermediate species in terms of its pollution toleration, especially the channel and flathead catfish, the stonecat madtom is an intolerant fish, but the yellow bullhead can withstand pollution that many other fishes cannot (EPA 2009/PFBC 2009a).

Another sign of improved fish diversity and water quality was the occurrence of several big river species considered intolerant to pollution (Lorson and Smith 2004). Table 4-6 shows that several smaller species, including shiners and darters, were also among the pollution-intolerant fishes collected in 2003.

TABLE 4-6
Pollution Intolerant Fish Species Collected in the Monongahela River in 2003

Pollution Intolerant Fishes	Location(s) of Collection*
Paddlefish	M
Mooneye	B, GL, M

Pollution Intolerant Fishes	Location(s) of Collection*
Sand shiner	GL
Mimic shiner	B, GL, M
Northern hogsucker	GL
River redhorse	B
Black redhorse	**GL**
Shorthead redhorse	GL, M
Smallmouth bass	B, GL, M
Greenside darter	B
Channel darter	M
Logperch	M
*Collections were made at Grays Landing (GL), Maxwell (M), and Braddock (B) locks and dams	
Source: Lorson and Smith, 2004	

4.5.5 Fish Habitats

Changes in fish communities of the upper Ohio River during historical times reflect available spawning habitats and human alterations. Reproductive modes are important in evaluating fish communities because reproductive failure in response to environmental stressors leads to rapid decline and elimination of fish populations. Spawning habitat in the mainstem is critically important to Ohio River fishes because most species are spawned in the mainstem, not in tributary streams or recently created embayments (Pearson and Krumholz 1984).

Fish guilds, defined as groupings of species capable of exploiting the same environmental resources or habitats in similar ways, provide a framework for reflecting upon changing environments. Balon, as cited by Pearson and Krumholz (1984), developed a reproductive guild classification for fishes that considers behaviors, preferred spawning substrates, and morphological adaptations of eggs and larvae in relation to predation and the availability of oxygen. Pearson and Krumholz used Balon's classification system as a framework for arranging Ohio River fishes into guilds based on their known spawning habits. They assigned 128 of the Ohio mainstem's 159 species into 13 guilds that they believe explain how human influences on the physical nature of the river have altered fish communities.

Early historical accounts of the river describe extensive reaches of clean gravel substrate in near-shore zones. Pearson and Krumholz note most fish species in the river were and are lithophils, species that spawn over clean gravel or rock. Siltation and inundation, together with agricultural clearing and channelization, altered these spawning substrates. Consequently, lithophils such as the shovelnose sturgeon, lake sturgeon, redhorses, blue sucker, and paddlefish declined in abundance while pelagophils, which produce floating eggs or larvae, increased in abundance. The three most abundant species during the period of quantitative collections since 1957 are the emerald shiner, gizzard shad, and freshwater drum. All have eggs or larvae that float in the water column. Three other species with pelagic eggs, however, have not been as successful and are either rare (burbot) or low in abundance (mooneye and goldeye). The burbot always has been rare in the river, but the

other three species are believed to migrate upstream before spawning and may be thwarted by dams (Pearson and Krumholz 1984).

According to Pearson and Krumholz, fishes such as carpsuckers and buffalofishes that spawn over vegetation and debris (usually from terrestrial sources) have maintained their relative abundance in the river. Nest-guarding species such as sunfishes, largemouth bass, smallmouth bass, and spotted bass are only abundant in protected embayments where spawning sites are available. Pearson and Krumholz theorize that disturbances from towboat wakes prevent successful spawning in the mainstem for almost all sunfish and bass species, but not white crappie. Van Hassel *et al.* (1988) observed overall that Ohio River habitats favor non-guarding (non-nesting), open substrate fish species. Pearson and Krumholz identified seven macrohabitats available to fishes in the Ohio River. These are summarized in Table 4-7.

TABLE 4-7
Fish Habitat Types in the Upper Ohio River

Habitat	Extent of Habitat	Substrate	Spawning Suitability	Other Comments
Main channel	At least 9 ft. deep and 300 ft. wide	Usually sand, but gravel, rubble, and bedrock possible	Limited (e.g., freshwater drum, gizzard shad)	Current of at least 0.5 ft./sec. always present; rooted vegetation absent
Main channel border	Between main channel & shore-debris zone	Sand or silt, with occasional extensive gravel or rubble	Pelagophils & lithophils (e.g., blue sucker, redhorses)	Rooted vegetation absent
Shore-debris zone	5 - 150 ft. out from shoreline	Sand or silt with sunken logs & branches partially buried	Primarily vegetation & nest spawners (e.g., buffalo, gar)	Rooted vegetation may be found
Tailwaters	Extending 0.5 mi. below navigation dams	Sand, gravel, or bedrock	Local lithophils (e.g., sauger, walleye)	Extensive turbulence & elevated oxygen occur; usually no rooted vegetation
Side channels	Areas separating near-shore islands from mainland	Soft-bottomed & often lined with eroded banks	Primarily nest spawners & some vegetation spawners (e.g., sunfishes, black basses)	Trees which have slumped into channel may be present; contain running water at normal pools
Sloughs and embayments	Varying in size, depending on river water levels	Soft-bottomed, often with standing & submerged timber	Very important for nest spawners (e.g., sunfishes, black basses)	May have rooted vegetation; no appreciable current at normal pools
Creek mouths & flooded	Variable in size & extent of flooding	Often steep-banked & soft-bottomed, but	Important for small stream species that only stray into main-	High gradient tributaries prevail above RM 450

Habitat	Extent of Habitat	Substrate	Spawning Suitability	Other Comments
channels		may have coarser substrates	stem (e.g., creek chub, stoneroller)	while low gradient tributaries prevail below RM 450
Source: Pearson & Krumholz, 1984				

Islands, more numerous in the upper and lower river than in the middle third, also are excellent fish habitats. They are important to spawning fishes because:

- They offer resistance to currents, which in turn may result in an increase in current speed on one or both sides of an island head and the clearing of coarse sand or gravel bars where lithophils can spawn;

- They often are separated from the mainland by narrow back channels, which are sheltered from waves generated by tows and recreational craft; and
- Narrow back channels often are bordered by undercut banks and fallen timbers, which can provide nesting cavities for certain species including catfishes.

The influence of tributaries on community structure of fishes in large midwestern rivers is still not well defined. Pearson and Krumholz (1984) found no evidence that tributaries are important for the spawning of Ohio River fishes. They suggested that tributaries serve as refuges where mainstem fish can avoid environmental stressors, as well as serving as reservoirs for small stream inhabitants such as the stoneroller, creek chub, northern hog sucker, madtoms, topminnows, and darters, which stray only occasionally into the Ohio mainstem. Emery (2003 personal communication) believes some species rely almost exclusively on tributaries for spawning, but are listed as Ohio River species because they are collected there as adults. Emery's observation corroborates Curry and Spacie's (1979) finding, as cited by Reash (1999), that the importance of tributaries in recruitment of mainstem fish populations is species specific (USACE 2006a).

4.5.6 Winter Habitat Used by Fishes in the Ohio River

Winter is a critical period in which high mortality occurs in fishes. Many temperate fishes undergo a torpor-like state when exposed to prolonged cold temperatures and short days (Oliver *et al.*1979; Cunjak 1996; Garvey *et al.* 1998; and Crawshaw 1984, as cited in Garvey *et al.* 2003). Swimming ability is compromised at low temperatures in many species. Further, given low food availability and the energetic costs of maintaining position during winter, fish may seek low velocity habitats to avoid energy depletion. As in other large temperate rivers, winter habitat requirements for fish in the Ohio River revolve around temperature, oxygen concentrations, flow velocities, and food availability. A literature review conducted by Garvey *et al.* (2003) for ORMSS found that because many Ohio River fish species likely home to the same overwintering locations each year, such areas are important for survival during critical winter periods. In addition, during winter, fish may be highly susceptible to vessel-passage induced displacement from velocity shelters. Relatively small velocity changes, such as those that can be induced by vessels, can displace small

bluegill and channel catfish from low velocity habitats when water temperatures are low (1 - 4° C) (Sheehan *et al.* 2000, as cited in Garvey *et al.* 2003). If fish are displaced into flowing channels at such temperatures, mortality will probably increase (Bodensteiner and Lewis 1994, as cited in Garvey *et al.* 2003).

In the Ohio River mainstem, quantity and availability of winter refuge may well determine the relative survival and abundance of resident fish populations. River habitat management that enhances/maintains accessibility to these areas should be beneficial to wintering fish in the Ohio River (USACE 2006a).

4.5.7 Indices of Biotic Integrity

Indices of Biotic Integrity (IBI) are used to assess the condition of water bodies by direct evaluation of biological attributes. IBIs involve integration of structural, ecological, trophic, and reproductive attributes of fish assemblages at multiple levels of organization (Karr 1981; Karr 1986; Fausch *et al.* 1990, as cited in Emery *et al.* 2003). ORSANCO has used the Modified Index of Well Being (MIwb) and, more recently, the ORFIn to assess the biotic integrity of the Ohio River.

The MIwb quantitatively measures the relative health of fish communities using four measures of fish communities that traditionally have been considered separately: numbers of individuals, biomass, and the Shannon Diversity Index based on numbers and weight (two separate calculations). ORSANCO (1992) adapted the MIwb to prevent attainment of high scores from degraded sites with large numbers of pollution tolerant fish. A positive correlation between the MIwb and water quality therefore illustrates that less impacted stream segments support a larger variety and abundance of fish than stressed segments (Ohio EPA 1987). An analysis of 1989 Ohio Environmental Protection Agency electrofishing data and ORSANCO lockchamber data from 1968 through 1990 indicated, in general, improving conditions in the fish communities from upstream to downstream, reflecting less concentrated human activity, lower levels of pollution, and less habitat deterioration (ORSANCO 1992). The study identified three river reaches that showed sags in the MIwb. Of these three reaches, one falls within the geographic scope of the upper Ohio River. This reach is from the Montgomery L/D (RM 31.7) to Pike Island L/D (RM 84.2). It is affected by point sources from heavy industry and acid mine drainage.

During the past several years, ORSANCO and other agencies have collaborated to develop an IBI specifically tailored to the distinctive ecological characteristics of the Ohio River. Table 4-8 shows the Ohio River Fish Index. The index measures 13 attributes of fish communities that either respond predictably to measures of human disturbance or reflect desirable features of the Ohio River.

TABLE 4-8
ORFIn Metrics, Selection Rationale, and Observations to Date

ORFIn Metric	Rationale for Metric Selection	Observations to Date*
Number of native species	Focuses on native species diversity by excluding nonindigenous species and hybrids that indicate a lack of biotic integrity	• # of native species decreases from upstream to downstream, possibly related to river geomorphology • # of native species was greater at deeper sites with coarser substrates than at shallower sites with more sand and fines • Native species also declined with degraded water quality
Number of sucker species	Suckers are a major component of Ohio River fish fauna. Round-bodied suckers are especially sensitive to habitat and water quality degradation and long life span provides a metric influenced by long-term environmental changes.	• # of sucker species was significantly correlated with coarse substrates, submerged vegetation, woody cover, and conductivity, and negatively correlated with elevated temperature, sands and fines, and degraded abiotic conditions • # of round-bodied suckers decreased downstream
Number of centrarchid species	Modified from Karr's 1981 IBI to include black basses, the dominant centrarchids in Ohio River pool habitats	• # of centrarchid species did not vary significantly from upstream to downstream • # of centrarchid species was greater at sites over coarse substrates and at sites with abundant woody or vegetative cover and lower at shallower sites with finer or embedded substrates • Species richness declined with increasing turbidity and water temperature
Number of Great River species (fishes typical of large floodplain rivers)	Represents fish species expected to predominate in Great Rivers and expected to decline with loss of associated floodplain habitat	# of Great River species was not strongly correlated with any abiotic factors, but this metric was retained because it expresses historical conditions in the Ohio River
Number of intolerant species	Reflected the highest levels of biotic integrity	• # of intolerant species decreased from upstream to downstream • They also decreased significantly with degraded water quality and at sites with increased sand, fines, and highly embedded substrates
% Tolerant individuals	Represent the worst conditions in the Ohio River prior to implementation of the CWA in 1972	• Tolerant species are becoming increasingly scarce as impacts of degradation are becoming more localized

ORFIn Metric	Rationale for Metric Selection	Observations to Date*
		• % of tolerant species increased with higher turbidity and lower dissolved oxygen levels
% Simple lithophils (fish species that scatter eggs among gravel substrates without parental care)	Represents reproductive guilds that are most sensitive to substrate disturbance and degradation	• Simple lithophils decreased from upstream to downstream, presumably as coarse substrates became increasingly less common • They also declined with increased temperatures
% Nonnative individuals	Measures the degree to which nonindigenous species and hybrids have reduced biotic integrity in the Ohio River	% nonindigenous species was significantly correlated with increased turbidity
% Detritivores	Represents fishes that feed on dead plants or animals or their wastes	% detritivores increased with increasing proportions of sand and fine substrates and higher water temperatures
% Invertivores	Measures the proportion of specialized sight feeders that feed on insect and other small invertebrates	• % invertivores decreased from upstream to downstream • % was higher at deeper sites with coarse substrates and lower at sites with finer substrates and higher temperatures
% Piscivores	Represent fishes at the top of the aquatic food web	• % top piscivores increased slightly from upstream to downstream • They also increased with increased depth and woody cover, but declined with increased water temperature
Relative number of DELT abnormalities (deformities, ecoparasites, lesions or tumors)	Measures the effects of contaminants, diet, and overcrowding	# of DELT abnormalities increased with increased turbidity and at sites with low dissolved oxygen
Catch per unit effort (CPUE)	Measures community productivity	Greater productivity is expected to reflect greater biotic integrity
* Based on data collected from by nighttime electrofishing from 709 Ohio River reaches from 1991-2001		
Source: Emery *et al.*, 2003		

The potential range of ORFIn scores is 1 - 65. ORFIn is sensitive to a wide range of habitat and water quality conditions and is being used to develop numeric biological criteria for the Ohio River for eventual incorporation into ORSANCO's Pollution Control Standards (Emery and Vicory 1998). The application of ORFIn to 2000-2001 fish population data indicated that only 7 miles of the Ohio River in the Meldahl Pool (RM 354-361) are impaired for aquatic life (ORSANCO 2002), thus indicating an overall improvement in conditions

compared to the earlier MIwb. ORFIn scores from non-outfall sites were significantly higher than those from sites within the first 500 meters downstream from point sources of chemical, thermal, and wastewater effluents. ORFIn scores were lowest at shallow sites with sand and fine substrates and higher at deeper sites with coarse substrates, clear water, and cooler temperatures (Emery *et al.* 2003), conditions favorable to simple lithophilic fish species typical of the pre-impoundment Ohio River.

Evaluation and refinement of ORFIn as a sustainability assessment tool will continue over the next several years.

4.5.8 Specific Concerns

Although the second half of the 20th century marked dramatic improvements to the three rivers surrounding Pittsburgh, there are still several issues threatening the sustainability of fish in these rivers. As has been the case throughout the history of these rivers, the biggest threat to fish is the degradation of water quality. Current factors and actions that could adversely affect water quality include: acid mine drainage; oil and gas exploration and production; industrial waste or spills; sedimentation and contamination caused by urban runoff; and thermal pollution from cooling water discharges. Other threats include the obstruction of fish migration by navigation dams and introduced and invasive fish species (USACE 2002).

Because of their conspicuousness, as well as their ecological, economic, and recreational importance, many studies have been conducted to determine the effects of various human actions on fishes of the Ohio, Allegheny, and Monongahela rivers. Several studies have considered the specific concerns mentioned. Some studies discussed in the following sections were specifically designed and conducted to address data gaps identified in the ORMSS scoping process. Since the Upper Ohio River Study EIS is tiering off the ORMSS EIS, specific concerns that were well thought out during the ORMSS study have been listed below. Information from the Lower Mon CEA and SGEIS is also utilized in the following sections.

4.5.8.1 Acid Mine Drainage

The most prevalent threat to the fish species within the Upper Ohio River system is acid mine drainage from abandoned mines. This especially holds true for the Monongahela River. Over 1,000 mines were once active within the area known as the Pittsburgh Coal Basin. Only 11 are currently active. The closed mines are known as orphan mines. Orphan mines that are located below surface drainage level are actively being flooded and have created an immense aquifer of mine water. This flooding has also resulted in new acid mine drainage discharges throughout the Pittsburgh Coal Basin. It is projected that in 2015 all orphan mines located below the surface drainage level will have reached their maximum capacity to hold water. Therefore, at this time, the maximum number of acid mine discharges from orphan mines should also be reached. It is estimated that 53,000 gallons per minute (gpm) of treated and untreated mine discharge will flow into the Monongahela River. Additionally, an estimated 8,000 gpm of mine water will discharge from above-drainage,

free-draining mines. The aquifer created by the flooding of orphan mines in the Pittsburgh Coal Basin will create the second largest spatially-continuous, high-yield aquifer in the Northern Appalachian Region (Donovan and Leavitt 2004). Known as the Monongahela River Mine Pool, it has been described as having a giant football shape, stretching from Fairmont, WV to Pittsburgh, PA and from Wheeling, WV to Uniontown, PA.

The West Virginia University Center for Coal Mining Research conducted an extensive study to map the underground mining and water quality of this mine pool (Ziemkiewicz and Vandivort 2004, as cited in Lorson and Smith 2004). They have documented extremely acidic water with gross heavy metal loads within the mine pool. The mine pool has several points where acid loads may be discharged to the Monongahela River, including Dunkard Creek (Mon RM 87.2), a tributary of the Monongahela where all aquatic life was killed in September 2009. Several resource agencies are involved in the development of long-term solutions to mine pool flooding.

The comprehensive mine pool studies of the Monongahela discussed in Section 4.5.4.4 provide a picture of a healthy fish population, characterized by 75 species, including several big river species, sport fish, forage fish, and Pennsylvania species of special concern. The improving water quality of the Monongahela River is substantiated by the increasing number of intolerant species collected throughout the river. Although environmental conditions will continue to influence fish populations for years to come, fishing the Monongahela River is continuing to increase in popularity. This well documented return of diverse fish communities continues to provide an incentive for protecting its aquatic resources from the potentially devastating impacts of acid mine drainage discharges from orphan mines (USACE 2001). Nonetheless, there is some uncertainty about whether any discharges from the Monongahela Mine Pool could affect the upper Ohio. Discharges could be of a limited magnitude, and, consequently, be confined to the Monongahela River if they happen. Or, if they do reach the Ohio River, flows from the Allegheny River would likely neutralize the effects to some degree.

4.5.8.2 Impacts of Dams on Upstream and Downstream Fish Migration

The ORMSS study evaluated the degree to which Ohio River navigation dams are an impediment to upstream fish movements. Opportunities for fish movement in an upstream direction are greatest under open river conditions, which occur seasonally under high flow (e.g., flood) conditions. Open river conditions occur infrequently at the dams on the upper river. As a result, a panel of aquatic experts convened under the ORMSS to discuss aquatic sustainability needs identified fish passage at navigation dams as an important systemic need for the river.

It has been observed that both upstream and downstream movements of some fishes occur through the navigation locks during normal locking procedures. At low use navigation facilities, such as those on the upper Allegheny River, special seasonal lock operations to facilitate upstream fish movement have proven to be successful. These movements, however, are more restricted than would occur under unimpounded conditions.

4.5.8.3 Navigation Impacts

Since the 1980s, the USACE and interested resource agencies have conducted substantial research on the effects of commercial navigation on habitats in large river systems such as the Mississippi, Ohio, and Illinois. The potential for tows to disturb bottom substrates and interfere with fish feeding and reproduction are of particular concern. About 20 years ago, the Louisville District initiated development of the Navigation Predictive Analysis Technique model to assess potential incremental biological effects of various navigation planning scenarios. Since then, the model has been used a number of times by the USACE on various studies. The goal of NAVPAT is to provide quantitative results, which can assess positive or negative changes in available fish habitat for a specific area of a river cross-section (called a "cell") or for an entire reach of river. In general, NAVPAT links tow movements to possible biological effects. The NAVPAT model consists of four primary input components:

- River reach characteristics – including information describing multiple reaches of a river which share basic aquatic habitat conditions (i.e., reaches with similar bathymetry, substrate, depth, and velocity profiles);

- Economic scenarios – including data on various navigation forecasts, as well as data simulating various tows by length, width, speed, travel direction, horsepower, propeller dimensions, and other measurable characteristics;

- Physical forces – including information about several types of hydraulic forces generated by tows moving through a waterway; and

- Biological species life-stage models – including fish life stages selected to represent guilds of all major habitats and life stages in a river system.

Table 4-9 shows the life stages of fishes in NAVPAT.

TABLE 4-9
Fish Life Stages Selected for Ohio River NAVPAT Model

Fish Species	Life Stages/ Functions of Concern	Rationale for Species Selection	Potential Impacts of Concern
Emerald shiner	Spawning, fry	Represents open water spawners in areas of lower ambient current velocity and fry with very limited mobility to avoid tow traffic	• Dislodgment from bottom substrates of nonadhesive eggs as water velocity increases with tow passage • Destruction of fry caused by entrainment through propellers or associated pressure and turbulence

Fish Species	Life Stages/ Functions of Concern	Rationale for Species Selection	Potential Impacts of Concern
Paddlefish	Spawning, larval stages	Represents open water spawners in areas of moderate ambient current velocity and fry with very limited mobility to avoid tow traffic	• Dislodgment from bottom substrates of adhesive eggs as water velocity increases with tow passage • Destruction of fry caused by entrainment through propellers or associated pressure and turbulence
Freshwater drum	Adult food, egg/larval stages	Represents open water spawners in almost any portion of a river and adults that feed on organisms found in bottom sediments	• Destruction of egg/larval stages caused by entrainment through propellers or associated pressure and turbulence • Dislodgment of substrates caused by water velocity from tow passage
Sauger	Spawning, larval stages	Represent spawners in relatively high ambient current in areas with coarse substrate and larvae that move to areas of lower ambient current velocity with very limited mobility to avoid tow traffic	• Dislodgment from bottom substrates of adhesive eggs as water velocity increases with tow passage and/or abrasion of eggs due to substrate scouring • Destruction of larvae caused by entrainment through propellers or associated pressure and turbulence
Channel catfish	Young-of-year	Represents species whose young feed primarily on aquatic insects in shallow water with low ambient current velocity	Dislodgment of substrate caused by water velocity from tow passage which could reduce the availability of aquatic insects on which these fish feed
Black crappie	Spawning, fry food, juvenile food, and adult food	Represents nest spawners in shallow water and fry, juveniles, and adult that feed significantly on benthic aquatic insects in predominantly different portions of a river channel throughout their lives	• Dislodgment of eggs from nests because of water velocity increases with tow passage and vulnerability of eggs to predation • Disturbance of substrate that could deposit on eggs and smother them • Disturbance of substrate that could reduce the availability of aquatic insects on which these fish feed
Spotted bass	Spawning, juvenile food	Represents nest spawners in moderate depth water with coarse substrates and	• Dislodgment of eggs from nests because of water velocity increases with tow passage and vulnerability of eggs to predation

Fish Species	Life Stages/ Functions of Concern	Rationale for Species Selection	Potential Impacts of Concern
		juveniles that feed significantly on small benthic invertebrates	• Disturbance of substrate that could reduce the availability of aquatic insects on which these fish feed
Source: U.S. Army Corps of Engineers, 1991			

Although refinements to NAVPAT continue, the model can be used to evaluate environmental effects on a given life stage for a given traffic scenario. The model has been applied to studies near Olmstead Locks and Dam, McAlpine Locks and Dam, Winfield Locks and Dam, Greenup Locks and Dam, and J. T. Myers Locks and Dam as well as to the entire mainstem as part of ORMSS. Life history, river stage, discharge, and water temperature data are sufficiently available to apply NAVPAT to the time period when a particular species' life stage may be vulnerable. The developers of NAVPAT emphasize, however, that while it is a useful tool for evaluating traffic-induced impacts, NAVPAT should not be extrapolated to other human activities on or in the river. It remains unclear whether verification of NAVPAT results could be made by long-term monitoring, primarily because of the potential cumulative impacts of other human activities that could be difficult to distinguish from impacts of commercial navigation traffic (USACE 2006a).

The original version of NAVPAT developed by the Louisville District assessed seven different species, including emerald shiner, paddle fish, Freshwater drum, sauger, channel catfish, black crappie and spotted bass, at various life stages (spawning, fry, larval, adult, etc.). In 2005, two significant changes were made to the biological models within NAVPAT. The model was altered so that guilds of fish were assessed instead of single species. In addition, the model was focused to evaluate specific life stages which were most susceptible to navigation traffic effects.

Dr. Jack Kilgore of ERDC, with input from an independent technical review committee, evaluated the results produced from past applications of the NAVPAT model. The model consistently predicted no impacts to adults and older juveniles due to commercial traffic. It was reasoned that tow traffic might temporarily disrupt behaviors during these life stages, however these animals have a higher tolerance to habitat changes and the ability to avoid navigational traffic. Conversely, harmful impacts were often calculated by the model for fish during early life stages. Younger animals are more susceptible to environmental disturbances. In addition, spawning and parenting behaviors occur during finite periods during the year. Sustained environmental disturbances could disrupt these behaviors to a point where reproductive efforts would be completely abandon for the year. Adult and older juvenile models were removed from NAVPAT, so the current version evaluates only impacts to early life history stages, from spawning through the larval stage.

The second alteration to NAVPAT consisted of the adoption of a guild system. The original system of individual species/life stages was replaced because large portions of the fish community were not considered in the analysis of impact. In the most recent iteration, 129 fish species which occur within the Ohio/Mississippi river drainage are divided into nine guilds by habitat preference and reproductive strategy. The original version of NAVPAT

omitted four complete guilds of fish, consisting of 76 species. Most of these fish occupy mid-channel and littoral zones of the river. (Janet Cote, pers. com.)

4.5.8.4 Cooling Water Intake Structures

Large volumes of cooling water are withdrawn from the Ohio River to cool various industrial facilities, including stream electric power plants, pulp and paper makers, chemical manufacturers, petroleum refiners, and manufacturers of primary metals such as iron, steel, and aluminum. Cooling water intake structures cause damage to fish and other aquatic organisms that are pulled (entrained) into industrial cooling systems. Once entrained, organisms may be killed or injured by heat, physical stress, or chemicals. Larger organisms, including fish, may be killed or injured when they are trapped against screens (impinged) at the front of an intake structure.

Section 316(b) of the Clean Water Act requires that the location, design, construction and capacity of cooling water intake structures reflect the best technology available for minimizing adverse environmental impacts. In accordance with regulations related to §316(b), USEPA evaluated entrainment and impingement rates at nine power plants on the Ohio mainstem between RM 53.9 and 560 (USEPA 2002). The main fish species the study found to be at risk were emerald shiner, freshwater drum, gizzard shad, sauger, white bass, white crappie, and white sucker (USEPA 2002). Several of these species have floating (pelagic) eggs or larvae that make them more vulnerable to intake damage.

When extrapolated to all cooling water intakes on the Ohio River, the results of the study indicated that impingement at all power facilities along the Ohio River causes the mortality of approximately 11.6 million age 1 equivalent fish per year, or 15,500 pounds of lost fishery annually. The entrainment results indicated that all facilities combined cause the mortality of approximately 24.5 million age 1 equivalent fish per year, representing nearly 40,000 pounds of lost fishery yield annually. However, because the study used limited 1977 data from a period when water quality in the river was worse and fish biomass was probably lower than it is presently, USEPA suggests that the results probably underestimate current entrainment and impingement losses.

Lohner *et al.* (2000) and Perry *et al.* (2002) report on modeling exercises to assess 316(b) impacts on Ohio River fish populations using more recent data from the long-term Ohio River Ecological Research Program and ORSANCO electrofishing. In six of 22 scenarios of fish species and river pool, the projected fish population changes due to impingement and entrainment were greater than the expected natural variability of existing populations, consequently indicating possible adverse environmental impacts (Perry *et al. 2002*). The significance of these findings is obscured by the combination of other abiotic (e.g., river flow, water quality, habitat quality) and biotic factors (e.g., predation, exotic species, competition) to which fish populations respond. Further §316(b) studies at several power plants along the Ohio River are anticipated as additional phases of the 316(b) program are implemented by USEPA in the coming years (USEPA 2006).

4.5.8.5 Introduced Species

Of the 10 fish species that were introduced into the upper Ohio River by 1992, the common carp, goldfish, white catfish, and banded killifish have established reproducing populations (Pearson 1992). In addition, there is evidence that striped bass have established a reproducing population (Simon 1986). There is also the potential that the northern pike has established a reproducing population (Pearson and Pearson 1989). Krumholz (1981) described the carp introduction in the late 1800s as the "earliest and most noticeable introduction to date." A native of Asia, the common carp continues to be a substantial component of the Ohio River fish community in both biomass and numbers. Several more Asian carp species, however, are now causing serious concern among fisheries biologists and recreational users in the lower mainstem.

Four additional species of Asian carp have been imported to the United States over a period of years – the grass, silver, bighead, and black carp. None of these carp have been documented within the geographic scope of this study. Although these species have not been reported within the upper Ohio River, these species are of increasing concern for several reasons:

- All except black carp now have reproducing populations in the Ohio River, but are of little value to sport fishermen.

- Grass carp feed aggressively on aquatic vegetation, compete with native fishes for food and space and destroy fish and waterfowl habitat by eliminating vegetation (Pflieger 1975). Unlike grass carp, common carp uproot vegetation as part of their feeding behavior.

- Silver and bighead carp are effective planktivores. Native larval fish also feed on plankton and may compete with bighead and silver carps for food resources if plankton becomes limiting. Plankton is not limited at this time, although proper species and sizes may not be sufficiently available when needed by larvae of native fishes. Some dietary overlap may also exist with native planktivores such as gizzard shad, paddlefish, and bigmouth buffalo. Larval fish must compete with these filter-feeding carp, while they risk being eaten themselves.

- Studies of the population dynamics of these species are complicated by the tendency of bighead and silver carp to startle easily and launch themselves out of the water, potentially seriously injuring recreational boaters (Perea and Gittinger 2002).

- A triploid (sterile) black carp has been documented at Horseshoe Lake in southwestern Illinois near the confluence of the Ohio and Mississippi rivers (Caswell 2004 personal communication). Black carp are molluscivorous with the potential to seriously impact already precarious populations of native mussels and snails if they enter the Ohio River ecosystem. Further, at all life stages black carp will compete for food with native fish species. Animals of riparian zones,

including turtles, waterfowl, raccoons, and muskrats, also are likely to be affected through competition for food. Under the authority of the Lacey Act Amendments of 1981, the USFWS is in the process of listing the black carp as an injurious wildlife species (USFWS 2009a). Such a listing would prohibit the importation and interstate transport of black carp. According to a comment received from the USGS, black carp do not compete for food with native fishes at all life stages. They will compete for food with native molluscivores if food resources are limited. Animals of riparian zones are only likely to be affected if they are dependent upon molluscan resources and these resources are limited in availability.

The 2005 publication (Nico *et al.*) will help develop a mitigation strategy for the Ohio River mainstem and tributaries. The USFWS developed a National Asian Carps Management and Control Plan. The plan seeks to integrate prevention and control activities to limit the further distribution and negative impacts of these four nuisance species. The potential impacts of Asian carps on the Ohio River native fish communities may prove a serious challenge to fish community sustainability. Because relatively little is known about the Asian carp's preferred habitats, prospects for long-term reproductive success, and best sampling methods, they also present challenges in adaptive management (USACE 2006a).

In addition to the introduced carp species, another species of concern is the white perch. Only nine individuals were collected during the Emsworth, Montgomery, and New Cumberland fish surveys conducted by ORSANCO (2007). However, the white perch is a prolific spawning species and therefore has the potential to establish a sizeable population in a short period of time (PFBC 2009b). White perch also have adverse effects on other fish species through direct competition for food and the predation of eggs (Harris 2006). White perch are known to consume the eggs of white bass (Schaeffer and Margraf 1987), alewife (Danchy *et al.* 1991), freshwater drum, and walleye (Roseman *et al.* 1996). Future monitoring will be necessary to determine if the white perch population is increasing within the Ohio River and if it is threatening native species.

4.5.8.6 Species of Special Concern

In 1987, Johnson reported that 18 percent (28 species) of Ohio River fish species are considered rare enough to be protected by law in one or more states bordering the Ohio River. An additional 13 percent (21 species) are of special concern in one or more states. Five species have been identified as species of special concern (SSC) under the federal Endangered Species Act: the paddlefish, blue sucker, crystal darter, Eastern sand darter, and longhead darter. Among the reasons for SSC designation are the species: 1) has a significant vulnerability to habitat modification or human exploitation which may result in its becoming a threatened species in the foreseeable future if effective management is not initiated, 2) may already meet certain criteria for designation as a threatened species but conclusive data are lacking, 3) has not significantly recovered from past depletion, or 4) may occupy such an essential ecological niche that its further decline would adversely affect other species to a significant degree (Florida Fish and Wildlife Conservation Commission [FFWC] 2004).

An ESA section 7 consultation for on-going operation and maintenance of the entire Ohio River navigation system is underway. Through the section 7 process, the USFWS worked with the USACE to: 1) provide information about listed, proposed, and candidate species and critical habitat in the Ohio River mainstem and navigable tributaries, 2) proactively emphasize the identification and informal resolution of potential species conflicts, and 3) advise the USACE on how to avoid adversely impacting listed species and their habitats (USFWS and National Marine Fisheries Service 1998).

During the recent fish surveys conducted within the Emsworth, Dashields, Montgomery, and New Cumberland pools, several Pennsylvania Threatened and Endangered Species and Candidate Species were collected in the four pools. These species were the mooneye, silver chub, spotted sucker, longear sunfish, warmouth, river shiner, and skipjack herring. The longnose gar, smallmouth buffalo, river redhorse, and channel darter where also collected during these surveys. However, as of March 7, 2009, these species were delisted from the existing threatened or candidate species lists (The Pennsylvania Bulletin 2009).

Pearson and Pearson (1989) noted that 19 native species had not been reported from the Ohio River since 1970. Most significant were three large river species: the lake sturgeon, Alabama shad, and crystal darter. Pearson and Pearson suggested that navigation dams, including those located on tributaries, may interfere with migratory species such as paddlefish, sturgeons (shovelnose and lake), and shad, while inundation of riffles and siltation probably reduced the crystal darter. Recently lake sturgeons have been recorded in the Ohio River in Lewis, Union, Livingston, and Ballard counties, Kentucky, although the species continues to be rare (Compton *et al.* 2004). Compton *et al.* suggest possible origins of recent specimens include a remnant Ohio River population and migrations from the Missouri (where they have been stocked) or the Wabash rivers in Indiana.

4.5.8.7 Fish Consumption Advisories

Federal and state agencies currently publish fish consumption advisories. All three of the states included in this study have consumption advisories in place for certain species of fish from the Ohio River, including its upper reaches. Possible ill effects of consuming locally caught fish continue to be a concern to many people. As evidence of this concern, it is noted that between 1993 and 2000, the number of fish advisories issued in the U.S. increased by almost 150 percent.

Almost 79 percent of all advisories issued in the U.S. are at least partly due to mercury contamination in fish and shellfish. As of December 2000, 41 states issued 2,242 fish advisories for mercury. Advisories other than mercury that exist in the study area are for polychlorinated biphenyls (PCBs) and dioxins (USEPA 2009). The United States Environmental Protection Agency (USEPA) issued a national mercury-based advisory in 2001 that states: "If you are pregnant or could become pregnant, are nursing a baby, or if you are feeding a young child, limit consumption of freshwater fish caught by family and friends to one meal a week. For adults, one meal is six ounces of cooked fish or eight ounces of uncooked fish; for a young child, one meal is two ounces of cooked fish or three ounces of uncooked fish." In 2004, the USEPA and the Federal Drug Administration (FDA) jointly

issued a national mercury-related advisory for store-bought fish and fish served in restaurants. Amendments to the 2001 advisory included a statement emphasizing the positive benefits of eating fish and recommend not eating any other fish in the same week as locally caught fish are consumed. The advice on the amount of locally caught fish to eat remained the same as the 2001 advisory.

State advisories related to the fish of the Ohio focus on the potential presence of certain contaminants and are derived from fish tissue sampling conducted by ORSANCO. This sampling program, initiated in 1976 and modified in 1987, allows appropriate state agencies to use data from the program as the basis for issuing fish consumption advisories. An advisory committee comprised of state health and environmental quality personnel is convened to discuss the data and the need for and basis of fish advisories. Fish advisories are issued, removed, or modified by state agency personnel. ORSANCO also facilitates communication among the states to minimize differences in advisories issued for Allegheny, Monongahela, and Ohio River fish.

4.6 INTERACTIONS WITH OTHER VALUED ENVIRONMENTAL COMPONENTS (VECS)

Because of their diverse ecological niches and their importance in river recreation and its related economy, fish are an important resource. Fish are highly mobile and widely distributed throughout the upper Ohio River. One of the strongest links occurs between fish and water and sediment quality. Fish species composition, abundance, and condition are all excellent indicators of water and sediment quality.

Many fish species that took refuge in the lower Ohio River during the worst decades of pollution have recovered. Consequently, densities, biomass, and fish community diversity have increased measurably as water quality has improved. Despite ongoing improvement in water quality, however, fish consumption advisories remain in effect for a number of upper Ohio River fish species. Sport fishing also has improved and increased in popularity as fish populations have increased. Increased sport fishing has enhanced the perception of the river's recreational value and, in turn, has benefited local economies.

Fish and mussels are very closely linked aquatic groups with generally mutually beneficial interactions. Mussels are an important food resource for certain bottom-dwelling fishes, including suckers and catfishes. Conversely, fish are critical to mussel distribution because they serve as hosts for the immobile glochidial (larval) stage of mussels. The black carp may be an exception to the beneficial interaction between fish and mussels as it has the potential to feed on already vulnerable native mussels.

Fish also are conspicuous components of riparian ecosystems. Wetlands and embayments along the upper Ohio River system provide vital spawning and nursery areas for many fish species. During winter, lower current velocities and warmer temperatures in these habitats offer refuges to fishes of all age groups. Waterfowl, including migratory species, rely on fish in riparian areas as an important food source. Islands, another riparian habitat

beneficial to fish, add to habitat diversity within the mainstem, while island back channels offer fish quieter refuges from the currents and traffic of the open channel.

A broad spectrum of human activities affects fish. Direct impacts include obstruction of fish movement, movements of commercial and recreational vessels, damage to fish habitats through removal or sedimentation of bottom substrates, and impingement or entrainment in cooling water intake structures.

4.7 INDICATORS OF ENVIRONMENTAL SUSTAINABILITY FOR FISH

Indicators of environmental sustainability provide benchmarks for measuring the strength of a given resource. Indicators characterize the current status of a resource and may predict changes to that resource. It is desirable to select indicators that can be supported by data that are measurable and relatively straightforward to collect. Further, if an indicator is to be accepted and used to guide policy, the data upon which indicators are based must be available to a wide range of interested parties (National Research Council [NRC] 2000).

Indicators selected for fish encompass the basic essentials for diverse communities of fish to thrive and reproduce in the upper Ohio River and include:

- Composition of fish communities, including numbers of intolerant and non-native species, abundance, and diversity;
- Amount of habitat with stable substrates, adequate depths, suitable currents, and sufficient food supplies;
- Reproductive viability as measured by amount of spawning habitat, genetic connectivity, and numbers of gravid females and larval individuals;
- Percent of population with abnormalities such as parasites, tumors, ulcers, and fin erosion;
- Water quality measurements such as levels of dissolved oxygen (DO), and pH; and
- Level of disturbance from biotic stressors, such as invasive species, and from abiotic stressors, such as river traffic.

4.8 RELEVANT FUTURE ACTIONS AFFECTING FISH

The Reasonably Foreseeable Future Actions (RFFAs) for fish were evaluated utilizing a matrix prepared during the scoping process. The matrix was an outgrowth of a similar matrix developed during the preparation of ORMSS. Results of the RFFA evaluation are summarized in Table 4-10.

TABLE 4-10
RFFA Cumulative Effects Matrix for Fish

RFFA[1]	Time Period[2]	Occurrence Probability[3]	Location on River[4]	Importance[5]	Effects[6]
USACE Actions					
Navigation Investments					
Replacement locks at Emsworth, Dashields, and Montgomery Dams (EDM)	A	H	S	H	+/-
Rehabilitation of EDM dams	1	H	S	H	-
Navigation aids - lock & dam signage	A	H	S	M	+
Non-structural navigation improvements	A	H	S	L	+
L&D operation and maintenance	A	H	S	H	-
Approach & channel dredging/disposal	A	H	E	M	-
Environmental design					
environmental sustainability operation actions	A	H	S	H	+
Pool maintenance	A	H	E	H	-
Sec 107 port development and maintenance dredging	2	L	S	L	+/-
Ecosystem Restoration					
Fish passage at EDM	1	H	S	H	+
Actions by Others					
Navigation System Dependent - "But For"					
Commercial navigation					
barge queuing	1	M	E	H	-
fleeting areas/barge storage	1	M	E	H	-
terminals & multi-modal sites	2	L	S	H	-
barge/tow tech/"green" design	A	M	E	M	+
accidents/spills	A	M	E	H	-
Coast Guard navigation aids - const., O&M	A	H	E	M	+
Energy					
hydropower on dams	2	M	S	M	-
continued operation of coal-fired power plants	A	M	S	M	-
Water-based recreation					
marina development & operation	A	M	S	M	-
commercial boating	A	H	E	H	-
personal boating	A	H	E	L	-

RFFA[1]	Time Period[2]	Occurrence Probability[3]	Location on River[4]	Importance[5]	Effects[6]
River Dependent					
Water supply/discharge					
municipal	A	M	S	H	-
industrial	A	M	S	H	-
Waste water treatment discharges (WWTP)					
onsite systems	A	H	E	H	-
stormwater discharges; CSOs; SSOs	A	H	S	H	-
Marcellus shale gas extraction (water impacts)	A	H	E	H	-
Resource extraction					
instream sand and gravel mining	A	H	E	M	-
Acid mine discharge (AMD)	A	M	E	M	-
Riverfront/Flood Plain Development					
Downtown Pittsburgh					
Ongoing Point State Park improvements	1	H	S	L	+
Convention Center riverfront park	1	H	S	L	+
residential development/conversions	A	H	S	L	+
North Shore development	1	H	S	L	+
Pittsburgh South Side					
continued riverfront development	A	H	S	L	+
continued South Side Works development	1	H	S	L	+
Riverfront trails					
Pittsburgh riverfront trail system	A	H	E	L	+
Beaver County trail system	A	M	E	L	+
Brownfields redevelopment					
Neville Island	1	H	S	M	+
PL&E, McKees Rocks	2	M	S	M	+
M&B Development	2	M	S	M	+
Fab Tech & Buckeye Pipeline	1	M	S	M	+
J&L site in Aliquippa	1	M	S	M	+
Leetsdale Industrial Park	1	H	S	M	+
Resource Protection/Restoration					
Ohio River Islands Wildlife Refuge System	A	H	S	H	+
Nationwide Rivers Inventory	A	M	S	H	+
Ecosystem restoration	A	M	E	H	+
Cultural resources	A	M	E	L	+

RFFA[1]	Time Period[2]	Occurrence Probability[3]	Location on River[4]	Importance[5]	Effects[6]
Bridges and Roadways					
Bridge renovations					
Ambridge/Aliquippa Bridge	1	H	S	L	+/-
Shippingport Bridge	1	H	S	L	+/-
Rochester Bridge	1	H	S	L	+/-
McKees Rocks Bridge	1	H	S	L	+/-
Birmingham Bridge	1	H	S	L	+/-
Rankin Bridge	1	H	S	L	+/-
New crossings					
Maglev	2	L	S	L	-
Roadways					
SR 28 widening/railroad relocation	1	H	S	L	-
CSX double stack upgrades (National Gateway)	1	M	S	L	-
Natural Events					
floods	A	M	E	L	+/-
droughts	A	L	E	M	-
invasive species	A	H	E	H	-
Regulatory Environment					
Phase I & 2 NPDES program	A	H	E	H	+
TMDLs	A	H	E	H	+
ALCOSAN & other consent decrees	A	H	E	H	+
Adaptive management in Sand & Gravel EIS	A	H	E	H	+
Pollution prevention	A	H	E	H	+
USACE permitting programs	A	H	E	H	+
Boating safety regulations	A	H	E	L	+
Monitoring programs - PA/ORSANCO	A	H	E	H	+
Environmental awareness education	A	H	E	H	+
Clean Water Act standards	A	H	E	H	+
Regulatory Environment					
Endangered Species Act (ESA)	A	H	E	H	+
Environmental sustainability practices	A	H	E	H	+

[1] Reasonably Foreseeable Future Actions

[2] Time period in which the RFFA may occur: A = all periods; 1 = within 10 years; 2 = in 10 - 25 years; 3 = in 25 - 60 years

RFFA[1]	Time Period[2]	Occurrence Probability[3]	Location on River[4]	Importance[5]	Effects[6]
[3] Occurrence probability or likelihood RFFA will happen: H = high; M = medium; L = low					
[4] Location or setting on river where RFFA is expected to occur: E = along entire length of river; S = specific location					
[5] Importance or impact of action on the VEC: H = high; M = medium; L = low					
[6] Effects of action on the VEC: + = positive effect; - = negative effect; +/- =mixed effects					

Impacts from the RFFAs can be complex and occur in many ways. While impacts result from an action, those impacts are not always apparent from a straightforward analysis of cause and effect. Often, similar actions do not affect resources in the same manner. As a means of further explaining potential impacts to fish, five vectors have been identified. The vectors have a specific relationship with one another and may influence the scope and magnitude of future impacts. Some actions will intercept with more than one vector. The five vectors are related to habitat changes, changes in disturbance regimes, changes in hydrologic patterns, effects on ecological services, and changes related to populations.

Actions that contribute to habitat changes physically alter aquatic habitats by damaging or removing substrates where fish live, feed, and reproduce. They may also limit prey visibility or blanket habit with sediment. They imperil habitat integrity, induce pattern changes, alter connectivity, and disrupt structural complexity. RFFAs that fall into this vector and the other four vectors are noted in Table 4-11.

Actions that contribute to changes in disturbance regimes primarily alter the conditions to which fish, related animal and plant species, and ecosystems have adapted to over a long period of time. RFFAs that fall into this vector are also noted in Table 4-11.

Actions that contribute to changes in hydrologic patterns alter the water connections that influence biodiversity and ecological integrity. They are closely linked to changes in disturbance regimes and changes to habitats. RFFAs that fall into this vector are also noted in Table 4-11.

Actions that have effects on ecological functions include nutrient cycling and purification services that break down toxins and transform soils and sediments. Nutrient cycling is the process whereby nitrogen, phosphorous, and carbon move through an ecosystem. Purification services are the subsequent result of effective nutrient cycling. RFFAs that fall into this vector are also noted in Table 4-11.

Actions that are related to populations include population dynamics and genetic diversity. These actions can inhibit or prevent normal reproduction. They can also isolate

fish communities from one another. Negative impacts in this vector can cause loss of species, populations, or genetic diversity, but positive impacts will strengthen existing populations and maintain the evolutionary potential of fish to adapt to future stresses. RFFAs that fall into this vector are also noted in Table 4-11.

TABLE 4-11
RFFAs and Fish Impact Vectors

RFFA	Actions that Contribute to Habitat Changes	Actions that Contribute to Changes in Disturbance Regimes	Actions that Contribute to Changes in Hydrologic Patterns	Actions that Have Effects on Ecological Services	Actions that are Related to Changes in Populations
USACE Actions					
Replacement locks at EDM	X	X	X		X
Rehabilitation of EDM Dams	X	X	X		X
Navigation aids – lock & dam signage	X				
L&D operation & maintenance	X	X		X	X
Approach & channel dredging/disposal	X	X	X	X	X
Environmental sustainability operation actions	X	X		X	X
Pool maintenance	X	X	X		
Fish passage at EDM	X				X
Barge queuing	X				X
Fleeting area/barge storage	X				X
Terminals & multi-modal sites	X	X	X		X
Barge/tow tech/green design				X	
Accidents/spills	X	X		X	X
Coast Guard navigation aids – construction, O&M	X				
Hydropower on dams	X		X		X
Operation of coal-fired plants			X		X
Marina development & operation	X	X	X		X
Commercial boating	X				X
Municipal water supply/discharge	X				X
Industrial water supply/discharge	X				X
WWTP - onsite systems	X				X
WWTP – stormwater	X				X

RFFA	Actions that Contribute to Habitat Changes	Actions that Contribute to Changes in Disturbance Regimes	Actions that Contribute to Changes in Hydrologic Patterns	Actions that Have Effects on Ecological Services	Actions that are Related to Changes in Populations
discharges, CSOs, SSOs					
Marcellus shale gas extraction	X			X	X
Instream sand and gravel dredging/mining	X			X	X
Acid mine discharge	X			X	X
Brownfields redevelopment	X	X	X	X	X
Ohio River Islands Wildlife Refuge System	X			X	X
Natural events	X	X		X	X
Nationwide Rivers Inventory	X			X	X
Ecosystem restoration	X	X		X	X
Regulatory Environment	X	X	X	X	X

Discussions of the potential permanent and temporary impacts of RFFAs with high and medium importance are presented in the remainder of this section. The discussions are organized around USACE actions and actions by others.

4.8.1 USACE Actions

4.8.1.1 Navigation Investments

Navigation investments will contribute to habitat changes, disturbance regimes, hydrologic patterns, ecological services, and fish populations. They are expected to have both positive and negative effects on the fish of the upper Ohio River.

Positive effects will occur as a result of replacing the locks and dams as well as from new navigation aids and environmental sustainability operation actions. By providing more efficient passage for boats and barges, queues will be reduced and the potential for incidents that could affect aquatic life will be minimized or, possibly, eliminated. Construction of new locks, however, will require excavation activities that could stimulate change in fish habitat and existing populations.

Navigation aids will direct barge traffic away from shallow areas that are potential spawning grounds for specific fishes. The environmental sustainability operation actions will improve the natural hydrologic regimes of the rivers, thus, creating conditions favored by river fishes.

The replacement of the Emsworth, Dashields, and Montgomery locks and dams could have temporary impacts during construction. New, reliable locks are likely to have an overall positive impact to fish because queuing, and the effect it has on fish populations, will be reduced.

The rehabilitation of EDM, approach and channel dredging/disposal, and pool maintenance could result in negative impacts on fishes of the upper Ohio River through sedimentation and cause subsequent impacts to habitat, disturbance regimes, and populations. Some substrates that provide both habitat and spawning grounds could be lost. Additionally, the operation of the locks and dams would result in continued barriers to longitudinal connectivity, which, in turn, will affect migration and genetic diversity. Maintenance on the locks and dams will continue, even with new or rehabilitated facilities, but less maintenance will be required, lessening the potential impacts from routine activities.

4.8.1.2 Ecosystem Restoration

Implementation of fish passage structures at EDM would provide a significant positive effect on fish populations and habitat by providing increased connectivity for fishes to migrate and spawn. Fish passage structures will primarily benefit those native species that will not use the lock chambers. Fish passage structures may also have a negative impact by providing opportunities for invasive species to migrate. The degree to which passage structures would increase expansion of invasive species is uncertain, as silver carp, for example, have demonstrated the ability to move through navigation locks and dams in the Mississippi and lower Ohio rivers without any passage aids.

4.8.2 Actions by Others

4.8.2.1 Navigation System Dependent – "But For"

"But for" actions which would have a positive effect on fish of the upper Ohio River include barge/tow tech/green design and the construction, operation, and maintenance of Coast Guard navigation aids. The barge/tow tech/green design action pertains to future operation and maintenance practices, new technology, and design practices focused on improving existing environmental conditions associated with commercial navigation. This would likely result in a positive impact on the fish of the river. The Coast Guard navigation aids would direct barge traffic to the navigation channel of the river, thus, minimizing the potential for accidental substrate strikes which provide habitat for certain fishes.

"But for" actions that would have a negative effect on fish populations and habitat of the upper Ohio River include: barge queuing, fleeting areas/barge storage, terminals and multi-modal sites, accidents/spills, hydropower on dams, continued operation of coal-fired power plants, marina development and operation, and commercial boating. Barge queuing, fleeting areas/barge storage, and commercial boating could have a negative impact to fish through accidental toe-ins or substrate strikes, prop wash and increased sedimentation and pollution associated with such activities. Accidents and spills would result in a negative impact through the potential introduction of a pollutant directly to the river, thus, negatively

affecting water quality and/orcausing direct mortality. Operation of coal-fired power plants could result in a negative impact on fish through wastewater thermal discharges and potential influxes of acidic waters to the river, affecting existing fish populations and their habitat. Intake structures pumping river water for cooling also contributes to direct mortality through impingement. Marina development and operation and new terminal and multi-modal sites could require dredging activities which may result in a negative impact to fish habitat. These types of facilities could also require clearing of existing vegetation, leading to the potential for siltation due to the associated earth disturbance and the loss of shoreline habitat that may indirectly support fish populations.

4.8.2.2 River Dependent

The river dependent actions described in Table 4-10 would likely result in negative effects on the fish populations and habitat of the upper Ohio River. New municipal and industrial discharges, as well as new discharges from onsite systems and stormwater systems, add an additional pressure to fish habitat and populations in the river since these are potential sources of water and sediment pollution. Acid mine discharge is an additional pollution source to the river that would apply negative pressure to fish. However, these discharges will be regulated, which will buffer some of the negative influences from these potential sources of pollution. Wastewater from Marcellus shale operations is an additional source of pollution to the river either through direct discharges or through waste water treatment plants that are not designed to adequately treat the contaminants. They could introduce new types of pollutants that could be suspended in the water or settle into the sediment. However, as noted previously, these discharges will be regulated to some degree under existing and potentially future regulations to minimize environmental impacts. Existing onsite waste water disposal systems and CSO/SSO discharges are continuing sources of pollution to the river. Consent Agreements with the USEPA to do away with these types of systems are in place which should, over time, minimize the effects of these discharges on fish. Sand and gravel mining could negatively affect fish by increasing sedimentation and eliminating specific fish habitat.

4.8.2.3 Riverfront/Floodplain Development

Brownfields redevelopment is a category of riverfront/floodplain development that would provide a positive effect on the habitat and population of fish within the river. Redevelopment of the existing brownfields along the upper Ohio River may result in the removal or isolation of potentially contaminated soils from accessing river flows. In some developments, hydrologic patterns are re-established when sites are returned to more natural soil and vegetation conditions. This in turn improves ecological services by reducing the level of unwanted nutrients that may reach the water and by purifying runoff through natural filtration systems. There are several brownfields along the upper Ohio River that may be redeveloped.

4.8.2.4 Resource Protection/Restoration

Resource protection and/or restoration provide(s) a significant positive benefit to the fish of the upper Ohio River. The purpose of the Ohio River Islands Wildlife Refuge System is "... for the development, advancement, management, conservation, and protection of fish and wildlife resources" (USFWS 2009b). The Nationwide Rivers Inventory protects portions of the upper Ohio River included within the geographic scope of this project. Ecosystem restoration projects would be beneficial for fish habitat and populations, as well as improve ecological services, as these types of projects would be focused on the improvement of existing habitats in or along the river.

4.8.2.5 Bridges and Roadways

Bridges and roadways are not expected to have a significant impact to the sustainability of fish in the upper Ohio River. This is due to either the low probability of these actions to occur or their low importance to the sustainability of fish.

4.8.2.6 Natural Events

Droughts can occur with some frequency and result in ecosystem changes, but fish populations have adapted to these changes over time. While they could cause changes in habitat, population, disturbance regimes, and ecological services, these changes are usually temporary. Also, because natural events occur with some regularity, although their intensity varies from season to season, fish have adapted over time to their occurrence.

On the other hand, invasive species have the potential to pose a major threat to fish. Invasive species destroy the habitat of native species, compete with native species for food, and consume the eggs of native fishes.

4.8.2.7 Regulatory Environment

The existing regulatory environment actions directly and indirectly provide protection for the fish of the upper Ohio River. The regulatory environment can contribute to changes across the spectrum, including habitat, populations, disturbance regimes, hydrologic patterns, and ecological services. In many respects, the regulatory environment is the strongest force affecting fish because it can address specific concerns of resource protection and put laws or funding programs into place to strengthen the resource further.

The Endangered Species Act of 1973 provides direct protection to federally listed endangered fish species. This regulation also provides protection for the habitat of listed species. USACE permitting programs provide authority to the USACE to review projects for impacts to natural resources and require measures to avoid, minimize, and mitigate for unavoidable impacts. Adaptive management in the Sand and Gravel Environmental Impacts Statement requires quarry operators to utilize the best available data and research techniques

to evaluate potential mining sites during the planning phases of a project. It also defines sensitive areas of the river that are to be avoided. Programs under the Clean Water Act, such as the National Pollution Discharge Elimination System (NPDES) and Total Maximum Daily Load (TMDL) programs, will provide for improved water quality conditions of the river through the permitting of discharges and limitations to pollutant discharges to the river. Consent decrees in place to remediate for CSO and SSO discharges should ultimately result in the elimination of such systems. Monitoring programs, such as ORSANCO's, will be continually testing the river and suggesting new regulations as land uses and industries along the river change over time. Environmental sustainability practices will improve the methods in which projects are planned and constructed. Finally, environmental awareness education will provide the opportunity to educate the public on the importance of fish populations to healthy river ecosystems.

4.9 ANALYSIS OF ENVIRONMENTAL SUSTAINABILITY

Indicators for determining the sustainability of fish measure the basic essentials of fish communities. They include composition of fish communities, amount of suitable habitat, reproductive viability, percent of population with abnormalities, water quality, and level of disturbance from biotic and abiotic stressors.

Environmental sustainability is a synergistic process whereby environmental considerations to fishes are effectively balanced through the life cycle of project planning, design, construction, operation, and maintenance to improve the quality of life for present and future generations. Accordingly, it represents a test of significance of potential cumulative effects.

4.9.1 Positive Forces Affecting Fish

The positive forces that are affecting fish of the upper Ohio River are primarily related to improving water quality, a shrinking population, and increasing public awareness of the importance of fish populations to healthy, functioning aquatic systems, and the existing regulatory environment that provides both direct and indirect protections to fish. Improving water quality is the most important positive force affecting fish. The regulatory actions requiring treatment of acid mine drainage and municipal and industrial wastes will continue to be important to maintain water quality that will provide fish with suitable habitat. The consent decrees aimed at future elimination of CSOs/SSOs will also continue to improve the water quality that is vital to fish.

As water quality has improved, so too has the composition of fish communities. Many species are returning and the diversity of fish populations is broadening. Paddlefish, mooneye, spotted gar, river carpsucker, smallmouth buffalo, and white bass have all increased, most likely as a direct response to water quality improvements in the upper Ohio River. Sport and commercially valuable fish species have exhibited a tremendous increase in diversity and abundance, even though they tend to be more intolerant of pollution than other species.

As water quality has improved, fish species have recolonized portions of the river that were once too polluted to inhabit. The first species to reappear were those that took refuge in upstream tributaries. As habitat improved within the mainstem, more fish seemed to have success. Many fish species that took refuge in the lower Ohio River during the worst decades of pollution have recovered and moved upstream. Consequently, densities, biomass, and fish community diversity have increased measurably.

Recent biological studies conducted within the New Cumberland, Montgomery, Dashields, and Emsworth pools have shown mixed, but generally favorable results in terms of habitat and reproductive viability. In the New Cumberland Pool, ORFIn scores average 9.9 points below what was expected. In the Montgomery Pool, approximately 87 percent of the sampled sites were in passing condition. In the Dashields Pool, 62 percent of the sites met their aquatic life designation. And in the Emsworth Pool, all 15 sampled sites met their aquatic life designation.

A shrinking human population surrounding the upper Ohio River will also be a positive force affecting fish albeit it minor. A smaller population leads to less domestic waste and less pressure to develop the riparian and wetland habitats that act as filters for water flowing into the river and potential habitat at specific life stages for fish.

Although public awareness for fish has historically been considerable, it continues to improve. This is accomplished through development that increases the availability and value of the river to people. It is also accomplished through programs under foundations such as the Ohio River Islands Wildlife Refuge System, Nationwide Rivers Inventory, and other similar organizations, projects, and agencies. These initiatives plus continued regulation throughout the upper Ohio River watershed are crucial to maintaining the integrity of the river.

4.9.2 Negative Forces Affecting Fish

The negative forces that are affecting fish in the upper Ohio River are related to invasive species, point discharges to the river, CSOs/SSOs, acid mine drainage discharges, dredging operations, and the development of riparian resources. The influence of wastewater discharges and dredging operations are buffered through existing regulations and potential permit conditions, but are still potential threats to the health of fish. CSOs/SSOs still affect the water quality on wet days, but plans are being created to eliminate these sources of municipal waste to the river in the future.

Although there are programs in place to remediate acid mine drainage, the Monongahela River Mine Pool is a potentially enormous problem that has not yet been adequately addressed by all entities. Of all issues facing the area that are related to the Ohio River environment, the Monongahela Mine Pool is the most uncertain, yet under certain circumstances – that is, if the pool would discharge into local water bodies, as some fear – it could end up having the greatest negative impact on the river's ecosystem. Compounding the uncertainty of the situation, however, is the possibility that discharges from the mine pool, if any, could be confined to the Monongahela River, or if they do reach the Ohio River, flows from the Allegheny River could neutralize the effects.

Abiotic stressors can also be important negative factors affecting fish if they increase in density or frequency. Although new development increases access to the upper Ohio River, development could interfere with the natural ecosystem and pose potential threats to the health of fish. Barge queuing, fleeting areas/barge storage, and commercial boating also have negative impacts to fish through accidental toe-ins or substrate strikes, prop wash and increased sedimentation and pollution associated with such activities. Accidents and spills result in a potential negative impact through the introduction of a pollutant directly to the river that could harm fish and their habitat.

Biotic stressors, such as invasive species, also threaten the native fish of the upper Ohio River. Invasive species compete with, and sometimes outcompete, native species for vital resources provided by the river. Invasive species also destroy habitat utilized by native species and even consume the eggs of fish that are considered very valuable to the river. Although the upper Ohio River has not been affected by invasive species to the same extent as lower portions, the potential of these species to travel upstream is a possibility. Of most concern to the biotic integrity of the upper Ohio River are Asian carp if they move into the geographical area and become established (bighead, silver, black, and grass). In portions of the Mississippi River, Asian carp comprise 95 percent of total biomass of the river (Asam 2009). These fishes compete with native filter feeders, and in the case of the black carp, feed on native mussel and snail species.

Some Asian carp species are currently extending their ranges throughout the Mississippi drainage basin. Established populations have been confirmed in the Missouri, Illinois, and Ohio River Basins. Although the competitive effect of Asian carp on native fishes may be averted in the Mississippi and Illinois Rivers due to their high productivity, the potential for negative consequences in less productive ecosystems should not be underestimated (Sampson 2008). The high productivity the Mississippi and Illinois Rivers is attributed to the high proportion of agricultural land use throughout the drainage basins. The Ohio River contains small amounts of nutrients, however, and does not sustain such levels of productivity (Antweiler 1995). Consequently, the Asian carp could have more drastic impacts of the native fish populations of the Upper Ohio River if they find the conditions suitable and become established.

Multiple management and control plans have been or are being designed to impede the upstream distribution of Asian carp. Illinois, Indiana, Ohio, and Pennsylvania have all included Asian carp within their aquatic invasive species management plans. In addition, the USFWS and Aquatic Nuisance Species Task Force have organized an Asian Carp Working Group and have submitted a management and control plan for Asian carp in the United States.

A number of the negative forces affecting fish populations of the upper Ohio River are buffered or minimized by existing regulations, potential permitting conditions, improved project planning in order to minimize environmental impacts, and potential emergency response plans. The negative forces on fish that are not buffered by the existing factors listed above include invasive species and potential acid mine drainage breakout in the Monongahela River.

4.9.3 Incremental Impacts on EDM

The incremental impacts of EDM improvements will be limited and generally positive. Modern, more reliable locks will allow for more efficient movement of commercial traffic from one pool to another. As traffic moves more efficiently, negative environmental impacts associated with queuing will be reduced. This reduction of queuing will result from less frequent main chamber closures due to the new reliable locks, and to use of the old main chamber as the auxiliary during closures rather than the current small auxiliaries.

Environmental design and ecosystem restoration (such as fish passages and instream habitat improvements) would benefit fisheries by restoring degraded habitat values and improving connectivity. Environmental sustainability operation actions would allow for pool fluctuations in order to mimic the natural flow conditions of the river.

4.10 DETERMINATION OF SUSTAINABILITY

Three definitions of environmental sustainability were used for the analysis:

- Not sustainable – conditions for the selected indicators do not reflect conditions that would facilitate attainment of acceptable standards or would not maintain existing standards in concert with collective impacts of proposed activities.

- Marginally sustainable – conditions for selected indicators are such that attainment is accomplished for the majority, but not all, of the potentially affected populations. However, the conditions are somewhat tenuous both in location and likelihood of occurrences. (In other words, the conditions are borderline for environmental sustainability, and there are uncertainties regarding specific quantitative measures.)

- Sustainable – conditions for selected indicators are such that attainment of acceptable conditions are accomplished for essentially all of the potentially affected populations in the project area, and such standards are maintained in concert with foreseeable future activity. Further, conditions exceed regulatory thresholds, and various governmental programs are in place to respond to any potential erosion of values related to fishes.

Figure 4-2 illustrates the environmental sustainability of fish. Based upon the previously described information and the actions and effects on the environmental sustainability of fish, the sustainability can be characterized as follows:

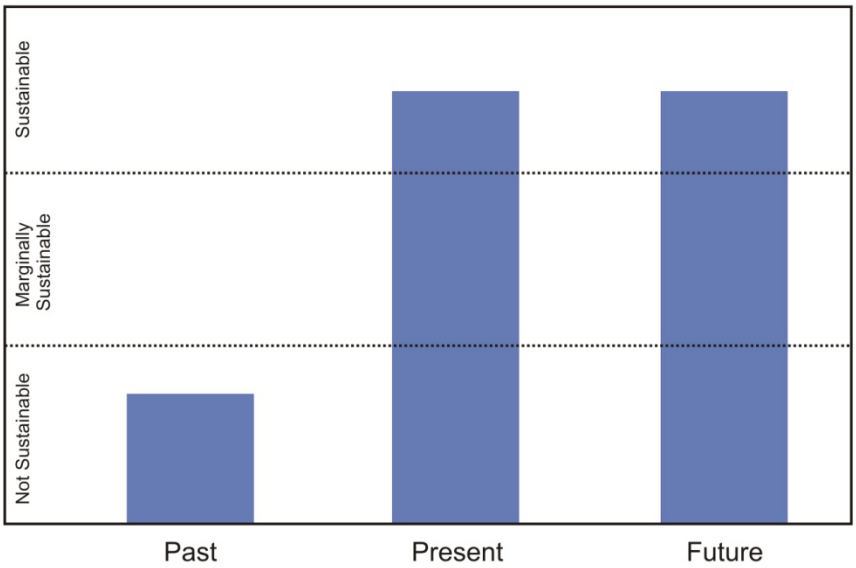
- In the time period from settlement and continuing to around the mid 20th century, fish populations can be classified as not sustainable due to the significantly degraded conditions of water quality and modification of existing flow regimes through construction of the modern lock and dam system. Further, the lack of awareness regarding the importance that fish populations have on a healthy river ecosystem contributed to this not sustainable condition.

- In the time period from the mid 20th century to the late 20th century, water quality conditions began to improve. This awareness led to the signing of an interstate compact in 1948 which led to development of the Ohio River Valley Water Sanitation Commission to clean up the waters of the Ohio River. Implementation of the Clean Water Act in the 1970s further improved the water quality conditions in the upper Ohio River. The Endangered Species Act of 1973 provided protection for listed species. These programs/regulations resulted in improved water quality, allowing for fish to redistribute to the river from their upstream refuges. This has allowed the fish community to return to conditions not observed since the mid-19th century. Stricter water quality standard are further improving water quality conditions of the river. The treatment of acid mine drainage has been crucial to maintaining the water quality standards necessary to support a fish population. These conditions suggest the current status of fish is sustainable.

- In the future, the growing awareness of current and potential threats to fish will help fish in the upper Ohio River maintain a sustainable condition. People from all walks of life are more aware of the need to maintain a clean environment, not only for human communities, but for animal and plant communities, too. Many factors have resulted in improved water quality, but key among them are federal and state regulations and their acceptance by society. Existing environmental regulations such as the Clean Water Act and water quality standards set by organizations such as ORSANCO should further improve water quality, with subsequent improvements for fish and their habitat, and guarantee the continuation of a sustainable condition. As water quality continues to improve, so too will the health, composition, and diversity of fish communities.

  The improvements which have occurred in the past half century will be built upon as current and future technologies and infrastructure continue to become more advanced. Although the transition of fish from past conditions to current conditions has been a success, monitoring and adaptive management will be vital when dealing with continuing water quality issues and the onslaught of invasive species that could jeopardize the health of the fish community in the upper Ohio River.

FIGURE 4-2
Environmental Sustainability of Fish



Source: Skelly and Loy, Inc., 2009

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Chapter 5
MUSSELS

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5.1 DEFINITION

Freshwater mussels are bivalve mollusks that burrow in the sand or mud of lakes and streams. They have soft bodies and platelike gills and are enclosed within two slightly elongated hinged shells.

Consideration is given here to how cumulative effects of human uses of the upper Ohio River have influenced mussel communities and what impacts on mussels may be anticipated in the foreseeable future. Mussels of the upper Ohio River are an important environmental component with an uncertain future. In spite of some encouraging trends, freshwater mussels in many portions of the Ohio River have drastically declined in recent decades due to compounding factors, including habitat modification and destruction, as well as increasing competition from non-indigenous species, especially the zebra mussel and Asian clam. Nowhere has the decline been more drastic than in the upper Ohio River, where only a very limited mussel fauna occurs today. Eight federally endangered species are listed within the upper Ohio River (River Mile

[RM] 0 – RM 40). The decline in both populations and species diversity of freshwater mussels of the Ohio River is likely occurring in other freshwater mollusks and aquatic organisms and is underscoring the need for conservation and restoration on the ecosystem and watershed levels (Williams and Neves, as cited in USACE 2006).

Freshwater mussels feed on organic particles, algae, and minute plants and animals, which they siphon out of the water. Because of their limited mobility, adult mussels are subject to a variety of environmental factors that can restrict their distribution and reproductive success. The availability of suitable fish hosts to ensure dispersal of juvenile mussels and completion of their life cycle is critical to their reproductive success. The limited mobility of mussels and their relatively long life spans make mussel populations good environmental indicators.

This chapter will consider cumulative effects on mussels from human use of the upper Ohio River, impacts to mussels anticipated in the foreseeable future, and measures that can be undertaken to mitigate potentially adverse impacts to this historically important and sensitive resource.

5.2 OBJECTIVES/SCOPE

5.2.1 Objectives

This chapter assesses the impacts on mussels which are directly or indirectly attributable to modernization of the navigation system. These impacts are evaluated in concert with impacts from other past, present, and reasonably foreseeable future actions (RFFAs) by the United States Army Corps of Engineers (USACE) and others.

Assessment of past and present actions and current conditions is the basis for identifying and interpreting the potential impacts of RFFAs. These future actions include the major navigation improvements identified in this study; other routine or potential actions by the USACE; projected actions by other federal, state, or local agencies, and non-governmental entities; and predictions of general economic expansion and development as well as regulatory changes.

The results of the cumulative effects assessment are intended to contribute to further discussion of the significance of the impacts of the RFFAs on the affected resources, the degree to which the proposed navigation improvements contribute to those outcomes, and what constitutes sustainable conditions for freshwater mussels of the upper Ohio River.

5.2.2 Geographic Scope

The geographic focus for impacts on mussels includes that portion of the upper Ohio Navigation System that is most directly affected by the existing and possible future modifications to the system. This includes the Allegheny and Monongahela tributaries of the Ohio River to the first upstream dam on each river. The downstream geographic limit is defined as the New Cumberland Lock and Dam.

The geographic scope includes the following pools: Emsworth, Dashields, Montgomery, and New Cumberland. Also included are the floodplains along either bank of the four pools. This floodplain zone is defined as the meander channel of the Ohio River and includes the 100- and 500-year floodplains as well as terraces of level land lying above these floodplains. Floodplain lands are considered in this assessment because mussel communities are affected by siltation, runoff, and contaminants associated with construction, industry, agriculture, and other land-based activities, and because rivers and floodplains normally interact as a complex ecosystem. Tributaries with viable mussel populations will be considered because of their importance to potential recolonization and sustaining of the mussel resource.

5.2.3 Time Frame

The established time frame for this assessment is 1885 to 2070. The earlier date is when initial lock and dam construction on the Ohio River began. Thus, it approximates the beginning of the modern lock and dam system. The latter date approximates the economic life of anticipated improvements on the Ohio River and is considered to be the planning horizon for the project.

5.3 ISSUES FROM SCOPING

Scoping has occurred as part of the Ohio River Mainstem Study (ORMSS) and for the Upper Ohio Navigation Study. A series of 12 public scoping meetings was held for ORMSS during the summer of 2001. Subsequently, a series of three public scoping meetings was held for the Upper Ohio Navigation Study in October 2006. Approximately 185 people attended the ORMSS meetings and approximately 40 people attended the Upper Ohio Navigation Study meetings.

Several comments related to mussels were made during both series of meetings. Comments that are directly or indirectly associated with mussels from these meetings, as well as concerns expressed by members of the Interagency Working Group (IWG), are shown in Table 5-1. The IWG, formed to assist in both scoping and coordination of this project, was comprised of federal and state resource agencies, non-governmental organizations and academia. Some data from ORMSS have been aggregated in the table below, and as a result may not tie directly into individual comments presented in the larger study.

TABLE 5-1
Comments on Mussels from Public Scoping Meetings

Comment	Number of Similar Comments	Scoping Meeting
Damage/destruction of mussel beds and fish spawning areas	4	ORMSS
Failure of barges to stay in designated shipping lanes	2	ORMSS
Importance of including commercial dredging and associated permitting process in CEA	3	ORMSS, IWG

Comment	Number of Similar Comments	Scoping Meeting
Loss of unique sensitive species due to water quality problems and habitat modifications	2	ORMSS
Need for USACE to coordinate with USFWS on threatened and endangered species issues	2	ORMSS, Upper Ohio Nav. Study
Habitat damage caused by USACE permitted commercial sand and gravel dredging	2	ORMSS, IWG
Increased spills and accidents potentially affecting aquatic life and impairing water quality	1	ORMSS
Need for long-term plan to address silt removal and prevent future sedimentation	1	ORMSS
Need to conduct surveys, including habitat assessment to identify baseline conditions	1	Upper Ohio Nav. Study
Need to improve sediment and erosion control from public and private developments	1	ORMSS
Need to prevent distribution of exotic/invasive plants and animals through USACE actions	1	ORMSS
Bank undercutting & failure caused by increased barge traffic, queuing and wave action	8	ORMSS, Upper Ohio Nav. Study
Mouths of tributaries silted in, impairing fish habitat, limiting access and damaging property	5	ORMSS
Cumulative effects of discharges to river may offset water quality improvements	4	ORMSS
Development of floodplains and wetlands resulting in increased runoff and habitat loss	4	ORMSS
Bank erosion caused by USACE-controlled pool fluctuations	3	ORMSS
Need for ongoing coordination and cooperation with concerned agencies and groups	3	ORMSS
Challenge to water quality presented by Combined Sewer Overflows (CSOs) and Sanitary Sewer Overflows (SSOs)	2	ORMSS
Impaired water quality and bioaccumulation in fish tissue of harmful substances stirred up by dredging	2	ORMSS
Importance of coordination of resources agencies in determining baseline conditions	2	ORMSS
Need for more stringent discharge permitting procedures or moratorium on permits	2	ORMSS
Possible use of dredge spoils to improve riparian or island habitat or for upland filling	2	ORMSS
High levels of mercury, arsenic, fecal coliform bacteria, and agri-chemicals in surface water	1	ORMSS
Importance of continued water quality improvements as a high priority	1	ORMSS

Comment	Number of Similar Comments	Scoping Meeting
Need to consider Clean Water Act (CWA) Section 404 application approvals and resultant actions as direct USACE actions	1	ORMSS
Possibility of implementing mechanical aeration in mainstem pools	1	ORMSS
Potential partnering with private enterprise to remove marketable aggregates when dredging	1	ORMSS
Marcellus shale operations impact on water quality	2	IWG
Presence of proper fish host for reproductive success	1	IWG
Agreement to a mussel sampling protocol	1	IWG
Dams are a barrier to fish host movement	1	IWG

Additional information and comments have been sought from the environmental resource agency representatives and planning officials serving on the IWG. Comments from IWG members on potential impacts to mussels have focused on proper fish hosts for a particular species of mussels, barriers to fish host movement (i.e., dams), mussel habitat loss due to commercial dredging activity, and water quality impacts associated with Marcellus shale operations.

5.4 LAWS, REGULATIONS, ORDINANCES, AND PROGRAMS

Several regulatory actions and related initiatives influence mussel populations in the study area. Table 5-2 presents information on important regulations and established programs, which directly or indirectly influence mussels in the upper Ohio River.

TABLE 5-2
Laws, Regulations, Ordinances, and Programs Relevant to Mussels

Law/Program (Lead Agency)	Key Components	Relevance to Mussels
Protocol for Mussel Surveys in the Ohio River where Dredging/Disposal/ Development Activity is Proposed (U.S. Army Corps of Engineers)	• Protocol provides basic mussel survey guidance for surveys throughout the Ohio River. (Notes that surveys on upper Ohio River should be coordinated with appropriate agencies to determine what modifications to protocol may be appropriate.)	Provides a buffer zone to limit in-stream activity surrounding known mussel concentrations or populations of federally threatened or endangered species

Law/Program (Lead Agency)	Key Components	Relevance to Mussels
USACE Permitting Statutes (U.S. Army Corps of Engineers)	• Section 10 of Rivers and Harbors Act (1899) prohibits the unauthorized obstruction or alteration of any navigable water of the United States. • Section 404 of Clean Water Act authorizes the USACE to issue permits for the discharge of dredged and fill materials into U.S. waters.	Permits require assessment of impacts on water quality, mussels, and other aquatic resources and mandate mitigation of adverse impacts
Water Resources Development Act(s) (U.S. Army Corps of Engineers)	• Authorizes USACE port development, navigation, flood control, and erosion control projects through the 1986 act and subsequent amendments	Contains provisions for environmental assessment and mitigation
Small Navigation Projects (U.S. Army Corps of Engineers)	• Section 107 of Rivers and Harbors Act (1960) authorizes USACE to develop and construct small navigation projects for harbor protection	Provides opportunity for USACE scrutiny of impacts of such actions on mussels
Spill Response (U.S. Coast Guard, ORSANCO)	• Includes emergency response activities for river-related spills and accidental discharges and is related to the Oil Pollution Act and Section 301 of the Clean Water Act	Minimizes adverse impacts of spills and discharges on mussels and other aquatic life and water quality
National CSO Control Policy (U.S. Environmental Protection Agency)	• Published by USEPA, calls for communities to implement long-term plan for combined sewer overflows (CSOs) to comply with the CWA.	Will reduce point source pollution to waterways from a major urban source
Oil Pollution Act (U.S. Environmental Protection Agency)	• Strengthened USEPA's ability to prevent & respond to catastrophic oil spills	Requires oil storage facilities and vessels to have an emergency response plan for accidental discharges
Clean Water Act (U.S. Environmental Protection Agency)	• Section 402 establishes National Pollution Discharge Elimination System (NPDES) for regulating pollution discharges into U.S. waters • Gives USEPA authority to implement pollution control programs • Requires establishment of water quality standards • Recognizes need to address nonpoint source pollution • Section 319 provides grant program to control nonpoint source pollution problems.	Protects mussels within general context of water quality improvements; contributes to reduced sediment loading to the river that could negatively affect mussel beds

Law/Program (Lead Agency)	Key Components	Relevance to Mussels
Site Remediation Statutes (U.S. Environmental Protection Agency)	• Includes CERCLA, RCRA, SARA, and related state programs that focus on cleanup and restoration of contaminated sites	Potentially reduces soil and groundwater pollution sources which may adversely impact mussels in the Ohio River
Safe Drinking Water Act (U.S. Environmental Protection Agency)	• Provides for establishment of primary regulations for the protection of public health and secondary regulations	Results in improved water quality
Phase 1 & 2 NPDES Program (U.S. Environmental Protection Agency)	• Requires municipalities and certain industrial and construction sites to adopt BMPs to control point sources of pollution	Should reduce pollution characteristics of stormwater discharges from urban and industrial zones that may adversely affect mussels in the Ohio River
TMDL Program (U.S. Environmental Protection Agency with ORSANCO)	Section 303 of Clean Water Act regulates the maximum load of a pollutant a water body can receive and still attain water quality standards	Presents a holistic option to water quality management that may be more beneficial to mussels than traditional "command and control" approaches
National Wildlife Refuge System Acts (U.S. Fish & Wildlife Service)	• Provides guidance for management and public use of refuge system, including development of comprehensive conservation plan for each refuge	Guides management & public use of Ohio River Islands National Wildlife Refuge
Endangered Species Act (U.S. Fish & Wildlife Service)	• Provides various means of protection for endangered and threatened species and their critical habitats • Provides process for designation of such species and their habitats • Encourages development of related state programs	Has enabled endangered species designation for five Ohio River mussel species and addition of other species to candidate list. State endangered species status further supports protection of these endangered Ohio River mussels.

Law/Program (Lead Agency)	Key Components	Relevance to Mussels
Fish and Wildlife Coordination Act (U.S. Fish & Wildlife Service)	• Requires that whenever water bodies are modified by a federal agency, that agency first shall consult with the USFWS and with appropriate state agencies with a view toward wildlife conservation	Provides for equal consideration and coordination of mussel conservation with other aspects of water resources development
National Invasive Species Act (U.S. Department of Transportation and Aquatic Nuisance Species Task Force)	• Requires all vessels operating in U.S. waters that are equipped with ballast tanks to comply with guidelines designed to prevent and reduce the dispersal of aquatic nuisance species	Helps reduce the further introduction and dispersal of invasive species that can impact native mussel populations
ORSANCO Monitoring (ORSANCO)	• Encompasses ongoing water quality and aquatic ecology monitoring programs by the Ohio River Valley Water Sanitation Commission	Tracks changes in biological communities of relevance to mussels; provides database for decision making
State Water Quality Certification (Appropriate state or interstate pollution control agencies)	• Section 401 of Clean Water Act requires certification from state or interstate water control agencies that a project is in compliance with established effluent limits and water quality standards.	Provides opportunity for state or interstate scrutiny of impacts of such actions on mussels
PA Sewage Facilities Act	• Provides for the planning and regulation of community and individual sewage systems	Improved water quality, as a result of this act; has a positive influence on mussel populations
PA Act 67 & 68	• The Pennsylvania Growing Greener Program falls under these regulations. Growing Greener has provided a strong funding source in which local watersheds have conducted water quality improvement projects.	Projects completed under Growing Greener provide for improved water and sediment quality.
PA Storm Water Management Act	• Requires PA counties to prepare and adopt watershed based stormwater management plans	New construction is required to manage the stormwater runoff generated at the site. Unchecked stormwater runoff can lead to significant sedimentation events on streams.

Law/Program (Lead Agency)	Key Components	Relevance to Mussels
Pennsylvania Fish and Boat Code (PA Fish & Boat Commission)	• Section 2305 authorizes the PFBC to evaluate projects for impacts to state listed threatened and endangered species	Several mussel species are found on the state threatened and endangered species list.

5.5 PAST TO CURRENT BASELINE CONDITIONS

Freshwater mussels, or bivalves, are valuable as indicators of environmental health; as a commercial resource in the cultured pearl industry; and as a major component of worldwide freshwater biodiversity (Williams *et al.,* as cited in USACE 2006). Mussels are the river's natural filter system, and they play an important role in the breakdown/compartmentalization of organic matter as well as provide habitat for other invertebrates. They also help stabilize the river substrate. Historically, one of the most diverse assemblages of freshwater mussels in the United States occurred in the Ohio River mainstem, with upwards of 80 species reported for the free-flowing river (United States Fish and Wildlife Service [USFWS], as cited in USACE 2006). However, the industrialization and urbanization of the upper Ohio River corridor resulted in severe negative impacts on the mussel populations of the river through the 19th and 20th centuries. It was becoming evident that the activities of people along the river were creating a serious impact on this river. During a congressional hearing in 1936, Brent Spence (D-Kentucky) testified that "the Ohio River is a cesspool." During the same hearing, the State Health Commissioner of Kentucky added that "the Ohio River, from Pittsburgh to Cairo, is an open sewer" (USEPA, as cited in USACE 2006). This awareness led to the signing of an interstate compact in 1948 which led to development of the Ohio River Valley Water Sanitation Commission (ORSANCO). The principal mission of ORSANCO was to abate existing pollution and control future pollution of waters in the Ohio River basin (ORSANCO, as cited in USACE 2006).

Implementation of the Clean Water Act (CWA) in the 1970s further improved the water quality conditions in the upper Ohio River. The improvement to the water quality conditions of the upper Ohio River began to allow opportunity for mussel recolonization of the river. The Endangered Species Act of 1973 (ESA) provided protection for listed species. This provides an additional protection to mussel species listed under the ESA. In a study conducted by Ecological Specialists, Inc. [ESI] (2000), evidence of 54 species of native freshwater mussels was observed in the upper Ohio River (RM 0 – RM 436). Tributaries with viable mussel populations also have been important to re-colonization and sustainment of the Ohio River mussel resource.

5.5.1 Mussel Populations of the Ohio River

Freshwater mussels are found worldwide but the North American continent supports the greatest diversity with approximately 297 recognized taxa (Williams *et al.* 1993). Furthermore, the waters of Pennsylvania historically supported a greatly diverse collection of freshwater mussels totaling at least 65 species (Bogan, as cited in EnviroScience, Inc. [ES] 2009). Of the 65 species, 44 are believed to still inhabit Pennsylvania, while the others are considered extirpated

within the Commonwealth. "The historical distribution of all these species amongst the six major drainages in the state are as follows: 53 in the Ohio River, 24 in Lake Erie, two in the Genesee River, six in the Potomac River, 12 in the Susquehanna River, and 14 in the Delaware River" (Bogan, as cited in ES 2009).

In a report by Ralph Taylor of Marshall University titled *Changes in Freshwater Mussel Populations of the Ohio River: 1,000 BP to Recent Times*, it is described that 31 species of freshwater mussels occurred in the upper Ohio River (RM 0 - 300) prior to 1800 (Taylor 1989). This species number was arrived at through research of existing data collected in Native American middens. Around the turn of the 20th century, Taylor reports that Arnold Ortmann recorded 37 species in this same reach of the river. At least three freshwater mussel surveys have been conducted in recent times. These include:

- Greenup Lock and Dam to Pittsburgh – Taylor, 1980;
- Upper Ohio River Mussel Database – Ecological Specialists, Inc., 2000; and
- Native Mussel Screening Survey, Upper Ohio Navigation Study – EnviroScience, 2009.

In a study conducted by Taylor from the Greenup Lock and Dam to Pittsburgh, no living mussels were collected in the Pennsylvania reach of the river. Only subfossil shells were found in this reach of the river (Taylor, as cited in USACE 2006). The Upper Ohio River Mussel Database, compiled by Ecological Specialists, Inc. (2000), enumerated the mussel beds observed within the pools of the upper Ohio River (RM 0 – RM 431). Of the pools within the project area (Emsworth, Dashields, Montgomery, New Cumberland), no mussel beds (a natural aggregation of mussels) were observed; however, 41 mussels representing eight species were collected from the New Cumberland Pool (ESI 2000).

A recent survey (summer 2008) of the Emsworth, Dashields, Montgomery, and New Cumberland pools identified eight species of native mussels within this area. The limits of the study investigated for this survey included the Ohio River from river mile 0 through river mile 35. Thirty-five non-random sampling points were investigated for the survey. The sample points were selected as high probability areas for habitat/substrate composition that would likely support mussel populations. As a result of the survey, 110 live mussels representing six species were collected. Two additional freshly dead species were collected during the investigation. Table 5-3 lists the species collected during this survey as well as the number of individuals by species.

TABLE 5-3
Native Mussels Collected During 2008 Survey of Upper Ohio River

Common Name	Scientific Name	Number of Individuals	Federal Status / State Status
Emsworth Pool			
Fatmucket	*Lampsilis siliquoidea*	1	– / –

Common Name	Scientific Name	Number of Individuals	Federal Status / State Status
Pink heelsplitter	*Potamilus alatus*	1*	– / Candidate rare
Dashields Pool			
Fluted-shell	*Lasmigona costata*	1	– / –
Fragile papershell	*Leptodea fragilis*	2*	– / Candidate rare
Threehorn wartyback	*Obliquaria reflexa*	5, 1*	– / Proposed extirpated
Pink heelsplitter	*Potamilus alatus*	13	– / Candidate rare
Mapleleaf	*Quadrula quadrula*	22	– / Proposed threatened
Fawnsfoot	*Truncilla donaciformis*	2	– / Condition undetermined
Montgomery Pool			
Fragile papershell	*Leptodea fragilis*	4*	– / Candidate rare
Threehorn wartyback	*Obliquaria reflexa*	1	– / Proposed extirpated
Pink heelsplitter	*Potamilus alatus*	14, 5*, 2**	– / Candidate rare
Mapleleaf	*Quadrula quadrula*	2	– / Proposed threatened
New Cumberland Pool			
Fragile papershell	*Leptodea fragilis*	3**	– / Candidate rare
Threehorn wartyback	*Obliquaria reflexa*	2, 10*	– / Proposed extirpated
Pink heelsplitter	*Potamilus alatus*	30, 1*, 4**	– / Candidate rare
Mapleleaf	*Quadrula quadrula*	17, 90*	– / Proposed threatened
Deertoe	*Truncilla truncata*	2*	– / Proposed extirpated
*Fresh dead shell			
**Weathered dead and sub-fossil shell			
Source: ES, 2009			

It is noted in the report for this survey that the mussel population within the study area "is relatively low in terms of density and diversity" in comparison to other mussel populations found in the middle Ohio River and within the navigable pools of the Allegheny River (ES 2009). This report goes on to state that: "Assuming a 50 percent efficiency, mussel density rarely reached or exceeded an estimated 0.4 mussels/m^2." Of the species collected during this survey, the most dominant species included the pink heelsplitter (*Potamilus alatus),* the mapleleaf (*Quadrula*

quadrula), and the threehorn wartyback (*Obliquaria reflexa*), with the pink heelsplitter being the most dominant. Two additional species were identified in the study area that warrant special note. These include the fawnsfoot (*Truncilla donaciformis*) and the deertoe (*Truncilla truncata*). These species warrant special note because the Pennsylvania status of the fawnsfoot is "unknown" and the deertoe is currently listed as extirpated within Pennsylvania. Additionally, the deertoe and threehorn wartyback are proposed by the USFWS, Pennsylvania Fish and Boat Commission (PFBC), and the Adaptive Management Group as species indicative of flowing water and large river habitats.

Of the three surveys discussed previously (Taylor 1980; ESI 2000; and ES 2009) the trend in the number of mussels collected has been increasing over the years. This may be attributable to improved water quality, but accepted sampling techniques have also been refined over the years to increase the opportunity for finding and collecting mussels. It is likely that a combination of these two factors has resulted in a greater yield in the number of mussels collected during a given survey.

5.5.2 Life History of Mussels – an Overview

A mussel is a relatively simple animal that is enclosed by two shells, or valves. The valves are connected to each other by a ligament. The valve is typically composed of calcium carbonate that is extracted from the water in which the animal lives. The animal, within the shell, consists of a soft body made up of gills, a digestive system, a muscular foot, and a mantle (USFWS 2009a). The lifespan, size, and coloration of freshwater mussels are extremely variable between species. Some are known to live approximately 10 years; some may live as long as 100 years. Variation in mussel sizes range from approximately 25 mm to over 300 mm in length. Shell coloration can vary from yellow to green to black to brown including combinations of each. Reproduction in mussels is a very unique process that, for most species, requires a fish host.

5.5.3 Mussel Species of Special Concern

Historically, the Ohio River supported a diverse population of freshwater mussels. As noted previously, 31 species of mussels were identified from Native American middens along the upper Ohio River. In the early years of the 20th century a large number of button factories which utilized mussel shells for button material were present along the river. Personal conversations between Taylor and elderly residents of the Huntington, WV area recall barge loads of shells being shipped on the river (Taylor 1989). These activities, along with changes in the river associated with the modern lock and dam system and degraded water quality, have resulted in drastic reductions in the mussel population of the Ohio River.

According to the Nature Conservancy, approximately 70 percent of the mussels of North America are extinct or imperiled. In comparison, only 17 percent of mammalian species and 15 percent of bird species are extinct or imperiled (USFWS 2009b). This project area is within the range of thirteen mussel species with status under the Endangered Species Act. These include eight endangered species, two proposed species, two candidate species, and one species of special concern. Table 5-4 describes these species.

TABLE 5-4
Mussel Endangered, Proposed Candidate Species, and Species of Concern

Species	Common Name	Habitat	Federal Status
Cyprogenia stegaria	Fanshell	Lotic	Endangered
Epioblasma torulosa rangiana	Northern riffleshell	Lotic	Endangered
Hemistena lata	Crackling pearlymussel	Lotic	Endangered
Lampsilis abrupta	Pink mucket	Lotic	Endangered
Obovaria retusa	Ring pink	Lotic	Endangered
Plethobasus cooperianus	Orange-foot pimpleback	Lotic	Endangered
Pleurobema clava	Clubshell	Lotic	Endangered
Pleurobema plenum	Rough pigtoe	Lotic	Endangered
Epioblasma triquetra	Snuffbox	Lotic	Proposed
Villosa fabalis	Rayed bean mussel	Lotic	Proposed
Plethobasus cyphyus	Sheepnose mussel	Lotic	Candidate
Quadrula cylindrical	Rabbitsfoot	Lotic	Candidate
Simpsonaias ambigua	Salamander mussel	Generalist	Species of Concern
Lotic – typical of flowing water and gravel and cobble substrates; lentic – minimal flow; sand or silt substrates; generalist – occurs in both habitat types.			
Source: USACE, 2002			

As mentioned earlier, two noteworthy species were identified during the 2008 survey of the upper Ohio River by EnviroScience. These include the fawnsfoot and the deertoe. These species warrant special note because the Pennsylvania status of the fawnsfoot is unknown and the deertoe is currently listed as extirpated within Pennsylvania.

Several mussel species have been provided protection status by the PFBC within Pennsylvania. The following species are currently designated Endangered: the Salamander mussel (*Simpsonaias ambigua*), the Rabbitsfoot mussel (*Quadrula cylindrica cylindrical*), the Snuffbox mussel (*Epioblasma triquetra*), the Northern riffleshell (*Epioblasma torulosa rangiana)*, and the Clubshell (*Pleurobema clava)*. The Sheepnose mussel (*Plethobasus cyphyus*) is a listed by Pennsylvania as Threatened.

5.5.4 Suitable Habitat and Connectivity between Mussel Beds

In an article published in the Ohio Journal of Science, Dr. Martin Huehner investigated the mussel preferences in habitat types (1987). Habitat features utilized for the investigation include substrate type, water depth, and current velocity. The results of these experiments suggest that individual mussels can change their microhabitat by moving to preferable substrate types and habitat conditions. Dr. Huehner cited two similar past studies, one indicating that mass

displacement of mussel beds can occur during periods of flooding in moderate sized streams (Roscoe and Reddings, Valentine and Stansbury, as cited in Huehner 1987). The other reporting that "larger mussel species, as well as larger individuals of a given species, were situated in coarser substrates on the upstream portions of river point bars, whereas smaller individuals occupied finer sediments in slower water downstream" (Pryor, as cited in Huehner 1987).

Table 5-5 describes the preferred habitat types of the mussel species observed to occur in the study area during the 2008 sampling event conducted in the Emsworth, Dashields, Montgomery, and New Cumberland pools.

TABLE 5-5
Preferred Habitat Features for Mussels Observed During 2008 Survey

Common Name	Scientific Name	Preferred Habitat*	Preferred Substrate*
Fatmucket	*Lampsilis siliquoidea*	Lakes or mid-sized streams	Mud, sand, or gravel
Pink heelsplitter	*Potamilus alatus*	Medium to large rivers	Mud or mixed mud, sand, or gravel
Fluted-shell	*Lasmigona costata*	Medium to large rivers	Sand, mud, or fine gravel in areas with slow to moderate flow
Fragile papershell	*Leptodea fragilis*	Streams of all sizes	Mud, sand, or gravel
Threehorn wartyback	*Obliquaria reflexa*	Large rivers	Sand or gravel; may be locally abundant in impoundments
Mapleleaf	*Quadrula quadrula*	Medium to large rivers and reservoirs	Mud, sand, or gravel bottom
Fawnsfoot	*Truncilla donaciformis*	Large rivers or the lower reaches of medium-sized streams	Sand or gravel
Source: Illinois Natural History Survey, 2009			

During the 2008 survey it was noted that mussels were observed in a broad range of habitat types, at an average depth of 11.5 feet, and a maximum depth of 26 feet. Nearly 50 percent of the mussels collected were observed greater than 150 feet from the shoreline. Additionally, live mussels were associated, in general, with substrates composed of silt, sand, gravel, cobble, boulder, and other materials (e.g., mud, wood, and bedrock). Substrate types observed, on average, during the 2008 survey, by pool, are as follows:

- Emsworth Pool: gravel (30 percent), cobble (25 percent), boulder (17 percent), and mud (11 percent). Other substrates, such as woody debris, comprise the remainder of the substrate composition.

- Dashields Pool: gravel (24 percent), cobble (22 percent), boulder (14 percent), and a relatively even mix of silt, mud, and sand (11 percent, 13 percent, and 13 percent, respectively). Other substrates, such as woody debris, comprise the remainder of the substrate composition.

- Montgomery Pool: Silt (34 percent), gravel (18 percent), boulder (15 percent), and cobble (14 percent). Other substrates, such as woody debris, comprise the remainder of the substrate composition.

- New Cumberland Pool: gravel (22 percent), silt (19 percent), cobble (19 percent), boulder (16 percent), and mud (8 percent). Other substrates, such as woody debris, comprise the remainder of the substrate composition.

Additional information regarding substrate types observed in the Emsworth and Montgomery pools has been presented in two reports published by ORSANCO titled *"A Biological Study of the Emsworth Pool of the Ohio River"* (ORSANCO 2007) and *"A Biological Survey of the Ohio River – The Montgomery Pool"* (ORSANCO 2006). Table 5-6 displays the substrate data provided in each report.

TABLE 5-6
Substrate Types Observed in Emsworth and Montgomery Pools

Site Number	River Mile	Bank	River	Boulder (%)	Cobble (%)	Fines (%)	Gravel (%)	Hardpan (%)	Sand (%)
Emsworth Pool									
1	2.2	LDB	Alleg.	2.3	31.3	0.0	33.6	1.6	31.3
2	5	LDB	Alleg.	0.7	19.1	5.7	34.8	0.0	39.7
3	5.7	LDB	Alleg.	1.4	21.7	4.9	37.8	0.0	34.3
4	2.6	LDB	Mon.	2.7	12.2	25.0	18.9	0.0	41.2
5	4.5	RDB	Mon.	2.6	9.4	24.8	18.8	0.0	44.4
6	4.8	RDB	Mon.	0.7	11.2	22.4	23.1	0.0	42.7
7	5.7	RDB	Mon.	1.4	7.0	30.1	23.1	0.0	38.5
8	6.3	RDB	Mon.	0.8	15.2	14.4	45.6	0.0	24.0
9	9.1	LDB	Mon.	0.0	12.6	17.0	33.3	0.0	37.1
10	10.8	RDB	Mon.	0.7	18.8	3.5	36.8	2.1	38.2
11	0.2	LDB	Ohio	0.0	20.7	11.5	23.0	5.7	39.1
12	1.9	LDB	Ohio	2.0	31.1	0.0	32.4	0.0	34.5
13	4	RDB	Ohio	0.8	24.0	6.6	29.8	0.0	38.8
14	4.3	RDB	Ohio	0.9	11.4	19.3	24.6	0.0	43.9
15	5.1	RDB	Ohio	3.2	31.8	0.0	34.4	0.0	30.6
Montgomery Pool									
1	13.7	LDB		2.0	30.6	0.0	38.9	0.0	28.5
2	14.1	RDB		1.3	14.6	1.3	41.4	0.0	40.7
3	15.8	RDB		2.7	5.5	4.1	34.2	0.0	53.6
4	16.6	RDB		4.8	9.0	17.5	27.7	0.0	41.0
5	19.3	RDB		17.4	12.9	6.1	26.5	0.0	37.1
6	22.0	LDB		5.4	17.8	14.0	26.0	0.0	36.8
7	23.1	RDB		6.3	15.5	12.6	29.9	0.0	35.6
8	26.0	LDB		12.0	21.0	6.0	17.0	0.0	45.0
9	27.0	LDB		7.1	10.9	34.2	9.3	0.0	38.5
10	27.1	RDB		8.1	29.7	1.4	36.9	0.0	23.9

Site Number	River Mile	Bank	River	Boulder (%)	Cobble (%)	Fines (%)	Gravel (%)	Hardpan (%)	Sand (%)
11	27.3	LDB		0.8	4.9	52.3	10.0	2.3	29.7
12	27.6	LDB		0.0	0.6	64.2	12.1	7.0	16.1
13	28.7	RDB		10.1	15.5	29.9	22.7	0.0	21.7
14	30.1	LDB		1.4	26.4	22.3	30.4	0.0	19.6
15	30.4	RDB		3.1	18.0	7.8	35.4	0.0	35.7
LDB = Left descending bank; RDB = Right descending bank									
Sources: ORSANCO, 2006, 2007									

Connectivity of mussel beds is directly related to the movement of fish hosts. Thus, the spatial distribution of mussel communities is a result of fish species associated with specific groups of mussels. Because the long range transport of freshwater mussels occurs during the parasitic phase of the animal in which it is attached to a host fish species, the condition of mussel beds is related to the "functional connectivity" of host fish species (Woolnough 2006). As a result, the presence of the navigational dams within the study area may limit the functional connectivity of host fish species and subsequently the connectivity of mussel beds within the project area.

5.5.5 Water Quality and Mussel Populations

Mussels are regularly filtering the water in which they live for feeding and respiratory processes and, during certain times of year, for reproduction. Because of this constant interaction, water quality plays a very large role in the life of a mussel. Therefore, mussels can provide a good indication of water quality. Limited numbers of individuals and species can be an indication of poor water quality whereas a diverse number of species and a high number of individuals can be an indication of good water quality. Of course, a declining mussel population may not solely be a result of poor water quality but could also occur from environmental pressures including dredging activities, changes in hydrologic flows, and others.

Although water quality has overall been improving over the years, mussel populations in many watersheds remain in an uncertain condition. A report titled *Water and Sediment Quality at Mussel (Unionidae) Habitats in the Ochlockonee River of Florida and Georgia* (Hemming *et al.* 2006) investigated water and sediment quality conditions within portions of the Ochlockonee River. Like many large river systems, the Ochlockonee River is experiencing a decline in the species richness of its freshwater mussel populations. It is described in the report that water quality standards in the Ochlockonee River have been failing to meet state and federal standards from time to time. This report attributes this condition to non-point source pollutants affecting the river. The report concluded that low dissolved oxygen is a factor that presents the greatest risk to aquatic species. Sedimentation also provides a risk to mussel populations, especially in instances where dams have been erected on rivers and the flushing of silts does not occur as it would in a free flowing river system.

Water and sediment quality conditions of the river have been improving since the inception of ORSANCO and implementation of the Clean Water Act. Low limits for dissolved oxygen levels have been established to protect aquatic life by ORSANCO. Due to the condition of the lock and dam system on the upper Ohio River, however, morphological features which

would provide dissolved oxygen to the river such as riffles are not present. Substrates observed in the pools of the upper Ohio River determine that fines are not the dominant substrate type in the river.

Historically, the pH of the river has demonstrated great variation. Acid mine drainage and the associated acidity have been greatly improving on the river. However, a potential threat to this condition exists in the Monongahela River drainage. Significant networks of abandoned underground mines in this watershed have filled or are filling with water. If this network of mines fills there is the potential for this water to be discharged to the Monongahela River resulting in a serious threat to aquatic life.

Many coal operations previously committed to pumping and treating their acid mine drainage discharges have declared bankruptcy. This had resulted in abandoned or orphan mines. Past deep mining operations in the Monongahela River Basin have left massive voids currently filled or filling with water. Orphan mines that are located below surface drainage level are actively being flooded, creating an immense aquifer of mine water. It is projected that in 2015 all orphan mines located below the surface drainage level will have reached their maximum capacity to hold water. The aquifer created by the flooding of orphan mines in the Pittsburgh Coal Basin will create the second largest spatially-continuous high-yield aquifer in the Northern Appalachian Region (Donovan and Leavitt 2004). Known as the Monongahela River Mine Pool, it has been described as having a giant football shape, stretching from Fairmont, WV to Pittsburgh, PA and from Wheeling, WV to Uniontown, PA.

The West Virginia University Center for Coal Mining Research conducted an extensive study to map the underground mining and water quality of this mine pool (Ziemkiewicz and Vandivort 2004, as cited in Lorson and Smith 2004). They have documented extremely acidic water with gross heavy metal loads within the mine pool. The mine pool has several points where acid loads may be discharged to the Monongahela River, including Dunkard Creek (Mon RM 87.2), a tributary of the Monongahela where all aquatic life was killed in September 2009. Several resource agencies are involved in investigations of the recent incident as well as the development of long-term solutions to mine pool flooding.

Elevated levels of coliform bacteria can result in altering nutrient levels, biochemical oxygen demand, dissolved oxygen, and suspended sediments and add organic compounds, thus potentially impacting mussel populations. Conditions related to reducing the levels of coliform bacteria have occurred. However, the current system of combined storm overflows and sanitary sewer overflows still contribute these pollutants to the river during rain events.

Suspended solids provide attachment points for heavy metals and bacteria. Turbidity can provide nourishment and shelter for pathogens. The mean turbidity of the river is higher now than it has been in the past. These pollutants can result in negative impacts to aquatic life through decreased visibility, clogging gills, smothering larvae, etc. ORSANCO's 2000 Pollution Control Standards do not have standards established for suspended solids or turbidity associated with the protection of aquatic life. However, it generally states that waters discharged to the river should be free of materials that could settle and form an objectionable sludge or suspended materials that will be unsightly or deleterious. Total maximum daily loads (TMDLs) have been

established on the upper Ohio River for PCBs and chlordane, which are two significant sediment pollutants that bioaccumulate in living tissues. The TMDLs for these pollutants will help to limit their impact on mussel populations.

5.5.6 Mussel Food Sources

It has been traditionally understood that the primary food source for mussels is provided by organic material suspended in the water column and siphoned through the animal. It has been reported that mussels ingest detritus, diatoms, phytoplankton, zooplankton, and other microorganisms (Coker *et al.*, as cited in USEPA 2007). However, there remains some uncertainty as to the source of the food that is consumed by mussels. In a report titled *Bivalve Diets in a Midwestern U.S. Stream: A Stable Isotope Enrichment Study* (Raikow and Hamilton 2001), the diet of freshwater mussels was investigated through the process of examining the chemical composition of stable isotopes in certain tissues of the organism. The tissues sampled included the stomach gland, the foot muscle, and gut contents. The results of this investigation indicate that mussels feed through filtration, not only of the water column (suspended particulate organic matter [SPOM]), but of nearby sediments (epipsammon [EPS, or detritus and possibly algae mixed with sand]) as well. Findings suggest that the mussel diet consisted of approximately 80 percent EPS and 20 percent SPOM. Additional research into this aspect of mussel biology is required to provide a definitive understanding of mussel feeding. Better understanding of the mussel feeding process will lead to better conservation practices in the protection of mussels.

5.5.7 Mussel Reproduction and Fish Hosts

Most mussel species require a fish host to complete their life cycle. During the breeding period, a male mussel will release its sperm into the water column. A female in proximity to the male will draw the sperm in through its incurrent siphon. The fertilized eggs develop within the marsupia of the female's modified gills until they mature into glochidia. The glochidia are a parasitic form of mussel that will attach to the gills or fins of a host fish. The glochidium mature on the fish for a period that is variable between species. Upon maturity, the glochidium drop off the host species and settle into suitable habitat (Figure 5-1).

FIGURE 5-1
Mussel Reproduction and Fish Hosts

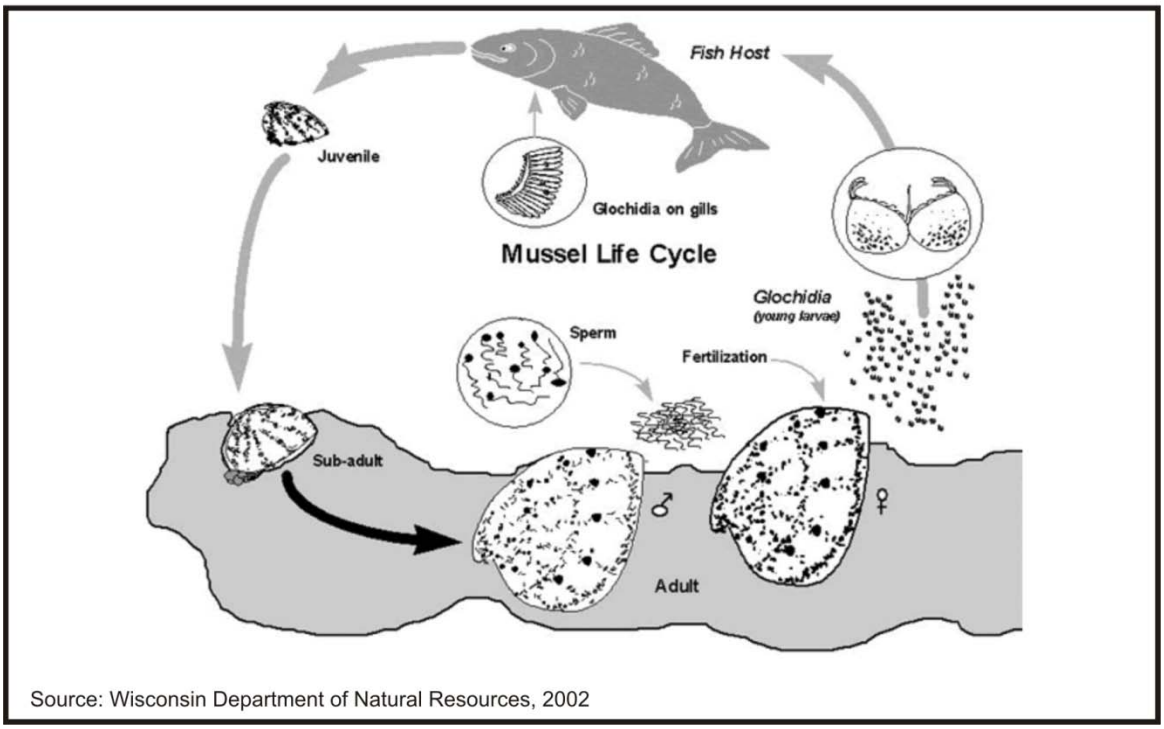


Table 5-7 describes the fish hosts of the mussel species observed to occur in the study area during the 2008 sampling event conducted in the Emsworth, Dashields, Montgomery, and New Cumberland pools.

TABLE 5-7
Fish Hosts for Mussels Observed During 2008 Survey

Mussel Species		Host Fish Species*	
Common Name	**Scientific Name**	**Common Name**	**Scientific Name**
Fatmucket	*Lampsilis siliquoidea*	White sucker	*Catostomus commersoni*
		Pumpkinseed	*Lepomis gibbosus*
		Warmouth	*Lepomis gulosus*
		Bluegill	*Lepomis macrochirus*
Pink heelsplitter	*Potamilus alatus*	Freshwater drum (Sheephead)	*Aplodinotus grunniens*
Fluted-shell	*Lasmigona costata*	Gizzard shad	*Dorosoma cepedianum*
		River Redhorse	*Moxostoma carinatum*
Fragile papershell	*Leptodea fragilis*	Freshwater drum (Sheephead)	*Aplodinotus grunniens*
Mapleleaf	*Quadrula quadrula*	Flathead catfish	*Pylodictis olivaris*
Fawnsfoot	*Truncilla donaciformis*	Freshwater drum (Sheephead)	*Aplodinotus grunniens*
		Sauger	*Sander Canadensis*
*Only included fish species identified through natural infestation (NI or NT)			
Source: Ohio State University, 2009			

5.5.8 Mussel Disturbance from Biotic and Abiotic Stressors

The biotic and abiotic stressors which affect mussel populations are numerous. Biotic stressors which affect our native freshwater bivalves include, but are not limited to, natural predators, human predation, and non-native, invasive species. Natural predators of our freshwater mussels include muskrats (*Ondatra zibethicus*), otters (*Lutra canadensis*), certain bird species, and certain fish species. Human predation of mussels included the past use of shells for manufacturing of pearl buttons (which have been replaced by plastic buttons) and currently as seed pearls for the cultured pearl industry. Non-native invasive species pose a significant risk to the populations of our native freshwater mussels. Some of the non-native, invasive species threats to the native freshwater mussel population of the upper Ohio River are Asiatic clam (*Corbicula fluminea*) and the zebra mussel (*Dreissena polymorpha*).

Zebra mussels were observed to be common on live mussels collected during the 2008 survey on the upper Ohio River. They were noted to be especially common in the New Cumberland Pool. The Asiatic clam was also observed during the 2008 survey of the upper Ohio River, but in low densities.

Table 5-8 lists some of the molluscivorous fish found in the Ohio River.

TABLE 5-8
Molluscivorous Fish Known to Occur in the Ohio River

Common Name	Scientific Name
Common carp[1]	*Cyprinus carpio*
White sucker	*Catostomus commersoni*
White perch	*Morone Americana*
White bass	*Morone chrysops*
Pumpkinseed	*Lepomis gibbosus*
Redear sunfish	*Lepomis microlophus*
Yellow perch	*Perca flavescens*
Freshwater drum	*Aplodinotus grunniens*
[1]Introduced species	
Sources: ORSANCO, 2004, 2006, 2007	

Abiotic stressors include, but are not limited to, habitat modification through changes in the resource, point source pollution, and non-point source pollution. Habitat modification includes activities such as dam building, channel dredging, in-stream sand and gravel mining, snag removal, and increased siltation. The central reason that habitat modifications have occurred on the upper Ohio River is for the utilization of the river for transportation purposes. Utilization of the river for transportation resulted in the construction of locks and dams, thus changing the river from a heterogeneous habitat, which included pools, riffles, and runs, to a more homogeneous habitat that is primarily composed of run flow features of varying depths from upstream to downstream. Channel dredging to maintain a shipping channel that allows barge traffic results in the removal of substrates and potential mussel habitat and can lead to the re-suspension of silts and potentially contaminants that have settled into the sediments (Watters

1999). In-stream sand and gravel mining can lead to similar impacts. To protect direct impacts from occurring on mussels, surveys are conducted prior to dredging. If mussels are found, they are translocated. Snag removal also results in a loss to the naturally occurring heterogeneity of an aquatic system. Increased siltation can result in a detrimental effect on feeding and respiratory efficiency as gills become clogged, disruptions occur in normal metabolic processes, as well as physical smothering (Various authors, as cited in USEPA 2007).

Point source pollutants are also known to be disruptive to the health of freshwater mussels. In a work titled *Freshwater Mussels: A Neglected and Declining Aquatic Resource* (Williams and Neves 1993, as cited in USEPA 2007), it is noted that heavy metals pose a threat to freshwater mussels. Non-point source pollutants, such as abandoned mine drainage, run-off from agricultural land uses, coal mines, roadways, and residential lawns, are also sources of negative pressures that are exerted on mussel populations.

5.6 INTERACTIONS WITH OTHER VALUED ENVIRONMENTAL COMPONENTS (VECS)

Recent drastic declines in native mussel populations have contributed to increased scrutiny of numerous human activities that affect them. Several valued environmental components (VECs) influence the sustainability of mussel populations in the Ohio River, primarily in connection with mussel habitat.

Water quality improvements in response to federal, state, and/or local regulations over the last half-century have generally been beneficial to mussels. Dramatic increases in the number of river miles fully supporting the warmwater aquatic life use designation have occurred in the past 20 years, as water quality has continued to improve. At the same time, changes in sediment patterns near high-lift dams and continuing sediment input from land development, agricultural activities, and dredging have resulted in siltation that has impaired respiration, feeding, and reproduction of mussels throughout the Ohio River. The transformation of the free-flowing Ohio River into a series of more lake-like pools has influenced current patterns and distributions of mussels, extirpation of some species, and extinctions of some big river riffle species. The dams themselves form barriers to fish movement, which might inhibit the distribution of mussel-specific fish hosts that are necessary to complete the mussels' life cycle.

River transportation and recreational boating have facilitated the spread of the invasive zebra mussel. After large infestations of zebra mussels in the mid- to late 1990s, zebra mussels have declined in the Ohio River. The long-term effects of this exotic invader remain to be seen. Barge transportation, with associated fleeting and mooring areas, terminals, and ports, potentially damages mussel beds through groundings, spills, and wave action that cause bank erosion.

Declines in freshwater mussel populations also underscore the need to maximize the effectiveness of regulations and programs to protect mussels. Concerns about mussel declines have:

- Influenced lock operation and maintenance (including zebra mussel control) and commercial navigation to mitigate the impacts of barge queuing, fleeting and storage, and dispersed traffic;
- Heightened the need to identify mussel beds and potential bed sites and develop protection plans before new developments such as lock extensions, bridges, marinas, and floodplain conversions are initiated;

- Influenced channel maintenance dredging practices and increased interest in using dredged materials to create new islands and sandbars and to restore eroded riparian areas; and

- Helped promote ecosystem restoration and other initiatives aimed at habitat conservation and restoration.

Table 5-9 summarizes the interactions of mussels with other VECs.

TABLE 5-9
Interactions of Mussels with Other VECs

VEC	Mussels & Potential Impacts	Past/Present Trends	Future Trends	Comments
Fish	Provide an important key in the reproductive success of mussels	Due to poor water quality in the past, fish populations in the Ohio River were significantly reduced. Improved water quality has led to a revitalization of the fish populations within the Ohio River. However, existing dams still represent a physical barrier to fish passage.	It is likely that water quality conditions will continue to improve as regulations become more stringent and technologies advance to treat waste materials. This will provide a benefit to fish species that utilize the river. Mitigation in the ORMSS commits the USACE to installing fish passage, if feasible, at EDM as part of this lock improvement project.	Installation of fish passage structures at navigation dams within the upper Ohio River could facilitate passage of fish hosts and subsequent distribution of mussel species between pools.

VEC	Mussels & Potential Impacts	Past/Present Trends	Future Trends	Comments
Recreation	Unintentional groundings could negatively impact mussel populations. Additionally, recreational users can provide a vector for the spread of invasive species.	Recreational use of the river in the past has been limited due to poor water quality. The improved water quality has led to the utilization of the river for recreational uses.	It is likely that water quality conditions will continue to improve as regulations become more stringent and technologies advance to treat waste materials. This will likely lead to additional use of the river for recreational purposes.	Boater education in regards to the presence and importance of freshwater mussels as well as invasive species would be a positive step in the protection of fresh water mussel species.
Riparian Resources	Healthy riparian resources control pollutants from entering stream flow and contribute to the overall health of the aquatic system.	Land areas supporting riparian resources have traditionally been exploited for human use. The importance of riparian resources as a important component to a healthy stream community has recently become an accepted fact.	It is assumed that greater understanding of the importance of riparian resources will be gained as we move forward. Increased regulations addressing riparian resources could also occur resulting in greater protection to these habitats.	Improved riparian resources could provide a positive benefit to the freshwater mussel populations found in the river.

VEC	Mussels & Potential Impacts	Past/Present Trends	Future Trends	Comments
Transportation and Traffic	Commercial boat traffic requires barge queuing, fleeting and storage areas, etc. Traffic can result in unintentional groundings and dispersal of invasive species.	Commercial traffic on the river and the associated maintenance activities have resulted in the manipulation of river habitats. The importance of mussels in the river has recently been accepted as a fact. Mussel populations are now taken into consideration in pool maintenance activities.	It is assumed that transportation and traffic on the river will increase slightly. It is also assumed that technologies will improve.	Improved technologies may reduce the "footprint" left behind by transportation and traffic on the river. Sharing of mussel bed locations with commercial boat pilots would allow them to effectively avoid known beds.
Water Quality/ Sediment Quality	Water quality and sediment quality are extremely important to mussel populations	Poor water/sediment quality in the past resulted in the extirpation and reductions of mussel populations in the Ohio River. Water/sediment quality has been improving in the past several decades allowing re-colonization of the Ohio River by mussels.	It is assumed that regulations governing discharges to waterways will become more stringent and technologies will advance to more effectively treat waste materials discharged to the rivers.	

5.7 INDICATORS OF ENVIRONMENTAL SUSTAINABILITY FOR MUSSELS

Sustainability of the mussel resource is attained when conditions for selected indicators are such that diverse, healthy populations of freshwater mussels are occurring along the majority of the river; further, when the conditions of the indicators exceed regulatory thresholds or other pertinent measures. Indicators of sustainability for mussels include:

- Amount of habitat with stable substrates, suitable depths, and currents and connectivity to other mussel populations;

- Measures of water quality parameters important to mussel populations;

- Extent of food supplies to help ensure good growth rates and reproduction;

- Availability of fish hosts to ensure reproductive success and maintain species diversity; and

- Extent of disturbance from biotic stressors, such as nonnative mussels, and from abiotic stressors, such as river traffic.

5.8 RELEVANT FUTURE ACTIONS AFFECTING MUSSELS

RFFAs for mussels were evaluated utilizing a matrix prepared during the scoping process. The matrix was an outgrowth of a similar matrix developed during the preparation of ORMSS. Results of the RFFA evaluation are summarized in Table 5-10.

TABLE 5-10
RFFA Cumulative Effects Matrix for Mussels VEC

RFFA[1]	Time Period[2]	Occurrence Probability[3]	Location on River[4]	Importance[5]	Effects[6]
USACE Actions					
Navigation Investments					
Replacement locks at Emsworth, Dashields, and Montgomery Dams (EDM)	1	H	S	L	+/-
Rehabilitation of EDM dams	1	H	S	L	+/-
Navigation aids - lock & dam signage	A	H	S	M	+
Non-structural navigation improvements	A	H	S	L	+/-
L&D operation and maintenance	A	H	S	L	+/-
Approach & channel dredging/disposal	A	H	E	H	+/-
USACE Actions					
Environmental design					
Environmental sustainability operation actions	A	H	S	M	+
Pool maintenance	A	H	E	H	+/-
Sec 107 port development and maintenance dredging	2	L	S	M	-
Ecosystem Restoration					

RFFA[1]	Time Period[2]	Occurrence Probability[3]	Location on River[4]	Importance[5]	Effects[6]
Fish passage at EDM	1	H	S	H	+
Actions by Others					
Navigation System Dependent - "But For"					
Commercial navigation					
barge queuing	1	M	E	M	-
fleeting areas/barge storage	1	M	E	M	-
terminals & multi-modal sites	2	L	S	L	+/-
barge/tow tech/"green" design	A	M	E	M	+
accidents/spills	A	M	E	M	-
Coast Guard navigation aids - const., O&M	A	H	E	M	+
Energy					
hydropower on dams	2	M	S	L	+/-
continued operation of coal-fired power plants	A	M	S	M	-
Water-based recreation					
marina development & operation	A	M	S	M	-
commercial boating	A	H	E	M	-
personal boating	A	H	E	L	+/-
River Dependent					
Water supply/discharge					
municipal	A	M	S	M	-
industrial	A	M	S	M	-
Waste water treatment discharges (WWTP)					
onsite systems	A	H	E	H	-
stormwater discharges; CSOs; SSOs	A	H	S	H	-
Marcellus shale gas extraction (water impacts)	A	H	E	H	-
Resource extraction					
instream sand and gravel mining	A	H	E	H	-
Acid mine discharge (AMD)	A	M	E	H	-
Riverfront / Flood Plain Development					
Downtown Pittsburgh					
Ongoing Point State Park improvements	1	H	S	L	+/-
Convention Center riverfront park	1	H	S	L	+/-
residential development /conversions	A	H	S	L	+/-
North Shore development	1	H	S	L	+/-
Pittsburgh South Side					

RFFA[1]	Time Period[2]	Occurrence Probability[3]	Location on River[4]	Importance[5]	Effects[6]
continued riverfront development	A	H	S	L	+/-
continued South Side Works development	1	H	S	L	+/-
Riverfront trails					
Pittsburgh riverfront trail system	A	H	E	L	+/-
Beaver County trail system	A	M	E	L	+/-
Brownfields redevelopment					
Neville Island	1	H	S	M	+
PL&E, McKees Rocks	2	M	S	M	+
M&B Development	2	M	S	M	+
Fab Tech & Buckeye Pipeline	1	M	S	M	+
J&L site in Aliquippa	1	M	S	M	+
Leetsdale Industrial Park	1	H	S	M	+
Resource Protection/Restoration					
Ohio River Islands Wildlife Refuge System	A	H	S	H	+
Nationwide Rivers Inventory	A	M	S	L	+/-
Ecosystem restoration	A	M	E	H	+
Cultural resources	A	M	E	L	+/-
Bridges and Roadways					
Bridge renovations					
Ambridge/Aliquippa Bridge	1	H	S	M	-
Shippingport Bridge	1	H	S	M	-
Rochester Bridge	1	H	S	M	-
McKees Rocks Bridge	1	H	S	M	-
Birmingham Bridge	1	H	S	M	-
Rankin Bridge	1	H	S	M	-
New crossings					
Maglev	2	L	S	M	-
North Shore connector	1	H	S	M	-
Roadways					
Mon/Fayette Expressway	2	L	S	M	-
SR 28 widening/railroad relocation	1	H	S	M	-
CSX double stack upgrades (National Gateway)	1	M	S	M	-
Natural Events					
floods	A	M	E	M	-
droughts	A	L	E	M	+
invasive species	A	H	E	H	-

RFFA[1]	Time Period[2]	Occurrence Probability[3]	Location on River[4]	Importance[5]	Effects[6]
Regulatory Environment					
Phase I & 2 NPDES program	A	H	E	H	+
TMDLs	A	H	E	M	+
ALCOSAN & other consent decrees	A	H	E	H	+
Adaptive management in Sand & Gravel EIS	A	H	E	H	+
Pollution prevention	A	H	E	H	+
USACE permitting programs	A	H	E	H	+
Boating safety regulations	A	H	E	L	+/-
Monitoring programs - PA/ORSANCO	A	H	E	M	+
Environmental awareness education	A	H	E	H	+
Clean Air Act standards	A	H	E	L	+/-
Clean Water Act standards	A	H	E	H	+
Endangered Species Act (ESA)	A	H	E	H	+
Environmental sustainability practices	A	H	E	M	+

[1] Reasonably Foreseeable Future Actions

[2] Time period in which the RFFA may occur: A = all periods; 1 = within 10 years; 2 = in 10 - 25 years; 3 = in 25 - 60 years

[3] Occurrence probability or likelihood RFFA will happen: H = high; M = medium; L = low

[4] Location or setting on river where RFFA is expected to occur: E = along entire length of river; S = specific location

[5] Importance or impact of action on the VEC: H = high; M = medium; L = low

[6] Effects of action on the VEC: + = positive effect; - = negative effect; +/- = mixed effects

Impacts can be complex and occur in many ways. While impacts result from an action, those impacts are not always apparent from a straightforward analysis of cause and effect. Often, similar actions do not affect resources in the same manner. As a means of further explaining potential impacts to mussel populations, four vectors have been identified. The vectors have a specific relationship with one another and may influence the scope and magnitude of future impacts on mussels. Some actions will intercept with more than one vector. The four vectors are related to actions directly contributing to habitat degradation and instability, actions indirectly contributing to habitat degradation and instability, actions affecting reproductive success and community connectivity, and actions beneficial to mussels.

Actions that directly contribute to habitat degradation and instability, physically alter mussels and their habitat by direct damage, or removal of mussels.

Actions that indirectly contribute to habitat degradation and instability and also physically alter mussels and their habitat. They also destabilize mussel populations and habitat by indirectly affecting reproductive success and community connectivity.

Actions that affect reproductive success, community connectivity, or inhibit or prevent normal reproduction. They also cause isolation of mussel communities.

Actions that directly and indirectly benefit mussels and the habitat. They are primarily related to management and regulatory activities that protect and strengthen the health of the resource. They often serve as counter-measures to the cumulative effects of other RFFAs.

RFFAs that fall each of these vectors arelisted in Table 5-11.

TABLE 5-11
RFFAs and Mussels Impact Vectors

RFFA	Actions Directly Contributing to Habitat Degradation and Instability	Actions Indirectly Contributing to Habitat Degradation and Instability	Actions Affecting Reproductive Success and Connectivity	Actions Beneficial to Mussels
USACE Actions				
Navigation aids – lock & dam signage				X
Approach & channel dredging/disposal	X			
Environmental sustainability operation actions				X
Pool maintenance	X			
Sec. 107 port development & maintenance dredging	X			
Fish passage at EDM			X	X
Actions by Others				
Barge queuing	X		X	
Fleeting areas/barge storage	X			
Barge/tow tech/"green" design				X
Accidents/spills	X	X		
Coast Guard navigation aids – const., O&M				X
Operation of coal-fired plants		X		
Marina development & operation	X		X	
Commercial boating	X	X	X	

RFFA	Actions Directly Contributing to Habitat Degradation and Instability	Actions Indirectly Contributing to Habitat Degradation and Instability	Actions Affecting Reproductive Success and Connectivity	Actions Beneficial to Mussels
Municipal water supply/discharge		X		
Industrial water supply/discharge		X		
WWTP - onsite systems		X		
WWTP – stormwater discharges, CSOs, SSOs		X		
Marcellus shale gas extraction		X		
Instream sand and gravel dredging/mining	X	X		
Acid mine discharge		X		
Brownfields redevelopment		X		
Ohio River Islands Wildlife Refuge System				X
Ecosystem restoration				X
Bridge renovations		X		
New crossings		X		
Roadways		X		
CSX Double stack upgrades		X		
Natural events			X	
Nationwide Rivers Inventory				X
Regulatory Environment				X

Discussions of the potential impacts of RFFAs with high and medium importance are presented in the remainder of this section. The discussions are organized around USACE actions and actions by others. Summaries of both permanent and temporary impacts are discussed.

5.8.1 USACE Actions

5.8.1.1 Navigation Investments

Navigation investment will have both negative and beneficial effects on mussels. Actions which would have a positive effect on mussels of the upper Ohio River include lock and dam signage and environmental sustainability operation. The navigation aids will direct barge traffic into lock approaches and away from known mussel beds, thus, minimizing potential for accidental substrate strikes.

Approach and channel dredging/disposal, pool maintenance, and maintenance dredging, however, could result in negative impacts on mussels through the removal of substrates. Impacts from these activities, however, are minimized through a rigorous survey protocols that identify beds prior to dredging. Also, since navigation related dredging is on-going, mussels beds do not become established in these locations. They may however, cause siltation which, in turn, could affect exiting mussel beds and potential habitat. Construction activities, such as these, may also increase turbidity and re-suspend legacy pollutants that have long been buried and may not be impacting mussels (until released). Related construction activity on land may affect stormwater drainage patterns. Changes in these patterns could subsequently create new sediment conditions that negatively alter mussel habitat.

The USACE maintains artificial pools to a minimum depth of 9 feet to facilitate traffic within the navigation channel. When the navigation dams were initially built, it resulted in a major disruption in flows, substrates and water depths, all parameters critically important to mussels on a species basis. Over the years, flows, substrates and depths have been relatively stable and the river now accommodates suitable habitat for some but not all the species that existed prior to dam construction. Mussel species that find these modified habitats acceptable, have either returned to the upper river, not yet re-colonized this reach, or are blocked for other reasons. These conditions are expected to remain constant for the forecast period, providing positive benefits for those species that can adapt to the depth and flow conditions. Conversely, those species adapted to pre-dam conditions are negatively affected.

5.8.1.2 Ecosystem Restoration

Implementation of fish passage structures at the Emsworth, Dashields, and Montgomery locks and dams would provide a significant positive effect on mussel populations. Fish passage structures would generally benefit mussels by allowing fish hosts of mussel species the opportunity to migrate beyond the existing barriers allowing for establishment of new beds and increasing genetic diversity between beds. Fish passages could, however, also allow better movement of invasive species which could negatively affect mussels.

5.8.2 Actions by Others

5.8.2.1 Navigation System Dependent – “But For”

“But for” actions which would have a positive effect on mussels of the upper Ohio River include barge/tow tech/green design, and Coast Guard navigation aids construction and O&M. The barge/tow tech/green design action pertains to future operation and maintenance practices, new technology, and design practices focused on improving existing environmental conditions associated with commercial navigation. This would likely result in a positive impact on the habitat of mussels of the river. The Coast Guard navigation aids are to direct barge traffic to stay within the navigation channel of the river and away from known mussel beds, thus, minimizing the potential for accidental substrate strikes.

“But for” actions that would have direct and indirect negative effects on mussels of the upper Ohio River include: barge queuing, fleeting areas/barge storage, accidents/spills, continued

operation of coal-fired power plants, marina development and operation, and commercial boating, all of which could potentially affect water quality and habitat. Barge queuing, fleeting areas/barge storage, and commercial boating could have a negative impact to mussels through accidental toe-ins or substrate strikes associated with such activities or through direct habitat removal. Accidents and spills would result in a negative impact through the potential introduction of a pollutant directly to the river, thus, negatively affecting water quality thereby affecting the health of existing mussel beds. Operation of coal-fired power plants could result in a negative impact on mussels through thermal wastewater discharges to the river. Marina development and operation could require dredging activities which may result in a negative impact on mussels by direct impacts to habitat. Marina development could also require clearing of existing vegetation, leading to the potential for siltation due to the associated earth disturbance.

Activities directly related to traffic on the river, regardless of whether it is industrial, commercial, or recreational, could affect reproductive success. Watercraft provide attachment mechanisms for invasive species, such as zebra mussels, thus, connecting river pools to allow more movement. Invasive species could outcompete native species for habitat and food.

5.8.2.2 River Dependent

River dependent actions would likely result in negative effects on the mussels of the upper Ohio River. New municipal and industrial discharges, as well as discharges from onsite systems, stormwater systems, CSOs, and SSOs, add an additional pressure to mussel populations in the river since these are potential sources of water and sediment pollution. Acid mine discharge is an additional pollution source to the river that would apply negative pressure to mussels. These discharges will be regulated, however, which will maintain tolerable levels of these potential sources of pollution. If a large AMD discharge were to occur on the Monongahela River, as predicted by some, this could result in a significant impact to mussels. Contaminants associated with AMD could be deposited within mussel habitat areas, killing existing populations and losing these sites for future populations. Of all issues facing the area that are related to the Ohio River environment, this potential discharge from the Monongahela Mine Pool is the most uncertain. Discharges from the mine pool, if any, could be confined to the Monongahela River, or if they do reach the Ohio River, flows from the Allegheny River would likely neutralize the effects to some degree.

Instream sand and gravel mining could have both direct and indirect effects on mussels and habitat. Although surveys would be performed before new mining activities would occur, potential habitat could be inadvertently disturbed through instream work. Sediments from mining operations could also be re-suspended. If this sediment contains any pollutants, those pollutants could negatively impact nearby mussels or habitat. Nearby habitat is also at risk if new sediment patterns create cascading effects that cause upstream changes or disturbances.

Wastewater discharges, either direct or through inadequate treatment, from Marcellus shale operations are an additional source of pollution to the river. These discharges will also be regulated to some degree under existing and future regulations to minimize environmental impacts, but some researchers believe not enough is known yet about the potential for negative

impacts to aquatic life. Existing CSO and SSO discharges are continuing sources of pollution to the river. A consent agreement to do away with these types of systems has been executed which will eliminate over time the effects of these discharges on mussels.

5.8.2.3 Riverfront/Flood Plain Development

Brownfields redevelopment is a category of riverfront/floodplain development that would provide a positive effect on the population of mussels within the river. Redevelopment of the existing brownfields along the upper Ohio River may result in the removal or isolation of potentially contaminated soils from accessing river flows. There are several brownfields along the upper Ohio River that may be redeveloped.

5.8.2.4 Resource Protection/Restoration

Resource protection and/or restoration provide positive benefits to the mussels of the upper Ohio River. The purpose of the Ohio River Islands Wildlife Refuge System is "the development, advancement, management, conservation, and protection of fish and wildlife resources" (USFWS 2001). Endangered freshwater mussels are a focus of the refuge. Ecosystem restoration projects would be beneficial for mussel populations as these types of projects would be focused on the improvement of existing habitats in or along the river. Additionally, the Endangered Species Act, Fish and Wildlife Coordination Act, and various state regulations all serve to help protect this resource as well.

5.8.2.5 Bridges and Roadways

Renovations to existing bridges and new bridge crossings could result in negative impacts to mussel populations of the river. New pier locations for support or implementation of causeways during construction could be necessary for a bridge project over the upper Ohio River. This could result in direct impacts to mussels through permanent loss of substrates for bridge piers.

While not directly impacting the river, the roadway and CSX double stack projects would indirectly affect mussels and their habitat. Construction activity on land adjacent to the river may affect stormwater drainage patterns. Changes in these patterns could subsequently create new sediment conditions that negatively alter mussel habitat.

5.8.2.6 Natural Events

Natural events such as moderate droughts or low flow events on a river can be beneficial to the reproductive success of mussel species. Strong recruitment has been observed in mussel species following periods of low flow events. During periods of low flow, host fish congregate in deeper water, increasing the contract with mussel beds where the glochidia can be transferred.

Higher water temperatures during droughts, however, could affect oxygen levels in the water and lead to stress for mussel populations. Oxygen is measured in its dissolved form as dissolved oxygen (DO). If more oxygen is consumed than is produced, DO levels decline and

some sensitive animals may migrate, become ill, or die. Because DO levels vary by season and day, mussels are most vulnerable to lowered DO levels in the early morning on very hot summer days when water temperatures are high and aquatic plants have not been producing oxygen since sunset.

Natural events such as floods can result in a negative impact to mussel populations within channelized rivers as strong flows associated with flooding in such systems can scour substrates, potentially dislodging mussels.

Certain mussel species have evolved to develop specialized anatomical features (mantles) whose purpose is to attract potential fish host species as carriers for freshwater mussel glochidia. Clearer waters during low flow events may also promote the success of this anatomical adaptation. Species from the tribe *Lampsilini* have developed specialized mantles to attract host fish species. Species observed in the project area that are within the tribe *Lampsilini* include: *Leptodea fragilis*, *Obliquaria reflexa*, and *Truncilla donaciformis*.

Invasive species can be very damaging to freshwater mussels. For example the zebra mussel (*Dreissena polymorpha*) populations can colonize a native mussel to the extent that they can suffocate the animal. Other invasive species such as the Asiatic clam (*Corbicula fluminea*) can extensively populate an area of river to the exclusion of native mussels.

5.8.2.7 Regulatory Environment

The existing regulatory environment potentially provides the greatest level of protection for freshwater mussels, both directly and indirectly. The Endangered Species Act of 1973 provides direct protection to federally listed endangered mussel species. This regulation also provides protection for the habitat of listed species. USACE permitting programs provide authority to review projects for impacts to natural resources and require measures to avoid, minimize, and mitigate for unavoidable impacts. Adaptive management requires quarry operators to utilize the best available data and research techniques to evaluate potential mining sites during the planning phases of a project. It also defines sensitive habitat areas of the river that are to be avoided. Programs under the Clean Water Act, such as the National Pollution Discharge Elimination System (NPDES), Section 319 for nonpoint source control, and TMDL programs, will provide for improved water quality conditions of the river through the permitting of discharges and limitations to pollutant discharges to the river. Consent decrees in place to remediate for CSO and SSO discharges are in place and should ultimately result in the elimination of such systems. Monitoring programs, such as ORSANCO's will be continually testing the river and suggesting new regulations as land uses and industries along the river change over time. Environmental sustainability practices will improve the methods in which projects are planned and constructed. Finally, environmental awareness education will provide the opportunity to educate the public on the importance of mussel populations to healthy river ecosystems.

5.9 ANALYSIS OF ENVIRONMENTAL SUSTAINABILITY

Sustainability of mussels is attained when there are diverse, healthy populations of freshwater mussels occurring along the majority of the river. Indicators of sustainability for mussels are related to habitat with stable substrates, suitable depths, and currents and connectivity to other mussel populations; water quality; food supplies to help ensure good growth rates and reproduction; availability of good fish hosts to ensure reproductive success and maintain species diversity; and limited biotic and abiotic stressors.

Environmental sustainability is a synergistic process whereby environmental considerations to mussels are effectively balanced through the life cycle of project planning, design, construction, operation, and maintenance to improve the quality of life for present and future generations. Accordingly, it represents a test of significance of potential cumulative effects.

5.9.1 Positive Forces Affecting Mussels

The positive forces that are affecting mussels of the upper Ohio River are related to water quality improvements, increased public awareness of the importance of mussel populations to healthy, functioning aquatic systems, the establishment of the Ohio River Islands National Wildlife Refuge, and the existing regulatory environment. All of these forces will improve habitat and support life stages, not only for mussels but also for other aquatic organisms that contribute to the health of native mussels.

Water quality provides the greatest positive influence on mussels. By regulating the pollutants discharged to the environment, negative effects on water quality, sediment quality, and mussel habitat are minimized. There are many parts of the regulatory environment working for environmental improvements. Consent decrees to eliminate CSO and SSO systems provide a significant positive influence on sediment quality by removing polluting systems. Monitoring programs regularly test water quality to ensure that entities with permitted discharges are following the conditions of their respective permits. Permitting programs administered by the USACE protect the health of water and sediment quality through project evaluation. Environmental sustainability practices improve construction projects.

Closely tied to water quality, the regulatory environment provides a significant opportunity for strengthening the health of mussels. Through the use of federal and state regulations, and related local initiatives, laws, policies, and programs protect threatened and endangered species, help preserve habitat, and improve water quality. The net result is the removal of pollution and enhancement of biological diversity.

Most mussel species require a fish host to complete their life cycle. Although there have been many changes in the fish population throughout the past, fish are rebounding, offering additional opportunities to host mussels. While not all fish serve as hosts, as fish populations increase, so too may mussel populations. The establishment of the Ohio River Islands National Wildlife Refuge provides refugia for mussels downstream of the project area and increases

awareness of this resource. Enhancement of islands create suitable habitat for new mussel beds which provide a genetic source of re-colonization upstream. Under ORMSS, the USACE has committed to evaluating fish passage opportunities around its locks and dams which historically has isolated mussel populations between pools.

The redevelopment of brownfields along the river provides a potential opportunity for the removal or isolation of potentially contaminated soils from accessing river flows and river sediment. This in turn could improve existing mussel habitat and potentially add new habitat areas.

Increased public awareness through environmental education will continue to provide further knowledge on the importance of mussel populations. The Ohio River Islands National Wildlife Refuge System, and other organizations like the Ohio River Valley Ecosystem Team Mollusk Group, local universities, and the Western Pennsylvania Conservancy, provide a positive force on mussels. Mussels and other aquatic life are species of focus for the Ohio River Islands National Wildlife Refuge System. Ecosystem restoration efforts also provide a positive influence through various habitat restoration projects that may occur.

Navigation aids, both at the locks and dams and throughout the pools, provide positive influences on mussels through the direction of barges to remain within the navigation channel minimizing the opportunity for unexpected substrate strikes or unnecessary propeller wash. Barge/tow tech/green design provides the opportunity for improved navigation practices that benefit existing environmental conditions; environmental sustainability practices will improve the methods in which projects are planned and constructed.

5.9.2 Negative Forces Affecting Mussels

Numerous biotic and abiotic stressors are affecting mussel populations negatively. Biotic stressors which affect native freshwater bivalves natural predators, human predation, and non-native, invasive species. Non-native invasive species pose a significant risk to the populations of native freshwater mussels. Abiotic stressors include habitat modification, point source pollution, and non-point source pollution. Habitat modification includes activities such as dam building, channel dredging, in-stream sand and gravel mining, snag removal, and increased siltation.

The primary food source for mussels is provided by organic material suspended in the water column and siphoned through the animal, however, there remains some uncertainty as to the source of the food that is consumed by mussels. Additional research into this aspect of mussel biology is required to provide a definitive understanding of mussel feeding. Until then, it will be difficult to determine the best conservation practices for mussels and potential food sources may remain unprotected.

Other negative forces affecting mussels are wastewater discharges to the river, existing and potential discharges of acid mine drainage, maintenance of the navigation pools, navigation traffic, legacy pollutants in sediment, and sand and gravel dredging operations. Commercial boating, barge queuing, and mooring/fleeting areas also provide potential negative influences on

mussels. Potential accidents and spills associated with shipping and industry along the river also have the potential to negatively affect mussel habitat.

New bridge crossings and rehabilitation to existing bridges over the upper Ohio River are another potential negative pressure on mussel species due to direct impacts from abutment placement and effects to habitat from changes in hydrologic flows. However, these impacts will be buffered through potential permit conditions to avoid or minimize impacts to mussels. Port development and maintenance dredging as well as marina development and operation provide additional negative forces on mussels due to loss of habitat and potential water quality issues from spills, but again, these impacts would likely be buffered through potential permit conditions. Commercial boating activities including barge queuing and mooring/fleeting areas also provide potential negative influences on mussels. These types of activities would also likely be buffered through planning and potential permitting requirements.

5.9.3 Incremental Impacts on EDM

The incremental impacts of EDM improvements will be limited and generally positive. Modern locks will allow for more efficient movement of commercial traffic from one pool to another. Environmental design and ecosystem restoration (such as fish passages) will benefit fisheries including host species of mussels.

5.10 DETERMINATION OF SUSTAINABILITY

Three definitions of environmental sustainability were used for the analysis:

- Not sustainable – conditions for the selected indicators do not reflect conditions that would facilitate attainment of acceptable standards or would not maintain existing standards in concert with collective impacts of proposed activities.

- Marginally sustainable – conditions for selected indicators are such that attainment is accomplished for the majority, but not all, of the potentially affected areas. However, the conditions are somewhat tenuous both in location and likelihood of occurrences. (In other words, the conditions are borderline for environmental sustainability, and there are uncertainties regarding specific quantitative measures.)

- Sustainable – conditions for selected indicators are such that attainment of acceptable conditions are accomplished for essentially all of the potentially affected project area in the project area, and such standards are maintained in concert with foreseeable future activity. Further, conditions exceed regulatory thresholds, and various governmental programs are in place to respond to any potential erosion of values related to mussels.

Figure 5-2 illustrates the sustainability of mussels. The sustainability of mussels can be characterized as follows:

- In the time period from settlement and continuing to around the mid 20th century, mussel populations can be classified as not sustainable due to the significantly degraded conditions of water quality and modification of existing flow regimes through construction of the modern lock and dam system, which resulted in severe impacts on the existing populations of mussels in the upper Ohio River. The lack of awareness regarding the importance that mussel populations have on a healthy river ecosystem, as well as the lack of knowledge regarding the mussel life cycles, further contributed to this not sustainable condition.

- In the time period from the mid 20th century to the late 20th century, water quality conditions began to improve. This awareness led to the signing of an interstate compact in 1948 which led to development of the Ohio River Valley Water Sanitation Commission to clean up the waters of the Ohio River. Implementation of the Clean Water Act (CWA) in the 1970s further improved the water quality conditions in the upper Ohio River. The Endangered Species Act of 1973 provided protection for listed species. These programs/regulations provided for improved water quality, allowing for a recolonization of the upper Ohio River by freshwater mussels, and the ESA provided for protections of mussel species found on the federal threatened and endangered species list. In more recent times, establishment of the Ohio River Islands National Wildlife Refuge provided a beneficial influence on mussels of the Ohio River. Stricter water quality standard are further improving water quality conditions of the river. A greater understanding of the biology of freshwater mussels has also been beneficial to mussel populations of the river. Greater public awareness on the importance of freshwater mussels will further benefit mussel populations of the river. These conditions suggest the current status of mussels may be marginally sustainable.

- The future sustainability of mussels is unclear; however, the status of mussels in the future is likely to remain unchanged. A significant amount of critical habitat has already been lost and it will be difficult for all of it to be restored. Mussel species that are more tolerant of changes in habitat are rebounding, however, which would suggest full sustainability is possible for some species. But even though the health of fish hosts has strengthened and water quality has improved, not all species are sharing equally and some parts of the aquatic system are still threatened by pollution and manmade pressures.

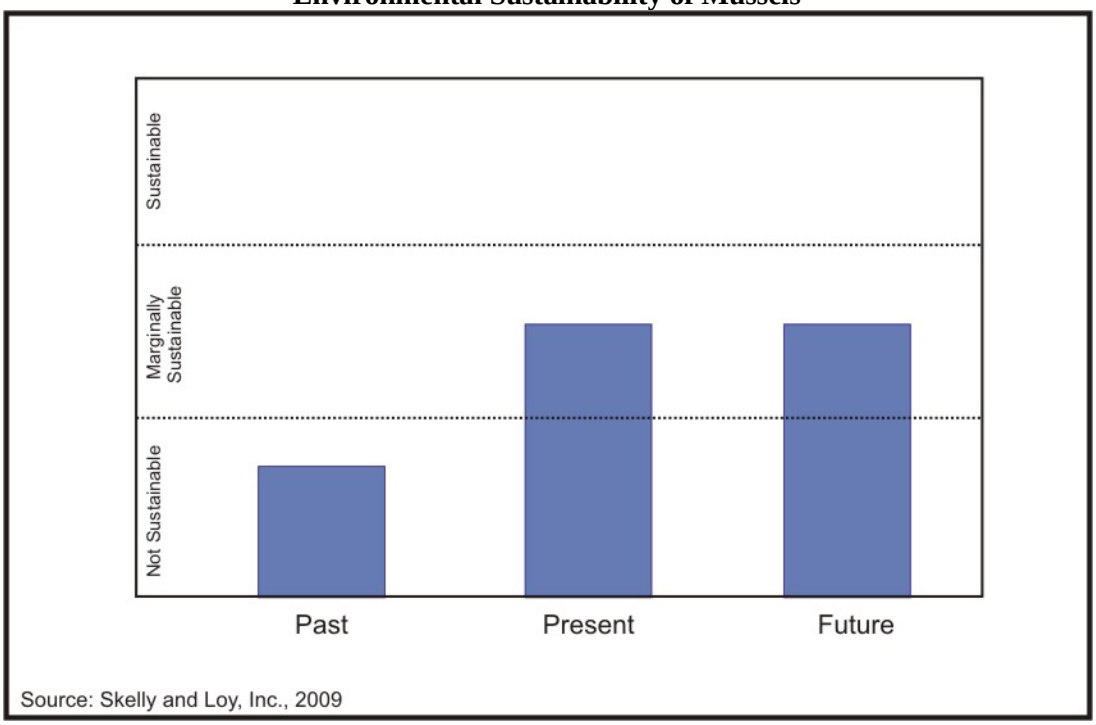
  Awareness of the ecological services performed by freshwater mussels has grown, however, which suggests a greater understanding of freshwater mussels by more people and groups. As time goes by, public perception of the importance of mussels may continue to grow and new programs may be put in place to specifically protect this form of aquatic life.

  Construction activities will continue to imperil mussel habitat, however, even though safeguards like pre-construction surveys, translocation, and post-activity monitoring are in place. Additionally, the presence of legacy pollutants in river sediment reduces the amount of habitat that could be available to future mussel populations.

Compounding the problems associated with legacy pollutants is the lack of specific programs or funding to remove these pollutants from the river.

Despite other ecological improvements that have benefitted other environmental resources, mussel habitat is unlikely to return easily. While regulations are in place that are aimed at preventing the loss of additional mussel populations, there is still uncertainty about whether or not all populations will rebound or simply hold to existing levels. Additionally, the long-term effects of invasive species, like the Zebra mussel, are still unknown. Consequently, there is a lot of uncertainty about future mussel populations. It is unlikely that a significant change in the current status of mussels will occur. Thus, conditions for mussels will remain marginally sustainable into the future.

FIGURE 5-2
Environmental Sustainability of Mussels



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Chapter 6

RIPARIAN RESOURCES

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6.1 DEFINITION

The National Research Council (NRC) cites the lack of a consistent definition for riparian areas as a major problem for federal and state programs managing and protecting these resources. The NRC has developed the following working definition for riparian areas:

> Riparian areas are transitional between terrestrial and aquatic ecosystems and are distinguished by gradients of biophysical conditions, ecological processes, and biota. They are areas through which surface and subsurface hydrology connect water-bodies with their adjacent uplands. They include those portions of terrestrial ecosystems that significantly influence exchanges of energy and matter with aquatic ecosystems (i.e., a zone of influence). Riparian areas are adjacent to perennial, intermittent, and ephemeral streams, lakes, and estuarine-marine shorelines (2002).

Riparian areas encompass portions of the channel system and associated features (gravel bars, islands, and woody debris); a vegetated zone of varying successional states influenced by floods, sediment deposition, soil-formation processes and water availability; and a transitional zone to the uplands of river valleys. Although riparian resources occupy only a small proportion of the total land area in most watersheds, they are regional hot spots for biodiversity and exhibit high rates of biological productivity (NRC 2002).

Several habitat types occur within the upper Ohio River's riparian areas. They include wetlands, bottomland hardwood forests, transitional/upland habitats, steep hill slopes, and riverine islands. Together, these habitats provide complex ecological buffers between the river and manmade development. Loss of riparian areas, changes in riparian quality, or habitat fragmentation affects both the natural environment and human health.

6.2 OBJECTIVES/SCOPE

6.2.1 Objectives

Riparian resources provide an interface between terrestrial and aquatic systems, but their ecological value has not been fully recognized or emphasized until relatively recently. Consequently, riparian resources have been depleted or completely removed in many urban areas. Whereas they may be taken for granted in more rural settings, agricultural cultivation may also degrade or eliminate riparian resources. Degradation of vegetation and soil erosion along stream corridors further compromise riparian quality and promote invasion of non-native plant species. The establishment of non-native vegetation in turn causes further degradation of habitat quality and riparian function. Such has been the case not only along the upper Ohio River, but along many other larger American rivers.

This chapter provides an overview of riparian resources throughout the upper Ohio River. Additionally, this chapter assesses the system-wide cumulative impacts to riparian resources of all likely actions along the river from 2009 to 2070. Impacts that are directly or indirectly attributable to modernization of the navigation system are evaluated in concert with impacts from other past, present, and reasonably foreseeable future actions (RFFAs) by the United States Army Corps of Engineers (USACE) and others.

Assessment of past and present actions and current conditions is the basis for identifying and interpreting the potential impacts of Reasonably Foreseeable Future Actions (RFFAs). Future actions include the major navigation improvements identified in this study; other routine or potential actions by the USACE; projected actions by other federal, state, or local agencies, and non-governmental entities; predictions of general economic expansion and development as well as regulatory changes.

The results of the cumulative effects assessment are intended to determine whether the impacts of the RFFAs constitute acceptable outcomes for the affected resources and how the proposed navigation improvements contribute to those outcomes.

6.2.2 Geographic Scope

The geographic focus for riparian resources extends to the limit of the 500-year floodplain along the upper Ohio River, as well as the 500-year floodplain of tributaries and embayments influenced by pool elevations of the upper Ohio River. Islands and habitats adjacent to floodplains, such as wetlands and aquatic macrophyte beds, are also considered. The downstream geographic limit is defined as the New Cumberland Lock and Dam. The upstream limit is defined as the first upstream dam on the Allegheny and Monongahela rivers. These are Lock and Dam Number 2 and the Braddock Lock and Dam, respectively.

6.2.3 Time Frame

The established time frame for this assessment is from 1885 to 2070. The earlier date is when initial the initial lock and dam construction on the Ohio River began. Thus, it approximates the beginning of the modern lock and dam system. The latter date approximates the economic life of anticipated improvements on the upper Ohio River and is considered the planning horizon for the project.

6.3 ISSUES FROM SCOPING

Scoping has occurred as part of the Ohio River Mainstem Study (ORMSS) and for the Upper Ohio Navigation Study. A series of 12 public scoping meetings was held for ORMSS during the summer of 2001. Subsequently, a series of three public scoping meetings was held for the Upper Ohio Navigation Study in October 2006. Approximately 185 people attended the ORMSS meetings and approximately 40 people attended the Upper Ohio Navigation Study meetings.

Several comments related to riparian resources were made during both series of meetings. Comments have been received verbally and in writing (either through letters or questionnaires). Comments that are directly or indirectly associated with riparian resources are shown in Table 6-1. Some data from ORMSS have been aggregated in the table below, and as a result may not tie directly into individual comments presented in the larger study.

TABLE 6-1
Comments on Riparian Resources from Public Scoping Meetings

Comment	Number of Similar Comments	Scoping Meeting
Potential adverse effects of higher pool elevations on bridges, other infrastructure, & property	12	ORMSS, Upper Ohio River Nav. Study
Bank undercutting & failure caused by increased barge traffic/queuing/wave action	11	ORMSS
Loss of shoreline trees & riverfront property	8	ORMSS

Comment	Number of Similar Comments	Scoping Meeting
Importance of maintaining shipping channel & improving intermodal transportation facilities	6	ORMSS
Increase in trash for property owners & river users	6	ORMSS
Mouths of tributaries silted in, limiting access and causing property damage	5	ORMSS
Development of marina facilities causing a loss of greenspace	5	ORMSS
Potential development of hydroelectric power at dams	5	ORMSS
Changes in shipping demand & river traffic	5	ORMSS, Upper Ohio
Procurement/control of land by federal government	3	ORMSS
Increased industrialization/traffic causing degradation of recreational value	3	ORMSS
Property restrictions	2	ORMSS
Increased development of scenic byways and bikeways	2	ORMSS
Effects on groundwater	2	ORMSS
Potential conflicts between siting of new navigation facilities and riverfront development	2	Upper Ohio River Nav. Study
Riverfront development constraints related to endangered species	1	ORMSS
Potential impairment of scenic value	1	ORMSS
Need for coordination between Corps & transportation planning agencies	1	Upper Ohio River Nav. Study

Additional information and comments have been sought from the environmental resource agency representatives and planning officials serving on an Interagency Working Group (IWG) that was specifically assembled for this project. Comments from IWG members on potential impacts to riparian resources have emphasized the narrow size of the floodplain along with the existing urbanized uses (e.g., commercial, industrial, residential) of the upper Ohio River floodplain. Invasive, exotic species are also a topic of concern expressed by IWG members. An additional topic of concern relates to the presence of dams on the river and how this condition has changed the characteristics of the riverbanks along the upper Ohio River.

6.4 LAWS, REGULATIONS, ORDINANCES, AND PROGRAMS

Table 6-2 lists regulatory statutes of significance to USACE activities related to the management and protection of riparian resources.

TABLE 6-2
Laws, Regulations, Ordinances, and Programs Relevant to Riparian Resources

Law/Program (Lead Agency)	Key Components	Relevance to Riparian Resources
Water Resources Development Act (U.S. Army Corps of Engineers)	• Authorizes USACE port development, navigation, flood control, and erosion control projects through the 1986 act and subsequent amendments	Contains provisions for environmental assessment and mitigation
USACE Permitting Statutes (U.S. Army Corps of Engineers)	• Section 10 of the Rivers and Harbors Act (1899) prohibits the unauthorized obstruction or alteration of any navigable water of the United States. • Section 404 of the Clean Water Act authorizes the USACE to issue permits for the discharge of dredged and fill materials into U.S. waters.	Permits require assessment of impacts on water quality and aquatic ecological resources and mandate mitigation of adverse impacts
Small Navigation Projects (U.S. Army Corps of Engineers)	• Section 107 of Rivers and Harbor Act (1960) authorizes USACE to develop and construct small navigation projects for harbor protection.	Includes impacts of such actions on riparian/floodplain resources
Spill Response (U.S. Coast Guard, ORSANCO)	• Includes emergency response activities for river-related spills and accidental discharges and is related to the Oil Pollution Act and Section 301 of the Clean Water Act	Minimizes adverse impacts of spills and discharges on riparian resources and on water quality
Clean Water Act (CWA) (U.S. Environmental Protection Agency)	• Establishes structure for regulating pollution discharges into U.S. waters (NPDES permits) • Gives USEPA authority to implement pollution control programs • Requires establishment of water quality standards • Recognizes need to address nonpoint source pollution	Implementation plans to achieve water quality standards in impaired water bodies can involve riparian management strategies. Specific provisions of the CWA provide for demonstration projects in riparian areas.
National Flood Insurance Act (U.S. Environmental Protection Agency)	• Encourages adoption of state & local floodplain regulations restricting certain types of development within floodplains • Provides for federally backed flood insurance to property owners living in eligible communities	Limits development impacts in riparian areas: insurance provided covers the collapse or subsidence of land along the shore of a lake or similar body of water as a result of erosion

Law/Program (Lead Agency)	Key Components	Relevance to Riparian Resources
Safe Drinking Water Act (U.S. Environmental Protection Agency)	• Provides for establishment of primary regulations for the protection of public health and secondary regulations related to taste, odor, and appearance of drinking water	Helps protect public water supplies
Site Remediation Statutes (U.S. Environmental Protection Agency)	• Includes CERCLA, RCRA, SARA, and related state programs that focus on cleanup and restoration of contaminated sites	Potentially reduces groundwater and soil pollution sources and contributions to pollution loads in the Ohio River
TMDL Program (U.S. Environmental Protection Agency)	• Regulates maximum pollutant load a water body can receive and still attain water quality standards	Many TMDL implementation plans require restoration of riparian areas as a management measure to achieve nonpoint source pollution reductions.
Phase 1 & 2 NPDES Program (U.S. Environmental Protection Agency)	• Requires municipalities and certain industrial and construction sites to adopt BMPs to control point sources of pollution	Should reduce pollution characteristics of stormwater discharges from urban and industrial zones along the Ohio River
Oil Pollution Act (U.S. Environmental Protection Agency & U.S. Coast Guard)	• Strengthened federal ability to prevent & respond to catastrophic oil spills	Protects riparian resources from pollution & damage from oil spills
Comprehensive Environmental Response, Compensation and Liability Act (U.S. Environmental Protection Agency)	• Provides for liability, compensation, cleanup, and emergency response for hazardous substances released into the environment and cleanup of inactive hazardous waste sites	Includes abandoned hazardous waste sites in the floodplain
National CSO Control Policy (U.S. Environmental Protection Agency)	• Calls for communities to implement a long-term plan for combined sewer overflows (CSOs) to comply with the CWA	Should reduce pollution to riparian resources from a major urban source
Executive Order 11988, Floodplain Management & Executive Order 11990 (Executive Branch 1997)	• Prevents federal agencies from contributing to the adverse impacts of floodplain development & modification	Restricts federal development in Ohio River floodplain wherever there are practicable alternatives
Executive Order 13112, Invasive Species (1999) (Multi-agency National Invasive Species Council)	• Requires federal agencies to prevent the introduction of invasive species and provide for their control and to minimize their economic, ecological, and human health impacts	Helps to maintain and/or restore the ecological integrity of riparian areas.

Law/Program (Lead Agency)	Key Components	Relevance to Riparian Resources
Executive Branch's No Net Loss Policy	• Limits the loss of wetland habitat.	Provides direction from the Executive Branch to stop the nationwide loss of wetland habitat
Emergency Wetlands Resources Act (U.S. Fish & Wildlife Service)	• Authorizes purchase of wetlands from Land and Water Conservation fund • Requires states to include wetlands in Comprehensive Outdoor Recreation Plans • Provides funding for the Migratory Bird Conservation Fund	Encourages federal-state cooperation in wetlands protection and outlines funding mechanisms
Endangered Species Act (U.S. Fish & Wildlife Service)	• Authorizes determination & listing of threatened & endangered species • Prohibits unauthorized taking, possession, sale & transport of endangered species • Provides for land acquisition to protect endangered species	Establishes framework for protection of threatened & endangered riparian species
Fish & Wildlife Coordination Act (U.S. Fish & Wildlife Service)	• Requires that when water bodies are modified by a federal agency, that agency first shall consult with the USFWS and with appropriate state agencies with a view toward wildlife conservation	Provides for equal consideration and coordination of riparian resources wildlife conservation with other aspects of water resources development
National Wildlife Refuge System Administration Act & National Wildlife Refuge System Improvement Act (U.S. Fish & Wildlife Service)	• Provide guidance for management and public use of refuge system, including development of comprehensive conservation plan for each refuge	Guides management & public use of Ohio River Islands National Wildlife Refuge
North American Wetlands Conservation Act (U.S. Fish & Wildlife Service with North American Wetlands Conservation Council)	• Provides funding and implementation of the North American Waterfowl Management Plan & North American nations wetlands agreement	Supports migratory bird conservation in the Ohio River valley
Migratory Bird Conservation Act (U.S. Dept. of Interior)	• Provides for the acquisition and maintenance of public land for habitat preservation of migratory birds	Applies to land, water, and transitional areas (e.g., riparian areas)

Law/Program (Lead Agency)	Key Components	Relevance to Riparian Resources
Migratory Bird Treaty Act (U.S. Dept. of Interior)	• Implements various treaties and conventions between the U.S., Canada, Mexico, Japan, and the former Soviet Union for the protection of migratory birds; prohibits taking, killing, and possession	Protects migratory birds utilizing riparian resources
National Invasive Species Act (U.S. Dept. of Trans. and Aquatic Nuisance Species Task Force)	• Requires all vessels operating in US waters that are equipped with ballast tanks to comply with guidelines designed to prevent and reduce the dispersal of aquatic nuisance species	Helps reduce the further introduction and dispersal of invasive species that can disrupt riparian ecosystems
ORSANCO Monitoring (ORSANCO)	• Encompasses ongoing water quality and aquatic ecology monitoring programs by the Ohio River Valley Water Sanitation Commission	Helps track trends in water quality and biological communities and provides database that can inform decision making
Nature Works Program (Ohio Depart. Of Natural Resources)	• Provides funding for riparian area protection and restoration projects, and for acquiring permanent and temporary easements on riparian areas and associated wetlands	Priority is given to easement program
PA Sewage Facilities Act	• Provides for the planning and regulation of community and individual sewage systems	Improved water quality as a result of this act; has a positive influence on riparian resources
PA Storm Water Management Act	• Requires counties to prepare and adopt watershed based stormwater management plans	New construction is required to manage the stormwater runoff generated at the site; unchecked stormwater runoff can lead to significant erosion events on streams.
PA Act 67 & 68	• These two acts encourage sound land-use planning at the local level and require state agencies to consider local land use ordinances and comprehensive plans when making permit or funding decisions.	Allow local government the ability to preserve selected open spaces and drive growth where it is wanted
State Water Quality Certification (Appropriate state or interstate pollution control agencies)	• Section 401 of the CWA requires certification from state or interstate water control agencies that a project is in compliance with established effluent limits and water quality standards.	Provides opportunity for state or interstate scrutiny of such actions on riparian and other aquatic resources

6.5 PAST TO CURRENT BASELINE CONDITIONS

6.5.1 Past Conditions

The natural climax community that occurs along the Ohio River consists of the bottomland hardwood forest. Dominant tree species found in this type of forest include silver maple (*Acer saccharinum*), American sycamore (*Platanus occidentalis*), and black willow (*Salix nigra*). Other tree species present may include slippery elm (*Ulmus rubra*), pin oak (*Quercus palustris*), river birch (*Betula nigra*), hickory species (*Carya* species), hackberry (*Celtis occidentalis*), black locust (*Robinia pseudoacacia*), green ash (*Fraxinus pennsylvanica*), and box elder (*Acer negundo*). Shrub species may include spice bush (*Lindera benzoin*), Virginia creeper (*Parthenocissus quinquefolia*), poison ivy (*Toxicodendron radicans*), and grape species (*Vitis* species). Hebaceous species may include wingstem (*Verbesina alternifolia*), pale jewelweed (*Impatiens palida*), spotted jewelweed (*Impatiens capensis*), white snakeroot (*Eupatorium rugosum*), among others (USFWS 2001).

"With rapid settlement and industrial growth, the common frontier perspective on natural resources as being both inexhaustible and available for private use caused the river and its riparian corridor to be taken for granted and exploited for municipal and private use" (USACE 2001). During the period of settlement, the Ohio River provided the most reasonable transportation route to points west. The utilization of the Ohio River as a transportation route led to the development of navigational improvements along the river that began with the removal of snags and has led to the development of the modern lock and dam system that is currently in place on the river (Frost and Mitsch 1989). Other developments that have occurred along the river include development of wharfs and historical locks and dams (Smith and Swetnam 1991). The existing floodplains of the Ohio River were also utilized as transportation corridors. Rail lines and rail yards were constructed along the banks or within the floodplains of the river. Highways were also constructed in these areas. In addition, the industrialization of the Pittsburgh region led to the use of riparian areas primarily for manufacturing purposes. Manufacturing facilities that were historically found along the river included boat building facilities, iron and glass works, and later steel manufacturing operations.

Heavy influence by human activities has also resulted in a significant reduction in the historic woodlands and other associated riparian vegetation through land clearing and development activities. Woodlands, for example, were dissected by roads and other transportation corridors, perforated by clearings and house lots, shrunk by introduction of other land uses, fragmented through development patterns, and disappeared altogether in some locations. Such processes not only have changed the appearance of woodlands and other riparian resources but also their ecological functionality.

Construction of dams and subsequent establishment of navigation pools have also impacted riparian areas. As a result of these activities, former riparian areas have been inundated. Wharfs for barge terminals have also eliminated some of the transition zone between aquatic and upland habitats. Where natural banks remained, riparian growth was often cut down

to expand terminals. In other cases, riparian areas were eliminated to accommodate fleeting activities associated with the terminals.

6.5.2 Present Status and Recent Trends

6.5.2.1 Floodplains

The floodplain along the upper Ohio River is generally narrow as it flows through a relatively flat-lying sequence of sedimentary rock. Throughout the study corridor, the floodplain of the upper Ohio River, including the lower portions of the Allegheny and Monongahela rivers, is heavily developed. Common land uses appear to be industrial and urban land. Transportation corridors (roadways and rail) are also common along the banks of the upper Ohio River. This includes several rail yard facilities. Woody vegetation is not uncommon on the banks of the upper Ohio River; however, in many areas the width of this vegetated corridor is minimal, consisting of one or two rows of trees. Approximately 25 meters of riparian vegetation is needed to adequately provide overland flow water filtration along a watercourse. Approximately 100 meters is needed to provide a functioning wildlife corridor (Patty Morrison personal communication, USFWS 2009a).

The existing floodplain of the upper Ohio River has been heavily developed since the period of settlement. This development has significantly reduced the functional floodplain of the upper Ohio River. A visual analysis of the project area utilizing readily obtainable aerial photography determined that less than 10 percent of the study area demonstrated riparian corridors approximately 60 meters or greater in width.

Management of the river for year round navigation results in a significant change to the large floodplain-river ecosystem. Variation in water levels of the river is a natural occurrence along a large river system. Different hydrologic conditions of the river benefit specific flora and fauna supported by this type of system. For example, lengthy spring flood events are important to fish species along the river that utilize floodplain lakes connected to the river for nesting and rearing areas. In unregulated streams, seasonal low flow conditions following recession of the spring floods provide the exposure of mud flats which allows for the growth of certain wetland plant species. Exposed mud flats typically become flooded to a shallow depth providing feeding habitat for migratory waterfowl (Sparks *et al.* 1998). But because the USACE maintains a 9-foot minimum navigation pool, exposure of mud flats is minimal. In fact, management of the river for navigation results in water level stability throughout the year with little deviation, which disrupts the natural functions of large river ecosystems.

6.5.2.2 Soils

The project area is situated within the Appalachian Plateau Physiographic Province. The soils found along the upper Ohio River Valley are comprised of alluvial sediments that consist of glacial outwash of sand and gravel. The sands and gravels found in this area are primarily derived from local Pennsylvanian and Permian age sedimentary rock. Table 6-3 shows the hydric soils and farmland soils found within the limits of the 500-year floodplain of the upper Ohio River.

Hydric soils constitute one of the three criteria to determine the presence of wetlands. Additionally, it is not uncommon to find prime farmlands soils on floodplains. Because wetlands are protected through the permitting process and prime farmland soils are accorded a level of protection through the permitting process, the land uses associated with these soils can be slower to change than others. Thus, the presence of hydric soils or prime farmland soils in riparian areas offers an indirect means of protecting riparian resources overall.

TABLE 6-3
Soils Within the 500-Year Floodplain of the Upper Ohio River

Map Unit Symbol	Map Unit Name	Hydric Soil	Farmland Soil
AgB	Allegheny silt loam, coarse, subsoil variant, 2-8% slopes	–	Yes
At	Atkins silt loam	Yes	–
Cg	Chagrin fine sandy loam	Yes	Yes
Ch	Chavies fine sandy loam	–	Yes
ChC	Chili silt loam, 8-15% slopes	–	Yes
CmC	Clymer loam, 8-15% slopes	–	Yes
CoB	Conotton gravelly loam, 3-8% slopes	Yes	Yes
CoC	Conotton gravelly loam, 8-15% slopes	Yes	Yes
Du - PA	Dumps	Yes	–
Du - WV	Dunning silt loam	Yes	Yes
ErB	Ernest silt loam, 2–8% slopes	Yes	Yes
ErC	Ernest silt loam, 8-15% slopes	Yes	Yes
EsD	Ernest very stony silt loam, 8-25% slopes	Yes	–
EvD	Ernest-Vandergrift silt loams, 15-25% slopes	Yes	–
GnC	Gilpin silt loam, 8-15% slopes	–	Yes
GpC	Gilpin–Upshur complex, 8-15% slopes	–	Yes
GvC	Guernsey-Vandergrift silt loams, 8-15% slopes	Yes	Yes
MoB	Monongahela silt loam, 3-8% slopes	Yes (WV)	Yes
Ld	Lindside silt loam	Yes	Yes
MoC	Monongahela silt loam, 8-15% slopes	–	Yes
Ne	Newark silt loam	Yes	Yes

Map Unit Symbol	Map Unit Name	Hydric Soil	Farmland Soil
Ph	Philo silt loam	Yes	Yes
Po	Pope silt loam	Yes	Yes
RaB	Rainsboro silt loam, 3-8% slopes	–	Yes
ToA	Tioga loam, 0-2% slopes, occasionally flooded	Yes	Yes
TyA	Tyler silt loam, 0-3% slopes	Yes	Yes
TyB	Tyler silt loam, 3-8% slopes	Yes	Yes
Ub	Urban land–Arents complex	Yes	–
UfD	Urban land-Conotton complex, 8-25% slopes	Yes	–
URB	Urban land–Rainsboro complex, gently sloping	Yes	–
WhC	Wharton silt loam, 8-15% slopes	Yes	Yes
Source: USDA, 2009a			

6.5.2.3 Wetlands

Wetlands are sensitive transitional habitats between terrestrial and aquatic systems that can provide valuable functions to the environment. Large wetland acreages are being lost nationwide at a high rate, although this rate appears to be slowing. A study by the USFWS presented that 54 percent of the estimated original 221 million acres of wetlands were lost in the continental United States between the years of 1780 to 1980. The amount of wetland acreage lost has been decreasing since the 1950s, but the continued acreage lost remains significant. Between 1985 and 1995, an average of 117,000 acres of wetlands was lost per year during this 10-year period (USFWS 1997).

A large proportion of the existing wetlands found along the upper Ohio River was lost following the advent of the modern lock and dam system. Although a large number of the naturally occurring wetlands was lost due to this new system of dams, the increase in water elevation resulted in the creation of embayments throughout this area. Embayments occur at the mouths of tributary streams where water from the mainstem has backed up due to increased water elevations. These embayments provide a majority of the remaining wetlands and shallow water habitat in the floodplain of the upper Ohio River (USFWS 2001). Table 6-4 shows the embayments found within the geographic scope of the project area from the New Cumberland Dam upstream to the Emsworth Pool. The embayments listed below were identified through review of on-line satellite imagery applications.

TABLE 6-4
Embayments

Stream Name	Pool Location
Tomlinson Run	New Cumberland Pool
Little Yellow Creek	New Cumberland Pool
Little Blue Run	New Cumberland Pool
Little Beaver Creek	New Cumberland Pool
Ohioview Peninsula	Montgomery Pool
Raccoon Creek	Montgomery Pool
Chartiers Creek	Dashields Pool

The USFWS National Wetlands Inventory (NWI) database was investigated to identify the NWI wetlands that occur within the geographic scope of the project (USFWS 2009b). This investigation determined that 55 NWI wetlands exist within the geographic scope. Table 6-5 lists the NWI wetland numbers and types found along the upper Ohio River.

TABLE 6-5
NWI Wetlands

Wetland Code	Wetland Type	Number of Wetland Type
PUBKx	Palustrine unconsolidated bottom, artificially flooded, excavated	7
PUBHx	Palustrine unconsolidated bottom, permanently flooded, excavated	17
PFO4C	Palustrine forested, needle-leaved evergreen, seasonally flooded	1
PEM1C	Palustrine emergent, persistent, seasonally flooded	3
PSS1C	Palustrine scrub-shrub, broad-leaved deciduous, seasonally flooded	1
PFO1C	Palustrine forested, broad-leaved deciduous, seasonally flooded	1
PEM1E	Palustrine emergent, persistent, seasonally flooded/saturated	2
PUBH	Palustrine unconsolidated bottom, permanently flooded	2
R2UBH	Riverine lower perennial, unconsolidated bottom, permanently flooded	1
R3UBH	Riverine upper perennial, unconsolidated bottom, permanently flooded	2
PEM1Eh	Palustrine emergent, persistent, seasonally flooded/saturated, diked/impounded	1
PFO1A	Palustrine forested, broad-leaved deciduous, temporarily flooded	11
PSS1A	Palustrine scrub-shrub, broad-leaved deciduous, temporarily flooded	3
PSS1E	Palustrine scrub-shrub, broad-leaved deciduous, seasonally flooded/saturated	1
PEM1A	Palustrine emergent, persistent, temporarily flooded	1
PUBHh	Palustrine unconsolidated bottom, permanently flooded, diked/impounded	1

Sources: Cowardin *et al.*, 1979; USFWS, 2009b

Two of the most dominant NWI wetland types observed to exist within the upper Ohio River include the PUBHx and PUBKx which are mostly associated with industry. Another dominant wetland type is the PFO1A type wetland habitat. The PFO1A wetland type found within the upper Ohio River is of particular importance as this is a habitat feature (bottomland hardwood forest) that is considered by the Pennsylvania Department of Conservation and Natural Resources (DCNR) as a threatened habitat type

6.5.2.4 Vegetation

The heavily developed urban area around Pittsburgh for the most part has been cleared of natural vegetation except for trees in small city parks and slivers of vegetation along the banks of the river. A botanical inventory of the vegetation present along the banks of the Allegheny, Monongahela, and Ohio rivers (within Allegheny County) was conducted by Dr. Susan Kalisz and Jessica Dunn for the 3 Rivers 2nd Nature program. As a result of this inventory, five of the eight riverine communities described in *Terrestrial and Palustrine Plant Communities of Pennsylvania* (Fike 1999) are found within these river corridors. The communities identified include:

- Sycamore – box elder floodplain forest;
- Silver maple floodplain forest;
- Black willow scrub/shrub wetland;
- Alder ninebark wetland; and
- Water willow – smartweed river bed community.

Of the communities listed above, all except for the water willow – smartweed river bed community are found in the upper Ohio River. The floodplain forest communities (sycamore – box elder floodplain forest and silver maple floodplain forest) present in the area are of particular interest for protection as this habitat type is described as globally threatened and is listed by the DCNR as threatened.

Within these four riverine communities, Kalisz and Dunn identified 72 different woody species to be present within the area. The 72 species identified include native, introduced, and invasive plant species. In general, native plant species are more abundant along the banks of the upper Ohio River than introduced species, although many introduced species are well established. The species identified by Kalisz and Dunn (2002) can be found in Table 6-6.

TABLE 6-6
Vegetation Identified in 3 Rivers 2nd Nature Botanical Surveys

Common Name	Scientific Name	Native (N)/Introduced (I)
American sycamore	*Platanus occidentalis*	N
Grape species	*Vitis species*	N
Willow species	*Salix species*	N
Silver maple	*Acer saccharinum*	N
Box elder	*Acer negundo*	N
Elm species	*Ulmus species*	N
Black locust	*Robinia pseudoacacia*	N
Dogwood species	*Cornus species*	N
Staghorn sumac	*Rhus typhina*	N
Poison ivy	*Toxicodendron radicans*	N
Virginia creeper	*Parthenocissus quinquefolia*	N
False indigo	*Amorpha fruitcosa*	N
Ninebark	*Physocarpus opulifolius*	N
Cottonwood	*Populus deltoides*	N
Blackberry, raspberry	*Rubus species*	N
Ash species	*Fraxinus species*	N
Alder species	*Alnus species*	N
Buttonbush	*Cephalanthus occidentalis*	N
Elderberry	*Sambucus canadensis*	N
Wild cherry	*Prunus species*	N
Hackberry	*Celtis occidentalis*	N
Crabapple	*Malus coronaria*	N
Tulip tree	*Liriodendron tulipifera*	N
Birch species	*Betula species*	N
Hop hornbeam	*Ostrya virginiana*	N
Hawthorn species	*Crataegus species*	N
Hydrangeae	*Hydrangea arborescens*	N
Basswood	*Tilia americana*	N
Honey locust	*Gleditsia triacanthos*	N

Common Name	Scientific Name	Native (N)/Introduced (I)
Walnut species	*Juglans species*	N
Quaking aspen	*Populus tremuloides*	N
Redbud	*Cercis canadensis*	N
Arrow-wood species	*Viburnum species*	N
Sweet-gum	*Liquidambar styraciflua*	N
Oak species	*Quercus species*	N
Currant species	*Ribes species*	N
Sugar maple	*Acer saccharum*	N
Meadowsweet species	*Spiraea species*	N
Sassafras	*Sassafras albidum*	N
Red maple	*Acer rubrum*	N
Buckeye species	*Aesculus species*	N
Devil's walking stick	*Aralia spinosa*	N
Witch-hazel	*Hamamelis virginiana*	N
Holly cultivar	*Ilex cv.*	N
Moonseed	*Menispermum canadense*	N
Tree-of-heaven	***Ailanthus altissima***	**I**
Mulberry	*Morus alba*	I
Japanese knotweed	***Polygonum cuspidatum***	**I**
Oriental bittersweet	***Celastrus orbiculatus***	**I**
Catalpa species	*Catalpa species*	I
Wisteria	*Wisteria floribunda*	I
Buckthorn alder	*Rhamnus frangula*	I
Multiflora rose	***Rosa multiflora***	**I**
Siberian elm	*Ulmus pumila*	I
Norway maple	*Acer platanoides*	I
Amur honeysuckle	*Lonicera maackii*	I
Honeysuckle vine	*Lonicera species*	I
Cherry cultivar	*Prunus cultivar*	I
Osage orange	*Maclura pomifera*	I
Bush honeysuckle species	*Lonicera species*	I
Mountain ash	*Sorbus aucuparia*	I

Common Name	Scientific Name	Native (N)/Introduced (I)
Birch cultivar	*Betula cultivar*	I
Forsythia	*Forsythia cultivar*	I
Pine cultivar	*Pinus cultivar*	I
Common privet	*Ligustrum vulgare*	I
Apple	*Malus pumila*	I
Weeping willow	*Salix babylonica*	I
Rose-of-Sharon	*Hibiscus syriacus*	I
Barberry cultivar	*Berberis cultivar*	I
Barberry	*Berberis thunbergii*	I
Spruce cultivar	*Picea cultivar*	I
Hops species	*Humulus species*	I
Boldface indicates introduced species considered to be invasive according to United States Department of Agriculture's (USDA's) National Invasive Species Information Center (USDA 2009b)		

Species identified along the rivers in Allegheny and Beaver counties in the county heritage inventories prepared by the Western Pennsylvania Conservancy (1994 and 1993) are listed in Table 6-7. The county heritage inventories are discussed in Section 6.5.2.6 of this CEA.

TABLE 6-7
Species Identified in County Heritage Inventories

Common Name	Scientific Name	Native (N)/Introduced (I)
Allegheny County Natural Heritage Inventory		
Species of special concern – SP003	–	N
Sugar maple	*Acer saccharum*	N
American beech	*Fagus grandifolia*	N
White ash	*Fraxinus americana*	N
Red oak	*Quercus rubra*	N
White oak	*Quercus alba*	N
Witch-hazel	*Hamamelis virginiana*	N
Mayapple	*Podophyllum peltatum*	N
Beaver County Natural Heritage Inventory		
Species of special concern – SP002	–	N
Species of special concern – SP003	–	N
Species of special concern – SP004	–	N
Silver maple	*Acer saccharinum*	N
Sycamore	*Platanus occidentalis*	N
Black willow	*Salix nigra*	N

Common Name	Scientific Name	Native (N)/Introduced (I)
Sugar maple	*Acer saccharum*	N
American beech	*Fagus grandifolia*	N
Red oak	*Quercus rubra*	N
White oak	*Quercus alba*	N
Basswood	*Tilia americana*	N
Jewelweed species	*Impatiens species*	N
Virginia waterleaf	*Hydrophyllum virginiana*	N
Cottonwood	*Populus deltoides*	N
Elm species	*Ulmus species*	–
White snakeroot	*Eupatorium rugosum*	N
Wingstem	*Actinomeris alternifolia*	N
Buckeye species	*Aesculus species*	N
American elm	*Ulmus americana*	N
Slippery elm	*Ulmus rubra*	N
Box elder	*Acer negundo*	N
Turks cap lily	*Lilium superbum*	N
Green dragon	*Arisaema draconitum*	N
Violet species	*Viola species*	–
Staghorn sumac	*Rhus radicans*	N
Japanese knotweed	***Polygonum cuspidatum***	**I**
Tree-of-heaven	***Ailanthus altissima***	**I**
Boldface indicates introduced species considered to be invasive according to USDA's National Invasive Species Information Center (2009b)		

6.5.2.5 Invasive Plant Species

Invasive species are defined as plant or animal species that are:

- Non-native (or alien) to the ecosystem under consideration; and
- Whose introduction causes or is likely to cause economic or environmental harm or harm to human health (OPUS 1999).

The spread of invasive plant species can be attributed to human activity and disturbances (USDAc). Invasive exotic plant species are of special concern in the geographic scope of the project because they appear to be displacing the native plants on the riverbanks, resulting in a loss of biodiversity in the area. As noted in ORMSS, "the USFWS considers invasive exotic plants second only to habitat loss as a threat to native species" (USACE 2006).

Within the upper Ohio River, Japanese knotweed (*Polygonum cuspidatum*), mile-a-minute (*Polygonum perfoliatum*), and multiflora rose (*Rosa multiflora*) are three prevalent invasive exotic plant species. Among the most problematic invasive plants species present in the upper Ohio River Valley, Japanese knotweed (*Polygonum cuspidatum*) is overwhelmingly considered the most serious threat (USACE 2006). Japanese knotweed was introduced to the United States in the late 19th century and since has become invasive, out-competing native species, especially in riparian zones. Outside its native range, Japanese knotweed propagates

through its long lateral rhizomes. Because very small segments of rhizomes are capable of producing new stands, human movement of soil easily disperses the plant. This is especially a concern on riverbanks where disturbing the soil can send rhizome fragments downstream to uncolonized areas. Once a stand of Japanese knotweed becomes established, herbaceous plants fail to survive under its dense canopy and recruitment of woody species is severely impaired.

In the survey conducted by Kalisz and Dunn (2002), Japanese knotweed was observed to comprise 11.5 percent of the abundance of all woody species and was more abundant than over 90 percent of the native species. They also found this species in areas that it did not occur two years prior, confirming the species' ability to spread rapidly along riparian corridors. This finding led the investigators to the conclusion that Japanese knotweed is overtaking native riparian plant species within their study limits (Allegheny, Monongahela, and Ohio rivers within Allegheny County). Finally, they noted a high level of public recognition and concern regarding problems related to invasive exotic riparian plants expressed at River Dialogue public forums held in 2001 and 2002 near Pittsburgh.

6.5.2.6 County Natural Heritage Inventories

The Western Pennsylvania Conservancy, in partnership with the counties of Pennsylvania, has developed, or is in the process of developing, natural heritage inventories for many counties within the area. Natural heritage inventories for Allegheny and Beaver counties were completed in 1994 and 1993, respectively. Among other things, these inventories identified areas within Allegheny and Beaver counties worthy of protection. Several of these areas are located within the floodplain of the upper Ohio River or are located on the steep hillslopes that the river flows along. Table 6-8 describes each of the areas of interest defined in each of the county natural heritage inventories.

TABLE 6-8
Areas of Interest

Area of Interest	Significance	Habitat Supported
Allegheny County		
Big & Little Sewickley Creek LCA	Exceptional	Largest tract of relatively contiguous, undeveloped greenspace within Allegheny County
Moon Run Slopes BDA	Notable	Forested slopes
Peregrine Falcon BDA	High	Tall city buildings provide nesting habitat for this species
Toms Run Valley BDA	Exceptional	Mesic central forest
Beaver County		
Four Mile Run BDA	Notable (tentative)	Unknown
Georgetown Island*	Exceptional	River gravel edge, floodplain forest
Lower Raccoon Creek BDA	High	Mesic central forest/wetland (robust emergent marsh) scrub-shrub, forested

Area of Interest	Significance	Habitat Supported
Midland Ravine BDA	High	Mesic central forest
Mill Creek BDA	Notable	Floodplain forest
Monaca Bluffs BDA	High	Mesic central forest
Ohio River BDA	High	River
Ohio View Peninsula BDA	Exceptional	Floodplain forest
Phyliss Island*	Exceptional	River gravel edge, floodplain forest
LCA = Landscape Conservation Area		
BDA = Biological Diversity Area		
*Part of Ohio River Islands National Wildlife Refuge		
Sources: Western Pennsylvania Conservancy, 1993, 1994		

6.5.2.7 Species of Special Concern

Riparian resources provide habitat features that are utilized by a diversity of wildlife species. As described in the *Ohio River Islands National Wildlife Refuge Comprehensive Conservation Plan* (USFWS 2001), bald eagles are abundant along the river especially during the winter months. The river provides these birds with an abundant source of food and occasional large roosting trees for use while their northern territories are typically frozen over.

Unique habitat features, such as islands and embayments, may be utilized by many species within the project area, including species of special concern. Table 6-9 provides a list of species of concern that may be present within the geographical scope of the project.

TABLE 6-9
Federal and State-Listed Species of Concern

Common Name (Scientific Name)	Federal Status / State Status	Range/Habitat along Ohio River	Reasons for Concern
Birds			
Bald eagle (*Haliaeetus leucocephalus)*	• Removed from Federal T/E list 2007 • Protected under Bald and Golden Eagle Protection Act and Migratory Bird Treaty Act OH – Threatened PA – Threatened WV– Very rare and imperiled	Range includes entire Ohio River mainstem; generally more common during winter months; builds huge nests in tops of trees near rivers, lake, and marshes	Continuing concerns include hunting for feathers and talons, electrocution on power poles, and poisoning from lead shot

Common Name (Scientific Name)	Federal Status / State Status	Range/Habitat along Ohio River	Reasons for Concern
Peregrine falcon (*Falco peregrinus*)	• Removed from Federal T/E list in 1999 • Protected under Migratory Bird Treaty Act OH – Threatened PA – Endangered WV– Extremely rare and critically imperiled	Migrates through Ohio River Valley in fall and Spring; nesting pairs of peregrine falcons can be found on high rises within the City of Pittsburgh	Killing and illegal possession are among remaining concerns. In 1999, the USFWS began a 13-year monitoring program to obtain data that reflect the status of at least two generations of peregrines. If the species is not maintaining its recovered status, it could be re-listed.
Mammals			
Indiana bat (*Myotis sodalis)*	Endangered OH– Endangered PA – Endangered WV- Extremely rare and critically imperiled	Found over most of eastern half of U.S. with populations hibernating in caves in OH, PA, and WV; in summer, they usually roost under loose tree bark (e.g., shagbark hickory).	Continuing concerns include human disturbance of hibernation caves, cave commercialization, and gates on caves that prevent access or alter habitat conditions, loss and fragmentation of forest habitat, and pesticides that contaminate bat food supply (insects), water, and feeding areas
Fish			
Lake sturgeon (*Acipenser fulvescens*)	No Federal Status OH – Endangered PA – Endangered WV – No State Status	Within the U.S., the majority of the natural range lies within the Mississippi River drainage basin from the upper Mississippi River and its major tributaries to the southern border of Arkansas	Habitat manipulation (dam placement) cut off the species from former spawning sites and impacts to the species' food sources (e.g., mussels and gastropods) through siltation, poor water quality, channelization, and drainage of streams and lakes.
Plants			

Common Name (Scientific Name)	Federal Status / State Status	Range/Habitat along Ohio River	Reasons for Concern
Butternut (*Juglans cinerea*)	No federal status	Found over much of the eastern half of the U.S.; the species is commonly found on streambank sites and within well drained soils.	A significant threat to this species is a fungus that may have been introduced from outside the U.S. The fungus, Butternut canker (*Sirococcus clavigignenti-juglandacearum*), will usually kill the tree several years following infection. This fungus is noted to have resulted in nearly an 80% decrease in the living butternut population in some states.
	OH – PA – No State Status WV – S3 (21 – 100 documented occurrences)		
Sources: USACE, 2006; Ohio Department of Natural Resources, 2009; Pennsylvania Natural Heritage Program, 2009; West Virginia Division of Natural Resources, 2009; Western North Carolina Nature Center, 2009; USDA, 2009c			

Other species of special concern not listed in Table 6-9 may occur within the geographic scope of the project. The Pennsylvania Natural Heritage Diversity Index (PNDI) was consulted to identify federal or state agencies that may be responsible for species of special concern known to occur along or within the Ohio River within Pennsylvania. Five different locations (Point State Park, Neville Island, the mouth of the Beaver River, Phyllis Island, and the state line) were investigated for potential project conflicts associated with species of special concern. As a result, species under the jurisdiction of the USFWS, PFBC, Pennsylvania Game Commission (PGC), and the DCNR were noted to occur within these areas. The bald eagle, peregrine falcon, and Indiana bat would fall under jurisdiction of the USFWS and the PGC. The lake sturgeon would fall under jurisdiction of the PFBC. The butternut would fall under jurisdiction of the West Virginia Division of Natural Resources.

6.6 INTERACTIONS WITH OTHER VALUED ENVIRONMENTAL COMPONENTS (VECS)

As with other resources in the project area, past development patterns have determined the present day conditions of riparian areas along the upper Ohio River. Although the future quality of riparian resources is dependent on actions in both the public and private sectors, the public sector is likely to lead efforts to preserve and expand existing riparian areas because:

> The future success of at least five national policy objectives – protection of water quality, protection of wetlands, protection of threatened and endangered species, reduction of flood damage, and beneficial management of federal public lands – depends on the restoration of riparian areas (NRC 2002).

Interacting VECs include Water Quality, Sediment Quality, Fish, Mussels, Recreation, Transportation and Traffic, and Socioeconomics. Table 6-10 summarizes the interactions of riparian resources with the other VECs.

TABLE 6-10
Interactions of Riparian Resources with Other VECs

VEC	Riparian Resources & Potential Impacts	Past/Present Trends	Future Trends	Comments
Water Quality/ Sediment Quality	Improved habitat for animal species, improved public health, recreational opportunity, and aesthetic values with improved water quality	Growth of river oriented activity with improved water quality	Present water quality will likely be maintained or improved	Expanding public recognition of water quality benefits and value
Mussels and Fish	Resource recoveries contribute to the understanding of riparian resources	Until last two decades, lack of understanding on importance of riparian resources	Expanding the commercial/ residential and recreational uses of river will conflict with habitat needs	Long term protection/ management of significant habitat areas required
Recreation	Expanding leisure time and disposable income per capita	Growth of river-oriented activity; development of riverfront parks and activities	Expanding variety of river-oriented activity; potential conflicts with habitat needs	Potential continued growth of urban river-front oriented development
Transportation & Traffic	Conflicts exist with habitat needs.	Use of riverfront for rail, barge activities	Rail and barge activities will continue	Limited alternatives for environmental justice populations if they cannot afford personal vehicle
Socio-economics	Expanding leisure time, interest in riverfront	Growth of river-oriented activity and riverfront parks and activities with expanded time and income	Expanding variety of river-oriented activity; potential conflicts with habitat needs	Continued growth of urban riverfront oriented development

6.7 INDICATORS OF ENVIRONMENTAL SUSTAINABILITY FOR RIPARIAN RESOURCES

Indicators of environmental sustainability vary by valued environmental component and provide benchmarks for measuring cumulative effects on a given resource or VEC. Indicators help to characterize the current status of a resource and to track or predict significant changes to that resource. The indicators selected for riparian resources of the upper Ohio River include:

- Adequacy of hydrologic connections between riparian areas and adjacent water bodies and uplands;
- Maintenance of normal navigation pool elevations;
- Capacity for water storage in the floodplain;
- Capacity of riparian areas to intercept pollution;
- Integrity of riparian habitats; and
- Measures of biodiversity.

The indicators of environmental sustainability were initially developed during ORMSS. They are based on the context of functionality (NRC 2002) and fall into three major functional categories: hydrology and sediment dynamics; biogeochemistry and nutrient cycling; and habitat and food web maintenance.

6.8 RELEVANT FUTURE ACTIONS AFFECTING RIPARIAN RESOURCES

Reasonably Foreseeable Future Actions (RFFAs) for riparian resources were evaluated utilizing a matrix prepared during the scoping process. The matrix was an outgrowth of a similar matrix developed during the preparation of ORMSS. Results of the RFFA evaluation are summarized in Table 6-11.

TABLE 6-11
RFFA Cumulative Effects Matrix for Riparian Resources

RFFA[1]	Time Period[2]	Occurrence Probability[3]	Location on River[4]	Importance[5]	Effects[6]
USACE Actions					
Navigation Investments					
Replacement locks at Emsworth, Dashields, and Montgomery Dams (EDM)	1	H	S	L	+/-
Rehabilitation of EDM dams	1	H	S	L	+/-
Non-structural navigation improvements	A	H	S	L	+/-
L&D operation and maintenance	A	H	S	L	+/-
Approach & channel dredging/disposal	A	H	E	L	-
Environmental design					
environmental sustainability operation actions	A	H	S	M	+
Pool maintenance	A	H	E	L	+/-
Sec 107 port development and maintenance dredging	2	L	S	M	-
Ecosystem Restoration					
Fish passage at EDM	1	H	S	L	+/-
Actions by Others					
Navigation System Dependent - "But For"					
Commercial navigation					
barge queuing	1	M	E	M	-
fleeting areas/barge storage	1	M	E	L	-
terminals & multi-modal sites	2	L	S	M	-
barge/tow tech/"green" design	A	M	E	L	+
accidents/spills	A	M	E	M	-
Coast Guard navigation aids - const., O&M	A	H	E	L	+
Energy					
hydropower on dams	2	M	S	M	-
continued operation of coal-fired power plants	A	M	S	M	-
Water-based recreation					
marina development & operation	A	M	S	H	-
commercial boating	A	H	E	H	+/-
personal boating	A	H	E	H	+/-
River Dependent					

RFFA[1]	Time Period[2]	Occurrence Probability[3]	Location on River[4]	Importance[5]	Effects[6]
Water supply/discharge					
municipal	A	M	S	M	-
industrial	A	M	S	M	-
Waste water treatment discharges (WWTP)					
onsite systems	A	H	E	L	-
stormwater discharges; CSOs; SSOs	A	H	S	H	-
Marcellus shale gas extraction (water impacts)	A	H	E	H	-
Resource extraction					
instream sand and gravel mining	A	H	E	H	-
Acid mine discharge (AMD)	A	M	E	H	-
Riverfront/Flood Plain Development					
Downtown Pittsburgh					
Ongoing Point State Park improvements	1	H	S	L	+/-
Convention Center riverfront park	1	H	S	L	+/-
residential development/conversions	A	H	S	L	+/-
North Shore development	1	H	S	L	+/-
Pittsburgh South Side					
continued riverfront development	A	H	S	L	+/-
continued South Side Works development	1	H	S	L	+/-
Riverfront trails					
Pittsburgh riverfront trail system	A	H	E	M	+/-
Beaver County trail system	A	M	E	M	+/-
Brownfields redevelopment					
Neville Island	1	H	S	H	+/-
PL&E, McKees Rocks	2	M	S	H	+/-
M&B Development	2	M	S	H	+/-
Fab Tech & Buckeye Pipeline	1	M	S	H	+/-
J&L site in Aliquippa	1	M	S	H	+/-
Leetsdale Industrial Park	1	H	S	H	+/-
Resource Protection/Restoration					
Ohio River Islands Wildlife Refuge System	A	H	S	H	+
Nationwide Rivers Inventory	A	M	S	L	+
Ecosystem restoration	A	M	E	H	+
Cultural resources	A	M	E	L	+/-
Bridges and Roadways					

RFFA[1]	Time Period[2]	Occurrence Probability[3]	Location on River[4]	Importance[5]	Effects[6]
Bridge renovations					
Ambridge/Aliquippa Bridge	1	H	S	L	+/-
Shippingport Bridge	1	H	S	L	+/-
Rochester Bridge	1	H	S	L	+/-
McKees Rocks Bridge	1	H	S	L	+/-
Birmingham Bridge	1	H	S	L	+/-
Rankin Bridge	1	H	S	L	+/-
New crossings					
Maglev	2	L	S	H	-
North Shore connector	1	H	S	H	-
Roadways					
Mon/Fayette Expressway	2	L	S	H	-
SR 28 widening/railroad relocation	1	H	S	H	-
CSX double stack upgrades (National Gateway)	1	M	S	H	-
Natural Events					
floods	A	M	E	H	+
droughts	A	L	E	H	+
invasive species	A	H	E	H	-
Regulatory Environment					
Phase I & 2 NPDES program	A	H	E	M	+
TMDLs	A	H	E	H	+
ALCOSAN & other consent decrees	A	H	E	H	+
Adaptive management in Sand & Gravel EIS	A	H	E	L	+
Pollution prevention	A	H	E	M	+
USACE permitting programs	A	H	E	H	+
Boating safety regulations	A	H	E	L	+
Monitoring programs - PA/ORSANCO	A	H	E	H	+
Environmental awareness education	A	H	E	H	+
Clean Air Act standards	A	H	E	L	+
Clean Water Act standards	A	H	E	H	+
Endangered Species Act (ESA)	A	H	E	H	+
Environmental sustainability practices	A	H	E	H	+

[1] Reasonably Foreseeable Future Actions

[2] Time period in which the RFFA may occur: A = all periods; 1 = within 10 years; 2 = in 10 - 25 years; 3 = in 25 - 60 years

[3] Occurrence probability or likelihood RFFA will happen: H = high; M = medium; L = low

RFFA[1]	Time Period[2]	Occurrence Probability[3]	Location on River[4]	Importance[5]	Effects[6]
[4] Location or setting on river where RFFA is expected to occur: E = along entire length of river; S = specific location					
[5] Importance or impact of action on the VEC: H = high; M = medium; L = low					
[6] Effects of action on the VEC: + = positive effect; - = negative effect; +/- = mixed effects					

Impacts from the RFFAs can be complex and occur in many ways. While impacts result from an action, those impacts are not always apparent from a straightforward analysis of cause and effect. Often, similar actions do not affect resources in the same manner. As a means of further explaining potential impacts to riparian resources, three vectors have been identified. The vectors have a specific relationship with one another and may influence the scope and magnitude of future impacts on riparian resources. Some actions will intercept with more than one vector. The three vectors are related to actions affecting hydrology and sediment dynamics, actions affecting biogeochemistry and nutrient cycling, and actions affecting habitats and food web maintenance.

Actions that affect riparian hydrology and sediment dynamics influence the movement, distribution, and quality of water and sediment composition. Land development often reduces the extent and functioning of riparian areas by disrupting hydrology and sediment dynamics. Land-based development can compact or remove soil, which can alter or eliminate water storage capacities, sever hydrological linkages, change flow directions, or change flow velocities. Any of these outcomes can, in turn, alter sediment dynamics. Activities such as construction, excavation, or mining are some of the actions that can affect hydrology and sediment dynamics. RFFAs that fall into this vector and the other two vectors are noted in Table 6-12.

Actions that affect biochemistry and nutrient cycling alter soil morphology and the ability of riparian buffers to filter pollutants and trap sediments. Infiltration, deposition, filtration, adsorption, and assimilation can all be affected when biogeochemistry is changed. RFFAs that fall into this vector are also noted in Table 6-12.

Actions that affect habitats and food web maintenance can impact the basic necessities of wildlife. Animal life can be affected by direct disturbance or modification and loss of habitat. The diversity of riparian habitats contributes many elements to habitat, including materials, nutrients, feeding niches, movement corridors, and food resources. RFFAs that fall into this vector are also noted in Table 6-12.

TABLE 6-12
RFFAs and Riparian Resources Impact Vectors

RFFA	Actions that Affect Hydrology and Sediment Dynamics	Actions that Affect Biogeochemistry and Nutrient Cycling	Actions that Affect Habitats and Food Web Maintenance
USACE Actions			
Environmental sustainability operation actions			X
Port development & maintenance dredging	X		X
Actions by Others			
Barge queuing			X
Terminals & multi-modal sites	X		X
Accidents/spills		X	X
Hydropower on dams	X	X	X
Operation of coal-fired plants	X		X
Marina development & operation	X		X
Commercial boating		X	
Personal boating		X	
Municipal water supply/discharge	X	X	X
Industrial water supply/discharge	X	X	X
WWTP – stormwater discharges, CSOs, SSOs		X	X
Marcellus shale gas extraction	X	X	X
Instream sand and gravel dredging/mining	X		
Acid mine discharge		X	X
Riverfront trails	X		X
Brownfields redevelopment	X		X
Ohio River Islands Wildlife Refuge System			X
Ecosystem restoration			X
New crossings	X		X
Roadways	X		X
CSX double stack upgrades	X		X
Natural events	X	X	X
Regulatory Environment		X	X

Discussions of the potential permanent and temporary impacts of RFFAs with high and medium importance are presented in the remainder of this section. The discussions are organized around USACE actions and actions by others.

6.8.1 USACE Actions

6.8.1.1 Navigation Investments

Navigation investments by the USACE will have few impacts on riparian resources, but they could affect hydrology and sediment dynamics, as well as habitat and food web maintenance, nonetheless. USACE actions impacting riparian resources will be limited to environmental sustainability operation actions and port development and maintenance dredging. Consideration of environmental sustainability in lock and dam operations could provide significant positive benefits to riparian resources depending on the practices utilized. For example, if the river could be managed to better mimic natural hydrologic regimes of the river, this would be a very positive condition to promote the health of the remaining riparian corridor within the study area.

Port development and maintenance dredging, however, pose the loss of additional riparian resources. New or expanded ports could extend into the remaining riparian area. While dredging operations themselves would not affect riparian resources, staging areas or disposal sites for these activities could require the use of riparian resources. In effect, these actions could convert riparian areas to other types of land use and create new hydrologic conditions that alter habitat.

6.8.2 Actions by Others

6.8.2.1 Navigation System Dependent – "But For"

Activities associated with commercial navigation on the river will likely result in negative impacts to riparian resources. Barge queuing and fleeting areas/barge storage would likely result in a negative impact to riparian resources, especially if barges are tied to trees, which could ultimately lead to loss of such trees and the habitat they constitute in riparian buffers. Loss of trees can lead to erosion and loss of more habitat subsequently. Shoreline expansion of these areas could also result in the loss of riparian buffers by direct takes for the facilities or access roads to them. Plant life within the riparian buffers could also be lost through the introduction of contaminants associated with navigation activities.

Expansion of terminals and development or expansion of existing multi-modal sites would likely result in negative impacts to the hydrology, sedimentation dynamics, and habitat of riparian areas. This could potentially occur as a result of clearing existing vegetation to expand existing facilities, construct new facilities, or accidental spills of material from loading/unloading activities. Any potential accidents or spills from barge traffic would likely result in a negative impact to biogeochemistry and nutrient cycling through the potential opportunity for contaminants to affect riparian areas. Contaminants could affect the health of vegetation in the riparian areas by weakening or killing native species and allowing invasive species to take hold.

Contaminants could also degrade water quality and poison both aquatic and terrestrial wildlife. Potential accidents or spills could also result in the necessity to create emergency access sites along the river where roadways do not currently exist. This could result in additional negative pressures on riparian resources.

Impacts to riparian resources as a result of the installation of hydropower generating equipment would result in impacts to riparian resources similar to any construction activity. The continued operation of coal fired power plants could result in negative impacts to riparian resources, again by affecting hydrology, sediment dynamics, or habitat. Negative effects from these activities could include facility expansion and subsequent removal of vegetation, potential spills that could contaminate soils of riparian resources, and/or ground disturbance that could allow for the colonization of invasive, exotic plant species. Transportation of resources to and from these facilities *via* barges also provides an opportunity to negatively affect riparian resources. In addition, the potential installation of new water intakes could result in a negative impact through the clearing of vegetation and potential colonization by invasive, exotic plant species near areas of activity that are temporarily impacted.

Besides normal construction activities, marina development and operation could lead to an impact to existing riparian vegetation through fragmentation or other valuable riparian features, such as wetlands, through filling or draining. Any earth disturbance associated with these types of activities could also provide the opportunity for invasive, exotic species to expand populations. These conditions would result in a negative impact to riparian resources. It is expected that replacement or rehabilitation of EDM lock chambers will lead to a slight increase of commercial traffic on the river. This could result in negative impacts to riparian resources in that additional facilities or expansions to existing facilities to handle additional traffic would likely be required. Dispersed barge traffic, which could occur as a result of additional commercial traffic, could lead to negative impacts to riparian resources through unexpected toe-ins, propeller wash, etc.

Personal and commercial boating may also increase due to a number of factors, not just the replacement or rehabilitation of EDM. Increased recreational boating could result in a negative impact to riparian resources through the unintentional transportation of invasive, exotic species. Boats are important vectors in the transport of such species. Education for operators of recreational boats should include the topic of invasive, exotic species so that they are aware of their potential to unknowingly transport these problem species.

6.8.2.2 River Dependent

Discharges from municipal or industrial sources to the river would not likely result in a significant impact to riparian resources. However, the construction activities associated with installing a new discharge or treatment plant could result in a significant impact to riparian resources. Because new treatment and discharge plants would be located adjacent to the river, existing riparian areas could be threatened with loss or alteration. The dynamics of those areas would be changed as a result of construction activities, new land uses, and the potential discharge of contaminants.

Existing combined sewer overflows (CSOs) and sanitary sewer overflows (SSOs) contribute a significant source of contaminants to waters of the river. During periods of heavy rain, when these types of systems typically discharge untreated wastewater to the river, flows from the river would be accessing the available floodplain. These would be periods when contaminated waters would be deposited into floodplains, potentially affecting biogeochemistry, nutrient cycling, habitat, and food web maintenance. Addressing the problems associated with these types of systems could result in a positive impact for riparian resources. In some systems, historic streams have been collected into the sewer systems. If these streams were to be removed from the systems and allowed to flow in channels designed following natural stream channel design techniques, this would provide a positive step in improving riparian resources. A new focus on gas well development (i.e., Marcellus Shale gas wells) could result in the necessity to build new or expand existing wastewater treatment facilities within the geographic scope of the project. Marcellus Shale operations have already shown the possibility of polluting local streams.

Instream sand and gravel operations could pose a threat to riparian resources depending on proximity of operations to shorelines or islands. However, as is described in the *Environmental Impact Statement on Commercial Sand and Gravel Dredging Operations in the Allegheny and Ohio Rivers, Pennsylvania* (USACE 2002), dredging operations are not to occur within proximity to such features. Additionally, compensatory mitigation for potential impacts to natural resources could include improvements to riparian resources.

Past deep mining operations in the Monongahela River Basin have left massive voids currently filled or filling with water. Orphan mines that are located below surface drainage level are actively being flooded, creating an immense aquifer of mine water. It is projected that in 2015 all orphan mines located below the surface drainage level will have reached their maximum capacity to hold water. The aquifer created by the flooding of orphan mines in the Pittsburgh Coal Basin will create the second largest spatially-continuous high-yield aquifer in the Northern Appalachian Region (Donovan and Leavitt 2004).

The West Virginia University Center for Coal Mining Research conducted an extensive study to map the underground mining and water quality of the Monongahela River Mine Pool (Ziemkiewicz and Vandivort 2004, as cited in Lorson and Smith 2004), a giant football-shaped aquifer stretching from Fairmont, WV to Pittsburgh, PA and from Wheeling, WV to Uniontown, PA. The research has documented extremely acidic water with gross heavy metal loads within the mine pool. The mine pool has several points where acid loads may be discharged to the Monongahela River, including Dunkard Creek (Mon RM 87.2), a tributary of the Monongahela where all marine life was killed in September 2009. Several resource agencies are involved in investigations of the recent incident as well as the development of long-term solutions to mine pool flooding.

If a large discharge of acid mine drainage (AMD) were to occur on the Monongahela River, as predicted by some, this could result in a significant impact to riparian resources. This is assumed because contaminants associated with AMD could be deposited within sensitive features of riparian resources that are important wildlife habitat areas. This condition could result in a temporary or permanent abandonment of these sites for use by wildlife. Compounding

the uncertainty of the situation, however, is the extent of the impacts. Discharges from the mine pool, if any, would probably be confined to the Monongahela River, or if they do reach the Ohio River, flows from the Allegheny River would likely neutralize the effects on riparian resources.

6.8.2.3 Riverfront/Floodplain Development

Further development of riverfront trails will have both positive and negative effects on riparian resources. New trails will bring more people to riverfront areas and offer the opportunity for people to learn about the ecological functions of riparian buffers and floodplains. The inclusion of riparian areas into new parkland will help preserve these areas and protect then from loss through other development. The construction activities associated with the creation of new trails are minor, compared to some other actions, but they could still affect hydrology, sediment dynamics, and habitat. In addition to minor impacts associated with construction, trails bring people into areas where man may have had little interaction – and even in the best of circumstances, people will make additional, informal trails that could unexpectedly alter open space. Heavy foot traffic can cause soil compaction and increased erosion. Sometimes, the attractiveness of riparian areas can be so great that too many people use them as recreational sites and the aesthetics of riparian areas are compromised.

Additionally, recreational traffic on trails could lead to the unintentional introduction of invasive, exotic species. Educational kiosks or programs within parks and along trails could inform the public of the problems associated with invasive species.

The cleanup and redevelopment of brownfields constitute a positive effect on riparian resources. The cleanup of a potential industrial contaminant source to the river and adjacent riparian resources would be beneficial through the potential improved water quality that would occur. Any redevelopment activities should take into account riparian resources and strive to provide riparian buffer zones planted with appropriate native vegetation.

6.8.2.4 Resource Protection/Restoration

The protection and restoration of existing, undeveloped islands through the Ohio River Islands Wildlife Refuge System constitutes a significant positive influence on the existing riparian resources in the study area. The Refuge was established in 1990 to protect and restore habitat for native wildlife within the Ohio River floodplain. There are twenty-two islands within the Refuge, located along nearly 400 miles of river. Two refuge islands are located on the Upper Ohio River within Pennsylvania.

Since riparian resources are directly connected to aquatic habitats, the restoration of aquatic ecosystems could result in a positive effect on riparian resources depending on the type of project and associated aspects. There are five habitat types defined in the Ohio River Ecosystem Restoration Program (ERP) an ecosystem restoration program developed by the USACE and authorized by Congress in 2000. These habitat types include: bottomland hardwood forest, aquatic habitat, islands, shoreline/riparian habitat, and wetlands. Although not currently funded, the ERP is a program that is focused on restoring significant ecosystem functions that have been degraded through time. Any projects that could be conducted under this

program (within the upper Ohio River), or any of the other ecosystem restoration authorities available through the USACE, would likely result in better riparian resources.

6.8.2.5 Bridges and Roadways

New river crossings, such as Maglev and the North Shore Connector, could result in a negative impact to existing riparian resources. The proposed design for Maglev uses several pier arrangements that span streams, wetlands, roadways, and existing developed areas. This system of transportation has more precise engineering requirements than typical bridges and roadways. Because of that, efforts to span other resources could end up impacting riparian areas. In similar fashion, the need for the North Shore Connector to cross under the Allegheny River with a subway rail line dictates certain design elements to meet other needs of the underground transportation system that could also impact riparian resources.

The Mon/Fayette Expressway in crossing the Monongahela River near Downtown Pittsburgh and the widening/relocation of SR 28 along the Allegheny River on Pittsburgh's North Side also threaten riparian areas. Some riparian buffers could be lost or fragmented to these projects. In similar fashion, the CSX double stack upgrades could cause minor alignment shifts. Much of the existing CSX track is located in the floodplain and any further intrusion into it is likely to result in the loss of additional riparian resources.

Negative impacts from these new actions could occur in several forms including fragmentation of habitat, crossings through sensitive habitats, or through the introduction of invasive species.

The corridors leading up to the new crossing locations could also result in fragmentation of the small forested riparian areas of adjoining tributaries. Earth disturbance, potential for introduction of invasive species, and the addition of a new potential pollution source are all negative effects that could be associated with new river crossings.

6.8.2.6 Natural Events

Periodic flooding is an important aspect to riparian resources. Habitat features have evolved around periodic flooding events. Flood flows will redefine channel sediment deposition on floodplains in ways "that define riparian composition and productivity" (USACE 2001).

These events will also influence habitats through deposition of seeds and other plant materials that can root (e.g., willow branches). However, these events could lead to a negative effect on riparian resources through the transport of invasive species to new areas. Droughts can also shape floodplain characteristics. Native vegetation that has evolved to live on a floodplain is typically resilient enough to sustain periods of drought as well as flooding. This condition may put stress on invasive species not tolerant of such extreme fluctuations in hydrology.

The presence or invasion of invasive plant and animal species can have a significant negative impact to riparian resources. Invasion of native habitats by such species can result in a

displacement of the native species that should occur in these habitats. It has been documented that invasive species are second only to habitat loss in threats to our native flora and fauna (USACE 2006).

6.8.2.7 Regulatory Environment

Riparian resources and their adjacent water course are intimately related; therefore, improvements to water quality also provide a benefit to riparian resources. Existing regulations are in place to protect water quality and limit water pollution. Regulations such as the National Pollution Discharge Elimination System (NPDES) and the Total Maximum Daily Load (TMDL) programs fall under the Clean Water Act. Also, there are consent decrees in place with organizations that discharge to the river to address concerns regarding CSOs and SSOs and other wet weather concerns. Addressing the problems associated with CSOs and SSOs will result in improved water quality. Under the Clean Water Act, the USACE is responsible for permitting programs which regulate impacts to aquatic resources (i.e., streams and wetlands). These regulations have a positive effect on riparian resources through the permitting process required for such landscape features. The Endangered Species Act also provides a significant benefit to riparian resources since it protects listed species as well as the habitat associated with those species.

Executive Order 13112 issued on February 3, 1999 directed federal agencies to prevent and control the spread of invasive species. In addition, the EO formed the Invasive Species Council made up of seven federal departments and co-chaired by the Secretaries of Interior, Agriculture and Commerce. This Council was charged with the preparation of the Invasive Species Management Plan which was first published in 2001 and later revised in 2008. This plan lays the groundwork for federal action regarding invasive species which are one of the primary contributors to riparian resource degradation.

6.9 ANALYSIS OF ENVIRONMENTAL SUSTAINABILITY

Generally, the indicators of environmental sustainability for riparian resources fall into three major functional categories: hydrology and sediment dynamics; biogeochemistry and nutrient cycling; and habitat and food web maintenance. Specifically, the indicators include an adequacy of hydrologic connections between riparian areas and adjacent water bodies and uplands; maintenance of normal navigation pool elevations; capacity for water storage in the floodplain; capacity of riparian areas to intercept pollution; integrity of riparian habitats; and measures of biodiversity. To some degree, all of these factors contribute to the health of riparian buffers

Environmental sustainability occurs when resources are effectively balanced through the life cycle of project planning, design, construction, operation, and maintenance to improve the quality of life for present and future generations. Accordingly, an analysis of sustainability represents a test of significance of potential cumulative effects.

6.9.1 Positive Forces Affecting Riparian Resources

The regulatory environment provides the best opportunity for strengthening the health of riparian resources. Though there are no regulations that directly govern riparian resources, the goals of other regulations (e.g., water quality improvement) indirectly contribute to creating a positive effect on riparian resources. Some regulations offer opportunities to maintain hydrologic connections between riparian areas and adjacent water bodies. Others protect the capacity of water storage in the floodplain. Others still encourage biological diversity and support the reduction of pollution.

Additionally, the growing awareness that riparian resources, especially evidenced with the Ohio River Islands National Wildlife Refuge and (in the state of Ohio) the *Nature Works Program*, contribute to healthy, functioning aquatic systems offers opportunities to protect the existing riparian resources, albeit indirectly. This awareness plays a supporting role in protecting the hydrologic connections between riparian areas, pollution reduction, and increased biodiversity.

6.9.2 Negative Forces Affecting Riparian Resources

Existing landscape features that provide negative pressure on riparian resources are unlikely to go away in the reasonably foreseeable future. Therefore, the existing functional floodplain of the upper Ohio River is a fraction of its condition prior to settlement or industrialization of the region. All of the indicators of sustainability are declining and could disappear with unchecked development, but further development of riparian areas is likely to occur. Despite increased public awareness, unless specific design elements that protect riparian areas are incorporated into new projects, riparian resources will continue to erode. Of all the resources examined during this cumulative effects assessment, riparian resources are in the most danger. They will also be the hardest to restore.

Unfortunately, there are no regulations or programs in place aimed specifically at stemming the loss of riparian resources or restoring areas already lost to development. Extensive development along the upper Ohio River acts as both a consumer of riparian resources and a limiting factor to the functioning floodplain. This development consists of residential, commercial, and industrial areas as well as rail and road transportation corridors. Much of this development was placed on fill to elevate it above areas that were regularly flooded. Consequently, this development reduces the capacity of water storage in the floodplain, reduces the capacity of riparian areas to intercept pollution, and limits biodiversity.

The onslaught of invasive vegetative species is most prevalent in “orphaned” areas – that is, areas no individual or group feels responsible for – often found along river banks and abandoned industrial areas. Some invasive species were introduced intentionally, providing ornamentation or inexpensive means of providing groundcover. Without adequate control, these species often escape from their intended environment and spread far and wide. Freed from their natural bounds, they proliferate in new, more habitable areas and crowd out native species. This in turn causes a deterioration of all habitat and limits biodiversity and valued ecological

functions. All of the existing riparian areas along the upper Ohio River have been attacked by invasive species.

6.9.3 Incremental Impacts on EDM

The incremental impacts of EDM improvements on riparian resources will be limited. Although unlikely, some loss of riparian areas adjacent to the EDM improvements, including related laydown and staging areas, could occur with future construction.

A modern lock and the use of the existing 600-foot chamber as the auxiliary will allow for more efficient movement of commercial traffic from one pool to another. With improved efficiencies, there would be little need for additional fleeting areas to be built that would serve as locations for reconfiguring of tows to transit the 600-foot chambers. With the improved reliability and larger auxiliary, there will also be less likelihood for long queues during maintenance outages. These reduced queues will negate the need for the tows to nose-in to the banks or tie off to shoreline trees.

6.10 DETERMINATION OF SUSTAINABILITY

Three definitions of environmental sustainability were used for the analysis:

- Not sustainable – conditions for the selected indicators do not reflect conditions that would facilitate attainment of acceptable standards or would not maintain existing standards in concert with collective impacts of proposed activities.

- Marginally sustainable – conditions for selected indicators are such that attainment is accomplished for the majority, but not all, of the potentially affected areas. However, the conditions are somewhat tenuous both in location and likelihood of occurrences. (In other words, the conditions are borderline for environmental sustainability, and there are uncertainties regarding specific quantitative measures.)

- Sustainable – conditions for selected indicators are such that attainment of acceptable conditions are accomplished for essentially all of the potentially affected project area, and such standards are maintained in concert with foreseeable future activity. Further, conditions exceed regulatory thresholds, and various governmental programs are in place to respond to any potential erosion of values related to riparian resources.

Figure 6-1 shows the environmental sustainability of riparian resources. The sustainability of riparian resources can be characterized as follows:

- In the time period prior to 1920, and continuing up to about 1950, riparian resources can be classified as not sustainable due to relatively rapid losses of riparian habitats and their functions, the lack of knowledge of the importance of these resources to both terrestrial and aquatic ecosystems, and the essential absence of any institutional programs to manage or control riparian areas. Further, the lack of awareness of

environmental services performed by riparian resources, coupled with ongoing floodplain development, led to the loss and fragmentation of riparian resources.

- In the time period from 1950 to the present, unsustainable conditions continued to occur as a result of still more disruptions and losses of riparian areas. However, awareness of riparian areas has grown, including regulation of wetlands, a highly productive riparian component. The establishment of the Ohio River Islands National Wildlife Refuge has slowed the disappearance of another riparian habitat type, islands, and also has brought greater visibility to riparian resources of the Ohio River embayments. These initiatives suggest the loss of riparian resources may have slowed.

- The loss of riparian areas along the Ohio River has been considerable. Compounding past losses, invasive vegetative species are widespread and threaten to choke the limited riparian areas that are present. Unfortunately, many land use practices that contributed to the loss of riparian areas are continuing, even if to a lesser degree. Also, little is being done to stop the spread of invasive vegetation. Although there is some growing awareness of the ecological services performed by riparian resources, coupled with an increasing demand for river corridor enhancement, specific environmental regulations and institutional programs are not in place to stem fragmentation and loss. Consequently, riparian resources are likely to remain in a not sustainable condition into the future.
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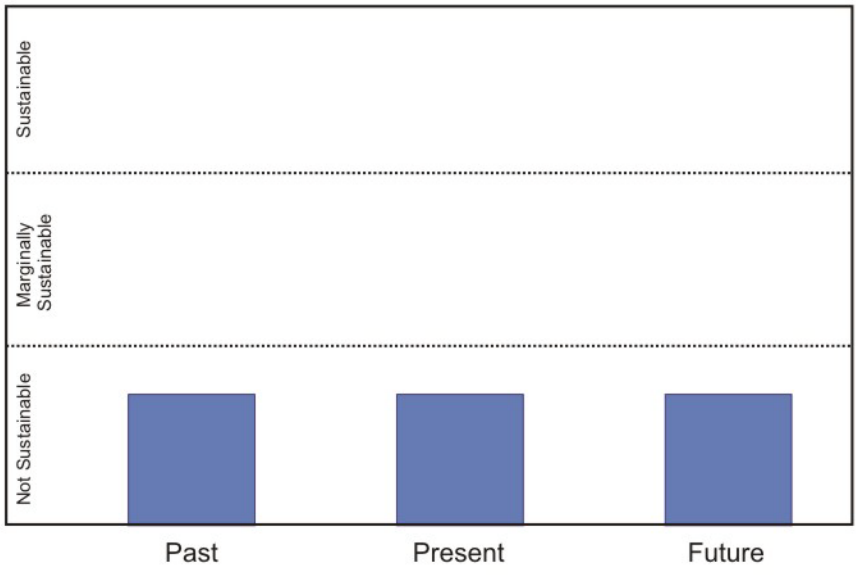
FIGURE 6-1
Environmental Sustainability of Riparian Resources



Source: Skelly and Loy, Inc., 2009

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Chapter 7

RECREATION

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7.1 DEFINITION

Recreation is defined as any leisure time activity that diverts, amuses, or stimulates an individual with the intent to restore or strengthen that individual's spirits. River-based recreation activities include, but are not limited to, recreational fishing, pleasure boating, water-skiing, and swimming. Pleasure boating includes the use of privately owned or rented motorboats, personal watercraft (PWC), and non-powered watercraft (canoes, kayaks, sail boats) as well as sightseeing, dining, and related activities aboard commercial watercraft. Additionally, the upper Ohio River and its riparian environs provide a setting for a broad range of shore oriented activities that include hiking, biking, fishing, festivals, regattas, and fireworks displays.

In addition to river oriented recreational activities, the riverfront is the setting for world-class sports facilities (Heinz Field and PNC Park), concerts (Point State Park), and museums (the Carnegie Science Center and related facilities), as well as on-shore dining,

shopping, entertainment (Rivers Casino), hotels, and convention centers. Further enhancement of recreation and tourism facilities are prominent factors in many riverfront plans in the study area.

These activities are expected to increase on the upper Ohio River due to overall improvements in river water quality, and increased access via boat ramps, marinas, trails, and parks. Publicly funded or subsidized recreational facilities have the potential to contribute to long term protection of resources (greenways, viewscapes, public access) and heighten demand for additional recreational opportunities.

Recreation oriented riverfront developments, however, also compete with other uses along the river. Potential health and safety impacts can occur to recreational users due to the proximity of these activities to barge traffic or other commercial uses of the river.

7.2 OBJECTIVES/SCOPE

7.2.1 Objectives

This chapter provides an overview of recreational activities and trends throughout the upper Ohio River. Additionally, this chapter assesses the system-wide cumulative impacts to recreation of all likely major navigation improvements along the river from 2008 to 2070. Impacts that are directly or indirectly attributable to modernization of the navigation system are evaluated in concert with impacts from other past, present, and reasonably foreseeable future actions (RFFAs) by the United States Army Corps of Engineers (USACE) and others.

Assessment of past and present actions and current conditions is the basis for identifying and interpreting the potential impacts of Reasonably Foreseeable Future Actions (RFFAs). Future actions include the major navigation improvements identified in this study; other routine or potential actions by the USACE; projected actions by other federal, state, or local agencies, actions by non-governmental entities; and predictions of general economic expansion and development.

The results of the cumulative effects assessment are intended to determine whether the impacts of the RFFAs constitute acceptable outcomes for the affected resources and how the proposed navigation improvements contribute to those outcomes.

7.2.2 Geographic Scope

The geographic focus for recreation includes that portion of the Upper Ohio River Navigation System that is most directly affected by the existing and possible future modifications to the system. This also includes the Allegheny and Monongahela tributaries of the Ohio River to the first upstream dam on each river. The downstream geographic limit is defined as the New Cumberland Lock and Dam. The geographic scope includes the following pools: Emsworth, Dashields, Montgomery, and New Cumberland.

Also included are the floodplains along either bank of the four pools. This floodplain zone is defined as the meander channel of the upper Ohio River and includes the 100- and 500-year floodplains as well as terraces of level land lying above these flood zones. Floodplain lands are considered in this assessment because certain recreation activities occur in the floodplain and are affected by siltation and contaminants associated with construction, industry, urban storm water, and other land-based activities. Streams and floodplains normally interact as a complex ecosystem which is the basis for various recreation activities.

7.2.3 Time Frame

The established time frame for this assessment is 1885 to 2070. The earlier date is when initial lock and dam construction on the Ohio River began. Thus, it approximates the beginning of the modern lock and dam system. The latter date approximates the economic life of anticipated improvements on the Ohio River and is considered the planning horizon for the project.

7.3 ISSUES FROM SCOPING

Scoping has occurred as part of the Ohio River Mainstem Study (ORMSS) and for the Upper Ohio Navigation Study. A series of 12 public scoping meetings was held for ORMSS during the summer of 2001. Subsequently, three public scoping meetings were held for the Upper Ohio Navigation Study in October 2006. Approximately 185 people attended the ORMSS meetings and approximately 40 people attended the Upper Ohio Navigation Study meetings.

Several comments related to recreation resources were made during both series of meetings. Comments that are directly or indirectly associated with recreation resources are shown in Table 7-1. Some data from ORMSS have been generalized and aggregated in the table below. As a result, specific comments found below may not tie directly into the individual comments presented in the ORMSS scoping minutes or its project documents.

TABLE 7-1
Comments on Recreation Resources from Public Scoping Meetings

Comment	Number of Similar Comments	Scoping Meeting
Need more public access ramps in each pool to reduce recreational craft usage of locks	5	ORMSS
Effects on fishing caused by water level fluctuations	3	ORMSS
Degradation of recreational value of river caused by increased industrialization	2	ORMSS
Increased development of scenic byways and bikeways	2	ORMSS
Increase in barge loading/unloading facilities limiting fishing access from shore	2	ORMSS, Upper Ohio River Nav. Study

Comment	Number of Similar Comments	Scoping Meeting
Under-representing of fishermen in scoping process	1	ORMSS
Danger to recreational users of submerged trees toppled by bank erosion	1	ORMSS
Need for examination of those licensed to operate recreational craft	1	ORMSS
Include recreational facilities as design components of L/D revitalization & construction projects	1	ORMSS
Need for long-term plan for replacement & maintenance of existing recreational launch ramps	1	ORMSS
Need more access ramps in each pool for emergency response and boating safety officials	1	ORMSS
Difficulties in future planning along riverfronts if pool level is uncertain	1	Upper Ohio River Nav. Study
Damage or loss of waterfront parks, paths, and docking facilities if pool level is raised	1	Upper Ohio River Nav. Study
Need for a safe boating environment for increasing number of non-motorized and motorized boaters	1	ORMSS, Upper Ohio River Nav. Study
Recreation should be more integrated into USACE decision-making process	1	Upper Ohio River Nav. Study

Additional information and comments have been sought from the environmental resource agency representatives and planning officials serving on an Interagency Working Group (IWG) specifically assembled for this project. Comments from IWG members on potential impacts to recreation resources have focused on economic growth, river traffic and transportation, and the potential for new generating plants along the Ohio River. Specifically for recreation resources, IWG members noted that the narrow floodplains along the upper Ohio River coupled with dense development for other uses have limited recreational opportunities and greenspace. Additionally, water quality issues have affected recreation.

7.4 LAWS, REGULATIONS, ORDINANCES, AND PROGRAMS

7.4.1 Agency Guidelines

Chapter 3 of the USACE Planning Guidance Notebook, ER 1105-2-100 (2000a) contains the following information related to river-based recreation:

- Statement – The USACE is one of the nation's largest providers of outdoor recreation opportunities. Although known primarily for the opportunities managed at its lake projects, the USACE also participates in the planning, design and construction of recreation facilities at a wide variety of other types of water resource projects.
- Policy – Lakes, or reservoirs, are impoundments created behind dams, or behind navigation locks and dams, if lands not subject to navigation servitude are needed

for water storage. Recreation policies applicable to lakes are not applicable to dry dams, that is, those dams not providing permanently impounded water. The Federal government may participate in basic recreation facilities on project lands or separable recreation lands if a non-Federal sponsor will participate and cost share. Economically justified recreation facilities are cost shared 50 percent federal and 50 percent non-federal. The same conditions apply to separable lands acquired for future recreation development.

7.4.2 Laws and Programs

The development and support of recreational opportunities by the USACE along the Ohio River are addressed through a number of laws and related authorizations. In addition to rulemaking that directly references recreational activities, other ordinances address stewardship of resources that indirectly contribute to the quality and variety of recreational opportunities. Laws and regulations affecting recreational resources are presented in Table 7-2.

TABLE 7-2
Laws, Regulations, Ordinances, and Programs Relevant to Recreation

Law/Program (Lead Agency)	Key Components	Relevance to Recreation
Federal Water Project Recreation Act (16 U.S.C. 460*l*-12). (U.S. Army Corps of Engineers, U.S. Fish and Wildlife Service)	• Establishes policy that consideration be given to opportunities for outdoor recreation and fish and wildlife enhancement in the investigating and planning of federal navigation, flood control, reclamation, hydroelectric or multi-purpose water resource projects, whenever any such project can reasonably serve either or both purposes consistently • May include recreation & wildlife benefits in project cost/benefit analysis	Basis for boat ramps and shore fishing access to project pools, other facilities cost shared with state/local operators
Reclamation Projects Authorization and Adjustments Act of 1992 Title XXVIII (16 U.S.C. 460*l*-31 - 460*l*-34), the *Reclamation Recreation Management Act* (U.S. Army Corps of Engineers, U.S. Fish and Wildlife Service)	• Amends provisions of the Federal Water Project Recreation Act regarding cost sharing requirements for the provision of new recreation facilities, for recreation and fish and wildlife enhancement, and for the expansion or modification of existing recreation facilities	Requirement for sponsor to assume 100% of operations, maintenance, and replacement costs is changed to "not less than one half the costs (16 U.S.C. 460*l*-13(a))."

Law/Program (Lead Agency)	Key Components	Relevance to Recreation
Flood Control Act of 1944 (U.S. Army Corps of Engineers)	• Authorizes the USACE to construct, maintain, and operate public park and recreational facilities at water resource development projects (includes non-reservoir projects); local interests also permitted to construct, operate, and maintain such facilities	Water areas of all such projects shall be open to public use for general recreational purposes; includes public access
Fish and Wildlife Conservation and Water Resource Developments-Coordination (16 U.S.C. § 661 et seq.) (U.S. Army Corps of Engineers)	• Recognizes contribution of wildlife resources to national interests; provides that wildlife conservation receive equal consideration and be coordinated with other features of water-resources development programs	Requires consultation with USFWS and state wildlife agencies from early planning to project completion; provides for the use of Civil Works projects for conservation, maintenance, and management of fish and wildlife resources and wildlife habitat
Emergency Wetlands Resources Act of 1986 (16 U.S.C. §§ 3901-3932) (U.S. Army Corps of Engineers)	• Promotes the conservation of wetlands to maintain the public benefits they provide, and to fulfill international obligations contained in various migratory bird treaties and conventions (16 U.S.C. 3901 [b]) • The means for this identified in the Act include: cooperative management and conservation efforts among private interests, local, state, and federal governments; and acquisition in fee, easements, or other interests and methods.	Regional offices of the USFWS develop Regional Wetland Concept Plans, which may be useful in identifying significant opportunities for ecosystem restoration. Maps and other information from the National Wetlands Inventory may be useful in Civil Works planning and natural resources management initiatives.
Clean Water Act (U.S. Environmental Protection Agency)	• Establishes structure for regulating pollution discharges into U.S. waters (NPDES permits)	Provides framework for water quality improvement and protection
Recreational Trails Program (Federal Highway Administration)	• Provides funds from the Federal Highway Trust Fund to state agencies to develop and maintain recreational trails and trail-related facilities for both nonmotorized and motorized recreational trail uses	Funds represent a portion of the motor fuel excise tax collected from nonhighway recreational fuel use: snowmobiles, all-terrain vehicles, off-highway motorcycles, and off-highway light trucks

Law/Program (Lead Agency)	Key Components	Relevance to Recreation
Intermodal Surface Transportation Efficiency Act of 1991; Transportation Equity Act for the 21st Century; and Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (Federal Highway Administration)	• Identifies and develops scenic byways that offer outstanding scenic, historic, natural, cultural, recreational, or archaeological values • Provides funds for Transportation Enhancement activities, such as landscaping and beautification, rehabilitation, operation of historic transportation facilities, bikeways, and trails • Provides funds to mitigate wetlands impacts directly associated with projects, participates in wetland mitigation banks, restoration, enhancement and creation of wetlands.	Offers many opportunities to develop recreation components associated with larger transportation projects
Fish and Wildlife Conservation Act (U.S. Fish and Wildlife Service)	• Declares that fish and wildlife are of ecological, educational, esthetic, cultural, recreational, economic, and scientific value to the nation	May provide financial and technical assistance to states to conduct inventories and conservation plans for non-game wildlife
National Trails System Act (16 U.S.C. §§ 1241 – 1251) (U.S. Dept. of the Interior)	• Acknowledges the increasing popularity of outdoor recreation; the need to promote access to and enjoyment of outdoor areas of the Nation, both near urban areas and in more remote scenic areas	The aesthetic attractiveness of scenic corridors available on project lands can be enhanced by incorporation of trails or trail systems.
Land and Water Conservation Fund Act of 1965 (16 U.S.C. §§ 460*l*-4 through 460*l*-11) (U.S. Dept. of the Interior)	• Provides money to federal, state, and local governments to purchase land, water, and wetlands • Establishes fund from the sale of surplus real and personal property under the Federal Property and Administrative Services Act of 1949; motorboat fuel taxes; and congressional appropriations or Outer Continental Shelf oil monies	In addition to providing money for the federal purchase of lands and waters, also provides financial assistance to states for outdoor recreation planning, acquisition of land or waters, or interests in land or waters, and facilities development

Law/Program (Lead Agency)	Key Components	Relevance to Recreation
National Outdoor Policy Act of 2005 (U.S. Dept. of the Interior)	• Directs the Secretary of the Interior to lead a multi-departmental effort to craft a National Recreation Strategy • Establishes a Recreation Inter-Agency Coordinating Council and authorizes appointment of recreation advisors from among the public	Recognizes the critical role of federal agencies in providing diverse recreation opportunities. Recognizes the important role recreation plays in meeting national goals for health, education, deterrence of crime, economic development and family and community stability
National Historic Preservation Act of 1966 (16 U.S.C. §§ 470 et seq.) (U.S. Dept. of the Interior)	• Act establishes preservation as a national policy and directs the federal government to provide leadership in preserving, restoring, and maintaining the historic and cultural environment of the nation	The USACE has the opportunity to provide leadership in the preservation of cultural resources and to protect sites and structures as part of the operation and maintenance of USACE projects.
Archeological Resources Protection Act of 1979 (16 U.S.C. § 470 et seq.) (U.S. Dept. of the Interior)	• Enacted to preserve and protect resources and sites on federal and Indian lands; prohibits the removal, sale, receipt, and interstate transportation of archaeological resources obtained illegally (i.e., without permits) from public or Indian lands	Authorizes federal agency permit procedures for investigations of archaeological resources on public lands under the agency's control
Rivers, Trails, and Conservation Assistance Program (National Parks Service)	• Implements the natural resource conservation and outdoor recreation mission of the National Park Service in communities across America	The community assistance arm of the National Park Service provides technical assistance to communities to conserve rivers, preserve open space, and develop trails and greenways.
Clean Ohio Trails Fund (Ohio Dept. of Natural Resources)	• Provides 75% state reimbursement for outdoor recreational trails.	Eligible projects include: land acquisition for a trail, trail development, trailhead facilities, engineering and design
Nature Works Program (Ohio Dept. of Natural Resources)	• Provides 75% state funding for acquisition, development, or rehabilitation of public park and recreation areas	All local governments are eligible for this program

Law/Program (Lead Agency)	Key Components	Relevance to Recreation
Community Conservation Partnerships Program (PA Dept. of Conservation and Natural Resources)	• Provides funding to local county governments and non-profit organizations to assist them with addressing their recreation and conservation needs • Also supports economically beneficial recreational tourism initiatives	Annual grants program for local conservation, recreation, and heritage preservation projects

7.5 PAST TO CURRENT BASELINE CONDITIONS

7.5.1 Early Recreational Activities

The Ohio River and its major tributaries have long been a setting for recreational activity. The advent of steamboat transportation in the early 19th century introduced luxury travel to the Ohio River. First class accommodations featured luxury staterooms, fine dining, gambling, music and live entertainment, whether traveling for business or pleasure (Blake 1981). Before long, some steamboats were entirely converted to floating entertainment centers. William Chapman's *Floating Theater*, built in Pittsburgh and launched on the Ohio River, made its initial trek to New Orleans in the summer of 1831 (Baldwin 1981). Showboats provided a variety of entertainment, including dining, jazz, blues, and popular music, theater and vaudeville, for over a century (Baldwin 1981). By the turn of the 20th century, individual and family oriented activities such as pleasure boating, fishing, swimming, and picnicking were all highly popular pastimes on the Ohio River (USACE 2001).

As completion of the low-level dams progressed through the 1920s, a variety of factors began influencing recreational activities on and around the region's rivers. Along the heavily industrialized reaches from Pittsburgh through Wheeling, industry and railroads crowded out residential and commercial uses of the floodplains while also discharging their industrial process effluents to the air and river. The combination of pollution and restricted access eliminated most recreational activities and contributed to negative perceptions of the river's recreational potential that persisted well into the 1970s (Muller 1972). Although some people did boat and fish on the Ohio River prior to the era of environmental improvements that began in the 1960s and 1970s, for the average Pittsburgher, the river was not viewed as a good place for high-quality recreation.

Navigation dams also had mixed impacts on recreational patterns. Fisheries associated with shallow riffles could only be found in the restricted tailwater areas immediately downstream of the dams. Changes in water quality, however, engendered the most dramatic impacts to recreational activities. Coordinated efforts to clean up the Ohio River and its major tributaries date from the establishment of the Ohio River Sanitation Commission (ORSANCO) in 1948, and early successes in many areas contributed to reestablishment of traditional recreational uses from approximately the mid-1960s. This period roughly corresponds to the era of completion of the high lift lock and dam projects

that replaced the first generation dams. Thus, the recovery and expansion of river-oriented recreation occurred in the relatively stable environment of the long pools behind the navigation dams that were in place *circa* the early 1970s (USACE 2001).

7.5.2 Present Status and Recent Trends

Readily available information regarding recreation facilities in the study area included Navigation Charts published by the Pittsburgh District of the USACE, aerial photographs, local maps and guides, planning documents, and records of recreation activity.

7.5.2.1 Inventory of Recreation Features on the River

A current inventory of water based recreation features directly related to the river is found in Table 7-3. The information is derived from appendices (*Small Boat Harbors, Ramps, Landings, etc.*) found in the USACE Navigation Charts (2004a, b) and other local sources. Facilities listed in the Navigation Charts appendices include public boat launching ramps, other public facilities, private marinas, and other private facilities. Inactive listings are not included in the table. Information was also obtained through the Pennsylvania Fish and Boat Commission (PFBC), Ohio Department of Natural Resources (ODNR), and West Virginia Division of Natural Resources (WVDNR). Additional recreation facilities that utilize the river as a setting or provide an enhanced recreational opportunity because they are adjacent to the river are discussed later in this chapter.

TABLE 7-3
Upper Ohio River Study Area Water-Related Recreation Facilities

Pool	River Mile	Bank	Public/ Private	Description
Emsworth Monongahela River	0.0	L	Public	Mooring, City of Pittsburgh
	0.2	R	Public	Mooring, Monongahela Wharf
	0.2	L	Private	Boat excursions, Gateway Clipper
	0.7	L	Public	South Side Riverfront Park and Ramp, City of Pittsburgh
	2.2	L	Public	Ramp, PFBC
	6.2	L	Private	Ramp
	10.8	R	Public	Ramp, Braddock Boro
Emsworth Allegheny River	0.0	L	Public	Mooring, City of Pittsburgh
	0.2	R	Public	Mooring, Clemente Park
	0.9	L	Private	Landing, David L. Lawrence Conf. Center
	1.2	L	Private	Mooring, Pittsburgh Yacht Club
	1.5	L	Private	Landing, Allegheny Marina (Strip District)
	1.8	L	Private	South Shore Marina
	2.5	R	Private	Mooring, Ramp, Washington's Landing
	2.6	C	Private	Rowing hulls, Three Rivers Rowing Assoc.
	3.3	R	Private	Mooring, Millvale Marina
	5.4	L	Private	Ramp, Mooring, Allegheny Marina (62nd St.)
	5.9	R	Private	Ramp, Sharpsburg Boat Docks (13th St. marina)
	6.35	R	Private	Mooring, Travel Lift. Silk's Crows Nest Marina

Pool	River Mile	Bank	Public/ Private	Description
Emsworth Ohio River	1.1	R	Private	Ramp, Newport Marina
	1.2	R	Private	Mooring, Point Cove Marina
	1.4	R	Private	Mooring, Ramp, Peggy's Harbor
	2.0	R	Private	Mooring, Branchport Boat Club
	2.1	R	Private	Ramp, Island Boat Club
Dashields Ohio River	8.3	R	Private	Mooring, Glenfield Delray Marina
	8.7	R	Private	Ramp, Mooring C&E Marina
	8.8	RBC	Private	Greater Pittsburgh Aquatic Club
	9.0	LBC	Public	Ramp, Mooring, B&L Marina
	9.1	LBC	Private	Ramp, Groveton Boat Club
	10.4	R	Private	Mooring, All States Marina
	11.8	R	Public	Ramp, Sewickley
Montgomery Ohio River	14.1	L	Private	Ramp, Glenwillard Boat Club
	15.0	R	Public	Ramp, PFBC (Leetsdale)
	25.4	R	Public	Ramp, Rochester
	25.6	L	Public	Ramp, PFBC (Monaca)
New Cumberland Ohio River	34.5	L	Public	Ramp, Shippingport
	42.3	RBC	Private	Ramp, Mooring, Ohio Valley Boat Club
	43.1	L	Public	Ramp, Chester (WVDNR)
	43.4	L	Private	Mooring, Holiday Yacht Club
	43.4	L	Private	Ramp, Smith Landing
	43.5	R	Public	Ramp, East Liverpool (Broadway)
	43.6	L	Private	Ramp, Mooring East Liverpool Yacht Club
	46.4	L	Private	Kennedy Park Marina
	47.1	R	Private	Ramp, Mooring, Kennedy Boat Marina
L = left; R = right; C = center; LBC = left bank center; RBC = right bank center				

Ramps, moorings, and landings are found throughout the area. There are 15 public facilities and 29 private facilities located within the project area. Summary information about the facilities listed above is presented in Table 7-4.

TABLE 7-4
Summary of River Recreational Facilities

Pool	River	Public Number/Type	Private Number/Type
Emsworth	Monongahela	5 / ramps, moorings	2 / ramp, excursions
Emsworth	Allegheny	2 / moorings	10 / ramps, moorings, clubs
Emsworth	Ohio	None	5 / ramps, moorings, clubs
Dashields	Ohio	2 / ramps, moorings	5 / ramps, moorings, clubs
Montgomery	Ohio	3 / ramps	1 / ramp, club
New Cumberland	Ohio	3 / ramps	6 / ramps, moorings, clubs
Total		15	29

The Emsworth Pool extends from the Monongahela River at mile 11.3 to the Allegheny River at mile 6.7 to the Ohio River at mile 6.2. Not surprisingly, because it is centered around Pittsburgh and falls entirely within Allegheny County – the area's most populated county – this pool has the most river recreational facilities. At 24.2 miles collectively, this is the longest continuous stretch of water within the study area. It also offers boaters contrasting views of residential, commercial, industrial, and natural panoramas. There are seven public facilities, including moorings and ramps, within the Emsworth Pool and 17 private ramps, moorings, or clubs.

The Dashields Pool extends from mile 6.2 on the Ohio River to mile 13.3. This pool also falls entirely within Allegheny County, but at 7.1 miles is the shortest stretch of water in the study area. Although the surrounding community is less populated than Pittsburgh, this pool allows easy access from some of Allegheny County's more affluent suburbs to the north and west of the city. There are two public facilities, including moorings and ramps, within the Dashields Pool and five private ramps, moorings, or clubs.

The Montgomery Pool extends from mile 13.3 on the Ohio River to 31.3. Although this pool begins in Allegheny County, most of it falls in Beaver County. This pool also transitions to the more heavily industrialized section of the Ohio River. There are three public ramps within the pool and one private ramp and club, the lowest number within any pool in the study area. While natural views and scenes of smaller but densely populated communities are offered to boaters within the Montgomery Pool, the scenery is considerably different than the Emsworth and Dashields pools. This could account for the low incidence of recreational facilities here.

The New Cumberland Pool extends from mile 31.3 on the Ohio River to mile 54.3. There are three public ramps and six private ramps, moorings, or clubs for a total of nine recreational facilities, second only to the more densely populated Emsworth Pool. West of Midland in Beaver County, at approximately mile 35.5, the pool transitions from an industrial setting to more natural scenery, especially as it crosses into West Virginia and Ohio at mile 40. Although there are still smaller residential communities to be seen, some of which have major industrial facilities on the banks of the river, the banks typically steepen in this stretch of river and offer more interesting green panoramas.

7.5.2.2 Recreational Boat Lockage

The USACE maintains records of all boat traffic that utilizes its locks. Some boaters routinely lock through as part of their touring and sightseeing experience. Others only do so as a necessity to get from available launching or marina facilities to a more desirable area. Still others avoid the locks altogether, especially as new marinas are established that facilitate more home pool boating without the necessity of travelling though any locks. Nonetheless, examining trips through the locks (lockages) provides additional insight into the health of river recreation in the study area.

On the Ohio River recreation traffic primarily uses the auxiliary lock chambers while commercial traffic uses the larger main chambers. The main chambers of all three locks are 110 x 600 feet. Their auxiliary chambers are 56 x 360 feet.

Recreation boat lockages on the upper Ohio River are shown in Table 7-5. Since the year 2001, when the combined lockages at all three dams was 7,716, lockages dropped approximately 39 percent to 4,675 in 2007, although not at a steady annual rate. In fact, lockages dropped to their lowest level in 2004 and have begun to rebound slightly.

Lockages through Emsworth Dam remain the highest of all three, followed by Dashields and then Montgomery. While decreases have been high through all the locks, Emsworth has only decreased by about 24 percent since 2001 while both of the other locks have seen decreases of about 50 percent.

TABLE 7-5
Recreational Lockages at Emsworth, Dashields, and Montgomery

Lock	2000	2001	2002	2003	2004	2005	2006	2007
Emsworth	2,739	3,140	3,222	2,302	1,998	2,948	2,328	2,392
Dashields	2,093	2,677	2,215	1,769	1,625	1,612	1,316	1,399
Montgomery	1,756	1,899	1,123	998	861	971	759	884
Total	6,588	7,716	6,560	5,069	4,484	5,531	4,403	4,675
Source: USACE, 2009								

The locks linking the three rivers to the Emsworth Pool are the busiest recreation locks for each of these rivers. Lockage activity declines as one travels away from Pittsburgh on any of the rivers (USACE 2001).

7.5.2.3 Boat Registrations

Allegheny County has been Pennsylvania's leading county in terms of boat registrations for a number of years. Annual boat registrations for the five counties within the study area are shown in Table 7-6. Boat registrations reached a peak of approximately 44,000 in year 2000 with Allegheny County accounting for two-thirds of the boat registrations in the study area. In three of the five counties (Allegheny, Beaver, and Jefferson), registrations increased to their highest levels in 2000, then declined steadily each year thereafter through 2006. In Allegheny and Beaver counties, registrations continued to drop through 2007, but there was a slight increase in Jefferson in 2007 over the previous year.

In Columbiana County, boat registrations peaked in 2003 and have held fairly steady overall. In Hancock County, where boat registrations are fewer than any of the other four study area counties, registrations have fluctuated year to year without any discernable pattern.

TABLE 7-6
Recreational Boat Registrations in the Study Area

County	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Allegheny	25,531	29,194	29,358	28,898	28,476	27,932	27,179	26,373	25,702	25,382
Beaver	5,641	6,556	6,732	6,689	6,525	6,490	6,377	6,156	6,010	5,912
Columbiana	4,104	4,119	4,276	4,155	4,218	4,295	4,287	4,250	4,239	4,259
Hancock	957	716	815	923	644	798	861	802	765	656
Jefferson	2,955	2,867	2,859	2,797	2,737	2,755	2,598	2,530	2,472	2,488
Total:	39,188	43,452	44,040	43,462	42,600	42,270	41,302	40,111	39,188	38,697
Sources: PFBC, ODNR, and WVDMV, 2009										

In Pennsylvania, any boat powered by a gasoline, diesel, or electric motor as its main power source is required to be registered. Unpowered boats are not required to be registered unless they are used at a PFBC access area or lake, or at Pennsylvania state park lakes. Similarly, in West Virginia, all boats propelled by an electrical, steam, gas, diesel, or other fuel propelled or driven motor, whether or not the motor is the principal source of propulsion, must be registered through the WV Division of Motor Vehicles (WVDMV). In Ohio, however, every recreational boat, including canoes, kayaks, pedal boats, and inflated boats, must be registered.

Of course, not all boats registered in the five counties of the study area are used on the Ohio River, but the number of registrations is indicative of interest in water recreation and the probability that the Ohio River is a popular sporting destination. Additionally, the amount of boating activity that occurs in any given year is highly dependent upon weather and water flow conditions during summer weekends, considered the primary boating season.

Nationally, annual recreational boat registrations climbed steadily from approximately 8 million in 1977 to about 12.9 million in 2001, an average annual growth of 2.7 percent (USACE 2000b). According to the National Marine Manufacturers Association (NMMA), however, boat registrations declined to 12.7 million by 2006 (NMMA 2008). Despite record high levels of boat registration during the growing years, average annual growth was slowing, as well (United States Coast Guard [USCG] 2002).

Though non-motorized boats are not registered, and it is difficult to obtain accurate statistics on their use, interest in canoeing and kayaking has been increasing in the area. The best evidence of that comes from Venture Outdoors. Venture Outdoors is a local non-profit organization transforming the region into a place where the outdoors is an integral part of the culture, identity, and lifestyle. Although it does many things to accomplish that goal, it began tracking kayakers in 2004. That year, approximately 1,600 people kayaked on the rivers around downtown Pittsburgh. Last year, the number had grown to slightly less than 9,000 (Venture Outdoors 2009).

7.5.2.4 Fishing and Access

Since 1991, the abundance and size of sport fish has been growing. Rick Lorson, a fisheries manager for the PFBC, has noted that there are healthy bass populations in the Monongahela, Allegheny and Ohio rivers, and that the number of bass over 12 inches has increased tremendously (Black 2005). The status of Pittsburgh's major rivers as a fishing destination was dramatically illustrated by the arrival of the Bassmaster Classic tournament in 2005. It was reaffirmed in August 2009 when the Forest L. Wood Cup Championship, a four-day bass fishing tournament that paid the winning angler $1 million and had a total purse of $2 million, was held in Pittsburgh – attracting national attention. Also, the largest flathead catfish caught in Pennsylvania during 2008 (over 37 pounds) was caught on the Ohio River (Pittsburgh Post-Gazette 2009). While boat fishing activity has generally been able to grow in response to demand, bank fishing opportunities remain constrained because access to the river is limited by railroads, industrial sites, steep terrain, narrow banks, other obstacles, and a lingering traditional negative community bias against fishing on the river.

7.5.2.5 Parks, Trails, and Opportunities

Waterfront settings provide opportunities for a broad spectrum of land-based recreation. Within the project area, in addition to a burgeoning trail network, the riverfront setting has proven a popular location for parks, two sports stadiums, a museum, a casino, and a major hotel/shopping complex. Table 7-7 provides a partial inventory of existing recreation-oriented facilities within the study area. Most of these facilities, however, do not have direct access to the river and, until recently, some did not make good use of the river's proximity.

TABLE 7-7
Additional Shoreline-based Recreation Facilities on the Study Area's Rivers

River	Facility	Location	Comments
Monongahela	Point State Park	0.0R	Downtown park, festivals, special events
	Station Square Trail	0.0R-1.5R	Walking trail
	Mon River Wharf	0.5R	Public mooring, parking
	Gateway Clipper	0.5L	Boat excursions, sightseeing, parties
	Station Square	0.8L	Dining/shopping/entertainment
	Eliza Furnace Trail	0.8-3.5R	Trail
	South Side Trail	1.5-4.5L	Riverfront trail
	South Side Riverfront Park	2.3L	Public park
	Baldwin Borough Trail	4.5-5.7L	Trail
	Duck Hollow Trail	6.0-7.4R	Trail
	Sandcastle	6.3L	Water park
	Steel Valley Trail	6.9-8.8L	Trail
	Kennywood Park	11.0L	Amusement park
Allegheny	Point State Park	0.0R	Park, festivals, special events
	Roberto Clemente Park	0.2R	Public Park
	North Shore Trail	0.2-2.4R	Trail
	PNC Park	0.3R	Professional baseball

River	Facility	Location	Comments
	David L. Lawrence Conf. Center	0.9L	Convention Center
	Millvale Trail	2.7-4.4R	Trail
	Lawrenceville Trail	2.8-3.5L	Trail
	Highland Park	6.5L	Park, zoo
Ohio	Point State Park	0.0R	Park, festivals, special events
	Heinz Field	0.1R	Professional football
	Carnegie Science Center	0.8R	Museum, educational center
	Island Sports Complex	9.9L	Ice rink, special events
	Phillis Island	35.1C	Ohio River Islands National Wildlife Refuge
	Georgetown Island	37.7C	Ohio River Islands National Wildlife Refuge
	Mountaineer Park	51.1L	Horse racing, casino, boxing
Sources: USACE, 2004a, 2004b			

During July and August 2006, Friends of the Riverfront conducted use surveys of the local trail system. Although the surveys did not provide a scientific sampling of trail users, rather, they merely counted users on some days, they do offer a "snapshot" of usage on the days the surveys occurred. The results of those surveys are shown in Table 7-8.

TABLE 7-8
Estimated Dailey Trail Usage in the Pittsburgh Riverfront Area, July – August 2006

Location	Total Users	Walking	Biking	Fishing
Station Square Area	130	121	9	0
Hot Metal Bridge Area	106	53	53	0
North Side Bike Station	75	23	49	3
Eliza Furnace Trail	67	23	44	0
Duck Hollow Trail	13	9	1	3
Lawrenceville Area	6	6	0	0
Millvale Trail	45	29	16	0
Chateau Trail	42	27	11	4
North Shore	78	45	33	0
South Side Riverfront	13	8	5	0
Total	575	344	221	10
Source: Friends of the Riverfront, 2006				

Although no studies have been done since 2006, anecdotal evidence indicates that use has been growing. Representatives from several organizations involved with recreation along the Ohio River, including the Southwest Planning Commission (SPC), Venture Outdoors, the Beaver Rowing Club, Friends of the Riverfront, and Riverlife Task Force (now called Riverlife), have indicated that numbers are steadily increasing.

Several local and regional planning initiatives have also addressed, in part, many environmental concerns that affect the Ohio River. The plans having the most potential to have a positive impact on recreation resources in the study area include:

- **Pittsburgh's Riverfront Development Plan:** This plan (City of Pittsburgh, 2005) envisions a network of trails (Three Rivers Heritage Trail) connecting all of the Monongahela, Allegheny, and Ohio river waterfronts within the City of Pittsburgh. Reports of the total length of this trail network vary by source (35 to 46 miles), possibly due to proposals of additional segments or connectors. Significant portions of trail are completed or currently under development through efforts of the Friends of The Riverfront. Friends of the Riverfront is a nonprofit organization that has worked closely with local governments, sponsors, and volunteers to establish trails and water trails in the Pittsburgh area. Although not yet fully completed, many of the interconnecting trail pieces are already in place. They include primarily the Chateau, North Shore, Millvale South Side, and Eliza Furnace trails, among others. In conjunction with the walking trails, the organization is also developing a water trail network on all three rivers; portions of it are already in place. The Three Rivers Heritage Trail has also linked to the Great Allegheny Passage, which includes organizations that are developing and maintaining the Montour Trail, Steel City Trail, Youghiogheny River Trail, and others. This network connects Pittsburgh to Cumberland, MD, and further to the C&O Canal Towpath to Washington, DC, a distance of over 300 miles.

  Together, much of this area is coming to be known as Three Rivers Park. The park is an initiative of Riverlife. The park is envisioned as a series of interconnected places. Linking more than ten miles of public and private riverfront property, it includes bridges, shorelines, and adjacent development. Of prime importance will be its accessibility to the riverfront. The complete park is expected to be completed by 2020. Key elements of this effort have been the recent restoration of Point State Park, and a future West End pedestrian bridge to connect the north and south shores of the Ohio River and the future transformation of the Mon Wharf from a river edge parking deck into a sustainable greenway.

- **Allegheny County Comprehensive Plan:** Allegheny County has currently entered the last stage of preparing its first county-wide comprehensive plan. Known as *Allegheny Places* (2008), the plan is a general guide for conservation, land use, and growth management. The plan recognizes that there is an extensive system of greenways, parks, trails, and waterways that connect the communities of the county and offer significant opportunities for environmental conservation. Specifically, the plan identifies that a new emphasis on riverfront development is currently underway through many different projects. Further, the plan calls these developments "notable greenways conservation" and suggests that all active uses of the rivers are considered during the development process (Allegheny County 2008). The comprehensive plan is still in draft form, but is expected to be endorsed by the end of 2009.

- **Allegheny County Comprehensive Parks Master Plan:** Allegheny County last prepared a *Comprehensive Parks Master Plan* in 2001. Although the plan's emphasis was on facilities under direct county management at the time, none of

which were on the Ohio River, the plan recognized a need to focus on open space preservation in the future – an effort that could include riverfront areas. Subsequent to the development of that plan, the American Institute for Leisure Resources conducted a follow-up study of the county park system in the summer of 2007. The results of that study defined systemwide revenue recommendations as well as individual park recommendations for each of the nine regional parks.

- **Beaver County Greenways and Trails Plan:** Beaver County's comprehensive plan, *Horizons: Planning for the 21st Century* (1999), provides an overall strategy guide for development. Key components of its recreation chapter were the promotion of open space, preservation of natural areas, and development of waterways and waterfront districts along the Ohio and Beaver rivers. Subsequent to completion of the comprehensive plan, a greenways and trails plan was prepared (2008). That plan, presented to the Beaver County Planning Commission in 2008, identified the Ohio River as the county's second most important conservation greenway corridor (after Brush/Connoquenessing Creeks).

- **The 3 Rivers 2nd Nature (3R2N) Project:** This wide ranging project (Studio for Creative Inquiry 2005) assimilated available data about surface water quality and riparian waterfront lands in Allegheny County from 2000 to 2005. The baseline analysis was followed by identification of opportunities and strategies for ecological restoration, studies of how to integrate restoration into local communities, and development of public dialogues about these subjects.

- **Natural Infrastructure of Southwest Pennsylvania:** This project (SPC 2005) inventoried natural resource features for the nine county Pittsburgh metropolitan region. Mapped features included floodplains, wetlands, woodlands, agricultural lands, groundwater resources, coal reserves, and other mineral resources. An overlay system was used to identify compatible or incompatible potential uses and a prioritization system was employed to recommend which resources should be protected where potential conflicts were identified.

- **Columbiana County Land Use Task Force Plan:** This plan (2007) is being developed to support economic growth through the appropriate location of infrastructure, protection of the natural environment, and preservation of green areas. When completed in late 2009 or early 2010, the plan is expected to help preserve the county's rivers, streams, lakes, forests, and open spaces for current and future generations.

- **Pennsylvania's Greenways – An Action Plan for Creating Connections:** Though a state initiative, rather than local, the Pennsylvania Greenways Partnership has identified water resources as an important part of the state's greenways. As noted in the plan, vegetative buffers between surface water resources and development can help curb non-point source pollution from urban stormwater runoff. Greenways can effectively serve this function while at the same time providing recreational and other amenities in a community. The

Commission's goal is to have a greenway in every Pennsylvania community by the year 2020.

In addition to these planning initiatives, several existing special events indicate that the environmental health of the upper Ohio River has improved. Among these events are the following:

- **Three Rivers Arts Festival:** This 10-day multidisciplinary arts festival attracts nearly 400,000 to Point State Park and Gateway Center. Currently in its 50th year, the Three River Arts Festival is considered by many people in Pittsburgh to be the kick-off event of summer.
- **Pittsburgh Three Rivers Regatta:** A four-day event that would not exist without the river, this family-oriented festival features boat racing, food, and music. Estimates of annual attendance of as high as 1.5 million have been cited in the past. The Regatta has been in existence for over 30 years.
- **Pittsburgh Triathlon:** This combined swimming, running, and biking event began in 2001 on a small scale and has become an annual event. The swimming portion of the triathlon consists of a 1.5K swim along the North Shore in the open waters of the Allegheny River. Participants swim towards the Roberto Clemente Bridge, turn around, and exit at the boat ramp near Heinz Field. Last year's event attracted nearly 300 participants and thousands of spectators.
- **Head of the Ohio:** This annual race features rowing crews and draws over 2,000 participants from high schools, colleges, and private crew teams. Now in it 22nd year, the one day race consistently ranks as one of the 10 largest autumn races in the country. The race begins on Washington's Landing and ends near Heinz Field.
- **Pittsburgh Dragon Boat Festival:** Operating from South Side Riverfront Park, this relatively new river festival features Asian music, dance, food, and art. It began about eight years ago and attracts significantly large crowds.

7.5.2.6 Americans with Disabilities Act (ADA)

The PFBC has installed fishing piers or made other accommodations at many locations to provide recreational opportunities for persons with disabilities. Within the project area and its immediate environs, those locations in Allegheny County are at the Brady Street Bridge and South Side Riverfront Park. In Beaver County, those locations are at Monaca and New Brighton. Boating docks and fishing piers are available at both Allegheny County sites; only boating docks are available at the two Beaver County sites.

A comprehensive self-evaluation and transition plan has been undertaken for Pennsylvania's state parks and other recreational facilities owned by the state. Within Point State Park, the main park entrance, riverfront wharf walkway, restrooms, numerous parking spaces, and water fountains are ADA accessible.

In Ohio, the Broadway Wharf in East Liverpool, a facility of the ODNR, is not yet accessible. ODNR is committed to making recreational opportunities available to all Ohio

citizens and in 2007 awarded a total of $3.6 million in Cooperative Boating Access Facility Program grants to improve public boating access at sites across the state.

Although the Chester ramp in West Virginia is not accessible for persons with disabilities, the WVDNR provides reasonable access to its programs and facilities in accordance with the Americans with Disabilities Act.

Since the ADA was enacted in 1990, the perception of persons with disabilities has greatly improved. The public sector has led the way by constructing new facilities that are fully accessible, committing financial resources to retrofit existing facilities, and creating an environment where programs make reasonable accommodations for accessibility. The private sector has responded, too, recognizing the importance of accessibility for society and its own business climate. Although it is sometimes difficult to make outdoor activities fully accessible, significant attempts are being made to accomplish that.

7.5.2.7 Water Quality Issues Related to Recreation

The occurrence of fecal coliform bacteria in aquatic environments indicates water has been contaminated with fecal matter of humans or other animals, generally from the overflow of domestic sewage or nonpoint sources of waste. Although the construction of water treatment plants has helped reduce the amount of sewage released into the upper Ohio River, releases of untreated sewage continue to degrade local water quality and impair the value of habitat, recreation, and public water supplies. The main sources of this untreated sewage are from combined sewer overflows (CSOs), sanitary sewer overflows (SSOs), and failing sewers.

Federal regulations require public notice when sewer overflows and runoff increase the likelihood of river contamination. Since 1995, the Allegheny County Health Department has issued river water advisories to warn of possible contamination and to caution people to limit contact with river water when boating, fishing, water skiing, swimming, or engaging in other river recreational activities. An advisory does not prohibit nor discourage river recreational activities; instead, it is intended to inform the public when river water may be contaminated so that precautions can be taken to minimize water contact. Advisories are issued during the summer river-recreation season, from May 15 to September 30, when sewer overflows and storm runoff increase the likelihood of river contamination. During the summer of 2000, when precipitation was above normal, 13 advisories were issued and included 71 of a total of 138 days (Fulton and Buckwalter 2004).

The results of wet and dry weather cross-sectional surveys of the pool of Emsworth Dam near Pittsburgh by Knauer (2001) demonstrated some impacts of precipitation and CSOs on bacteriologic conditions in the river near urban areas. During dry weather in the 2001 recreation season (May 15 - September 30), fecal coliform concentrations generally met target goals for recreational use ($\leq$200 col/100 ml). Storms with precipitation intensities of less than 0.7 inch had little lasting impacts on fecal coliform concentrations. However, more significant and persistent fecal coliform contamination occurred following storms with

greater than 1.2 inches of precipitation. Areas near the river banks tended to have higher fecal coliform concentrations, and to recover less quickly than mid-channel locations. Unfortunately, most contact recreation occurs near shore. Also, local small urban stream tributaries to the navigation system, while not large enough to measurably affect the mainstem, tended to be contaminated with fecal coliforms even during dry weather. Shallow bars at the mouths of these streams were observed to be fishing and recreation concentration points along the river, as were actual CSO discharge locations. The exact number of CSOs along the mainstem Ohio River in this area is probably less important than the fact that there are a total of 420 CSOs in urban Allegheny County near Pittsburgh which impact the Ohio River.

Because of their unique microbial resistance to chlorination and/or filtration, primary potential waterborne gastrointestinal human pathogens of concern today include *Giardia lamblia* and *Cryptosporidium parvum* (Fulton and Buckwalter 2004). Though outbreaks of diseases from these organisms have occurred in other parts of the nation, and there were serious incidents and concerns with giardiasis from the City of McKeesport's Monongahela/Youghiogheny River water supply several decades ago, and a serious apparently waterborne disease epidemic limited to persons connected to the Sewickley water supply system during the 1970s, there is no recent evidence that southwestern Pennsylvania has experienced any waterborne disease outbreak that could link impaired source water quality with human health effects. Also, amoebic meningoencephalitis from thermophilic *Naegleria fowleri* is a unique potential health problem in the thermal discharges and receiving waters of the steam-electric power plants along the lower Monongahela River. Data developed by Sykora *et al.* (1983) suggests that the optimum water temperature for pathogenic *Naegleria* strains in artificially heated effluents is between 27° and 35° C. While the probability that heated effluents might contaminate large bodies of generally cooler water is limited, swimming and other contact activities are not advisable in heated effluents and in sections of receiving waters affected by elevated temperatures.

7.5.2.8 Recreational Demand and Need

Public interest in recreational opportunities, ecological preservation, enhancement of riverscape vistas, and other community aesthetics appears to be very high. Numerous public and private organizations have initiated plans that finally recognize the importance of the river to the region's economic and environmental health. These efforts are resulting in improved public access and ecological restoration of waterways, floodplains, and bluffs encompassing the upper Ohio River valley.

Recreational opportunities along the Ohio River have increased in some ways, but decreased in others. New parks, trails, and marinas have been built, but boat registrations – while still strong, especially in Allegheny County – are decreasing. At the same time, interest in nonmotorized boating is growing. Additionally, population is decreasing and is expected to continue to decrease. Recreational lockages through the Emsworth, Dashields, and Montgomery dams have likewise decreased. Additionally, improved water quality and fisheries contribute to both on-river and shore activities.

7.6 INTERACTIONS WITH OTHER VALUED ENVIRONMENTAL COMPONENTS (VECS)

Recreational activities on the Ohio River exhibit very high levels of interaction with other valued environmental components, especially water quality and biological resources. Water quality appears to be the primary factor affecting the attractiveness of most recreational activities. Recreation on and around the river declined where water pollution reached excessive levels, but returned after water quality recovered. Water quality also impacted fishing quality, which subsequently affected recreational activity.

Riparian corridors, islands, and other natural features provide varied settings for river-based activities. The bluffs and wooded hillsides contribute to a scenic backdrop and provide a natural contrast to the project area's urban skyline. The varied natural and built landscapes also create an interesting recreational focus. Recreational demand also contributes to public and private efforts to protect or enhance the area's natural resources, especially when viewed in context of an urban fabric.

Although recreation and commercial navigation seem to be conflicting activities, they have managed to coexist with minimum friction. The navigation industry maintains a high degree of professionalism among its operators, contributing to very low accident rates between commercial tows and recreational boaters. Likewise, the USCG, state agencies, and some municipalities have improved boating safety through development of safety equipment standards, boat operator training, and enforcement of operational rules. In highly congested areas, no wake zones are employed to improve safety on the water.

Important relationships exist between cultural resources and recreational activities along the Ohio River. Potential income from tourism has helped motivate the identification, renovation, and protection of historic sites, buildings, and districts. Similarly, recognition and protection of cultural features may be incorporated into the planning and design of parks, trails, scenic byways, greenways, and urban redevelopment projects.

The general relationships between recreation factors and other VECs are summarized in Table 7-9.

TABLE 7-9
Interactions of Recreation Factors with Other VECs

VEC	Factors & Impacts	Past/Present Trends	Future Trends	Comments
Water Quality/ Sediment Quality	Improved water quality is a principal factor underlying past and ongoing growth of recreational activity.	Growth of river-oriented activity with improved water quality and accessibility	Continued growth of river oriented activity with improved water quality and accessibility	Recreational experience, activity contributes to demand for better water quality
Riparian Resources	Resource recoveries contribute to quality, variety of recreational experience.	Growth of river-oriented activity with improved scenic riparian landscape	Expanding navigation, commercial/ residential, and recreational uses of river will conflict with habitat needs.	Long term protection/ management of biological resources required to maintain recreational quality
Fish & Mussels	Resource recoveries contribute to improved recreational opportunity, aesthetic values.	See recreation, health and safety comments.	Expanding navigation, commercial, and recreational uses will conflict with habitat needs.	Long term protection/ management of significant habitat areas are required.
Transpor-tation & Traffic	Mutual coexistence between commercial transportation and aquatic recreation	Growth of both activities has not yet created major conflicts.	Continued growth of both activities may contribute to future conflicts, congestion.	Most recreationists accept barge navigation as part of scenic river environment.
Socio-economic	Expanding leisure time and disposable income per capita	Growth of river-oriented activity with expanded time and income	Expanding variety of river-oriented activity; potential conflicts from crowding or incompatible uses	Continued growth of urban riverfront oriented development (housing, shopping, and recreation)
Health & Safety	Expanding river oriented activities contribute to expanding exposure to river-related risks.	Water quality improvements, spill prevention & response, and improved monitoring has reduced risks.	Continued expansion of river-oriented activities requires improved water quality & monitoring to maintain low risks.	Control of contaminant sources affecting water contact recreation and fish consumption issues has slowed following early gains.

VEC	Factors & Impacts	Past/Present Trends	Future Trends	Comments
Cultural Resources	Historic sites, districts, and architecture add variety & quality to recreation experience.	Recreation growth, interest supports historic preservation and heritage tourism.	Continued growth of recreational interests in cultural heritage features	Parks, trails, greenways, and urban riverfront projects can all incorporate cultural resources in planning & design.
Air Quality	Particulate emissions and ozone formation can impair visibility.	Viewscapes and recreational quality have benefited from improved air quality.	Appears likely that present air quality will be maintained or improved.	Potential for haze from industrial sources exists

7.7 INDICATORS OF ENVIRONEMENTAL SUSTAINABILITY FOR RECREATION

Three principal factors contribute to the sustainability of recreational activities: opportunity, accessibility, and experience. Recreational activity occurs during leisure time and often derives from the general prosperity of the population. A population with better than average employment and income is assumed to have more opportunity for recreational activity than a population that is less affluent. Over time, population growth and economic prosperity tend to expand recreational activity.

Accessibility to recreational resources falls along a continuum from easy to difficult. Individuals living within Pittsburgh and the surrounding areas have easier access than individuals living farther away. The presence of boat launch ramps, community parks, and public access to the shoreline provides improved access in comparison to areas without such facilities.

Experience often determines the likelihood that people will engage in a particular activity. Experiences gained from participation in a recreational activity will directly influence future recreational choices. Not only are individuals more likely to repeat pleasurable recreational experiences, they are likely to encourage others to join in the same activities. The collective experiences of a given population provide indicators of future activity. They also help predict how future population may respond to changes in recreation resources.

7.8 RELEVANT FUTURE ACTIONS AFFECTING RECREATION

Reasonably Foreseeable Future Actions (RFFAs) for recreation resources were evaluated utilizing a matrix prepared during the scoping process. The matrix was an outgrowth of a similar matrix developed during the preparation of ORMSS. Results of the RFFA evaluation are summarized in Table 7-10.

TABLE 7-10
RFFA Cumulative Effects Matrix for Recreation VEC

RFFA[1]	Time Period[2]	Occurrence Probability[3]	Location on River[4]	Importance[5]	Effects[6]
USACE Actions					
Navigation Investments					
Replacement locks at Emsworth, Dashields, and Montgomery Dams (EDM)	1	H	S	H	+
Rehabilitation of EDM dams	1	H	S	H	+
Navigation aids - lock & dam signage	A	H	S	H	+
Non-structural navigation improvements	A	H	S	M	+
L&D operation and maintenance	A	H	S	H	+
Approach & channel dredging/disposal	A	H	E	L	+/-
Environmental design					
environmental sustainability operation actions	A	H	S	H	+
Pool maintenance	A	H	E	M	+
Sec 107 port development and maintenance dredging	2	L	S	M	+
Ecosystem Restoration					
Fish passage at EDM	1	H	S	H	+
Actions by Others					
Navigation System Dependent - "But For"					
Commercial navigation					
barge queuing	1	M	E	M	-
fleeting areas/barge storage	1	M	E	M	-
terminals & multi-modal sites	2	L	S	M	-
barge/tow tech/"green" design	A	M	E	M	+
accidents/spills	A	M	E	H	-
Coast Guard navigation aids - const., O&M	A	H	E	H	+
Energy					
hydropower on dams	2	M	S	M	-
continued operation of coal-fired power plants	A	M	S	M	-
Water-based recreation					
marina development & operation	A	M	S	H	+
commercial boating	A	H	E	H	+
personal boating	A	H	E	H	+
River Dependent					

RFFA[1]	Time Period[2]	Occurrence Probability[3]	Location on River[4]	Importance[5]	Effects[6]
Water supply / discharge					
municipal	A	M	S	H	-
industrial	A	M	S	H	-
Waste water treatment discharges (WWTP)					
onsite systems	A	H	E	M	-
stormwater discharges; CSOs; SSOs	A	H	S	M	-
Marcellus shale gas extraction (water impacts)	A	H	E	M	-
Resource extraction					
instream sand and gravel mining	A	H	E	L	-
Acid mine discharge (AMD)	A	M	E	L	-
Riverfront/Flood Plain Development					
Downtown Pittsburgh					
Ongoing Point State Park improvements	1	H	S	M	+
Convention Center riverfront park	1	H	S	M	+
residential development/conversions	A	H	S	M	+
North Shore development	1	H	S	M	+/-
Pittsburgh South Side					
continued riverfront development	A	H	S	H	+
continued South Side Works development	1	H	S	L	-
Riverfront trails					
Pittsburgh riverfront trail system	A	H	E	H	+
Beaver County trail system	A	M	E	H	+
Brownfields redevelopment					
Neville Island	1	H	S	H	+/-
PL&E, McKees Rocks	2	M	S	L	+/-
M&B Development	2	M	S	L	+/-
Fab Tech & Buckeye Pipeline	1	M	S	L	+/-
J&L site in Aliquippa	1	M	S	L	+/-
Leetsdale Industrial Park	1	H	S	L	+/-
Resource Protection/Restoration					
Ohio River Islands Wildlife Refuge System	A	H	S	H	+
Nationwide Rivers Inventory	A	M	S	H	+
Ecosystem restoration	A	M	E	H	+
Cultural resources	A	M	E	H	+
Bridges and Roadways					

RFFA[1]	Time Period[2]	Occurrence Probability[3]	Location on River[4]	Importance[5]	Effects[6]
Bridge renovations					
Ambridge/Aliquippa Bridge	1	H	S	L	+/-
Shippingport Bridge	1	H	S	L	+/-
Rochester Bridge	1	H	S	L	+/-
McKees Rocks Bridge	1	H	S	L	+/-
Birmingham Bridge	1	H	S	L	+/-
Rankin Bridge	1	H	S	L	+/-
New crossings					
Maglev	2	L	S	L	+/-
North Shore connector	1	H	S	L	+/-
Roadways					
Mon/Fayette Expressway	2	L	S	L	+/-
SR 28 widening/railroad relocation	1	H	S	L	+/-
CSX double stack upgrades (National Gateway)	1	M	S	L	+/-
Natural Events					
floods	A	M	E	H	-
droughts	A	L	E	H	-
invasive species	A	H	E	H	-
Regulatory Environment					
Phase I & 2 NPDES program	A	H	E	H	+
TMDLs	A	H	E	H	+
ALCOSAN & other consent decrees	A	H	E	H	+
Adaptive management in Sand & Gravel EIS	A	H	E	L	+
Pollution prevention	A	H	E	H	+
USACE permitting programs	A	H	E	M	+
Boating safety regulations	A	H	E	H	+
Monitoring programs - PA/ORSANCO	A	H	E	M	+
Regulatory Environment (continued)					
Environmental awareness education	A	H	E	H	+
Clean Air Act standards	A	H	E	L	+
Clean Water Act standards	A	H	E	H	+
Endangered Species Act (ESA)	A	H	E	M	+
Environmental sustainability practices	A	H	E	M	+

[1] Reasonably Foreseeable Future Actions

RFFA[1]	Time Period[2]	Occurrence Probability[3]	Location on River[4]	Importance[5]	Effects[6]
[2] Time period in which the RFFA may occur: A = all periods; 1 = within 10 years; 2 = in 10 - 25 years; 3 = in 25 - 60 years					
[3] Occurrence probability or likelihood RFFA will happen: H = high; M = medium; L = low					
[4] Location or setting on river where RFFA is expected to occur: E = along entire length of river; S = specific location					
[5] Importance or impact of action on the VEC: H = high; M = medium; L = low					
[6] Effects of action on the VEC: + = positive effect; - = negative effect; +/- = mixed effects					

Discussion of the RFFAs potentially impacting recreation is organized around USACE actions and actions by others. A qualitative analysis of actions with potentially high or medium probability and high or medium impacts follows.

7.8.1 USACE Actions

7.8.1.1 Navigation Investments

Lock modernization at Emsworth, Dashields, and Montgomery would result in short-term negative impacts during construction where onsite or nearby recreational uses may be closed. Short-term negative impacts are associated with any major construction activity regardless of the alternative because access through the locks during construction may be temporarily restricted to commercial vehicles. Long-term positive impacts would be realized, however, as new locks provide more efficient and dependable service to recreational boaters.

Non-structural improvements or lock and dam maintenance would generally contribute to long term safety and efficiency of lockage services to recreational users. Short term suspension of service may occur, however, during some lock repair closures.

There would be some temporary inconvenience during dredging operations, especially with turbidity or sedimentation that could affect boating and fishing. Long-term impacts to habitat loss could result if turbidity or sedimentation degrades fishery. There could also be long-term impacts in proportion to the amount of maintenance dredging required to maintain the new channel.

Pool maintenance provides stability and benefits docks and other shoreline recreational infrastructure and maintains minimum pool level, benefiting recreational use and

fishery habitat. Recreational use would be restricted during construction and could potentially be permanently altered during port development.

7.8.1.2 Ecosystem Restoration

Environmental design and ecosystem restoration would potentially enhance recreation. Long term protection of aquatic and terrestrial habitats, providing beneficial environmental improvements, would also protect the economic viability of recreation oriented businesses. By providing improvements, these actions would have the effect of making recreation an even more pleasant experience than it is now.

7.8.2 Actions by Others

7.8.2.1 Navigation System Dependent – "But For"

"But for" actions are actions that would not occur "but for" the existence and maintenance of the lock and dam system along the river. Navigation traffic including barge queuing, though supporting important aspects of commerce, may create conflicts with recreational traffic and shoreline fishing. Long-term negative impacts to fisheries may result from the cumulative impacts of concentrated commercial navigation, which can result in substrate scouring from prop wash.

Negative, long-term impacts are also associated with conflicts between recreation and commercial activity around fleeting areas, barge storage areas, terminals, and multi-modal sites. Loss of shallow water habitat resulting from dredging to allow commercial boat access would affect fish habitat, while loss of riparian habitat would impact wildlife in general and degrade water quality.

The continuation of coal-fired power plants could negatively affect recreation, primarily through their discharges into the river. Negative impacts include impingement mortalities of fish at intakes and thermal and dissolved oxygen impacts in the discharge of cooling waters. Metals or biocide contamination may occur from cooling waters discharge. Effects on water quality could have a corresponding effect on recreation. Construction of hydropower at the dam can affect fisheries through entrainment and reduction in DO.

Positive, long-term impacts are possible due to an increase in facilities specifically designed for water recreation, but marina construction and operations can contribute to loss of riparian resources. Background research indicated that passive forms of relaxing outdoors are the most popular forms of river-oriented recreation. Improved aesthetic factors, solitude, peace and quiet all affect recreation in a positive manner.

7.8.2.2 River Dependent

Wastewater treatment plants (WWTP) have made significant contributions to improved water quality. Impacts depend on the level of treatment, operational consistency, water levels in the receiving stream, and condition of the collection system. Though having a

positive effect overall, toxicity, temperature, odors, fecal contamination, and visual effects are potential negative impacts to recreation as the result of WWTPs. Onsite systems tend to be less reliable than WWTPs and can negatively impact water quality and recreational use.

Stormwater discharges include combined sewer overflows, storm sewer overflows, and runoff from urban surfaces. These contribute to elevated bacteriological contamination that can create health risks and aesthetic impacts for recreational users of the river. Stormwater runoff in urban settings often includes oils, grease, metals, and fecal contaminants. Not only do CSOs and nonpoint sources of pollution detract from river recreation, they create public health concerns.

There has been significant discussion in the area concerning drilling for natural gas. Marcellus shale underlies much of Pennsylvania and portions of West Virginia. It is estimated to hold trillions of cubic feet of natural gas. Long considered too expensive to retrieve, advances in drilling technology and current natural gas prices have attracted more interest. Drilling and fracking requires upwards of one million gallons of water per well much of which returns to the surface and must be disposed. This waste water contains numerous compounds some of which are hazardous. Current regulations in Pennsylvania allow this wastewater to be treated in local wastewater treatment plants even though the plants are not designed for the material to be treated. Effluent from these plants can pose health risks.

Although mine drainage degrades water quality and contributes to poor sediment quality, the development of the Longview Power Plant in West Virginia is alleviating the imminent threat of a mine pool burst. A non-profit organization is voluntarily pumping the Shannopin Mine pool under permit from PADEP. This activity is anticipated to dewater the mine pool to levels that will sustain an effort to mine coal from an adjacent or deeper coal seam. Although current pumping rates are causing adverse impacts to Dunkard Creek, they are not expected to adversely impact the Monongahela or Ohio rivers. If current pumping rates ceased immediately, it would take a number of years before the pool would again reach critical levels. For the foreseeable future, impacts to the Monongahela River are controllable. There is some uncertainty of the situation, however, because discharges from the mine pool, if any, could be confined to the Monongahela River. Additionally, if discharges do reach the Ohio River, flows from the Allegheny River could neutralize the effects.

7.8.2.3 Riverfront/Floodplain Development

Much of the proposed development within the area's floodplain deals with parks, trails, and recreation amenities. For the most part, they are continuations of planning initiatives started in the last ten years. Together, they are creating additional greenspace along the riverfront. Besides adding new facilities, this new greenspace will contribute to the health of recreation by improving riparian resources, water quality, and other related resources. Some of the proposed developments in the area's floodplains, however, could negatively affect recreation. Although brownfields redevelopment is generally a positive thing, it could continue some of the river access restrictions that currently exist.

7.8.2.4 Resources Protection/Restoration

Resource protection through the Ohio River Islands Wildlife Refuge System, the Nationwide Rivers Inventory, and other initiatives protect both natural and cultural resources. Additionally, they raise awareness of the importance of these resources on quality of life and public health. They also protect intrinsic qualities associated with recreational pursuits.

7.8.2.5 Bridges and Roadways

Although renovations of bridges and roads will improve accessibility and safety, construction work during transportation projects could have temporary negative impacts to recreation. Recreational boaters may not have access to some parts of the river during renovation activities. In addition, changes to population and existing land use patterns could occur as existing bridges are rehabilitated or transportation alignments shift. These impacts will be mitigated, however, through the regulatory environmental process.

7.8.2.6 Natural Events

Negative impacts can occur to recreational resources during and after floods and droughts. Floods cause a wide range of environmental damage, but the risks of floods have been reduced because flood control reservoirs and flood damage reduction programs are in place. Severe droughts could have a significant impact on recreation. Elevated temperatures, potential algae blooms in low-water pools, and reduced aeration at the locks and dams could contribute to decreased dissolved oxygen levels and potential fish kills. Floods and droughts also affect water quality. Flood conditions can cause overspills from sewer systems and add pollutants to local waters, while droughts provide less dilution of pollutants released from other sources.

Some invasive plant species have been introduced intentionally, providing ornamentation or inexpensive means of groundcover. Most invasive animal species, however, are generally introduced unintentionally, migrating into the area or being inadvertently dumped into local waterways. Freed from their natural bounds, they proliferate in new, more habitable areas, overtake native species, eliminate native wildlife, and decrease biodiversity. To some extent, they are slowly destroying an ecosystem that has been decades in the making. Widespread establishment of invasive species can also threaten human health and well-being. If left unchecked, many invasive species – regardless of whether they are plant or animal – could be a catalyst for changes in water and sediment quality or soil erosion and landslides.

7.8.2.7 Regulatory Environment

Stormwater runoff is partly responsible for high bacteria counts and water contact warnings after rain events. Correcting this problem through the Phase I and II National Pollutant Discharge Elimination System (NPDES) program would have long-term benefits to recreation. Total maximum daily loads (TMDLs) represent an important tool for managing water quality over time. Consent decrees, Clean Water Act and Clean Air Act standards, and

other environmental documents are legal commitments that assure clean water and air for future generations.

Long-term positive impacts would be associated with continued pollution prevention and the USACE permitting program. Permits are necessary for most recreation developments and other activities in and surrounding the river. Additionally, there are many grants and aid programs providing federal, state, and local funds for recreation and associated conservation projects. Permitting and grant programs have an overall positive effect on the environment.

Safety regulations assure the orderly use of the river. Valuable now, they can be expected to be strengthened in the future as new issues arise.

Monitoring programs provide data for management and enforcement responsibilities and contribute to the maintenance of water quality. Educational programs become increasingly important as environmental management shifts from point source regulations to watershed-scale, non-point initiatives. Such initiatives often rely on an informed public, supported by grass roots organization and high public participation. As environmental conditions improve in the area, habitat capable of supporting threatened and endangered species will grow. Environmental sustainability practices will allow responsible future uses of the river and its resources.

7.9 ANALYSIS OF ENVIRONMENTAL SUSTAINABILITY

Three principal factors have been identified earlier in this CEA as contributing to the sustainability of recreation: opportunity, accessibility, and experience. Recreational opportunity arises during leisure time. Generally, a more prosperous population finds more recreational opportunities than a less prosperous population. The amount of recreational opportunity available to a population is a direct result of the distance to, and variety of, recreational activities and facilities found in a specific area. Thus, individuals living within Pittsburgh, and its surrounding area, have greater access to recreational facilities within the region than individuals living farther away. Generally, experiences gained from participation in a recreational activity directly influence future recreational choices. Consequently, people tend to repeat pleasurable recreational experiences and encourage others to try those same activities.

Environmental sustainability balances environmental and economic considerations through the life cycle of project planning, design, construction, operation, and maintenance to improve the quality of life for present and future generations. Accordingly, it represents an ultimate test of significance of potential cumulative effects. In the Pittsburgh area, conditions sustaining recreation are mixed, with both positive and negative forces affecting recreational resources.

7.9.1 Positive Forces Affecting Recreation

Although the general decline of the region's industrial base has contributed to unemployment and population has been shrinking, the economy has been shifting to a commercial and medical service base. Typically, those who work have more leisure time available to them than in the past. As a result, both the public and private sectors have moved to develop additional recreational outlets, providing people with more opportunity to pursue various recreational activities.

With the creation of new hiking trails throughout the region, and an effort to link those trails together, accessibility to river-related recreation has improved tremendously. When coupled with resource protection, environmental improvements and development of more recreational facilities each year, these new facilities have become even more attractive because of their volume and modern appearances.

Participation in a recreational activity influences future recreational choices. People tend to recommend others try recreational activities they enjoyed themselves. Public and private actions that contribute to the maintenance or enhancement of recreational quality will, thus, be influenced by experience and will contribute to long-term sustainability.

Although there have been declines in motorized boating in the area, other outdoor facilities and pursuits are experiencing increasing numbers of participants. Within the project area there are many dramatic natural and urban viewscapes that contribute to the attractiveness of parks and trails. Water-based recreation, especially the growing trend in nonmotorized boating, is very popular throughout the study area. New trails and parks raise environmental awareness (and opportunity) which in turn contributes to healthy river corridor habitats.

Other positive influences on recreation are the local transportation system and the regulatory environment. Rehabilitation of the area's existing bridges and roadways are a positive force affecting the health of recreation resources. By providing a better and safer transportation system throughout the region, accessibility and opportunity for recreational activities are increased. The consequences of laws and regulations have improved the environment and increased environmental awareness, allowing recreational opportunity, accessibility, and experience to progress unimpeded.

7.9.2 Negative Forces Affecting Recreation

Although significantly improved, water quality remains an issue for water-based recreational users of the river. Poor water quality is an obstacle to the use of the river, especially if contact with the water is expected by potential users. Additionally, natural events, such as flooding, poor weather, or surface freezing restrict the use of the river t certain times of the year.

As the quality of the natural environment continues to improve and additional trails and water-related recreation facilities are constructed, however, there would appear to be few forces negatively affecting recreation. Conflicts could arise, however, as the current trend from motorized recreation on the river shifts to kayaking, canoeing, and additional shoreline trails. The different modes of recreation have different needs and some and adaptation between competing interests must occur to accommodate everyone. To date, these groups have been able to share opportunities and accessibility, but they could change in the future.

Some elements of redevelopment can also negatively affect recreation. Although there are tremendous benefits from using brownfields sites as new commercial or light industry centers, additional development can further cut off access to the river although for the most part trail rights-of-way have been established in the Pittsburgh area. A lack of accessibility could, in turn, restrict opportunity and create poor experiences.

Finally, as the population of the area continues to decrease and the average age of the population increases, some recreation pursuits may see a decline. Motorized boating is already seeing a drop in its practitioners. Other improvements currently being planned could end up being underutilized if demographic trends continue or if different types of recreation become more popular to future populations.

7.9.3 Incremental Impacts on EDM

The incremental impacts of EDM improvements will be limited and generally positive. Modern locks will allow for more efficient movement of commercial traffic from one pool to another. This will lessen potential conflicts between commercial and recreational traffic and increase safety and accessibility during on-river recreation pursuits. As traffic becomes more efficient, environmental benefits will accrue as potential conflicts are eliminated.

Environmental design and ecosystem restoration (such as fish passages) will improve water quality and fisheries. As individual elements of the environment continue to improve, the magnetic draw of the river as a valuable recreation resource will continue to grow in concert.

7.10 DETERMINATION OF SUSTAINABILITY

Three definitions of environmental sustainability were used for the analysis:

- Not sustainable – conditions for the selected indicators do not reflect conditions that would facilitate attainment of acceptable standards or would not maintain existing standards in concert with collective impacts of proposed activities.

- Marginally sustainable – conditions for selected indicators are such that attainment is accomplished for the majority, but not all, of the potentially affected populations. However, the conditions are somewhat tenuous both in location and

likelihood of occurrences. (In other words, the conditions are borderline for environmental sustainability, and there are uncertainties regarding specific quantitative measures.)

- Sustainable – conditions for selected indicators are such that attainment of acceptable conditions are accomplished for essentially all of the potentially affected populations in the project area, and such standards are maintained in concert with foreseeable future activity. Further, conditions exceed regulatory thresholds, and various governmental programs are in place to respond to any potential erosion of values related to recreation.

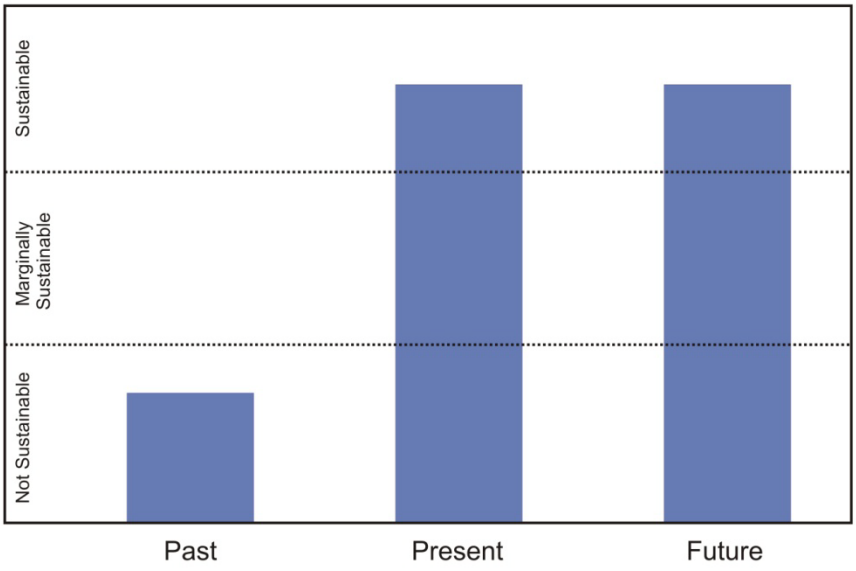
Figure 7-1 illustrates the sustainability conclusions for recreation. The environmental sustainability of recreation can be characterized as follows:

- Prior to 1905 and continuing to about 1970, recreation on the river occurred in a degraded environment due to largely untreated and uncontrolled pollution discharges. Access to the river was difficult in most cases and the experience once there was not always pleasant. Therefore, in the past, recreation was not sustainable.

- Currently, recreation is sustainable due to water quality improvements related to ORSANCO, the Federal Water Pollution Control Act, the Clean Water Act, a decline in industrial activity, and a shift in the primary types of river recreation. Water quality improvements have increased the demand for shoreline parks, trails, and other recreation facilities. Some of this growth may be attributable to convenience, but the recent era of integrated riverfront planning has increased available recreational choices.

- Community planning and development of recreation facilities will continue to expand. Additionally, water quality improvements, habitat protection, and restoration efforts will continue to enhance recreation experiences. Although socioeconomic projections show a decreasing population over the next decade and boat registrations and lockages have declined, an improved standard of living is expected to result in high demand for recreational opportunities and the slow shift from use of the river for motor-boating recreation to other forms of river-related recreation is expected to continue. Consequently, the future is sustainable.

FIGURE 7-1
Environmental Sustainability of Recreational Resources



Source: Skelly and Loy, Inc., 2009

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Chapter 8

TRANSPORTATION AND TRAFFIC

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8.1 DEFINITION

Transportation is defined as the movement of goods and people along the upper Ohio River and its associated traffic activities. Traffic is defined as the amount of activity found within the transportation system.

Transportation and traffic in the context of this cumulative effects assessment (CEA) primarily considers the Upper Ohio Navigation System's shipping volumes, shipping modes, and shipped commodities, as well as intermodal transportation facilities and connections (intermodality). Intermodality focuses on how individual transportation modes can be integrated into a seamless, sustainable system.

Numerous business and economic forces influence changes in population, which, in turn, influence transportation and traffic. Market forces and economic factors also influence the navigation system. Consistency and predictability in operation of the navigation system are keys to efficient, cost-effective transportation on the upper Ohio River.

8.2 OBJECTIVES/SCOPE

8.2.1 Objectives

This chapter assesses the cumulative effects of modernizing the navigation system within the study area on transportation and traffic. The analysis evaluates the cumulative effects on transportation and traffic in concert with other past, present, and reasonably foreseeable future actions (RFFAs) by the United States Army Corps of Engineers (USACE) and others.

Assessment of past and present actions and current conditions is the basis for identifying and interpreting the potential impacts of RFFAs. These future actions include the major navigation improvements identified in this study; other routine or potential actions by the USACE; projected actions by other federal, state, or local agencies; actions by non-governmental entities; and predictions of general economic expansion and development. The results of the assessment are used to determine the environmental sustainability of transportation and traffic.

8.2.2 Geographic Scope

The primary geographic focus for transportation and traffic impacts includes the areas directly impacted by existing and possible future modifications to the operation and maintenance of the navigation system within the upper Ohio River from the New Cumberland Lock and Dam to the first upstream dams on the Allegheny and Monongahela tributaries. The geographic scope includes the Emsworth, Dashields, Montgomery, and New Cumberland pools as well as associated ports, terminals, and intermodal sites located in adjacent riparian areas. The more comprehensive intermodal perspective of the study area includes railways and highways radiating into the larger Ohio River Basin.

8.2.3 Time Frame

The time frame for this assessment is 1885 to 2070. The earlier date corresponds to the initial construction of wooden wicket dams on this section of the Ohio River. The latter date approximates the economic life of anticipated improvements for the Emsworth, Dashields, and Montgomery locks and dams (EDM) and is considered the planning horizon for the Upper Ohio Navigation Study.

8.3 ISSUES FROM SCOPING

Scoping has occurred as part of the Ohio River Mainstem (ORMSS) and for the Upper Ohio Navigation Study. A series of 12 public scoping meetings was held for the ORMSS during the summer of 2001. In October 2006, three public scoping meetings were held for the Upper Ohio Navigation Study. Approximately 185 people attended the ORMSS meetings, and approximately 40 people attended the Upper Ohio Navigation Study meetings. Interagency Working Group (IWG) progress meetings were also held for the Upper Ohio Navigation Study. This group was specifically assembled to provide on-going scoping and

coordination to USACE planners. Participants represented local, state, and federal agencies, non-governmental organizations and academia..

Numerous comments related to transportation and traffic were made during these meetings. Table 8-1 summarizes these comments, indicates the number of similar comments regarding each issue, and identifies the meeting in which the comment was received.

TABLE 8-1
Comments on Transportation and Traffic from Public Scoping Meetings

Comment	Number of Similar Comments	Scoping Meeting
Study may overemphasize transportation and river commerce	1	ORMSS
Application of Ohio River Navigation Investment Model to ORMSS	1	ORMSS
Integration with ORMSS with the U.S. DOT Marine Transportation Study	1	ORMSS
Inclusion of no-action alternative in ORMSS	1	ORMSS
Loss of shoreline trees and river property caused by barge activity	7	ORMSS
Reliability of barge traffic forecasts	5	ORMSS
Failure of barges to stay in designated shipping lanes	2	ORMSS
Changes in shipping demand as low sulfur coal reserves near depletion in next 25 years	1	ORMSS
Changes in shipping demand if high sulfur coal use increases in response to installation of scrubbers at power plants	1	Upper Ohio River Nav. Study
Why USACE expects only 1% increase in barge traffic, while a 3% increase in gross domestic product is expected	1	ORMSS
Navigation structures presently not keeping pace with traffic demands	3	ORMSS
Clarification of scheduling and frequency of lock closures	1	ORMSS
View of navigation improvements as benefiting only shipping industry	1	ORMSS
Why economic forecast model is based on use of auxiliary locks	1	ORMSS
Has ORNIM (Ohio River navigation investment model) been run on the system?	1	ORMSS
Support expressed for value and maintenance of OR Navigation System	3	ORMSS
Importance of maintaining shipping channel	2	ORMSS
Bank undercutting and failure caused by increased barge traffic, queuing, and wave action	7	ORMSS

Comment	Number of Similar Comments	Scoping Meeting
Enhancement of river transportation capabilities through corresponding development/improvement of intermodal transportation facilities	2	ORMSS
Need for long-range coordination with FHWA, state, and local transportation agencies	1	ORMSS
Need to integrate navigation with other transportation modes	2	ORMSS
Concern about ancillary movement of goods and services in emergencies, e.g., bridge destruction	1	ORMSS
Use of AWO and DINAMO to notify towing industry of public meetings	1	ORMSS
Interest in including a vision of the river for the year 2070	1	ORMSS
Accuracy of models for predicting population growth and development	1	ORMSS
Relationship between CEA and SIP products schedules	1	ORMSS
Relationship between USACE navigation project planning and the Transportation Improvement Program (TIP)	1	Upper Ohio River Nav. Study
Need to consider most operations of commercial navigation system as direct USACE actions	1	ORMSS
ORMSS schedule possibly lagging behind future navigation needs	5	ORMSS
Overall effects of navigation structures and activities on groundwater levels	1	ORMSS
Increase in barge loading/unloading facilities limiting fishing access from shore	1	ORMSS
Stress and disruption of waterfowl migratory patterns caused by barge traffic	1	ORMSS
Estimated number of officers that enforce shipping regulations along Ohio River	1	ORMSS
Need for USACE to encourage uniformity in navigation charts along length of Ohio River	1	ORMSS
Possible increase in river shipment of containers	1	Upper Ohio River Nav. Study
Possible traffic congestion if L/D rehabilitations occur	1	Upper Ohio River Nav. Study
Opinion that L/D rehabilitations are a congestion nightmare and waste public funds	1	Upper Ohio River Nav. Study
Damage or loss to trails and docking facilities if pool levels rise due to removal of Dashields L/D	1	Upper Ohio River Nav. Study
Concern regarding responsibility of damages due to runaway barge traffic	1	Upper Ohio River Nav. Study
Address rails and roads in the CEA	1	IWG

8.4 LAWS, REGULATIONS, ORDINANCES, AND PROGRAMS

One of the most significant legislative acts related to USACE regulatory activities and river transportation was enacted more than a century ago in 1899 when the Rivers and Harbors Appropriation Act was passed. Since then, the act has been amended several times, but many original sections of the act remain relevant to river transportation and traffic in the 21st century, including the authority of the USACE to issue permits under the act.

The Water Resources Development Act, first enacted in 1976 and subsequently reauthorized several times, also has far-ranging implications for USACE activities and includes general provisions that enlarge its civil works mission to include environmental protection in planning, designing, constructing, operating, and maintaining projects. During the 1980s, both the Harbor Maintenance Tax and Inland Waterways Trust Fund began to generate significant funds dedicated to maintaining and expanding the navigation system on the nation's inland waterways. Other environmental acts that directly influence USACE activities, such as the national Environmental Policy Act (NEPA), the Clean Water Act, and the Oil Pollution Act, were also passed during the latter part of the 20th century. Table 8-2 summarizes information on various regulations and programs that influence transportation and traffic on the Ohio River.

TABLE 8-2
Laws, Regulations, Ordinances, and Programs Relevant to Transportation and Traffic

Law/Program (Lead Agency)	Key Components	Relevance to Transportation and Traffic
Rivers and Harbors Act (U.S. Army Corps of Engineers)	• Addresses projects and activities in navigable waters and harbor and river improvements • Section 7 authorizes promulgation of regulations for use of navigable waterways, including operations that provide channel improvements. • Section 10 relates to permits for physical obstructions to navigable U.S. waters.	Provides for improvements, maintenance, and safety of ports and navigation channels
Water Resources Development Act (U.S. Army Corps of Engineers)	• Authorizes the study and/or implementation of various projects and programs to improve river and harbors, including several general environmental provisions • WRDA of 1986 enacted the Harbor Maintenance Tax, paid by shippers, to cover costs of maintaining navigation channels. • Implements a cost-share formula between local ports and the federal government for improving harbors and channels	Facilitates safe traffic movement through maintenance of ports and navigation channels
National Environmental Policy Act (NEPA) (Council on Environmental	• Requires preparation of environmental impact statements for new construction projects by private and governmental agencies • Includes federal government's responsibility to prevent environmental degradation	Applies to all projects receiving federal funding, including construction of navigation structures and port developments

Law/Program (Lead Agency)	Key Components	Relevance to Transportation and Traffic
Quality and other agencies)		
Clean Water Act (U.S. Environmental Protection Agency)	• Establishes structure for regulating discharges of dredged or fill and pollution materials into U.S. waters and requires establishment of water quality standards • Section 401 requires applicants proposing activities, which may result in discharge to U.S. waters, to obtain state certification of compliance with state water quality standards.	Applies to removal and disposal of materials dredged to maintain navigation channels or to expand or construct navigation structures
Emergency Planning and Community Right-to Know Act (U.S. Environmental Protection Agency and state and local emergency response agencies)	• Requires emergency planning and preparedness at state and local levels • Section 304 establishes spill-reporting requirements for facilities that release extremely hazardous substances.	Requires commercial shipping companies to prepare emergency response plans and submit records on hazardous chemicals they are transporting
Pollution Prevention Act (U.S. Environmental Protection Agency)	• Establishes the policy of pollution prevention and reduction and recycling in an environmentally safe manner whenever feasible • Requires facilities filing annual toxic chemical release forms to also file a toxic source reduction and recycling report	Protects public safety by requiring pollution reduction or recycling of hazardous substances, toxic chemicals, and toxic and radiological wastes at their sources
Oil Pollution Act (U.S. Environmental Protection Agency and U.S. Coast Guard)	• Strengthens governmental ability to prevent & respond to catastrophic oil spills • Requires oil storage facilities and vessels to submit plans detailing how they will respond to large discharges	Protects drinking water supplies and natural resources from pollution & damage from oil spills
Executive Order 13274 (Executive Branch)	• Enhances environmental stewardship and streamlines decision making process for major transportation projects • Requires DOT to prioritize projects and establishes interagency task force to coordinate decision making across federal agencies	Applies to transportation projects on inland waterways
Abandoned Shipwreck Act (National Park Service)	Provides federal protection for any shipwreck that meets the criteria for eligibility for inclusion on the National Register of Historic Places	Prohibits disposal of dredged or other material in or near historic shipwrecks
Safe, Accountable, Flexible, Efficient Transportation Act: a Legacy for Users (U.S. Dept. of Transportation)	• PL 109-59, signed into law on August 10, 2005, effective through FY 2009 • Builds on the ISTEA and TEA-21 acts to promote balanced, integrated, and efficient transportation approaches that connect various transportation modes	Emphasizes intermodal facilities and connections (e.g., between barge transportation and highways or railways); encourages flexibility to

Law/Program (Lead Agency)	Key Components	Relevance to Transportation and Traffic
		attempt new transportation solutions
Hazardous Materials Transportation Act (U.S. Department of Transportation)	• Governs the transportation of hazardous materials, including, but not limited to, solvents, asbestos, PCBs, paints, pesticides, hazardous wastes, etc.	Requires commercial shipping companies to comply with DOT requirements for documentation, labeling, and all other regulations associated with safe transport of hazardous materials
Inland Waterways Revenue Act (U.S. Dept. of Treasury)	• Created a diesel fuel tax to defray costs of lock and dam construction and major rehabilitation along major inland waterways •	Provides a dedicated source of funding for navigation system expansion and maintenance
Spill Response (ORSANCO and U.S. Coast Guard)	Includes emergency response activities for river-related spills and accidental discharges and is related to the Oil Pollution Act and Section 301 of the Clean Water Act	Minimizes adverse impacts of spills and discharges on mussels and other aquatic life and on water quality

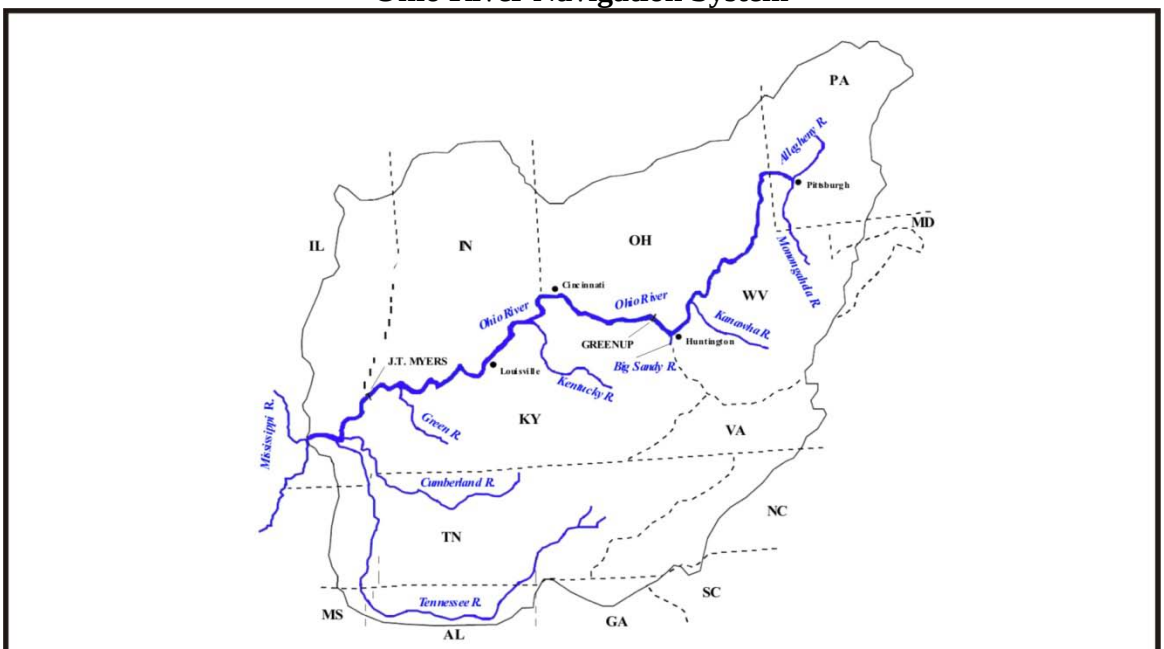
8.5 PAST TO CURRENT BASELINE CONDITIONS

8.5.1 Transportation Patterns During the 19th and Early 20th Centuries

The Ohio River is an important artery of the nation's inland waterway system, providing for commercial navigation in the eastern third of the country. The Ohio River Navigation System consists of the Ohio mainstem and navigable portions of eight tributaries (Figure 8-1). The mainstem serves as a collector of system traffic for distribution points within and outside the Ohio River Basin. While this chapter focuses primarily on water transportation, it also considers the intermodal linkages that extend the influence of commerce on the Ohio mainstem far beyond the Ohio basin.

The Upper Ohio Navigation Study project area includes the three uppermost locks and dams (L/Ds) on the Ohio mainstem: Emsworth, Dashields, and Montgomery (EDM). The study area also includes the confluence of the Allegheny and Monongahela rivers at the Port of Pittsburgh, the second busiest inland port in the nation. The transportation patterns that have developed over the decades within the upper Ohio have been influenced by the economic development and navigational improvements along the entire river.

FIGURE 8-1
Ohio River Navigation System



Source: U.S. Army Corps of Engineers, 2006a

Bigham (1998) refers to the Ohio mainstem as the nation's first interstate highway, bringing goods and people to the first western frontier. During the early decades of settlement, the Ohio River provided the primary corridor of transportation, both for immigration of new settlers and for the shipment of regional products; consequently, initial settlements within the region tended to cluster along the Ohio River. Certain port development opportunities related to transportation, such as the National Road crossing at Wheeling, directly contributed to the location and expansion of towns along the Ohio. Some early riverfront settlements subsequently prospered as hubs or service centers to interior regions reached overland by horse and wagon. This was an early example of intermodal transportation.

The earliest flatboats and keelboats mostly provided one-way transport downstream, necessitating shipment of produce through New Orleans and coastal shipping to reach eastern markets. The arrival of steamboats around 1815 permitted two-way traffic and greatly reduced travel times (Carlisle and Mulligan 2001). Development of the Ohio River in the 1800s included the removal of snags and completion of the initial canal and locks around the Falls of the Ohio in 1833, and of the first wicket dam at Davis Island, near Pittsburgh in 1885. However, the Ohio River remained largely unimproved prior to the 1920s. The ability to move commodities, consequently, was constrained by the seasonal availability of high water flows sufficient to support navigation.

Inland canals provided the first significant alternative or supplement to river transport, beginning in 1825 with completion of the Erie Canal from Buffalo to New York

City. Important canals in the Ohio River Valley included the Ohio & Erie from Lake Erie to Portsmouth, OH; the Pennsylvania Mainline from Pittsburgh to Philadelphia; and the Pennsylvania & Ohio from Pittsburgh to the Mahoning River Valley in Ohio (Carlisle and Mulligan 2001). Canals provided nearly year-round transportation and the ability to ship products more directly to eastern markets instead of overland from the Upper Ohio, Allegheny, or Monongahela ports. Canal development supplemented river traffic more than it competed with or replaced river traffic. Steamboats hauled goods to canal terminals on the Ohio River, creating another early form of multimodality.

The expansion of railroads provided a far more significant level of competition to river transport and quickly became the primary means of commercial transportation in the region. Railroads provided true year-round transport capabilities, greatly reduced transport times, and could be quickly built to serve any point-to-point business opportunity. The first railroad in the Middle Ohio River Valley was completed in the 1840s, connecting Lake Erie with the Ohio River. By 1850, 242 miles of track were completed in the Middle Ohio River Valley. By 1855, this number exploded to 1,247 miles and virtually saturated rail transport opportunities in the region. Rail mileage in the region grew only an additional 80 miles by 1860 (Carlisle and Mulligan 2001). Railroads almost immediately rendered canals obsolete. Track sometimes was laid beside or over the abandoned canals.

Commercial river transport also declined at a slow but steady pace in competition with railroads. The year-round operability of rails had a distinct advantage over the seasonal limitation of steamboats. Inland cities with good rail connections grew substantially. To a large degree, the early river communities along the Ohio River either prospered or perished with the railroads, depending on their ability to attract rail service. Subsequently, further prosperity came to most towns able to establish railroad bridges across the Ohio River.

The latter decades of the 19th century and early decades of the 20th century included a period of heavy industrial development along the middle and upper Ohio River. This development centered on the iron and steel industry in Pittsburgh, with its convergence of raw materials, coal, river, and rail and river transportation to move materials and products into and out of the region.

8.5.2 Transportation Patterns from the 1920s to the Present

Construction of the system of wicket locks and dams ultimately revitalized the Ohio River as a major transportation corridor. Following construction of the first project in 1885 at Davis Island near Pittsburgh, the next lock and dam project was not finished until 1904. Initial construction of the dams was opposed by some members of the barge industry who feared that breaking up multiple barge tows for passage through the locks would make river freight impractical (McVarnish 2001). However, completion of the initial projects proved the advantages of this navigation development and sentiment began to change to favor canalization. After the Davis Island Lock was in operation, an unexpected flood in July 1888 particularly gave momentum to downstream canalization. One hundred coal barges sank along the Ohio River, but no barge in the harbor behind Davis Island was lost. Furthermore, industry located along the Davis Island Pool benefited from a more reliable water supply.

Any fears that the pool would become a stagnant breeding ground for disease proved unfounded. Instead, sewage and other offensive effluents, which had formerly festered along the shoreline during low water periods, were washed away.

Both rivermen and industrialists urged the extension of canalization downriver (Johnson 1977, as cited in McVarnish 2001). Six lock and dam projects were completed between 1904 and 1910; 23 were completed between 1911 and 1920; and the entire system of more than 50 lock and wicket dam projects was completed by 1929. The original design for a navigation depth of six feet was modified in 1910 to provide the nine-foot depth required for coal barges that had begun operating on the river by 1900.

As construction of the navigation system continued, however, river traffic declined, primarily because of rail transportation. In 1917, cargo carried on the river reached a low of about 4.6 million tons, caused largely by the decline of coal shipments from Pittsburgh to New Orleans, as coal was diverted to steel plants in the Upper Ohio Valley. The turning point came as World War I continued and wartime shipping overburdened the country's land transportation system. By 1920, cargo volume on the Ohio River had risen to almost 9.4 million tons, a total that increased further to 10.8 million tons in 1924, 16 million tons by 1925, and 22.3 million tons by 1930 (Froggett 1926a, b; Robinson 1983; and USACE-ORD 1979, as cited in McVarnish 2001). Where traffic once consisted primarily of coal and steel products moving downstream, new products were being added as the century progressed. Freight soon included petroleum and its products, iron and steel, dry and liquid chemicals, grain, cement, and a variety of other items (Gaum 1970, as cited in McVarnish 2001).

Commerce on the river grew steadily through the 1930s and 1940s while development of diesel towboats and larger barges created opportunities for larger scale, more efficient movement of commodities. Designed for about 15 million tons of commerce annually, the old locks and dams handled more than 70 million tons in 1954; in addition, traffic moving upstream on the Ohio had nearly equaled that moving downstream. Plans to improve system efficiency and accommodate the larger tugs and barges called for reducing the number of dams by building high-lift projects with larger capacity locks. The final plan, approved in 1954, envisioned a total of 19 high-lift projects with dual lock chambers. It began with the construction of the Greenup and New Cumberland L/Ds, although construction of Emsworth, Dashields, Montgomery and Gallipolis L/Ds during the 1930s had already replaced some old locks and wicket dams on the upper river. Implementation of the current phase of lock extensions actually overlaps completion of the mid-century modernization program. Olmsted Locks and Dam, under construction at River Mile (RM) 964.4, will complete the 1954 modernization plan and replace old L/D 52 and 53. Upon Olmsted's completion, there will be 19 lock and dam projects along the Ohio River, as envisioned over 50 years ago. Table 8-3 provides a synopsis of the key dates in the historical development of navigation on the Ohio River.

TABLE 8-3
Chronology of Navigation Development on the Ohio River

1811	The NEW ORLEANS is the first steamboat to navigate the Ohio
1824	First federal funding for river improvements; removal of snags and clearing sand bars
1874	Beacons, buoys, and daymarks put into use on the river
1885	Davis Island Lock and Dam completed near Pittsburgh
1929	Series of 51 locks and wicket dams completed
1954	USACE begins modernization program replacing movable dams with stationary high-lift dams
1992	Construction begins on Olmsted Locks and Dam, last project in 1950's modernization program

8.5.3 Overview of the Ohio River Mainstem

As the oldest locks and dams on the Ohio River, it is important to view the EDM facilities in context of the entire mainstem. Because of their age and problems associated with their reliability and maintenance, the EDM are significantly different than the rest of the locks and dams on the Ohio River. By examining the functionality of the EDM facilities in context of the entire mainstem, an appreciation can be gained for the operational and maintenance problems that are specific to the Upper Ohio River.

With the completion of Olmstead L/D in 2014, 19 modernized locks and dams will control navigation along the Ohio River. The modernized dam system generally provides for safe navigation of commercial tows. Today, a typical large jumbo-hopper-barge tow consists of fifteen 195 feet x 35 feet barges, plus a towboat of varying dimensions, resulting in a tow of about 1170 feet x 105 feet.

The 19 locks and dam facilities along the Ohio mainstem may be classified into the three broad groups described below.

- The three oldest structures are the EDM facilities. They were constructed prior to 1936 just downstream of Pittsburgh PA; these three locks each have one larger 600 foot x 110 foot main chamber and a 360 foot x 56 foot auxiliary chamber. Fifteen barge tows must be processed in two sections, called "double-cuts," through the main chamber, while the small size of the auxiliary chamber allows for only one barge to lock through at a time.

- The 13 modernized lock and dam structures, including those constructed between 1954 and 1979 and Byrd L/D, which has new locks completed in 1993. Each of the locks has a 1200 foot x 110 foot main lock chamber and a 600 foot x 110 foot auxiliary chamber. The 1200 foot long main chamber allows 15 barge tows to

lock through in a single operation, while smaller tows or other vessels usually use the auxiliary chambers.

- Locks and dams with dual 1200 foot x 110 foot lock chambers, including Smithland (placed in operation in 1980), McAlpine (chamber expansion from 600 feet to 1200 feet completed in 2009), and Olmsted (under construction). WRDA 2000 authorized 600 foot auxiliary lock extensions at J.T. Myers and Greenup L/D, which are currently being designed.

Specifications for the existing locks and dams are summarized in Table 8-4.

TABLE 8-4
Current Ohio River Lock Specifications

Lock & Dam	River Mile	Year Operational			Year Rehabilitated			Chamber Sizes	
Project Name	(downstream of Pittsburgh)	**Main**	**Aux.**	**Dam**	**Main**	**Aux.**	**Dam**	**Main (feet)**	**Aux. (feet)**
Emsworth	6.2	1921	1921	1922	1984	1984	1984	600x110	360x56
Dashields	13.3	1929	1929	1929	1990	1990	1990	600x110	360x56
Montgomery	31.7	1936	1936	1936	1989	1989	1989	600x110	360x56
North Cumberland	54.4	1956	1959	1961				1200x110	600x110
Pike Island	84.2	1963	1963	1965				1200x110	600x110
Hannibal	126.4	1972	1972	1975				1200x110	600x110
Willow Island	162.4	1972	1972	1973				1200x110	600x110
Belleville	203.9	1968	1968	1969				1200x110	600x110
Racine	237.5	1967	1967	1970				1200x110	600x110
R.C. Byrd	279.2	1993	1993	1937			2002	1200x110	600x110
Greenup	341	1959	1959	1962				1200x110	600x110
Meldahl	436.2	1962	1962	1964				1200x110	600x110
Markland	531.5	1959	1959	1964				1200x110	600x110
McAlpine	606.8	1961	1921	1964		2009		1200x110	1200x110
Cannelton	720.7	1971	1971	1971				1200x110	600x110
Newburgh	776.1	1975	1975	1975				1200x110	600x110
J.T. Myers	846	1975	1975	1975				1200x110	600x110
Smithland	918.5	1979	1979	1979				1200x110	1200x110
L/D No. 52*	938.9	1969	1928	1929	1983	1983	1984	1200x110	600x110
L/D No. 53*	962.6	1980	1929	1929	1983	1982	1984	1200x110	600x110

*Notes**:** Olmsted L/D (now under construction near L/D 53) will replace both L/D 52 and L/D 53. Olmsted will have dual 1200’ x 110’ chambers, with completion projected for 2014.

Source: USACE, 2006a

The USACE currently operates the Ohio River projects on a first-come/first served basis during normal periods. The normal procedures for operating the navigation projects follow (USACE 2003a):

1) Tows are processed on a first-come/first-served basis;

2) The main chamber is used to lock most tows;

3) The auxiliary chamber is primarily used to lock recreational craft and lightboats (towboats without barges);

4) Due to the small size of the main chamber of EDM, tows are split into two sections (referred to as two-cut lockage) and locked through the main chamber. Permanent tow haulage systems are used to extract the unpowered section of barges to avoid "double-tripping" of the tow. For all other locks on the Ohio River, tows are restricted to one-cut lockage operations (no splitting of tows) in the main chamber;

5) All craft are restricted to one-cut lockage operations through the auxiliary chamber;

6) Locks are operational nearly 100 percent of the time during the year (with a low number of weather related closures).

Over eight of every ten tows locked through the main chamber at the projects in 2007. Tows generally use the main chamber even when they could one-cut through the auxiliary chamber, due to the better approach of the main chamber and the lock operator's greater familiarity with the main chamber. At EDM, the small size of the auxiliary chamber makes use of them under normal operating conditions impractical.

One important indicator of the adequacy of the size of a lock is the size of the tows compared to the dimensions of the lock. As noted previously, the lengths of the main locks are 600 feet at EDM and 1,200 feet at all other projects. Tows that measure between 600 feet and 1,200 feet in length comprise approximately 90 percent of the tows on the lower river, but only 45 percent of the tows on the upper river as indicated in Table 8-5. Tows of this size can lock through the lower locks as a single tow, but must double lock through EDM. In order to prevent the need to double lock through the smaller locks, towing companies often reconfigure their tows with one less barge, placing the towboat into the empty slot. In 2002, approximately one-half of the tows longer than 600 feet listed for Emsworth required only a single cut to pass through the lock. These were eight barge rather than nine barge tows (USACE 2003b).

Table 8-5 compares the tonnage, tons per tow, and barges per tow of the fleet at the Ohio River projects in 1999. As this table indicates, EDM processed approximately half the tonnage of the middle and lower Ohio River projects. Likewise, the tons per tow and the barges per tow at EDM are approximately half that of the lower projects. Average tow sizes

are relatively constant from Hannibal to Smithland, and drop off significantly as they approach Emsworth.

TABLE 8-5
Ohio River Projects Fleet Comparison

Project	Tonnage (Thousand Tons) (1999)	Tons per Tow (1999)	Barges per Tow (1999)	Average Percentage of Tows Greater than 600 Feet in Length (1998 – 2002)
Emsworth	23,800	4,700	5.6	38%
Dashields	24,800	5,300	6.5	44%
Montgomery	26,900	5,700	6.7	48%
New Cumberland	35,000	7,900	8.5	71%
Pike Island	42,700	8,600	9.1	75%
Hannibal	49,200	11,200	10.7	84%
Willow Island	46,200	11,500	10.6	84%
Belleville	50,100	12,300	11.2	87%
Racine	50,800	11,900	10.8	85%
R.C. Byrd	54,900	11,400	10.7	86%
Greenup	72,800	10,900	10.8	89%
Meldahl	65,900	12,000	11.3	93%
Markland	56,400	11,400	10.2	89%
McAlpine	No Data	No Data	No Data	80%
Cannelton	56,900	12,300	10.8	88%
Newburg	65,200	11,100	10.7	85%
Myers	71,400	11,900	11.2	90%
Smithland	83,100	11,300	10.6	90%
Sources: USACE, 2003b, 2004				

Capacity and processing times for the Ohio River projects were computed for ORMSS. Table 8-6 summarizes the capacities and processing times for most of the projects on the Ohio River. (McAlpine and R.C. Byrd were not included in the analysis.) Capacities and processing times computed for full operation refer to normal lock operation with no closures. The capacities and times reported for the main chamber assume a 365-day closure of the auxiliary chamber. Likewise, the capacities and times computed for the auxiliary chamber assume a 365-day closure of the main chamber.

As the information on Table 8-6 reveals, the capacity at full operation of EDM is approximately one-third the capacity of the other projects on the Ohio River. With a yearlong closure of the main chamber, the auxiliary chamber would be able to process approximately one-quarter that of the other projects. The processing times at these three locks are also significantly longer than at the other locks. Processing time through the main chambers is longer because many tows must double lock. Processing times through the auxiliary chambers are significantly longer, since only one barge can lock through at a time.

TABLE 8-6
Capacity and Processing Times

	Project Capacities (Million Tons)			Processing Times at Capacity (Minutes/Tow)		
Project	**Full Operation**	**Main Chamber**	**Auxiliary Chamber**	**Full Operation**	**Main Chamber**	**Auxiliary Chamber**
Emsworth*	45.8	39.4	12.6	64.0	70.1	174.0
Dashields*	51.7	46.5	12.9	59.9	63.5	196.3
Montgomery*	47.6	43.9	12.9	71.3	73.9	217.4
New Cumberland	132.9	78.5	44.5	48.1	54.1	82.0
Pike Island	151.2	99.5	47.5	44.9	48.2	85.9
Hannibal	152.1	103.1	52.4	63.2	55.6	102.7
Willow Island	155.1	107.5	54.2	50.6	53.7	100.6
Belleville	167.2	114.6	56.3	63.0	54.7	105.6
Racine	151.1	110.5	54.0	51.2	53.7	102.4
Greenup	144.2	113.3	54.3	62.6	50.0	96.4
Meldahl	151.0	116.3	55.5	59.8	49.5	97.9
Markland	160.5	119.0	57.1	56.6	48.5	93.4
Cannelton	162.1	124.0	59.0	63.6	50.1	99.9
Newburg	169.8	135.6	61.7	42.9	43.9	87.9
Myers	170.6	137.3	63.6	39.4	38.3	82.8
Smithland	264.4	143.4	132.9	38.9	39.3	38.0
* Without helper boats in main chamber						
Source: USACE, 2004 (Information not provided for McAlpine or R.C. Byrd)						

Average traffic and delays for the projects were reviewed for the years 2000 to 2007. Table 8-7 summarizes the traffic and delays by chamber for 2007. Except for a few anomalies in the data for this time period, average delays are relatively consistent from year to year. Delays are generally highest at EDM and at the eight lowest L/Ds. Delays at the uppermost L/Ds can be attributed to the small size of the locks; delays at the lowermost L/Ds occur due to high traffic levels (USACE 2003a).

Significant delays at Ohio River locks and dams are linked to lock closures rather than to spikes in hourly, daily, or monthly arrivals (USACE 2003a). Lock closures are nearly always scheduled, last from 30 to 60 days, and occur on a five- to ten-year maintenance cycle. Navigation notices, published about six months before lock closures, provide details on operating procedures and expected delays, and give industries time to adapt their operations to reduce closure effects.

TABLE 8-7
2007 Traffic and Delays by Chamber

	Number of Tows			Delays - Hrs/tow		
Project	**Main**	**Aux.**	**Total**	**Main**	**Aux.**	**Weighted Average**
Emsworth	3242	516	3758	0.93	0.79	0.91
Dashields	3187	408	3595	0.46	0.03	0.41
Montgomery	3160	399	3559	0.99	0.03	0.89

Project	Number of Tows			Delays - Hrs/tow		
	Main	Aux.	Total	Main	Aux.	Weighted Average
New Cumberland	2703	910	3613	0.28	0.04	0.22
Pike Island	3258	907	4165	0.27	0.05	0.22
Hannibal	3533	973	4506	0.44	4.74	1.37
Willow Island	3581	538	4119	0.43	0.04	0.38
Belleville	3885	382	4267	0.50	0.02	0.46
Racine	3947	451	4398	0.68	0.03	0.61
R.C. Byrd	4422	347	4769	0.73	0.04	0.68
Greenup	5681	251	5932	0.98	0.12	0.94
Meldahl	4859	180	5039	0.99	0.15	0.96
Markland	4000	400	4400	0.76	5.26	1.17
McAlpine	5027	1	5028	1.25	0.00	1.24
Cannelton	4574	454	5028	0.75	4.82	1.12
Newburg	5893	594	6487	0.69	0.04	0.63
Myers	5400	465	5865	0.69	0.02	0.63
Smithland	3336	3620	6956	0.25	0.40	0.33
L/D 52	6972	2277	9249	5.71	9.30	6.60
L/D 53	6804	235	7039	0.78	0.29	0.76
Total:	87464	14308	101772			
Percent of Total:	86%	14%				
Source: USACE, 2009						

To minimize delays, normal operating policies change when lock closures occur. At EDM, tows are broken apart and lock through the auxiliary lock one barge at a time. For all other projects on the Ohio River, tows are processed in two-cut lockages through the auxiliary locks. During closure delays, the first-come/first-served policy is changed to "N up/N down," a policy that processes multiple barges moving in one direction, followed by an equal number of tows moving in the opposite direction to assist in reducing delays (Frechione and Walker 2003, as cited in USACE 2006a). For EDM, three tows are processed sequentially; six tows are processed sequentially at other projects on the Ohio River.

The towing industry makes adjustments to lock closures, particularly at locks where the longest delays occur. At all times, including closures, shippers attempt to minimize the time spent pushing empty barges by arranging shipments in both directions. The percent of empty barges is higher at projects along the upper river, where one-way coal traffic is more dominant (USACE 2003a). Towing companies also try to reduce the number of trips through locks with significant delays. In some cases, they dispatch additional equipment (e.g., helper boats) to assist with assembling barges above and below congestion points.

8.5.4 Nonstructural Traffic Management Measures

Nonstructural traffic management measures are used to facilitate tow passage through the locks to improve transportation efficiencies, particularly during planned lock closures and unexpected lock chamber outages, as well as during normal operations when two or more

tows arrive simultaneously expecting lockage service. Nonstructural measures can be divided into two groups:

1) Technical measures that increase capacity of the system of locks and dams; and

2) Demand management measures that provide the lowest cost to users who value the system most.

Technical measures seek to improve tow passage through locks during times of congestion when the first-come/first-served policy is less effective than under normal operating conditions. In contrast, demand management measures seek to alter shipper behavior either by more closely aligning shipper costs with the true economic costs of using the navigation system or by educating users such that external costs are reflected in their prices. Demand management efforts do not directly increase lock throughput; instead they potentially decrease traffic delays by moving traffic away from congested shipping periods and locations.

Table 8-8 describes the main nonstructural measures currently in use during lock closures on the upper Ohio River. These measures are also employed at all other projects on the Ohio River, except those with dual 1200 foot chambers. A permanent tow haulage system, which is part of the normal operating procedures for EDM, is a third option for use on projects where the auxiliary chamber is one-half the size of the main chamber. This measure consists of cabling unpowered barges to a moveable unit that extracts the barges from the auxiliary chamber.

TABLE 8-8
Technical Nonstructural Measures that Increase System Capacity

Measure	How Measure Works	Effectiveness	Current Usage
Sequential tow processing (N-up/N-down) N = 3 at EDM; N = 6 at all other projects	• Changes tow processing from first-come/first-served to sequential processing of tows moving in the same direction • Allows tow to wait at the lock for processing rather than wait at the approach point several hundred feet distant.	Reduces approach time by about 15 minutes per tow and therefore increases efficiency of locks by reducing idle time	Employed during lock closures at all projects with auxiliary chambers smaller than the main chamber
Helper boats	When double lockages are required: 1) The last towboat to arrive at a congested project in the direction opposite of ongoing lockage operations disconnects from its barges, moves to the lock, and helps the tow locking through by extracting unpowered cuts of barges from the lock chamber. 2) It will then move the barges to a refleeting site away from the project so that tow reassembly does not interfere with lockage operations.	Typically reduces time a tow occupies a lock by as much 25 minutes. Time saved at the smaller Montgomery Lock is approximately 50 minutes.	Employed during lock closures at all projects with auxiliary chambers smaller than the main chamber.

Measure	How Measure Works	Effectiveness	Current Usage
	3) Help is provided to each tow until all barges have moved through the lock. Most Ohio River projects allow two cuts. Exceptions are the three uppermost projects, which allow up to five cuts per tow.		
Source: Frechione and Walker 2003, as cited in USACE 2006a			

Successful demand management measures encourage shippers to internalize congestion and environmental costs and focus on the efficient movement of goods, not just vessels, to reduce delays. The Transportation Research Board's (TRB's) Committee for the Study of Freight Capacity for the Next Century (TRB 2002) has identified traffic demand management as a means of forestalling expensive capital investments in all modes of freight transportation. On waterways, traffic demand management measures are designed to reduce or redirect tow arrivals away from times when a lock is in heavy use. The goal of traffic demand management during lock closures is the complete avoidance by recreational watercraft of locks experiencing closures and a dramatic slowing in commercial tows arriving at the project. Although most measures are proposed to expedite river traffic during significant delays, some measures may be implemented on a full-time basis to reduce shipping costs or eliminate delays during normal use (Frechione and Walker 2003, as cited in USACE 2006a). Table 8-9 compares two demand management measures applicable to EDM.

TABLE 8-9
Potential Traffic Demand Management Measures

Measure	How Measure Works	Effectiveness	Current Usage
Congestion fees	Charges tow a fee for processing through congested locks. Fees are aimed at reducing tow arrivals at congested locks to some "optimum" number that would maximize system benefits given lock closure inefficiencies	• Magnitude of delays is related to number of tows continuing to be processed through locks despite fees. • Where congestion is directly related to structural condition problems, congestion fees have not performed well.	Implementation of such fees is considered in all USACE inland navigation studies, although implementation would require additional authority.
Lockage appointment system	Requires shippers to have an appointment "slot" to lock through a project on a specific date at a specific time. With demand for slots likely exceeding lock capacity during closures, slots would be awarded to carrier via	• Use of this option to alleviate costly delays during closures has not been evaluated at USACE projects on the Ohio River. • Where congestion is directly related to structural condition problems, this option, like congestion fees, fails to address the	Not currently in use in the Ohio River system; implementation would require additional authority A survey conducted by the USACE in 2001 revealed industry opinion that scheduling lockages would not be effective in dealing

Measure	How Measure Works	Effectiveness	Current Usage
	lottery or sale.	major cause of periodic and costly closures. • Among concerns related to this option are when to require appointments, how to award slots, length of slots, and how to manage purchase/exchange of slots.	with delays, primarily because of difficulty in predicting tow arrival times at locks, given varying weather conditions and other factors. Also of concern was unfairness of locking tows except in the order that they arrive. Industry spokesmen favored helper boats as a more effective alternative.
SOURCE: Frechione and Walker 2003, as cited in USACE 2006a			

Other demand management measures that have been proposed for the entire system include:

1) Use of vessel tracking systems to allow operational centers to locate and track all equipment moving on the river, enhancing identification of congestion areas and homeland security. Many large tows already are equipped with geo-positioning systems (GPS) such that shippers can monitor their vessels and customers can locate their cargo.

2) A controlled schedule of shipments similar to that used on the Panama Canal, requiring passage through locks by appointment for the entire trip, not simply for a single lockage at a congested project. This concept has met with industry opposition due to unpredictability related to weather, potential crew inexperience, and other factors.

3) Use of auxiliary locks to reduce normal delays. This is not effective at EDM L/D where only one barge can be locked through the auxiliary chamber at a time, nor is time-effective at projects with auxiliary chambers one-half the size of the main chamber, due to the increase in processing time needed to double cut through the smaller chamber.

The most recent analysis of traffic demand management measures (Frechione and Walker 2003, as cited in USACE 2006a), concluded that such measures do not perform well relative to structural solutions (e.g., lock extensions) when addressing episodic delays related to structural condition problems at specific projects. Frechione and Walker's report further states:

> Diminishing lock reliability due to unplanned failures of major lock components and more frequent maintenance and repair of heavily used, aging, structures will lead to degraded system performance at many locks, i.e., more tows sitting in queues incurring lengthy delays, a growing hesitancy on the part of shippers to use the waterway for

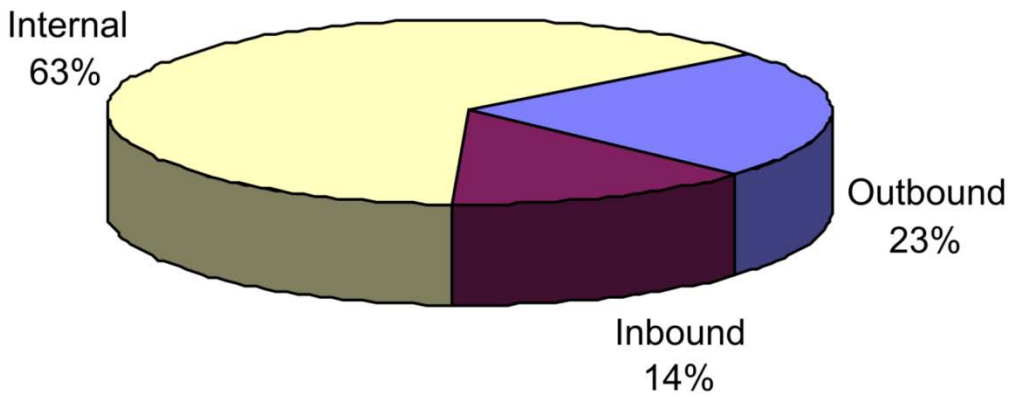
bulk shipments, and increased reliance on overland modes that leads to greater exposure of the general public to highway congestion, the risk of accidents, and air pollutants. In this instance, structural alternatives more directly address the underlying problems of degraded lock conditions and their associated delays. Delays and the associated accumulation of delay costs that occur during normal operations of the locks are sizable. It is here that the more aggressive, price-related demand management measures may be most appropriate and, therefore, worthy of consideration.

8.5.5 Transportation Efficiencies, Commodities Transported, and Traffic Demand Forecasting

Inland waterways carry 11 percent of domestic intercity ton-miles nationwide, but account for only 1 percent of freight expenditures, making inland shipping the cheapest freight mode in terms of average transportation cost per ton-mile (USACE 2006a). Barge transportation also is the most energy efficient mode for carrying large quantities of bulk commodities. A typical jumbo barge (195' x 35') can transport as much coal as 15 rail cars for one-fourth the energy per ton-mile (USACE 2006a). A typical Ohio River tow consisting of 15 barges and carrying a total of 22,500 tons is equivalent to 225 railcars or 870 semi-trucks.

As Figure 8-2 indicates, 63 percent of traffic on the Ohio River system is internal (i.e., confined to the Ohio mainstem and navigable tributaries). The average haul length on the Ohio River is about 400 miles, which is the lowest average haul length in the inland waterway system (USACE 2006a). Haul length is directly related to the nature of commodities shipped, their origins, and destinations. Commodities transported on the Ohio River system are the products of coal mines, petroleum refiners, stone quarries, cement plants and farms, along with raw materials for construction companies, steel mills, electric utilities, paper plants, aluminum manufacturers, and chemical companies – the foundation of the region's economy. Commodity traffic flow at a given lock and dam is largely determined by its geographic location. The commodity mix consequently influences barge type and flow configuration (USACE 2000b).

FIGURE 8-2
Ohio River System Traffic



Note: Inbound freight originates from points outside the Ohio Basin to destinations within the Basin. Outbound is freight from within the Basin to points outside. Internal freight moves entirely from one port to another within the system.
Source: U.S. Army Corps of Engineers, 2006b

Since the 1970s, coal has accounted for over 50 percent of the tonnage of commodities shipped on the Ohio River mainstem each year (Table 8-10). Coal transport historically has been most prevalent on the upper portion of the Ohio River. The primary markets for coal shipments are domestic electric utility plants. Coal traffic also moves to coal blending facilities, industrial facilities, and coking facilities. These three coal destinations, however, collectively accounted for less than 20 percent of the total coal traffic in 2000 (USACE 2006b). Although Table 8-10 shows a 2.5 percent annual increase in coal traffic from 1965 through 2003, coal traffic began declining in the early 1990s. From 1993 through 2003, coal traffic declined 0.9 percent annually. There are many reasons for this decline, including improved generating technologies, competition from other energy sources, loss of local manufacturing facilities, and labor changes in the coalfields. Nonetheless, coal is still the major commodity transported on the river and is likely to remain so for the foreseeable future.

Two other important commodities, aggregates and iron, experienced growth rates exceeding 3.0 percent annually from 1993 to 2003. Aggregates, which consist primarily of crushed limestone, sand and gravel, and building stone, accounted for approximately 18 percent of traffic at mainstem locks in 2003. These construction materials typically are extracted as close as possible to their market areas; therefore, aggregate traffic on the Ohio River is frequently short-haul and may be entirely within one pool. These intra-pool movements are reported as part of system statistics; however, they do not contribute to lock delays.

TABLE 8-10
Historic Ohio River Mainstem Traffic by Commodity
(Million tons)

Note: Petrol – Petroleum Products; Aggs – Aggregates; Chem – Cemicals; Asphalt was reclassified as Petrol in 1998. Previously, asphalt was grouped in other.
Source: USACE, 2006b

Transport of iron on the system has changed with the massive changes undergone by the iron and steel industry in recent decades. Only one integrated steel mill remains in operation in Pittsburgh, once one of the largest steel producing cities in the world.

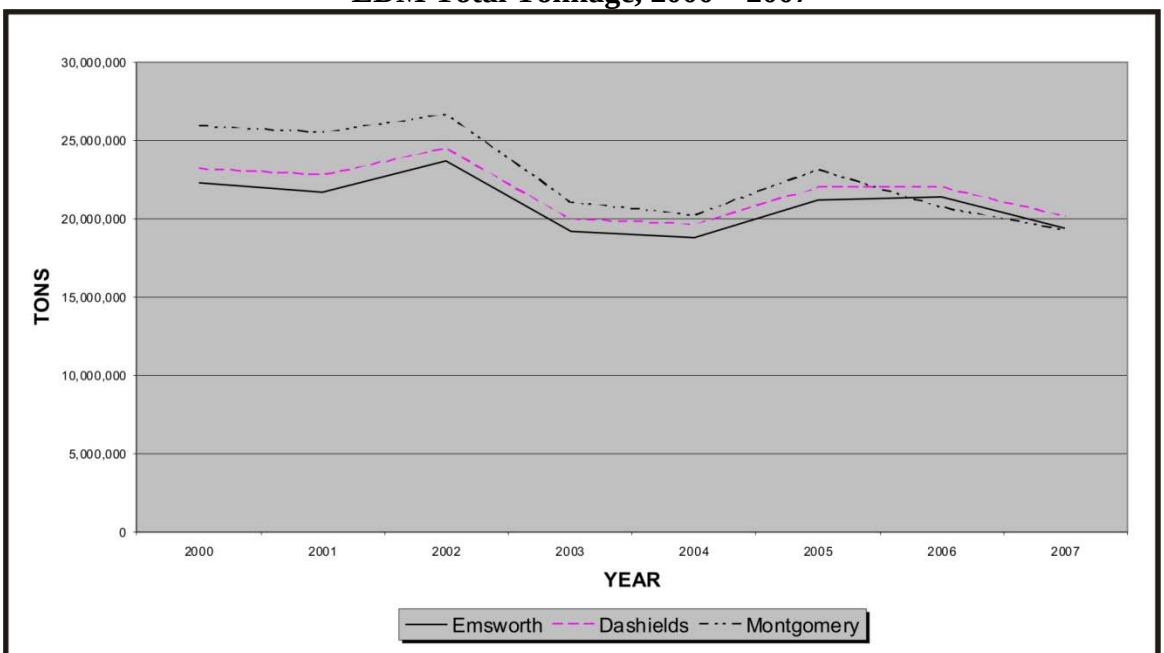
Table 8-11 compares the total commodity traffic of the EDM L/Ds to the Ohio River mainstem for the period 1970 to 2000. During this 30-year period, the uppermost projects experienced the lowest growth rates of all the Ohio River projects. Lock-level commodity traffic growth was hampered in the 1990s by a reduction in the transport of coal. Since 1990, the growth rate for the Emsworth and Montgomery lock and dams has been less than 0.1 percent. Dashields has experienced a negative growth rate over this period. However, because of the specific requirements of shipping materials by river, trends for river traffic are generally much longer than ten years. Consequently, traffic demand is still expected to grow for the long-range term.

TABLE 8-11
Historic Traffic Demand
Ohio River Mainstem and EDM L/Ds, 1970-2000
(Million Tons)

Project	Year				Annual % Growth	
	1970	1980	1990	2000	1970 - 2000	1990 - 2000
Emsworth	19.6	20.0	21.8	21.9	0.4	0.1
Dashields	20.2	21.0	23.2	22.4	0.3	-0.4
Montgomery	17.4	20.4	25.0	25.2	1.2	0.1
Ohio River Mainstem	126.8	160.7	225.7	236.5	2.1	0.6
Source: USACE, 2006b						

Since 2000, tonnage through EDM has declined, as depicted in Figure 8-3. Total tonnage through EDM in 2007 has regressed to pre-1980 volumes.

FIGURE 8-3
EDM Total Tonnage, 2000 – 2007



Source: U.S. Army Corps of Engineers, 2009

The small main and auxiliary chambers at EDM pose substantial constraints to system traffic. The potential for induced traffic on the upper Ohio River as a result of improving these locks and dams was evaluated as part of the economic analysis for ORMSS. This study, which was completed in 2000 by the Tennessee Valley Authority (TVA) for the USACE Pittsburgh District, determined that an additional 1 million tons of commodities could have been induced to use the waterway had improvements to EDM been in place.

Additional information regarding this study can be found within the SIP Attachment 4, Traffic Demand Forecasts (USACE 2005).

8.5.6 Upper Ohio River Traffic and Intermodal Connections

State profiles from the United States Department of Transportation's (USDOT's) Freight Analysis Framework ($FAF^{2.2}$) (2009) were reviewed to obtain a comprehensive perspective on current and future freight movement in the three states bordering the upper Ohio River. The data included in the $FAF^{2.2}$ represent the total freight shipped within, to, and from each state by weight and by value. Benchmark dates used in the $FAF^{2.2}$ were 2002 and 2035. Figures 8-4, 8-5, and 8-6 show that the proportions of truck, rail, and water transportation are generally expected to remain constant in each state from 2002 through 2035, although tonnages by mode are expected to increase.

In Pennsylvania and Ohio, truck transportation is by far the leading freight mode, comprising as much as 64 percent of the total freight traffic in Pennsylvania in 2002. Truck transportation is expected to increase in tonnage and percent of total freight in all states throughout the forecast period. Truck transportation is expected to increase by over 80 percent in West Virginia and Ohio, while Pennsylvania is expected to experience a 57 percent increase in freight transported by truck.

FIGURE 8-4
Pennsylvania Freight by Mode, 2002-2035

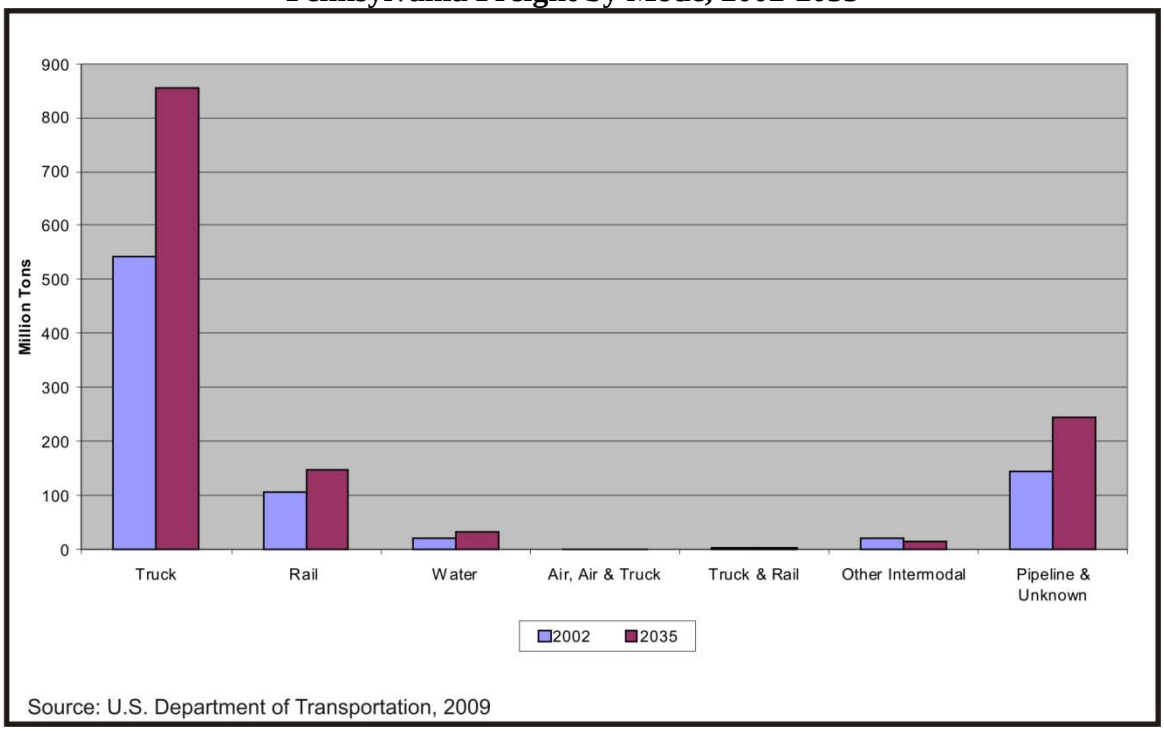


FIGURE 8-5
West Virginia Freight by Mode, 2002-2035

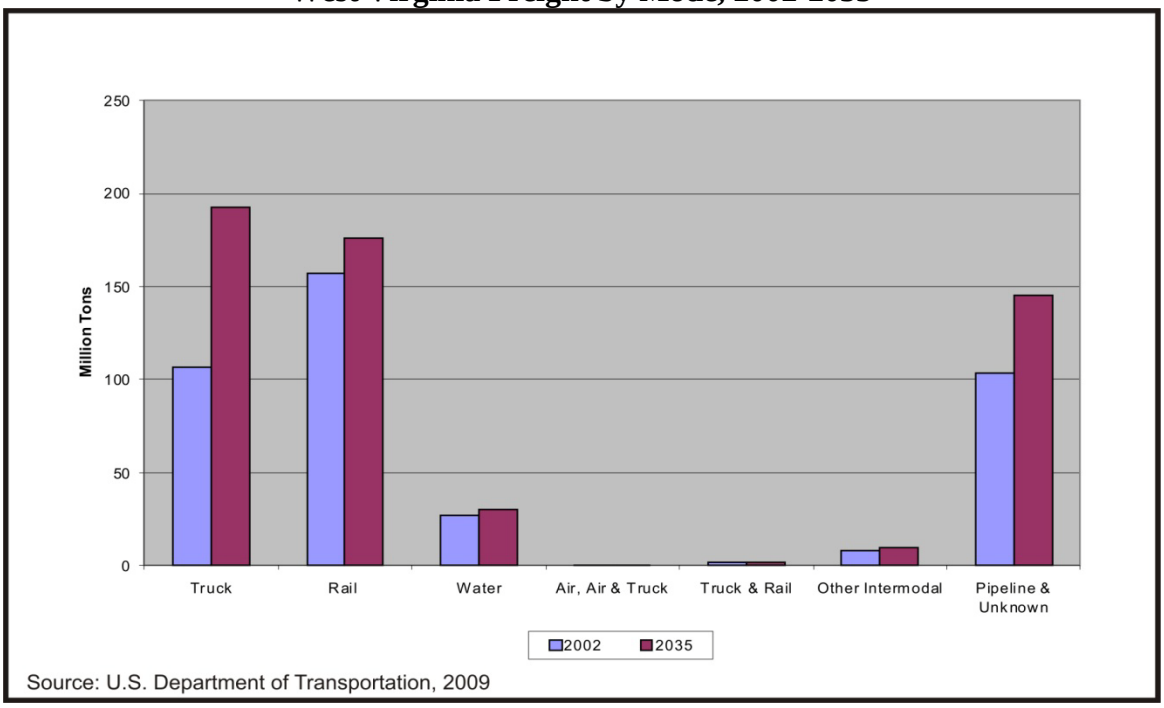
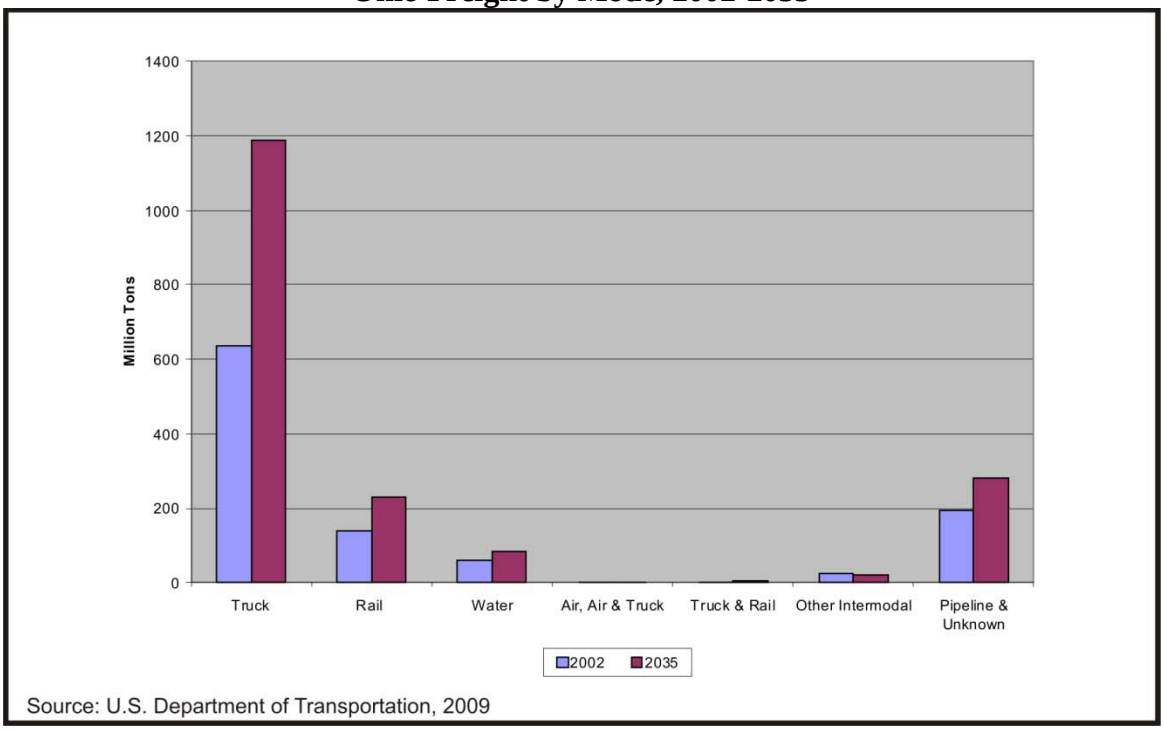


FIGURE 8-6
Ohio Freight by Mode, 2002-2035



In 2002, rail was the dominant mode of transportation in West Virginia, carrying about 38 percent of total freight. Rail is expected to remain a primary freight mode in West

Virginia through 2035, although total tonnage transported by truck is expected to exceed rail by 2035. Rail freight is expected to increase by 37 percent in Pennsylvania and by 66 percent in Ohio by 2035.

In Pennsylvania, freight moved by water comprised less than 3 percent of total freight. Pennsylvania is expected to see a 62 percent increase in the amount of freight moved by water, although this increased tonnage will still comprise less than 3 percent of the projected 2035 total tonnage. Ohio is expected to experience a 37 percent increase in freight transported by water by 2035. In West Virginia, freight moved by water is expected to increase by only 12 percent.

The FAF[2.2] also looks at the principal commodities by weight. In 2002, coal and gravel ranked first and second, respectively, as the top commodities in Pennsylvania, West Virginia, and Ohio. Coal and gravel will continue to be important commodities throughout the forecast period.

There are several terminals and intermodal facilities in the study area that currently meet the demand for goods movement and transfer of commodities. Table 8-12 provides a list of those facilities.

TABLE 8-12
Major Riverfront Terminals and Intermodal Facilities

Site	River	Mile	Location	Size	Rail Available
Gordon Terminal Services	Ohio	3.2L	McKees Rocks	--	No
McKees Rocks Industrial Enterprises		4.0L		90 ac	Yes
Mol-Dok Co.		14.1R	Leetsdale	20 ac	Yes
Three Rivers Aggregates		14.4L	Glenwillard	10 ac	No
Port of BeeMac		14.5R	Leetsdale	--	Yes
Pittsburgh Intermodal Terminals		16.5	Ambridge	30 ac	Yes
Aliquippa Terminals		16.8L	Aliquippa	31 ac	Yes
Gordon Terminal Services		21.1L	Coraopolis	--	No
Colona Transfer		23.5L	Monaca	60 ac	Yes
Industry Terminal and Salvage Co.		33.2R	Industry	--	No
Kinder Morgan		33.5R		40 ac	Yes
S.H. Bell		40.1R	E. Liverpool	85 ac	Yes
S.H. Bell (Braddock)	Monongahela	9.9R	Braddock	7 ac	Yes
Josh Steel		10.1R		--	Yes
Gulf Materials Dock		10.2R		5 ac	Yes
None	Allegheny	--	--	--	--
Source: Port of Pittsburgh Commission, 2009					

While these intermodal facilities are important to the overall transportation system now, they would be more so in the event of reduced lock service. Because of the age of the Upper Ohio River's lock and dam system, reduced lock service is considered probable. This could cause

the diversion of waterway traffic to land-based modes of transportation. The USACE recently completed a study to measure the social costs – known as external effects – that could be incurred with such occurrences (USACE 2000a). Those effects include increased fuel usage, increased pollution, increased accidents, and accelerated deterioration of roadways.

The following summarizes the findings of that study.

Both short-term (45 days or less) and long-term conditions (over 45 days) were examined at the Emsworth, Dashields, and Montgomery (EDM). Under short-term conditions, locks could be closed infrequently to make minor repairs. With long-term conditions, either lengthy or more frequent short-term closures could occur. It is expected that long-term conditions would cause businesses to permanently change their transportation patterns.

Short-term closures are expected to result in minimal impacts to the regional economy even though short-term conditions could result in higher costs for environmental and social features than with existing conditions. River-dependent facilities have successfully managed operations during short-term closures in the past. Consequently, they are expected to successfully adapt to such closures in the future.

Under long-term conditions, some facilities would shut down, re-source materials to other suppliers, or ship goods to closer markets. With long-term closures or increased unreliability, some materials would not be shipped or shipped less distance. Long-term closures or an unreliable lock system would have a negative impact on the regional economy. Approximately 8,200 jobs could be lost in the region. Lost wages could total almost $250 million.

Future transportation demands relative to Ohio River system capacity by mode are difficult to assess. The transportation rate study performed by the Tennessee Valley Authority (2001) for the USACE's Navigation Center in Huntington, WV did not review traffic movements with regard to capacity, but assumed that system capacity would be built as needed. The Transportation Research Board's special report on *Freight Capacity for the 21st Century* (2002) was reviewed to gain an understanding of capacity problems the freight industry is experiencing today nationwide. The TRB report, however, does not forecast future capacity or traffic volumes, presumably because numerous factors can complicate such predictions and compromise their reliability. For water transportation, the report noted that capacity constraints on the inland waterway include aging infrastructure and peak-period congestion at certain locks. Rail capacity constraints are also localized in time and space, but most trends are consistent with tightening capacity, including long-term contraction of the rail network. The report concluded that if the nation's addition of transportation capacity lags and congestion worsens, a massive breakdown of the system would not occur. In effect, industries and people would adjust the way they use the system to accommodate their needs.

8.6 INTERACTIONS WITH OTHER VALUED ENVIRONMENTAL COMPONENTS (VECS)

The increase in shipping traffic demands on the Ohio River has been accompanied by increasing interactions with several other valued environmental components (VECs). River transportation and traffic are closely linked with socioeconomic resources of the upper Ohio River and its tributaries. The growth of recreation on the river, also related to socioeconomic factors, causes conflict with commercial barge traffic.

Maintenance of the navigation pools and support infrastructure has resulted in habitat changes that have shifted the fauna away from riverine species to those more suited to lake-like conditions. The chapters on mussels and fish provide additional details on ways the navigation system and traffic movement influence distribution and reproductive success of species in these groups. Good water quality, essential for healthy aquatic life, is influenced by potential spills and handling of commodities transported and transferred on or near the river. Terminals and barging areas require the dredging of near shore habitat to produce the depths needed to maneuver and dock. Maintenance dredging also results in the loss of shallow habitat and structure along the river.

The infrastructure that supports traffic, including terminals, has affected cultural resources through burial and loss as terminals and related infrastructure are developed. Pool maintenance, which enables navigation, continues to inundate some cultural resources in the floodplain. The reduction in natural fluctuations of water levels due to pool maintenance also has caused changes in riparian resources and floodplain hydrology.

Transportation and traffic are linked directly to air quality, although emissions from tows are a minor component of mobile source emissions along the Ohio River corridor. Barge is more fuel-efficient than truck and rail transport and results in lower emissions than other modes of surface transportation. One fully loaded barge can move 588 tons of goods or material one mile per one gallon of fuel expended. Conversely, rail can only move 255 tons one mile per one gallon of fuel. Likewise, truck transportation is less efficient, only moving 75 tons one mile per one gallon of fuel.

Transportation and traffic are also linked to health and safety. Many studies have determined that inland barge transportation is one of the safest modes of transport, having the fewest number of incidents, injuries, and fatalities of all surface modes of transportation. According to the United States Coast Guard, water transport has fewer accidental spills and collisions than any other mode of transportation.

8.7 INDICATORS OF ENVIRONMENTAL SUSTAINABILITY FOR TRANSPORTATION AND TRAFFIC

To determine whether a traffic and transportation is environmentally sustainable, measurable indicators were developed to evaluate cumulative effects. In past studies, the USACE has defined sustainability of transportation and traffic as occurring when cost-

effectiveness, efficiency, and the minimization of externalities are achieved. Thus, indicators relevant to the sustainability of transportation and traffic include:

- Barge tonnage passing through each lock over time;
- Numbers of terminals and intermodal transfer facilities over time;
- Average queuing times for barge traffic;
- Fuel usage.

8.8 RELEVANT FUTURE ACTIONS AFFECTING TRANSPORTATION AND TRAFFIC

Reasonably Foreseeable Future Actions (RFFAs) for transportation and traffic were evaluated utilizing a matrix prepared during the scoping process. The matrix was an outgrowth of a similar matrix developed during the preparation of ORMSS. Results of the RFFA evaluation for transportation and traffic are summarized in Table 8-13. The table summarizes the effects of the RFFAs on transportation and traffic. RFFAs that directly affect navigation within the study area received a high (H) importance ranking. All RFFAs that received a high ranking were found to have a positive effect on transportation. RFFAs that indirectly affect transportation by enhancing support facilities or by creating conflict with existing traffic received a medium (M) ranking. RFFAs that received a medium ranking could have a positive or negative effect on transportation and, in several instances, both. RFFAs that have minimal effect on transportation received a low (L) ranking. Beneficial effects are those that will improve the conveyance of goods and people within the study area; detrimental effects are those that reduce the efficiency of the conveyance of goods and people.

TABLE 8-13
RFFA Cumulative Effects Matrix for Transportation and Traffic

RFFA[1]	Time Period[2]	Occurrence Probability[3]	Location on River[4]	Importance[5]	Effects[6]
USACE Actions					
Navigation Investments					
Replacement locks at Emsworth, Dashields, and Montgomery Dams (EDM)	1	H	S	H	+
Rehabilitation of EDM dams	1	H	S	H	+
Navigation aids - lock & dam signage	A	H	S	H	+
Non-structural navigation improvements	A	H	S	M	+/-
L/D operation and maintenance	A	H	S	H	+
Approach & channel dredging/disposal	A	H	E	M	+/-
Environmental design					

RFFA[1]	Time Period[2]	Occurrence Probability[3]	Location on River[4]	Importance[5]	Effects[6]
environmental sustainability operation actions	A	H	S	M	+/-
Pool maintenance	A	H	E	H	+
Sec 107 port development and maintenance dredging	2	L	S	M	+/-
Ecosystem Restoration					
Fish passage at EDM	1	H	S	L	-
Actions by Others					
Navigation System Dependent - "But For"					
Commercial navigation					
barge queuing	1	M	E	M	-
fleeting areas/barge storage	1	M	E	M	+
terminals & multi-modal sites	2	L	S	M	+
barge/tow tech/"green" design	A	M	E	M	+/-
accidents/spills	A	M	E	L	-
Coast Guard navigation aids - const., O&M	A	H	E	H	+
Energy					
hydropower on dams	2	M	S	L	+/-
continued operation of coal-fired power plants	A	M	S	H	+
Water-based recreation					
marina development & operation	A	M	S	M	-
commercial boating	A	H	E	M	+
personal boating	A	H	E	M	-
River Dependent					
Water supply / discharge					
municipal	A	M	S	L	-
industrial	A	M	S	L	-
Waste water treatment discharges (WWTP)					
onsite systems	A	H	E	L	-
stormwater discharges; CSOs; SSOs	A	H	S	L	-
Marcellus shale gas extraction (water impacts)	A	H	E	L	-
Resource extraction					
instream sand and gravel mining	A	H	E	M	+/-
Acid mine discharge (AMD)	A	M	E	L	-
Riverfront/Flood Plain Development					
Downtown Pittsburgh					
Ongoing Point State Park improvements	1	H	S	L	-

RFFA[1]	Time Period[2]	Occurrence Probability[3]	Location on River[4]	Importance[5]	Effects[6]
Convention Center riverfront park	1	H	S	L	-
residential development /conversions	A	H	S	L	-
North Shore development	1	H	S	L	-
Pittsburgh South Side					
continued riverfront development	A	H	S	L	-
continued South Side Works development	1	H	S	L	-
Riverfront trails					
Pittsburgh riverfront trail system	A	H	E	L	-
Beaver County trail system	A	M	E	L	-
Brownfields redevelopment					
Neville Island	1	H	S	L/M	+/-
PL&E, McKees Rocks	2	M	S	L/M	+/-
M&B Development	2	M	S	L/M	+/-
Fab Tech & Buckeye Pipeline	1	M	S	L/M	+/-
J&L site in Aliquippa	1	M	S	L/M	+/-
Leetsdale Industrial Park	1	H	S	L/M	+/-
Resource Protection/Restoration					
Ohio River Islands Wildlife Refuge System	A	H	S	L	-
Nationwide Rivers Inventory	A	M	S	L	-
Ecosystem restoration	A	M	E	L	-
Cultural resources	A	M	E	L	-
Bridges and Roadways					
Bridge renovations					
Ambridge/Aliquippa Bridge	1	H	S	L	-
Shippingport Bridge	1	H	S	L	-
Rochester Bridge	1	H	S	L	-
McKees Rocks Bridge	1	H	S	L	-
Birmingham Bridge	1	H	S	L	-
Rankin Bridge	1	H	S	L	-
New crossings					
Maglev	2	L	S	L	-
North Shore connector	1	H	S	L	-
Roadways					
Mon/Fayette Expressway	2	L	S	L	-
SR 28 widening/railroad relocation	1	H	S	L	-

RFFA[1]	Time Period[2]	Occurrence Probability[3]	Location on River[4]	Importance[5]	Effects[6]
CSX double stack upgrades (National Gateway)	1	M	S	L	-
Natural Events					
floods	A	M	E	M	-
droughts	A	L	E	L	-
invasive species	A	H	E	L	-
Regulatory Environment					
Phase I & 2 NPDES program	A	H	E	L	+
TMDLs	A	H	E	L	-
ALCOSAN & other consent decrees	A	H	E	L	+
Adaptive management in Sand & Gravel EIS	A	H	E	M	+/-
Pollution prevention	A	H	E	L	+/-
USACE permitting programs	A	H	E	M	-
Boating safety regulations	A	H	E	M	+
Monitoring programs - PA/ORSANCO	A	H	E	L	-
Environmental awareness education	A	H	E	L	-
Clean Air Act standards	A	H	E	L	-
Clean Water Act standards	A	H	E	M	-
Endangered Species Act (ESA)	A	H	E	L	-
Environmental sustainability practices	A	H	E	M	-

[1] Reasonably Foreseeable Future Actions

[2] Time period in which the RFFA may occur: A = all periods; 1 = within 10 years; 2 = in 10 - 25 years; 3 = in 25 - 60 years

[3] Occurrence probability or likelihood RFFA will happen: H = high; M = medium; L = low

[4] Location or setting on river where RFFA is expected to occur: E = along entire length of river; S = specific location

[5] Importance or impact of action on the VEC: H = high; M = medium; L = low

[6] Effects of action on the VEC: + = positive effect; - = negative effect; +/- = mixed effects

Impacts from the RFFAs can be complex and occur in many ways. While impacts result from an action, those impacts are not always apparent from a straightforward analysis of cause and effect. Often, similar actions do not affect resources in the same manner. As a means of further explaining potential impacts to transportation and traffic, three vectors have been identified. The vectors have a specific relationship with one another and may influence the scope and magnitude of future impacts. Some actions will intercept with more than one vector. The three vectors are related to actions directly affecting traffic, actions related to commerce on the river, and actions conflicting with barge traffic.

Actions that directly affect traffic either facilitate or impede transportation flow on the river. They are primarily related to locks and dams and other projects or facilities that support commercial navigation. Because traffic flow can be facilitated by enhancing links with other modes of transportation, however, not all of these actions are located directly on the river. RFFAs that fall into this vector and the other two vectors are noted in Table 8-14.

Most actions that affect traffic will result in positive impacts because these actions are initiated specifically to increase capacity or facilitate safe and efficient movement. Some actions, such as barge queuing, impede traffic and will negatively affect traffic. As with any construction activity, actions that affect traffic could have temporary impacts that restrict movement in or near construction sites. Temporary construction activity can also halt movement on the river or cause temporary closures of locks for periods of time. Natural events, as well, can temporarily affect transportation and traffic.

Actions that relate to commerce on the river are generally associated with the transportation of bulk commodities such as coal and gravel. The movement of these materials is a large part of the commercial traffic on the upper Ohio. It represents a major component of the local economy. There is a considerable amount of overlap between these actions and those that directly affect traffic, and, consequently, have similar effects, both positive and negative. RFFAs that fall into this vector are also noted in Table 8-14.

Actions that conflict with barge traffic generally support other aspects of the river environment, particularly recreation, personal boating, and marina development. They can also include activities that restrict traffic, such as brownfields development and dredging operations. Redeveloped brownfields often place an emphasis on commercial, recreational, and residential development rather than a continuation of industrial activity. While the redevelopment of brownfields supports economic development by returning shuttered sites to productivity, the shift from industrial use to other types of activity may add more recreational traffic to the river. Because the underlying reasons for travel and type of watercraft are so different, recreational traffic – by its very nature – conflicts with barge transportation. RFFAs that fall into this vector are also noted in Table 8-14.

TABLE 8-14
RFFAs and Transportation and Traffic Impact Vectors

RFFA	Actions Directly Affecting Traffic	Actions Related to Commerce on the River	Actions Conflicting with Barge Traffic
USACE Actions			
Replacement locks at EDM	X	X	
Rehabilitation of EDM Dams	X	X	
Navigation aids – lock & dam signage	X	X	
Non-structural navigation improvements	X	X	

RFFA	Actions Directly Affecting Traffic	Actions Related to Commerce on the River	Actions Conflicting with Barge Traffic
L&D operation & maintenance	X	X	
Approach & channel dredging/disposal	X	X	
Environmental sustainability operation actions	X		
Pool maintenance	X	X	
Port development & maintenance dredging	X	X	
Actions by Others			
Barge queuing	X	X	
Fleeting area/barge storage	X	X	
Terminals & multi-modal sites	X	X	
Barge/tow tech/green design	X	X	
Coast Guard navigation aids – construction, O&M	X	X	
Operation of coal-fired plants		X	
Marina development & operation	X		X
Commercial boating	X	X	
Personal boating			X
Instream sand and gravel dredging/mining			X
Brownfields redevelopment	X		X
Natural events	X		
Regulatory Environment	X	X	

Discussions of the potential permanent and temporary impacts of RFFAs with high and medium importance are presented in the remainder of this section. The discussions are organized around USACE actions and actions by others. RFFAs that have a low probability of occurring within the upper Ohio River study area or that have no or minimal effect on transportation and traffic are not considered further in this cumulative effects assessment.

8.8.1 USACE Actions

Maintaining and improving the navigation infrastructure will enhance traffic flow and have a positive effect on transportation, traffic, and commerce; these actions are primarily related to maintenance of the lock and dam system and to other projects or facilities that support commercial navigation. Replacing the locks and rehabilitating the dams will improve the reliability of the locks and increase capacity of the auxiliary chambers. Tows

will not be restricted to one-barge lockages during periods of main chamber maintenance, and efficiency of the movement of goods will be improved.

Some nonstructural navigation improvements, sequential locking, and expanded mooring facilities, would have positive effects on navigation by reducing congestion at locks. Some nonstructural navigation improvements, such as vessel scheduling and prioritization, would restrict barge traffic and delaying some shipments.

Proactive lock and dam maintenance would be beneficial by keeping the navigation system efficient. Channel dredging, port development, maintenance dredging, lock and dam signage, environmental sustainability operation actions, and navigation aids would all have positive impacts on traffic by maintaining and improving the navigation infrastructure.

Maintaining a 9-foot pool depth is crucial for ensuring the continuation of commercial barge traffic on the river. Without an adequate pool depth, river navigation would be limited to seasonal high flows, as previously experienced on the river prior to 1855.

The construction of the investment projects will have short-term negative effects on transportation and traffic. Likewise, port development and lock and dam maintenance and operation activities would negatively impact commercial traffic during those activities; however, the negative effects would be temporary and permanent effects of these activities would be positive.

8.8.2 Actions by Others

8.8.2.1 Navigation System Dependent – "But For"

The actions included in this group generally have an indirect effect on transportation and traffic. Although many of them affect commerce, others cause conflicts with barge traffic. Those actions that encourage commercial transportation include fleeting areas/barge storage areas, terminals, and multi-modal sites while barge queuing, decreases efficiencies in the transportation system.

In general, the development of terminals, ports, multimodal sites, and Coast Guard navigation aids would facilitate movement of commodities in the navigation system and enhance links with other modes of transportation.

The continued operation of coal-fired power plants directly affects transportation and traffic, since coal accounts for over 50 percent of freight transported within the study area. A reduction in the usage of coal for energy will reduce barge traffic and lessen congestion. The development of hydropower generators at the dams, while contributing to the economy's needs for additional power, would have no effect on the demand for coal since the amount of hydropower that could be produced at these dams would be insignificant compared with regional needs. It is likely, however, that as hydropower facilities come on line, demand will increase for all types of power generation and the coal-fired plants will be unaffected by the different technology.

Marina development and personal boating indirectly affect transportation and traffic by encouraging competing river uses and potentially increasing conflicts with barge traffic.

Actions that increase the number of commercial vessels on the river are beneficial to transportation and traffic, although increased commerce without a corresponding increase in navigation investment actions would result in increased congestion and delays.

8.8.2.2 River Dependent

Instream sand and gravel mining have a positive impact on transportation by increasing transportation demand. Instream sand and gravel mining is also considered to have a negative component due to its potential to cause conflicts with other barge traffic.

8.8.2.3 Riverfront/Floodplain Development

Redevelopment of the area's brownfields has the potential to positively impact transportation and traffic if these areas are utilized for industrial use. If these sites were converted to commercial, residential, or other uses, such as the previously developed Waterfront in Homestead, the effect on transportation and traffic could be negative by encouraging recreational boating and subsequent conflicts with barge traffic.

8.8.2.4 Natural Events

Natural occurrences, such as floods, can have short-term adverse effects on commercial navigation and support facilities. Flooding could damage or close facilities temporarily. Barge operations are also likely to cease during floods or periods with swiftly-moving currents.

8.8.2.5 Regulatory Environment

Water transportation is one of the nation's most heavily regulated modes of transportation. These regulations have helped to make water transport one of the safest modes of transportation; however, these regulations may also hinder or reduce the free flow of trade.

Some regulatory measures have a positive effect on commercial transportation. For instance, increasing boating safety regulations may improve awareness of recreational watercraft operators and help reduce conflicts with barge traffic. Spill prevention measures should improve safety and decrease cleanup costs.

Activities subject to USACE permitting programs that involve dredging or discharges can cause short-term conflicts or disruptions to navigation traffic. Adopting environmental sustainability practices would likely negatively impact transportation by imposing restrictions on commercial barge traffic.

Adopting the sand and gravel extraction guidelines included in the Sand and Gravel EIS would negatively affect transportation demand by reducing the volume of sand and gravel to be transported. Conversely, reducing in-stream mining operations may reduce conflict with other barge traffic.

Impacts associated with Clean Water Act Standards could occur. Although they could be negative, they are likely to be temporary in nature and would be mitigated or minimized. Implementing more restrictive air standards would have a profound negative effect on transportation and traffic by reducing the use of coal as an energy source.

8.9 ANALYSIS OF ENVIRONMENTAL SUSTAINABILITY

Actions that enhance barge traffic movements improve waterway navigation and move transportation and traffic toward sustainable conditions. Full sustainability of transportation and traffic occurs with cost-effectiveness, efficiency, and minimization of externalities. Indicators relevant to the sustainability of transportation and traffic include barge tonnage, the number of terminals and intermodal transfer facilities within the system, barge traffic queuing times, and fuel usage.

Environmental sustainability balances environmental and economic considerations through the life cycle of project planning, design, construction, operation, and maintenance to improve the quality of life for present and future generations. Accordingly, it represents an ultimate test of significance of potential cumulative effects.

8.9.1 Positive Forces Affecting Transportation and Traffic

The current trends to conserve natural resources, to promote “green” methodologies, and to employ environmental sustainability practices support the use of inland water transportation over other modes of transportation.

The current proposal to update the lock and dam facilities in the study area, to enhance transportation and traffic on the river by increasing capacity of the auxiliary locks and increasing reliability of the main chambers, will result in decreased delays and congestion. Enhancing the efficiency of the Upper Ohio Navigation System may slightly increase demand by potentially inducing users of other surface transportation modes to switch to barge. This, in turn, would result in reduced land-based transportation along with the concomitant congestion, safety and pollution problems.

The use of coal is a major contributor to the near term viability of the navigation system contributing 74 percent of the current commodities being transported in the upper river. Long-term use of coal is bracketed by economic scenarios described elsewhere in this report. Under both the base case and low growth scenarios, coal transport will grow for the next 30 years and decline thereafter. Under the high growth scenario, coal will grow throughout the 60 year planning horizon. Demand to move coal will not decline over the planning period.

8.9.2 Negative Forces Affecting Transportation and Traffic

The nature of the inland water transportation system limits the type of commodities that may be shipped by barge. Barge traffic, although reliable, is slow, and commodities are limited to those that are not time-sensitive or that may be stockpiled. Commodities are also limited to those that may be shipped in bulk, such as coal, gravel, and scrap metal. Destinations of commodities transported by barge are limited to industrial sites or multi-modal transfer sites immediately adjacent to the river.

The decline of the steel industry in the Pittsburgh region has negatively affected barge traffic on the upper Ohio River. The reduction in cost of foreign steel has contributed to the decline of the steel industry and to the decline of steel in river transport.

Also, an increase in the affluence of the nation, as enjoyed since World War II, has encouraged the recreational use of the river, which conflicts with barge traffic. Recreational boating in the area is also seeing a shift from motorized boats to non-motorized canoes and kayaks. Although this shift is gradual and may be limited to certain demographic segments of the population, conflicts could continue.

8.9.3 Incremental Impacts on EDM

Implementing improvements at EDM will have a long-term positive effect on transportation and traffic. Modernlocks will improve the efficiency and reliability of the lock and dam system through the region thus reducing congestion and delays.

Based on a survey conducted in 2000 for the USACE Pittsburgh District, improving the navigation system will likely encourage existing industrial and commercial users to switch transportation modes from rail and truck to barge. Due to its greater fuel efficiency, commodities transported by barge will experience a lower fuel cost and lower congestion on area highways.

Since water transport is considered the safest and most environmentally friendly mode of surface transportation, transferring goods from rail or truck transportation to barge will improve overall safety and reduce the potential of accidental spills during the movement of goods.

The EDM improvements will have minor negative impacts on transportation and traffic during construction; however, these will be short term and temporary.

8.10 DETERMINATION OF SUSTAINABILITY

Three definitions of environmental sustainability were used for this analysis. They include the following:

- Not sustainable – conditions for the selected indicators reflect conditions that do not facilitate attainment of acceptable standards or that do not maintain existing standards in concert with collective impacts of proposed activities.

- Marginally sustainable – conditions and selected contributing indicators for transportation and traffic are problematic at several locations, thus periodic short-term declines in the cost-effectiveness and efficiency of the movement of goods, and associated increases in externalities, would be expected to occur.

- Sustainable – conditions for transportation and traffic are such that sustained conditions of cost-effectiveness and efficiency, along with the minimization of externalities, are achieved. A cost-effective and efficient waterway transportation network for the upper Ohio River is one that is affordable, operates efficiently, connects with other transportation modes, and supports a vibrant economy. A waterway transportation network that minimizes externalities is one that limits emissions and waste within the environment's capacity to handle them, minimizes consumption of non-renewable resources, limits consumption of renewable resources to the sustainable yield level, reuses and recycles its components, and minimizes use of land and production of noise.

Over time, RFFAs that enhance barge traffic should lead to increased cost effectiveness and efficiency for the movement of goods. Additionally, the RFFAs that enhance barge traffic should minimize externalities by decreasing average queuing times for barge traffic at locks. Although the amount of fuel used by tows would be expected to increase with more barge traffic, the fuel economy of barge traffic over rail or highway will reduce total fuel consumption and total emissions.

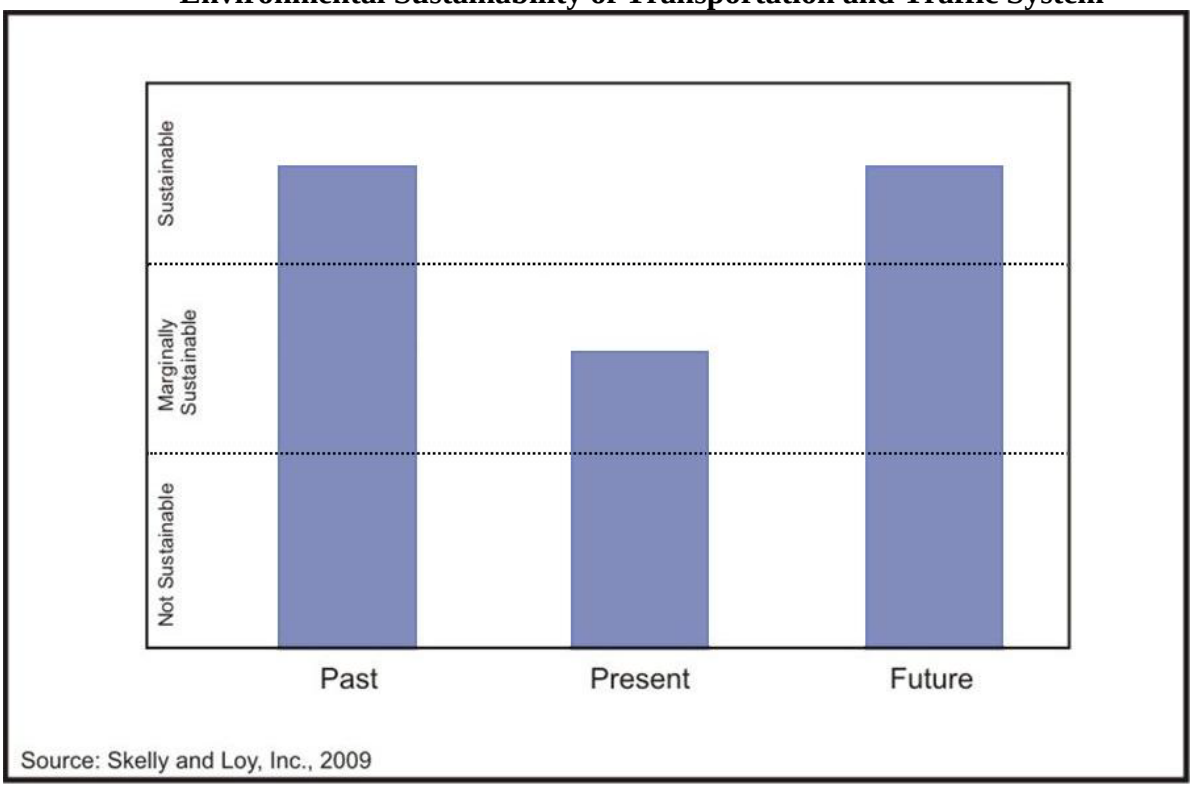
On the other hand, RFFAs that restrict barge traffic move the waterway navigation system away from a sustainable condition. They can lead to decreased cost effectiveness and efficiency for the movement of goods and could result in a shift to other modes of transportation. Under these circumstances, higher consumption of fuel by railroads and trucks could occur. This in turn could increase air emissions. Because of their unpredictability, short term closures increase costs significantly more than long term closures when industry can adjust to the closings with better advance planning. Fuel usage costs would be about $99 million per year with short-term closures and about $57 million per year with long-term closures (USACE 2000a). Emissions abatement costs would be about $48 million per year with short-term closures and about $25 million per year with long-term closures (USACE 2000a).

Figure 8-7 illustrates the sustainability conclusions for transportation and traffic. Based upon the previously described historical information; the RFFAs and their effects; and the indicators of environmental sustainability for transportation and traffic, sustainability can be characterized as follows:

- In the time period prior to 1920, and continuing up to about 1950, the waterway system can be classified as sustainable. During this period, the river navigation system was newly constructed and very reliable. The capacity of the locks were adequate to handle to tonnage passing through them. The area was also well served by both railroads and roadways.

- In the time period from 1950 to 2008, less than ideal conditions were often experienced as a result of the decreasing reliability of the locks, inadequately sized auxiliary chambers, and the incongruous size of the main chambers which were smaller than the main chambers downriver. Through-tows transiting multiple locks often stop to reconfigure before moving through the main chambers at EDM. Even though the chambers are adequate to pass the tonnage, this reconfiguration results in reduced efficiencies. When the main chamber is closed for repair, something that can be expected to occur more frequently, the results are significant delays when using the single-barge-sized auxiliary locks. Nonetheless, in 2007, approximately 20 million tons of material moved through each of the EDM locks. Although that is a decrease from prior years, and the downward trend since 2000 has been continuing, it represents a considerable social and environmental cost-savings from using other transportation systems to move this material. The system, however, is well past its design life, and funding to replace these structures in a timely manner is not available. The lack of replacement dollars has taken a toll on the entire Ohio River System with a notable waiting time for those projects that have not begun construction. This delay in funding could result in a structure failure that could close the upper river to all navigation for a significant period of time depending on the nature of the failure. Thus, based primarily on this reliability question along with growing congestion on area roadways and rail lines, the sustainability of the transportation and traffic is considered to be in the marginally sustainable condition.

FIGURE 8-7
Environmental Sustainability of Transportation and Traffic System



- As a result of future navigation investment actions, capacity and reliability problems at the existing locks and dams will be addressed and constraints to water-borne transportation removed. Consequently, the sustainability of the transportation and traffic would improve to full sustainable condition.

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Chapter 9

AIR QUALITY

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9.1 DEFINITION

Air quality refers to ambient or outdoor air that is safe to breathe by all members of the general population, including young children, elderly citizens and other "at risk" individuals such as asthmatics. Specific standards are used to assess the levels at which air quality is measured and health protected.

9.2 OBJECTIVES/SCOPE

9.2.1 Objectives

This chapter assesses the area-wide cumulative air quality impacts of all likely major navigation improvements along the upper Ohio River during the period from 1885 to 2070. Air quality impacts that are directly or indirectly attributable to modernization of the navigation system are evaluated in concert with impacts from other past, present, and reasonably foreseeable future actions (RFFAs) by the United States Army Corps of Engineers (USACE) and others.

Assessment of past and present actions and current conditions is the basis for identifying and interpreting the potential impacts of RFFAs. These future actions include the major navigation improvements identified in this study; other routine or potential actions by the USACE; projected actions by other federal, state, or local agencies; actions by non-governmental entities; and predictions of general economic expansion and development. The results of the assessment are used to determine the environmental sustainability of air quality.

9.2.2 Geographic Scope

The geographic area of focus for air pollutant sources includes the region directly served by upper Ohio River barge transport. The geographic area includes Allegheny and Beaver counties in Pennsylvania; Jefferson and Columbiana counties in Ohio; and Hancock County, West Virginia. The geographic area includes the Emsworth, Dashields, and Montgomery Locks and Dams (EDM). The contribution of these sources to both local and regional air quality concerns is discussed in this chapter.

9.2.3 Time Frame

The established time frame for this assessment is 1885 to 2070. The earlier date is when the initial lock and dam construction on the Ohio River began. Thus, it approximates the beginning of the modern lock and dam system. The latter date approximates the economic life of anticipated improvements on the Ohio River and is considered the planning horizon for the project.

9.3 ISSUES FROM SCOPING

Scoping has occurred as part of the Ohio River Mainsten Study (ORMSS) and for the Upper Ohio Navigation Study. A series of 12 public scoping meetings was held for the Ohio River Mainsten Study during the summer of 2001. Subsequently, three public scoping meetings were held for the Upper Ohio Navigation Study in October 2006. Approximately 185 people attended the ORMSS meetings and approximately 40 people attended the Upper Ohio Navigation Study meetings. Only one comment (from an ORMSS meeting) directly addressed air quality, noting the “importance of continued air quality improvements as a high priority.”

Comments have also been sought from the environmental resource agency representatives and planning officials serving on the Interagency Working Group (IWG). No comments specifically associated with air quality were received from the IWG.

9.4 LAWS, REGULATIONS, ORDINANCES, AND PROGRAMS

9.4.1 Impacts of Air Pollution

Air pollutants that are currently contributing to significant air quality issues in the counties of the upper Ohio River region include: ground level ozone (O_3), oxides of nitrogen

(NOx), sulfur dioxide (SO_2), volatile organic compounds (VOCs), particulate matter ($PM_{2.5}$, PM_{10}), and carbon monoxide (CO).

NOx combines with VOCs in the presence of sunlight to produce tropospheric ozone (ground level O_3), which is a threat to human health in a number of upper Ohio River communities. Primary sources of NOx include motor vehicles, power plants, and other industrial combustion sources. VOCs are produced from motor vehicles, chemical plants, refineries, factories, and some consumer of commercial products. Short-term (1-3 hours) and prolonged (6-8 hours) exposures to O_3 are associated with increased hospital admissions and emergency room visits for respiratory distress, especially among active children and adults with a pre-existing susceptibility such as asthma. Exposures to O_3 contribute to respiratory infections, lung inflammation, decreased lung function, chest pains, and cough.

Because O_3 is primarily an area-wide pollutant, it is typically assessed in system-level planning as part of the air quality State Improvement Plan (SIP) development and conformity process. Through the Transportation Improvement Program (TIP)/SIP evaluation process, this pollutant is evaluated on a regional level. As the designated Metropolitan Planning Organization (MPO) for a 10-county (including Allegheny and Beaver counties) region within Southwestern Pennsylvania, the Southwestern Pennsylvania Commission (SPC) is the responsible agency for assuring that the transportation process is followed.

SO_2 and NOx are the primary causes of acid rain, which impacts people and ecosystems throughout the midwest and northeast, and in southeastern Canada. Coal-fired power plants are the primary source of SO_2. Other sources include metal smelting, other industrial processes, and combustion of sulfur-containing fuels such as diesel. Locomotives, large ships, and some non-road diesel equipment currently burn high sulfur fuel and emit SO_2. Acidification of soils, lakes, and streams has caused the destruction of commercial and recreational fisheries, degraded agricultural and forest production, and accelerated corrosion of buildings and monuments (USACE 2006).

NOx, SO_2, and VOC are also major precursors to fine particulate matter that is 2.5 microns or less in size ($PM_{2.5}$). These gases interact with other compounds in the air to form fine particles. $PM_{2.5}$ also consists of dry particles emitted directly from sources such as fuel combustion by motor vehicles, power plants, and industrial facilities. Fine particles are associated with deep penetration into the lungs, contributing to increased hospital and emergency room visits, increased respiratory symptoms and disease, decreased lung function, and even premature death. By comparison, course particles that are 10 microns or less in size (PM_{10}) are typically earth-based materials emitted by vehicle travel on unpaved roads, materials handling, crushing and grinding operations, and windblown dust. Exposure to coarse particles is primarily associated with the aggravation of respiratory conditions, such as asthma.

CO is a colorless, odorless gas that is formed when carbon in fuel is not burned completely. CO is a potentially poisonous by-product of motor vehicle exhaust, and high concentrations typically occur in areas with heavy traffic congestion. Peak CO

concentrations typically occur in winter when CO emissions are greatest and nighttime inversion conditions concentrate the pollutants.

9.4.2 Air Quality Standards and Regulations

National Ambient Air Quality Standards have been established by USEPA for the seven categories of air pollutants presented in Table 9-1 (USEPA 2008a). The latest standards for ground level ozone and fine particulate matter are included in this table.

On March 12, 2008, USEPA revised the NAAQS for ozone by setting the 8-hour standard at 0.075 parts per million (ppm). The prior 8-hour standard was 0.08 ppm, last revised in 1997. Initial non-attainment designations will be assigned in 2010. States will then have three years to develop SIPs for these areas. Some states will have until as late as 2030 to comply.

In 1997, USEPA added the $PM_{2.5}$ standards to the existing particulate standards for PM_{10} which were intended to regulate inhalable coarse particles that ranged from 2.5 to 10 micrometers in diameter. PM_{10} measurements, however, contain both fine and coarse particles. USEPA revised the air quality standards for particle pollution in 2006. The 2006 standards tightened the 24-hour fine particle standard from the prior level of 65 micrograms per cubic meter ($\mu g/m^3$) to 35 $\mu g/m^3$, and retained the current annual fine particle standard at 15 $\mu g/m^3$. USEPA decided to retain the existing 24-hour PM_{10} standard of 150 $\mu g/m^3$, while it revoked the annual PM_{10} standard, because available evidence does not suggest a link between long-term exposure to PM_{10} and health problems. An ambient monitoring and analysis program for $PM_{2.5}$ that was conducted from 1987 through 2001 found the highest concentrations of $PM_{2.5}$ to be occurring in the eastern United States. The primary source of these particles was sulfates from utility and industrial boilers throughout the region.

On November 12, 2008, USEPA published a final rule revising the NAAQS for lead under the Clean Air Act, 73 Fed. Reg. 66,964. The rule reduced the primary (health-based) NAAQS from 1.5 $\mu g/m^3$ (set in 1978 and last reviewed in 1990) to 0.15 $\mu g/m^3$ measured as total suspended particles (TSP). USEPA also set the secondary (welfare-based) NAAQS at the same level. The U.S. District Court for the Eastern District of Missouri ordered USEPA to complete the review and issue any revisions within three years. *Missouri Coalition for the Environment v. EPA*, No. 4:04-CV-00660 (E.D. Mo. Sept. 14, 2005). The final rule became effective January 12, 2009.

Air quality is monitored primarily by the states, but with substantial assistance of larger monitoring networks supported by USEPA and others. Within the project area, Allegheny County Health Department (ACHD) is the only local monitors point source air pollution concentrations within Allegheny County. States are additionally responsible for establishing and maintaining emission inventories that quantify the location, concentration, and net emissions from major, minor, and mobile sources statewide. The combination of monitoring and inventory management is the primary basis for tracking air quality trends and the progress of emission control efforts.

Areas failing to meet one or more NAAQS are identified as being in non-attainment. Non-attainment areas may be individual communities or multi-county regions, depending on the type and extent of the pollution problem. Non-attainment areas typically cross state lines wherever population centers are located near such borders.

TABLE 9-1
National Ambient Air Quality Standards

	Primary Standards		Secondary Standards	
Pollutant	**Level**	**Averaging Time**	**Level**	**Averaging Time**
Carbon Monoxide	9 ppm (10 mg/m^3)	8-hour [1]	None	
	35 ppm (40 mg/m^3)	1-hour [1]		
Lead	0.15 µg/m^3 [2]	Rolling 3-month average	Same as Primary	
	1.5 µg/m^3	Quarterly average	Same as Primary	
Nitrogen Dioxide	0.053 ppm (100 µg/m^3)	Annual (arithmetic mean)	Same as Primary	
Particulate Matter (PM_{10})	150 µg/m^3	24-hour [3]	Same as Primary	
Particulate Matter ($PM_{2.5}$)	15.0 µg/m^3	Annual [4] (Arithmetic Mean)	Same as Primary	
	35 µg/m^3	24-hour [5]	Same as Primary	
Ozone	0.075 ppm (2008 std)	8-hour [6]	Same as Primary	
	0.08 ppm (1997 std)	8-hour [7]	Same as Primary	
	0.12 ppm	1-hour [8] (Applies only in limited areas)	Same as Primary	
Sulfur Dioxide	0.03 ppm	Annual (Arithmetic Mean)	0.5 ppm (1300 µg/m^3)	3-hour [1]
	0.14 ppm	24-hour [1]		

[1] Not to be exceeded more than once per year.
[2] Final rule signed October 15, 2008.
[3] Not to be exceeded more than once per year on average over 3 years.
[4] To attain this standard, the 3-year average of the weighted annual mean $PM_{2.5}$ concentrations from single or multiple community-oriented monitors must not exceed 15.0 µg/m^3.
[5] To attain this standard, the 3-year average of the 98th percentile of 24-hour concentrations at each population-oriented monitor within an area must not exceed 35 µg/m^3 (effective December 17, 2006).
[6] To attain this standard, the 3-year average of the fourth-highest daily maximum 8-hour average ozone concentrations measured at each monitor within an area over each year must not exceed 0.075 ppm. (effective May 27, 2008)

TABLE 9-1 (continued)
National Ambient Air Quality Standards

	Primary Standards		Secondary Standards	
Pollutant	**Level**	**Averaging Time**	**Level**	**Averaging Time**
(7) (a) To attain this standard, the 3-year average of the fourth-highest daily maximum 8-hour average ozone concentrations measured at each monitor within an area over each year must not exceed 0.08 ppm. (b) The 1997 standard—and the implementation rules for that standard—will remain in place for implementation purposes as EPA undertakes rulemaking to address the transition from the 1997 ozone standard to the 2008 ozone standard.				
(8) (a) The standard is attained when the expected number of days per calendar year with maximum hourly average concentrations above 0.12 ppm is $\leq$ 1. (b) As of June 15, 2005 EPA revoked the 1-hour ozone standard in all areas except the 8-hour ozone non-attainment Early Action Compact (EAC) Areas.				
Source: USEPA, 2008a				

States have primary responsibility for establishing management goals and implementing programs to achieve the standards. States manage non-attainment programs in their portion of multi-state areas. State programs are formally documented as State Implementation Plans, which are subsequently approved by USEPA. Additionally, air quality programs in some areas have been delegated by the states to local authorities. In the upper Ohio River study the Allegheny County Health Department (ACHD) is the only local authority that has received such a designation.

In actual practice, programs to reduce air pollution include a complex mixture of national, state, local, and multi-jurisdictional initiatives. Basic emission standards for automobiles and gasoline are national programs, as are forthcoming regulations addressing diesel engines and fuels. Inspection programs to ensure vehicles are properly maintained to minimize emissions are administered by the states and implemented at the local level. More recently, a variety of market-oriented initiatives, such as emission caps for a specific group of sources and trading of emission allotments, have been implemented. These are intended to allow the group of sources to utilize more cost-effective strategies to reduce net emissions from the group. The acid rain program addresses SO_2 and NOx emissions from coal-fired electric utilities nationwide. Three additional programs address NOx from utilities and other industrial sources throughout the midwest and northeast.

9.5 PAST TO CURRENT BASELINE CONDITIONS

9.5.1 Historic Air Quality Conditions

Pittsburgh was known as the “Smoky City” by the 1800s and persisted in that designation through the Pittsburgh Renaissance of the 1950s. The problem of smoke pollution in Pittsburgh resulted from a combination of urbanization, industrialization, topography, and the availability of low cost, high-volatile bituminous coal. Heavy coal burning for industry, railroad engines, residential and commercial heating, and the coke ovens combined with local topographical and climatic factors that often produced temperature inversions trapping the smoke pollution in the area.

Smoke and fuel research in the 1920s and 1930s, suggested that the smoke problem persisted because the amount of black smoke produced by a pound of coal is greater when fired in a domestic furnace.

The period between 1940 and 1960, when Pittsburgh and Allegheny County began its Smoke Control Movement, is a pivotal point in the area's environmental history and the success of eliminating, to a large extent, the dense smoke from the area's atmosphere. The success of the smoke control initiative was the result of two interactive factors: (1) major changes in the fuels and/or combustion technology used by a majority of Pittsburgh homes and commercial businesses, railroads, and some manufacturing industries; and (2) a municipal smoke control policy that required domestic consumers, industries, and transportation companies to change their fuel type and/or combustion equipment. The main idea was to use cleaner burning (smokeless) coal and smokeless heating equipment that burned regular bituminous coal. However, from 1945 to 1950, over half of the households in Pittsburgh switched their fuel from coal to natural gas. This change also required the retrofitting or replacement of the existing combustion heating systems. This had a large effect in reducing the amount of smoke in the Pittsburgh sky. In 1941 the Commission for the Elimination of Smoke enacted a plan with the concept of controlling smoke at its source and established a two-year time table for implementation for all fuel users to either burn smokeless fuels or to adopt smokeless mechanical equipment as follows:

- Industries, office buildings, hotels, apartments, houses, and commercial establishments by October 1, 1941;
- Railroads by October 1, 1942; and
- Domestic users and all other fuel consumers by October 1, 1943.

The Smoke Control ordinance of Allegheny County became effective on June 1, 1949 detailing regulations governing the operation and inspection of all fuel-burning equipment in industrial, commercial, and residential settings and mandating fines or equipment shutdowns for law violations. By the late 1950s the smoke control legislation of the 1940s had achieved its purpose of the elimination of blatant ash and soot pollution that required street lights to be on at high noon. However, high levels of nitrogen and sulfur dioxide and micro-dust pollution continued, especially in river valley mill towns.

Air quality continued to improve after Pittsburgh's steel industry experienced a shut down in the early 1980s, taking 120,000 manufacturing jobs from the region. Today a lot of these former sites are retail and entertainment complexes. The poor air quality of the past for the Upper Ohio River region has greatly improved with the demise of the steel industry in the area.

Although great advances in air quality were achieved between 1940 and 1960, information about air quality impacts during this period is primarily anecdotal. Comprehensive monitoring of emissions and research addressing the relationships between human health and air pollution dates from the early 1970s, corresponding to the first

generation of national air quality laws and regulations (e.g., CAA of 1970) and establishment of USEPA and state level air agencies. The year 1980 serves as a convenient benchmark of the point at which many regulations began to take effect and air emission quantities began to level off or decline. It is frequently the earliest date from which reliable trend data are reported by USEPA.

The extensive and diverse industrial development in the project area continued up to about 1970 without regulation of air emissions. Extensive highway development from 1945 through 1970 contributed to the growing popularity of the automobile for personal transportation as well as development of an extensive commercial trucking industry. Leaded gasoline and diesel fuel from these mobile sources added concentrations of lead, VOC, CO, NOx, PM and other pollutants to the air. While detailed local or regional estimates are difficult to establish, USEPA estimates that national emissions of NOx increased 690 percent between 1900 and 1970. During the same period, VOC emissions increased 260 percent and SO_2 increased by 210 percent (USACE 2006). Air quality trends in the project area probably approximate these national trends with the exception of SO_2, which was very heavily concentrated in the project area. Localized impacts of smog (ground level O_3), PM, and lead attracted the most attention during the two decades of debate that preceded finalization of national air quality regulation in the early 1970s. Long-range transport and atmospheric chemical interactions that contributed to acid rain, O_3, and other impacts were less obvious, but the earliest legislation established the monitoring and research programs that led to better understanding of these processes.

One of the earliest programs to improve air quality focused on the automobile. Nationally, average lead concentrations decreased dramatically after USEPA regulations reduced the lead content in gasoline in the mid-1970s. Lead has been blended with gasoline, primarily to boost octane levels, since the early 1920s. USEPA began working to reduce lead emissions soon after its inception, issuing the first reduction standards in 1973, which called for a gradual phase-down of lead to one tenth of a gram per gallon by 1986. The average lead content in gasoline in 1973 was 2-3 grams per gallon or about 200,000 tons of lead a year. In 1975, passenger cars and light trucks were manufactured with a more elaborate emission control system which included a catalytic converter that required lead-free fuel.

The Clean Air Act Amendments of 1990 (CAAA) were designed to curb three major threats to the nation's environment and to the health of millions of Americans: acid rain, urban air pollution, and toxic air emissions. The CAAA achieved the air quality goals and regulatory reform by specifically:

- Encouraging the use of market-based principles and other innovative approaches, like performance-based standards and emission banking and trading;
- Providing a framework from which alternative clean fuels will be used by setting standards in the fleet and California pilot program that can be met by the most cost-effective combination of fuels and technology;

- Promoting the use of clean low sulfur coal and natural gas, as well as innovative technologies to clean high sulfur coal through the acid rain program;

- Reducing energy waste and creating a market for clean fuels derived from grain and natural gas, consequently, cutting dependency on oil imports by one million barrels/day; and

- Promoting energy conservation through an acid rain program that gives utilities flexibility to obtain needed emission reductions through programs that encourage customers to conserve energy.

By 1995 leaded fuel accounted for only 0.6 percent of total gasoline sales and less than 2,000 tons of lead per year. Effective January 1, 1996, the CAAA banned the sale of the small amount of leaded fuel that was still available in some parts of the country for off-road uses, including aircraft, racing cars, farm equipment, and marine engines. Additional engine design and performance standards also contributed to reduced emissions of VOC and CO. Subsequent fuel efficiency standards reduced emissions by increasing the number of miles traveled per gallon of fuel consumed. Significant progress towards improved air quality was gradually achieved over about 15 years as the previous generation of leaded vehicles was gradually retired.

Many local air pollution problems are the result of concentrated populations and local weather patterns that concentrate pollutants over a period of several days. This is especially true of O_3 non-attainment areas in the project area. High O_3 levels can result from hot, dry weather and stagnant or little movement of air masses that continues for several days. Western Pennsylvania's and West Virginia's mountainous topography can add to O_3 levels by capturing air in the valleys, limiting air dispersion. Transportation management is one of the primary strategies at the local level for non-attainment communities, as well as for communities trying to maintain their attainment status. Vehicle inspection programs are a fundamental means of assuring that owners perform routine maintenance to keep their vehicle emissions in compliance. Communities can also require the use of reformulated fuels that burn more efficiently and emit fewer pollutants. Motor vehicle engine design standards and winter blend reformulated gasoline for problem areas have combined to reduce national average CO ambient concentrations by 57 percent in the past 20 years, with an estimated 93 percent reduction in the number of exceedances of the standard. Support of mass transit programs is motivated, in part, to reduce vehicle emissions.

Local program efforts are supplanted with emergency procedure approaches when local air quality threatens to exceed compliance thresholds. Local authorities may encourage or require reduced activities by public agencies, local industries, area sources, and individuals until air quality improves.

In general, regional conditions in the project area reflect the national pattern for overall improvement in air quality. Table 9-2 illustrates the progress of the five counties in the project area that were designated as being in non-attainment since 1992.

TABLE 9-2
Attainment History in the Upper Ohio River Valley

County	Pollutant	Area Name	Years in Non-attainment	Redesignation to Attainment
Pennsylvania				
Allegheny	CO	Pittsburgh, PA	1992 - 2002	1/13/2003
Allegheny	1-hr O_3	Pittsburgh-Beaver Valley, PA	1992 - 2001	9/02/2005
Allegheny	8-hr O_3	Pittsburgh-Beaver Valley, PA	Subpart 1 (Basic)[a] 1992 - 2008	--
Allegheny	PM_{10}	Clairton & 4 Boroughs, PA	1992 - 2003	10/14/2003
Allegheny	SO_2	2-mile radius of Hazelwood, PA	Maintenance[b] 1992 - 2008	--
Beaver	1-hr O_3	Pittsburgh-Beaver Valley, PA	1992 - 2001	9/02/2005
Ohio				
Columbiana	1-hr O_3	Columbiana Co., OH	1992 - 1994	3/10/1995
Jefferson	1-hr O_3	Steubenville, OH	1992 - 1994	3/10/1995
Jefferson	PM_{10}	Jefferson Co., OH	Maintenance[b] 1992 - 2008	--
Jefferson	SO_2	Jefferson Co., OH	Maintenance[b] 1992 - 2008	--
West Virginia				
Hancock	PM_{10}	Weirton, New Manchester-Grant Mag. District (Hancock), WV	Nonattainment 1992-2008	--
Hancock	SO_2	Weirton, New Manchester-Grant Mag. District (Hancock), WV	Maintenance[b] 1992 - 2008	--

[a] Areas designated "Basic" non-attainment under Subpart 1 of Part D under Subchapter I of the CAA are areas with a 1-hour ozone designation value (at the time of designation) that is below the level of 0.121 ppm.

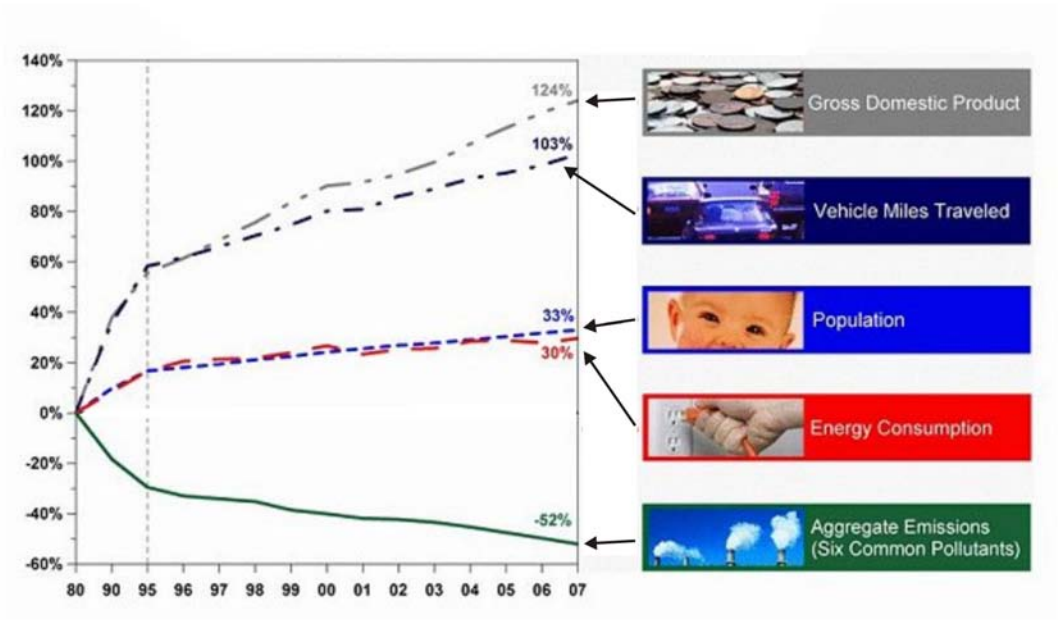
[b] Maintenance Areas are geographic regions previously designates as non-attainment for a specific pollutant and subsequently re-designated to attainment at a later date. These areas are required to develop a maintenance plan under Section 175A of the CAA and undergo regional and project level conformity determinations until the area formally achieves attainment status as designated by USEPA.

Source: USEPA, 2009

Between 1970 and 1999, emissions of the six NAAQS pollutants had decreased by 31 percent nationwide. These advances were achieved in concert with significant economic and population growth. Between 1970 and 1999, U.S. Gross Domestic Product increased 147 percent, vehicle miles traveled increased 140 percent, and the U.S. population increased by 33 percent. From 1970 to 1999, national emissions from all of the NAAQS pollutants decreased, with the exception of NOx. Between 1970 and 1999, emissions of NOx increased 17 percent. The majority of this increase can be attributed to heavy-duty diesel vehicles and coal-fired power plants (USACE 2006).

As shown in Figure 9-1, between 1980 and 2007 emissions of the six NAAQS pollutants had improved, even as the U.S. Gross Domestic Product increased 124 percent; vehicle miles traveled increased 103 percent; the U.S. population increased by 33 percent; and energy consumption increased by 30 percent. Nationwide air quality for the six NAAQS pollutants has also significantly improved between 1980 and 2007 with the combined emissions of the six NAAQS pollutants decreasing by 52 percent nationwide.

FIGURE 9-1
Comparison of Growth Areas and Emissions, 1980-2007



Source: USEPA, 2008b

The trend for improved air quality has continued since the CAA was amended in 1990. Between 1990 and 2007 emissions of the six NAAQS pollutants had improved, even as the U.S. Gross Domestic Product increased 63 percent; vehicle miles traveled increased 45 percent; the U.S. population increased by 21 percent; and energy consumption increased by 20 percent. Nationwide air quality for the six NAAQS pollutants has also significantly improved between 1990 and 2007 primarily because of cleaner cars, industries, and consumer products. The combined emissions of the six NAAQS pollutants had decreased by 41 percent nationwide. In the east, there was a significant decline in the 8-hour ozone levels due largely to reductions in NOx emissions required by the Acid Rain Program and USEPA's NOx SIP Call rule for reducing regional transport of ground-level ozone required in 22 states and the District of Columbia. (USEPA 2008b).

USEPA creates air quality trends using measurements from monitors located across the country. Air quality based on concentrations of the common pollutants has improved nationally since 1980. Air pollution was lower in 2007 than in 1980 and 1990 as indicated in the following Tables 9-3 and 9-4.

TABLE 9-3
Percent Change in National Air Quality
(Expressed in concentrations of pollutant)

	1980 vs. 2007	1990 vs. 2007
8-hour CO	-76	-67
8-hour O_3	-21	-9
Lead (Pb)	-94	-80
NO_2	-43	-35
PM_{10} (24-hr)	---	-28
Annual $PM_{2.5}$	---	-11
24-hr $PM_{2.5}$	---	-9
SO_2	-68	-54
1. --- Trend data not available 2. $PM_{2.5}$ air quality based on data since 2000. 3. Negative numbers indicate improvements in air quality or reductions in emissions.		
Source: USEPA, 2008c		

The following improvements in air emissions were seen nationally between 1980 and 2007, and 1990 and 2007.

TABLE 9-4
Percent Change in National Emissions

	1980 vs. 2007	1990 vs. 2007
CO	-55	-44
Pb	-97	-72
NO_x	-39	-33
VOC	-50	-35
Direct PM_{10}	-65	-33
Direct $PM_{2.5}$	---	-51
SO_2	-49	-45
1. --- Trend data not available 2. $PM_{2.5}$ air quality based on data since 2000. 3. Direct PM_{10} emissions for 1980 are based on data since 1985. 4. Negative numbers indicate improvements in air quality or reductions in emissions.		
Source: USEPA, 2008c		

Locally, SO_2 and NO_2 emissions from all Phase I (electric generating plants that existed prior to 1990) and Phase II (Phase I plants and subsequently-built plants) affected sources in PA, OH, and WV since the implementation of Title IV of the CAA Amendments of 1990 are depicted in Table 9-5. Phase I of the SO_2 reduction program was implemented January 1, 1995. On that date additional limitations were imposed on SO_2 emissions from electric utility plants (17 located east of the Mississippi River). Phase II of the SO_2 emissions reduction program was implemented on January 1, 2000. Phase II of the SO_2 emissions reduction program targeted existing utility servicing generators with an output capacity of greater than 25 megawatts and all new utility units located throughout the United States. Phase I of the NOx reductions was implemented January 1, 1996 and Phase II was implemented January 1, 2000. Emissions of SO_2 and NOx decreased substantially in the

three project area states between 1995 and 2006 as shown in Table 9-5. The reductions in NOx were primarily from high temperature combustion sources, such as those that occur in coal-fired electric plants and automobiles.

TABLE 9-5
Percent Change in State Emissions

Year	Sulfur Dioxide Emissions (1000 tons) from Phase I and Phase II Affected Sources				Nitrogen Oxides Emissions (1000 tons) from Phase I and Phase II Affected Sources			
	PA	OH	WV	Total	PA	OH	WV	Total
1990	1,213.4	2,211.6	968.6	4,393.6	--	--	--	--
1995	1,054.5	1,199.9	606.8	2,861.2	264.6	528.7	276.8	1,070.1
1996	1,013.7	1,479.0	658.3	3,151.0	254.5	555.9	296.5	1,106.9
1997	1,071.7	1,448.5	663.6	3,183.8	244.6	538.2	321.6	1,104.4
1998	1,072.9	1,415.0	667.9	3,155.8	239.4	516.0	292.5	1,047.9
1999	964.2	1,309.9	694.5	2,968.6	198.0	426.8	285.0	909.8
2000	935.2	1,209.5	593.3	2,738.0	209.4	375.2	258.4	843.0
2001	944.9	1,125.5	498.1	2,568.5	203.3	332.9	204.3	740.5
2002	889.9	1,132.1	507.1	2,529.1	217.8	368.7	226.3	812.8
2003	967.2	1,175.9	539.9	2,683.0	174.3	350.2	203.5	728.0
2004	997.3	1,091.5	473.8	2,562.6	177.6	266.8	172.3	616.7
2005	985.5	1,085.5	467.1	2,538.1	171.0	254.4	159.5	584.9
2006	894.2	962.1	454.2	2,310.5	171.2	238.6	151.7	561.5
Average Percent Reduction[1]	19.0	44.9	41.3	--	--	--	--	--
Average Percent Reduction[2]	--	--	--	--	22.2	27.4	15.5	--
Percent Reduction[3]	--	--	--	--	35.3	54.9	45.2	--

[1]Average percent reduction in SO_2 emissions from 1995-2006 relative to 1990 emissions.
[2]Average percent reduction in NOx emissions from 1996-2006 relative to 1995 emissions.
[3]Percent reduction in 2006 NOx emissions relative to 1995 emissions.

Source: Penn State Institutes of Energy and the Environment, 2007

The Allegheny County Health Department monitors the emissions from major pollution generators within the county. Between 1996 and 2006 emissions of CO have declined 29 percent, NOx nearly 45 percent, PM_{10} nearly 51 percent, and VOCs nearly by 56 percent (see Table 9-6). However, SO_2 emissions have only declined 17 percent during that same period. In any year, well over 80 percent of SO_2 emissions from Allegheny County's point sources are generated by the Reliant Cheswick Power Station located on the Allegheny River in Springdale, PA. SO_2 emissions can vary with the demand for electrical power and/or the sulfur content of the coal burned. In 2006, the facility emitted 12 percent less SO_2 emissions than in 2005. Coincidently, the reported sulfur content of the coal burned in 2006 was 12 percent less than that in 2005. The use of Continuous Emissions Monitoring System (CEMS) at this plant has improved the accuracy of emissions estimated as well. The

Cheswick station has acted to reduce the amount of pollution generated and in 2003 NOx emissions were reduced by the installation of a Selective Catalytic Reduction (SCR) device. The current air quality in the project area is typical of Allegheny County and is summarized in Table 9-6.

TABLE 9-6
Allegheny County, PA Estimated Point Source Criteria Pollutants

	Pollutant					
	CO (Tons/Yr)	**NOx (Tons/Yr)**	**$PM_{2.5}$ (Tons/Yr)**	**PM_{10} (Tons/Yr)**	**SO_2 (Tons/Yr)**	**VOC (Tons/Yr)**
1996 Base Year	10,259	24,141	--	4,205	46,789	4,762
1997	10,044 -2.1%	24,695 2.3%	--	4,178 -0.7%	50,337 3.0%	4,875 2.3%
1998	9,313 -9.2%	19,806 -18.0%	--	3,526 -16.2%	38,303 -18.1%	3,799 -20.2%
1999	8,960 -12.7%	19,272 -20.2%	1,768	3,191 -24.1%	43,028 -8.0%	3,750 -21.3%
2000	9,277 -9.6%	18,908 -21.7%	1,548 -12.5%	2,848 -32.3%	50,200 7.3%	3,289 -30.9%
2001	8,700 -15.2%	17,634 -27.0%	1,218 -31.1%	2,511 -40.3%	54,271 16.0%	2,847 -40.2%
2002	8,549 -16.7%	16,225 -32.8%	1,394 -21.2%	2,583 -38.6%	47,197 0.9%	2,640 -44.6%
2003	8,792 -14.3%	14,458 -40.1%	1,551 -12.2%	2,665 -36.6%	50,874 8.7%	2,473 -48.1%
2004	8,265 -19.4%	14,093 -41.6%	1,481 -16.2%	2,548 -39.4%	46,281 -1.1%	2,587 -45.7%
2005	7,864 -23.3%	12,591 -47.8%	1,357 -23.2%	2,256 -46.4%	43,867 -6.2%	2,457 -48.4%
2006	7,284 -29.0%	13,333 -44.8%	1,211 -31.5%	2,090 -50.3%	38,800 -17.1%	2,112 -55.6%

Changes in point source criteria air emissions is shown as tons per year emitted, and a percentage of the 1996 baseline year.

Source: ACHD, 2007

9.5.2 Current Air Quality Conditions

The current status of air quality in the project area as of October 2008 is summarized in Table 9-7 and Figures 9-2, 9-3, and 9-4. Within the project area, only the Pittsburgh-Beaver Valley area in Pennsylvania is designated as Subpart 1 (Basic) non-attainment for ozone (based on the new 8-hour standard). Three counties, one in each of the project area states, are designated as being in maintenance non-attainment for SO_2. Ten counties in the three states are designated as being in non-attainment for $PM_{2.5}$ and five portions of Allegheny County, PA (Liberty, Lincoln, Port Vue, and Glassport boroughs and the City of Clairton) are designated as being in maintenance non-attainment for PM_{10}. All counties in the project area are in attainment for CO, NO_2, and lead.

TABLE 9-7
Non-attainment Counties of Upper Ohio River Project Area

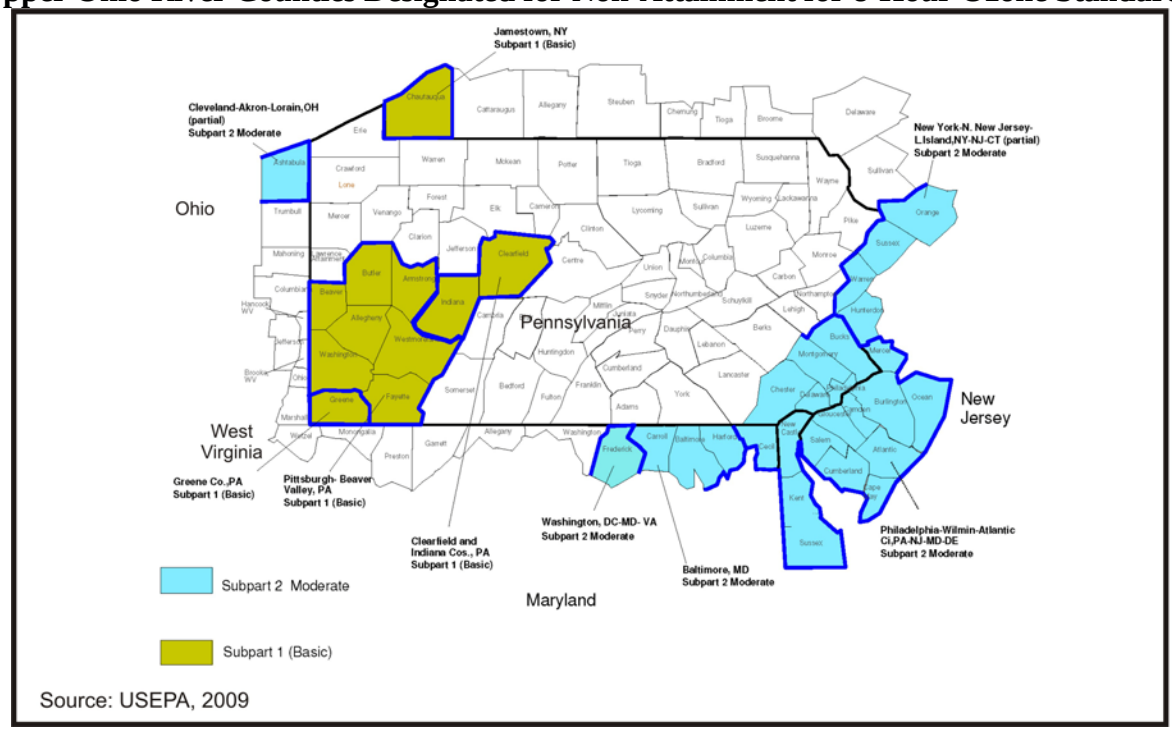
State	Non-attainment Area Name	Counties	Classification
Designations for 8-hour Ozone Standard			
Pennsylvania	Pittsburgh-Beaver Valley, PA	Allegheny Armstrong Beaver Butler Clearfield Fayette Greene Washington Westmoreland	Subpart 1 (Basic)[a]
Designations for SO_2			
Pennsylvania	Hazelwood, PA	Allegheny	Maintenance [b]
Ohio	Jefferson Co, Ohio	Jefferson	Maintenance [b]
West Virginia	Weirton, WV	Hancock	Maintenance [b]
	New Manchester-Grant Magisterial District	Hancock	Maintenance [b]
Designations for PM_{10}			
Pennsylvania	City of Clairton and Liberty, Lincoln, Port Vue, and Glassport boroughs	Allegheny	Maintenance [b]
Ohio	Jefferson Co., Ohio	Jefferson	Maintenance [b]
Designations for $PM_{2.5}$			
Pennsylvania	Pittsburgh-Beaver Valley, PA	Allegheny Armstrong Beaver Butler Greene Lawrence Washington Westmoreland	Non-attainment[c]
Ohio	Jefferson Co., Ohio	Jefferson	Non-attainment[c]
West Virginia	Hancock Co., WV	Hancock	Non-attainment[c]

TABLE 9-7 (continued)
Non-attainment Counties of Upper Ohio River Project Area

[1]No Upper Ohio River counties or sub areas are designated non-attainment for CO, NO_2, or lead.
[a] Areas designated "Basic" non-attainment under Subpart 1 of Part D under Subchapter I of the CAA are areas with a 1-hour ozone designation value (at the time of designation) that is below the level of 0.121 ppm.
[b]Maintenance areas are geographic regions previously designated as non-attainment for a specific pollutant and subsequently redesignated to attainment at a later date. These areas are required to develop a maintenance plan under Section 175A of the CAA and undergo regional and project level conformity determinations until the area formally achieves attainment status as designated by USEPA.
[c] Areas where air pollution levels persistently exceed the NAAQS are designated "non-attainment" for that specific pollutant. These areas must take specific emission reduction measures to reach compliance with the NAAQS.
Source: USEPA, 2009

Emission standards and emission reduction programs at the national or multi-state regional level will play a critical role in helping all local programs achieve their air quality objectives. While most of these programs are currently in some stage of implementation, other program elements and impacts will be realized in the near to long-term future.

FIGURE 9-2
Upper Ohio River Counties Designated for Non-Attainment for 8-Hour Ozone Standard



Source: USEPA, 2009

FIGURE 9-3
Upper Ohio River Counties Designated for Non-attainment for $PM_{2.5}$ Standard

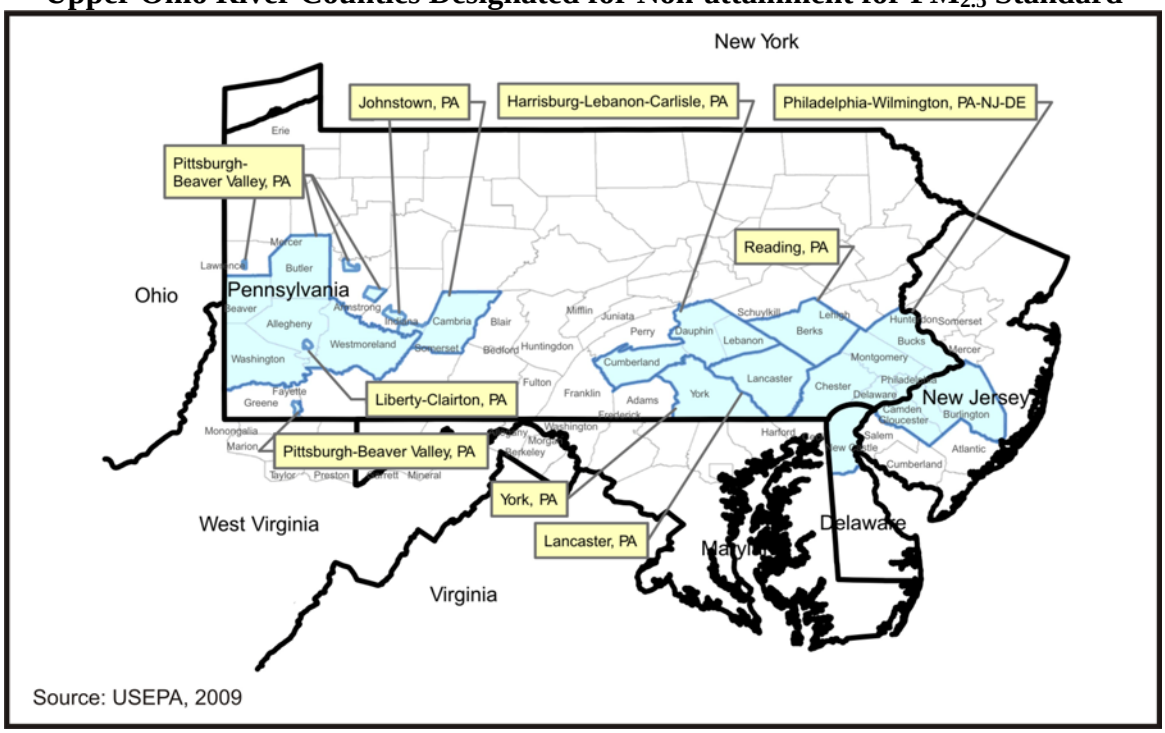
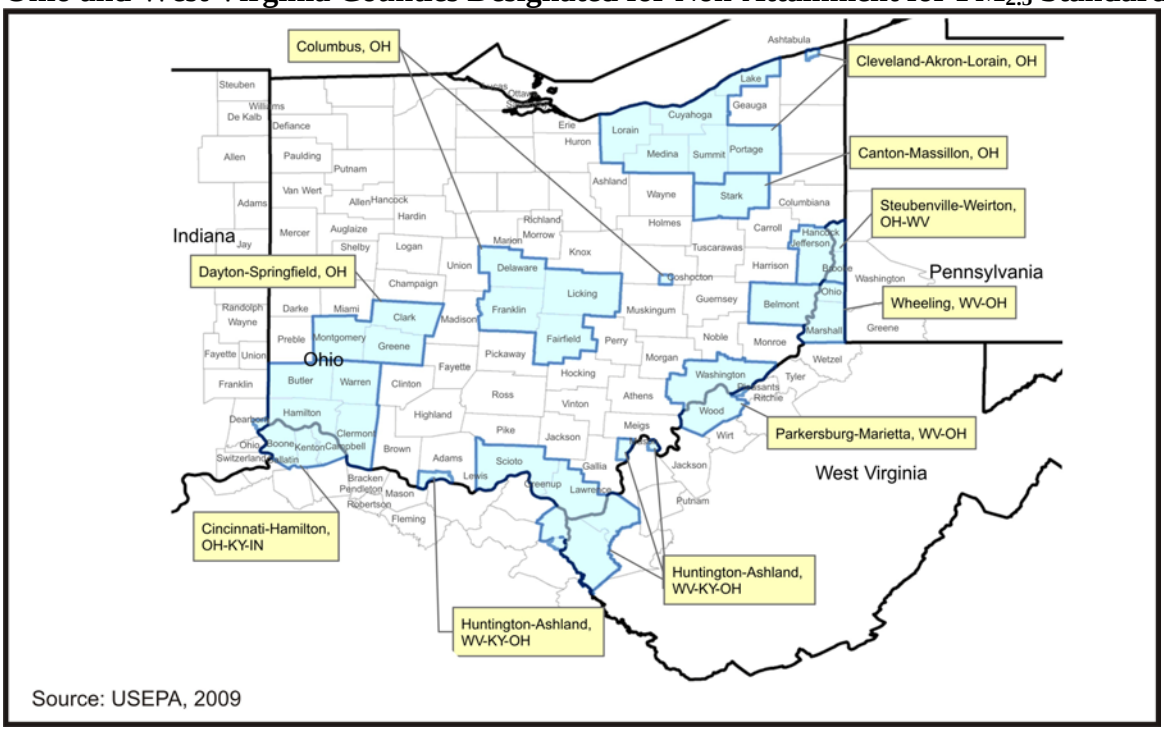


FIGURE 9-4
Ohio and West Virginia Counties Designated for Non-Attainment for $PM_{2.5}$ Standard



9.5.3 Current Air Emissions

For this study, the most current emission inventories from point sources for Allegheny County shown on Table 9-6 are assumed to be typical of other counties adjacent to the project area.

One category of point source is "marine vessels" which includes all watercraft activities on the Ohio River and tributaries within the adjacent counties. In addition to all aspects of barge traffic (tows underway, port, and fleeting operations), this category includes dredging operations, recreational boating activity, and commercial excursion boating.

The most significant emissions associated with marine vessels are NOx, as would be expected from a source group dominated by diesel engines. The emission rates reported here for the project area are consistent with other estimations of marine diesel contributions to emission inventories in port and waterway areas (USACE 2006). For the project area inventories of total emissions, the most significant contributions of NOx come from coal-fired utilities and highway transportation.

The USEPA is adopting standards that will dramatically reduce emissions of diesel PM and NOx from locomotives and marine diesel engines. This existing USEPA regulations in 40 CFR parts 92 and 94 include standards for emissions of PM, NOx, hydrocarbons (HC), and CO from locomotive and marine compression-ignition engines (also called marine diesel engines). These standards rely on engine-based technologies to reduce emissions. The opportunity to gain large additional public health benefits, as well as the similarities between these engines and highway diesel and non-road engines, have led USEPA to implement additional emission controls based on the high-efficiency after treatment technologies that will soon be in use by highway and non-road engines.

9.6 INTERACTIONS WITH OTHER VALUED ENVIRONMENTAL COMPONENTS (VECS)

The health impacts of degraded air quality constitute the most significant interaction of air quality with other valued environmental components (VECs). The importance of this interaction is reflected in the extent to which air quality regulations focus on improved health standards. Numerous scientific studies have linked air pollution to a variety of health problems including aggravation of respiratory and cardiovascular disease, decreased lung function, increased respiratory infections, effects on the nervous system, cancer, and premature death.

Air quality also interacts significantly with recreational and cultural resource values. Visibility impairment can detract from the enjoyment of urban or rural parks, river viewscapes, and cultural features. Visibility is reduced by particle pollutants that scatter and absorb light. Typical visual range in the eastern states is 15 to 30 miles, approximately one-third of what it would be without man-made air pollution. Pollution in the form of acids and acid-forming compounds (such as SOx and NOx) can deposit from the atmosphere to Earth's surface as acid deposition which can be either wet or dry. Wet deposition is commonly

known as acid rain. Corrosion from acid rain results in permanent damage to cultural features and reduces the quality of recreational experiences associated with impacted cultural features.

Corrosion from acid rain also impacts transportation structures, such as bridges and overpasses, and generally affects broader socioeconomic values through impacts to agriculture, forest, and aquatic resources. Air pollution impacts to natural systems within the project area are generally attenuated by the buffering capacity of the region's deep soils and forest cover. Downwind areas such as the Adirondack Mountains Region of New York have less buffering capacity and are more susceptible to forest and aquatic resource impacts. Interactions between air quality and other VECs are summarized in Table 9-8.

TABLE 9-8
Interactions of Air Quality Factors with Other VECs

VEC	Factors & Impacts	Past/Present Trends	Future Trends	Comments
Recreation	Particulate emissions and ozone formation can impair visibility.	Viewscapes and recreational quality have benefited from improved air quality.	Appears likely that the present air quality will be maintained or improved.	Haze from coal burning and other sources persists throughout Upper Ohio River corridor.
Cultural Resources	Corrosive impacts of acid rain	Loss or degradation of grave markers, building facades, historic artifacts	Improved air quality should reduce rate of degradation.	Continuing impact of damaged resources (no recovery)
Health and Safety	Respiratory infections, lung inflammation, decreased lung function, asthma, and effects on the nervous system	Improved air quality contributes to improved public health.	Appears likely that the present air quality will be maintained or improved. Shift of focus to air quality in buildings (mold, air conditioning impacts)	Ozone monitoring and alerts to minimize health impacts of short-term air quality degradation episodes
Transportation and Traffic	Role of transportation as major source; corrosive impacts of acid rain	Modification of car and truck engines (gasoline and diesel), and vehicle fuels have improved air quality.	Continued improvements of gasoline and diesel fuels, vehicles, and equipment	Minimal application to date of travel restrictions, regulation of transportation infrastructure
Water Quality, Fish, Mussels, and Riparian Resources	Degradation impacts of acid rain	Loss of fisheries, forest diversity, soil, and crop productivity	Resource recovery in response to reduced deposition rates	Impacts most prominent to downwind resources (PA, NY, New England)

TABLE 9-8 (continued)
Interactions of Air Quality Factors with Other VECs

VEC	Factors & Impacts	Past/Present Trends	Future Trends	Comments
Socio-economics	Development restrictions in non-attainment areas, regional health care costs	Emission controls, industrial process modifications, new source performance standards	Impacts, restrictions minimized in response to improved air quality	Air quality regulations can also spur improved production efficiencies, modernization of equipment

9.7 INDICATORS OF ENVIRONMENTAL SUSTAINABILITY FOR AIR QUALITY

National air quality standards are established by the United States Environmental Protection Agency (USEPA) under authority of the Clean Air Act of 1970 (CAA) and serve as established regulatory thresholds for environmental indicators of sustainability. Cumulative effects are explicitly recognized in the establishment of air quality standards. The CAA requires USEPA to set National Ambient Air Quality Standards (NAAQS) for pollutants considered harmful to public health and the environment. Those pollutants and their established thresholds are listed in table 9-1. The CAA establishes two types of national air quality standards: primary and secondary. Primary standards set limits to protect public health, including the health of sensitive populations such as asthmatics, children, and the elderly. Secondary standards set limits to protect public welfare, including protection against decreased visibility and damage to animals, crops, vegetation, and buildings. In addition to tracking compliance with the standards, the CAA requires that the USEPA continually evaluates the effectiveness of the standards in protecting human health and other resources. New standards, as well as revisions of existing standards, are developed and implemented to maintain these protections.

9.8 RELEVANT FUTURE ACTIONS AFFECTING AIR QUALITY

RFFAs for air quality issues were evaluated utilizing a matrix prepared during the scoping process. The matrix was an outgrowth of a similar matrix developed during the preparation of ORMSS.

Results of the RFFA evaluation for air quality issues are summarized in Table 9-9 and discussed in further detail in the text following the table.

TABLE 9-9
RFFA Cumulative Effects Matrix for the Upper Ohio River – Air Quality

RFFA[1]	Time Period[2]	Occurrence Probability[3]	Location on River[4]	Importance[5]	Effects[6]
USACE Actions					
Navigation Investments					
Replacement locks at Emsworth, Dashields, and Montgomery Dams (EDM)	1	H	S	M	+/-
Rehabilitation of EDM dams	1	H	S	M	+/-
L&D operation and maintenance	A	H	S	L	+/-
Approach & channel dredging/disposal	A	H	E	M	-
Environmental design					
environmental sustainability operation actions	A	H	S	M	+
Pool maintenance	A	H	E	M	-
Sec 107 port development and maintenance dredging	2	L	S	M	-
Actions by Others					
Navigation System Dependent - "But For"					
Commercial navigation					
barge queuing	1	M	E	H	-
fleeting areas/barge storage	1	M	E	H	-
terminals & multi-modal sites	2	L	S	M	-
barge/tow tech/"green" design	A	M	E	M	+
Energy					
hydropower on dams	2	M	S	H	+
continued operation of coal-fired power plants	A	M	S	M	-
Water-based recreation					
marina development & operation	A	M	S	M	-
commercial boating	A	H	E	M	-
personal boating	A	H	E	L	+/-
River Dependent					
Resource Extraction					
instream sand and gravel mining	A	M	E	H	-

TABLE 9-9 (continued)
RFFA Cumulative Effects Matrix for the Upper Ohio River – Air Quality

RFFA[1]	Time Period[2]	Occurrence Probability[3]	Location on River[4]	Importance[5]	Effects[6]
Actions by Others					
Riverfront/Flood Plain Development					
Downtown Pittsburgh					
Ongoing Point State Park improvements	1	H	S	L	+/-
Convention Center riverfront park	1	H	S	L	+/-
residential development /conversions	A	H	S	L	-
North Shore development	1	H	S	L	+/-
Pittsburgh South Side					
continued riverfront development	A	H	S	L	+/-
continued South Side Works development	1	H	S	L	+/-
Riverfront trails					
Pittsburgh riverfront trail system	A	H	E	L	+
Beaver County trail system	A	M	E	L	+
Brownfields redevelopment					
Neville Island	1	H	S	M	+
PL&E, McKees Rocks	2	M	S	M	+
M&B Development	2	M	S	M	+
Fab Tech & Buckeye Pipeline	1	M	S	M	+
J&L site in Aliquippa	1	M	S	M	+
Leetsdale Industrial Park	1	H	S	M	+
Bridges and Roadways					
Bridge renovations					
Ambridge/Aliquippa Bridge	1	H	S	L	+/-
Shippingport Bridge	1	H	S	L	+/-
Rochester Bridge	1	H	S	L	+/-

TABLE 9-9 (continued)
RFFA Cumulative Effects Matrix for the Upper Ohio River – Air Quality

RFFA[1]	Time Period[2]	Occurrence Probability[3]	Location on River[4]	Importance[5]	Effects[6]
Actions by Others					
Bridges and Roadways					
McKees Rocks Bridge	1	H	S	L	+/-
Birmingham Bridge	1	H	S	L	+/-
Rankin Bridge	1	H	S	L	+/-
New crossings					
Maglev	2	L	S	M	-
North Shore connector	1	H	S	M	-
Roadways					
Mon/Fayette Expressway	2	L	S	M	-
SR 28 widening/railroad relocation	1	H	S	M	-
CSX double stack upgrades (National Gateway)	1	M	S	M	+
Regulatory Environment					
Pollution prevention	A	H	E	H	+
Monitoring programs - PA/ORSANCO	A	H	E	H	+
Environmental awareness education	A	H	E	H	+
Clean Air Act standards	A	H	E	H	+
Clean Water Act standards	A	H	E	H	+
Environmental sustainability practices	A	H	E	H	+

[1] Reasonably Foreseeable Future Actions

[2] Time period in which the RFFA may occur: A = all periods; 1 = within 10 years; 2 = in 10 - 25 years; 3 = in 25 - 60 years

[3] Occurrence probability or likelihood RFFA will happen: H = high; M = medium; L = low

[4] Location or setting on river where RFFA is expected to occur: E = along entire length of river; S = specific location

[5] Importance or impact of action on the VEC: H = high; M = medium; L = low

[6] Effects of action on the VEC: + = positive effect; - = negative effect; +/- = mixed effects

Each of the RFFAs that have a high or medium importance to air quality is discussed in the following sections. RFFAs that have a low probability of occurring within the project area or that have no or minimal effect on air quality are not considered further in this cumulative effects assessment.

9.8.1 USACE Actions

9.8.1.1 Replacement Locks at EDM

Two primary classes of air emissions (PM and combustion emissions from the construction site) may be expected to occur as a result of the EDM replacement projects. Emissions from commercial tow traffic delayed by site construction activities are discussed in the "Actions by Others" section.

Construction of the lock chambers requires establishment of parking and maintenance areas for equipment, burning of cleared vegetation, a lay-down yard for materials, disposal areas for excess soil and rock, and some earthwork where portions of the new lock chamber connect with the riverbank. Potential dust problems will be controlled through a variety of standardized best management practices (BMPs) such as seeding, periodic wetting of bare surfaces, or wind screens. These practices are routinely employed as needed to minimize nuisance dust and PM emissions at USACE construction sites. Other potential sources of air pollution from construction include dust from concrete removal (sawing or blasting) and from concrete batch plants (if needed onsite). Concrete batch plants normally require a state air emissions permit.

The diesel engines that power bulldozers, crawler tractors, cranes, generators, and other equipment are the primary source of combustion air emissions at most construction sites and gasoline powered equipment accounts for the remainder. Emissions from these sources include NOx, VOC, CO, sulfur oxides (SOx), and PM. This has traditionally been an unregulated class of combustion equipment, and large projects that require substantial equipment operations can produce locally significant quantities of air pollutants.

Air emissions from a construction site are subject to state and local air quality regulations (including rights of inspection and enforcement), and contractors may be required to obtain an air emissions permit in some cases. Except for unusual cases, such permit conditions are fairly straightforward, requiring use of BMPs appropriate to the scale of operations, maintenance of equipment in good working order to minimize unnecessary emissions, and prohibition of open burning of construction wastes. In certain situations (e.g., a large project in a heavily populated area) there may be provisions for additional control or restriction of construction activities during times when pollution is a problem or during ozone alert conditions. Ozone levels are consistently higher during the construction season (i.e., April 1 to October 31).

Air quality impacts as a result of the construction of new locks and dams would be temporary and air quality conditions should return to existing levels following construction. The long-term result would improve traffic flow through the Upper Ohio Navigation System by allowing larger vessels and barge tows than are now possible to pass through at one time. Additionally, queuing times of barge tows will be reduced. Therefore, improved air quality in the area would occur as a result of improved EDM facilities.

9.8.1.2 Rehabilitation of EDM

The ongoing commercial use of the lock and dam facilities requires periodic upkeep and rehabilitation. This includes major and minor repairs of both primary locks and auxiliary locks. As existing locks age, the need for such repairs becomes more frequent. The frequency of repairs also increases in proportion to ongoing increases in the amount of commercial traffic (and resultant use of the lock chambers) on the upper Ohio River.

Each lock repair event produces the same types of air quality impacts as was described previously for lock construction projects. Construction site and equipment emissions are smaller, in proportion to the reduced scale of the repair activity. If the repairs require lock closures, emissions attributable to delayed barge traffic are proportional to the period of time that the locks are closed.

Air quality impacts as a result of the periodic maintenance and rehabilitation to the lock and dams are temporary and air quality conditions return to existing levels following rehabilitation activities.

Maintenance and repair events would also continue to be required following completion of the EDM projects. However, completion of new locks can reduce repair activities and associated air quality impacts in several ways. First, it may be feasible to schedule some lock extensions so as to eliminate an auxiliary chamber repair event. Second, each extension creates a lock in new condition, allowing for a longer time interval between the auxiliary chamber repair events. Finally, increased capacity would allow improved lockage efficiency during future repairs, thus minimizing barge queuing impacts associated with such repairs (USACE 2006).

9.8.1.3 Lock and Dam Operations, Maintenance, Approach and Channel Dredging/Disposal

Locks and dams (L/D) on the Ohio River are operated by electrical power and produce no direct air emissions. Lights, loudspeakers, and instrumentation are also generally operated by electrical power. Facilities may have back-up power facilities such as diesel powered generators on site. This type of equipment may require a state-issued basic or "source registration" permit which allows for periodic testing, emergency operation, and listing in local emission inventories. Additional air emissions result from employees driving their vehicles to the site and maintenance operations such as lawn mowing. The amount of air emissions attributable to these activities is constant for all levels of lock activity.

Dredging to maintain the 9-foot navigation channel in the upper Ohio River is a significant component of lock and dam operations. Diesel emissions from dredging operations emit the same types of pollutants (NOx, VOC, and PM) as do engines on linehaul and harbor towboats. However, these emissions account for only a small proportion of total towboat emissions. Additionally, navigation channel dredging occurs at locations remote from lock and dams and would not be expected to change with lock improvements.

9.8.1.4 Other Activities

The USACE conducts other actions with potential air quality impacts. These include the full spectrum of maintenance and repair of all components of the navigation system infrastructure other than the locks (including pool maintenance, port development, maintenance dredging, and environmental design). These ongoing activities (and their attendant air quality impacts) will occur independently of the lock maintenance or extension activities addressed by this study and are not expected to cause significant delays of towboat traffic.

The largest of these activities involves major rehabilitation of the dams (as opposed to rehabilitation of lock chambers). While the timing of rehabilitation projects is subject to numerous variables, this activity primarily corresponds to the useful life cycle of the dam. Of the 20 dams currently on the river, six have been rehabilitated in the past two decades, at an average age of 60 years following their initial construction. All three of the dams on the upper Ohio River will require rehabilitation sometime during their 60-year economic life.

Air emissions from dam rehabilitation projects will be similar to construction site and construction equipment emissions described previously for lock extension and replacement projects. The activities will be subject to the same state and local permit requirements. Air emission quantities from these projects would likely be comparable to rehabilitation or new construction of highway interchanges, office buildings, or other major projects occurring over a several month period. USEPA non-road diesel regulations apply to construction activities and require sulfur content in fuel to be reduced to 500 ppm in 2007 and to 15 ppm by 2010. These regulations would be expected to improve the overall air quality by requiring cleaner fuel be used in typical construction diesel equipment.

9.8.2 Actions by Others

9.8.2.1 Navigation System Dependent - "But for"

"But for" actions are actions that would not occur without the existence and maintenance of the lock and dam system along the river.

<u>Commercial Navigation</u>

Commercial towboats operating on the Ohio River can be classified in two general categories: large towboats that move the fleets of barges up and down the river (linehaul) and smaller harbor tows operating in the ports and major fleeting areas. Linehaul towboats are typically powered by marine diesel engines of 1,500 horsepower (hp) to 8,000 hp and maneuver tows of up to 15 barges up and down the river. Harbor towboats assemble and disassemble the barge tows within the fleeting areas, assembling individual tows according to their delivery destination. Some barge tows may be assembled and delivered to a single destination, but many contain a mix of commodities with various assembly and delivery points. The harbor towboats add or remove individual barges to these mixed tows while the linehaul towboats maintain control of the primary tow (USACE 2006).

The marine diesel engines that power these towboats emit NOx, PM, SO_2 and VOC. These emissions are treated in this study as a direct consequence of both the existing navigation system and proposed project actions because it is the existence and maintenance of the lock and dam system that makes commercial barge traffic possible on the Ohio River. This has until recently been an unregulated source, but regulations applicable to new and remanufactured engines took effect in 2004 (USACE 2006). In March 2008, the USEPA adopted new standards that will dramatically reduce emissions of diesel PM and NOx from locomotives and marine diesel engines. The final requirements will bring earlier and significantly greater emission reductions of NOx and PM from the locomotive and marine sector than the proposed program envisioned. This will be accomplished by finalizing the first-ever national standards for re-manufactured large commercial marine diesel engine above 600 kilowatts (kW) and starting Tier 4 NOx requirements for linehaul locomotives and for the largest (2000-3700 kW) marine engines two years earlier than initially proposed. These changes reflect important cooperative efforts by the locomotive marine sector to implement cleaner technology as early as possible and will provide communities across the United States with crucial emissions reductions both in the near-term and long-term.

The purpose of barge/tow tech/green designs are to provide cleaner types of facilities for river fleets and their associated land-based facilities. By their very nature, they will work toward reducing emissions further.

One of the reasons that emissions from marine diesel engines have not previously been regulated is that they were considered a relatively minor source when compared to other mobile source classifications. However, as progress has occurred in the control of emissions from other sources, the relative contribution from marine diesel engines has increased. While a very busy river port such as Pittsburgh may exhibit the highest concentrations of river towboat activity, the linear nature of river transportation means that some degree of activity will be maintained throughout the river corridor area. Additional concentrations of river towboats occur when they are forced to queue up due to lock construction, repairs, or general traffic congestion. While barge tug emissions may be insignificant in a large population center such as Pittsburgh, a similar level of emissions would have a relatively larger effect in the smaller population centers.

Barge Queuing, Fleeting Areas/Barge Storage

Queuing delays occur as a result of general traffic congestion and/or due to lock closures for repair or extension. Replacement of the 600-foot main lock chambers and the 360-foot auxiliary lock chambers with larger lock chambers at the three upper Ohio River dams will require curtailment of lockage services. Since the existing 600-foot main chambers are landward locks at these upper river sites, they would remain in service during construction of new locks riverward of the auxiliary chambers. Linehaul towboats that are delayed by such closures will emit excess pollutants in proportion to the delay times. These excess emissions may be concentrated in specific locales due to queuing in close proximity to the closed locks.

Linehaul tows that are delayed by construction closures or curtailments from the lock and dam replacements emit excess pollutants in proportion to the delay times. Air quality impacts from diesel sources directly attributable to lock extension activities would increase in proportion to delay times created by the construction activity. Following completion of the lock replacements, air quality impacts directly attributable to maintenance and repair activities would decrease in proportion to the expected reduction of repair activity. Queuing delays associated with traffic congestion also would significantly decrease following the completion of lock extensions, since the new chamber capacity would minimize the need for queuing.

Emission factors for marine diesel engines are expressed as pollutants emitted per ton of fuel burned (USACE 2006). Project documentation for construction of lock extensions at Myers and Greenup L/D included estimates of the total quantity of diesel fuel that would be burned as a result of delays during maintenance closures, under the Without Project scenario, over the 70-year span from 2000 to 2070 (USACE 2006). In these estimates, fuel consumption due to queuing at Greenup was predicted to be more than twice the amount predicted for Myers, due in part to the history of longer and more frequent maintenance closures at Greenup. Using predicted closures at Myers as the case representing a typical lock and dam on the Ohio River, total emissions due to maintenance-related queuing were calculated as a function of traffic volume for the entire Ohio River L/D system. These projected emissions for the upper Ohio River locks and dams are reported in Table 9-10.

TABLE 9-10
Total Emissions from Maintenance Delays, 2000-2070

Lock and Dam Project	1998 Tonnage	Diesel[1] Burned	NOx (tons)	PM (tons)	VOC (tons)	CO (tons)
Montgomery	26,866	2.8	686	14.4	28.8	88.8
Dashields	24,563	2.6	627	13.2	26.4	81.6
Emsworth	23,153	2.4	591	12.6	25.2	76.8
Total		7.8	1,904	40.2	80.4	247.2

[1]Diesel, millions of gallons burned during closure delays over 70-year study period

Source: USACE, 2006

In addition to the queuing emissions, air emissions from maintenance and repair construction activities would also occur. For most repairs, construction site and equipment emissions will be smaller, in proportion to the reduced scale of the repair activity compared to those of lock extensions. Major repair events to upgrade or overhaul aging lock systems would be comparable to construction emissions that would occur as a result of a lock extension. Total air emissions attributable to construction activities were calculated for proposed improvements at J.T. Myers and Greenup (USACE 2000). Because the two projects are similar in scope to the EDM projects, the estimated air emissions would likely be the same. Estimated construction emissions for one project presented in Table 9-11 are representative of the EDM projects.

Average annual air emissions attributable to routine and major repair events can be roughly estimated. If major repair events occur about once every ten years, it can be assumed that average annual emissions from the repair activity are about 10 percent of the total estimated for a 600-foot to 1,200-foot lock extension. This would result in an estimate of 9.1 tons per year of NOx emissions due to construction activities at each project on the Ohio River.

TABLE 9-11
Estimated Air Emissions from Typical 600' to 1,200' Lock Extension

Emissions in Tons (numbers rounded)				
600' Lock Extension	**VOC (tons)**	**CO (tons)**	**NOx (tons)**	**PM (tons)**
Year 1	2	12	13	1
Year 2	11	66	74	8
Year 3	1	3	3	<1
Total	**14**	**81**	**90**	**10**
Source: USACE, 2006				

Terminals & Multi-modal Sites

The activities at these sites include transfer of coal, limestone, sand and gravel, gypsum, and other bulk materials. PM emissions are the primary air pollutant from the bulk handling processes (i.e., conveyors, open stockpiles, gravel separation, and coal blending) associated with loading and unloading barges. Loading facilities are also typically a minor source of exhaust emissions because the equipment is powered by diesel engines.

Each individual barge loading/unloading facility normally operates under the requirements of a state or local air permit. Permit conditions typically include measures to minimize fugitive dust emissions; for example, through the stipulation of equipment maintenance standards, and a variety of BMPs such as wetting stock piles and conveyance points to control dusts. New USEPA regulations (EPA420-F-08-004) address diesel fuel formulations and engine performance standards, and compliance with these regulations will reduce emissions from combustion sources (USEPA 2008d). Barge loading operations located in non-attainment areas may be subject to closer monitoring or somewhat more stringent standards than would occur at loading sites in attainment areas.

The National Waterways Foundation released a study in 2008 titled *New National Study That Compares Freight Transportation by Barge, Truck and Train* that compared the cost of U.S. freight transportation modes. This study compares cargo capacity of trucks, trains, and inland river barges and concluded that one common 15 barge river tow has the same capacity as 1,050 trucks or 216 rail cars pulled by six locomotives. This study further showed that barges can move a ton of cargo 576 miles with a single gallon of fuel, while trains get 413 ton-miles per gallon, and trucks get 155 ton-miles per gallon. Therefore, inland waterway transport would generate fewer emissions of PM, CO, NOx, and hydrocarbons than rail or truck modes on a per ton-mile moved basis.

Other Commercial Navigation Actions

Regional industries with strong ties to Ohio River navigation can be classified in two broad air quality groups. The first group includes primarily PM sources such as sand and gravel mining, quarrying, and gypsum processing. The second group includes industrial operations that emit a broader spectrum of air pollutants-chemical plants, steel mills, and related sources. All of these industrial sources are required to obtain air pollution permits and must meet emission standards as specified in those permits. Permit requirements are established on the basis of CAA regulations that establish industry standards, control technology feasibility, and address the sensitivity of impacted areas. Industry standards help to establish regulation of equivalent industrial processes while the control capabilities of available technology help to define what is achievable. Industrial sources located in non-attainment areas, emitting significant quantities of a priority pollutant, or otherwise impacting a sensitive resource, may be required to meet more stringent emission control standards. New source performance standards, applicable to new or extensively renovated facilities, require use of the most advanced available controls, helping to integrate reduced air emissions into the process of industrial modernization.

Since 1971 when Pennsylvania's Air Quality program was established, all new and modified facilities with sources of pollutants were required to go through a pre-construction review process which required that best available technology (BAT) be used. Many additional state and federal regulations have been promulgated since then, resulting in lowered emissions throughout the region. Other reductions have resulted with the shutdown of sources and entire facilities due to shifts in market demand and profitability. The most significant examples of reductions and shutdowns for the facilities in the project area are detailed in Table 9-12.

TABLE 9-12
Local Facilities and Air Quality Controls

Facility	Location	Comments
Firstenergy Gen Corp/Bruce Mansfield Plant (Power)	Shippingport Boro, Beaver County	Installation of SCR for NOx control, improvements to scrubber for better SOx control
Aes Beaver Valley LLC/Beaver Valley LLC (Power)	Potter Township, Beaver County	Added SOx scrubber and low NOx burners
Horsehead Corp/Monaca Smelter	Potter Township, Beaver County	Improved PM control, low NOx burners on coal-fired boiler
Dominion Trans Inc/Beaver Station	N. Sewickley Township, Beaver County	Ignition improvements for NOx reduction
US Gypsum Co (Wallboard)	Aliquippa, Beaver County	Installed under pre-construction review; met PA BAT and federal standards

TABLE 9-12 (continued)
Local Facilities and Air Quality Controls

Facility	Location	Comments
Anchor Acquisition (Glass)	Monaca, Beaver County	Combustion controls for NOx reductions
Jewel Acquisition (Steel)	Midland Boro, Beaver County	Shut down of melting furnace
Ipsco Koppel Tubulars Corp/Koppel Plt	Koppel Boro, Beaver County	NOx and PM reductions
Nova Chemicals (Formerly Arco)	Potter Township, Beaver County	Reformulations and installation of thermal oxidizer for VOC reductions
Arrow Terminals (Bulk Terminal)	Industry Boro, Beaver County	Enclosure with PM controls for truck loading/unloading
J & L Steel	Aliquippa, Beaver County	Shut down of entire steel mill
Armstrong World Inc. (Ceiling Tiles)	Beaver Falls, Beaver County	Reformulation of paints for VOC reductions
Centria (Printing)	Ambridge Boro, Beaver County	Reformulations and installation of thermal oxidizer for VOC reductions
Tegrant (Expanded Polystyrene)	New Brighton Boro, Beaver County	Reformulations of raw materials for VOC reductions
National Gypsum Co. (Wallboard)	Shippingport Boro, Beaver County	Installed under pre-construction review; met PA BAT and federal standards
Basf Corp (Chemicals)	Potter Township, Beaver County	Reformulations and installation of thermal oxidizer for VOC reductions
SCR = Selective Catalytic Reduction (NOx Control Technology); BAT = Best Available		
Source: PADEP, 2009		

Hydropower on Dams

The option of hydropower use is considered on all facilities on the upper Ohio River. It would be expected that the use of hydropower to generate electricity would reduce output from coal-fired power plants and therefore result in cleaner air because of fewer emissions.

Continued Operation of Coal-fired Power Plants

Abundant coal reserves in states bordering the Ohio River are one of the primary cornerstones of past economic development in the region and provide the overwhelming majority of fuel for electric generating capacity in three project area states today. In 2006,

approximately 94 percent of the coal consumed in Pennsylvania, West Virginia, and Ohio was used to generate electric (U.S. Energy Information Administration 2008). Development of affordable, reliable coal transport was one of the primary motivations for initial and subsequent development of Ohio River navigation improvements. Coal accounted for approximately 53 percent of all commodities shipped on the Ohio River in 2007 (USACE 2007).

Coal-fired power plants, in conjunction with the high sulfur content of much of the region's coal, are the number one air pollution source in the region for SO_2, NOx, and PM. Since 1980, the three states bordering the upper Ohio River have ranked high nationally for sources of SO_2 from coal-fired utilities. NOx emissions from these sources contribute to local concentrations of O_3, NOx, and SO_2, the key contributors to acid rain impacts throughout the midwest and northeast and into southeastern Canada. SO_2 is a primary contributor to regional haze/visibility and fine particulate impacts (USACE 2006).

There are two coal-fired power plants along the upper Ohio River. The Bruce Mansfield Power Station in Shippingport Borough, Beaver County, is Pennsylvania's largest electrical generator, capable of producing 2,741 megawatts of electricity. The AES Beaver Valley LLC Power Plant in Potter Township, Beaver County, is a coal-fired independent power producer, supplying up to 125,000 lb/hour of steam to the adjacent NOVA Chemical facility and up to 125 megawatts of electricity to West Penn Power. Both of these facilities employ NOx controls and a scrubbing process that removes SO_2 from stack gases.

Water-based Recreation

Water-based recreation activities, including marina development, marina operation, and commercial boating (sightseeing, water taxis), will have negative impacts on air quality, but they will be limited in scope. Personal motor-boating activities are held from approximately April through September, but commercial boating can extend into November or December, depending on overall weather conditions. Additionally, they are limited to a few hours per day. Air emissions from smaller craft dissipate quickly, although higher concentrations can be found around marinas.

9.8.2.2 River Dependent

Commercial extraction of sand and gravel currently occurs in portions of the Ohio River with the exception of the Emsworth Pool. In general, elevated levels of CO and PM usually relate to localized conditions such as congested traffic intersections, large construction projects, or large point sources. With respect to dredging operations, the primary source of combustion-type emissions (CO, NOx, SO_2, and PM) are marine vessels, large diesel equipment used on dredges, and transportation vehicles. Dredging activities will generate short-term temporary impacts to air quality in the vicinity of the operations. Four primary factors contribute to carbon emissions from marine vessels, transportation vehicles, and equipment: (1) amount of fuel used; (2) type of fuel used; (3) engine condition and maintenance; and (4) number of vehicle miles traveled. Reducing diesel engine idling time will minimize combustion-type emissions. A diesel truck engine typically uses

approximately one gallon of fuel to idle for one hour. Utilizing properly operating and late model vehicles and low-sulfur fuel that burns cleaner will also reduce air pollution emissions.

9.8.2.3 Riverfront/Floodplain Development

Riverfront development planned in the project area includes the restoration of Point State Park, construction of a network of trails and parks along the three rivers, and the conversion of brownfields to park or retail land uses. For the most part, these developments will have a neutral or positive effect on air quality by creating additional greenspace and by improving riparian resources along the riverfront.

9.8.2.4 Bridges and Roadways

Bridge renovations and replacements are expected to occur along the river corridor as warranted. Although these projects although will have some short-term air quality impacts from construction activities and temporary traffic delays, they also would be expected to improve air quality when complete because of improved traffic flow.

New river crossings and roadways would bring air emissions from transportation sources to a new area along or near the river corridor and thus be expected to degrade the air quality in the immediate vicinity of these transportation facilities. However, transportation facilities such as these will be assessed in system-level planning as part of the air quality State Improvement Plan development and conformity process. Through the Transportation Improvement Program (TIP)/SIP evaluation process, NOx, VOC, and O_3 are evaluated on a regional level.

The implementation of the CSX double stack upgrades to the systems of tracks, tunnels, and rail cars would have short-term air quality impact from construction activities, but the long-term impact would be positive because they would remove truck traffic from the highways and move more freight with the same train trip.

9.8.2.5 Regulatory Environment

USEPA and the states are currently implementing major initiatives to reduce NOx emissions from heavy-duty diesel vehicles, coal-fired power plants, and other industrial sources. USEPA expects air quality to continue to improve as recent regulations are fully implemented and states work to meet national standards. Among these regulations are: the Locomotive Engines and Marine Compression – Ignition Engines Rule, the Tier II Vehicle and Gasoline Sulfur Rule, the Heavy-Duty Highway Diesel Rule, the Clean Air Non-road Diesel Rule, and the Mobile Source Air Toxics Rule. The vehicle initiatives will have nationwide impacts through reduction of emissions from highway trucks and buses, diesel locomotives, construction equipment, commercial marine engines, and other classifications of diesel combustion sources. In addition to the acid rain program, which establishes national NOx emission standards, three regional programs are in effect that will further reduce NOx emissions from power plants and other industrial sources in the midwest and northeast. In this region, NOx and VOC are the principal contributors for local ozone

problems, NOx and SO_2 are principal contributors for acid rain, and NOx is an additional contributor to the formation of $PM_{2.5}$.

The Diesel Emissions Reduction Act (DERA) establishes a voluntary national and state-level grant and loan program to reduce emissions from existing diesel engines through clean diesel retrofits. This program is intended to build on the success of USEPA's Clean School Bus USA program and its Clean Diesel Initiative. The USEPA estimates that, if DERA is fully funded, it would reduce particulate matter emissions by 70,000 tons.

Under DERA, the USEPA and the states provide grant money to projects that improve air quality by reducing diesel emissions from trucks and buses and equipment. The money is allocated on a competitive basis to projects that provide the greatest emissions reductions in areas that have the worst air quality. Funding can be used to retrofit trucks with emissions controls such as diesel particulate filters or selective catalytic reduction to reduce nitrogen oxide emissions. It can also be used for idling reduction technology. Reducing emissions from diesel engines is one of the most important air quality challenges facing the country today. The American Recovery and Reinvestment Act of 2009 included $300 million to support clean diesel initiatives.

Regulation of utility emissions under national and regional cap and trade allowance programs is reducing present emissions and will impose a ceiling on any future increases. These programs are intended to establish a sustainable balance – enough emissions to allow sustained viability of the coal electric industry, trading of emission allowances to promote cost-effective control of emissions, and enough reductions to allow recovery of impacted populations and resources (USACE 2006).

In 2003, USEPA began to administer the NO_x Budget Trading Program under the NO_x SIP Call. The NO_x Budget Trading Program is a market-based cap and trade program created to reduce emissions of NO_x from power plants and other large combustion sources in the eastern United States. NOx is a prime ingredient in the formation of ground-level ozone (smog), a pervasive air pollution problem in many areas of the eastern United States. The NO_x Budget Trading Program was designed to reduce NO_x emissions during the warm summer months, referred to as the ozone season, when ground-level ozone concentrations are highest.

While emissions from coal-fired utilities can be expected to decline and stabilize during the early years of the study period, the cap and trade regulations may contribute to a number of changes in the transport of coal. For the short term at least, net tonnage of coal transport on the upper Ohio River has declined between 1998-2007 (-18 percent) and appears to have leveled (USACE 2007). Virtually all expansion of electric utility capacity since 1996 has come from natural gas and no plans for expansion of coal facilities during the next several years have been formally recorded. There is some expert agreement that expansion of coal capacity, when it eventually occurs, will be centered on existing coal-fired plants. These plants already occupy the best sites and would likely face less complicated permitting than would new sites.

There has been a significant increase in quantities of low sulfur western coal being shipped up the Ohio River, compensating for decreases of higher sulfur coal from mines in the area. On a smaller scale, installation of SO_2 scrubber technology is contributing to shipments of limestone to the plants and gypsum (a marketable by-product of desulphurization) from the plants (USACE 2006). The AES Beaver Valley power plant has incorporated a second generation scrubber system to maintain outstanding SO_2 removal rates, but removes the clean-liquor scrubbing solution to remote vessels before solids are generated. An additional chemical reaction (oxidation) creates two salable by-products, gypsum (calcium sulfate), which is used in the cement industry, and magnesium hydroxide, which is used in water treatment applications. Finally, the long-term relationship between coal consumption and energy production could fluctuate up or down. Western coal tends to have lower energy content, requiring more coal per unit of electricity produced. Advances in coal combustion technology could result in a decrease in use of western coal and an increase in use of coal from the local area over the long term.

Substantial progress has already been made in the control of VOCs, but future gains will be more difficult to achieve. However, new VOC standards are being implemented for recreational boats and other classifications of gasoline combustion engines.

In general, $PM_{2.5}$ is primarily composed of sulfates, nitrates, ammonium, organic carbon, and, to a lesser degree, elemental carbon and crustal material. For the upper Ohio River region, sulfates are the primary precursor to the formation of $PM_{2.5}$, accounting for approximately one-third of particulate composition at monitoring stations in western PA. Decreases in SO_2 since the CAAA are highly variable from year to year and are based on climatic patterns, especially the amount, distribution, and timing of precipitation. However SO_2 emissions for the tri-state project area in 2006 were at the lowest level since monitoring began. The use of low sulfur coal and the installation of SO_2 scrubber technology are contributing to lower SO_2 concentrations. Fifty percent of the decrease in SO_2 emissions from integrated carbon steel production since 1998 is attributed to the closing of the Hazelwood LTV Coke Works. NOx is an important secondary precursor. Nitrate concentrations have declined continuously since 1996 during the post-CAAA period. The trend is not as variable as it is for sulfate concentrations. The acid rain program, regional NO_x SIP Call programs, and NOx vehicle initiatives are the primary activities that will contribute to reduced $PM_{2.5}$ emissions in the project area.

National initiatives to control emissions of NOx, VOC, $PM_{2.5}$, and sulfates from SO_2 will reinforce the local and regional programs of the non-attainment areas. Additionally, state and national programs provide a broad spectrum of assistance in the form of training, equipment grant/loans, shared data and information, and approaches to implementing new programs (USACE 2006).

Within the states in the project area, it seems likely that coal will continue to be the primary source of electric power generation. In 2006, approximately 94 percent of the coal consumed in Pennsylvania, West Virginia, and Ohio was used to generate electric (U.S. Energy Information Administration 2008). The region possesses massive supplies of coal; no alternative power source shows any indication of supplying a significant share of the net

load; and the developed infrastructure of mines, coal transport, power plants, and transmission system constitutes one of the most cost efficient power production systems in the nation. The cap and trade system of controlling emissions allows room for significant growth with existing control technology and incentives to achieve additional growth through plant renovation and modernization.

Setting the stage for the first federal regulation of gases blamed for global warming, the USEPA, on April 17, 2009, said it was ready to use the Clean Air Act to require power plants, cars, and trucks to curtail their release of climate-changing pollution, especially carbon dioxide (CO) from the burning of fossil fuels. The decision would allow the USEPA to regulate carbon dioxide emissions under existing pollution laws without the passage of new legislation. In addition to CO, the USEPA finding covers five other emissions that scientists believe are warming the earth when they concentrate in the atmosphere: methane (CH4), nitrous oxide (N2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF6). USEPA cautioned that regulations are not imminent and the current administration would prefer that Congress address the climate issue through a broader cap-and-trade program that would limit heat-trapping pollution.

The Energy and Commerce Committee is holding legislative hearings on the discussion draft of The American Clean Energy and Security Act of 2009. The bill calls for a reduction of carbon dioxide and other greenhouse gases by 20 percent from 2005 levels by 2020, and 83 percent by mid-century. It also would require utilities to produce a quarter of their electricity from renewable sources by 2025.

Therefore, future regulation of greenhouse gasses, including CO, will be likely in the next decade and would further result in cleaner emissions and cleaner air in the future.

9.9 ANALYSIS OF ENVIRONMENTAL SUSTAINABILITY

National air quality standards have been established by the USEPA under authority of the CAA. For this CEA, those standards are being used as indicators of environmental sustainability for air quality. Environmental sustainability balances environmental and economic considerations through the life cycle of project planning, design, construction, operation, and maintenance to improve the quality of life for present and future generations. Accordingly, it represents an ultimate test of significance of potential cumulative effects.

Cumulative effects are explicitly recognized in the establishment of air quality standards for pollutants considered harmful to public health and the environment. Primary standards found in the CAA set limits to protect public health, including the health of sensitive populations such as asthmatics, children, and the elderly. Secondary standards set limits to protect public welfare, including protection against decreased visibility and damage to animals, crops, vegetation, and buildings. In the Pittsburgh area, conditions sustaining air quality are mixed, with both positive and negative forces affecting air quality.

9.9.1 Positive Forces Affecting Air Quality

Air quality monitoring is currently conducted at several locations in the Pittsburgh area. The Allegheny County Health Department operates a 24-hour monitoring station network throughout Allegheny County to collect air quality data on particulates (dust and smoke), O_3, SO_x, NO_x, CO, and lead, as well as other special chemicals (such as benzene) and weather data. The ACHD reports that emissions of all criteria pollutants from point sources in Allegheny County declined from 1996 to 2006. Local trends indicate that there would not be significant cumulative air quality concerns, and future air quality would be expected to improve from decreased point source emissions.

The passage of the American Clean Energy and Security Act of 2009, calling for a reduction of carbon dioxide and other greenhouse gases by 20 percent from 2005 levels by 2020 and 83 percent by mid-century, would further result in cleaner emissions and cleaner air in the future.

Additionally, USEPA is addressing emissions from marine engines in two ways, through their fuels and through their emission limits. In May 2004, as part of the *Clean Air Nonroad Diesel Rule*, USEPA finalized new requirements for non-road diesel fuel that will decrease the allowable levels of sulfur in fuel used in marine vessels by 99 percent. These fuel improvements, began to take effect in 2007, and are expected to create immediate and significant environmental and public health benefits by reducing PM from new and existing engines. In March 2008, USEPA finalized a three part program that will dramatically reduce emissions from marine diesel engines below 30 liters per cylinder displacement. These include marine propulsion engines used on vessels from recreational and small fishing boats to towboats, tugboats, and Great Lake freighters, and marine auxiliary engines ranging from small generator sets to large generator sets on ocean-going vessels. The rule is expected to cut PM emission from these engines by as much as 90 percent and NOx emissions by as much as 80 percent when fully implemented.

9.9.2 Negative Forces Affecting Air Quality

Although existing and future regulations under the CAA will reduce the emissions from existing coal-fired power plants, their continued operation will continue to have a negative effect on the air quality of the region. Fuels used in automobile and diesel vehicles are expected to run cleaner and emit fewer emissions but will remain a major source of air pollution. As older cars and trucks leave the vehicle mix and are replaced by more fuel-efficient vehicles with advanced pollution controls, the level of emissions will be reduced but again will remain a major source of air pollution.

Temporary air quality impacts from diesel sources directly attributable to lock extension activities would increase in proportion to delay times created by the construction activity. However, overall air quality conditions will improve following construction.

9.9.3 Incremental Impacts on EDM

No significant air quality concerns have been identified as a result of the project. This conclusion is based upon a combination of considerations related to: (1) the small contributions of the waterway navigation system to annual emission inventories in the study area when compared with industry and transportation emissions, and (2) the existence of the CAA and its comprehensive requirements for air pollutant source control measures, pollutant caps, and the attainment of ambient air quality standards. Further, additional reductions in NO_x emissions from marine diesel engines are anticipated by the USEPA. Accordingly, no unique mitigation requirements are envisioned for the waterway navigation system other than conventional practices and BMPs used to reduce pollutant emissions during construction. Finally, improvements to the navigation system will reduce barge queuing and associated incremental emissions.

Air quality impacts directly attributable to maintenance and repair activities would decrease in proportion to the expected reduction of repair activities. Queuing delays associated with traffic congestion also would significantly decrease following the completion of larger lock replacements, since the new chamber capacity would minimize the need for queuing, and reduce the excess emissions that can become concentrated due to prolonged queuing in close proximity to the locks.

If total energy demand does not increase, hydropower generating plants could reduce some of the emissions currently emitted from coal-fired power plants. Hydropower facilities would provide a cleaner source of electricity and result in cleaner air. If demand increased, emissions would rise, but emissions from a new hydropower plant would be less than from a new or existing coal-fired plant.

The positive and negative impacts discussed above will have little or no incremental impacts on the EDM project itself. However, the EDM project will likely improve air quality because of improved boat and barge traffic flow through the area and the potential to remove some truck or rail freight from the overall transportation system.

9.10 DETERMINATION OF SUSTAINABILITY

Three definitions of environmental sustainability were used in the analysis of environmental sustainability:

- Not sustainable – conditions for the selected indicators do not reflect conditions that would facilitate attainment of acceptable standards or would not maintain existing standards in concert with collective impacts of proposed activities.

- Marginally sustainable – conditions for selected indicators are such that attainment of acceptable living conditions and quality of life is accomplished for the majority, but not all, of the potentially affected populations. However, the conditions are somewhat tenuous both in location and likelihood of occurrences.

(In other words, the conditions are borderline for environmental sustainability, and there are uncertainties regarding specific quantitative measures.)

- Sustainable – conditions for selected indicators are such that attainment of acceptable living conditions and quality of life is accomplished for essentially all of the potentially affected populations in the project area, and such standards are maintained in concert with foreseeable future activity. Further, conditions do not exceed regulatory thresholds, and various governmental programs are in place to respond to any potential erosion of ambient air quality.

Numerous sources of NO_x, CO, SO_2, PM, and VOC emissions exist within the study area. The sources are associated with direct actions of the USACE (e.g., construction of lock chamber extensions; lock maintenance, repair, and rehabilitation; operation of the system; and dam rehabilitation); direct actions by others (e.g., commercial navigation activities; barge traffic waiting to pass through locks; and barge loading/unloading and other intermodal operations); and indirect actions by others (e.g., industrial plants, coal utilities, urban and rural transportation, and commercial sand and gravel operations).

Air quality management programs were initiated in 1970 with the passage of the CAA. Numerous amendments have occurred since then, thus leading to the current comprehensive program coordinated by USEPA and administered by state agencies in the three states located along the upper Ohio River. The current program includes ambient air quality standards, emission standards for stationary sources, emission standards for mobile sources (cars, trucks, etc.), allowance trading for SO_x emissions from power plants, monitoring requirements, and many other features. The current program and the anticipated more stringent requirements in the near-term for related pollutant emission actions in the study area indicate that air quality is subject to numerous controls and regulatory measures focused on reducing undesirable effects on human health.

The federally mandated NO_x Budget Trading Program is intended to significantly reduce NO_x emissions from large fossil-fuel combustion sources and mitigate interstate transport of NO_x and ground-level ozone. Affected states adopt the USEPA's NO_x Budget Trading Program through a revision of their State Implementation Plan, as a result of federal rule 40 CFR Part 96, commonly known as the NO_x SIP Call. The NO_x SIP Call required 19 states, including the three project area states, and the District of Columbia to submit revisions to their respective air quality SIP. The affected states' SIP revisions demonstrate NO_x emission reductions from power plants and large industrial boilers, and contain provisions for affected sources to participate in the federal NOx Budget Trading Program.

As of October, 2008, the air quality status in the project area designates the Pittsburgh-Beaver Valley area in Pennsylvania as being in non-attainment for ozone (based on the new 8-hour standard) in the project area. All of the other counties in Ohio and West Virginia are in compliance with the standards. Three counties, one in each of the project area states, are designated as being in maintenance non-attainment for SO_2. Ten counties in the three states are designated as being in non-attainment for $PM_{2.5}$ and five portions of Allegheny County, PA (Liberty, Lincoln, Port Vue, and Glassport boroughs and the City of

Clairton) are designated as being in maintenance non-attainment for $PM_{10.}$ All counties in the project area are in attainment for CO, NO_2, and lead.

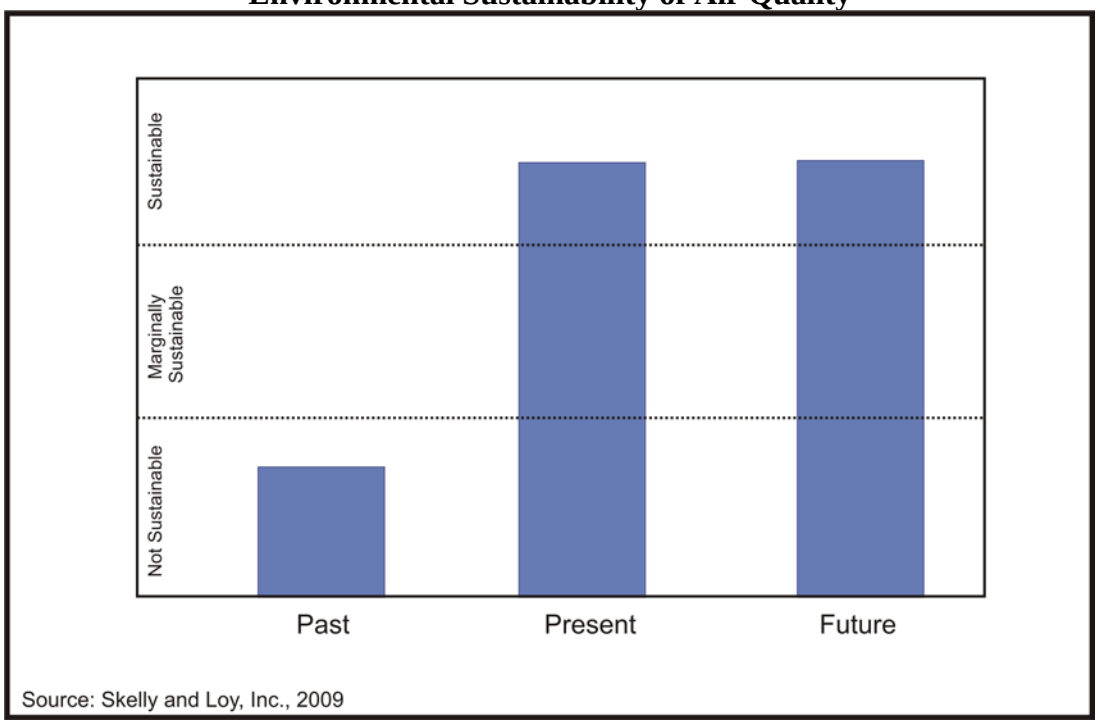
Because the cumulative air quality effects are not significant, no special modifications or mitigation measures would be required under either the "With Project scenario" or the "Without Project scenario". This is based on the valid assumption that environmentally responsible practices would be used to reduce the NO_x, CO, VOC, and PM emissions during various construction, maintenance, repair, and rehabilitation activities. Further, because an extensive air quality monitoring network already exists in the study area, no special monitoring for cumulative air quality effects will be required. Thus, air quality for the project area can be characterized and is depicted in Figure 9-5 as follows:

- In the time period prior to 1920, and continuing up to about 1970, the air quality of the Upper Ohio River project area was in a degraded state and thus classified as not sustainable due to largely untreated and uncontrolled point and nonpoint pollutant discharges from coal-fired power plants, other types of industries, and vehicular sources.

- Due the requirements of the CAA of 1970 and subsequent amendments in 1990, the air quality in the region has shown a steady improvement in recent decades and is currently sustainable.

- In the future, it is expected that air quality in the project area will further improve as a result of the continuation of source control and other pollution reduction programs; thus, it will be maintained in a sustainable condition.

FIGURE 9-5
Environmental Sustainability of Air Quality



Source: Skelly and Loy, Inc., 2009

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Chapter 10

HEALTH AND SAFETY

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Supplement 10-A: Example Maps and Records from Site Database Search

10.1 DEFINITION

In the context of this CEA, health is defined from a public or community aspect, not a clinical one. In part, health prolongs life and promotes efficiency through organized community effort for the sanitation of the environment and control of communicable infections (Winslow 1920). Similarly, safety is defined as the condition of being safe or free from danger, risk, and injury.

Health and safety are related to human communities rather than resources and ecosystems. Health and safety concerns are related to issues of worker health and safety, general population health, and recreational boater safety. The types of workers include construction workers, workers related to lock and dam operation, and workers in the navigation industry (e.g., assemblage/disassemblage of barges, operation of tows and helper boats, and barge loading/unloading). Primary concerns relate to the possible effects of work-related accidents.

General population health refers to chemical or bacteriological exposures to the population using the upper Ohio River as a water supply, or during body contact recreation (e.g., swimming and/or water skiing). Exposures can occur from barge transportation spills, releases of contaminants from hazardous waste sites or sediments in the river, from point discharges, nonpoint sources, and ruptures of pipelines crossing the river. Exposures can occur from ingestion of river water prior to or following treatment, from ingestion of contaminated fish or aquatic species, and from dermal exposure to the water.

Recreational boater safety refers to accidents experienced by those persons engaged in recreational boating.

10.2 OBJECTIVES/SCOPE

10.2.1 Objectives

This chapter assesses the systemwide cumulative health and safety impacts of proposed improvements for the Emsworth, Dashields, and Montgomery locks and dams (EDM). Health and safety impacts that are directly or indirectly attributable to modernization of the navigation system are evaluated in concert with impacts from other past, present, and reasonably foreseeable future actions (RFFAs) by the United States Army Corps of Engineers (USACE) and others.

10.2.2 Geographic Scope

The geographic scope is tailored to each valued environmental component. Health and safety impacts include those areas most directly affected by operation and maintenance of the navigation system. Other potential health and safety impacts occur during construction site activities at the locks and dams; boating accidents, spills, and operational practices associated with commercial navigation; other boating accidents; and spills or related impacts from other sources.

The geographic scope includes that portion of the Upper Ohio Navigation System that is most directly affected by the existing and possible future modifications to the system. This includes the Allegheny and Monongahela tributaries of the Ohio River to the first upstream dam on each river. The downstream geographic limit is defined as the New Cumberland Lock and Dam. The geographic scope includes the Emsworth, Dashields, Montgomery, and New Cumberland pools. Also included are the floodplains and adjacent areas along either bank of the four pools. This floodplain zone is defined as the meander channel of the upper Ohio River and includes the 100- and 500-year floodplains as well as terraces of level land lying above these floodplains. Floodplain lands are considered in this assessment because they encompass facilities that process, transfer, or store oils and fuels; industrial facilities that use other toxic or hazardous materials; construction sites such as bridges or riverfront developments; contaminated sites that may leach pollutants; other municipal and industrial point sources; and contaminated surface runoff. To account for such sources, the geographic focus for health and safety impacts is defined as the river surface plus the land surface for one mile from either bank. Point and nonpoint sources such as combined sewer system

overflows (CSO) or stormwater runoff that do not fit this geographic scope are also recognized.

10.2.3 Time Frame

The established time frame for this assessment is 1885 to 2070. The earlier date is when initial lock and dam construction on the Ohio River began. Thus, it approximates the beginning of the modern lock and dam system. The latter date approximates the economic life of anticipated improvements on the Ohio River and is considered the planning horizon for the project.

10.3 ISSUES FROM SCOPING

Scoping has occurred both as part of the Ohio River Mainstem Study (ORMSS) and for the Upper Ohio Navigation Study. A series of 12 public scoping meetings was held for ORMSS during the summer of 2001. Subsequently, a series of three public scoping meetings was held for the Upper Ohio Navigation Study in October 2006. In addition, an interagency working group (IWG) provided comments in January 2009.

Several comments related to health and safety were made during the meetings. Comments associated with health and safety are shown in Table 10-1. Some data from ORMSS have been aggregated in the table. As a result, they may have been interpreted differently here and do not tie directly into individual comments found in ORMSS.

TABLE 10-1
Comments on Health and Safety from Public Scoping Meetings

Comment	Number of Similar Comments	Scoping Meeting
Failure of barges to stay in designated shipping lanes	2	ORMSS
Increased spills and accidents potentially affecting aquatic life and impairing water quality	1	ORMSS
Safety concerns related to uneven arrangement of barges on towboats	1	ORMSS
Challenges to water quality presented by CSOs and SSOs	3	ORMSS, IWG
High levels of mercury, arsenic, fecal coliform bacteria, and agri-chemicals in surface water	1	ORMSS
Importance of continued water quality improvements as a high priority	2	ORMSS, IWG
Need to protect public groundwater supplies	1	ORMSS
Impaired water quality and bioaccumulation in fish tissue of harmful substances stirred up by dredging	2	ORMSS

TABLE 10-1 (continued)
Comments on Health and Safety from Public Scoping Meetings

Comment	Number of Similar Comments	Scoping Meeting
Health and safety concerns related to increased traffic and development	4	ORMSS, Upper Ohio River Nav. Study
Danger to recreational users of submerged trees toppled by bank erosion	1	ORMSS
Clarification of USACE responsibilities and other agencies in promoting safe boating	1	Upper Ohio River Nav. Study
Role of alcohol in causing boating accidents	1	Upper Ohio River Nav. Study
River sediment quality	1	IWG
Other Comments with Implications for Health and Safety		
Cumulative effect of discharges on river may offset water quality improvements	4	ORMSS
Instream sedimentation forming bars and causing vessel groundings	1	ORMSS
Need for examination of those licensed to operate recreational craft	1	ORMSS
Concern about ancillary movement of goods and services in emergencies, e.g., bridge destruction	1	ORMSS
Importance of coordination between USACE and Ohio River public water suppliers	1	ORMSS
Clarification of responsible parties in aftermath of accident where rail cars with ethanol derailed into the Beaver River	1	Upper Ohio River Nav. Study

10.4 LAWS, REGULATIONS, ORDINANCES, AND PROGRAMS

Spill response refers to emergency response activities to barge/tow spills or accidental discharges, or to industrial plant spills or accidental discharges, into the Ohio River or its tributaries. The Ohio River Valley Sanitation Commission (ORSANCO) has a spill monitoring system in place. The three states within the project area and related federal agencies with pertinent responsibilities have contingency plans in place to respond to spills or accidental discharges. Section 301 of the Clean Water Act (CWA) requires many industrial facilities to develop and maintain plans for preventing and responding to spills of oil and hazardous substances, such plans are called Spill Prevention Control and Countermeasure (SPCC) Plans (USEPA 2009a).

Boating safety regulations refer to legislation and rules related to the operation of recreational watercraft, including personal watercraft, on the Allegheny, Monongahela and Ohio rivers. Such regulations are issued by the three states in the project area and by the recreational boating safety program of the United States Department of Transportation

(USDOT) and United States Coast Guard (USCG). Federal funding authorized by the Transportation Equity Act for the 21st Century is used in conjunction with state revenues to support both educational and enforcement efforts. Marine Safety Offices of the USCG are responsible for: homeland defense activities, port safety and security, commercial vessel inspection, pollution response, waterways management, and marine casualty investigation.

ORSANCO monitors water quality and aquatic ecology in the Ohio River and portions of the Allegheny and Monongahela rivers. River water quality monitoring for selected parameters is conducted at identified monitoring stations and fish monitoring is conducted *via* several research programs. ORSANCO also serves as a repository for information on the quality of river water used for public water supplies. Monitoring data support health advisories regarding water contact recreational activity.

Table 10-2 lists federal, state, and local regulations and established programs that directly or indirectly influence health and safety in the upper Ohio River area.

TABLE 10-2
Laws, Regulations, Ordinance, and Programs Relevant to Health and Safety

Law/Program (Lead Agency)	Key Components	Relevance to Health and Safety
USACE Permitting Statutes (U.S. Army Corps of Engineers)	• Section 10 of the Rivers and Harbors Act (1899) relates to permits for physical obstructions to navigable U.S. waters. • Section 404 of CWA authorizes the USACE to issue permits for the discharge of dredged and fill materials into waters of the U.S.	Includes safeguards for public health and safety
Recreational boating safety regulations and programs (U.S. Coast Guard, U.S. Dept. of Transportation, and state agencies)	• Provides boater safety education and training • Establishes procedures for accident reporting	Enhances safety and enjoyment of recreational boat users on the Allegheny, Monongahela and Ohio rivers
Federal Motor Boat Act of 1940 (U.S. Coast Guard, U.S. Dept. of Transportation, and state agencies)	• Specified that certain types of safety equipment and standards were on non-steam powered vessels	Contributed significantly to growing list of safety standards for “non-inspected” recreation and commercial boats
Federal Boat Safety Act of 1971 (U.S. Coast Guard, U.S. Dept. of Transportation, and state agencies)	• Includes manufacturing standards for boats, improved boater education, and better coordination with state governments • Implements a national coordinated safety program	Improves boating safety by encouraging and assisting state governments, boating industry, and boating public

TABLE 10-2 (continued)
Laws, Regulations, Ordinance, and Programs Relevant to Health and Safety

Law/Program (Lead Agency)	Key Components	Relevance to Health and Safety
National Environmental Policy Act (NEPA) (Council on Environmental Quality and other federal agencies)	• Requires preparation of environmental impact assessments for new construction projects by private and governmental agencies • Includes federal government's responsibility to prevent environmental degradation that could become a threat to public health or safety	Provides basic national charter for environmental protection, including efforts that promote human health and welfare
Emergency Planning and Community Right-to Know Act (U.S. Environmental Protection Agency and state and local emergency response agencies)	• Requires emergency planning and preparedness at state and local levels • Section 304 establishes spill reporting requirements for facilities that release extremely hazardous substances • Section 312 requires certain facilities to file annual toxic chemical release forms.	Provides emergency planning and provides citizens, local governments, and local response authorities with information on potential hazards in their community
Pollution Prevention Act (U.S. Environmental Protection Agency)	• Establishes the policy of pollution prevention, reduction, and recycling in an environmentally safe manner whenever feasible • Requires facilities filing annual toxic chemical release forms to also file a toxic source reduction and recycling report	Protects public safety by requiring pollution reduction or recycling of hazardous substances, toxic chemicals, and toxic and radiological wastes at their sources
Resource Conservation and Recovery Act (U.S. Environmental Protection Agency)	• Addresses the increasing problems with growing volume of municipal and industrial waste • Amended the Solid Waste Disposal Act of 1965	Lists sites where reportable spills of oil or hazardous materials have occurred
Safe Drinking Water Act (U.S. Environmental Protection Agency)	• Provides for establishment of primary regulations for the protection of public health and secondary regulations related to taste, odor, and appearance of drinking water	Helps protect public water supplies for approximately three million people who use the Allegheny, Monongahela, and Ohio rivers as their source of drinking water
Oil Pollution Act (U.S. Environmental Protection Agency and U.S. Coast Guard)	• Strengthens governmental ability to prevent and respond to catastrophic oil spills • Requires oil storage facilities and vessels to submit plans detailing how they will respond to large discharges	Protects drinking water supplies and natural resources from pollution and damage from oil spills

TABLE 10-2 (continued)
Laws, Regulations, Ordinance, and Programs Relevant to Health and Safety

Law/Program (Lead Agency)	Key Components	Relevance to Health and Safety
Site Remediation Statutes (U.S. Environmental Protection Agency and state regulatory agencies)	• Include the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), Superfund Amendments and Reauthorization Act (SARA), Resource Conservation and Recovery Act (RCRA) and related state programs that focus on cleanup and restoration of contaminated sites	Protect human health and the environment and eliminates or reduces the generation of hazardous wastes
Toxic Substances Control Act (U.S. Environmental Protection Agency and state regulatory agencies)	• Designed to establish a system by which all chemicals are evaluated before use to ensure they pose no unnecessary risk to human health, other living organisms, or the environment • Intended to mitigate the hazards of other chemicals already in use	Tries to balance benefits and risks of chemicals in use to ensure human and environmental safety
Clean Air Act (U.S. Environmental Protection Agency)	• Establishes national ambient air quality standards	Protects public health by establishing standards and safeguards
Clean Water Act (CWA) (U.S. Environmental Protection Agency)	• Establishes structure for regulating pollution discharges into U.S. waters (NPDES permits) • Requires establishment of water quality standards • Section 301 requires many industrial facilities to develop and maintain plans for preventing and responding to spills of oil and hazardous substances, called Spill Prevention Control and Countermeasure Plans.	Provides a comprehensive framework for water quality protection that includes protecting public health and safety, as well as natural resources
TMDL Program (U.S. Environmental Protection Agency)	• Increasingly important part of the Clean Water Act; regulates maximum pollutant load a water body can receive and still attain water quality standards	Helps protect public water supplies for approximately three million people who use the Allegheny, Monongahela and Ohio rivers as their source of drinking water
Phase 1 & 2 NPDES Program (U.S. Environmental Protection Agency)	• Also within the CWA, requires municipalities and certain industrial and construction sites to develop programs to control point sources of pollution	Reduce pollution characteristics of stormwater discharges from urban and industrial zones along area rivers

TABLE 10-2 (continued)
Laws, Regulations, Ordinance, and Programs Relevant to Health and Safety

Law/Program (Lead Agency)	Key Components	Relevance to Health and Safety
National CSO Control Policy (U.S. Environmental Protection Agency)	• Calls for communities to implement long-term plan for combined sewer overflows to comply with the CWA • Administered through each state's NPDES permit program	Should reduce pollution from a major urban source, including pathogens harmful to public health
Intermodal Surface Transportation Efficiency Act of 1991; Transportation Equity Act for the 21st Century; and Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (Federal Highway Administration)	• Authorizes the Federal surface transportation programs for highways, highway safety, and transit	Although the principal highway and transit funding program, can be used in conjunction with state revenues to support both educational and enforcement efforts
Occupational Safety and Health Act (National Institute for Occupational Safety and Health)	• Requires employers to provide workers a place of employment free from recognized hazards to safety and health, such as exposure to toxic chemicals, excessive noise levels, mechanical dangers, heat or cold stress, and unsanitary conditions	Provides a comprehensive framework for worker and workplace safety; establishes standards for workplace health and safety
Spill Response (ORSANCO and U.S. Coast Guard)	• Includes emergency response activities for river-related spills and accidental discharges and is related to the Oil Pollution Act and Section 301 of the Clean Water Act	Minimizes adverse impacts of spills and discharges on mussels and other aquatic life and on water quality
ORSANCO Monitoring	• Encompasses ongoing water quality and aquatic ecology monitoring programs by the Ohio River Valley Water Sanitation Commission	Helps track trends in water quality and biological communities
PA Pure Waters Act of 1905	• Banned the discharge of untreated sewage by any new municipal system	Assured supplies of clean drinking water would be available for future generations

TABLE 10-2 (continued)
Laws, Regulations, Ordinance, and Programs Relevant to Health and Safety

Law/Program (Lead Agency)	Key Components	Relevance to Health and Safety
PA Clean Streams Law of 1937	• Established the basic authority for Pennsylvania to protect streams from pollution and the effects of surface coal mining	Prohibited untreated wastewater or sewage from being discharged into state waterways
PA Sewage Facilities Act	• Provides for the planning and regulation of community and individual sewage systems	Improved water quality
State Water Quality Certification (Appropriate state or interstate pollution control agencies)	• Section 401 of the Clean Water Act requires certification from state or interstate water control agencies that a project is in compliance with established effluent limits and water quality standards	Provides opportunity for state or interstate scrutiny
State Fish Consumption Advisories	• Establishes advisory limits for consumption of fish caught in local water bodies for specific segments of the population	Provide safeguards for public health

10.5 PAST TO CURRENT BASELINE CONDITIONS

Project scoping suggested that the most important factors affecting health and safety include:

- Hazardous industrial activities;
- Hazardous waste sites;
- Spills or related accidental discharges;
- Recreational boating accidents;
- Commercial transportation; and
- Water quality.

Industrial activities located or conducted in proximity to the river may pose a public health risk from pollution point sources; production and disposal of hazardous wastes; and spills of potentially hazardous or polluting materials associated with the transfer, storage, and

use of the materials. Past industrial activities have contributed to the creation of contaminated sites and landfills that pose ongoing threats to groundwater, surface water, and public health. When raw materials, products, and wastes are transported by barge, rail, or truck, these materials are subject to spillage while in transit, especially when they arrive at material transfer points.

Commercial transportation on the river is most visibly connected with the potential for spills and for potential conflicts with recreational users and adjoining property owners. Recreational boating on the river may be subject to higher levels of risk than would normally be encountered on inland lakes and streams. Strong currents, water level fluctuations, and the presence of barge traffic are more prevalent on rivers than in other settings. Recreational boating on the rivers has resulted in a number of injuries, fatalities, and property damage. Boating and other river-oriented recreational activities appear to have grown significantly over the past several decades in conjunction with improving water quality. Growth of such activities could contribute to more crowded conditions and increased risk of accidents.

While overall water quality has improved to the point where almost all of the Allegheny, Monongahela, and Ohio rivers can support recreational activities and consumptive uses most of the time, temporary impacts can still increase risks. Such impacts may include elevated fecal coliform counts in urban areas following wet weather, or major spills that threaten drinking water supplies. Additionally, ongoing effects of past contamination are reflected in fish consumption advisories and the remediation costs of contaminated sites.

Over the past 20 to 30 years new and amended federal, state, and local laws/regulations have been a major contributing factor to the improvement of the environment of the upper Ohio River. Water quality, frequency of accidents (commercial and recreational), and the frequency of spills on and surrounding the study area have all improved with the implementation of these laws/regulations.

One example of a new law would be the creation of the Oil Pollution Act (OPA) of 1990 which was created following the Ashland Oil spill that occurred on the Monongahela River in 1988. This act improved the nation's ability to prevent and respond to oil spills by establishing provisions that expand the federal government's authority, and provide the money and people necessary, to respond to oil spills. The OPA also created the national Oil Spill Liability Trust Fund, which is available to provide up to one billion dollars per spill incident. In addition, the OPA provided new requirements for contingency planning both by government and industry. The OPA also increased penalties for regulatory noncompliance, broadened the response and enforcement authorities of the federal government, and preserved state authority to establish law governing oil spill prevention and response.

The National Oil and Hazardous Substances Pollution Contingency Plan (NCP) has been amended utilizing a three-tiered approach: 1) the Federal government is required to direct all public and private response efforts for certain types of spill events; 2) Area Committees composed of federal, state, and local government officials must develop detailed, location-specific Area Contingency Plans; and 3) owners or operators of vessels and

certain facilities that pose a serious threat to the environment must prepare their own facility response plans.

10.5.1 Hazardous Site/Spill Databases

Certain industrial activities, waste sites, and spill locations have been recorded in one or more databases. These include sites such as hazardous waste generators or underground storage tank operators that require a permit to operate contaminated sites such as Resource Conservation and Recovery Act listed sites where reportable spills of oil or hazardous materials have occurred. To obtain a perspective on the distribution of such sites along the upper Ohio River, data were collected from all available databases. All records occurring on or within the floodplain of the river were selected and mapped. Table 10-3 summarizes the federal and state databases that were searched and the number of records found for each database type.

This effort identified 832 sites, but most sites are listed by more than one database. For example, site 950 in Pittsburgh includes records for a past leaking underground storage tank, current registration of underground tanks, and a reported spill. As would be expected, sites are concentrated in urban and major port areas, but several sites are present along the length of the river. Supplement 10-A to this chapter includes an overview of mapped areas, Area Map 1, Detail Map 1 (Pittsburgh), and records for an example site (950).

TABLE 10-3
Databases Searched within the Upper Ohio River Study Area

Agency	Database	Type of Records	# Cited
USEPA	NPL	National Priority List	1
USEPA	CORRACTS	Resource Conservation and recovery Act (RCRA) Corrective Actions	12
STATE	SPL	State equivalent priority list	0
USEPA	RCRA-TSD	RCRA permitted treatment, storage, disposal facilities	11
STATE	SCL	State equivalent Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS) list	3
US EPA	CERCLIS/NFRAP	Sites under review by US EPA	50
STATE/REG/CO	LUST	Leaking Underground Storage Tanks	83
STATE/REG/CO	SWLF	Solid waste landfills, incinerators, or transfer stations	13
STATE/CO	UST	Registered underground storage tanks	141
STATE	AST	Registered aboveground storage tanks	163

TABLE 10-3 (continued)
Databases Searched within the Upper Ohio River Study Area

Agency	Database	Type of Records	# Cited
USEPA	GNRTR	RCRA registered small or large generators of hazardous Waste	290
USEPA/STATE	SPILLS	Emergency Response Notification System (ERNS) and state spills lists	222
CERCLIS/NFRAP = Site under review by US EPA; LUST = Leaking Underground Storage Tank; SWLF = Solid Waste Landfill; UST = Underground Storage Tank; AST = Aboveground Storage Tank; GNRTR = RCRA Generator; SPILLS = Emergency Response Notification System (ERNS) and spills; NPL = National Priority List; CORRACTS = Resource Conservation and Recovery ACT (RCRA) Corrective Actions; SPL = State Equivalent Priority List; RCRA-TSO = RCRA Permitted Treatment, Storage, Disposal Facilities; SCL = State Equivalent Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS) List			
Source: Fidelity National Information Solutions, 2001			

10.5.2 Spill Records

Spill records were difficult to interpret because of extreme rates of record duplication. Of the 222 records cited in Table 10-3, it appeared that virtually all state records were duplicates of the national Emergency Response Notification System (ERNS). Spill records were identified and reviewed from 1990 through 2008 (US EPA 2009a).

The ERNS system identified 2,100 records in Allegheny and Beaver counties in Pennsylvania, Hancock County in West Virginia, and Columbiana and Jefferson counties in Ohio. There were 589 records identified in Allegheny County; 681 records in Beaver County; 208 in Hancock County; 191 in Columbiana County; and 431 in Jefferson County. Of the 2,100 records identified, water was affected in 1,258 incidents and the incident type was an unknown sheen or vessel in 636 incidents. Spill events were not randomly distributed along the rivers; they were more concentrated in the major port areas and industrial areas. The majority of the spills were railroad or non-river related spills occurring within the floodplain along the upper Ohio River within the study area.

10.5.3 Boating and Accidents

According to the USCG and the Pennsylvania Fish and Game Commission (PFBC), only 5 to 10 percent of actual boating accidents that occur are reported (USCG 2007). The USCG and the USDOT compile statistics in separate databases for recreational and commercial boating accidents.

10.5.3.1 Recreational Boating Statistics

Recreational boating accident statistics are compiled and published annually by the USCG. Data for the accident statistics come from two sources: Boating Accident Report (BAR) data forwarded to the USCG by jurisdictions with an approved numbering and

casualty reporting system, and reports of USCG investigations of fatal boating accidents that occurred on waters under federal jurisdiction. Recreational boating accident investigation data are used if submitted to the USCG and are relied on as much as possible to provide accurate accident statistics.

Under the authority of USCG, the Prevention Policy Directorate has been delegated the responsibility to collect, analyze, and annually publish statistical information obtained from recreational vessel numbering and casualty reporting systems. Within the Directorate, the Office of Auxiliary and Boating Safety, Boating Safety Division has the responsibility to administer the National Recreational Boating Safety Program. These annual reports provide statistics on recreational boating accidents and state vessel numbering activities. Current regulations (33 Code of Federal Regulations 173.55) require the operator of any vessel, numbered or used for recreational purposes, to file a BAR as a result of an occurrence that involves the vessel or its equipment when:

- A person dies;
- A person is injured or requires medical treatment beyond first aid (i.e., treatment at a medical facility or by a medical professional other than at the accident scene);
- Damage to vessel totals $2,000 or more or there is a complete loss of any vessel (prior to July 2, 2001, the property damage threshold was $500); or,
- A person disappears from the vessel under circumstances that indicate death or injury.

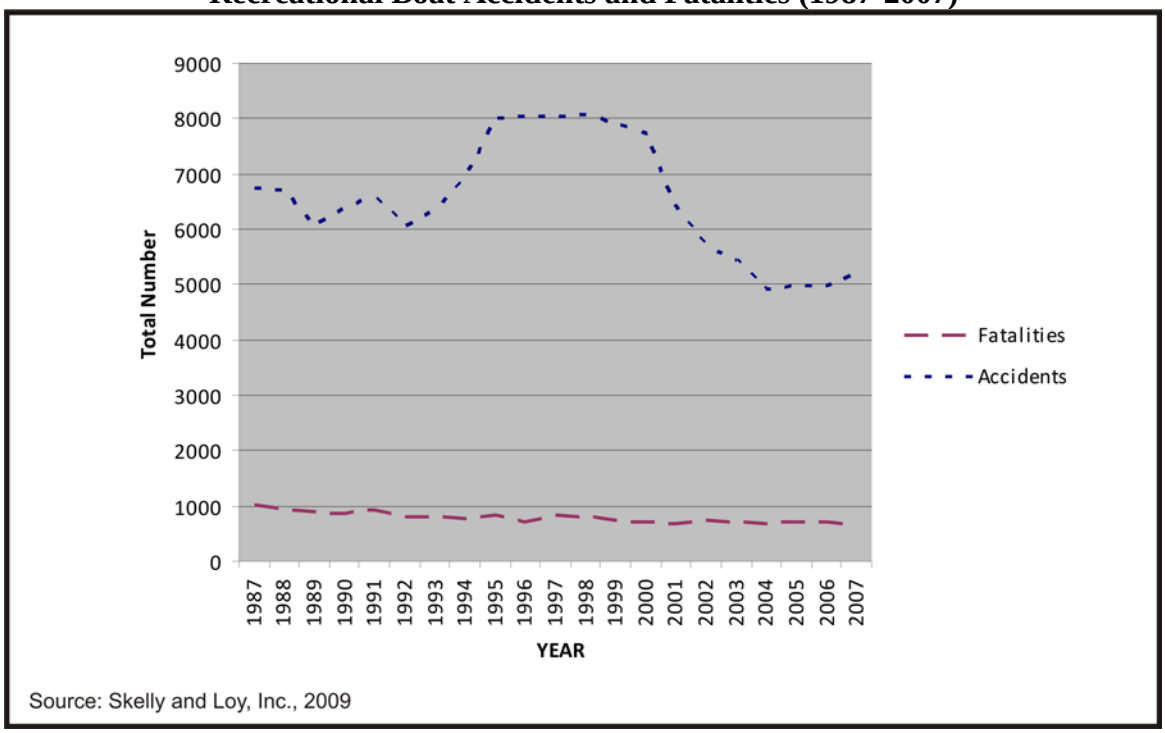
Users of these boating statistics need to be aware of the following facts that may affect results of accident report data:

- The Recreational Vessel Casualty Reporting System does not include every accident involving a recreational vessel. Some accidents are not in the system because they are not required to be reported. Many more accidents are not reported because boaters may be unaware of the law and the inherent difficulty in enforcing the law. It is believed that only a small fraction of all non-fatal boating accidents occurring in the United States are reported to the USCG, state, or local law enforcement agencies.
- Fluctuations from year to year in non-fatal accident statistics may be caused by factors other than the change in the total number of recreational boating accidents. A seemingly small change in the low reporting rate may cause a relatively large change in the statistics. Overall, the more serious the accident, the more frequent the reporting. Therefore, it is believed that nearly all fatal recreational boating accidents are reported.

National recreational boating accident and fatality totals from 1987 to 2007 are illustrated in Figure 10-1. Trends indicate that both accident and fatality numbers have been

on a decreasing trend over the 20-year period. These decreases could be related to the decrease in the number of registered boats, which should mean a decrease in the number of boats on the waterways, thus, creating fewer opportunities for unsafe boating. According to the USCG, new laws and regulations have also contributed to making boating safer, thus, helping decrease the number of boating accidents and fatalities (USCG 1999, 2000, 2001, 2002, 2003, 2004, 2005, 2006a, 2007).

FIGURE 10-1
Recreational Boat Accidents and Fatalities (1987-2007)



In 1932, the Pennsylvania Board of Fish Commissioners published their first regulations on motorboats in an effort to make the waterways of Pennsylvania a safer place. In 1940, these boating regulations were rewritten to conform with the Federal Motorboat Act of 1940. Later, the National Boating Safety Advisory Council was established by the Federal Boat Safety Act of 1971 as another approach towards improving boater safety.

Federal and state laws requiring and offering boater safety education may also be contributing to the decline in the number of recreational boating accidents and fatalities over the past 20 years. A comparative analysis of recreational boating policies regarding education requirements was completed by the USCG in 2006. This study concluded that new, stricter education requirements by states have been related to the decline in fatalities. As a result of such statistics and trends presented in the study, most states have pursued motorboat operator education requirements as a way to reduce the current levels of fatalities.

For the period from 1999-2007, Ohio, Pennsylvania, and West Virginia accounted for 4 percent of all boating accidents nationwide. Each state's share of accidents varies from a

low of 0.3 percent for West Virginia, to 1.3 percent for Pennsylvania, to a high of 2.4 percent for Ohio. Boating accident totals are shown in Table 10-4.

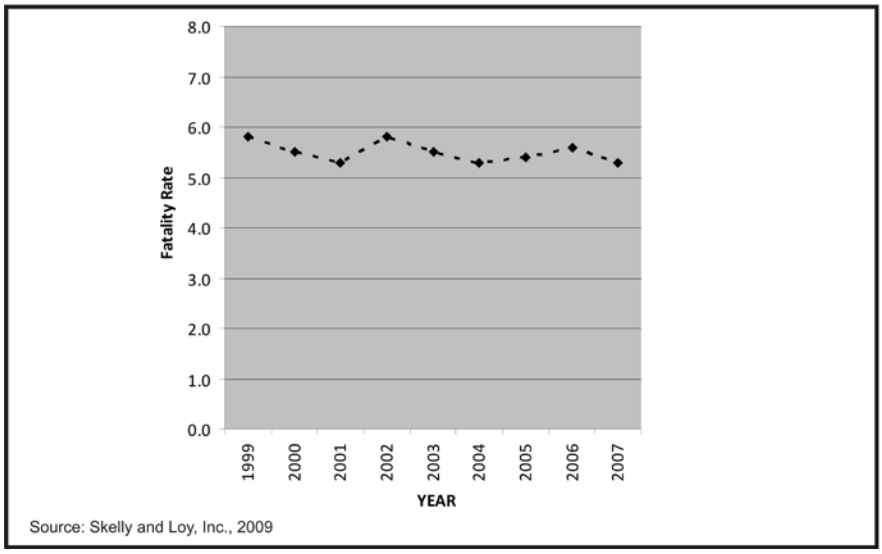
For the period from 1999-2007, a total of 2,146 accidents were reported in Pennsylvania, Ohio, and West Virginia. Collision with another vessel was the most common event, accounting for 509 accidents or 24 percent of the total. Other allisions (floating/sunken objects, docks, etc.) or groundings accounted for 417 events (19 percent); flooding/swamping or capsizing the vessel accounted for 406 events (19 percent); and falling overboard, on or within the vessel, accounted for 341 events (16 percent). Other types of accidents included skier mishaps (8 percent), fire/explosion (4 percent), victims in water struck by boat or prop (3 percent), sinking (2 percent), and miscellaneous/other (5 percent).

TABLE 10-4
Recreational Boating Accidents: State Totals

	1999	2000	2001	2002	2003	2004	2005	2006	2007	Totals (9 yrs)	State Share
National	7931	7740	6419	5705	5438	4904	4969	4967	5191	53264	–
OH	232	198	139	140	122	105	132	111	121	1300	2.4%
PA	125	88	80	74	79	58	61	56	64	685	1.3%
WV	25	20	15	17	14	9	14	21	26	161	0.3%
Total (3 states)	382	306	234	231	215	172	207	188	211	2146	4.0%
Sources: USCG, 1999, 2000, 2001, 2002, 2003, 2004, 2005, 2006a, 2007											

There are approximately 20 accidents per year on the Pennsylvania portion of the Ohio River (ORMSS 200). For the limited years of available data, there is no apparent trend in the annual average number of accidents in Pennsylvania, Ohio, and West Virginia. Annual numbers vary widely, from a low of 9 in 2004 (West Virginia) to a high of 232 in 1999 (Ohio). On a national scale, statistics for boating fatalities suggest that a trend towards improved boating safety is occurring. From 1999 through 2007, annual boating fatalities have declined by an average of 0.7 percent per year, or a total of 5.9 percent over the 9 years of record, illustrated in Figure 10-2.

FIGURE 10-2
National Annual Recreational Boating Fatality Rates (1999-2007)
Number of Deaths per 100,000 Registered Recreational Vessels



The Boating Accident Reports include the primary cause of each accident and may also list other causes. Table 10-5 summarizes the primary causes of boating accidents in Pennsylvania, Ohio, and West Virginia.

TABLE 10-5
Causes of Recreational Boating Accidents for Pennsylvania, Ohio, and West Virginia

Principal Causes	1999	2000	2001	2002	2003	2004	2005	2006	2007	totals
Capsizing	28	25	24	22	27	16	28	38	28	236
Carbon Monoxide	0	0	0	0	0	0	0	0	1	1
Collision w/ fixed object	41	32	16	19	16	13	17	17	22	193
Collision w/ floating object	5	14	4	5	8	11	4	6	7	64
Collision w/ vessel	106	85	59	53	55	35	54	27	35	509
Departed vessel	0	0	0	0	4	3	4	3	5	19
Ejected from vessel	0	0	0	0	0	0	1	6	14	21
Electrocution	0	0	0	0	0	0	0	0	0	0
Fall in vessel	21	15	7	12	9	5	12	5	10	96
Fall on vessel	0	0	0	0	0	0	0	0	2	2
Falls overboard	39	26	25	27	24	18	22	22	19	222
Fire/Explosion (fuel)	12	4	7	2	5	5	7	4	5	51
Fire/explosion (non-fuel)	0	0	0	0	0	0	0	0	4	4
Fire/explosion (unknown)	6	4	6	5	2	3	1	1	0	28

TABLE 10-5 (continued)
Causes of Recreational Boating Accidents for Pennsylvania, Ohio, and West Virginia

Principal Causes	1999	2000	2001	2002	2003	2004	2005	2006	2007	totals
Flooding/swamping	33	24	29	14	18	17	11	14	10	170
Grounding	23	13	4	15	8	5	8	7	12	95
Other	7	9	14	8	5	3	4	9	5	64
Sinking	13	6	7	2	4	3	5	4	1	45
Skier mishap	21	21	17	33	13	16	18	18	23	180
Struck by vessel	7	6	2	3	5	3	1	1	0	28
Struck by motor and/or propeller	5	6	3	2	4	3	3	4	6	36
Struck submerged object	14	14	10	7	4	7	6	2	1	65
Unknown/Not Reported	1	2	0	2	4	6	1	0	1	6
Total Accidents	**382**	**306**	**234**	**231**	**215**	**172**	**207**	**188**	**211**	**2146**
Injuries	**215**	**161**	**169**	**156**	**144**	**119**	**164**	**102**	**161**	**1391**
Drownings	21	32	30	32	27	18	25	35	23	243
Other deaths	11	10	8	3	6	3	5	10	9	65
Total Deaths	**32**	**42**	**38**	**35**	**33**	**21**	**30**	**45**	**32**	**411**

[1]Conditions at time of accident, not necessarily causal to accident.

Sources: USCG, 1999, 2000, 2001, 2002, 2003, 2004, 2005, 2006a, 2007

The contributing factors of a boating accident are the causes of the accident. The USCG national accident reporting database divides the contributing factors into five categories. The categories are operation of vessel, loading of passengers or gear, failure of vessel or vessel equipment, environment, and miscellaneous. These five categories are explained in Table 10-6.

TABLE 10-6
Primary Contributing Factors of Recreational Accidents and Casualties (2007)

		Accidents	Deaths	Injuries
Operation of Vessel	Alcohol Use	391	145	341
	Careless/Reckless Operation	552	33	445
	Drug Use	5	4	5
	Excessive Speed	473	31	425
	Failure to Vent	17	1	20
	Lack of or Improper Vessel Lights	18	1	10
	No Proper Lockout	375	20	266
	Operator Inattention	628	47	436
	Operator Inexperience	353	42	234
	Restricted Vision	69	7	49
	Rules of the Road Infraction	54	2	42
	Sharp Turn	51	6	44

TABLE 10-6 (continued)
Primary Contributing Factors of Recreational Accidents and Casualties (2007)

		Accidents	Deaths	Injuries
Loading of Passengers or Gear	Improper Loading	49	28	28
	Improper Anchoring	43	4	8
	Overloading	33	13	23
	Passenger/Skier Behavior	492	47	458
	Standing/Sitting on Gunwales, Bow, Transom	12	3	9
Failure of Vessel or Vessel Equipment	Equipment Failure	141	17	40
	Hull Failure	60	4	10
	Machinery Failure	312	21	146
Environment	Congested Waters	107	1	72
	Dam/Lock	14	13	12
	Force of Wave/Wake	128	1	118
	Hazardous Waters	83	11	61
	Weather	148	36	70
Miscellaneous	Ignition of Spilled Fuel or Vapor	31	0	21
	Other	305	61	170
	Unknown	247	86	110
All Categories Combined		**5191**	**685**	**3673**
Sources: USCG, 2007				

10.5.3.2 Commercial Boating Statistics

Commercial vessel accident statistics are collected by the USDOT Maritime Administration. There are several advantages to inland barge transportation such as lower fuel costs, less pollution, less land use and social impacts, and it is much safer. Many different studies have been done comparing different types of transportation modes, and each of these studies identifies inland barge transportation as being one of the most environmentally friendly methods. The studies identify that there is little to no impact on the environment when compared to other modes of cargo transportation.

Although water transport has the fewest numbers of incidents, fatalities, and injuries of any surface mode, there are still some inherent risks in shipping by barge. According to the USCG, however, water transport is the safest and most regulated form of transportation and has fewer accidental spills or collisions than any other mode. This excellent record is directly attributed to both exacting operational safeguards imposed by carriers themselves as well as strict federally mandated inspections standards.

River barges share their rights-of-way mostly with recreational boaters that primarily operate both in warmer weather and during daylight hours. Where as barges generally travel at slow speeds and are confined to a narrow channel in the river, recreational boaters range the full width of the river, and their speed and maneuverability allow them to steer clear of the barges' tow paths. In addition, the barge industry has taken an active role in educating recreational boaters on safely coexisting with commercial vessels through various programs.

The primary reason for the infrequency of barge spills and accidents is the existence of extensive training programs, and the documentation, licensing, and testing of all people involved in handling the products being transported. Lastly, barge transportation operates in a waterway environment that has few crossing junctures and is relatively remote from population centers.

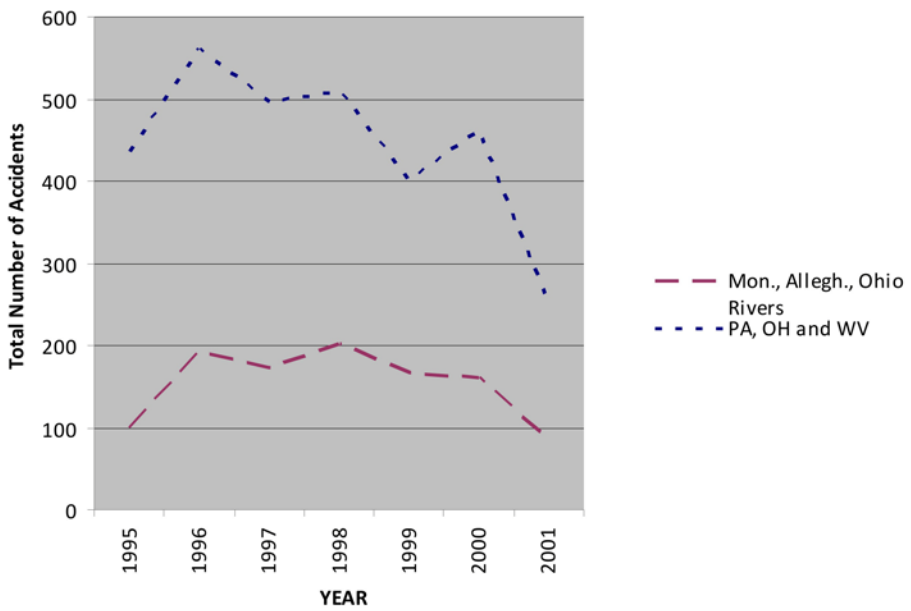
Commercial boating statistics are shown in Table 10-7. From 1995 until 2001, Ohio, Pennsylvania, and West Virginia accounted for approximately 8.3 percent of all commercial boating accidents nationwide. Each state's share of accidents varies from a low of 1.1 percent for West Virginia, to 3.5 percent for Ohio, to a high of 3.6 percent for Pennsylvania.

Commercial boating accident totals for the Allegheny, Monongahela, and Ohio rivers as well as for PA, OH and WV from 1995 to 2001 are illustrated in Figure 10-3. The trend lines indicate that accident totals for both the rivers and states have been on a decreasing trend over the seven-year period. As mentioned previously, educational programs and different regulations could be a major influence in the decreasing trends (RITA 2002).

TABLE 10-7
Commercial Boating Accidents: Totals

	National	OH	PA	WV	Total (3 states)	OH-Ohio River	WV-Ohio River	PA-Ohio, Allegheny, Monongahela Rivers
1995	5,349	224	179	32	435	62	16	20
1996	5,260	248	225	88	561	65	53	73
1997	5,504	207	210	79	496	62	39	73
1998	5,767	201	228	81	510	58	45	99
1999	5,526	166	173	62	401	60	39	67
2000	5,403	163	250	48	461	71	32	58
2001	4,958	105	111	38	254	32	26	26
Total	37,767	1,314	1,376	428	3,118	410	250	416
Percents	--	3.5	3.6	1.1	8.3	1.0	0.7	1.1

FIGURE 10-3
Commercial Boat Accidents (1995-2001)



Source: Skelly and Loy, Inc., 2009

10.5.4 Bacteria Contamination and Monitoring

In the early 1800s sewers and wastewaters in Pittsburgh discharged directly into the upper Ohio River. In 1875, the Pittsburgh Board of Health considered wastewater to be a major health issue. As a result, in 1905, the Pennsylvania Pure Waters Act was passed forbidding the discharge of any untreated sewage into state waterways. After almost no improvement in water quality was noticed in the rivers of the region, this act was followed up in 1937 by the Clean Streams Law, which stated that untreated wastewater/sewage could not be discharged into state waterways. Independent community treatment began thereafter, but it was not until in 1959, with the creation of the Allegheny County Sanitary Authority (ALCOSAN) that sewage in the Pittsburgh region was treated in a concerted and coordinated manner (Tarr 2003).

Good water quality is essential for contact recreation activities such as boating, swimming, and water skiing. ORSANCO works with local health departments throughout the Upper Ohio Navigational Study area to make bacteria data more available and to better inform the public about water quality issues. To protect human health associated with contact recreation, ORSANCO tests water quality from May through October for bacteria five times monthly, at four stations in the Pittsburgh area, for both fecal coliform and *E. coli*. In addition to this seasonal monitoring, bacteria data are provided by two water utilities in the study area (Wilkinsburg Wastewater Treatment Plant [WTP] and Hays Mine WTP).

From May to October, fecal coliform are not to exceed 400 colony forming units (CFU) per 100 milliliters mL in more than ten percent of the samples at a given site, nor should they have a monthly geometric mean greater than 200 CFU per 100 mL. *E. coli* are not to exceed 240 CFU per 100 mL in any single sample, nor to exceed 130 CFU per 100 mL as a monthly geometric mean (ORSANCO 2009).

Two water supply utilities in the study area perform analysis for fecal coliform bacteria on their raw intake water and provide these results to ORSANCO on a monthly basis. ORSANCO has adopted a criterion that specifies a maximum monthly geometric mean for fecal coliform of 2,000 CFU per 100 mL to protect public drinking water supplies. These sites, added to the four stations mentioned previously, result in six monitoring points for fecal coliform (ORSANCO 2009).

There were no violations of the stream criterion set for public drinking water supplies during calendar year 2008 (the latest year available). From May through October 2008, violations of the contact recreation standards for both fecal coliform bacteria and *E.* coli were recorded at all stations in Pittsburgh (ORSANCO 2009).

Records for 2008 reflect the general pattern in recent years for bacteriological exceedances in the Pittsburgh area. Exceedances occur annually in most urban areas and are generally associated with high flow conditions. Combined sewer overflows, leakage, and overflow from sanitary sewer collection systems, as well as urban stormwater runoff are suspected as the primary sources of these biological contaminants.

10.5.5 Fish Consumption Advisories

Federal and state agencies currently publish fish consumption advisories applicable to the Allegheny, Monongahela, and Ohio rivers. Between 1993 and 2000, the number of fish advisories issued in the U.S. increased by almost 150 percent. Almost 79 percent of all advisories issued in the U.S. are at least partly due to mercury contamination in fish and shellfish. As of December 2000, 41 states issued 2,242 fish advisories for mercury. Advisories other than mercury that exist in the study area are for polychlorinated biphenyls (PCBs) and dioxins (USEPA 2009b).

The United States Environmental Protection Agency (USEPA) issued a national mercury-based advisory in 2001 that states: "If you are pregnant or could become pregnant, are nursing a baby, or if you are feeding a young child, limit consumption of freshwater fish caught by family and friends to one meal a week. For adults, one meal is six ounces of cooked fish or eight ounces of uncooked fish; for a young child, one meal is two ounces of cooked fish or three ounces of uncooked fish."

In 2004, the USEPA and the Federal Drug Administration (FDA) jointly issued a national mercury-related advisory for store-bought fish and fish served in restaurants. Amendments to the 2001 advisory included a statement emphasizing the positive benefits of eating fish and recommend not eating any other fish in the same week as locally caught fish

are consumed. (The advice on the amount of locally caught fish to eat remained the same as the 2001 advisory.)

Ohio's statewide mercury advisory, issued in 1997, is similar to the USEPA''s advisory in that it advised women of child-bearing age and young children (age 6 and under) to eat no more than one meal per week of fish (any species) from any Ohio body of water or no more than the number of meals specified for the more restrictive advisories listed in the annual advisories. Although the one meal per week advice applies mainly to these sensitive populations, the current general advisory for Ohio, issued in 2003, recommends that everyone follow that advice. As per the 2004 USEPA national advisory amendments, if no local advice is available, eat up to six ounces (one average meal) per week of fish caught from local waters, but do not consume any other fish during that week.

All three of the states included in this study have consumption advisories in place for certain species of fish from the Ohio River. These advisories primarily focus on the potential presence of certain contaminants and are derived from fish tissue sampling conducted by ORSANCO. This sampling program, initiated in 1976 and modified in 1987, allows appropriate state agencies to use data from the program as the basis for issuing fish consumption advisories. An advisory committee comprised of state health and environmental quality personnel is convened to discuss the data and the need for and basis of fish advisories. Fish advisories are issued, removed, or modified by state agency personnel. ORSANCO also facilitates communication among the states to minimize differences in advisories issued for Allegheny, Monongahela, and Ohio River fish.

Current consumption advisories for the study area from USEPA and the three states are presented in Table 10-8.

TABLE 10-8
Fish Consumption Advisories for the Study Area

Authority	Fish Species	Applicable Population	Advisory	Contaminant
USEPA	All species	Women, pregnant or nursing	No more than one meal per week	Mercury
Ohio	All species	General population	No more than one meal per week	Mercury
	Black crappie, common carp, flathead catfish, freshwater drum, sauger, smallmouth bass, smallmouth buffalo, striped bass hybrid, walleye, white bass	General population	No more than one meal per month	PCBs
	Channel catfish	General population	No more than one meal per two months	PCBs

TABLE 10-8 (continued)
Fish Consumption Advisories for the Study Area

Authority	Fish Species	Applicable Population	Advisory	Contaminant
Pennsylvania	All species	General population	No more than one meal per week	Mercury
Pennsylvania Allegheny River (Allegheny County)	Carp, channel catfish	General population	No more than one meal per month	PCBs
Pennsylvania Monongahela River (Allegheny County)	Freshwater drum	General population	6 meals per year	PCBs
	Carp	General population	Do not eat	PCBs
	Channel catfish	General population	No more than one meal per month	PCBs
Pennsylvania Ohio River (Allegheny and Beaver counties)	Walley, sauger, white bass, freshwater drum	General population	No more than one meal per month	PCBs
	Carp, channel catfish	General population	Do not eat	PCBs
Pennsylvania Ohio River (Montgomery lock to state border)	White bass, hybrid striped bass, freshwater drum, walleye 17” and over	General population	No more than one meal per month	PCBs
	Flathead catfish, channel catfish under 17”	General population	6 meals per year	
	Channel catfish over 17”	General population	Do not eat	
West Virginia, All Waters (except where listed in the specific advisories below)	All species	General population	No more than one meal per week	Mercury
	White bass, hybrid striped bass	General population	One meal per month	Mercury, PCBs
	Black bass (largemouth, smallmouth, spotted), channel catfish greater than 17”, flathead catfish, rock bass, walleye, saugeye, sauger, all suckers	General population	2 meals per week	Mercury, PCBs
	Channel catfish less than 17”	General population	One meal per week	Mercury, PCBs
	Rainbow trout	General population	No limit	Mercury, PCBs

West Virginia Ohio River (entire length)	Carp, channel catfish greater than 17”	General population	Do not eat	Mercury, PCBs, dioxin
	Channel catfish less than 17”, flathead catfish	General population	6 meals per year	Mercury, PCBs, dioxin
	Smallmouth buffalo, drum	General population	One meal per month	Mercury, PCBs, dioxin
Sources: Ohio EPA, 2009; PADEP, 2009; WVDHHR, 2009; USEPA, 2009				

10.6 INTERACTIONS WITH OTHER VALUED ENVIRONMENTAL COMPONENTS (VECs)

Impacts of river-related health and safety on other resources, ecosystems, and human communities are related to the transportation and traffic, recreation, socioeconomics, water quality, air quality, and biological resources, (i.e., fish, mussels, and riparian resources) VECs. The interactions of VECs with health and safety are shown in Table 10-9.

TABLE 10-9
Interactions of Health and Safety With Other VECs

VEC	Risk Factors and Impacts	Past/Present Trends	Future Trends	Comments
Transpor-tation and Traffic	Source of fuel/oil spills, hazardous cargo spills, other cargo spills, boating accidents	• Reduced spills (all types) due to regulatory standards and improved handling procedures • Boating accidents minimized through training and equipment upgrades	Increases in commercial traffic contribute to additional risk factors.	Role of lock and dam projects and operation and maintenance (O&M) activity to promote safe commercial use of the river.
Recreation	Boating accidents, fuel/oil spills	Accidents/spills minimized through boater education, boat safety equipment standards, regulatory presence	Increases in recreational traffic contribute to additional risk factors.	Role of USCG, state, and municipal authorities to establish and enforce safe boating standards, especially in congested use areas

TABLE 10-9 (continued)
Interactions of Health and Safety With Other VEC

VEC	Risk Factors and Impacts	Past/Present Trends	Future Trends	Comments
Socio-Economics	Spills/discharges from river-oriented industry; also, from CSOs, urban stormwater, nonpoint sources	• Frequent exceedances of contact recreation standards (fecal coliform and/or E. coli) from CSO and urban stormwater sources • Reduced industrial spills/dis-charges per historic levels	CSO, urban stormwater, and nonpoint sources need further improvement to reduce discharge impacts.	Role of state EPAs to monitor and maintain stability/containment of former waste disposal sites, contaminated industrial sites, and contaminated fills in the Allegheny, Monongahela and Ohio rivers
Water Quality	Primary impacts are as described for Transpor-tation and Traffic and Socioeconomics .	Significant past improvements contribute to increased recreational uses and sustainability of drinking water sources and industrial and transportation uses	Population decreases and decreased recreational use on the water may accelerate water quality improvements	Role of ORSANCO to monitor water quality parameters on Allegheny, Monongahela, and Ohio rivers and major tributaries
Air Quality	Acid rain and ground-level ozone continue to pose health risks to local and down-wind populations.	Significant past improvements contribute to improved health, sustainability of coal utilities, and other industrial activities	Ongoing implementation of long-term source reduction programs will contribute to reduced emissions and improved air quality.	More stringent ozone standards will require expanded local programs plus new programs in new areas.
Biological Resources (aquatic and riparian)	Aquatic and riparian organisms are susceptible to same spectrum of impacts as described previously for people.	Significant past improvements contribute to recovering populations and sustainability of many river organisms.	Nutrients from nonpoint sources may be important risk factor for local and downstream impacts to biological resources.	Expansion and recovery of aquatic and riparian habitats may be more important than further pollution reductions to expanded populations, species diversity and sustainability.

10.7 INDICATORS OF ENVIRONMENTAL SUSTAINABILITY FOR HEALTH AND SAFETY

Federal, state, and local agencies broadly recognize the contribution of effective monitoring and response procedures to the protection of public health and safety. As a result, numerous quantitative resources are available that can serve as indicators of health and safety concerns. Tracking these concerns over time permits an evaluation of sustainability in the context of improving, stable, or declining conditions. Table 10-10 shows the principal concerns and available quantitative measures.

TABLE 10-10
Indicators of Sustainability

Principal Health and Safety Concerns	Available Quantitative Measures
Spills of oil, fuel, and other hazardous or toxic materials	USEPA Emergency Response Notification System (ERNS) spills database
Potential sources of contamination associated with past or present activities – industrial sites, landfills, underground storage tanks	USEPA databases for sites on the National Priority List (NPL); Resource Conservation and Recovery Act (RCRA) Corrective Action (CORRACTS) sites; and candidate NPL or CORRACTS sites under USEPA or state review. RCRA permitted treatment, storage and disposal (TSD) facilities; RCRA registered generators of hazardous waste; and state lists of leaking underground storage tanks (LUST), registered aboveground/underground storage tanks (AST, UST), and solid waste landfills, incinerators, or transfer stations (SWLF).
Accidents associated with commercial or recreational boating	Boating accident records maintained by US Coast Guard (USCG) and states
Health impacts of water quality – boating, swimming, fish consumption	ORSANCO water quality data and indices for the Ohio River; state and federal fish consumption advisories

10.8 RELEVANT FUTURE ACTIONS AFFECTING HEALTH AND SAFETY

RFFAs for health and safety were evaluated utilizing a matrix prepared during the scoping process. The matrix was an outgrowth of a similar matrix developed during the preparation of ORMSS. Results of the RFFA evaluation for health and safety are summarized in Table 10-11.

TABLE 10-11
RFFA Cumulative Effects Matrix for Health and Safety

RFFA Cumulative Effects Matrix for Upper Ohio River – Health and Safety					
RFFA[1]	**Time Period[2]**	**Occurrence Probability[3]**	**Location on River[4]**	**Importance[5]**	**Effects[6]**
USACE Actions					
Navigation Investments					
Replacement locks at Emsworth, Dashields, and Montgomery Dams (EDM)	1	H	S	H	+/-
Rehabilitation of EDM dams	1	H	S	H	+/-
Navigation aids - lock & dam signage	A	H	S	H	+
Non-structural navigation improvements	A	H	S	H	+
L&D operation and maintenance	A	H	S	H	+/-
Approach & channel dredging/disposal	A	H	E	M	+/-
Environmental design					
environmental sustainability operation actions	A	H	S	L	+
Pool maintenance	A	H	E	L	+/-
Sec 107 port development and maintenance dredging	2	L	S	L	+/-
Actions by Others					
Navigation System Dependent - "But For"					
Commercial navigation					
barge queuing	1	M	E	M	+/-
fleeting areas/barge storage	1	M	E	M	+/-
terminals & multi-modal sites	2	L	S	L	+/-
barge/tow tech/"green" design	A	M	E	L	+
accidents/spills	A	M	E	H	-
Coast Guard navigation aids - const., O&M	A	H	E	H	+
Energy					
hydropower on dams	2	M	S	L	+
continued operation of coal-fired power plants	A	M	S	M	-
Water-based recreation					
marina development & operation	A	M	S	L	+/-
commercial boating	A	H	E	M	-
personal boating	A	H	E	M	+/-

TABLE 10-11 (continued)
RFFA Cumulative Effects Matrix for Health and Safety

RFFA Cumulative Effects Matrix for Upper Ohio River – Health and Safety					
RFFA[1]	**Time Period[2]**	**Occurrence Probability[3]**	**Location on River[4]**	**Importance[5]**	**Effects[6]**
Actions by Others					
River Dependent					
Water supply/discharge					
Municipal	A	M	S	M	+/-
Industrial	A	M	S	M	+/-
Waste water treatment discharges (WWTP)					
onsite systems	A	H	E	M	+/-
stormwater discharges; CSOs; SSOs	A	H	S	M	+/-
Marcellus shale gas extraction (water impacts)	A	H	E	M	+/-
Resource extraction					
instream sand and gravel mining	A	H	E	L	-
Acid mine discharge (AMD)	A	M	E	M	-
Riverfront/Flood Plain Development					
Downtown Pittsburgh					
Ongoing Point State Park improvements	1	H	S	L	+/-
Convention Center riverfront park	1	H	S	L	+/-
residential development /conversions	A	H	S	L	+/-
North Shore development	1	H	S	L	+/-
Pittsburgh South Side					
continued riverfront development	A	H	S	L	+/-
continued South Side Works development	1	H	S	L	+/-
Riverfront trails					
Pittsburgh riverfront trail system	A	H	E	L	+/-
Beaver County trail system	A	M	E	L	+/-
Brownfields redevelopment					
Neville Island	1	H	S	M	+/-
PL&E, McKees Rocks	2	M	S	M	+/-
M&B Development	2	M	S	M	+/-
Fab Tech & Buckeye Pipeline	1	M	S	M	+/-

TABLE 10-11 (continued)
RFFA Cumulative Effects Matrix for Health and Safety

RFFA Cumulative Effects Matrix for Upper Ohio River – Health and Safety					
RFFA[1]	**Time Period[2]**	**Occurrence Probability[3]**	**Location on River[4]**	**Importance[5]**	**Effects[6]**
Actions by Others					
Riverfront/Flood Plain Development					
J&L site in Aliquippa	1	M	S	M	+/-
Leetsdale Industrial Park	1	H	S	M	+/-
Resource Protection/Restoration					
Ohio River Islands Wildlife Refuge System	A	H	S	L	+/-
Nationwide Rivers Inventory	A	M	S	L	+/-
Ecosystem restoration	A	M	E	L	+/-
Bridges and Roadways					
Bridge renovations					
Ambridge/Aliquippa Bridge	1	H	S	L	+/-
Shippingport Bridge	1	H	S	L	+/-
Rochester Bridge	1	H	S	L	+/-
McKees Rocks Bridge	1	H	S	L	+/-
Birmingham Bridge	1	H	S	L	+/-
Rankin Bridge	1	H	S	L	+/-
New crossings					
Maglev	2	L	S	L	+/-
North Shore connector	1	H	S	L	+/-
Roadways					
Mon/Fayette Expressway	2	L	S	L	+/-
SR 28 widening/railroad relocation	1	H	S	L	+/-
CSX double stack upgrades (National Gateway)	1	M	S	L	+/-
Natural Events					
Floods	A	M	E	L	+/-
Droughts	A	L	E	L	+/-

TABLE 10-11 (continued)
RFFA Cumulative Effects Matrix for Health and Safety

RFFA Cumulative Effects Matrix for Upper Ohio River – Health and Safety					
RFFA[1]	**Time Period[2]**	**Occurrence Probability[3]**	**Location on River[4]**	**Importance[5]**	**Effects[6]**
Actions by Others					
Regulatory Environment					
Phase I & 2 NPDES program	A	H	E	H	+
TMDLs	A	H	E	H	+
ALCOSAN & other consent decrees	A	H	E	H	+
Adaptive management in Sand & Gravel EIS	A	H	E	H	+
Pollution prevention	A	H	E	H	+
USACE permitting programs	A	H	E	H	+
Boating safety regulations	A	H	E	H	+
Monitoring programs - PA/ORSANCO	A	H	E	H	+
Environmental awareness education	A	H	E	H	+
Clean Air Act standards	A	H	E	H	+
Clean Water Act standards	A	H	E	H	+
Endangered Species Act (ESA)	A	H	E	H	+
Environmental sustainability practices	A	H	E	H	+
[1] Reasonably Foreseeable Future Actions					
[2] Time period in which the RFFA may occur: A = all periods; 1 = within 10 years; 2 = in 10 - 25 years; 3 = in 25 - 60 years					
[3] Occurrence probability or likelihood RFFA will happen: H = high; M = medium; L = low					
[4] Location or setting on river where RFFA is expected to occur: E = along entire length of river; S = specific location					
[5] Importance or impact of action on the VEC: H = high; M = medium; L = low					
[6] Effects of action on the VEC: + = positive effect; - = negative effect; +/- = mixed effects					

Each of the RFFAs that ranked high or medium in importance to health and safety is discussed in the following sections. RFFAs that have a low probability of occurring within

the upper Ohio River study area or that have no or minimum effect on health and safety are not considered further in this cumulative effects assessment.

10.8.1 USACE Actions

Navigation investments by the USACE will generally have positive effects on health and safety. Overall, longer, more efficient locks will create a safer operational environment for river transportation by eliminating the need for the double cut and the inherent risks associated with it. Replacement locks are more efficient because they will be longer and allow barges to pass through the locks quicker, eliminating queuing at the locks and around related cargo facilities. As barges move through the system quicker, there will be less conflict with other commercial traffic and recreational boaters by decreasing congestion throughout the entire river system. Rehabilitation of the existing locks and dams will have a positive effect on health and safety by making the system more reliable, thus, avoiding some of the problems associated with queuing and congestion. Not only will more efficient locks decrease congestion, they will eliminate the need to break-up barge loads into smaller units. One-barge restrictions, a potential cause of accidents because of the need to hook-up and unhook barges, will be lifted. Once barges are hooked together, they could possibly stay connected as they travel from one pool to another.

Navigation aids and non-structural improvements will have a positive effect on health and safety by maintaining approach warnings and distance buoys at the dams. Other navigation aids in place include rules and guidance for lock approaches, which also are put into place to improve operational safety. Non-structural improvements, like vehicle scheduling, coordination, and stockpiling will also generally have a positive impact by working to streamline operations and limit congested areas.

Lock and dam operation and maintenance and approach channel and dredging/disposal will have both positive and negative benefits. Safety and public health improvements are inherent in these actions. An adequately maintained and operated system of locks and dams, supported by the appropriate channel depths will assure safe operations, but there is a potential for negative effects during construction operations to improve the locks and dams, regardless of whether it is new construction, rehabilitation of the existing locks and dams, or maintenance and operation activities. Worker safety is the most critical area of potential risk, but construction sites can also create situations where onlookers are not careful and disregard safety measures in place to reduce risk. Human error or malfunctioning equipment are always possibilities. The potential for negative temporary effects related to noise or accidental discharges into the water system also exist during construction. Raising and lowering of pool levels during maintenance and construction periods would also have potential health and safety impacts that could extend beyond the immediate construction site.

10.8.2 Actions by Others

The effects of actions by others will be mixed. Although health and safety has continued to improve during the current period, and is expected to continue improving the future, some actions will have positive impacts, but others will have negative.

10.8.2.1 Navigation System Dependent – "But For"

Various activities related to commercial navigation have the potential to negatively affect recreational use, safety, and water quality. These include barge queuing, fleeting operations, and activities at terminals or multi-modal sites. Ongoing negative safety concerns include traffic congestion and spills during transfer of materials at these facilities. Commercial navigation is a significant source of potential safety concerns. The scope of such risks was illustrated during January 2005 at Montgomery Lock and Dam when four people were lost as strong currents pushed their tugboat and six barges of coal through the dam (ORMSS 2006).

Spills of hazardous or toxic materials are an ongoing problem associated with commercial navigation and river-oriented industry. Areas of particular concern include vessel fueling operations (including midstream), barge loading/off-loading operations, queuing areas and river reaches with heavy debris. Although the energy industry is highly regulated and committed to safety, the transference of a significant amount of coal is a key component of the industry and even though much of this work is automated, there is still the potential for accidents. Short to long-term impacts are associated with exposure of spills and public drinking water intakes. Spills also may damage or contaminate shoreline areas.

Although areas where transfers of cargo and fleeting operations occur or queuing is prevalent will continue to offer challenges, longer locks will eliminate some of the need. Nonetheless, there will still be locations where cargo shipments originate or end within the area. Even on a less congested river, commercial navigation may also conflict with recreational boaters. While educational programs have resulted in increased safety during recreational boating, all rules and policies are not consistently followed by all members of the population.

10.8.2.2 River Dependent

Industries and communities with properly functioning water and waste water treatment systems, regardless of type, can have a positive effect on public health and safety. When clean public water is available and a community has adequate sewer facilities in place, public health improves and the community becomes more attractive as a place to live or work. When such systems are not in place, or not functioning properly, potential pollution can cause sickness or deter growth and development.

Stormwater runoff and nonpoint urban surfaces contribute to bacteriological contamination and associated health risks. Significant investments are required to reduce or eliminate CSO and SSO discharges. Onsite systems are often not as effective at controlling waste water treatment discharges as municipal facilities. Additionally, they are often scattered throughout the area and sometimes it is difficult for government agencies to assure that they are functioning properly. Implementation of proper best management practices for managing stormwater runoff can limit erosion, pollution, and other negative impacts that affect public health.

Although there has been a major improvement to the acidity of the upper Ohio River, problems from old Pittsburgh coal seam mines are now developing along the Monongahela River. Many coal operations previously committed to pumping and treating of their acid mine drainage discharges have declared bankruptcy. This had resulted in abandoned or orphan mines. Deep mining operations in the Monongahela River Basin over a period of more than a hundred years have left massive voids currently filled or filling with water. Orphan mines that are located below surface drainage level are actively being flooded, creating an immense aquifer of mine water. This flooding has also resulted in new acid mine drainage discharges throughout the Pittsburgh Coal Basin. It is projected that in 2015 all orphan mines located below the surface drainage level will have reached their maximum capacity to hold water. The Monongahela River Mine Pool has been described as having a giant football shape, stretching from Fairmont, WV in the south to Pittsburgh, PA in the north, and from Wheeling, WV in the west to Uniontown, PA in the east. The aquifer created by the flooding of orphan mines in the Pittsburgh Coal Basin will create the second largest spatially-continuous high-yield aquifer in the Northern Appalachian Region (Donovan and Leavitt 2004).

The West Virginia University Center for Coal Mining Research conducted an extensive study to map the underground mining and water quality of this mine pool (Ziemkiewicz and Vandivort 2004, as cited in Lorson and Smith 2004). They have documented extremely acidic water with gross heavy metal loads within the mine pool. The mine pool has several points that are at a level where they may discharge their acid load to the Monongahela River in the near future. Ten Mile Creek (Mon RM 65.5) and Dunkard Creek (Mon RM 87.2) have been identified as primary discharge points. All marine life in Dunkard Creek was killed in September 2009. Preliminary analysis has suggested an algae bloom as the cause of that loss, but other factors may have contributed to the extensive devastation, including mine waste discharges. Several resource agencies are involved in investigations of the recent incident. A collaboration of natural resource agencies are also involved in aggressive efforts to fully document other fishery resources which may be damaged or lost if an adequate solution to the mine pool flooding problem is not found in the near future. Compounding the uncertainty of the situation, however, is the possibility that discharges from the mine pool, if any, could be confined to the Monongahela River, or if they do reach the Ohio River, flows from the Allegheny River could neutralize the effects.

There has also been significant discussion in the area concerning drilling for natural gas. Marcellus shale underlies much of Pennsylvania and portions of West Virginia. It is estimated to hold trillions of cubic feet of natural gas. Long considered too expensive to retrieve, advances in drilling technology and current natural gas prices have attracted more interest. Because energy markets have fluctuated and there are community initiatives against drilling, interest may wane. Nonetheless, most landowners, including some government entities, see Marcellus shale as a new revenue source. Health and safety implications relate to the proper treatment and disposal of fracturing, production fluids, and saltwater brines. New technologies are being explored by the industry to advance its development as well as spark interest in drilling for even deeper resources within the area.

10.8.2.3 Riverfront/Floodplain Development

Redevelopment of brownfields sites offers opportunities to correct past situations that caused a deterioration of the environment and negatively impacted health and safety. Clean-up of brownfields sites may remove ground pollutants from the area and allow potentially harmful areas to be restored. Use of brownfields sites, however, will require proper construction techniques and disposal of contaminated soils and materials.

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10.8.2.4 Resource Protection/Restoration

For the most part, resource protection and restoration projects would have positive effects as these activities would be undertaken with the specific goal of improving the natural environment. As with any activity, however, the potential does exist for accidents to occur during construction.

10.8.2.5 Bridges and Roadways

By improving highway safety, construction of new bridges and roadways will have a positive effect on overall health and safety. Temporary impacts could occur during construction, however.

10.8.2.6 Natural Events

Floods or storms are dangerous occurrences for river users, especially inexperienced boaters or recreational users. Inclement weather can increase the potential for river-related accidents, barge breakaways, and pollution incidents. Heavy precipitation, high winds, rising water, swift currents, lightning and debris all endanger boaters and shoreline workers. Though most people have sense to get off the water during storms, bad weather can arise quickly and catch boaters or work crews in precarious situations. Although these occurrences cannot be prevented, better forecasting, improved communications, and enhanced boater education can help prevent injuries and deaths and minimize environmental impacts.

10.8.2.7 Regulatory Environment

One of the key underlying components of the regulatory environment is to assure good public health. Almost all of the regulations in place have an underlying theme of public health improvements, even programs aimed at bringing additional recreational resources to the area. Regulations, policies, and programs supporting health and safety will continue and are likely be strengthened as new problems arise.

The regulatory environment includes boating safety regulations, other safety regulations, ORSANCO monitoring, and spill response. Recreational boating accidents, however, often are a result of alcohol consumption, inexperience, or inattention to boat and river conditions. These are difficult activities to overcome with regulations alone. Better educational programs and enforcement would result in safer boating on the Ohio River.

Awareness of ORSANCO and its programs have increased. Measures currently in place by ORSANCO, USCG, USACE, USEPA, and state agencies should continue to reduce accidental spills and their adverse effects on water quality, particularly on drinking water and edible fish. Measures currently in place by OSHA and state agencies will

10.9 ANALYSIS OF ENVIRONMENTAL SUSTAINABILITY

Numerous quantitative resources are available to serve as indicators of health and safety. Indicators for health and safety include the number and severity of oil, fuel, and other hazardous or toxic materials spills; sources of past and present contamination (industrial sites, landfills, underground storage tanks); commercial and recreational boating accidents; and health impacts associated with water quality issues.

Environmental sustainability occurs when environmental and economic considerations are balanced through the life cycle of project planning, design, construction, operations, and maintenance to improve the quality of life for present and future generations. Accordingly, environmental sustainability, as measured by the indicators discussed above, represents an ultimate test of significance of potential cumulative effects. In the Pittsburgh area, conditions sustaining healthy and safety are mixed, with both positive and negative forces affecting them.

10.9.1 Positive Forces Affecting Health and Safety

Since the 1970s, regulatory programs have been put in place to improve the environment. These regulatory programs include laws and regulations for facilities that process, store, and transport hazardous materials; facilities that discharge into the rivers; education requirements for employees that handle hazardous wastes; navigational improvements for both commercial and recreational traffic on the rivers; increase in education of recreational and commercial boaters; and an increase in the number and type of national and statewide fish consumption advisories.

These laws and regulations have been and will continue to be a major influence in improving the environment in the upper Ohio River study area. Evidence of their success is apparent by a review of the indicators of sustainability.

While in the past, spills on the river were likely to occur anywhere, they are now generally concentrated in major port areas and industrial areas. These are locations where the volume of activity and type of operation increase the probability of incidents. Nonetheless, regulations are in place to limit spills and respond quickly.

Contamination from industrial sites, landfills, and underground storage tanks are decreasing. Although much contamination has been eliminated because industrial and similar type facilities have shut down, regulations have toughened, making significant pollution a thing of the past. Additionally, old brownfields sites are being redeveloped into cleaner, more environmentally friendly areas, correcting past mistakes from pollution that have affected public health.

Boating accidents are also decreasing. Over the past 20 years, accidents for recreational boating have dropped nationally from a high of about 8,000 in the late 1990s to about 5,000 two years ago. Locally (Ohio, Pennsylvania, and West Virginia), there were 382 boating accidents in 1999 and 211 in 2007, although the decline was not at a uniform rate over the intervening years. Still, the occurrence of accidents is trending downward.

Water quality is improving. Nothing has been more vital to water quality improvements than the Clean Water Act and the ORSANCO Compact. These agreements have resulted in vast improvements to water quality and will continue to maintain and improve water quality throughout the upper Ohio River. The treatment of acid mine drainage and municipal and industrial wastes will continue to be important to maintaining and improving water quality.

10.9.2 Negative Forces Affecting Health and Safety

As the quality of the natural environment continues to improve and regulatory programs that have been put in place continue, there would appear to be few forces negatively affecting health and safety. Conflicts could arise, however, if the amount of traffic on the river increases and more shorelines are developed, which could lead to the potential for more spills and accidents.

Regulations regarding sewage and other types of discharges into the river have been initiated; however, untreated sewage discharging into the river, especially during rain events where flow levels are higher than the capacity of the treatment facility, is still an issue. There is not enough funding currently available to correct this situation throughout the area.

10.9.3 Incremental Impacts on EDM

For the most part, the incremental impacts of EDM improvements will be positive. Modern, longer locks will allow for more efficient movement of commercial traffic from one pool to another. This will increase safety and accessibility. Lock extensions could, however, indirectly cause demand for development within study area floodplains, riparian buffers, and open space by creating opportunities for additional commercial or industrial development. Commercial and industrial development could lead to an increase in commercial barge traffic, hazardous substances stored along the river and outfalls, and potential discharges into the river. There are also likely to be some temporary negative effects on health and safety during construction.

10.10 DETERMINATION OF SUSTAINABILITY

Three specific definitions of environmental sustainability were used for the analysis:

- Not sustainable – conditions for the selected indicators do not facilitate attainment of acceptable standards or would not maintain existing standards in concert with collective impacts of proposed activities.

- Marginally sustainable – conditions for selected indicators are such that attainment of acceptable conditions is accomplished for the majority, but not all, of the potentially affected resources. However, the conditions are somewhat tenuous both in location and likelihood of occurrences. (In other words, the conditions are borderline for environmental sustainability, and there are uncertainties regarding specific quantitative measures.)

- Sustainable – conditions for selected indicators are such that attainment of acceptable conditions is accomplished for essentially all of the potentially affected resources in the project area, and such standards are maintained in concert with foreseeable future activity. Further, conditions exceed regulatory thresholds, and various governmental programs are in place to respond to any potential erosion of values related to, in this case, health and safety.

Figure 10-4 illustrates the environmental sustainability of health and safety. Sustainability of health and safety can be characterized as the following:

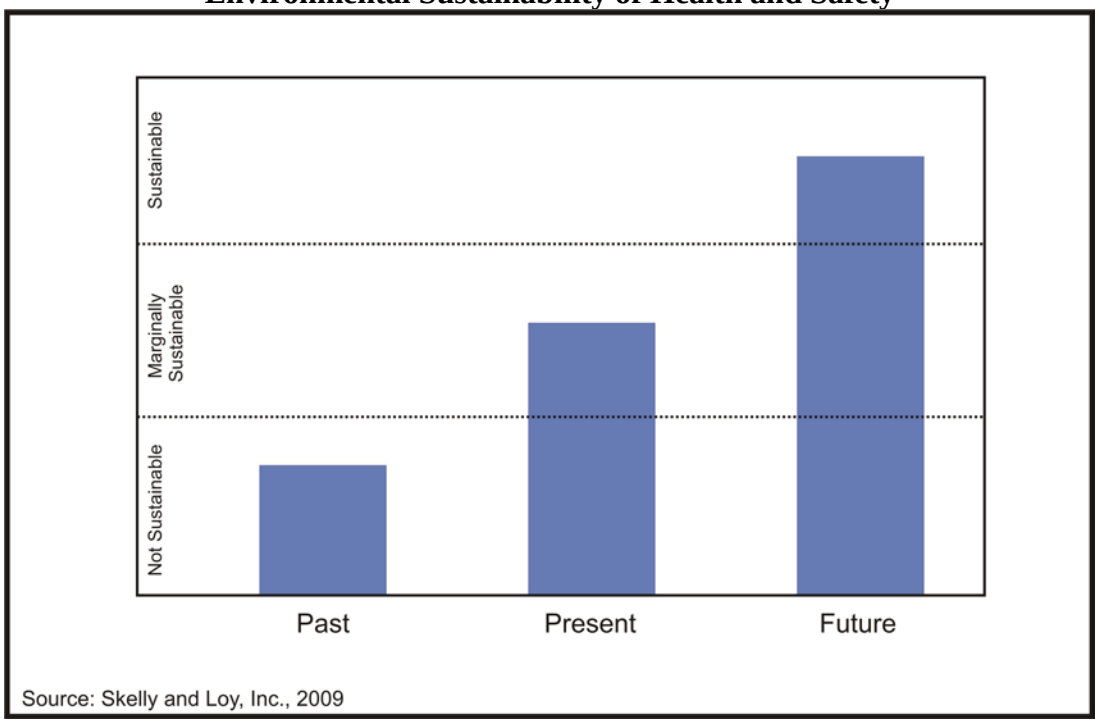
- In the time period prior to 1920 and continuing into the 1960-70s, health and safety issues on the Ohio River represented a broad spectrum of risk factors. Construction and workplace conditions were generally more dangerous than at present; spills and discharges from commercial navigation, river-oriented industries, and untreated municipal effluents contributed to a variety of public health risks; and little or no information was available to advise the public of ambient risk levels associated with river-oriented activities. While individual risk factors no doubt varied significantly from time to time, most issues for the period are categorized as not sustainable.

- Improvements to water quality, reduced risks of spills and faster responses, improved workplace safety standards, and effective safety standards for recreational boating have all combined to make the Ohio River area a safer place to work, live, and play. Brownfields sites have been cleaned and in many cases redeveloped for less benign use. Improved conditions have also contributed to reduced risk factors associated with contact recreation and fish consumption. However, problems associated with continued exceedances of biological standards, persistence of some contaminants associated with fish consumption, and mixed signals regarding fish consumption standards result in a present classification of marginally sustainable.

- With respect to the future, most issues are expected to reach a sustainable condition, primarily because the long term effect of laws and regulations put in place over the past 40-50 years will continue to bear fruit. Additionally, there is a renewed emphasis from society, in general, to improve health and safety for recreation users and workers. Some of the efforts required for continued improvement, such as rehabilitation of sanitary sewer systems to eliminate CSOs and SSOs, or reduction of mercury emissions from coal combustion, however, will require significant investments and a longer period of time to achieve results.

While improved health and safety improvements may slow, they will most likely not be diminished.

FIGURE 10-4
Environmental Sustainability of Health and Safety



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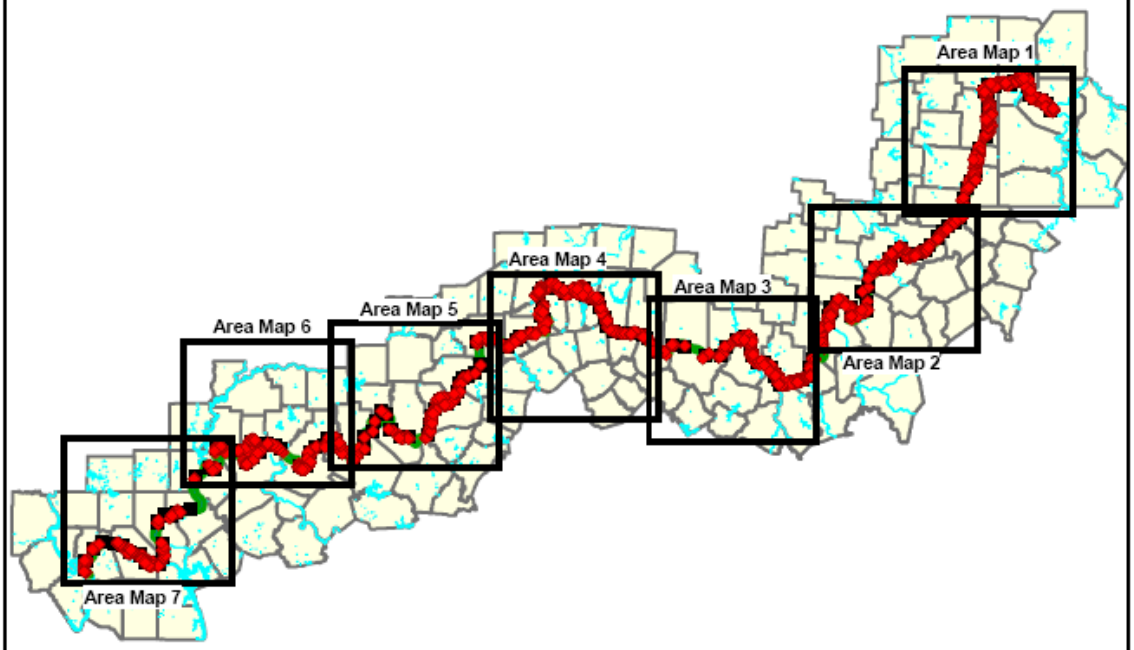
SUPPLEMENT 10-A

EXAMPLE MAPS AND RECORDS FROM

SITE DATABASE SEARCH

SITE ASSESSMENT - SPECIAL PROJECT (ALL DATABASES SEARCHED TO 1 MILE)

Overview Map



Subject Centerline

Search Area

Risk Sites

Risk Sites Plotted as Polygons

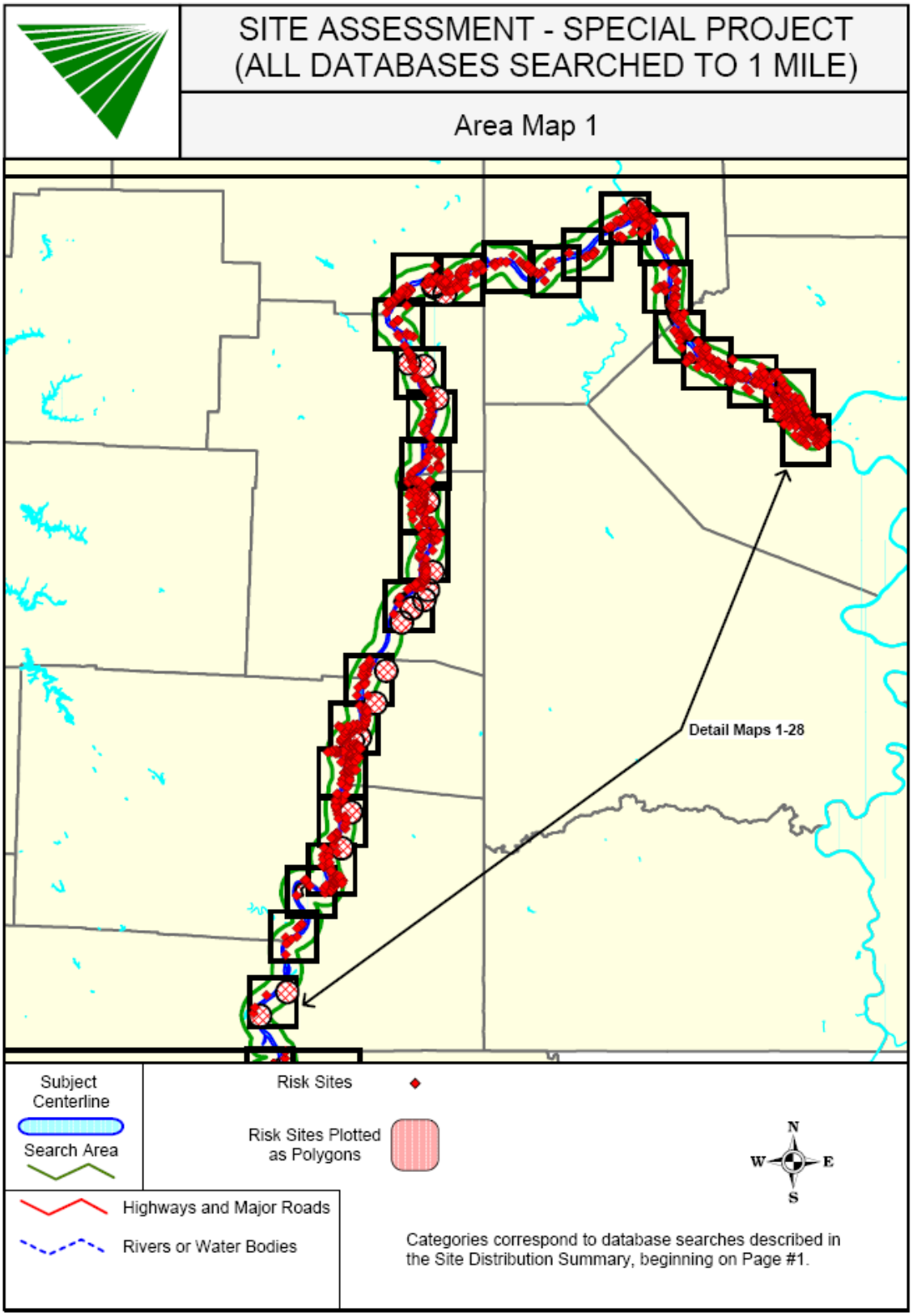
N
W
E
S

Highways and Major Roads

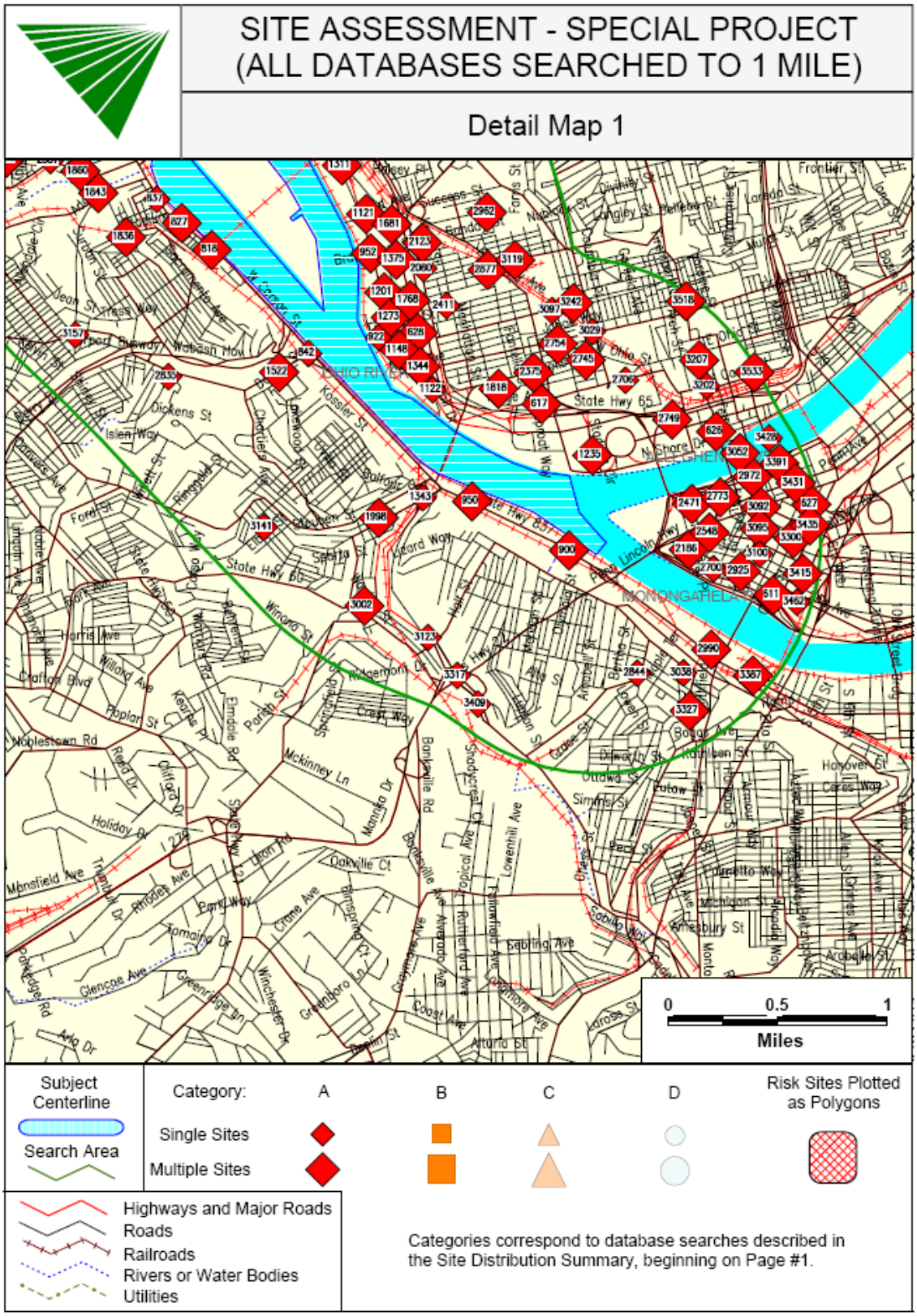
Rivers or Water Bodies

Categories correspond to database searches described in the Site Distribution Summary, beginning on Page #1.

For More Information Call VISTA Information Solutions, Inc. at **1 - 800 - 767 - 0403**
Report ID: **436489001**
Date of Report: **October 25, 2001**



For More Information Call VISTA Information Solutions, Inc. at **1 - 800 - 767 - 0403**
Report ID: **436489001** Date of Report: **October 25, 2001**



For More Information Call VISTA Information Solutions, Inc. at **1 - 800 - 767 - 0403**
Report ID: **436489001** Date of Report: **October 25, 2001**

Incident Reports for Site 950 (page 1 of 3)

VISTA Address*:	1686 W KARSON PITTSBURGH, PA 0	VISTA ID#:	66130614
		Distance/Direction:	0.06 MI / E
		Plotted as:	Point
ERNS - Emergency Response Notification System / SRC# 8		Agency ID:	530590

Agency Address:	SAME AS ABOVE
NRC Report #:	530590
Location	1686 W KARSON PITTSBURGH PA
County:	ALLEGHENY
Discharger Last Name:	UNKNOWN
Discharger Company	GUTTMAN OIL
Discharger Organization Type	PRIVATE ENTERPRISE
Discharger Address	1686 WEST KARSON PITTSBURGH PA
Discharger Phone #	4122552935
Date/Time Reported:	30-MAY-00
Date/Time Completed:	30-MAY-00
Call Taker:	JLC3759
Cause of Incident:	UNKNOWN
Date/Time of Incident:	30-MAY-00
Description of Incident:	COMPLAINT OF DIESEL FUEL SPILL AT A GAS STATION
Incident Type:	FIXED
Air Release:	NO
Land Release:	NO
Water Release:	YES
Ground Release:	NO
Facility Release:	NO
Other Release:	NO
Media Affected	WATER
Source:	UNAVAILABLE
Comments	NEUTRALIZED MATERIAL,INVESTIGATION UNDERWAY
CAS #:	000000-00-0
CHRIS Code:	OTD

Material Spilled:	OIL, FUEL: NO. 2-D
Material Quantity:	4
Unit Of Measuere:	GALLON(S)
Fields Not Reported by the Source Agency for this Site:	Name(1), Location II(1), Location III(1), Discharger First Name(1), Discharger Secondary Address(1), Additional Medium Information(1)

Incident Reports for Site 950 (page 2 of 3)

VISTA Address*:	WEST CARSON STREET EXXON 1686 W CARSON ST PITTSBURGH, PA 15219	VISTA ID#: Distance/Direction: Plotted as:	2418934 0.06 MI / E Point
STATE UST - State Underground Storage Tank / SRC# 450		EPA/Agency ID:	N/A

Agency Address:	SAME AS ABOVE
Facility Name:	WEST CARSON STREET EXXON
Facility Address:	1686 W CARSON ST PITTSBURGH, PA 15219
Facility ID #:	02-03574
Total Underground Tanks:	5
Total Aboveground Tanks:	NOT REPORTED
Total Tanks Removed:	NOT REPORTED
Owner ID #:	21838
Owner Name:	GUTTMAN OIL CO
Owner Address:	200 SPEERS ST BELLE VERNON, PA 15012
Owner Phone #:	6372448335
Tank ID #:	952
Tank Sequence:	001
Tank Installation Date:	19781201
Tank Capacity (G):	00008000
Tank Contents:	DIESEL
Tank Status:	CURRENTLY IN USE
Tank ID #:	953
Tank Sequence:	002
Tank Installation Date:	19811201
Tank Capacity (G):	00008000
Tank Contents:	GASOLINE
Tank Status:	CURRENTLY IN USE
Tank ID #:	954
Tank Sequence:	003
Tank Installation Date:	19781201
Tank Capacity (G):	00010000
Tank Contents:	DIESEL
Tank Status:	CURRENTLY IN USE
Tank ID #:	955
Tank Sequence:	004
Tank Installation Date:	19811201
Tank Capacity (G):	00010000

Incident Reports for Site 950 (page 3 of 3)

Tank Contents:	GASOLINE
Tank Status:	CURRENTLY IN USE
Tank ID #:	956
Tank Sequence:	005
Tank Installation Date:	19811201
Tank Capacity (G):	00010000
Tank Contents:	GASOLINE
Tank Status:	CURRENTLY IN USE
Fields Not Reported by the Source Agency for this Site:	Facility Secondary Address(1)

STATE LUST - State Leaking Underground Storage Tank / SRC# 453	EPA/Agency ID:	N/A

Agency Address:	WEST CARSON STREET EXXON 1686 W CARSON ST PITTSBURGH, PA 0
Site Name:	WEST CARSON STREET EXXON
Site Address:	1686 W CARSON ST
Site City:	PITTSBURGH
Site State:	PA
Site County:	ALLEGHENY
Site Region:	SOUTHWEST
Class:	CLEANUP OF UNDERGROUND STORAGE TANKS AT FEDERALLY REGULATED PETROLEUM FACILITIES
Substance Leaked:	LEADED GASOLINE
Media Affected:	NOT REPORTED
Discovery Date:	NOT REPORTED
Class:	CLEANUP OF UNDERGROUND STORAGE TANKS AT FEDERALLY REGULATED PETROLEUM FACILITIES
Date Closed	2/16/96
Substance Leaked:	UNLEADED GASOLINE
Media Affected:	NOT REPORTED
Discovery Date:	NOT REPORTED
Fields Not Reported by the Source Agency for this Site:	Date Closed(1)

Chapter 11

SOCIOECONOMICS

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11.1 DEFINITION

Socioeconomics is the study of the economic, demographic, and social interactions of humans. The study of socioeconomic factors identifies the relationship between economic activity and social life. It also quantifies those relationships so that comparisons and contrasts between groups can be made.

The *National Environmental Policy Act* (NEPA) provides the basic national charter to assess and mitigate impacts to human communities, neighborhoods, cultural groups and others. These social impacts have been defined in the Interorganizational Committee on Guidelines and Principles (1994) as:

> The consequences to human populations of public or private actions that alter the ways in which people live, work, play, relate to one another, organize to meet their needs and generally cope as members of society. The term also includes cultural impacts involving changes to the norms,

values, and beliefs that guide and rationalize their cognition of themselves and their society.

Environmental justice is a major component of social impact analyses related to NEPA. It addresses the issue of potential disproportionate impacts on minority and economically disadvantaged populations. Executive Order 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations*, provides that "each Federal agency shall make achieving environmental justice part of its mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations" (Office of the President 1994).

Economic development and infrastructure projects can lead to direct changes in land use and changes in population density. Of all the factors influencing the environment, mankind – as a modifier and user of land – will have the most critical impact on all resources – socioeconomic or natural (Weber 1974). Land use changes occur as a result of population increases or decreases in localized areas.

11.2 OBJECTIVES/SCOPE

11.2.1 Objectives

This chapter provides an overview of socioeconomic trends throughout the upper Ohio River area. This chapter also assesses the system-wide cumulative impacts to socioeconomic resources from likely future major navigation improvements. Impacts that are directly or indirectly attributable to modernization of the navigation system are evaluated in concert with impacts from other past, present, and reasonably foreseeable future actions (RFFAs) by the United States Army Corps of Engineers (USACE) and others.

Assessment of past and present actions and current conditions is the basis for identifying and interpreting the potential impacts of RFFAs. These future actions include the major navigation improvements identified in this study; other routine or potential actions by the USACE; projected actions by other federal, state, or local agencies; actions by non-governmental entities; and predictions of general economic expansion and development.

The results of the cumulative effects assessment (CEA) are intended to determine whether the impacts of the RFFAs constitute acceptable outcomes for the affected resources and how the proposed navigation improvements contribute to those outcomes.

11.2.2 Geographic Scope

The geographic focus for examining potential impacts to socioeconomic resources includes those areas most directly impacted by operation and maintenance of the navigation system. In order to reflect influences of the navigation system in the context of broader business and economic forces, as well as to maintain consistency with the scope of other

chapters, the Pittsburgh Metropolitan Statistical Area (PMSA) is included in the geographic focus for identifying these impacts.

11.2.3 Time Frame

The established time frame for this assessment is 1885 to 2070. The earlier date is when initial the initial lock and dam construction on the Ohio River began. It approximates the beginning of the modern lock and dam system. The latter date approximates the economic life of anticipated improvements on the Ohio River and is considered the planning horizon for the project.

11.3 ISSUES FROM SCOPING

Scoping has occurred both as part of the Ohio River Mainstem Study (ORMSS) and for the Upper Ohio Navigation Study. A series of 12 public scoping meetings was held for ORMSS during the summer of 2001. Subsequently, a series of three public scoping meetings was held for the Upper Ohio Navigation Study in October 2006. Approximately 185 people attended the ORMSS meetings and approximately 40 people attended the Upper Ohio Navigation Study meetings.

Several comments related to socioeconomic resources were made during both sets of meetings. Comments that are associated with socioeconomic resources, including environmental justice issues, are shown in Table 11-1. Some data from ORMSS have been aggregated in the table below. As a result, they may have been interpreted differently here and do not tie directly into individual comments found in ORMSS.

TABLE 11-1
Comments on Socioeconomic Resources from Public Scoping Meetings

Comment	Number of Similar Comments	Scoping Meeting
Potential adverse effects of higher pool elevations on bridges, other infrastructure, and property	12	ORMSS, Upper Ohio River Nav. Study
Bank undercutting and failure caused by increased barge traffic/queuing/wave action	11	ORMSS
Loss of shoreline trees and riverfront property	8	ORMSS
Importance of maintaining shipping channel and improving intermodal transportation facilities	6	ORMSS
Increase in trash for property owners and river users	6	ORMSS
Mouths of tributaries silted in, limiting access and causing property damage	5	ORMSS
Development of marina facilities causing a loss of greenspace	5	ORMSS
Potential development of hydroelectric power at dams	5	ORMSS

TABLE 11-1 (continued)
Comments on Socioeconomic Resources from Public Scoping Meetings

Comment	Number of Similar Comments	Scoping Meeting
Changes in shipping demand and river traffic	5	ORMSS, Upper Ohio River Nav. Study
Clarify project communication and processes	4	Upper Ohio River Nav. Study
Loss of farmland along river corridor	3	ORMSS
Navigation structures not keeping pace with traffic demands	3	ORMSS
Procurement/control of land by federal government	3	ORMSS
Increased industrialization/traffic causing degradation of recreational value	3	ORMSS
Property restrictions	2	ORMSS
Increased development of scenic byways and bikeways	2	ORMSS
Effects on groundwater	2	ORMSS
Potential conflicts between siting of new navigation facilities and riverfront development	2	Upper Ohio River Nav. Study
Riverfront development constraints related to endangered species	1	ORMSS
Potential impairment of scenic value	1	ORMSS
Need for coordination between USACE and transportation planning agencies	1	Upper Ohio River Nav. Study

Additional information and comments have been sought from the environmental resource agency representatives and planning officials serving on the Interagency Working Group (IWG). Comments from IWG members on potential impacts to socioeconomic resources focused on economic growth, river traffic and transportation, and the potential for new generating plants along the Ohio River.

11.4 LAWS, REGULATIONS, ORDINANCES, AND PROGRAMS

Council on Environmental Quality (CEQ) regulations (CEQ 1997) note that when "economic or social and natural or physical environmental effects are interrelated," an environmental impact statement (EIS) should discuss them in context of their impact on the human environment (40 CFR 1508.14). Specific laws, regulations, ordinances, and programs related to social impact assessment or environmental justice are found in Table 11-2.

Although virtually every law, regulation, or program addressing the development or management of public resources can be interpreted as having a social impact component, Table 11-2 lists regulatory statutes of significance to USACE activities that include specific reference to public (or state/local) participation in agency decision making or that mandate attention to differential impacts of program activities.

TABLE 11-2
Laws, Regulations, Ordinances, and Programs Relevant to Socioecomic Resources

Law/Program (Lead Agency)	Key Components	Relevance to Socioeconomic Resources
Emergency Planning and Community Right-To-Know Act of 1986 and Pollution Prevention Act of 1990 (U.S. Army Corps of Engineers)	• Provides citizens, local governments, and response authorities with information regarding potential hazards in their community • Requires emergency planning, mandates reporting, designates local authorities as recipients of information	Designated to promote emergency planning and preparedness at both the state and local levels
Permitting Statutes (U.S. Army Corps of Engineers)	• Section 10 of Rivers and Harbors Act (1899) prohibits the unauthorized obstruction or alteration of any navigable water of the United States. • Section 404 of the Clean Water Act authorizes the USACE to issue permits for the discharge of dredged and fill materials into waters of the U.S.	Permits require assessment of impacts on water quality, aquatic ecological resources, and socioeconomics; and mandate mitigation of adverse impacts
Flood Control Act of 1944 (U.S. Army Corps of Engineers)	• Authorizes the USACE to construct, maintain, and operate public park and recreational facilities at water resources development projects (includes non-reservoir projects) • Local interests also permitted to construct, operate, and maintain such facilities	Water areas of all such projects shall be open to public use for general recreational purposes; includes public access
National Environmental Policy Act (NEPA) (Council on Environmental Quality and other agencies)	• Requires preparation of environmental impact assessments for new construction projects by private and governmental agencies • Includes federal government's responsibility to assess the social impact of proposed actions	Provides basic national charter to assess and mitigate impacts to human communities, neighborhoods, cultural groups, and others

TABLE 11-2 (continued)
Laws, Regulations, Ordinances, and Programs Relevant to Socioecomic Resources

Law/Program (Lead Agency)	Key Components	Relevance to Socioeconomic Resources
Site Remediation Statutes (U.S. Environmental Protection Agency and state regulatory agencies)	• Includes the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), Superfund Amendments and Reauthorization Act (SARA), Resource Conservation and Recovery Act (RCRA) and related state programs that focus on cleanup and restoration of contaminated sites	Protects human health and the environment and eliminates or reduces the generation of hazardous wastes
Executive Order 12898 Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations	• Directs federal agencies to address disproportionately high and adverse human health or environmental effects of agency programs, policies, and activities on minority populations and low-income populations	Includes provisions for assisting disadvantaged groups' participation in agency decision making
Title VI of the Civil Rights Act of 1964 (U.S. Department of Justice)	• Requires agencies to ensure effects of actions are nondiscriminatory	Similar to environmental justice, but generally required action by affected groups to address impacts
Ohio Revised Code	• Provides the legal basis for land use planning and zoning	Planning is permissive rather than mandatory, key aims are to limit sprawl and preserve natural resources, especially farmlands
PA Municipalities Planning Act	• Provides the legal basis for land use planning and zoning	Focuses on the comprehensive plan as the key component guiding land use planning, but allows for development of other types of local planning
WV State Code Chapter 8A Planning and Zoning	• Provides the legal basis for land use planning and zoning	Establishes procedures for planning, but is generally permissive rather than mandatory. Requires plans and plats for land development
State Programs on Economic Development	• Provides grants and loans for development efforts, many programs focus on redevelopment of brownfields	Often, a key mechanism for determining how land will be redeveloped, frequently focuses on job creation

11.5 PAST TO CURRENT BASELINE CONDITIONS

Although Pittsburgh's location at the confluence of the Monongahela, Allegheny and Ohio rivers served it well during its early years, the rapid construction of railroads in the Ohio River Valley was a catalyst for the subsequent decline of river transportation between 1850 and 1860. The railroad's ability to operate year round was a significant advantage over the seasonal and unpredictable fluctuations of river borne commerce. Railroads also offered steeply discounted freight rates during the 1850s. As a result, rail lines came to dominate the transportation of upper and middle Ohio River Valley agricultural produce to national markets and the movement in merchandise and manufactured goods moving the other way (Muller 1972: 343).

The emergence of railroads in the mid-19th century has tended to overshadow the economic contributions of the Ohio River Navigation System during the twentieth century. Construction of the initial navigation system between 1904 and 1929 occurred at a time when commercial river traffic was falling due to the combined impact of railroads and the emergence of the nation's highway system. The growth of these forms of transportation blurred recognition of the continuing but lower amplitude contribution of river commerce to contemporary urban life, especially in the cost-effective transport of bulk commodities such as coal and steel products, petroleum, and chemicals (USACE 2001).

Completion of the navigation system resulted in the availability of dependable year-round transportation in a 9-foot channel. The demands of World War I contributed to a rediscovery of the capabilities of the improved system and cargo shipments began to increase from 1917. They continued increasing through the 1920s. Commercial towing companies and related construction, maintenance, and repair facilities became an important part of the river valley economy (Blagg 1947).

By the 1920s, Pittsburgh produced one third of the national output of finished and rolled steel, and had the world's largest tube and pipe mill, structural steel plant, rail mill, wire manufacturing plant, and bridge and construction fabricating plant. Many of these manufacturing facilities were located adjacent to the area's three main rivers. After the Second World War, the Ohio River Valley enjoyed an economic boom that was based on the low cost of moving bulk goods on the river and the region's low electric power costs. Between 1946 and 1953 many new industrial plants were built in the Ohio River Valley (Bigham 1991:165). Electric plants in the region grew because of the advantages of cheap transportation of coal by water from both the Appalachian and lower Ohio fields.

One of the few specific studies of the economic benefits of the Ohio River Navigation System was conducted by Joseph R. Hartley. Hartley found that river shipping had experienced a dramatic decline in the late 19th and early 20th centuries due to the national growth of railroads and, beginning in the 1920s and 1930s, to the development of long-haul trucking, but made a significant comeback by the 1950s, growing from 20 billion ton-miles in 1939 to 120 billion ton-miles in 1957. Hartley also noted that transporting coal on the Ohio River to industrial consumers, many of them electrical generating plants, had kept the cost of both coal and electrical power down for millions of consumers. Because these electrical generating plants were developing transmission lines to towns and cities

within 100-150 miles of the river, the benefits of cheaper electricity were being shared with urban centers far removed from the Ohio River itself (Hartley 1959).

By the mid-1950s, the Ohio River Navigation System had helped to sustain lower costs for the coal, electric utility, and steel industries. In turn, energy prices and the cost of durable goods (automobiles, stoves, and refrigerators) were held low for individual consumers. Hartley found that the Ohio River Valley had benefited directly from increased industrial investment, job growth, greater per capita income, higher retail sales, and urban growth. The last three categories were higher in the Ohio River Valley than for the nation as a whole even though the overall prosperity of the Ohio River Valley still lagged behind the rest of the country. Hartley concluded, "Improvement of the River has helped provide an economic base for healthy, sustained, and rational economic growth" (1959). Pittsburgh and its surrounding communities were the beneficiaries of much of this growth during the time.

Pittsburgh's prominence was established through many things, but its point of connection was one of the major factors supporting its industrial growth (USACE 2001). Unfortunately, population and the area's economic base began to decline in the 1960s. In the late 1970s and early 1980s, over 100,000 steel workers lost their jobs as the economy of the region shifted to service and retail-oriented businesses. According to Carlisle and Mulligan, jobs and people left and there was a virtual collapse of heavy industry in the mid-1980s (USACE 2001). By 2000, Pittsburgh's population had dropped to levels not seen since before WWII.

Though population decline and the loss of many industrial operations has continued through today, Pittsburgh has recently "reimagined itself as a high tech center and met with more success than other communities" (Florida 2009). Though not called a reimagining, the draft Allegheny County comprehensive plan also recognized the transition from manufacturing to a service-based economy, noting that while manufacturing remains an important sector, it is no longer a significant generator of income (Allegheny County 2008).

The shift away from industrial employment is apparent upon an examination of the region's top employers. Of the region's 25 top employers in 2008, only three (US Steel Corporation, Westinghouse Electric Company, and Allegheny Technologies) are manufacturers. The remaining top employers are primarily involved with health care, government, education, financial, or retail services. In fact, the area's top employers are the University of Pittsburgh Medical Center (UPMC), the U.S. government, the Commonwealth of Pennsylvania, Giant Eagle Supermarkets, and the West Penn Allegheny Health System. The first manufacturer on the list is US Steel, ranked at number 16.

Despite the industrial decline of the Pittsburgh area, there are still many industrial facilities along the upper Ohio River. Some of those facilities in Allegheny County are clustered in McKees Rocks, on Neville Island, and at the Leetsdale Industrial Park. In Beaver County, they include Horsehead Corporation, U.S. Gypsum, Nova Chemicals, National Gypsum Company, and BASF, among others. In Hancock County, they include the Homer Laughlin China Company and the Bellofram Corporation. In Columbiana County, they include Polar Minerals, Quality Liquid Feeds, and PROBEX.

The Neville Island industrial and office complex, however, is the only new major industrial facility developed along the Ohio River since 2006. Several other brownfields or potential redevelopment sites were identified during Allegheny County's comprehensive planning process. Included as possible redevelopment sites are the following:

- PL & E, McKees Rocks;
- 3400 Grand Avenue, Neville Island;
- M&B Development;
- The Neville Island Keystone Opportunity Zone;
- Fab Tech and Buckeye Pipeline; and
- Leetsdale Industrial Park.

Despite the fact that, other than on Neville Island, there have been no redevelopment activities at these specific locations yet, the Pittsburgh area has finally started to focus efforts on riverfront development after years of neglect. Although opportunities are finite, light industry, commercial and residential development, and recreational complexes in and around Pittsburgh are finally using the river environment to its full advantage (Muller 2003).

Table 11-3 provides a list of major riverfront terminals and intermodal facilities currently in operation along the river within the study area.

In addition to these terminals, the Port of Pittsburgh has identified additional economic development opportunities in the area. In Allegheny County, those properties are located at the Leetsdale Industrial Park, McKees Rocks Industrial Enterprises, and Davis Island Parcel. Approximately 44 acres with rail connections are available at the Davis site. There are five additional opportunities in Beaver County. Those properties are located at Industry, Aliquippa, and Ambridge. Together they offer approximately 260 acres for redevelopment.

11.5.1 Population History and Projections

Population history and projections for each county in the project area (Allegheny and Beaver counties, PA, Columbiana and Jefferson counties, OH, and Hancock County, WV) were obtained from a variety of sources, including the draft ORMSS Programmatic EIS/System Investment Plan (Environmental Appendix Volume 1, *Cumulative Effects Assessment*), the U.S. Census Bureau, the Southwest Pennsylvania Commission, Brooke-Hancock-Jefferson Metropolitan Planning Commission (BHJ), the Ohio Department of Development, and the West Virginia Development Office. Population projections were also obtained for each core based statistical area (CBSA) that encompasses the project area in part. The Office of Management and Budget (OMB) defines CBSAs as metropolitan or micropolitan areas for purposes of collecting, tabulating, and publishing federal data.

TABLE 11-3
Major Riverfront Terminals and Intermodal Facilities

Site	River	Mile	Location	Size	Rail Available
Gordon Terminal Services	Ohio	3.2L	McKees Rocks	--	No
McKees Rocks Industrial Enterprises		4.0L		90 ac	Yes
Mol-Dok Co.		14.1R	Leetsdale	20 ac	Yes
Three Rivers Aggregates		14.4L	Glenwillard	10 ac	No
Port of BeeMac		14.5R	Leetsdale	--	Yes
Pittsburgh Intermodal Terminals		16.5	Ambridge	30 ac	Yes
Aliquippa Terminals		16.8L	Aliquippa	31 ac	Yes
Gordon Terminal Services		21.1L	Coraopolis	--	No
Colona Transfer		23.5L	Monaca	60 ac	Yes
Industry Terminal And Salvage Co.		33.2R	Industry	--	No
Kinder Morgan		33.5R		40 ac	Yes
S.H. Bell		40.1R	E. Liverpool	85 ac	Yes
S.H. Bell (Braddock)	Monongahela	9.9R	Braddock	7 ac	Yes
Josh Steel		10.1R		--	Yes
Gulf Materials Dock		10.2R		5 ac	Yes
None	Allegheny	--	--	--	--
L = Left; R = Right					
Source: Port of Pittsburgh Commission, 2009					

The three CBSAs in the project area are Pittsburgh (including Allegheny, Armstrong, Beaver, Butler, Fayette, Washington, Westmoreland counties, all in Pennsylvania), Steubenville-Weirton (including Brooke and Hancock counties in West Virginia and Jefferson County in Ohio), and Youngstown-Warren-East Liverpool (including Columbiana, Mahoning, and Trumbull counties, all in Ohio).

The population of the United States is expected to grow from about 304,000,000 in 2008 to approximately 439,000,000 in 2050. During this timeframe, the total population of the United States is expected to grow by less than one percent each year, gradually slowing from approximately 0.9 percent change from 2008 to 2009 to about 0.8 percent change from 2049 to 2050. These data were prepared by the U.S. Census Bureau (USCB) as part the National Population Projections (USCB 2008). The National Population Projections provide projections of population and demographic components of change (births, deaths, and net international migration) through 2050. The projections are based on the 2000 Census using a cohort-component method to determine demographic change. The components used are births, deaths, and net international migration for each birth cohort (all persons born in a given year).

Population has been declining for the combined CBSAs in the project area for many decades, decreasing at an average rate of 3.9 percent annually since 1970. Population is expected to continue declining through 2020, but based on the strength of the Pittsburgh

CBSA alone, begin increasing again between 2020 and 2030. Population trends for the CBSAs within the project area are shown in Table 11-4.

TABLE 11-4
Population Trends for Core Based Statistical Areas in the Project Area (in millions)[1]

CBSA	1970	1980	1990	2000	2010	2020	2030	2040	2050
Pittsburgh	2,792	2,683	2,504	2,467	2,428	2,447	2,499	2,541	2,588
Steubenville-Weirton	167	163	142	137	129	126	125	125	126
Youngstown-Warren-East Liverpool	644	645	601	595	576	559	540	524	508
Totals	3,603	3,491	3,247	3,199	3,133	3,132	3,164	3,190	3,222

[1] 1970-2000 are actual counts; remaining years are projections

Sources: USCB, 2009; USACE, 2006; Ohio Department of Development, 2000; Workforce West Virginia, 2008a

All three of the CBSAs have generally lost population over the past 40 years. As noted earlier, this trend is expected to continue except for the Pittsburgh area, which is should rebound slightly by 2040. Even with modest growth, however, the overall Pittsburgh area is not expected to see population return to its earlier population peaks.

Population decline has been the trend within the individual counties found in the project area, too. Population loss is expected to continue through 2030 in Columbiana and Jefferson counties, but is expected to begin growing again in Allegheny and Beaver counties by 2020 and in Hancock County by 2050. The population trends for the individual counties are shown in Table 11-5.

TABLE 11-5
Population Trends for Counties in the Project Area (in millions)[1]

County	1970	1980	1990	2000	2010	2020	2030	2040[2]	2050[2]
Allegheny County, PA	1,605	1,450	1,336	1,281	1,236	1,298	1,395	1,422	1,422
Beaver County, PA	208	204	186	181	178	188	206	216	216
Columbiana County, OH	108	114	108	112	112	113	112	112	112
Hancock County, WV	40	40	35	33	30	29	28	28	29
Jefferson County, OH	96	92	80	74	67	61	56	56	56
Totals	2,057	1,900	1,745	1,681	1,623	1,689	1,797	1,834	1,835

[1] 1970-2000 are actual counts; remaining years are projections.

[2]Projections for 2040 and 2050 are unavailable for all but Hancock County. The 2035 projection for Allegheny and Beaver counties is used for 2040 and 2050 and all other counties are held constant from 2030 to 2050.

Sources: USCB, 2000a, 2008; SPC, 2007; Ohio Department of Development, 2005, 2008; West Virginia University, 2008

In related national trends, U.S. labor force participation for civilians 16 and older is expected to increase from a rate of about 0.67 percent in 1997 to about 0.71 percent by 2016. Thereafter, it is expected to slow to 0.59 percent by 2050. Productivity or Gross Domestic Productivity (GDP) per worker is expected to increase at an annual rate of 1.16 percent between 1997 and 2025, and thereafter grow at a rate of 1.12 percent between 2025 and 2050 (USACE 2006).

More specifically, employment within the project area is expected to increase. Although it is difficult to analyze potential future trends in employment within the project area because of the way projections are developed in the different jurisdictions within the area, Table 11-6 shows the expected rate of change for geographic areas adjacent to the upper Ohio River. Statewide information is also provided in comparison.

TABLE 11-6
Employment Trends in the Project Area

State/Area	Employment 2004/2006	Employment 2014/2016	Increase	Percent Change
State				
Ohio	5,842,100	6,102,580	260,480	4.5
Pennsylvania	5,641,050	6,022,580	381,530	6.8
West Virginia	785,204	834,712	49,508	6.3
Area				
East Central Ohio	237,300	247,800	10,500	4.4
Pittsburgh CMSA	1,133,270	1,151,060	17,790	1.6
WV Workforce Area #5	75,441	77,665	2,224	2.9

Sources: West Virginia Development Office, 2009; Ohio Department of Jobs and Family Services, 2006, 2007; Pennsylvania Department of Labor and Industry, 2004; SPC, 2007; and United States Bureau of Labor Statistics, 2008

Employment is expected to grow within the project area at a slower pace than in the respective states. While employment throughout Ohio, Pennsylvania, and West Virginia is projected to grow from 4.5 to 6.8 percent, employment within the sub-regions that are part of the project area is only expected to grow from 1.6 to 4.4 percent.

Employment within the individual counties is also expected to grow. As shown on Table 11-7, the positive trend in employment is similar for all the counties within the region. Together, employment should grow by approximately 11 percent through 2040. Although the employment projections presented in Table 11-7 came from several different sources, a similar employment forecast developed by the University of Pittsburgh Center for Social and Urban Research tended to agree with those separate projections: employment is expected to increase over the next 20 years, but at a slower rate than other projects suggest, with employment gains primarily in the service sector (Allegheny County 2008).

TABLE 11-7
County Employment Trends in the Project Area

County	2010	2020	2030	2040	Percent Change
Allegheny	925,477	968,564	998,838	1,029,748[1]	11.2
Beaver	74,081	77,924	83,575	85,553[1]	15.5
Columbiana[2]	46,900	48,119	49,370	50,653	8.0
Hancock	15,396	16,230	17,253	18,540	20.4
Jefferson	39,768[3]	39,832	38,627[3]	34,546[3]	-13.1
Totals	1,101,622	1,150,669	1,187,663	1,219,040	10.6

[1]Projections from 2035 held constant to 2040
[2]Based on trends suggested by Ohio One-stop Center, Columbiana County
[3]Extrapolated from BHJ Long Range Transportation Plan

Sources: West Virginia Development Office, 2009; Ohio Department of Job and Family Services, 2006; BJH, 2004; SPC 2007; Workforce West Virginia, 2008b

Educational attainment also contributes to the level of economic opportunity and personal satisfaction. Educational attainment in the five-county study area generally lags behind their respective states. Table 11-8 shows the educational attainment levels for Ohio, Pennsylvania, and West Virginia, as well as the five counties in the project area. While the percentages of high school graduates in Allegheny, Beaver, and Hancock counties exceed the percentage of high school graduates throughout their respective states, the percentages of high school graduates in Columbiana and Jefferson counties are less than the rest of Ohio.

TABLE 11-8
Educational Attainment in the Project Area

State/County	Total Population Year 2000	Percent of Population with Bachelor's or Graduate Degrees	Percent of Population 25 or older with H.S. Diploma
State			
Ohio	11,353,140	13.8	83.0
Pennsylvania	12,281,054	15.0	81.9
West Virginia	1,808,344	10.1	75.1
County			
Columbiana County	112,075	7.3	80.5
Jefferson County	73,894	8.3	81.7
Allegheny County	1,281,666	19.7	86.3
Beaver County	181,412	11.1	83.6
Hancock County	32,667	8.3	82.9

Looking at college graduates and individuals with graduate degrees alone, only Allegheny County shows a higher percentage than its respective state. This is somewhat surprising because the area has gradually shifted from an industrial-based economy to a service and commercial economy. Many jobs in the area, especially in medical services and research, require a college level degree for an entry-level position. In the past, individuals with only a high school diploma could find interesting and fulfilling jobs in the industrial sector.

In a recent article in *Atlantic*, Richard Florida, a nationally known researcher on economic competitiveness and former professor at Carnegie Mellon University noted, "Thirty years ago, educational attainment was spread relatively uniformly throughout the country, but that's no longer the case. Cities like Seattle, San Francisco, Austin, Raleigh, and Boston now have two or three times the concentration of college graduates of Akron or Buffalo" (2009). It could be argued that the area from Pittsburgh to Steubenville has also seen a loss of educated people as they move to other locations for better employment opportunities. If national trends continue, educational attainment could decrease in the area, despite the region's many fine colleges and universities.

11.5.2 Minority Populations

By comparing county averages for minority populations against statewide averages, a preliminary environmental justice screening threshold can be established. Table 11-9 shows those counties within the ORMSS study region that exceeded their state averages for minority populations (USACE 2006). Within the upper Ohio River study area, only Allegheny County exceeded the state average for minority populations. The other four counties, Beaver, Columbiana, Hancock, and Jefferson, fell below their respective state averages for minority populations.

TABLE 11-9
Non-White Populations That Exceed State Averages in the ORMSS Study Region

State/County	1960	1970	1980	1990	2000
Pennsylvania	7.6%	9.0%	10.2%	11.4%	15.9%
- Allegheny	8.3%	9.3%	11.2%	12.5%	16.2%
Ohio	8.2%	9.4%	11.1%	12.2%	16.0%
- Hamilton	14.4%	16.1%	19.9%	22.3%	27.6%
West Virginia	4.9%	4.1%	3.8%	3.8%	5.4%
- Cabell	4.5%	4.4%	4.9%	4.9%	7.1%
- Ohio	3.1%	3.4%	4.1%	4.1%	5.9%

Percentages indicate the portion of the total population that is non-white, as defined by the U.S. Censu
Source: USACE, 2006

Census data were also examined to identify Native American populations. Through 1980, very few individuals who identified themselves as Native American appeared to be living in the area. With the 1990 and 2000 censuses, however, there appeared to be slightly larger populations of Native Americans in the area. Table 11-10 lists state averages and all counties that exceed the state average, none of which are in the upper Ohio River project area.

TABLE 11-10
Native American Populations in the ORMSS Study Region

State/County	1960	1970	1980	1990	2000
Pennsylvania	0.1%	0.1%	0.1%	0.1%	0.1%
Ohio	0.1%	0.1%	0.1%	0.2%	0.2%
- Adams	0	0.1%	0.1%	0.3%	0.7%
- Athens	0.1%	0.1%	0.1%	0.3%	0.3%

TABLE 11-10 (continued)
Native American Populations in the ORMSS Study Region

State/County	1960	1970	1980	1990	2000
- Gallia	0	0	0.1%	0.1%	0.4%
- Meigs	0.1%	0.1%	0.1%	0.2%	0.3%
- Scioto	0.1%	0.1%	0.1%	0.5%	0.6%
West Virginia	0.1%	0.1%	0.1%	0.1%	0.2%
- Pleasants	0	0.1%	0.1%	0.1%	0.5%
American Indian and Alaska Native = A person having origins in any of the original peoples of North and South America (including Central America) and who maintain tribal affiliation or community attachment.					
Sources: USCB, 2000a; USACE, 2006					

Census records for 1970-2000 were also reviewed to identify numbers of people of all ages in poverty. Table 11-11 lists those counties in the Ohio River region with higher than average poverty rates. Counties were identified as having high poverty rates if the percent in poverty exceeded 1.5 times the state average or 1.5 times the regional average for the six-state region analyzed in ORMSS for any two of the four periods measured. As with the analysis of minority populations, a preliminary environmental justice screening threshold can be established by comparing county data to statewide averages. None of the counties in the upper Ohio River project area exhibited poverty rates above the threshold.

TABLE 11-11
People of All Ages in Poverty in the ORMSS Study Region

State/County	1970	1980	1990	2004 (estimate)
Pennsylvania	10.6%	14.6%	11.1%	11.2%
- Fayette	20.8%	21.0%	20.9%	16.9%
Ohio	10.0%	14.0%	12.5%	11.7%
- Adams	31.6%	24.7%	28.5%	16.1%
- Athens	20.0%	21.6%	28.7%	20.2%
- Gallia	22.8%	14.9%	22.5%	17.4%
- Lawrence	20.2%	15.2%	23.5%	17.4%
- Meigs	23.9%	16.7%	26%	18.1%
- Monroe	18.1%	13.5%	21.5%	12.4%
- Scioto	20.5%	17.9%	25.8%	18.9%
West Virginia	22.2%	20.6%	19.7%	16.2%
- Mason	26.1%	18.7%	22.1%	17.3%
- Wayne	26.5%	25.3%	21.8%	17.4%
- Wetzel	21.4%	18.1%	20.5%	16.6%
Sources: USCB, 2000b; USACE, 2006				

Per capita income was also examined to determine the economic health, or lack thereof, within the project area. Table 11-12 shows per capita incomes from the last Census for the United States, Ohio, Pennsylvania, West Virginia, and the five counties within the project area. Each county is compared to both the nation and their respective state. Except for Allegheny County, per capita income in each of the other counties is much lower than in the nation. Per capita income in all but Allegheny and Hancock counties is also much lower in the other counties than what is found in the individual states.

TABLE 11-12
Per Capita Incomes in the Project Area

Area	Per Capita Income (2000)	Percent Different Than Nation	Percent Different Than State
United States	$21,587	--	--
State			
Ohio	$21,003	-2.8	--
Pennsylvania	$20,880	-3.3	--
West Virginia	$16,477	-23.7	--
County			
Columbiana County	$16,655	-22.8	-21.0
Jefferson County	$16,476	-23.6	-27.5
Allegheny County	$22,491	4.2	7.7
Beaver County	$18,402	-14.8	-11.9
Hancock County	$17,724	-17.9	7.6
Source: USCB, 2000b			

11.5.3 Land Use

County land use planning efforts are active in three of the study area's five counties. These are supplemented by many local planning initiatives at the municipal level, mostly in Beaver and Allegheny counties. Comprehensive planning, overall, is strongest in Beaver and Allegheny counties, and weakest (perhaps nonexistent) in Hancock County. The county-level efforts include the following:

- **Allegheny County Comprehensive Plan:** Allegheny County has currently entered the last stage of preparing its first county-wide comprehensive plan. Known as *Allegheny Places* (2008), the plan is a general guide for conservation, land use, and growth management. The plan recognizes several different kinds of historic settlement patterns within the county, including pedestrian villages, industrial towns, inclined plane neighborhoods, railroad suburbs, trolley suburbs, and automobile suburbs. Over the last two decades, however, low-density sprawl has been the predominant land use development pattern. This has led to a declining core that may be unsustainable. The comprehensive plan is still in draft form, but is expected to be endorsed by the end of 2009.

- **Beaver County Comprehensive Plan:** Beaver County's comprehensive plan, *Horizons: Planning for the 21st Century* (1999), provides an overall strategy guide for development. Prior to 1999, development in Beaver County occurred in relation with existing infrastructure, such as public water and sewer service, highways, rail, and waterways. This past year, the county began the process of updating its comprehensive plan. The new plan is expected to develop strategies for balancing new development, redevelopment of existing places, and preservation of the county's natural and cultural assets (Beaver County 2008).

- **Columbiana County Land Use Task Force Plan:** This plan is being developed to support economic growth through the appropriate location of infrastructure,

protection of the natural environment, and preservation of green areas. When completed in late 2009 or early 2010, the plan is expected to help preserve the county's rivers, streams, lakes, forests and open spaces for current and future generations (Columbiana County 2007).

11.5.4 Social Cost of Diverting River Traffic

Because of the age of the Upper Ohio River's lock and dam system, reduced lock service is considered probable. This could cause the diversion of waterway traffic to land-based modes of transportation. The USACE recently completed a study to measure the social costs – known as external effects – that could be incurred with such occurrences (USACE 2000). Those effects include increased fuel usage, increased pollution, increased accidents, and accelerated deterioration of roadways.

The following summarizes the findings of that study.

Both short-term (45 days or less) and long-term conditions (over 45 days) were examined at the Emsworth, Dashields, and Montgomery (EDM). Under short-term conditions, locks could be closed infrequently to make minor repairs. With long-term conditions, either lengthy or more frequent short-term closures could occur. It is expected that long-term conditions would cause businesses to permanently change their transportation patterns.

Short-term closures are expected to result in minimal impacts to the regional economy even though short-term conditions could result in higher costs for environmental and social features than with existing conditions. River-dependent facilities have successfully managed operations during short-term closures in the past. Consequently, they are expected to successfully adapt to such closures in the future.

Under long-term conditions, some facilities would shut down, re-source materials to other suppliers, or ship goods to closer markets. With long-term closures or increased unreliability, some materials would not be shipped or shipped less distance. Long-term closures or an unreliable lock system would have a negative impact on the regional economy. Approximately 8,200 jobs could be lost in the region. Lost wages could total almost $250 million.

11.6 INTERACTIONS WITH OTHER VALUED ENVIRONMENTAL COMPONENTS (VECS)

Socioeconomic resources, including environmental justice factors, interact with many valued environmental components, especially the Transportation and Traffic, Recreation, Health and Safety, Cultural Resources, Water Quality and Sediment Quality, Air Quality, Mussels, Fish, and Riparian Resources VECs**.** Most address various community values that are reflected in the socioeconomic character of the region. Connectivity is less obvious between socioeconomic resources and environmental resources, but the natural systems represented by those VECs contribute to the well being of human communities. VEC interactions are illustrated in Table 11-13.

TABLE 11-13
Interactions of Socioeconomic Resources with Other VECs

VEC	Socioeconomic Resources & Potential Impacts	Past/Present Trends	Future Trends	Comments
Transportation and Traffic	Vehicle ownership opportunities and expectations	Expanding highway network to accommodate traffic growth	Continued growth of miles driven per capita	Limited alternatives for environmental justice populations if they cannot afford a personal vehicle
Recreation	Expanding leisure time and disposable income per capita	Growth of river-oriented activity with improved water quality and accessibility	Expanding variety of river-oriented activities; potential conflicts from crowding or incompatible uses	Potential continued growth of urban riverfront-oriented development (housing-shopping-recreation)
Health and Safety	Expanding river-oriented activities contribute to expanding exposure to river related risks.	Water quality improvements, spill prevention & response, and improved monitoring have reduced river-related risks.	Continued expansion of river-oriented activities requires improved water quality and monitoring to maintain low risk factors.	Control of contaminant sources affecting water contact recreation and fish consumption issues has slowed following early gains.
Cultural Resources	Development threatens architectural and archaeological resources.	Regulatory oversight contributes to protection, impact avoidance, and mitigation.	Interpretations at landscape scale expand complexity of cultural resource protection.	Cultural resource protection is most effective when part of planning & design vs. reactive assessment.
Water Quality/ Sediment Quality	Improved public health, recreational opportunities, aesthetic values with improved water quality	See recreation and health and safety comments.	Appears likely present water quality will be maintained or improved	Broad and expanding public recognition of water quality benefits and value
Air Quality	Improved public health and aesthetic values with improved air quality	See recreation and health and safety comments.	Appears likely present air quality will be maintained or improved	Broad and expanding public recognition of air quality benefits and value

TABLE 11-13 (continued)
Interactions of Socioeconomic Resources with Other VECs

VEC	Socioeconomic Resources & Potential Impacts	Past/Present Trends	Future Trends	Comments
Mussels, Fish, and Riparian Resources	Resource recoveries contribute to improved recreational opportunities, aesthetic values.	See recreation and health and safety comments.	Expanding navigation, commercial/ residential, and recreational uses of river will conflict with habitat needs.	Long term protection/ management of significant habitat areas required to maintain bio resources

11.7 INDICATORS OF ENVIRONMENTAL SUSTAINABILITY FOR SOCIOECONOMICS

Indicators of the environmental sustainability of socioeconomic resources reflect the general health and well being of the population. Typically, sustainability of socioeconomic resources is attained when stable to slowly expanding populations are supported by stable or expanding labor force participation. Declining populations are interpreted as an undesirable condition, but rapidly expanding populations may signal significant changes in the community. Either condition may produce desirable and undesirable conditions. While on the one hand, a declining population limits some economic opportunities, it also opens up doors to others, especially by lessening consumption pressures on the environment. Conversely, a growing population is generally viewed as a positive trend, but it also places pressure on existing infrastructure and environmental resources. This additional pressure could result in the adaptive reuse of existing infrastructure and resources, but it could also affect further impacts on resources.

Specific indicators of general health and well being include income, mortality rates, life expectancy, and labor force participation. Additionally, identification of potential environmental justice issues may indicate the possibility of impacts affecting specific population groups, but not necessarily the community as a whole. To some degree, cost of living, mortality rates, life expectancy and immigration/outmigration rates are typical factors used in population and employment projections.

11.8 RELEVANT FUTURE ACTIONS AFFECTING SOCIOECONOMICS

RFFAs for socioeconomic resources, including environmental justice issues, were evaluated utilizing a matrix prepared during the scoping process. The matrix was an outgrowth of a similar matrix developed during the preparation of ORMSS. Results of the RFFA evaluation for socioeconomic resources are summarized in Table 11-14.

TABLE 11-14
RFFA Cumulative Effects Matrix for Socioeconomics

RFFA Cumulative Effects Matrix for Upper Ohio River – Socioeconomics					
RFFA[1]	**Time Period[2]**	**Occurrence Probability[3]**	**Location on River[4]**	**Importance[5]**	**Effects[6]**
USACE Actions					
Navigation Investments					
Replacement locks at Emsworth, Dashields, and Montgomery Dams (EDM)	1	H	S	H	+/-
Rehabilitation of EDM dams	1	H	S	H	+/-
Non-structural navigation improvements	A	H	S	M	+
L&D operation and maintenance	A	H	S	H	+
Approach & channel dredging/disposal	A	H	E	H	+/-
Pool maintenance	A	H	E	H	+
Sec 107 port development and maintenance dredging	2	L	S	M	+/-
Actions by Others					
Navigation System Dependent - "But For"					
Commercial navigation					
barge queuing	1	M	E	H	-
fleeting areas/barge storage	1	M	E	H	-
terminals & multi-modal sites	2	L	S	H	+/-
accidents/spills	A	M	E	H	-
Energy					
hydropower on dams	2	M	S	M	+/-
continued operation of coal-fired power plants	A	M	S	H	+/-
Water-based recreation					
marina development & operation	A	M	S	M	+/-
commercial boating	A	H	E	M	+/-
personal boating	A	H	E	M	+/-

TABLE 11-14 (continued)
RFFA Cumulative Effects Matrix for Socioeconomics

RFFA Cumulative Effects Matrix for Upper Ohio River – Socioeconomics					
RFFA[1]	**Time Period[2]**	**Occurrence Probability[3]**	**Location on River[4]**	**Importance[5]**	**Effects[6]**
Actions by Others					
River Dependent					
Water supply/discharge					
municipal	A	M	S	H	+/-
industrial	A	M	S	H	+/-
Waste water treatment discharges (WWTP)					
onsite systems	A	H	E	H	+/-
stormwater discharges; CSOs; SSOs	A	H	S	H	+/-
Marcellus shale gas extraction (water impacts)	A	H	E	H	+/-
Resource extraction					
instream sand and gravel mining	A	H	E	L	+/-
Acid mine discharge (AMD)	A	M	E	M	+/-
Riverfront/Flood Plain Development					
Downtown Pittsburgh					
Convention Center riverfront park	1	H	S	M	+
residential development/conversions	A	H	S	H	+
North Shore development	1	H	S	H	+/-
Pittsburgh South Side					
continued riverfront development	A	H	S	M	+/-
continued South Side Works development	1	H	S	M	+/-
Riverfront trails					
Pittsburgh riverfront trail system	A	H	E	M	+
Beaver County trail system	A	M	E	M	+

TABLE 11-14 (continued)
RFFA Cumulative Effects Matrix for Socioeconomics

RFFA Cumulative Effects Matrix for Upper Ohio River – Socioeconomics					
RFFA[1]	**Time Period[2]**	**Occurrence Probability[3]**	**Location on River[4]**	**Importance[5]**	**Effects[6]**
Actions by Others					
Riverfront/Flood Plain Development					
Brownfields redevelopment					
Neville Island	1	H	S	M	+/-
PL&E, McKees Rocks	2	M	S	M	+/-
M&B Development	2	M	S	M	+/-
Fab Tech & Buckeye Pipeline	1	M	S	M	+/-
J&L site in Aliquippa	1	M	S	M	+/-
Leetsdale Industrial Park	1	H	S	M	+/-
Bridges and Roadways					
Bridge renovations					
Ambridge/Aliquippa Bridge	1	H	S	H	+/-
Shippingport Bridge	1	H	S	H	+/-
Rochester Bridge	1	H	S	H	+/-
McKees Rocks Bridge	1	H	S	H	+/-
Birmingham Bridge	1	H	S	H	+/-
Rankin Bridge	1	H	S	H	+/-
New crossings					
Maglev	2	L	S	H	+/-
North Shore connector	1	H	S	H	+/-
Roadways					
Mon/Fayette Expressway	2	L	S	H	+/-
SR 28 widening/railroad relocation	1	H	S	H	+/-
CSX double stack upgrades (National Gateway)	1	M	S	H	+/-

TABLE 11-14 (continued)
RFFA Cumulative Effects Matrix for Socioeconomics

RFFA Cumulative Effects Matrix for Upper Ohio River – Socioeconomics					
RFFA[1]	**Time Period[2]**	**Occurrence Probability[3]**	**Location on River[4]**	**Importance[5]**	**Effects[6]**
Actions by Others					
Natural Events					
floods	A	M	E	M	-
droughts	A	L	E	L	-
Regulatory Environment					
Phase I & 2 NPDES program	A	H	E	H	+
TMDLs	A	H	E	H	+
ALCOSAN & other consent decrees	A	H	E	H	+
Pollution prevention	A	H	E	H	+
USACE permitting programs	A	H	E	H	+
Clean Air Act standards	A	H	E	H	+
Clean Water Act standards	A	H	E	H	+
Environmental sustainability practices	A	H	E	L	+
[1] Reasonably Foreseeable Future Actions					
[2] Time period in which the RFFA may occur: A = all periods; 1 = within 10 years; 2 = in 10 - 25 years; 3 = in 25 - 60 years					
[3] Occurrence probability or likelihood RFFA will happen: H = high; M = medium; L = low					
[4] Location or setting on river where RFFA is expected to occur: E = along entire length of river; S = specific location					
[5] Importance or impact of action on the VEC: H = high; M = medium; L = low					
[6] Effects of action on the VEC: + = positive effect; - = negative effect; +/- = mixed effects					

The following sections discuss the RFFAs potentially impacting socioeconomic resources in more detail. A qualitative analysis of those actions with potentially high or medium impact is presented. Some of the RFFAs have been grouped together, where appropriate.

11.8.1 USACE Actions

Although lock replacement or rehabilitation of EDM would result in the creation of temporary employment for construction workers, the long-term positive impacts to efficiency of the navigation industry and reduced shipping costs are the principal justifications for navigation improvements. A more efficient navigation system could also create new job opportunities. Because of the potential magnitude of construction activities, however, there could be temporary negative impacts due to construction and some permanent impacts to the environment due to enlarging the footprint of the existing locks and dams.

Non-structural navigation improvements, such as vessel scheduling and coordination, expanded mooring facilities, reduced movement of empties, and stockpiling of materials, increase economic efficiencies. Similarly, port development and maintenance dredging occur specifically to maintain economic efficiency. As a result, they will have a positive impact on socioeconomics by design. Negative effects can occur, however, with port development and maintenance dredging if construction activity footprints are expanded.

Temporary employment of construction workers would be a benefit for any of the actions. Short-term local income and revenues could increase as a result of this employment. On-site or nearby uses may be closed or curtailed during construction. No long-term changes to population, property values, or local tax collections are expected.

Overall lock and dam operation and maintenance, approach and channel dredging/disposal, and pool maintenance would contribute to the continuation of an efficient navigation system. They would also contribute to the continuation or creation of temporary and permanent employment.

11.8.2 Actions by Others

11.8.2.1 Navigation System Dependent – "But For"

Idling of tows during barge queuing increases operation and shipping costs and potentially increases accidents. Shoreline stabilization costs may also be incurred. Fleeting activities can deter recreational use of the river and the loss of revenues associated with recreational activities. Potential accidents and spills from fleeting activities add increased costs. Locating fleeting areas away from shore helps reduce negative impacts but can be problematic during low flows with narrowed river widths. Fleeting activities can conflict with boaters and shoreline residents.

Terminals and multi-modal facilities provide employment opportunities and potential expansion of related shipping facilities. Potential negative impacts are related to traffic and spills during transfer of materials. New terminals or expansion of existing facilities could compete with other uses in floodplains and cause the loss of riparian habitats.

Negative economic impacts are associated with accidents and spills. Short- to long-term economic impacts of accidents and spills vary with the extent of each spill. These impacts may discourage boaters, reducing associated recreation revenues. Bank tie-offs,

groundings, and related shoreline encroachments result in bank erosion, property damage, and conflicts with shoreline residents. Resulting shoreline damages may incur costs for clean up and possible litigation. Provisions for monitoring, spill detection, notification, and response systems help avert damage and associated economic impacts.

The navigation system and the availability of water encourage the location of utility plants near the river. Coal utilities account for more than 60 percent of commercial traffic on the Ohio River and are expected to account for the majority of projected traffic growth. Plants located along the river enjoy lower transportation costs than facilities located elsewhere. The cost of shipping bulk materials by river barge is significantly less than by rail or truck. With lower costs from coal utilization and its reasonable transportation, energy providers can keep costs low for other industries, commercial development, and household consumers.

Impacts include local economic benefits. Coal-fired power plants and hydropower plants provide employment opportunities and potential development or expansion of related shipping facilities. Potential negative impacts could occur during construction, but are primarily related to traffic and spills during transfer of materials. New utilities and expansion of existing facilities will compete with other uses in limited floodplain areas and could result in loss of riparian habitats.

Additional water-based recreation could create additional concessions and employment. The potential for growth in this sector exists, but population, boat registrations, and lockages have declined. While these declines could indicate erosion of recreational boating, other forms of river-oriented recreation could increase and stimulate construction of other types of recreational facilities. Commercial boating could grow, too, as the river becomes more attractive and people and businesses realize its potential for commercial travel. Public access to resources would be improved and the value of nearby commercial developments may be enhanced. Increased recreational activities would generate new revenues for the local economy, but could result in the loss of riparian resources. New marinas would result in some permanent employment and changes in property values and the tax base.

Boating generates significant trip-related and boat-related revenues (Husak 1999), but commercial navigation, industrial or commercial growth, and other competing uses may limit the capacity for growth of recreational activity on the Ohio River. Potential conflicts also exist between motorized boating and the growing interest in canoeing and kayaking.

11.8.2.2 River Dependent

Clean industries and communities associated with properly functioning water and waste water treatment systems, regardless of type, can encourage economic growth. Adequate water supply and discharge for municipal and industrial use can become a controlling factor in future development. When public water is available and a community has adequate sewer facilities in place, public health improves and the community becomes more attractive as a place to live or work. When such systems are not in place, or not functioning properly, potential pollution and aesthetic problems can deter growth and development.

Stormwater runoff and nonpoint urban surfaces contribute to bacteriological contamination and associated health risks. Significant investments are required to reduce or eliminate CSO and SSO discharges. Onsite systems are often not as effective at controlling waste water treatment discharges as municipal facilities. Additionally, they are often scattered throughout the area and sometimes it is difficult for government agencies to assure that they are functioning properly. Implementation of proper best management practices can limit erosion, pollution, and other negative environmental impacts from stormwater runoff.

Although there has been a major improvement to the acidity of the upper Ohio River, potential problems from primarily old Pittsburgh coal seam mines are now developing along the Monongahela River. Many coal operations previously committed to pumping and treating of their acid mine drainage discharges have declared bankruptcy. This had resulted in abandoned or orphan mines. Deep mining operations in the Monongahela River Basin over a period of more than a hundred years have left massive voids currently filled or filling with water. Orphan mines that are located below surface drainage level are actively being flooded, creating an immense aquifer of mine water. This flooding has also resulted in new acid mine drainage discharges throughout the Pittsburgh Coal Basin. It is projected that in 2015 all orphan mines located below the surface drainage level will have reached their maximum capacity to hold water. The Monongahela River Mine Pool has been described as having a giant football shape, stretching from Fairmont, WV in the south to Pittsburgh, PA in the north, and from Wheeling, WV in the west to Uniontown, PA in the east. The aquifer created by the flooding of orphan mines in the Pittsburgh Coal Basin will create the second largest spatially-continuous high-yield aquifer in the Northern Appalachian Region (Donovan and Leavitt 2004).

The West Virginia University Center for Coal Mining Research conducted an extensive study to map the underground mining and water quality of this mine pool (Ziemkiewicz and Vandivort 2004, as cited in Lorson and Smith 2004). They have documented extremely acidic water with gross heavy metal loads within the mine pool. The mine pool has several points that are at a level where they may discharge their acid load to the Monongahela River in the near future. Ten Mile Creek (Mon RM 65.5) and Dunkard Creek (Mon RM 87.2) have been identified as primary discharge points. All marine life in Dunkard Creek was killed in September 2009. Preliminary analysis has suggested an algae bloom as the cause of that loss, but other factors may have contributed to the extensive devastation, including mine waste discharges. Several resource agencies are involved in investigations of the recent incident. A collaboration of natural resource agencies are also involved in aggressive efforts to fully document other fishery resources which may be damaged or lost if an adequate solution to the mine pool flooding problem is not found in the near future. Compounding the uncertainty of the situation, however, is the possibility that discharges from the mine pool, if any, could be confined to the Monongahela River, or if they do reach the Ohio River, flows from the Allegheny River could neutralize the effects.

There has also been significant discussion in the area concerning drilling for natural gas. Marcellus shale underlies much of Pennsylvania and portions of West Virginia. It is estimated to hold trillions of cubic feet of natural gas. Long considered too expensive to retrieve, advances in drilling technology and current natural gas prices have attracted more interest. Because energy markets have fluctuated and there are community initiatives

against drilling, interest may wane. Nonetheless, most landowners, including some government entities, see Marcellus shale as a new revenue source.

Current water quality implications concern proper treatment and disposal of fracturing, production fluids, and saltwater brines. New technologies are being explored by the industry to advance its development as well as spark interest in drilling for even deeper resources within the area. Water quality impacts during recent droughts resulted from a number of sources, one of which was the disposal of oil and gas production fluid into the Ohio River and its tributaries.

11.8.2.3 Riverfront/Flood Plain Development

Development in Downtown Pittsburgh or on the South Side would generally create employment opportunities, add to local revenues, and potentially change property values and the tax base. Commercial development would likely not generate new business for the shipping industry, but expanded recreational activities could potentially conflict with it. Development could take land from riparian habitat uses.

There would likely be temporary employment increases during construction of new riverfront trails and bike paths, but permanent job gains are unlikely. Development could spur interest in preserving riparian habitats. There is potential for economic growth in this sector because of changing recreational interests.

Redevelopment of former industrial areas would generally create employment opportunities, add to local revenues, potentially change property values and the tax base, and improve some environmental conditions. Public services would likely not need to be extended, but there could be costs associated with improvements. Some areas could be used strictly for conservation preservation. It is unlikely that all brownfields sites could be redeveloped.

11.8.2.4 Bridges and Roadways

Increased safety, efficiency, and congestion management are the principal justification for surface transportation projects. Short-term local income and revenues would increase as a result of future transportation projects, including bridge renovations, new crossings, roadways, and CSX double stack upgrades, primarily through related employment and support expenditures. Significant changes to population, property values, local taxes, and existing land use patterns could occur if bridge locations are changed or shifted. Temporary impacts could includes brief periods of shutdowns, additional congestion, or detours.

11.8.2.5 Natural Events

Flooding increases the potential for river-related accidents, including vessel casualties, barge breakaways, and pollution incidents. Enormous economic costs occur when homes, businesses, and industries in flood-prone areas are damaged. Low water conditions during droughts increase the potential for river-related accidents and degradation

of water quality through vessel groundings, barge breakaways, exposed river hazards, pollution incidents, and poor dilution rates.

Some invasive plant species have been introduced intentionally, providing ornamentation or inexpensive means of groundcover. Most invasive animal species, however, are generally introduced unintentionally, migrating into the area or being inadvertently dumped into local waterways. Freed from their natural bounds, they proliferate in new, more habitable areas, overtake native species, eliminate native wildlife, and decrease biodiversity. To some extent, they are slowly destroying the existing ecosystem. Widespread establishment of invasive species can also threaten human health and well-being. If left unchecked, many invasive species – regardless of whether they are plant or animal – could be a catalyst for changes in water and sediment quality or soil erosion and landslides.

11.8.2.6 Regulatory Environment

Long-term positive impacts would be associated with the improved environmental conditions guaranteed through the regulatory environment. These regulations are especially important in urban settings where there are numerous development opportunities. Most initiatives impact air, energy consumption, and transportation with indirect impacts on water quality, recreational space or resources.

Stormwater runoff is partly responsible for high bacteria counts and water contact warnings after rain events. Correcting this problem through the Phase I and II National Pollutant Discharge Elimination System (NPDES) program would have long-term benefits to socioeconomic resources. Total maximum daily loads (TMDLs) represent an important tool for managing water quality over time. Consent degrees, Clean Water Act and Clean Air Act standards, and other environmental documents are legal commitments that assure clean water and air for future generations.

Long-term positive impacts would be associated with continued pollution prevention and the USACE permitting program. Permits are necessary for most developments and other activities in and surrounding the river. To the extent that these programs address components of the Clean Water Act and Clean Air Act, they reduce pollutant discharges and economic benefits accrue to the area. USACE permitting plays a potentially significant role where social conflicts arise over competing uses of resources. USACE permits are necessary for most developments along the river.

11.8.3 Actions Affecting Environmental Justice

Based on the preliminary screening of county data, there could be disproportionate effects on environmental justice populations in Allegheny and Hancock counties. USACE actions, however, would collectively benefit environmental justice populations and non-environmental justice populations alike. While there do not appear to be systemwide disproportionate impacts on environmental justice populations, the site-specific EDM projects are located in denser, more urban settings. Because they have the potential to impact more people, they also have the potential for disproportionate effects on environmental justice populations (positive or negative).

Although not specifically discussing navigation improvements, the Southwestern Pennsylvania Commission (SPC) *Report on Environmental Justice* (2008) concluded that the benefits of the regional transportation planning process accrue to both environmental justice and non-environmental justice populations and that low-income and minority populations are not disproportionately impacted. As the region's federally designated metropolitan planning organization (MPO), SPC is responsible for planning and prioritizing all state and federal transportation funds allocated to the region. Its ten-county region includes the City of Pittsburgh and the counties of Allegheny, Armstrong, Beaver, Butler, Fayette, Greene, Indiana, Lawrence, Washington, and Westmoreland. According to its environmental justice report, Allegheny County and the City of Pittsburgh have the largest minority, low-income, and elderly populations in the region. Areas within the study area where local minority and low-income populations are greater than or equal to the regional average (11.6 percent for low-income populations and 9.9 percent for minority populations) include Pittsburgh, Coraopolis, McKees Rocks, Stow Township, and Leetsdale in Allegheny County and Ambridge, Aliquippa, Bridgewater, Beaver, Rochester, and Midland in Beaver County.

The Brooke-Hancock-Jefferson Metropolitan Planning Commission, the federally designated MPO for the Steubenville-Weirton area, did a similar analysis of environmental justice within its long range transportation plan, *BHJ 2025 Regional Transportation Plan* (2004). Based on a review of that plan, the northern parts of Hancock and Jefferson counties (areas that fall within the study area) are considered target areas for environmental justice concerns. The northern part of Hancock County exhibits higher levels of low-income populations than the BHJ area as a whole and the northern part of Jefferson County exhibits higher levels of minority populations specifically with low incomes than the BHJ area as a whole.

Publicly-owned facilities developed since 1994, when *Executive Order 12898: Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations* was signed into law, have been required to consider the potential disproportionate effect of new projects on minority and low-income populations. Research conducted by the USACE indicated that some recreation facilities may be disproportionately popular with environmental justice populations (Gramann 1996; Dunn, 1999). Factors such as accessibility, available activities, facility design, affordability, and safety can strongly influence the choices of minority groups. Some of the recreation areas within the communities identified by SPC and BHJ as areas of environmental justice concern include Pittsburgh's riverfront trail system and public boat ramps in Pittsburgh, and public ramp areas in Leetsdale, Rochester, and Chester, West Virginia.

As the EDM project progresses, further analysis of environmental justice issues would be required and special efforts, including collaborative planning with potentially impacted communities, may be necessary.

11.9 ANALYSIS OF ENVIRONMENTAL SUSTAINABILITY

Indicators of the environmental sustainability of socioeconomic resources reflect the general health and well being of the population. Such sustainability is usually attained when

stable to slowly expanding populations are supported by stable or expanding labor force participation. However, some declines in population can be positive. While a growing population is generally viewed as a positive trend, a declining population often lessens pressures on the environment. Thus, management of resources during any period of radical population change, regardless of whether it is growing or declining, becomes very important.

Specific indicators of general health and well being include income, mortality rates, life expectancy, and labor force participation. Additionally, identification of potential environmental justice issues may indicate the possibility of impacts affecting specific population groups. Cost of living, mortality rates, life expectancy and immigration/outmigration rates are all used in population and employment projections.

Environmental sustainability balances environmental and economic considerations through the life cycle of project planning, design, construction, operation, and maintenance to improve the quality of life for present and future generations. Accordingly, it represents an ultimate test of significance of potential cumulative effects. In the project area, conditions sustaining socioeconomics are mixed, with both positive and negative forces affecting socioeconomic resources.

11.9.1 Positive Forces Affecting Socioeconomics

The area is supported by a fully developed economic infrastructure. This economic infrastructure includes rail, highway, river, and air transportation, modern communication capabilities, and affordable and reliable utilities including coal-fired electricity generation that depends directly on the river navigation system. While much of the infrastructure is aging, the government, local communities, and individuals have recognized the need to replace old and deficient infrastructure. To accomplish this, management of resources is occurring routinely. Plans and programs are in place to make replacement a reality. The social system is also well established, with a generally healthy and technically skilled population. Quality of life appears to be good for most residents and businesses.

Ongoing investments in social and economic infrastructure should have a positive impact on socioeconomic resources. Most primary infrastructure investments in the region have already been accomplished. Expansion plans for much of this system continue, but a relatively stable population contributes to reduced demand for additional primary infrastructure. Thus, future improvements to this system would focus primarily on maintenance or replacement.

Improved water quality has contributed to increased redevelopment of riverfront areas, especially as recreational settings. Growing interest in environmental amenities in residential and commercial settings contributes to community-oriented projects that combine floodplain and habitat enhancement, open space, recreational activities, and stormwater management.

11.9.2 Negative Forces Affecting Socioeconomics

Although the area currently enjoys a high quality of life, the entire region continues to lose population. Even though population loss may have bottomed-out, projections still show a future population much less then the area's peak in the early 1960s. Trends do not clearly indicate whether or not, the population that remains necessarily can support a social, economic, and physical infrastructure created for a much larger population and its related economy. Problems could arise if future populations cannot support the infrastructure or manage future resource levels.

Disparity among communities throughout the region is expected to continue into the foreseeable future. While incomes and educational attainment are high in Allegheny County, they are measurably less in outlying counties. As a result, Allegheny County will have better opportunities to accrue benefits from future improvements. This could lead to future negative impacts, especially to environmental justice populations, if the regional core is strengthened but not the ring around it.

11.9.3 Incremental Impacts on EDM

For the most part, the incremental impacts of EDM improvements will be positive. Modern, longer locks will allow for more efficient movement of commercial traffic from one pool to another. This will lessen transportation shipping times and increase safety and accessibility. As traffic becomes more efficient, cost savings could be transferred to other sectors of the economy.

Lock extensions could, however, indirectly cause demand for development within floodplains, riparian buffers, and open space by creating opportunities for additional commercial or industrial development. Once converted, such lands are unlikely to revert to their former, more natural states. Expansion of navigation infrastructure would also compete for space with mixed-use waterfront developments, marinas, and other recreation-oriented developments. Waterfront development policies that support conversion of brownfields, unused or underdeveloped terminals, or other underutilized industrial sites could help minimize conversion impacts to existing riparian habitats.

11.10 DETERMINATION OF SUSTAINABILITY

Three specific definitions of sustainability were used for the analysis:

- Not sustainable – conditions for the selected indicators do not reflect conditions that would facilitate attainment of acceptable standards or would not maintain existing standards in concert with collective impacts of proposed activities.

- Marginally sustainable – conditions for selected indicators are such that attainment of acceptable living conditions and quality of life is accomplished for the majority, but not all, of the potentially affected populations. However, the conditions are somewhat tenuous both in location and likelihood of occurrences.

(In other words, the conditions are borderline for environmental sustainability, and there are uncertainties regarding specific quantitative measures.)

- Sustainable – conditions for selected indicators are such that attainment of acceptable living conditions and quality of life is accomplished for essentially all of the potentially affected populations in the project area, and such standards are maintained in concert with foreseeable future activity. Further, conditions exceed regulatory thresholds, and various governmental programs are in place to respond to any potential erosion of values related to, in this case, socioeconomic resources.

The primary indicators of sustainability used in this chapter are the individual projections of populations and employment for the project area counties. Projections were derived from a variety of sources, but utilize similar demographic variables including national census information, fertility, mortality, and immigration rates (which comprise other indictors). These individual projections are used for statewide or local planning efforts and are considered the most reliable source for the individual governmental entities utilizing them.

Projections of stable to slowly expanding populations are interpreted within the context of these measurements as the most desirable outcomes. Though declining populations can have some positive effects on an area, they are generally interpreted as an indicator of undesirable conditions. Additionally, rapidly expanding populations are interpreted as an indicator of significant changes in the community that, depending on how growth is managed, may produce a mix of desirable and undesirable outcomes.

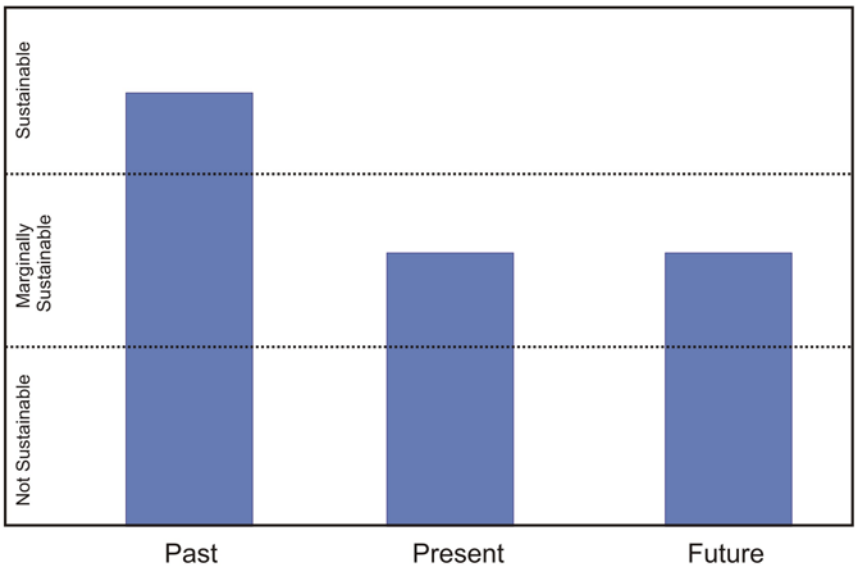
The environmental sustainability of socioeconomic resources is shown on Figure 11-1. Its sustainability can be characterized as follows:

- As the area experienced growth in population through the 1950s, jobs and infrastructure grew to accommodate the increased population. Population grew at a steady pace and the increase was accommodated by an expansion of the local economy. Although population decline began in the 1960s and major industries began leaving the area, there was still an over-riding sense of prosperity for large segments of society. Thus, population change and its consequences were managed well, creating a socioeconomic climate that was sustainable.

- The general socioeconomic status for the present is marginally sustainable. Although the region offers a reasonably healthy mix of industrial, commercial, financial, education, and health care services, the population in the area has continued to decline. Concurrently, more manufacturing jobs have left the area, leaving many people unemployed or underemployed. This loss of people and jobs has created a somewhat tenuous socioeconomic situation. Although the area seems to be adapting to fewer people and fewer jobs, trends are not clear yet as to whether those losses will be managed to avoid a gradual decline in socio-economic health.

- The declining population is expected to continue its decrease in four of the area's five counties and three of the area's CBSAs over the next several decades. Although the area is attempting to "reinvent" itself as a medical, educational, and high-technology area, the trade-off between these new industries and the old manufacturing-based economy may not be sufficient to stem the tide of further socioeconomic loss. Additionally, with some exceptions, educational attainment in the area generally lags behind the states of Ohio, Pennsylvania, and West Virginia. If population loss does not stabilize, there is a danger that there could be too few people and too few jobs to support them. All of these trends will require a concerted effort by local leaders and the public to overcome or adapt to in a positive way. Consequently, environmental sustainability into the future is likely to remain as marginally sustainable.

FIGURE 11-1
Environmental Sustainability of Socioeconomic Resources



Source: Skelly and Loy, Inc., 2009

The projected decline in population growth in Allegheny and Beaver counties over the next 10-15 years, however, with their subsequent potential of slow growth in the future offers the area both stabilization and opportunity. This could serve as the catalyst for transitioning from marginally sustainable conditions to full sustainability. Projected modest increases in employment provide for a realistic expansion of the economy and the necessary supporting infrastructure that will likely avoid past boom and bust patterns. Consequently, there is an opportunity to proceed with a gradual and better planned process of redevelopment serving a stable and established population.

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Chapter 12

CULTURAL RESOURCES

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12.1 DEFINITION

The USACE defines cultural resources as buildings, structures, sites or other artifacts created by or associated with human culture and valued for their cultural and/or historic significance. Historic buildings can be individual homes or entire neighborhoods designated as historic districts (USACE 2009). In the context of typical environmental analyses, these resources are often eligible for or listed on the National Register of Historic Places (NRHP), but for this cumulative effects assessment (CEA), that definition has been expanded to include other important archaeological and historic resources.

Cultural resources are associated with or representative of peoples, cultures, human activities or events in the past, and include related artifacts, records, and structural remains. Among the types of cultural resources considered are historic buildings, structures, objects, districts, and pre-contact and historic period archaeological sites. The United States Army Corps of Engineers (USACE) Planning Guidance Notebook (PGN 2000) includes the following definition of cultural resources:

> An historic property is any prehistoric or historic district, site, building, structure, or object included in or eligible for inclusion on the National Register of Historic Places NRHP. Such properties may be significant for their historic, architectural, engineering, archeological, scientific, or other cultural values, and may be of national, regional, state, or local significance. The term includes artifacts, records, and other material remains related to such a property or resource. It may also include sites, locations, or areas valued by Native Americans because of their association with traditional religious or ceremonial beliefs or activities.

Under the NRHP criteria, any resource over 50 years of age must be considered for potential listing in the NRHP. In rare instances, and based on stringent criteria, some cultural resources that are less than 50 years of age should also be considered.

12.2 OBJECTIVES/SCOPE

12.2.1 Objectives

This chapter assesses the cumulative effects of potential navigation system improvements associated with the Emsworth, Dashields, and Montgomery locks and dams (EDM). Impacts directly or indirectly attributable to modernization of the navigation system are evaluated in concert with impacts from other past, present, and future actions. Future actions include the major navigation improvements identified in this study; other routine or potential actions by the USACE; projected actions by other federal, state, or local agencies; actions by non-governmental entities; predictions of general economic expansion and development; and regulatory changes.

12.2.2 Geographic Scope

The geographic scope for impacts to cultural resources includes those regions most directly affected by the operation and maintenance of the navigation system. This means that cultural resources located in the rivers themselves (e.g., locks and dams), as well as on lands adjacent to the upper Ohio River and upstream to the location of the first dam on the Allegheny and Monongahela rivers must be considered. The lands comprising the geographic scope for cultural resources are defined as the meander channel of the upper Ohio River and includes the 100- and 500-year floodplains, as well as terraces of level land lying above and adjacent to these floodplains. Because of their proximity to the rivers, these floodplains and associated terraces are recognized as rich and diverse natural resource zones and thus potentially important locations for the evidence of past peoples and cultures to be present. In addition, previous cultural resource research indicates that both pre-contact and historic period archaeological sites, as well as historic period structures, are commonly located on these landforms. Floodplains and first terraces adjacent to major streams such as the Ohio, Monongahela, and Allegheny rivers are high potential areas for the locations of many types of cultural resources.

12.2.3 Time Frame

The established time frame for this assessment is 1885 to 2070. The earlier date is the beginning of the navigation system with the completion of the first lock and dam on the Ohio River. The latter date approximates the economic life of anticipated improvements on the Ohio River and is considered the planning horizon for the project.

12.3 ISSUES FROM SCOPING

Scoping has occurred as part of the Ohio River Mainstem Study (ORMSS) and for the Upper Ohio Navigation Study. A series of 12 public scoping meetings was held for ORMSS during the summer of 2001. Subsequently, a series of three public scoping meetings was held for the Upper Ohio Navigation Study in October 2006. Approximately 185 people attended the ORMSS meetings and approximately 40 people attended the Upper Ohio Navigation Study meetings. In addition, an Upper Ohio Navigation Study interagency working group (IWG) provided comments in January 2009. Comments directly or indirectly associated with cultural resources, including archaeology and historic structures, are shown in Table 12-1.

TABLE 12-1
Comments on Cultural Resources from Public Scoping Meetings

Comment	Number of Similar Comments	Scoping Meeting
Consider locally important/significant cultural resources	1	IWG
Coordinate with the Pennsylvania Historical and Museum Commission (PHMC) regarding cultural resources	1	IWG
Coordinate with the City of Pittsburgh regarding cultural resources	1	IWG
Effects of previous extensive and future increased modification of the river banks and adjacent land on cultural resources	3	IWG
Need to address the Native American Grave Protection and Repatriation Act (NAGPRA)	3	ORMSS
Need to contact State Historic Preservation Offices (SHPOs) when specific projects are proposed	1	ORMSS
Eligibility of locks for classification as historic structures	1	ORMSS
Potential adverse effects of higher pool elevations on bridges, other infrastructure, and property	6	ORMSS
Need to develop comprehensive plans for development along river	3	ORMSS
Will USACE do site-specific documents for each action?	1	ORMSS

12.4 LAWS, REGULATIONS, ORDINANCES, AND PROGRAMS

Various regulatory actions influence cultural resources in the Upper Ohio Navigation System study area. Information about these important laws, regulations, or established programs is presented in Table 12-2.

TABLE 12-2
Laws, Regulations, Ordinances, and Programs Relevant to Cultural Resources

Law/Program (Lead Agency)	Key Components	Relevance to Cultural Resources
2009 Programmatic Agreement (U.S. Army Corps of Engineers, Pittsburgh, Huntington, Louisville Districts; National Advisory Council on Historic Preservation; State Historic Preservation Officers of states bordering the Ohio River)	• Provides framework for agreement that was developed to ensure that projects related to modernization of the Ohio River Navigation System shall be administered in accordance with USACE responsibility under Section 106 of NHPA	Ensures that projects specifically related to modernization of the Ohio River Navigation System will be administered in accordance with USACE responsibility under Section 106 of NHPA
USACE Permitting Statutes (U.S. Army Corps of Engineers)	• Section 10 of the Rivers and Harbors Act (1899) prohibits the unauthorized obstruction or alteration of any navigable water of the United States. • Section 404 of the Clean Water Act authorizes USACE to issue permits for the discharge of dredged and fill materials into waters of the U.S.	USACE permit analysis and the resultant decision document must address cultural resources and any comments from SHPOS and/or the ACHP.
National Environmental Policy Act (NEPA) (Council on Environmental Quality and other agencies)	• Requires preparation of an environmental impact statement (EIS) for every major federal action affecting the human environment, which is defined to include cultural resources	An EIS must include the comments of the Advisory Council on Historic Preservation (ACHP) for cultural resources identified for the project.

TABLE 12-2 (continued)
Laws, Regulations, Ordinances, and Programs Relevant to Cultural Resources

Law/Program (Lead Agency)	Key Components	Relevance to Cultural Resources
Executive Order 13287 "Preserve America" (Executive Branch)	• Restates and emphasizes the policy originally established in NHPA that calls for federal agencies to take a leadership role in preserving America's heritage.	Seeks maximum integration of NHPA into federal agency programs, by using partnerships with state, local, and tribal governments and the private sector to promote preservation consistent with agency missions, and designating a senior policy level official to oversee the agencies' historic preservation programs, and promote the re-use of historic properties for heritage tourism and appropriate related economic development related to historic and natural sites on federal lands
National Historic Preservation Act of 1966 (NHPA) (Federal agency varies by project)	• Established the primary policy; Sections 106, 110, and 111; and authority for preservation activities.	Provided funding for the establishment of state historic preservation offices, restoration projects, surveys, and staff
Archaeological Resources Protection Act 1979 (ARPA) (U.S. Dept. of the Interior)	• Protects cultural resources on federal and tribal lands	Prohibits the removal, excavation, or alteration of any resource from federal or tribal lands except by permit issued from the DOI
Archaeological and Historic Preservation Act 1974 (AHPA) (U.S. Dept. of the Interior)	• Extends protection to scientific, prehistoric, and archaeological data from all federal undertakings and requires the federal agency to notify the DOI about adverse impacts	Specifically provides for the preservation of historical and archaeological data (including relics and specimens) which might otherwise be irreparably lost or destroyed

TABLE 12-2 (continued)
Laws, Regulations, Ordinances, and Programs Relevant to Cultural Resources

Law/Program (Lead Agency)	Key Components	Relevance to Cultural Resources
Native American Graves Protection and Repatriation Act (NAGPRA) (National Park Service)	• Gives ownership of Native American cultural items - human remains, funerary objects, sacred objects, and items of cultural patrimony - to lineal descendants of the deceased, tribes on whose lands the items are recovered from, or to culturally affiliated tribes	Requires (on federal or tribal lands) any intentional excavation of Native American burials and other cultural items or inadvertent discoveries of such items be carried out according to specific provisions and in consultation with the appropriate tribe
Abandoned Shipwreck Act (ASA) (National Park Service)	• Establishes U.S. title to all abandoned shipwrecks on submerged state lands that are either embedded in such lands or included in or determined eligible to the NRHP	Guidelines are intended to maximize the enhancement of cultural resources; state and federal agencies are free to adopt the guidelines in their entirety, make changes to accommodate the diverse needs of each state or agency, reject parts as inapplicable, or use alternative approaches. Creation of public underwater parks and preserves is encouraged, and investigations of historic shipwrecks which remain in federal jurisdiction require federal AHPA permits.
Historic Sites, Buildings and Antiquities Act of 1935 (HSA) (National Park Service)	• Established a national policy to preserve historic sites, buildings, and objects of national significance for the inspiration and benefit of the people of the U.S. • Authorizes and directs the Secretary of the Interior (SOI) to make a survey of historic and archeological sites, buildings, and objects for the purpose of determining which possess exceptional value in commemorating or illustrating the history of the U.S.	Created the National Historic Landmark (NHL) Program within the NPS; NHLs are designated unilaterally by the SOI, based on recommendations by an advisory council; NHLs are automatically listed in the NRHP; the SOI will consult with federal agencies and others before making an NHL designation.

TABLE 12-2 (continued)
Laws, Regulations, Ordinances, and Programs Relevant to Cultural Resources

Law/Program (Lead Agency)	Key Components	Relevance to Cultural Resources
State cultural resources regulations (PHMC, Bureau for Historic Preservation [BHP]; Ohio Historical Society [OHS], Ohio State Historic Preservation Office [OHPO]; WV Division of Culture and History [DCH], WV State Historic Preservation Office [WVSHPO])	• Various regulations and programs administered by each SHPO. • Includes excavation/survey permit requirements, methodology and documentation standards, penalties for disturbance or damage to cultural resources, protocols for protection of human remains and unmarked graves, and criteria for historic designation, easements, etc.	Provides state-specific protection and preservation of cultural resources

12.5 PAST TO CURRENT BASELINE CONDITIONS

Since measures of sustainability for cultural resources are framed within the federal regulatory environment, it is difficult to discuss conditions prior to the existence of those regulations. Likewise, it is difficult to foretell what types of modifications to the regulatory framework might occur in the future. Therefore, for the purposes of this discussion, only the presence or absence of the federal regulatory framework is considered. This is appropriate since this study is being performed specifically for a federal agency. State and local influences on sustainability are briefly included as pertinent to the discussion, especially in regards to maintaining and increasing future sustainability.

Because consideration of the identification, recordation, and preservation of cultural resources is mandated by laws, the history of the sustainability of cultural resources in the study area directly follows the evolution of historic preservation legislation through time. The following legislative history is mainly excerpted from *Cultural Resource Laws and Practice: An Introductory Guide* (King 1998).

12.5.1 Past

Despite earlier attempts by the federal government, such as the creation of the Library of Congress in 1800, the Smithsonian Institution's ethnographic and archaeological research beginning after the Civil War, and the creation of the Department of the Interior, to manage cultural resources, the first regulatory statute to specifically address this issue was the Antiquities Act of 1906 (16 U.S.C. 431-433). This law prohibited the excavation of antiquities from public lands without a permit from the Secretary of the Interior. Prior to this time, earthworks, mounds, petroglyphs, and other types of cultural resources that would have been present in the study area were being destroyed both intentionally (e.g., looting, razing

old to replace with new structures) and unintentionally (e.g., ignorance of the presence of archaeological sites, no communal concept of preservation). The sustainability of cultural resources prior to 1906 would have to be categorized as not sustainable. There were no measures in place to identify, record, or preserve cultural resources and there was no codified concept of historical preservation as important to the common good of the society.

With increased awareness of cultural resources under the Antiquities Act, the National Park Service (NPS) was organized in 1916. During the Great Depression, "make work" programs contributed significantly to the overall public awareness of historic preservation and cultural resources as well as identified, recorded, restored, and preserved resources including buildings and structures, archaeological sites, regional histories, and historic districts. As local governments became increasingly involved in historic preservation at this time, ideas about broadening the concept of historic preservation took hold. No longer were just individual resources considered, but groups of resources, such as historic districts, were also considered in geographical, functional, and thematic contexts.

With the conclusion of World War II, the federal government concentrated on the expansion of infrastructure by having the USACE build dams and reservoirs, and Departments of Transportation build the interstate highway system. These two programs began to do damage to historic neighborhoods, buildings, structures, and archaeological sites. The federal government's response was to enact the Reservoir Salvage Act (16 U.S.C. 469) and the Federal Records Act as well as to help charter the National Trust for Historic Preservation. Although generally characterized as not sustainable, the sustainability of cultural resources between 1906 and *ca.* 1949 increased to what can be considered marginally sustainable. However, there was still no cultural resource legislation broad enough to encompass all of the federal government's actions, and there was very little participation at the state and local government levels.

Urban renewal programs in the 1950s negatively affected historic resources by sometimes razing entire historic neighborhoods. Beautification programs in the 1960s led to the concept of a national historic preservation program and provided a catalyst for the enactment of the National Historic Preservation Act in 1966. Section 106 of NHPA provided the first comprehensive historic preservation language which applied to all federal agencies and undertakings in the consideration of cultural resources. The same Congress enacted the Department of Transportation Act which included some conservation stipulations such as Section 4(f). In addition, the Indian Civil Rights Movement brought Native Americans into the cultural resource process as major players. NHPA also authorized the NPS to expand and maintain the National Register of Historic Places, created the Advisory Council on Historic Preservation, and provided a funding mechanism to assist state governments with historic preservation through the SHPOs.

With the publication of Rachel Carson's *Silent Spring* (Carson 1962), came a recognized need to proactively protect the environment. As a response to this need, NEPA was enacted in 1969. With NEPA came the first holistic linking of natural and cultural resources as part of the human environment. These actions further strengthened the concept that the identification, recordation, and preservation of cultural resources are as important to

our human psyche and the good of society as clean air and water. One major revision to the NHPA that drastically increased the scope of the law on cultural resources was Executive Order 11593. This order directed federal agencies to treat eligible cultural resources as though they were listed in the NRHP and established a process to determine eligibility.

In 1974, with the enactment of the Moss-Bennett Act (Archaeological Data and Historic Preservation Act) which mandated that federal agencies identify archaeological sites threatened by their undertakings and fund the recovery of the data they contain, the USACE provided the model of how the whole business of archaeology and historic preservation could be done. Other legislation during the 1970s which increased the overall sustainability of cultural resources included the Indian Self-Determination and Education Act (25 U.S. C. 450-451n, 455-458e) in 1975; the American Folklife Preservation Act (20 U.S.C. 2101) in 1976; and the American Indian Religious Freedom Act (42 U.S. 1996) in 1978. One piece of legislation, the Archaeological Resource Protection Act (16 U.S.C. 470aa-mm: ARPA) of 1979, clarified requirements for managing the disturbance of archaeological sites, features, and objects on federal and Indian tribal lands. This legislation is used to help prosecute people involved with intentional acts of vandalism to archaeological sites and added an important tool to help increase the sustainability of cultural resources. In concert with all of the legislation enacted during the 1970s, the SHPOs were increasingly exerting more influence on historic preservation at the state and local levels. With President Carter's 1978 memorandum on Environmental Quality and Water Resources Management, the role of the SHPOs in the federal Section 106 process was established and became binding. The increased role of the SHPOs provided federal agencies with the state and local expertise to consider cultural resources within the most appropriate contexts and at a regional level. More and varied cultural resources were now being considered, increasing the overall sustainability.

In 1980, extensive changes were made to NHPA. Most of these changes codified previous executive orders and memoranda; however, one new section, Section 110 was added. Section 110 specifically delineated the federal agencies' and SHPO's responsibilities and recognized local government participation as Certified Local Governments. Language about intangible aspects of our cultural heritage was also added so these types of resources would be protected. In order to compensate for funding cutbacks during the 1980s, many historic preservation initiatives devolved to the state level, thus again emphasizing the importance of more local or regional cultural resources.

Many states instituted programs at the state level (State Environmental Protection Act [SEPA]) which mirrored NEPA. In the states with SEPAs, cultural resources are given an added level of consideration that does not occur in states where only federal undertakings are subject to compliance under Section 106. In 1990, one of the most influential pieces of cultural resource legislation since NHPA, the Native American Graves Protection and Repatriation Act (NAGPRA) was enacted. NAGPRA provides for the repatriation of culturally affiliated Native American human remains, funerary objects associated with human remains, funerary objects not associated with human remains, sacred objects, and objects of cultural patrimony; and for the protection of these cultural items. In 1992, NHPA

was amended again to expand federal agency responsibilities and establish a program for support of tribal historic preservation programs.

12.5.2 Present

While there has been some reorganizing of the historic preservation agencies spawned from NHPA and some revisions to the law,, NHPA remains the basis for all Cultural Resource Management being practiced in the United States today. Cultural resource sustainability began as not sustainable prior to 1906 but through creation of new legislation, revisions to existing legislation, increased participation by state, local, and tribal governments, as well as other minority populations and the general public, sustainability of cultural resources has increased.

At the present, cultural resources enjoy a high level of protection because there is sufficient legislation in place to provide a mechanism to identify, record, and preserve cultural resources in large numbers and varieties, leading to more resources being listed in the NRHP, more resources being maintained and preserved, more examples of the same or similar resources being preserved, and more active and meaningful participation in the process by all people.

Cultural resources within the study area represent human behaviors and occupations over many centuries, including both pre-contact and historic period uses. The previously identified cultural resources point to the central role of the rivers as transportation arteries and resource extraction areas for pre-contact and historic period peoples living in, traveling through, and visiting the region. In both the pre-contact and historic periods, permanent and temporary human settlements developed in the study area along the Monongahela, Allegheny, and Ohio rivers.

12.5.3 Culture History

12.5.3.1 Pre-contact Period

The pre-contact period is defined as that period of time in North America prior to European contact with Native Americans. As such, the exact end date for the period overlaps and is different in different geographic areas. The periods typically considered to be in the pre-contact period archaeological chronology include the Paleoindian (14,000? to 8,000 B.C./15,950 to 9,950 B.P.), Archaic (8,000 to 1,000 B.C./9,950 to 2,950 B.P.), Woodland (1,000 B.C. to A.D. 1050/2,950 to 900 B.P.), and Late Pre-contact/Protohistoric periods (A.D. 1050 to 1500/900 to 450 B.P.). These periods represent the Native American cultures prior to the influence of European contact, and their behaviors and culture are represented in the archaeological record.

Through the use of the Pennsylvania Historical and Museum Commission (PHMC), BHP Cultural Resource Geographic Information System (CRGIS) the total number of previously recorded pre-contact period archaeological sites within Allegheny and Beaver counties, Pennsylvania could be determined (PHMC 2009). When previously recorded sites

within Allegheny and Beaver counties are considered as a whole, including those that may not be located in the study area, the Paleoindian period sites number 14, Archaic period sites number 291, Woodland period sites number 233, and Late Pre-contact period sites number one. When only those previously recorded archaeological sites located within the study area are considered, general pre-contact period sites number 71, pre-contact period petroglyphs number three, and pre-contact period earthworks number two. The overwhelming majority of previously recorded pre-contact period sites in the study area are open habitation sites without a specific chronological assignation. A few of the previously recorded sites are listed as having both pre-contact and historic period components and are counted in both groups. This same type of site information is not available online for the Ohio and West Virginia portions of the study area; however, based on a general overview of the literature, many of the same types of sites are recorded in these states as well and would be expected within the study area.

In addition to having used the rivers and streams in the study area as transportation routes, the pre-contact peoples would have used terrestrial trails as well. The routes of multiple Indian paths are known to be located in or near the study area. The following information about these paths is excerpted from *Indian Paths of Pennsylvania* (Wallace 1987). The Catfish Path was named for an influential Delaware Indian, Tingoocque. The route of the Catfish Path began in Greene County at Brant Summit where it met the Warriors Branch Path. From here it trended north through Waynesburg, Amity, Braddock, Canonsburg, Bridgeville, Carnegie, to Pittsburgh. The Raystown Path was an east/west route which originated in Harrisburg, Pennsylvania and ended at Pittsburgh. The route of the Venango Path stated at Pittsburgh, ran north through the Indian town of Venango (Franklin) at the mouth of French Creek, to Presque Isle (Erie). After crossing the Allegheny River at the Forks of the Ohio (Pittsburgh), the Kuskusky-Ohio Forks Path followed the Venango Path north through West View, Perrysville, Ogle, Wurtemberg, Chewton, and finally New Kuskusky (New Castle). There are multiple paths named Mohoning; however, the Mahoning Path located in the study area ran from Beaver to Akron and was a short cut on the Great Path. The five paths described mainly have their origin or terminus in the study area, but the bulk of their routes are outside of the study area. The Great Path, which ran from Pittsburgh to Detroit, had a large portion of its route in the study area. The Great Path crossed the Allegheny River at Pittsburgh, ran along the east side of the Ohio River through Avalon, Sewickely, Logstown, and Crow's Town (Conway), to Logan's Town (Rochester) and Beaver's Town at the mouth of the Beaver River. From there, the path turned west away from the Ohio River and continued into Ohio. After reaching Beaver, the route of the path is no longer within the study area. As was true of most Indian paths, Euroamerican trappers and traders, the military, and early settlers also would have used the paths.

The Paleoindian period encompasses the terminal Pleistocene, a cold, windy, and dry period of the declining Late Wisconsinan glaciation (Watts 1979), the southernmost advance of which halted approximately 35.4 km (22.0 mi) north of the study area. The widely held view of Paleoindians as single focus "Big-Game Hunters" has been challenged, with some arguing that eastern groups included generalized foragers (Meltzer and Smith 1986), and others arguing that modern fauna "were taken only when megafauna were not readily available," at least during the early Paleoindian period (Anderson 1995:151). Meltzer and

Smith (1986) point out that while some have argued for uniformity among Paleoindian toolkits throughout North America, the variation found between tundra sites and boreal forest sites implies the existence of diverse resource strategies, as well.

The fluted lanceolate projectile point is the primary early Paleoindian diagnostic artifact, appropriate for tipping a thrusting spear or for use as a knife blade. While patterns of Paleoindian mobility and site selection have traditionally been linked to the distribution of megafauna across the terminal Pleistocene landscape, Gardner (1974, 1977, 1983; Gardner and Verrey 1979) proposes that base camp locations and home ranges were determined by the distribution of bedded, high quality, cryptocrystalline raw materials, which were the materials of choice for making projectile points. The study area does not contain primary sources of these cryptocrystalline raw materials; however, secondary sources found in cobbles along the three rivers and their tributaries would have been available for knappers' use.

No direct association of Paleoindian material culture and megafauna has yet been found in Pennsylvania, and such remains are rare on eastern and midwestern sites (Anderson 1995; Brush and Smith 1994; Graham *et al.* 1981). Blood residue analysis from lithic artifacts recovered in Ohio indicates the use of both deer and elephant (Brush and Smith 1994:15). Stone tools from the Shoop site, in central Pennsylvania, retained blood residue attributed to the family *Cervidae*, which includes deer, elk, moose, and caribou (Burt and Grossenheider 1976). Although some Paleoindian bands may have relied heavily upon migrating caribou herds, caribou hunting may have been a seasonal alternative for some, or merely an occasional pursuit for others (Spiess *et al.* 1985:156). The existence of Paleoindian groups with more diverse and generalized economies, including the use of smaller mammals, birds, fish, and floral resources, is becoming increasingly apparent (Dent and Kauffman 1985; Meltzer and Smith 1986; Spiess *et al.* 1985). The types of fauna associated with Paleoindian component sites elsewhere would have been drawn to the study area by the abundance of fresh water and other natural resources related to the rivers.

Gradual climatic warming followed the close of the Pleistocene, encouraging the development of modern deciduous forests, which supported more numerous and varied species of flora and fauna. Archaic period peoples have traditionally been characterized as small mobile bands that relied upon the seasonal exploitation of exclusively wild resources. White-tailed deer, turkey, and fish were important faunal resources, while nuts, fruits, and berries provided wild floral resources. All or many of these resources would have been available in the study area. Increasing data, especially from the midwest and mid-south, place the genesis of native crop domestication during the Late Archaic period, although there is little evidence that such resources formed an important part of the Archaic diet (Jefferies 1995; Yarnell 1993). Numerous Archaic resource types could be expected to occur in the study area region, including recurrent to semi-permanent base camps; single event hunting and butchering stations; seasonal hunting, fishing, and floral resource collecting/processing camps; and isolated hunting strays.

While the Early Archaic period saw a technological/stylistic shift from weapons tipped with lanceolate projectile points to projectiles and knives fitted with a variety of

notched and stemmed blade forms, the non-projectile point flaked stone tool assemblages were little changed. Projectile points diagnostic of the Early Archaic period include Palmer, Kirk Corner-Notched, Charleston, and Big Sandy I, bifurcate base, Hardaway-Dalton, LeCroy, and St. Albans Side-Notched (George 1964; Herbstritt 1981; Fitzgibbons 1982; Boldurian 1985).

Data from outside of the study area support the continuation of a broad-based hunting/collecting economy into the Middle Archaic period (Asch and Asch 1985; Chapman and Watson 1993). The most critical resource would have been white-tailed deer, with a full range of nut resources also available. Evidence of domesticated dogs appears in the Midwest by the Middle Archaic period (Anderson and Semken 1980). Stanly Stemmed, Morrow Mountain, Kirk, and Amos Corner-Notched projectile points are reported from Middle Archaic sites in southwestern Pennsylvania (George 1992a:20-21; Chapman 1976:7, 1978:45; Griffin 1974:13; Kraft 1975:6-9; Maslowski 1983; Youse 1983:54, 1985:46).

Late Archaic period components in the study area region typically represent lithic scatters with one or more diagnostic projectile points, and many are multi-component sites. A pattern of small seasonal campsites probably continues in the region, although few sites have been investigated in detail. Excavated cultural features, radiocarbon dates, and floral/faunal associations are extremely rare to non-existent at the Late Archaic sites located in the study area region. Temporally diagnostic projectile points attributed to previously recorded Late Archaic sites have been predominantly associated with the "Laurentian Tradition," which was originally defined in New York State (Ritchie 1938). These projectile point types include Otter Creek, Brewerton, and unspecified Laurentian. Funk (1988:34) cautions against assigning the term Laurentian "... to manifestations outside the Laurentian homeland in which only one or two elements may be present, for example the Brewerton Side-Notched projectile point (e.g., Dragoo 1959; McKenzie 1967)." These cited works refer to Archaic manifestations in the Upper Ohio and Lower Scioto valleys, respectively. The terms "Laurentian" and "Brewerton" are probably over-used in the Upper Ohio region. Many of these projectile points may actually represent local unrelated Brewerton-like traditions of various age.

While Late Archaic subsistence data are virtually non-existent in the study area, a broad-based hunting/collecting economy centered on the hunting of white-tailed deer, elk, bear, turkey, and fish, and the seasonal collection of acorns, hickory nuts, black walnuts, hazelnuts, assorted berries, and seeds probably continued in the region. Squash/gourd (*Cucurbita pepo*) and sumpweed (*Iva annua*) are the earliest confirmed eastern domesticates, followed by chenopod (*Chenopodium* sp.) and sunflower (*Helianthus annuus*) (Yarnell 1993:Table 2-1). Such remains have not been found on Late Archaic sites in the northeastern portion of North America (Funk 1993:205).

In Pennsylvania, the Terminal Archaic/Transitional period has been defined by the appearance of broadspear projectile point types and the use of new implements and technologies, such as steatite bowls and cooking vessels (Witthoft 1971). An increased reliance on aquatic resources is evidenced at this time, and an increase in exotic materials suggests that extensive trade networks were established. Terminal Archaic diagnostic

projectile point/knife forms include Susquehanna Broad, Perkiomen Broad, Lehigh Broad, Savannah River Stemmed, Genessee, and Orient Fishtail. Diagnostic Terminal Archaic projectile point types for the general study area region are confined to Panhandle Archaic Steubenville points, untyped broadspears, and Orient Fishtail points (Mayer-Oakes 1955a, 1955b; Crane and Griffin 1958).

Fragments of stone bowls carved from steatite are commonly associated with the makers of the various broadspears in the Upper Ohio Valley. Broadspear projectile points/knives are recorded from collections from the floodplains of the Upper Beaver River (Adovasio *et al.* 1974; Mayer-Oakes 1953, 1955a; Prufer and Sofsky 1965) and the Middle and Upper Allegheny River (Dragoo and Lantz 1967, 1969; George and Bassinger 1975; Herbstritt and Love 1975; Lantz 1967a, 1971; Mayer-Oakes 1953, 1955a). The constant association of Susquehanna Broadspears and steatite vessels on the floodplains of the Upper Ohio Valley suggests more permanent base camps and perhaps larger populations of the Terminal Archaic. However, this association may merely represent a new economic orientation reflected by a shift in seasonal rounds for the broadspear tradition population.

A variety of Woodland period resource types could occur within the study area, including isolated artifacts; single event to seasonal hunting, fishing, plant collecting, and lithic workshop camps; and recurrent to semi-permanent camps, farmsteads, and hamlets. When reported, the comparatively rare Early and Middle Woodland components consist primarily of surface scatters with projectile points and ceramic sherds that are usually characterized as being mixed with other cultural components. Though little concrete information is available, the Early and Middle Woodland periods are expected to show broad continuities in settlement and subsistence practices with the preceding Archaic period. The dominant settlement pattern throughout much of the Woodland period was one of small, dispersed, seasonal to semi-sedentary communities. Landforms in the study area would have been used for these types of sites. Larger, nucleated and fortified settlements were probably not prominent fixtures on the landscape until well into the Late Woodland period, *ca*. 750 years B.P. or later.

In the general archaeological literature, the Woodland period has been connected to experimentation with and progressively greater reliance on native seed crops like chenopod, maygrass, sumpweed, little barley, and sunflower, as well as cultivated tropical plants, especially in the Midwest. However, indications are that the hunting and gathering lifeways of the Archaic period largely continued through the Early and Middle Woodland periods. Squash, as previously outlined, was being grown by Late Archaic times, but the remains of native weed crops are sparse and scattered, with little evidence for their use prior to the appearance of maize in the region. It was the successful adoption of maize that eventually tipped the balance from food gathering toward food production, although the use of wild plants, especially nuts, as well as hunting, continued well into the historic period.

The beginning of the Early Woodland period is best delineated by archaeological evidence for the widespread manufacture and use of ceramic vessels. There is increasing evidence for the great antiquity of ceramics in the Northeast and the probability that ceramics actually preceded and coexisted with rather than followed the use of steatite vessels.

Because of the difficulty of accurately cross-dating most Late Archaic through Middle Woodland "diagnostic" projectile points when they are found in plowzone artifact scatters, and the tendency to over-attribute these artifacts to the Late Archaic period in the absence of ceramics, the number of Early and Middle Woodland sites is probably under-reported.

Since the earliest ceramic wares are very fragile and often difficult to recover when they are found, their earliest consistently radiocarbon-dated appearance in the archaeological record should be taken as sufficient evidence for the onset of the Early Woodland period. This apparently occurred by 3,500 years B.P. or earlier within the Northeast, including the Upper Ohio region, suggesting that the Early Woodland period encompasses a significant portion of the interval that has been traditionally defined as the Terminal Archaic or Transitional period (Witthoft 1953), which has been generally dated between 3,950 and 3,000 years B.P. Associated projectile point styles include small triangular and stemmed forms, as well as Lagoon, Orient Fishtail, and Meadowood.

The paucity of recorded Early and Middle Woodland sites, relative to Late Archaic and Terminal Archaic/Transitional sites, has been attributed to depopulation by some authors. The inclusion of Transitional period sites within the Early Woodland period inventory effectively eliminates the archaeological site frequency imbalance between these two periods. In addition, since it appears that certain Early and Middle Woodland stemmed and notched projectile points are indistinguishable from named stemmed and notched projectile point styles that have been attributed to the Late Archaic period, and since many different projectile point styles may have been in use on a single site at the same time, a potentially large number of surficial or undated Late Archaic (especially Brewerton and Lamoka) components are potentially of Early or Middle Woodland age.

The Early Woodland period in the Northeast is signaled by the widespread manufacture and use of ceramic vessels, as well as the beginnings of incipient horticulture. In the Upper Ohio River Valley, the earliest evidence for both of these phenomena is from Meadowcroft Rockshelter (36WH297) where a large Fayette Thick ware sherd (locally known as Half Moon ware) was recovered in association with a squash seed and a radiocarbon date of *ca.* 1,115 B.C. (Adovasio and Johnson 1981; Johnson 1982).

In the Ohio Valley, the Early Woodland period is typified by the well-known mortuary ceremonialism of the Adena complex, with its diagnostic ovate-base projectile point/knife forms as well as distinctive ceramic types, ground and polished banded slate ornaments, and tubular smoking pipes (Dragoo 1963; Greenman 1932; Webb and Baby 1957; Webb and Snow 1974). The late Adena site of McKees Rocks Mound (36AL6) is the largest known earthen mound upstream from Moundsville, West Virginia and is located within the study area (Mayer-Oakes 1955a; McMichael 1956).

Like the Early Woodland, the Middle Woodland period in western Pennsylvania is poorly known, and excavated sites are few and scattered. The beginning of the Middle Woodland period is signaled by the appearance of pottery that was decorated using a variety of tools and techniques including rocker-stamping, dentate-stamping, and pseudo-scallop shell-stamping (Ritchie 1969). These pots typically occur along with stemmed and side-

notched projectile points. While these projectile points indicate evidence for hunting, numerous items of fishing gear (netsinkers, composite barbed bone fishhooks, copper gorgets and fishhooks, antler harpoons, and barbed bone points) reflect what may have been the most important mode of subsistence. No evidence of horticulture is associated with these sites. Another important aspect of this period is the culmination of mortuary ceremonialism, which apparently had its antecedents within the Late Archaic through Early Woodland cultures of the region.

Projectile point forms that are diagnostic of the Middle Woodland period in the project region include Snyders, Chesser, and Manker. Snyders projectile points are diagnostic of the early Middle Woodland period and appear with the rise of Hopewell ceremonialism (Justice 1987). The Chesser Notched type appeared during the terminal Middle Woodland period and became more widespread during the Late Woodland period (Prufer and Shane 1970). Chesser Notched points fit chronologically between the Middle Woodland Snyders forms and Late Woodland types such as Jack's Reef Corner Notched. The Anderson Mound (36AL96), located on a terrace of the Lower Allegheny River in Oakmont, Pennsylvania, just northwest of the study area, has produced a curious mix of Early and Middle Woodland traits (George 1978), including Adena-like and Fox Creek points, a sandstone blocked-end tubular pipe, a banded slate bannerstone, a Snyders-like point, and fragments of a sandstone tempered Half Moon Cordmarked vessel.

The Late Woodland/Late Pre-contact period is noted for the importance of maize horticulture, the appearance of the bow and arrow with associated small triangular arrow points, and, in some areas, the construction of nucleated, fortified villages. Lantz (1989) equates Raccoon Notched projectile points with the arrival of the bow and arrow in western Pennsylvania, and Seeman (1992:45) postulates the introduction of this weapon into the Midwest from the Northeast between *ca*. A.D. 700 and 900, based upon the presence of Kipp Island phase diagnostics, including Jack's Reef projectile points and certain ceramic types, in the Middle Ohio Valley. The construction of low, stone slab burial mounds continues into the Late Woodland period (Applegarth and Cowin 1982; Dragoo 1956). Bennington Corner-Notched, Jack's Reef, and Raccoon Notched projectile points are diagnostic of the late Middle Woodland to early Late Woodland periods in the upper Ohio River Valley (Mayer-Oakes 1955a, Johnson 1990:V.7). Four additional small projectile point varieties (Garvers Ferry Corner-Notched, Kiski Notched, Murphys Stemmed, and Backstrum Side-Notched) are at least partial contemporaries of the Jack's Reef and Raccoon Notched projectile points in southwestern Pennsylvania (George 1982, 1988, 1992a, 1992b; Lantz 1989). A number of Late Woodland/Late Pre-contact period groups and phases have been identified in northeastern North America, including the Monongahela culture.

Monongahela components have been found in northern West Virginia, eastern Ohio, northwestern Maryland, and southwestern Pennsylvania including in the study area. The time frame for Monongahela sites spans the period from *ca.* A.D. 1150/1100 to the early seventeenth century. Monongahela subsistence was based primarily on maize horticulture. Other cultigens recovered from excavations at Monongahela sites include beans, squash, and possibly sunflower. Evidence also indicates that various nut species were extensively utilized. Village sites were preferred over hamlets and farmsteads, and were generally

situated in upland locales (Johnson *et al.* 1989). Most Monongahela village sites were generally surrounded by one or more stockade lines, which were often paralleled by trenches. The layout of a typical Monongahela village consisted of houses placed near the stockade, leaving an open central courtyard. House patterns were generally circular to oval, with outward-sloping walls, although rectangular house patterns have been reported at a few sites. Villages typically contained numerous storage and refuse pits (Johnson *et al.* 1989).

The most visible change in Monongahela domestic gear from earlier periods is the appearance of new ceramic manufacturing technology (shell tempering), vessel forms, and decorative modes. Generally following Mayer-Oakes (1955a:232, Table 7), Johnson *et al.* (1989:24) split the Monongahela culture into three sequent periods (Early, Middle, and Late), based almost exclusively upon technomorphological changes in ceramics, although some changes in house and storage structure style, and site size and distribution have been recognized. The latest period is signaled by the appearance of European-produced trade goods. Monongahela culture sites are absent from the archaeological record after the first third of the seventeenth century.

Late Prehistoric period settlement patterns were dominated by large villages, with some scattered hamlets, farmsteads, and ancillary camps, which have been attributed to people of the Monongahela culture. The increase in settlement size during this period apparently reflected an increase in the local population base, rather than an influx of alien populations (Johnson 1991; Maslowski 1973, 1984a, 1984b). This population increase is generally attributed to the introduction of intensive maize horticulture, which produced a valuable storable resource. Villages were predominantly in the uplands, although valley floor situations have been documented. Among the most preferred upland locales were saddles, Monongahela River bluff/Illinoian terrace situations, and ridge tops. Village sites recorded in riverine settings account for only a small percent of the total.

The planned, nucleated larger village sites often reflect periodic expansion, abandonment, and reuse. This cycle was probably related to the exhaustion of arable land and usable timber within the local catchment area. A byproduct of this shifting settlement system was the creation of attractive edge habitat for white-tailed deer, which continued to remain an important multi-purpose resource. While the Monongahela subsistence economy apparently emphasized maize and bean horticulture, wild plant and animal resources were also important. Possible domesticates included goosefoot (*Chenopodium* sp.) and smartweed (*Polygonum* sp.), while other floral specimens included amaranth (*Amaranthus* sp.), hickory nutshell (*Carya* sp.), grape (*Vitus* spp.), and plum (*Prunus* sp.). The frequency of carbonized nutshell on Monongahela sites suggests a continuation of the Archaic/Woodland seasonal gathering pattern. White-tailed deer continued to provide a valuable food and raw material source. Wild turkey and fish were also important faunal resources. Large amounts of freshwater mussel shell have also been recovered at Late Prehistoric period sties (Church 1994). Most petroglyphs in the Ohio River Valley are likely Late Prehistoric in origin; however, Woodland and Archaic petroglyph sites are known.

12.5.3.2 Historic Period

The historic period is defined as that period of time in North America after European contact with Native Americans. The historic period has been divided into the following periods: Early Euro-American Exploration through the First Half of the Eighteenth Century, Second Half of the Eighteenth Century, First Half of the Nineteenth Century, Second Half of the Nineteenth Century, First Half of the Twentieth Century, and Second Half of the Twentieth Century. Historic period cultural resources are represented both in the archaeological record as sites as well as in the built environment as records and structural remains.

Through the use of the CRGIS, the total number of previously recorded historic period archaeological sites within Allegheny and Beaver counties, Pennsylvania could be determined. When previously recorded sites within Allegheny and Beaver counties are considered as a whole, including those that may not be located in the study area, pre-eighteenth century historic sites number two, eighteenth century sites number 13, nineteenth century sites number 165, and twentieth century sites number 81. When only those previously recorded historic period archaeological sites located within the study area are considered, historic period sites number 79 and cemeteries number one. These previously recorded historic period archaeological site types range from domestic, to industrial, to military. A few of the previously recorded sites are listed as having both pre-contact and historic period components and are counted in both groups. This type of information is not available online for the Ohio and West Virginia portions of the study area; however, based on a general overview of the literature, many of the same types of sites are recorded in these states as well.

Based on a further review of the CRGIS, there are 31 historic period properties located in the study area that are listed in the NRHP, 69 historic period properties eligible for listing in the NRHP, and four National Historic Landmarks. These historic properties range in age from 1785 to 1955. The eighteenth century is represented by a military fort. The nineteenth century is represented by properties including residential, religious, industrial, commercial, and public buildings/structures; locks/dams; bridges; railroads; and districts. The twentieth century is represented by many properties including residential, religious, industrial, commercial, and public use buildings/structures; locks/dams; bridges; railroads; and districts. The four National Historic Landmarks include “Forks of the Ohio” (Pittsburgh), representative of the seventeenth century; the Smithfield Street Bridge, representative of the eighteenth century; and Carrie Furnace No. 6 and 7 – US Steel Swissvale Plant and Old Economy Village, both representative of the nineteenth century.

Prior to 1966 when the NRHP was established by NHPA, there was no codified means or process to designate historic properties as worthy of preservation. With the establishment of the NRHP, agencies and individuals had a national listing for these important cultural resources. A review of the NRHP identified 13 properties in Hancock County, West Virginia; 185 properties in Allegheny County, Pennsylvania; 20 properties in Beaver County, Pennsylvania; 44 properties in Columbiana County, Ohio; and 27 properties in Jefferson County, Ohio. Of course some or all of these properties may not be located in

the study area; however, determining specific numbers and types of resources would involve a much more involved level of effort than was determined appropriate for the compilation of this document.

The numbers do indicate some trends. Not surprisingly, the highest number of NRHP listings are associated with the most populous areas along the rivers (e.g., Pittsburgh, Allegheny County, Pennsylvania; and East Liverpool, Columbiana County, Ohio). In addition to single listed resources, the Pittsburgh metropolitan area and some of the other smaller metropolitan areas (e.g., Beaver, Beaver County, Pennsylvania) in the study area have listed historic districts that encompass numerous individual contributing resources. The increased numbers of individual resources and historic districts in more populous areas most likely reflect local and state levels of interest, effort, and funding for historic preservation as well as higher proportions of federal projects which involve the Section 106 process in these areas. The annual number of new listings has remained relatively stable in the past decade in West Virginia, Pennsylvania, and Ohio. The number of listings is predicted to remain at a similar level in the coming decade.

Kent *et al.* (1981) indicate that there were six eighteenth century Indian towns along the Allegheny and Ohio rivers in the study area. There are no known eighteenth century Indian towns along the Monongahela River until well south and upstream of the study area limits. The Delaware Indian town of Shannopin's Town is mapped along the Allegheny River near the confluence of the Monongahela and Allegheny rivers where Pittsburgh is today. This town dates from *ca.* 1751 to 1760. The Iroquois town, Allaquippa's Town, dating from *ca.* 1748 to 1755, is located along the west side of the Ohio River near McKees Rocks. Logstown is associated with multiple Indian groups, including the Iroquois, Delaware, Mingoes, and Shawnee. The town was located along the east side of the Ohio River near present day Ambridge. The town appears to date from *ca.* 1743 to 1764+. Crows Town was identified further downstream along the Ohio River near present day Conway; however, its cultural and temporal associations are not known. The Mingo settlement of Logan's Town is present at the confluence of the Beaver and Ohio rivers near present day Rochester. Across the Beaver River, at present day Beaver, was Shingas Old Town. This location was associated with the Mingo, Delaware, and Shawnee peoples and was known to have been occupied *ca.* 1748 to 1756. The presence of these towns indicates that several Indian groups, including the Iroquois, Delaware, Mingo, and Shawnee, were present in the study area during the contact and early historic periods.

A detailed history for the Ohio River Mainstem was completed in 2001 by Carlisle and Mulligan (2001). Much of the following information specific to the study area is taken from that document.

No substantial Euro-American settlement occurred within the upper Ohio River Valley before the second half of the eighteenth century. The first Europeans in the area were French explorers, who reached the *Belle Riviere*, as they called the Ohio River, from the north *via* explorations of the Great Lakes in the late seventeenth century (Carlisle and Mulligan 2001:3-4). The explorers were followed by French and British trappers and traders. These early frontierspeople generally traveled between Indian towns and trading posts. The

former Indian town of Logstown, Pennsylvania, on the right bank of the Ohio River near present day Ambridge, was a popular location for both French and British traders (Agnew 1894; Montresor 1776). There are no surviving structures associated with these early travelers along the Ohio River, in part because they did not establish any permanent settlements.

In 1753 a young George Washington was sent to the region by Governor Dinwiddie of Virginia to scout the territory and to ascertain the strength and intentions of the French forces, who had begun building military fortifications at Lake Erie and south along French Creek. Upon reaching the Forks of the Ohio (now a National Historic Landmark located at present day Pittsburgh), where the Allegheny and Monongahela rivers combine to form the Ohio River, Washington commented on the natural advantages afforded by the site. With navigable waterways, protective hills, and clear vantage points, he deemed that the site was well situated for an English fort. The following year (1754) the modest Fort Prince George was built at the site.

The new fort and the scouting done by Washington for Dinwiddie and by agents of the Ohio Company, an English land settlement company, covered contested lands claimed by the English, the French, and Native Americans, many of whom had already been displaced from their homelands further east. In 1754, before Fort Prince George could be completed, the French overwhelmed the small British garrison and erected the larger Fort Duquesne in its place. After one failed attempt, the British retook the site in 1758 and constructed the even larger Fort Pitt near the ruins of Fort Duquesne. The Fort Pitt Blockhouse, dating from 1764, is the only surviving structure from this period though several excavations have been undertaken to learn about the forts (Fort Pitt Museum 2009).

Other forts were erected along the Ohio River as both the French and the English sought to assert their control of the region, though few remnants of the forts remain today. The only other fort from this period located within the study area was Fort McIntosh, which was built in 1778 during the American Revolution to protect the western frontier from British and American Indian raids. The fort was located on the right bank of the Ohio River at present day Beaver, Pennsylvania, but today the only visible traces of the fort that remain are provided by the excavations undertaken in the mid-1970s (Beaver Area Heritage Foundation 2009). The first formal United States military training camp was established at Legionville, Pennsylvania on a bluff overlooking the Ohio River in 1792. Under the direction of Major General “Mad” Anthony Wayne, over 2,000 enlisted men were drilled at the site, which had 500 structures in addition to parade grounds (Oliver 1993).

The presence of a fort, and the often nominal protection it provided, encouraged the creation of small communities and, eventually, towns along the river. The earliest Euro-American settlements clustered near the forts, where land was cleared, small farms were established, and rudimentary log dwellings were built. The rare appearance of brick and stone as building materials was generally limited to the latter part of this period.

The Upper Ohio River Valley suffered a period of almost constant conflict over the course of the second half of the eighteenth century. The French were defeated in the French

and Indian War, the British were defeated in the American Revolutionary War, and the American Indians were compelled by multiple treaties and by force to abandon their lands in the area and move further westward ahead of the western advance of American settlers. Despite the war and violence that marked this period, hundreds of settlers came to the Upper Ohio River Valley and laid the foundations for the more permanent and prosperous communities that emerged by the beginning of the nineteenth century.

The earliest Euro-American endeavors in the area had been limited primarily to hunting, trapping, and farming. By the early nineteenth century, a diversified economy, which supported several small industries, began to develop. Because the Ohio River served as a major transportation corridor and gateway to the west, boat-building industries, which exploited the ample local timber resources, were quite successful. Sawmills, planing mills, and lumberyards were frequent sites along the river, and keelboats and flatboats were early lucrative products. Following the first voyage of a steamboat from Pittsburgh down the Ohio and Mississippi rivers to New Orleans in 1811, the building of steamboats became a major industry in the region. By 1834, 304 steamboats had been built in Pittsburgh (Jensen and Moore 2009). A map from later in the century shows a steamboat yard lining the right bank of the Ohio River at Freedom, Pennsylvania, and another steamboat yard on the left bank at Shousetown, Pennsylvania (Hayes 1877).

Pittsburgh's first major industry, glass making, began in a factory established along the left bank of the lower Monongahela River in 1797 (DaParma 2008). The glass making industry thrived because of the abundant local resources of sand, coal, and iron and the proximity of the Ohio River and its burgeoning trade. In 1827, machine technologies were introduced to the factories, and by 1840 Pittsburgh was considered the "pressed glass capital of the world" (DaParma 2008).

Among the most industrious of the settlers in the region were the Harmony Society, a German separatist sect, which settled at Economy on the right bank of the Ohio River in 1825. The Harmonists adopted new technologies to aid in their textile manufacturing and agricultural production. They constructed textile factories that were powered and heated by steam engines and produced wool and cotton, and they perfected the manufacture of silk fabric beginning with the worms and mulberry bushes raised within the community. They also built shops for blacksmiths, tanners, hatters, wagon makers, cabinetmakers and turners, linen weavers, potters, and tinsmiths, and they developed a centralized steam laundry and a centralized dairy. The Society disbanded in 1906, and some of their property at Economy was acquired and preserved by the Commonwealth of Pennsylvania in 1916. Now known as Old Economy Village, this National Historic Landmark represents an early and unique effort to sustain cultural resources along the Ohio River (Old Economy Village 2009).

Other fledgling industries in the Upper Ohio Valley included many iron furnaces and foundries, coalmines, stone quarries, brick making yards, and potteries. At East Liverpool, Ohio, beginning in 1840, so many potteries were operating that the town became known as the "Pottery Capital of the World" (Carnegie Public Library 2006). The hundreds of potteries ranged in size from small home potteries located in log or frame buildings to large complexes with multiple kilns covering many acres of land. Archaeological excavations in

1991 identified and explored the remains of several of these potteries located only two blocks from the Ohio River in East Liverpool (Gundy and Casselberry 2005). Other pottery centers along the Ohio and its tributaries included West Union, Foulkstown (Calcutta), and Wellsville, Ohio; and Little Beaver River, Little Yellow Creek, and Georgetown, Pennsylvania.

The increasingly intense settlement and population growth characteristic of this period is reflected in the establishment of counties and county seats, the incorporation of numerous towns, and the formation of the State of Ohio (1803) which helped formalize American control of the Upper Ohio River Valley. Beaver, the county seat of Beaver County located at the confluence of the Big Beaver River and the Ohio River, was founded in 1801. Because it was founded as a governmental center and not an industrial or commercial town, the formal town layout of Beaver ignores the nearby rivers in a manner that is unique within the study area. Further west, the town of Wellsville, Ohio was formally laid out in 1823 and incorporated in 1833. The area had been first settled in 1797 with log houses and small farms. Sawmills and boatbuilding sites took advantage of the town's position on the right bank of the Ohio River. By the 1830s, it was notorious as a rough river town, and indeed it was an important trade center for inland Ohio counties with wharves and warehouses in addition to its schools, churches, and fine stone houses (Bush 1973).

Major improvements in transportation were made in the first half of the nineteenth century as well. In 1824 Congress authorized the USACE to improve navigation on the Ohio River. The USACE began by clearing away snags and sandbars from the river (USACE 2009b). Four locks and dams were completed on the Monongahela River in 1844 under private sponsorship (Carlisle and Mulligan 2001:3-21). The necessary improvements were timely because the creation of both the National Road and the Erie Canal threatened to draw traffic away from the Ohio River. Construction of the National Road began in 1811 at Cumberland, Maryland, and followed an inland route that connected with the Ohio River below the study area at Wheeling, (West) Virginia, thereby bypassing the Upper Ohio River Valley (Carlisle and Mulligan 2001:3-15). The creation of the Erie Canal in 1825 offered a continuous route from New York City to Lake Erie, eliminating the need for many shippers to travel along the Ohio River. The Ohio & Erie Canal and the Pennsylvania Main Line Canal were subsequent responses to ensure that the communities along the Ohio River still benefited from lucrative trade (Carlisle and Mulligan 2001:3-18). The canal era was vibrant but short-lived as the canals were overshadowed by the contemporary development of railroad networks to facilitate overland transportation. The railroads proved the biggest threat to the river because they offered routes and spurred development that were not linked to the waterway. By the time bigger industries were established in the second half of the nineteenth century, however, the railroads and the river networks often worked in tandem to move raw materials and finished goods.

Historic structures from the first half of the nineteenth century may include resources linked directly to the river: wharves, landings, canalizations, bridges, and locks and dams. In this period, industries tended to line the river in towns and cities with furnaces, kilns, factories, and warehouses often built of brick as a fireproofing measure. Houses were also located along the river in towns and in rural areas. Houses were still constructed of log,

though brick, stone, and sawn lumber were increasingly available as building materials. These developments were often located on the sites of earlier settlements (including the forts), where the already cleared land and ready materials were assets.

The *Illustrated Atlas of the Upper Ohio River and Valley*, produced in 1877, offers a detailed description of the development of towns and communities along the Ohio River in the second half of the nineteenth century (Hayes 1877). The mapping, like the study area, begins with the lower portions of the Allegheny and Monongahela rivers. It then follows the Ohio River through western Pennsylvania and along the Ohio-West Virginia border past the lower limit of the study area at the New Cumberland Dam to Cincinnati, Ohio. In 1877, the lower Allegheny River had five road bridges and one railroad bridge, and the lower Monongahela River had three road bridges, one railroad bridge, and one dam. No bridges spanned the broader expanse of this section of the Ohio River, though at least 12 ferries for river crossings were indicated on the atlas. There are 19 islands shown, which ranged in size from small uninhabited sand bars to the large Neville Island with 42 named residents (families), two churches, two schools, and a river landing. Four other landings or wharves are indicated along the Ohio River on the mapping.

Railroads were a common feature paralleling the rivers in second half of the nineteenth century. Along the lower Allegheny River, the Allegheny Valley Railroad followed the left bank to the railroad's terminus in Pittsburgh's wholesale foods district, while the Western Pennsylvania Railroad followed the right bank of the Allegheny River to Allegheny City (annexed to Pittsburgh in 1906), where it turned inland. The Cleveland & Pittsburgh Railroad and the Pittsburgh, Fort Wayne & Chicago Railroad followed the right bank of the Ohio River north toward Rochester where the Pittsburgh, Fort Wayne & Chicago Railroad proceeded to the north and the Cleveland & Pittsburgh Railroad continued to follow the Ohio River across the Big Beaver River and to the west beyond the limit of the study area. Along the lower Monongahela River, the Pittsburgh, Washington & Baltimore Railroad paralleled the right bank, while the Pittsburgh, Virginia & Charlestown Railroad and several short coal spurs were located on the left bank a few blocks inland from the river. Near the mouth of the Ohio River, the Monongahela, Pittsburgh, Cincinnati & St. Louis Railroad paralleled the left banks of the Monongahela and Ohio rivers until it was forced inland by the terrain near McKees Rocks. There are no other rail lines indicated on the atlas along the remainder of the left bank of the Ohio River within the study area.

During the late nineteenth century, the cities of Pittsburgh and Allegheny had the densest concentrations of buildings along the rivers within the study area. Both had many sawmills, planing mills, lumberyards, small steel works, rolling mills, iron forges, foundries, and coke ovens. The small craft industry steel works are especially telling of the period, because beginning in 1873 with the creation of the Edgar Thomson Steel Works in North Braddock by Andrew Carnegie, steel mills became larger and larger. The Bessemer process employed by Carnegie allowed the steel works to evolve into a major complex employing hundreds of workers and able to produce 225 tons of steel rails a day.

Lining the right bank of the Allegheny River in Allegheny City, there were also several cotton mills and woolen mills, breweries, ice houses, tanneries, oil works, gas works,

and railroad yards. South of Pittsburgh along the left bank of the Monongahela River were several glass works and multiple coal rail spurs that ran perpendicular to the river with coal tipples perched above the river's edge. At the Forks of the Ohio, the land that was once dominated by frontier forts was almost completely industrialized by 1877 with foundries, boiler works, and warehouses. The downtown area of Pittsburgh was also characterized by small industries. By the early twentieth century, banks, stores, and office buildings became the dominant building types in Pittsburgh. Along the riverbanks of Pittsburgh and Allegheny, the presence of different ethnic groups of immigrant workers was reflected in the crowded narrow lots of workers' housing and the ethnic churches at their center.

The thriving nineteenth century industries of Pittsburgh contributed to the image of the "Smoky City", and various resort areas were built as getaways further down the Ohio River. Wealthy industrialists built mansions on the hills surrounding Sewickley, Pennsylvania, but the presence of hotels and an "eating house" near the railroad station provided amenities at the level of the river as well. In nearby Haysville, the only development shown in 1877 is the home of Captain John Hays and the elaborate spa and hotel called the Ellanova Springs Hotel, which burned in 1881 (Sewickley Valley Historical Society 2006:32).

Further north, the town of Rochester, Pennsylvania, developed in terraces on the hillside overlooking the confluence of the Ohio and Big Beaver rivers. At the level of the Ohio River floodplain, development along the right bank of the river included an ice house, two hotels, a bank, a plow manufacturer, a foundry, two planing mills, a saw mill, a brickyard, several railroad buildings, and a wharf near the ferry crossing (Hayes 1877)

In the region west of Beaver, as far as New Cumberland, West Virginia, the majority of development was located on the right bank of the Ohio River. Coalmines, oil works, gas works, firebrick yards, potteries, and (not identified as such but most likely) farms are the most common designations. At the town of East Liverpool, the concentration of potteries was so great that new complexes were established at Chester and Newell, West Virginia on the opposite side of the Ohio River. At Wellsville, the establishment of the Cleveland & Pittsburgh Railroad yards with a roundhouse and various machine shops highlighted the town's regional importance as a transportation center.

The proliferation of industry in the Upper Ohio River Valley in this period led to congestion of barges and boats on the river. In 1885 the USACE completed construction of the lock and dam at Davis Island below Pittsburgh (USACE 2009c). The improvement was necessary to handle the increased size and number of vessels navigating the waterway. The lenticular truss Smithfield Street Bridge, a National Historic Landmark, was erected across the Monongahela River in 1881.

The early twentieth century was marked by the supplanting of smaller independent industries into large complexes. A good example is the development of the Jones & Laughlin Steel Plant at Aliquippa on the left bank of the Ohio River below Pittsburgh. The plant was built near the site of a long abandoned Indian town. In the late nineteenth century, the Pittsburgh & Lake Erie Railroad built an amusement park on Crow's Island to entice day

travelers from the city. By 1909, however, Jones & Laughlin Steel had demolished the amusement park, filled in the back channel and began erecting what would become the largest, integrated steel mill in the world, stretching seven miles along the river (Ireton 2009). They built a company town as well. Across the river near the former site of the Harmonists' community, the American Bridge Company built another company town to support its steel mill workforce and called it Ambridge.

Steel mills proliferated in the Monongahela River Valley as well. Along the Allegheny River, the expansion of the H.J. Heinz Company food bottling facilities similarly dominated the riverside. By 1906 the potteries at East Liverpool extended for over three miles along the Ohio River and the North American Manufacturing Company was building a new state-of-the art plant with 30 kilns in Newell, West Virginia. In 1907 the Homer Laughlin China Co. moved into a new plant that was the largest pottery in the world at the time (Carnegie Public Library 2006).

In many cases, the unchecked development of the early twentieth century physically cut cities and towns off from the river. Zoning, natural or planned, tended to separate business and residential districts from industrial ones. The City Beautiful Movement became popular in this period as attempts to rationalize and rehabilitate the physical environment became increasingly urgent. The City Beautiful Movement championed green spaces and parks as promoters of health and morality, and it decried urban slums and evidence of blight as detriments to society.

The early twentieth century was a great era of bridge building in the region. In 1910, the Pittsburgh & Lake Erie Railroad built the elegant truss Beaver Bridge at the confluence of the Ohio and Big Beaver rivers. Three self-anchored suspension bridges, known as the Three Sisters, were among the many significant bridges built across the Allegheny River in the 1920s. The West End Bridge (1932), McKees Rocks Bridge (1932), and Ambridge-Aliquippa Bridge (1926) are notable Ohio River crossings from this period.

The Rivers and Harbors Act authorized a system of 51 locks and dams for the entire length of the Ohio River, resulting in canalization of the river by 1929. These measures improved navigation but did not alleviate the threat of flooding. The worst flood to hit the region in the first half of the twentieth century occurred on March 17 and 18, 1936, when flood levels peaked at 46 feet in Pittsburgh and 100,000 buildings in the city were destroyed. Flood control measures, including the construction of a far-reaching system of reservoirs, were authorized in the wake of the flood. Wellsville, Ohio, also suffered record flooding in 1936 and 1937. In 1938 the first million-dollar floodwall was built, the only one on the upper Ohio River (Bush 1973). Pollution control measures for the air, land, and water were also urgently needed, but the advent of World War II and the massive wartime mobilization effort undertaken in the region delayed any action.

The wartime mobilization and post-war boom provided continued industrial prosperity to the region. Steel mills and other local industries were producing at record levels during the second half of the twentieth century. In 1954, the USACE undertook the Ohio River Navigation Modernization program to accommodate the larger and longer diesel-

powered river traffic that clogged the Ohio River (USACE 2009c). The rail yards at Conway, Pennsylvania, on the right bank of the Ohio River were converted to ultra-modern freight classification yards in the mid-1950s. Conway's updated facility stretched for four and a half miles along the river and handled thousands of rail cars a day. It was known at the time as the busiest automated rail yard in the world (Buerkle 2009; Pennsylvania Railroad 1958).

The small community of Shippingport, Pennsylvania, also expanded dramatically in this period. In 1877 the town, located on the left bank of the Ohio River, was the site of a river landing, two stores, a post office, a hotel, a blacksmith shop, a school, and two mills (Hayes 1877). Today, the town is dominated by the former Shippingport Atomic Power Plant facility built in 1957 as "the world's first full-scale atomic electric power plant devoted exclusively to peacetime uses" (United States Nuclear Regulatory Commission 2007). The huge facility was constructed on a five hundred acre site.

In 1945, Pittsburgh Mayor David Lawrence and the Allegheny Conference on Community Development proposed a grand program for Pittsburgh called the Pittsburgh Renaissance. The program was designed to clean up Pittsburgh by enacting smoke and water pollution regulations and by constructing new modern structures, including glass, steel, and aluminum skyscrapers, a cultural arena, and a dramatic focal point park for the Forks of the Ohio. All over the city, the policy of eminent domain allowed the seizure and destruction of properties that were deemed blighted. One of the unforeseen consequences of the Pittsburgh Renaissance was the emergence of an opposition who favored the preservation of historic structures, led in part by the Pittsburgh History & Landmarks Foundation, which was founded in 1964. Similar changes were wrought on the landscape of the Upper Ohio River Valley by development associated with the construction of interstates. At Wellsville, Ohio, three historic schools, the old City Hall, and a rock formation called "Indian Head Rock" were demolished in the early 1970s for the construction of a four-lane highway through the city (Bush 1973).

In the late 1970s, the steel industry in Pittsburgh and the Upper Ohio River Valley began to fail. Foreign competition, combined with outdated facilities and technologies and depleted natural resources, led to the closure of local steel plants. The closure of the steel plants then affected other industries like railroads and mines. By the mid-1980s, shuttered steel mills lined the rivers. Often, the former mill properties sat unused because they were contaminated brownfield sites. Over time, many of the former mill sites have been rehabilitated and redeveloped as at the Pittsburgh Technology Center office park in Hazelwood, at the Washington's Landing residential community on Herr's Island, or at the Waterfront shopping complex in Homestead (Dettore 2009). Concurrently, efforts have been made to evaluate, preserve, and interpret what groups like the National Rivers of Steel Heritage Area can save of the industrial heritage of the region (Rivers of Steel Heritage Area 2009).

Preservation concerns have been more carefully considered in new development programs in the late twentieth century thanks to stricter federal regulations, more powerful preservation agencies, and increased public awareness of and sensitivity to historic resources.

Beginning in the late twentieth century, many cities made concerted efforts to reclaim their waterfronts and reconnect to their rivers. At Pittsburgh, this has been achieved in part by the development of trails like the Three Rivers Heritage Trail with a pedestrian trail and greenway system around Pittsburgh running for 37 miles along both sides of the Allegheny, Monongahela, and Ohio rivers (Friends of the Riverfront 2009).

12.6 INTERACTION WITH OTHER VALUED ENVIRONMENTAL COMPONENTS (VECs)

Cultural resources are associated to varying degrees with several other VECs, but appear to be most closely related to those VECs associated with human communities including socioeconomics, transportation and traffic, and recreation. The most significant interactions and potentially adverse impacts to cultural resources occur because of socioeconomic land use changes along the river. Transportation and traffic appears to directly affect cultural resources through promoting development along the river that can negatively impact known and unknown historic structures and archaeological resources.

Recreation along the rivers is becoming increasingly important as cities and towns once again consider their riverfronts as community assets. Riverfront recreation can have a negative and/or positive effect on cultural resources. Attendant damage or destruction of historic structures and archaeological resources can result from increased recreation along the river. Recreational development that is subject to regulatory oversight, however, can produce knowledge and educational opportunities that enhance our understanding of history. It can also provide information important to promoting heritage tourism, an important aspect of local and regional socioeconomics. For example, the Rivers of Steel National Heritage Area covering the study area is an organization that promotes heritage tourism centered upon the rivers and their related historic resources.

A moderate level of interaction occurs between cultural resources and the natural resource VECs. As floodplain hydrology and terrestrial resources are modified through time by changes in land use and vegetation, cultural resources can become vulnerable to inundation, burial, exposure/erosion, or other types of destruction. Worsening water and air quality can affect the context and preservation of cultural resources and the ability to use them to positively promote heritage tourism.

12.7 INDICATORS OF ENVIRONMENTAL SUSTAINABILITY FOR CULTURAL RESOURCES

Indicators of environmental sustainability will vary with each valued environmental component , but generally they provide benchmarks for measuring cumulative effects on that VEC. There are no regulatory requirements or standards that mandate a specific level of sustainability for cultural resources in terms of either quantity or type. How many or what types of cultural resources are valued or are deemed necessary to achieve sustainability is a subjective decision. Some individuals and communities do not see much, if any, value in considering or preserving cultural resources and would consider cultural resources sustainable if few or no resources were considered, while other individuals and communities

are very active in interpreting and preserving our shared cultural heritage and would mandate much larger quantities and varieties for sustainability. The regulations that do exist are procedural only. They allow for consideration of cultural resources within certain project contexts, but do not determine a level of outcome or sustainability that has to be reached for either individual resources or groups of resources that are adversely affected. Quantitative measurements of sustainability for cultural resources do not exist as codified standards. For cultural resources identified within the federal regulatory environment, "significance" or eligibility for listing in the NRHP is used as a measure of sustainability for individual resources. Significance is determined by consideration of the four NRHP criteria.

For cultural resources outside of the federal regulatory environment, their sustainability depends on other subjective measures. The intrinsic value of cultural resources, and potentially their sustainability, should be viewed in terms of their contribution to the public good as a means to better understand humanity, its history, and behaviors and the environmental context within which human activities take place (Fowler 1991). However, because human individual as well as group behaviors are both patterned and random through time, all cultural resources are unique and non-renewable, and the circumstances that created each resource are unique and difficult to duplicate. Each cultural resource demonstrates unique benchmarks for measurements of cumulative effects at an individual level. In addition, the value attributed to cultural resources in governmental laws and regulations, or appreciation of cultural resources at any given point in time by various individuals or populations, also fluctuates making the quantitative measurement of their sustainability fluid as well.

Factors contributing to sustainability for cultural resources include those actions or measures that help to slow the loss of cultural resources, and those that help preserve cultural resources directly or the important information about cultural resources. In order to ensure maximum contributions to the public good, the sustainability, identification, recordation, and/or preservation of cultural resources that are representative of the full temporal range of pre-contact and historic periods, and the wide range of humans and their behaviors, is desirable. To achieve this goal, information about the frequency and significance of cultural resources located in the study area must be ascertained. Fortunately, the federal regulatory environment has bolstered the numbers and types of cultural resources and the information about them that has been preserved. The vast quantity of information about cultural resources gleaned from cultural resource management in the past and the information that will continue to accumulate in the future provides a tremendous body of knowledge.

In addition to federal protections, cultural resource sustainability can be correlated with the level of protection provided at the state and local levels. Historic preservation as well as zoning ordinances can contribute to the sustainability of cultural resources which would otherwise not be considered in the federal regulatory environment. Often these state and local considerations are the direct result of private and non-profit historic preservation interest groups such as historical and preservation societies, state historic preservation offices, certified local government commissions, downtown and Main Street revitalization organizations, amateur and professional archaeological societies, and museums. The Upper Ohio River region is rich with these types of organizations which tend to be headquartered in

larger cities but can be involved with one specific resource at a local level or many resources within a larger geographic region.

There are over 235 of these types of organizations in Pennsylvania with a substantial number headquartered in western Pennsylvania, or concerned with western Pennsylvania historic preservation and cultural resource issues. The state of Ohio has over 190 of these types of organizations and West Virginia has over 25. A few examples of these state and local organizations with interests in the study area include, but are not limited to: Carnegie Museum of Natural History, Rivers of Steel National Heritage Area, Pittsburgh History and Landmarks Foundation, Pennsylvania Historical and Museum Commission, Society for Pennsylvania Archaeology, Pennsylvania Archaeological Council, Preservation Pittsburgh, The Senator John Heinz History Center, Manchester Historical Society, Beaver County Model Railroad and Historical Society, The Historical Society of Western Pennsylvania, Homestead & Mifflin Township Historical Society, Beaver County Genealogy & History Center, Little Beaver Historical Society, *Sewickley Valley Historical Society*, East Liverpool Museum of Ceramics, Ohio Archaeological Council, East Liverpool Historical Society, Wellsville Historical Society Inc., West Virginia Archaeological Council, West Virginia Division of Culture and History, Preservation Alliance of West Virginia, and the Historic National Road in West Virginia. These organizations and their members are the people who worked for historic preservation prior to the passing of national historic preservation legislation, worked for the passage of national historic preservation legislation, and continue to promote historic preservation and provide viewpoints outside of the national historic preservation programs.

Specific indicators of sustainability would include:

- The number of properties/sites within the study area listed or eligible for listing in the NRHP or listed in any special state or local listings;

- The physical condition of properties/sites within the study area listed or eligible for listing in the NRHP or in any special state or local listings;

- The integrity and stability of cultural resource contexts with changing circumstances (e.g., access to the public, new construction, advances in preservation techniques, changes in ownership, etc.);

- The frequency and importance of a resource, or group of like resources;

- The effectiveness of federal regulations and State Historic Preservation Officers (SHPOs) in identifying, recording, interpreting, and preserving cultural resources within the study area; and

- The level of effort necessary to minimize impacts from unavoidable past and future actions.

Sustainability is attained when conditions for the indicators are good and meet or exceed regulatory thresholds (i.e., successful completion of the regulatory process) or other pertinent measures. In addition, the successful resolution of special concern issues through consultation and cooperation is another indicator of long-term sustainability. The indicators when viewed as a group should be used for comparative purposes to help with the allocation of energy and economic resources channeled toward future recovery, research, and preservation efforts, especially when fiscal resources are limited.

12.8 RELEVANT FUTURE ACTIONS AFFECTING CULTURAL RESOURCES

RFFAs for cultural resources were evaluated utilizing a matrix prepared during the scoping process. The matrix was an outgrowth of a similar matrix developed during the preparation of ORMSS. Results of the RFFA evaluation are summarized in Table 12-3.

TABLE 12-3
RFFA Cumulative Effects Matrix for Cultural Resources

RFFA Cumulative Effects Matrix for Upper Ohio River – Cultural Resources					
RFFA[1]	**Time Period[2]**	**Occurrence Probability[3]**	**Location on River[4]**	**Importance[5]**	**Effects[6]**
USACE Actions					
Navigation Investments					
Replacement locks at Emsworth, Dashields, and Montgomery Dams (EDM)	1	H	S	H	+/-
Rehabilitation of EDM dams	1	H	S	M	+/-
L&D operation and maintenance	A	H	S	M	+/-
Approach & channel dredging/disposal	A	H	E	M	-
Pool maintenance	A	H	E	L	-
Sec 107 port development and maintenance dredging	2	L	S	M	-
Ecosystem Restoration					
Fish passage at EDM	1	H	S	L	+/-
Actions by Others					
Navigation System Dependent - "But For"					
Commercial navigation					
terminals & multi-modal sites	2	L	S	H	+/-
accidents/spills	A	M	E	L	-

TABLE 12-3 (continued)
RFFA Cumulative Effects Matrix for Upper Ohio River – Cultural Resources

RFFA Cumulative Effects Matrix for Upper Ohio River – Cultural Resources					
RFFA[1]	**Time Period[2]**	**Occurrence Probability[3]**	**Location on River[4]**	**Importance[5]**	**Effects[6]**
Actions by Others					
Energy					
hydropower on dams	2	M	S	M	+/-
continued operation of coal-fired power plants	A	M	S	L	+/-
Water-based recreation					
marina development & operation	A	M	S	M	-
River Dependent					
Water supply/discharge					
municipal	A	M	S	L	-
industrial	A	M	S	L	-
Waste water treatment discharges (WWTP)					
onsite systems	A	H	E	L	-
stormwater discharges; CSOs; SSOs	A	H	S	M	+/-
Resource extraction					
instream sand and gravel mining	A	H	E	M	-
Riverfront/Flood Plain Development					
Downtown Pittsburgh					
Ongoing Point State Park improvements	1	H	S	M	+/-
Convention Center riverfront park	1	H	S	M	+/-
North Shore development	1	H	S	H	+/-
Pittsburgh South Side					
continued riverfront development	A	H	S	M	+/-
continued South Side Works development	1	H	S	M	+/-
Riverfront trails					
Pittsburgh riverfront trail system	A	H	E	L	+/-
Beaver County trail system	A	M	E	L	+/-
Neville Island	1	H	S	L	+/-
PL&E, McKees Rocks	2	M	S	L	+/-
M&B Development	2	M	S	L	+/-

TABLE 12-3 (continued)
RFFA Cumulative Effects Matrix for Upper Ohio River – Cultural Resources

RFFA Cumulative Effects Matrix for Upper Ohio River – Cultural Resources					
RFFA[1]	**Time Period[2]**	**Occurrence Probability[3]**	**Location on River[4]**	**Importance[5]**	**Effects[6]**
Actions by Others					
Fab Tech & Buckeye Pipeline	1	M	S	L	+/-
J&L site in Aliquippa	1	M	S	L	+/-
Leetsdale Industrial Park	1	H	S	L	+/-
Brownfields redevelopment					
Resource Protection/Restoration					
Ohio River Islands Wildlife Refuge System	A	H	S	L	+/-
Ecosystem restoration	A	M	E	M	+/-
Cultural resources	A	M	E	H	+
Bridges and Roadways					
Bridge renovations					
Ambridge/Aliquippa Bridge	1	H	S	H	+/-
Shippingport Bridge	1	H	S	M	+/-
Rochester Bridge	1	H	S	M	+/-
McKees Rocks Bridge	1	H	S	H	+/-
Birmingham Bridge	1	H	S	M	+/-
Rankin Bridge	1	H	S	M	+/-
New crossings					
Maglev	2	L	S	H	+/-
North Shore connector	1	H	S	M	+/-
Roadways					
Mon/Fayette Expressway	2	L	S	L	+/-
SR 28 widening/railroad relocation	1	H	S	M	+/-
CSX double stack upgrades (National Gateway)	1	M	S	M	+/-
Natural Events					
floods	A	M	E	M	-

TABLE 12-3 (continued)
RFFA Cumulative Effects Matrix for Upper Ohio River – Cultural Resources

RFFA Cumulative Effects Matrix for Upper Ohio River – Cultural Resources					
RFFA[1]	**Time Period[2]**	**Occurrence Probability[3]**	**Location on River[4]**	**Importance[5]**	**Effects[6]**
Actions by Others					
Regulatory Environment					
Adaptive management in Sand & Gravel EIS	A	H	E	M	+/-
Pollution prevention	A	H	E	L	+
USACE permitting programs	A	H	E	H	+/-
Environmental sustainability practices	A	H	E	L	+/-
[1] Reasonably Foreseeable Future Actions					
[2] Time period in which the RFFA may occur: A = all periods; 1 = within 10 years; 2 = in 10 - 25 years; 3 = in 25 - 60 years					
[3] Occurrence probability or likelihood RFFA will happen: H = high; M = medium; L = low					
[4] Location or setting on river where RFFA is expected to occur: E = along entire length of river; S = specific location					
[5] Importance or impact of action on the VEC: H = high; M = medium; L = low					
[6] Effects of action on the VEC: + = positive effect; - = negative effect; +/- = mixed effects					

12.8.1 USACE Actions

12.8.1.1 Navigation Investments

Like any action which directly affects the built environment, navigation investments are expected to have mixed effects on cultural resources located in the upper Ohio River. Replacement of the EDM locks with modernized structures or rehabilitation of the existing lock and damns will negatively affect historic aspects of the locks and dams by physically altering these historic resources. Similar effects could occur, but likely in less intensity, during lock and dam operation and maintenance. Non-structural improvements would generally not impact cultural resources. These effects can be mitigated, however. In lieu of preserving the actual historic physical structures, alternative methods of information retrieval may be used to continue to build the body of knowledge about the resources.

Approach and channel dredging and disposal and Section 107 Port development and maintenance dredging also have the potential to affect historic resources. Dredging operation

of any kind can potentially affect sunken historic resources are archaeological resources buried in the substrates.

Lands in the vicinity of each navigation facility that would be necessary to support construction of new locks may have the potential to involve cultural resources. If no alternative lands are available, and potential sites can not be avoided, any adverse effects would require mitigation to comply with historic preservation law. Any new project could also affect the stability and integrity of cultural resource contexts that are sometimes not clearly understood by the public without sufficient interpretation.

12.8.1.2 Ecosystem Restoration

Ecosystem restoration projects would potentially have mixed effects on cultural resources, depending on the type of project and the construction methods used. Any project that would reduce erosion would enhance the preservation of potential cultural resources located along the banks of the river. However, the methods necessary to construct projects may incur negative effects to potential cultural resources along the banks or under the water. With existing federal cultural resources regulatory guidance, both the positive and negative potential effects of each ecosystem restoration activity on cultural resources would be assessed, and any adverse effects would be minimized and mitigated.

12.8.2 Actions by Others

Given the varied nature of the actions by others, the varied agencies or private groups carrying out the actions, and the applicability or lack of applicability of regulatory guidance, actions by others will have mixed effects on cultural resources.

12.8.2.1 Navigation System Dependent – "But For"

"But for" actions by others are actions that would not occur without the existence and maintenance of the lock and dam system along the river; however, many of these activities tie into the federal cultural resource regulatory process because they are regulated, permitted, or funded by federal agencies. Projects with high importance include terminals and multi-modal sites, hydropower on dams, and marina development and operation. There could be positive and negative effects with these types of projects. Any federally regulated actions undertaken within the Section 106 process will contribute to the overall sustainability of cultural resources, because knowledge will be preserved, but could result in the unavoidable loss of some resources. Positive benefits could accrue, however, where cultural resources are protected as part of these projects and research is advanced. Projects initiated within the project sector, however, do not necessarily have the same level of protection and it is possible that even meaningful projects with out government participation or requiring government-permitting could inadvertently cause the loss of cultural resources.

12.8.2.2 River Dependent

Due to many of the river dependent actions being performed by municipal level governments or private entities, potential for negative effects on cultural resources is higher in this category of actions by others. Because problems with stormwater discharges, and combined sewer overflows/sanitary sewer overflows (CSOs/SSOs) are so widespread in the area, these are likely to impact cultural resources at some point. New facilities would aid in improving the environment in which cultural resources are presented and heighten public awareness, but they could also alter existing facilities.

Prehistoric and historic artifacts are vulnerable to loss during resource extraction operations. They are particularly vulnerable during underwater sand and gravel mining when resources could be lost inadvertently. Individual actions and applicable regulatory processes will determine the specific effects, however.

12.8.2.3 Riverfront/Flood Plain Development

Because many actions associated with riverfront/flood plain development are performed by private developers, the potential for negative affects on cultural resources is high. Most actions likely to occur locally, however, including improvements in Downtown Pittsburgh and on the South Side will be completed by the public sector or through public/private partnerships. Consequently, consideration of cultural resources will be an integral part of the projects. Individual actions and applicable regulatory processes will determine the specific effects.

12.8.2.4 Resource Protection/Restoration

Since the Ohio River Islands Wildlife Refuge System and ecosystem restoration, by their very nature, are mainly predicated on preservation goals of government agencies, these actions will have an overall positive effect on cultural resources.

12.8.2.5 Bridges and Roadways

Although the affects of bridge and roadway projects on cultural resources are mixed, these projects are tied to federal funding or permitting and, therefore, are subject to Section 106 as well as Section 4(f) compliance. These regulatory processes ensure that the significance of individual cultural resources is considered and help contribute to the overall sustainability of cultural resources in the region.

12.8.2.6 Natural Events

Since flooding is unpredictable and largely uncontrollable, if cultural resources are affected, it is usually negatively. Flooding can cause damage to cultural resources through inundation, soil erosion, or loss of standing structures and their contents. Flooding can also cause changes to the context of the resources by altering the land surrounding the resources.

12.8.2.7 Regulatory Environment

The existing federal regulatory environment directly and indirectly provides protection for cultural resources present or yet to be discovered in the upper Ohio River region. Not only does the regulatory environment speak directly to preservation of physical structures and sites, it also provides for consideration of information preservation and dissemination. It is only with the incorporation of all of these goals that the sustainability of cultural resources will be maintained and improved. Finally, historic preservation awareness education can provide the opportunity to educate the public on the importance of preserving our shared cultural heritage.

12.9 ANALYSIS OF ENVIRONMENTAL SUSTAINABILITY

Sustainability is attained when the indicators meet or exceed regulatory thresholds or other measures. Although there are no regulatory requirements or standards that mandate a specific level of sustainability for cultural resources, existing regulations consider cultural resources within project contexts. Consequently, for cultural resources identified within the federal regulatory environment, "significance" or eligibility for listing in the NRHP is used as a measure of sustainability for individual resources. In addition to federal protections, cultural resource sustainability can be correlated with the level of protection provided at the state and local levels.

For cultural resources outside of the federal and state regulatory environments, their sustainability depends on more subjective measures. Factors contributing to sustainability for cultural resources include those actions or measures that help to slow the loss of cultural resources, and those that help preserve cultural resources directly or the important information about cultural resources.

Specific indicators of sustainability include properties or sites listed or eligible for listing in the NRHP, state listings, or local listings; the physical condition of those properties or sites; the integrity and stability of cultural resource contexts; the frequency and importance of a resource, or group of like resources; the effectiveness of federal regulations and State Historic Preservation Officers (SHPOs) in identifying, recording, interpreting, and preserving cultural resources within the study area; and the level of effort necessary to minimize impacts from unavoidable past and future actions.

Environmental sustainability balances environmental and economic considerations throughout the life cycle of project planning, design, construction, operation, and maintenance. The purpose of achieving environmental sustainability is to improve the quality of life for present and future generations. The analysis of cultural resource sustainability consists of the consideration of the connectedness between the identified RFFAs, their effects, and the identified sustainability indicators. The analysis of cultural resource sustainability discusses the current sustainability of cultural resources and whether it is expected to improve or decline in the future.

12.9.1 Positive Forces Affecting Cultural Resources

Positive forces affecting cultural resources would be those that increase the number and types of eligible or listed cultural resources; improve the physical condition, integrity, and stability of cultural resources in light of changing circumstances (e.g., access to the public, new construction, advances in preservation techniques, changes in ownership, etc.); and decrease the level of effort necessary to minimize impacts from unavoidable future actions.

The regulatory historic preservation environment has a positive impact on the recordation and preservation of cultural resources within the region. The consequences of laws and regulations have improved the consistency of identification, recordation, and preservation of cultural resources as well as the total numbers and types of cultural resources that are considered. In addition, the increased expenditures of public funding for cultural resource compliance research have increased public interest and awareness.

In addition, private and non-profit historic preservation interest groups and amateur and professional archaeological societies and museums are positive forces in the continued sustainability of cultural resources. Many of these groups existed in the region before regulatory legislation became the main catalyst for historic preservation, and they will likely continue to have a presence in the future. They address cultural resources at a level (regional and local) which is more visible and accessible to the general public. As advocates for and experts in historic preservation, these groups as a whole are a positive force for the sustainability of cultural resources in the Upper Ohio Navigation System region.

12.9.2 Negative Forces Affecting Cultural Resources

Changing economic conditions and political climates are the major negative forces affecting cultural resources, especially through the lessening of protections contained in legislation. It is expected that the body of legislation regulating historic preservation within the federal realm will continue in place for the foreseeable future; however, private interest groups with agendas in opposition to those of the historic preservation community often provide the catalyst for changes to that legislation. In addition, when the economy is not robust, less private and government funding is available to private and non-profit historic preservation groups with missions that contribute to the local and regional sustainability of cultural resources.

12.9.3 Incremental Impacts on EDM

In terms of proposed changes to EDM, the incremental impacts will be limited to the physical structures themselves, and to supporting work areas. The Emsworth Dams are presently undergoing a major rehabilitation for dam safety purposes, which was coordinated under Section 106 of the National Historic Preservation Act (NHPA) with the PHMC. Unavoidable adverse effects were identified, and a Memorandum of Agreement (MOA) between the USACE and PHMC was executed identifying appropriate mitigation. Further compliance with the NHPA for EDM will be under the terms of a Programmatic Agreement

for the Ohio River Mainstem Systems Study executed between the Advisory Council on Historic Preservation, the three Corps of Engineers district offices and the six states bordering the Ohio River. This agreement requires the identification, evaluation and appropriate treatment of affected cultural resources. Continued coordination between USACE, PHMC, other interested parties, and the public will be necessary during the continued planning and implementation of the proposed changes to ensure that the incremental impacts are addressed.

12.10 DETERMINATION OF SUSTAINABILITY

Three specific definitions of environmental sustainability were used for the analysis:

- Not sustainable – conditions for the selected indicators do not reflect conditions that would facilitate attainment of acceptable standards or would not maintain existing standards in concert with collective impacts of proposed activities.

- Marginally sustainable – conditions for selected indicators are such that attainment of acceptable conditions is accomplished for the majority, but not all, of the potentially affected resources. However, the conditions are somewhat tenuous both in location and likelihood of occurrences. (In other words, the conditions are borderline for environmental sustainability, and there are uncertainties regarding specific quantitative measures.)

- Sustainable – conditions for selected indicators are such that attainment of acceptable conditions are accomplished for essentially all of the potentially affected resources in the project area, and such standards are maintained in concert with foreseeable future activity. Further, conditions exceed regulatory thresholds, and various governmental programs are in place to respond to any potential erosion of values related to, in this case, cultural resources.

The environmental sustainability of cultural resources within the Upper Ohio Navigation System region prior to the implementation of NHPA in 1966 can be characterized as not sustainable. There was little public knowledge of or interest in preserving our shared cultural past, and no regulatory mechanism to promote or fund historic preservation. There were no uniform or widespread efforts to identify, record, or preserve cultural resources. The historic preservation that was taking place was for the most part limited to the efforts and funding of local groups focused on single resources (e.g., town historical society) or larger museums (e.g., Carnegie Museum of Natural History) that were building their collections; therefore, the quantity and variety of resources being preserved were very limited, biased, and homogenous (e.g., resources relating mostly to white upper-class men of historic prominence). Very limited federal, state, or local government involvement prior to 1966 is probably the leading contributing factor to a rating of not sustainable. Not only were governmental entities not considering cultural resources, they were also contributing to the uncontrolled destruction of cultural resources through publicly funded projects (e.g., interstate highway system; military training facilities and bases; water, wastewater, and sewage treatment; zoning). With the advent of NHPA and subsequent legislation, public

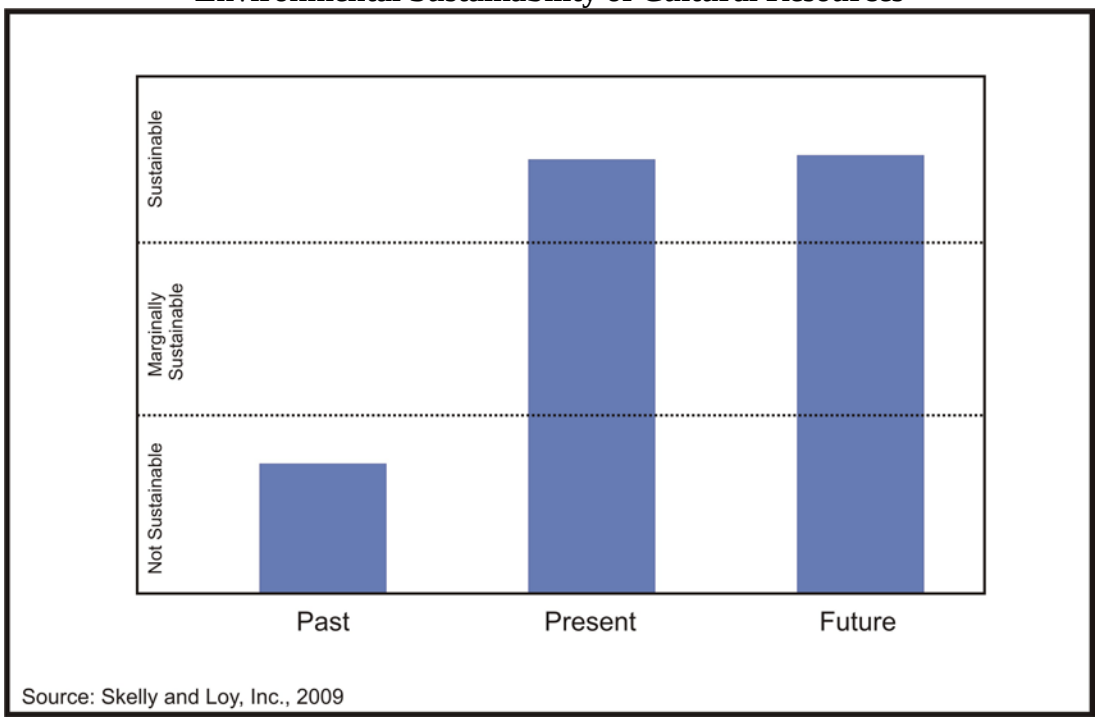
education, increased funding mechanisms, etc., the sustainability of cultural resources has increased through time.

Currently, cultural resources are sustainable due to the existence of federal and some state and local legislation providing for the consideration, identification, recordation, and preservation of varied types and unlimited quantities of cultural resources. Accompanying funding mechanisms have allowed increased public participation in and awareness about the importance of preserving cultural resources. This increased awareness by governmental agencies, interested parties, and the public resultant from regulatory legislation has led to the consideration of cultural resource types that would not have been considered previously, and in larger numbers than would have been possible before.

It is expected that the body of legislation regulating historic preservation within the federal realm will continue in place for the foreseeable future, and therefore cultural resources will continue to be identified, recorded, and preserved, maintaining or improving their sustainability. However, changes to this legislation will likely happen and be based on changing economic conditions and political climates. Gauging these factors will be a good indicator of potential upturns or downturns in cultural resource sustainability for the future.

Figure 12-1 illustrates the sustainability for cultural resources.

FIGURE 12-1
Environmental Sustainability of Cultural Resources



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Chapter 13

SEDIMENT QUALITY

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13.1 DEFINITION

Sediment is defined as mineral and organic particles deposited on the river bed or suspended near the bottom. To varying degrees, a mixture of silt, sand, gravel, chemical precipitates, and fossil fragments, sediment is derived from pre-existing rock or biogenic sources, or precipitated by chemical processes.

Consideration is given here as to how cumulative effects of human use of the upper Ohio River have influenced sediment quality and what sediment quality impacts may be anticipated in the foreseeable future. The assessment of sediment quality will examine substrate composition and potential effects of legacy or residual contaminants, a topic of special interest and importance in the heavily industrialized upper Ohio River near Pittsburgh. Benthic macroinvertebrate populations also reflect sediment quality and will be considered in this chapter. Freshwater mussels, as biological indicators of Ohio River sediment quality, will be mentioned generally. The interactions of sediment quality with other important environmental components also will be integrated into this chapter.

13.2 OBJECTIVES/SCOPE

13.2.1 Objectives

This chapter assesses the systemwide cumulative impacts on sediment quality of all likely major navigation improvements along the upper Ohio River during the period from 1885 to 2070. Impacts directly or indirectly attributable to modernization of the navigation system are evaluated in concert with impacts from other past, present, and reasonably foreseeable future actions (RFFAs) by the United States. Army Corps of Engineers (USACE) and others.

Assessment of past and present actions and current conditions is the basis for identifying and interpreting the potential impacts of RFFAs. These future actions include the major navigation improvements identified for the Emsworth, Dashields, and Montgomery locks and dams (EDM); other routine or potential actions by the USACE; projected actions by other federal, state, or local agencies; actions by non-governmental entities; and predictions of general economic expansion and development as well as regulatory changes.

The results of the cumulative effects assessment (CEA) will lead to further consideration of the significance of impacts of the RFFAs on affected resources, the degree to which proposed navigation improvements contribute to those impacts, and what constitutes sustainable sediment quality for the upper Ohio River.

13.2.2 Geographic Scope

For sediment quality impacts, the geographic focus includes that portion of the Upper Ohio Navigation System that is most directly affected by the existing and possible future modifications to the system. This includes the Allegheny and Monongahela tributaries of the Ohio River to the first upstream dam on each river. The downstream geographic limit is defined as the New Cumberland Lock and Dam. The geographic scope includes the following pools: Emsworth, Dashields, Montgomery, and New Cumberland. Also included are the floodplains along either bank of the four pools. This floodplain zone is defined as the meander channel of the upper Ohio River and includes the 100- and 500-year floodplains as well as terraces of level land lying above these floodplains. Floodplain lands are considered in this assessment because sediment quality is affected by siltation and contaminants associated with construction, industry, urban storm water, and other land-based activities and because streams and floodplains normally interact as a complex ecosystem.

13.2.3 Time Frame

The established time frame for this assessment is 1885 to 2070. The earlier date is when initial lock and dam construction on the Ohio River began. Thus, it approximates the beginning of the modern lock and dam system. The latter date approximates the economic life of anticipated improvements on the Ohio River and is considered to be the planning horizon for the project.

13.3 ISSUES FROM SCOPING

Scoping has occurred as part of the Ohio River Mainstem Study (ORMSS) and for the Upper Ohio Navigation Study. A series of 12 public scoping meetings was held for ORMSS during the summer of 2001. Subsequently, a series of three public scoping meetings was held for the Upper Ohio Navigation Study in October 2006. Approximately 185 people attended the ORMSS meetings and approximately 40 people attended the Upper Ohio River Study meetings.

Several comments relating to sediment quality were made during both series of meetings. Comments that are directly or indirectly associated with sediment quality are shown in Table 13-1. Some data from ORMSS have been aggregated in the table below, and as a result may not tie directly into individual comments presented in the larger study.

TABLE 13-1
Comments on Sediment Quality from Public Scoping Meetings

Comment	Number of Similar Comments	Scoping Meeting
Bank undercutting and failure caused by increased barge traffic, queuing, and wave action	7	ORMSS, Upper Ohio Nav. Study
Loss of shoreline trees and river property caused by barge activity	7	ORMSS
Loss of green space and wildlife habitat with development of marina facilities	5	ORMSS, Upper Ohio Nav. Study
Cumulative effect of discharges on river may offset water quality improvements	4	ORMSS
Development of floodplains and wetlands resulting in increased runoff and habitat loss	4	ORMSS
Need for ongoing coordination and cooperation with concerned agencies and groups	4	ORMSS, Upper Ohio Nav. Study
Bank erosion caused by USACE-controlled pool fluctuations	3	ORMSS
Importance of coordination of resources agencies in determining baseline conditions	3	ORMSS, Upper Ohio Nav. Study
Loss of significant farmland to urban development along river corridor	3	ORMSS
Need to develop comprehensive plans for development along river	3	ORMSS
Challenges to water quality presented by combined sewer overflows (CSOs) and sanitary system overflows (SSOs)	2	ORMSS
Importance of including commercial dredging and associated permitting process in CEA	2	ORMSS
Increased spills and accidents potentially affecting aquatic life and impairing water quality	2	ORMSS, Upper Ohio Nav. Study

TABLE 13-1 (continued)
Comments on Sediment Quality from Public Scoping Meetings

Comment	Number of Similar Comments	Scoping Meeting
Loss of unique, sensitive species due to water quality problems and habitat modifications	2	ORMSS
Methods to be used for assessing water quality	2	ORMSS
Need for more stringent discharge permitting procedures or moratorium on permits	2	ORMSS
Development of ongoing program to reevaluate cumulative effects every 5 years	1	ORMSS
High levels of mercury, arsenic, fecal coliform bacteria, and agri-chemicals in surface water	1	ORMSS
Importance of continued water quality improvements as a high priority	1	ORMSS
Importance of coordination between USACE and Ohio River public water suppliers	1	ORMSS
Need for long-term plan to address silt removal and prevent future sedimentation	1	ORMSS
Need to consider 404 application approvals and resultant actions as direct USACE actions	1	ORMSS
Need to improve sediment and erosion control from public and private developments	1	ORMSS
Need to protect public groundwater supplies	1	ORMSS
Overall effects of navigation structures and activities on groundwater levels	1	ORMSS
Possibility of implementing mechanical aeration in mainstem pools	1	ORMSS
Prolonged bureaucratic procedures in obtaining discharge permits	1	ORMSS

Additional information and comments have been sought from federal, state, and local environmental resource agency representatives and planning officials serving on an interagency working group (IWG) related to both the ORMSS and the Upper Ohio River Study. Comments from IWG members on potential impacts to water and sediment quality include:

- Effects of Marcellus Shale operations;
- Waste water discharge;
- Direct and indirect effects to wetlands;
- Contaminants in the sediment (pesticides, nutrients, endocrine disruptors, *E. coli*, acid mine drainage); and
- Monongahela River mine pool is a serious threat.

13.4 LAWS, REGULATIONS, ORDINANCES, AND PROGRAMS

Several regulatory actions and related initiatives influence soil/sediment quality in the study area. Table 13-2 presents information on important regulations and established programs, which directly or indirectly influence soil/sediment quality in the upper Ohio River.

TABLE 13-2
Laws, Regulations, Ordinances, and Programs Relevant to Sediment Quality

Law/Program (Lead Agency)	Key Components	Relevance to Sediment Quality
Water Resources Development Act (WRDA) (U.S. Army Corps of Engineers)	• Authorizes USACE port development, navigation, flood control, and erosion control projects through the 1986 act and subsequent amendments	Contains provisions for environmental assessment and mitigation
USACE Permitting Statutes (U.S. Army Corps of Engineers)	• Section 10 of Rivers and Harbors Act (1899) prohibits the unauthorized obstruction or alteration of any navigable water of the United States. • Section 404 of CWA authorizes the USACE to issue permits for the discharge of dredged and fill materials into waters of the U.S.	Permits require assessment of impacts on water quality and aquatic ecological resources and mandate mitigation of adverse impacts
Small Navigation Projects (U.S. Army Corps of Engineers)	• Section 107 of Rivers and Harbor Act (1960) authorizes USACE to develop and construct small navigation projects for harbor protection.	Includes impacts of such actions on water quality
Spill Response (U.S. Coast Guard & ORSANCO)	Includes emergency response activities for river-related spills and accidental discharges and is related to the Oil Pollution Act and Section 301 of the CWA.	Minimizes adverse impacts of spills and discharges on mussels and other aquatic life and on water quality
National Environmental Policy Act (NEPA) (Council on Environ-mental Quality and other resource agencies)	• Requires preparation of environmental impact assessments for new construction projects and other actions with significant environmental impacts by private and governmental agencies	Includes water quality impacts of new projects along the Ohio River such as power plants, USACE projects and riverfront developments
Clean Water Act (CWA) (U.S. Environmental Protection Agency)	• Establishes structure for regulating pollution discharges into U.S. waters (NPDES permits) • Gives USEPA authority to implement pollution control programs • Requires establishment of water quality standards • Recognizes need to address nonpoint source pollution	Provides a comprehensive framework for water quality improvement and protection applicable to all waters of the United States

TABLE 13-2 (continued)
Laws, Regulations, Ordinances, and Programs Relevant to Sediment Quality

Law/Program (Lead Agency)	Key Components	Relevance to Sediment Quality
TMDL Program (U.S. Environmental Protection Agency)	• Increasingly important section (§303) of CWA; regulates maximum pollutant load a water body can receive and still attain water quality standards.	Presents a more holistic option to water quality management than traditional "command and control" approaches.
Phase 1 & 2 NPDES Program (U.S. Environmental Protection Agency)	• Also developed within the CWA, requires municipalities and certain industrial and construction sites to adopt BMPs to control point sources of pollution.	Should reduce pollution characteristics of stormwater discharges from urban and industrial zones along the Ohio River.
Safe Drinking Water Act (SDWA) (U.S. Environmental Protection Agency)	• Provides for establishment of primary regulations for the protection of public health and secondary regulations related to taste, odor, and appearance of drinking water	Helps protect public water supplies for approximately three million people who use Ohio River as their source of drinking water
Site Remediation Statutes (U.S. Environmental Protection Agency)	• Includes CERCLA, RCRA, SARA, and related state program that focus on cleanup and restoration of contaminated sites.	Potentially reduces groundwater and soil pollution sources and contributions to pollution loads in the Ohio River
Oil Pollution Act (U.S. Environmental Protection Agency)	• Strengthened USEPA's ability to prevent & respond to catastrophic oil spills	Provides protection from pollution & damage from oil spills
National CSO Control Policy (U.S. Environmental Protection Agency)	• Published by USEPA, calls for communities to implement long-term plan for combined sewer overflows (CSOs) to comply with the CWA. • Administered through each state's NPDES permit program.	Should reduce pollution from a major urban source.
ORSANCO Monitoring (ORSANCO)	• Encompasses ongoing water quality and aquatic ecology monitoring programs by the ORSANCO.	Helps track trends in water quality and biological communities and provides database that can inform environmental decision-making
State Water Quality Certification (Appropriate state or interstate pollution control agencies)	• Section 401 of the CWA requires certification from state or interstate water control agencies that a project is in compliance with established effluent limits and water quality standards.	Provides opportunity for state or interstate scrutiny of such actions on fish and other aquatic resources

TABLE 13-2 (continued)
Laws, Regulations, Ordinances, and Programs Relevant to Sediment Quality

Law/Program (Lead Agency)	Key Components	Relevance to Sediment Quality
PA Sewage Facilities Act	• Provides for the planning and regulation of community and individual sewage systems	Improved water quality, as a result of this act, has a positive influence on sediment quality.
PA Storm Water Management Act	• Requires PA counties to prepare and adopt watershed based stormwater management plans.	New construction is required to manage the stormwater runoff generated at the site. Unchecked stormwater runoff can lead to significant siltation events on streams.
PA Act 67 & 68	• The Pennsylvania Growing Greener Program falls under these regulations. Growing Greener has provided a strong funding source in which local watersheds have conducted water quality improvement projects.	Projects completed under Growing Greener provide for improved water and sediment quality.

13.5 PAST TO CURRENT BASELINE CONDITIONS

The urban, industrial heritage of Pittsburgh and its surrounding region heavily influence the condition and health of the upper Ohio River and its contributing waterways within the region. The heavy industrialization of the Pittsburgh region began in the 19th century. During this time the Ohio River provided the most reasonable transportation route to points west. Utilization of the river for transportation led to navigational improvements. The navigational improvements helped to spur on the development of the Pittsburgh region, with its abundance of natural resources for manufacturing and a natural transportation corridor to ship goods west. Concurrently, increased residential and commercial development occurred as well.

Severe negative effects from development and a lack of wastewater treatment were becoming evident by the early to middle portion of the 20th century. During a congressional hearing in 1936, Brent Spence (D-Kentucky) testified that “the Ohio River is a Cesspool”. During the same hearing, the State Health Commissioner of Kentucky added that “the Ohio River, from Pittsburgh to Cairo, is an open sewer” (USEPA, as cited in USACE 2006). Prior to 1948, less than one percent of the communities along the Ohio River serviced by sewers treated their wastewater. This awareness led to the signing of an interstate compact in 1948 which led to the development of the Ohio River Valley Water Sanitation Commission (ORSANCO). The principal mission of ORSANCO was to abate existing pollution and control future pollution of waters in the Ohio River basin (ORSANCO, as cited in USACE 2006). In 1970, ORSANCO developed its first water pollution control standards. Since that time, these standards have been revised every three years for all municipal and industrial discharges to the river. The Federal Water Pollution Control

Amendments of 1972 (Clean Water Act) further provided protection to the river. Since 1972, major amendments to the act have been adopted (Clean Water Act of 1977 and Water Quality Act of 1987). These regulations have greatly improved the water quality and sediment quality conditions of the river while human activities along the river have continued to occur (USACE 2006).

13.5.1 Substrate Composition of the Upper Ohio River

The substrates of the upper Ohio River include a mixture of the substrate types found in the Allegheny and Monongahela rivers. The south flowing Allegheny River drains both glaciated and non-glaciated portions of the Appalachian Plateau Physiographic Province. Generally, the substrates of the Allegheny River are composed of glacial till and gravel. The north flowing Monongahela River flows through primarily softer, sedimentary geology. The substrates which develop from this parent material typically dissociate to sands and other fine substrate materials. Substrates of the upper Ohio River are, therefore, composed of a mixture of the material carried in the two contributing rivers (USACE 2001).

A Biological Study of the Emsworth Pool of the Ohio River (ORSANCO 2007) characterized the substrate types at 15 sample points within the Emsworth Pool. Substrate types observed within the Emsworth Pool included: boulder, cobble, fines, gravel, hardpan, and sand. Table 13-3 summarizes the data presented in this study.

TABLE 13-3
Substrate Types Observed in Emsworth Pool

Site Number	River Mile	Bank	River	Boulder (%)	Cobble (%)	Fines (%)	Gravel (%)	Hardpan (%)	Sand (%)
1	2.2	LDB	Alleg.	2.3	31.3	0.0	33.6	1.6	31.3
2	5	LDB	Alleg.	0.7	19.1	5.7	34.8	0.0	39.7
3	5.7	LDB	Alleg.	1.4	21.7	4.9	37.8	0.0	34.3
4	2.6	LDB	Mon.	2.7	12.2	25.0	18.9	0.0	41.2
5	4.5	RDB	Mon.	2.6	9.4	24.8	18.8	0.0	44.4
6	4.8	RDB	Mon.	0.7	11.2	22.4	23.1	0.0	42.7
7	5.7	RDB	Mon.	1.4	7.0	30.1	23.1	0.0	38.5
8	6.3	RDB	Mon.	0.8	15.2	14.4	45.6	0.0	24.0
9	9.1	LDB	Mon.	0.0	12.6	17.0	33.3	0.0	37.1
10	10.8	RDB	Mon.	0.7	18.8	3.5	36.8	2.1	38.2
11	0.2	LDB	Ohio	0.0	20.7	11.5	23.0	5.7	39.1
12	1.9	LDB	Ohio	2.0	31.1	0.0	32.4	0.0	34.5
13	4	RDB	Ohio	0.8	24.0	6.6	29.8	0.0	38.8
14	4.3	RDB	Ohio	0.9	11.4	19.3	24.6	0.0	43.9
15	5.1	RDB	Ohio	3.2	31.8	0.0	34.4	0.0	30.6

LDB = Left-descending bank; RDG = Right-descending bank

Source: ORSANCO, 2007

A Biological Survey of the Ohio River: The Montgomery Pool (ORSANCO 2006) characterized the substrate types at 15 sample points within the Montgomery Pool.

Substrates observed in the Montgomery Pool included: boulder, cobble, fines, gravel, hardpan, and sand. Table 13-4 summarizes the data presented in this study.

TABLE 13-4
Substrate Types Observed in Montgomery Pool

Site Number	River Mile	Bank	Boulder (%)	Cobble (%)	Fines (%)	Gravel (%)	Hardpan (%)	Sand (%)
1	13.7	LDB	2.0	30.6	0.0	38.9	0.0	28.5
2	14.1	RDB	1.3	14.6	1.3	41.4	0.0	40.7
3	15.8	RDB	2.7	5.5	4.1	34.2	0.0	53.6
4	16.6	RDB	4.8	9.0	17.5	27.7	0.0	41.0
5	19.3	RDB	17.4	12.9	6.1	26.5	0.0	37.1
6	22.0	LDB	5.4	17.8	14.0	26.0	0.0	36.8
7	23.1	RDB	6.3	15.5	12.6	29.9	0.0	35.6
8	26.0	LDB	12.0	21.0	6.0	17.0	0.0	45.0
9	27.0	LDB	7.1	10.9	34.2	9.3	0.0	38.5
10	27.1	RDB	8.1	29.7	1.4	36.9	0.0	23.9
11	27.3	LDB	0.8	4.9	52.3	10.0	2.3	29.7
12	27.6	LDB	0.0	0.6	64.2	12.1	7.0	16.1
13	28.7	RDB	10.1	15.5	29.9	22.7	0.0	21.7
14	30.1	LDB	1.4	26.4	22.3	30.4	0.0	19.6
15	30.4	RDB	3.1	18.0	7.8	35.4	0.0	35.7
Source: ORSANCO, 2006								

Substrate types of the upper Ohio River were also characterized during 2008 as part of the data collection effort associated with a native mussel screening survey. Percent substrate compositions were characterized at each sample point. The substrate data for each pool were then averaged. Table 13-5 summarizes the data presented in the report entitled, *Native Mussel Screening Survey Upper Ohio River Navigation* (EnviroScience, Inc. 2009).

TABLE 13-5
Substrate Types Observed in Upper Ohio River Pools

Pool	Boulder (%)	Cobble (%)	Gravel (%)	Mud (%)	Sand (%)	Silt (%)	Other (%)
Emsworth	17.0	25.0	30.0	11.0	- -	- -	17.0
Dashields	14.0	22.0	24.0	13.0	13.0	11.0	3.0
Montgomery	15.0	14.0	18.0	- -	- -	34.0	19.0
New Cumberland	16.0	19.0	22.0	8.0	- -	19.0	16.0
Source: EnviroScience, Inc., 2009							

The data collected during these recent surveys suggests that the substrate composition of the Ohio River displays a diverse composition of natural substrate types.

13.5.2 Water Quality Conditions

Water quality and sediment quality conditions of the river are very closely tied together. Sediment quality is greatly influenced by water quality conditions and sediment quality can affect water quality through the resuspension of pollutants that may be contained in sediments that are agitated. Discharges of heavy metals, polychlorinated biphenyls (PCBs), phenols, and chlordane can result in the contamination of stream sediments. Historical land uses along the river resulted in the significant contribution of these types of pollutants to the upper Ohio River. The deposition of heavy metals has been attributed to coal mining activities and iron and steel manufacturing. Sources of PCBs are various. The former Westinghouse facility in Turtle Creek provided a significant source of PCBs to the lower Monongahela River. Phenols are utilized in the manufacturing of various industrial products, germicidal paints, pharmaceutical products, dyes, etc. (World Health Organization 1994). Chlordane was historically utilized by the pest control industry for termite control.

Total suspended solids (TSS) and turbidity are two categories of water quality that are very closely associated with sediment quality. Suspended solids provide attachment points for heavy metals and bacteria. Turbidity can provide nourishment and shelter for pathogens. ORSANCO's 2000 Pollution Control Standards do not have standards established for turbidity or suspended solids associated with the protection of aquatic life. However, it generally states that waters discharged to the river should be free of materials that could settle and form an objectionable sludge or suspended materials that will be unsightly or deleterious.

Since the inception of ORSANCO, authorization of the Clean Water Act, and other water quality improvement programs, the overall water quality of the upper Ohio River has been significantly improving. Healthy populations of fish have returned to the river. Native freshwater mussels have also returned to the river, indicating that sediment quality of the river is improving as well as the water quality.

13.5.3 Legacy Pollutants

Historical and ambient chemical data on industrial legacy contamination of sediments in the upper Ohio River are limited. "Bottom sediments are natural sinks for many toxic and persistent pollutants that enter waterways. Consequently, sediment quality can reflect historical changes in watershed economies related to industrial and agricultural activity. These deposits represent potential sources of contaminants that may reenter the water column through stream scouring, anaerobic release, and bioaccumulation, as well as through dredging for channel maintenance" (Youger and Mitsch, as cited in USACE 2006). Table 13-6 lists legacy pollutants that have been associated with sediments of the upper Ohio River.

TABLE 13-6
Legacy Pollutants

Pollutant	Application or Source
Barium	Iron/Steel Manufacturing
Cadmium	Iron/Steel Manufacturing
Chlordane	Pest Control
Chromium	Iron/Steel Manufacturing
Copper	Iron/Steel Manufacturing
Iron	Iron/Steel Manufacturing/Drainage from Coal Mining
Lead	Iron/Steel Manufacturing
Manganese	Drainage from Coal Mining
Mercury	Coal Powered Utilities and Manufacturing
Nickel	Iron/Steel Manufacturing
PCBs	Various commercial and industrial uses
Phenols	Various industrial uses
Zinc	Iron/Steel Manufacturing
Source: USACE, 2006	

The Pennsylvania Department of Environmental Protection (PADEP) has developed total maximum daily load (TMDL) standards for PCBs and chlordane within the Ohio River from River Mile (RM) 0 to the state line. (TMDL is a calculation of the maximum amount of a pollutant that a water body can receive and still meet water quality standards.) These limits are 0.00004 micrograms per liter (ug/L) and 0.0005 ug/l, respectively.

The production and use of PCBs have been banned in the United States since 1979. Some of the past applications for PCBs included insulating fluids for electrical transformers, cutting oils, and carbonless paper. Chlordane was widely used as a broad-spectrum agricultural pesticide until it was restricted for termite control and its use was finally banned in 1988. Both of these chemicals become associated with solid particles once introduced to a waterbody, at which point these pollutants become sediment pollutants. Potential nonpoint sources of PCBs within the Ohio River drainage include the: H.K. Porter Site in Hopewell Township, Beaver County; Breslube-Penn Site in Coraopolis, Allegheny County; former Allis Chalmers Site in Pittsburgh, Allegheny County; atmospheric deposition as the result of volatilization from storage, disposal, or spill sites or from the incineration of products that contain PCBs (PADEP 2001).

The toxicity of dioxins and PCBs varies. Exposure to dioxins can cause damage to the nervous and immune systems and result in birth defects. Human and other animal exposure to PCBs can cause skin conditions, liver damage, cognitive disorders, immune system deficiencies, and reproductive impairment. In an effort to understand the extent of legacy pollutants in the Ohio River, ORSANCO began a program to measure these pollutants. PCB levels sampled by ORSANCO in 2001 and 2003 are provided in Table 13-7.

TABLE 13-7
PCB Levels in River Sediments

Date	River	River Mile	Total PCBs (ng/g)
08/13/01	Allegheny	2.1	102.8
08/13/01	Monongahela	2.6	5508.0
11/18/03	Monongahela	1.4	134.4
11/18/03	Monongahela	2.4	78.3
11/18/03	Monongahela	2.6	513.4
11/18/03	Monongahela	2.6	3598.6
11/18/03	Monongahela	2.8	97.8
11/18/03	Monongahela	3.6	52.1
11/18/03	Monongahela	5.8	308.3
08/13/01	Ohio	1	289.3
08/14/01	Ohio	2.7	196.6
08/14/01	Ohio	8.5	171.3
08/14/01	Ohio	10	213.3
08/15/01	Ohio	16.1	257.0
08/15/01	Ohio	22.2	213.8
08/15/01	Ohio	24.3	114.4
08/16/01	Ohio	32.9	150.1
08/16/01	Ohio	32.9	168.2
08/16/01	Ohio	36.3	4726.9
08/16/01	Ohio	47.1	48.0
11/19/03	Ohio	34.5	97.6
11/19/03	Ohio	34.5	100.7
11/19/03	Ohio	35.1	222.7
11/19/03	Ohio	36	128.9
11/19/03	Ohio	36.3	108.2
11/19/03	Ohio	36.3	199.7
11/19/03	Ohio	36.5	186.9
11/19/03	Ohio	37.3	1145.2
08/14/01	Ohio	3.3	1611.8
08/14/01	Ohio	12.8	146.4
08/14/01	Ohio	12.8	173.3
08/15/01	Ohio	15.2	153.1
08/15/01	Ohio	17.2	176.5
08/15/01	Ohio	24.6	172.2
08/15/01	Ohio	29.1	561.7
08/15/01	Ohio	29.1	583.0
08/16/01	Ohio	42.3	134.1
11/17/03	Ohio	28.2	133.9
11/17/03	Ohio	28.9	159.0
11/17/03	Ohio	29.1	53.1
11/17/03	Ohio	29.1	188.9
11/17/03	Ohio	29.3	98.1
11/17/03	Ohio	30.2	110.9
11/18/03	Ohio	1.1	190.6
11/18/03	Ohio	2	1437.1

TABLE 13-7 (continued)
PCB Levels in River Sediments

Date	River	River Mile	Total PCBs (ng/g)
11/18/03	Ohio	3	274.2
11/18/03	Ohio	3.3	182.0
11/18/03	Ohio	3.3	1146.0
11/18/03	Ohio	3.8	455.1
11/18/03	Ohio	4.5	172.2
11/18/03	Ohio	4.5	187.9
n/g = Nanogram per gram			
Source: ORSANCO, 2009			

A considerable range of PCB concentration has been found in the upper Ohio and some of these concentrations are significantly high. Some PCBs are resistant to biodegradation and are chemically stable; thus, potential environmental risks may be present for a long time. Sediments containing PCBs can also release them into the surrounding water, but the primary problem with PCBs is that they can accumulate in small organisms and fish. The level of PCB concentration found in aquatic life may actually be many thousands of times higher than what is found in the water itself. Thus, through biomagnification, PCBs progressively accumulate through successive levels of the food chain (ATSDR 2006a).

Dioxins, or chlorinated dibenzo-*p*-dioxins (CDDs), are a class of structurally similar chlorinated hydrocarbons. The basic structure is comprised of two benzene rings joined via two oxygen bridges at adjacent carbons on each of the benzene rings. Not all dioxins have the same toxicity or ability to cause illness and adverse health effects. The most toxic chemical in the group is TCDD. It is the standard to which other dioxins are compared. The levels of other dioxins measured in the environment are converted to a TCDD-equivalent concentration on the basis of how toxic they are compared to TCDD. (TCDD is 2,3,7,8-tetrachlorodibenzo-*p*-dioxin, the most toxic form of dioxins.) These converted dioxin levels are then added together to determine the total equivalent (TEQ) concentration of the dioxins in a sample (ATSDR 2006b). Data pertaining to dioxin levels from samples taken in summer 2001 are provided in Table 13-8. Dioxins are likely to appear in sediment anywhere in the United States with a manufacturing or industrial heritage. Although there are no established reference concentrations or doses (RfC/RfD) for dioxins, dioxin levels from the upper Ohio samples do not appear to be as high as in some other industrialized areas. Nonetheless, they remain a concern because of their potential toxicity if disturbed.

TABLE 13-8
Dioxin Levels in River Sediments

Date	River	River Mile	Dioxin Toxic Equivalent (pg/g)
08/13/01	Allegheny	2.1	6.80
08/13/01	Monongahela	2.6	17.90
08/13/01	Ohio	1	13.93
08/14/01	Ohio	2.7	21.14

TABLE 13-8 (continued)
Dioxin Levels in River Sediments

Date	River	River Mile	Dioxin Toxic Equivalent (pg/g)
08/14/01	Ohio	8.5	12.67
08/14/01	Ohio	10	3.18
08/15/01	Ohio	16.1	12.29
08/15/01	Ohio	22.2	9.13
08/15/01	Ohio	24.3	4.25
08/16/01	Ohio	32.9	10.61
08/16/01	Ohio	32.9	12.25
08/16/01	Ohio	36.3	5.38
08/16/01	Ohio	47.1	9.46
08/14/01	Ohio	3.3	14.59
08/14/01	Ohio	12.8	9.06
08/14/01	Ohio	12.8	9.83
08/15/01	Ohio	15.2	5.02
08/15/01	Ohio	17.2	3.30
08/15/01	Ohio	24.6	9.41
08/15/01	Ohio	29.1	16.27
08/15/01	Ohio	29.1	13.96
08/16/01	Ohio	42.3	7.56
pg/g = Picogram per gram			
Source: ORSANCO, 2009			

The data collected by ORSANCO indicate that in the past pollutants penetrated the substrates in significant amounts. Given the industrial heritage of the Ohio River Valley, it is not surprising that these constituents have been reported from sediment samples.

13.5.4 Effectiveness of Point Source and Nonpoint Source Control Programs

The success of polluting control programs are individually documented in summary articles found on the United States Environmental Protection Agency (USEPA) website (USEPA 2009a). Although not directly affecting the Upper Ohio River, these projects serve as examples of control programs in similar environments.

For a dam modification project on the Middle Cuyahoga River, a TMDL study was conducted by the Ohio Environmental Protection Agency (Ohio EPA) in 1999 on the Middle Cuyahoga River. As a result of this study, it was determined that this river was partially attaining goals for its designated use – warmwater habitat (WWH). This stream was entered into Ohio's 303(d) list as "impaired by nutrients, siltation, low dissolved oxygen, flow alteration, and other habitat alteration." Further evaluation of the stream by the Ohio EPA determined that the Kent Dam was a significant contributing factor to the impairment of the Middle Cuyahoga River. "Prior to the project, the Index of Biological Integrity (IBI) – an objective measurement of the diversity of the fish community – indicated that fish life within the river failed to meet WWH standards." Physical habitat conditions were also evaluated.

The Qualitative Habitat Evaluation Index (QHEI) was utilized to evaluate the habitat. The existing habitat features did not meet WWH standards either. Following completion of the project, the IBI scores increased by 57 percent and the QHEI increased by 56 percent. Due to the improvements, the Cuyohoga River fully attained its WWH aquatic live use designation and was expected to be removed from the 303(d) list (USEPA 2005).

A Pennsylvania project on Semiconon Run, a tributary to Connoquenessing Creek, was highlighted. This stream was determined to be significantly impaired by an acidic abandoned mine discharge that provided iron and to a lesser extent aluminum and manganese to the stream. This led to an impairment of the biological habitat provided by Semiconon Run. As a result, this stream was added to Pennsylvania's 303(d) list of impaired waters for metals. To remediate this problem a passive treatment facility was constructed which included a settling basin, treatment wetland, and limestone spillway. Data collected during a stream survey three years following completion of the project determined that the stream habitat was no longer impaired. As a result of the project, the stream was removed from Pennsylvania's 303(d) list (USEPA 2008a).

West Virginia's Morris Creek is a stream that is severely degraded in several areas by acid mine drainage. Morris Creek is a tributary to the Kanawha River. This stream was first added to the state's 303(d) list in 1996 for metals and then again in 1998, 2000, 2002, and 2004 for pH and metals. To remediate these problems the Morris Creek Watershed Association identified four priority treatment sites. By 2006 the treatment systems were in operation and improved water quality conditions were realized immediately. It is anticipated that Morris Creek will be removed from the 303(d) list by 2010 if conditions remain improved (USEPA 2008b).

The improved water quality that has been observed on the upper Ohio River further demonstrates the success of these point and nonpoint source pollution control programs.

13.5.5 Benthic Macroinvertebrate Populations

Benthic macroinvertebrates are good indicators of the health of an aquatic system for several reasons. They live in the water for a large portion of or their entire lives, they interact with the water and substrates in which they are found, their mobility is limited, and they differ in tolerances to types and amounts of pollutants (USEPA 2009b). Since bottom sediments act as sinks for many pollutants that enter waterways, benthic macroinvertebrate populations provide a good indicator of sediment health. Table 13-9 shows the macroinvertebrates collected within the study area during 2002 by ORSANCO. This table does not list all of the macroinvertebrates collected, however, just those species that had an associated tolerance level defined within the data.

TABLE 13-9
Benthic Macroinvertebrates from Upper Ohio River

Order	Family	Genus	Species	Tolerance
Emsworth Pool				
Basommatophora	*Physidae*	*Physella*	- -	Tolerant
Bivalvia	*Corbiculidae*	*Corbicula*	*fluminea*	Moderately intolerant
Diptera	*Chironomidae*	*Ablabesmyia*	*rhamphe*	Moderately tolerant
Diptera	*Chironomidae*	*Nanocladius*	*distinctus*	Moderately tolerant
Diptera	*Chironomidae*	*Polypedilum*	*illinoense*	Tolerant
Diptera	*Chironomidae*	*Cricotopus*	*bicinctus*	Moderately tolerant
Diptera	*Chironomidae*	*Dicrotendipes*	*lucifer*	Moderately tolerant
Diptera	*Chironomidae*	*Glyptotendipes*	- -	Moderately tolerant
Diptera	*Chironomidae*	*Nanocladius*	*distinctus*	Moderately tolerant
Diptera	*Chironomidae*	*Tanytarsus*	- -	Moderately intolerant
Diptera	*Chironomidae*	*Cricotopus*	*bicinctus*	Moderately tolerant
Diptera	*Chironomidae*	*Dicrotendipes*	*lucifer*	Moderately tolerant
Diptera	*Chironomidae*	*Glyptotendipes*	- -	Moderately tolerant
Diptera	*Chironomidae*	*Nanocladius*	*distinctus*	Moderately tolerant
Diptera	*Chironomidae*	*Tanytarsus*	- -	Moderately intolerant
Diptera	*Chironomidae*	*Glyptotendipes*	- -	Moderately tolerant
Diptera	*Chironomidae*	*Polypedilum*	*illinoense*	Tolerant
Diptera	*Chironomidae*	*Tanytarsus*	- -	Moderately intolerant
Ephemeroptera	*Tricorythidae*	*Tricorythodes*	- -	Moderately intolerant
Ephemeroptera	*Tricorythidae*	*Tricorythodes*	- -	Moderately intolerant
Ephemeroptera	*Tricorythidae*	*Tricorythodes*	- -	Moderately intolerant
Trichoptera	*Hydropsychidae*	*Hydropsyche*	*oris*	Moderately intolerant
Trichoptera	*Hydropsychidae*	*Potamyia*	*flava*	Moderately intolerant
Tricladida	*Planariidae*	*Dugesia*	*tigrina*	Moderately tolerant
Tricladida	*Planariidae*	*Dugesia*	*tigrina*	Moderately tolerant
Tricladida	*Planariidae*	*Dugesia*	*tigrina*	Moderately tolerant
Tricladida	*Planariidae*	*Dugesia*	*tigrina*	Moderately tolerant
Dashields Pool				
Diptera	*Chironomidae*	*Cricotopus*	*bicinctus*	Moderately tolerant
Diptera	*Chironomidae*	*Dicrotendipes*	*lucifer*	Moderately tolerant
Diptera	*Chironomidae*	*Glyptotendipes*	- -	Moderately tolerant
Diptera	*Chironomidae*	*Nanocladius*	*distinctus*	Moderately tolerant
Diptera	*Chironomidae*	*Rheotanytarsus*	- -	Moderately intolerant
Tricladida	*Planariidae*	*Dugesia*	*tigrina*	Moderately tolerant
Montgomery Pool				
Basommatophora	*Planorbidae*	*Menetus*	*dilatatus*	Tolerant
Basommatophora	*Pleuroceridae*	*Pleurocera*	*acuta*	Moderately intolerant
Basommatophora	*Planorbidae*	*Menetus*	*dilatatus*	Tolerant
Diptera	*Chironomidae*	*Dicrotendipes*	*lucifer*	Moderately tolerant
Diptera	*Chironomidae*	*Glyptotendipes*	- -	Moderately tolerant
Diptera	*Chironomidae*	*Glyptotendipes*	- -	Moderately tolerant
Diptera	*Chironomidae*	*Polypedilum*	*illinoense*	Tolerant
Diptera	*Chironomidae*	*Rheotanytarsus*	- -	Moderately intolerant
Diptera	*Chironomidae*	*Cardiocladius*	*obscurus*	Moderately intolerant

TABLE 13-9 (continued)
Benthic Macroinvertebrates from Upper Ohio River

Order	Family	Genus	Species	Tolerance
Montgomery Pool				
Diptera	*Chironomidae*	*Cricotopus*	*bicinctus*	Moderately tolerant
Diptera	*Chironomidae*	*Dicrotendipes*	*lucifer*	Moderately tolerant
Diptera	*Chironomidae*	*Glyptotendipes*	- -	Moderately tolerant
Diptera	*Chironomidae*	*Nanocladius*	*distinctus*	Moderately tolerant
Diptera	*Chironomidae*	*Cricotopus*	*bicinctus*	Moderately tolerant
Diptera	*Chironomidae*	*Cricotopus*	*sylvestris*	Tolerant
Diptera	*Chironomidae*	*Dicrotendipes*	*lucifer*	Moderately tolerant
Diptera	*Chironomidae*	*Glyptotendipes*	- -	Moderately tolerant
Diptera	*Chironomidae*	*Nanocladius*	*distinctus*	Moderately tolerant
Diptera	*Chironomidae*	*Rheotanytarsus*	- -	Moderately intolerant
Ephemeroptera	*Tricorythidae*	*Tricorythodes*	- -	Moderately intolerant
Ephemeroptera	*Tricorythidae*	*Tricorythodes*	- -	Moderately intolerant
Haplotaxida	*Tubificidae*	*whc*	- -	Tolerant
Haplotaxida	*Tubificidae*	*woch*	- -	Tolerant
Trichoptera	*Polycentropodidae*	*Neureclipsis*	- -	Moderately intolerant
Trichoptera	*Hydropsychidae*	*Potamyia*	*flava*	Moderately intolerant
Tricladida	*Planariidae*	*Dugesia*	*tigrina*	Moderately tolerant
Tricladida	*Planariidae*	*Dugesia*	*tigrina*	Moderately tolerant
Tricladida	*Planariidae*	*Dugesia*	*tigrina*	Moderately tolerant
New Cumberland Pool				
Basommatophora	*Planorbidae*	*Menetus*	*dilatatus*	Tolerant
Basommatophora	*Physidae*	*Physella*	- -	Tolerant
Basommatophora	*Planorbidae*	*Menetus*	*dilatatus*	Tolerant
Bivalvia	*Corbiculidae*	*Corbicula*	*fluminea*	Moderately intolerant
New Cumberland Pool				
Diptera	*Chironomidae*	*Ablabesmyia*	*rhamphe*	Moderately tolerant
Diptera	*Chironomidae*	*Dicrotendipes*	*lucifer*	Moderately tolerant
Diptera	*Chironomidae*	*Glyptotendipes*	- -	Moderately tolerant
Diptera	*Chironomidae*	*Polypedilum*	*illinoense*	Tolerant
Diptera	*Chironomidae*	*Dicrotendipes*	*lucifer*	Moderately tolerant
Diptera	*Chironomidae*	*Ablabesmyia*	*rhamphe*	Moderately tolerant
Diptera	*Chironomidae*	*Cricotopus*	*bicinctus*	Moderately tolerant
Diptera	*Chironomidae*	*Glyptotendipes*	- -	Moderately tolerant
Diptera	*Chironomidae*	*Polypedilum*	*illinoense*	Tolerant
Diptera	*Chironomidae*	*Ablabesmyia*	*rhamphe*	Moderately tolerant
Diptera	*Chironomidae*	*Dicrotendipes*	*lucifer*	Moderately tolerant
Diptera	*Chironomidae*	*Polypedilum*	*illinoense*	Tolerant
Diptera	*Chironomidae*	*Rheotanytarsus*	- -	Moderately intolerant
Odonata	*Corduliidae*	*Neurocordulia*	*obsoleta*	Moderately intolerant
Odonata	*Coenagrionidae*	*Enallagma*	- -	Moderately tolerant
Odonata	*Cordulidae*	*Neurocordulia*	*obsoleta*	Moderately intolerant
Tricladida	*Planariidae*	*Dugesia*	*tigrina*	Moderately tolerant
Tricladida	*Planariidae*	*Dugesia*	*tigrina*	Moderately tolerant

Tolerant = Species with high pollution/disturbance tolerance.
Intolerant = Species with low pollution/disturbance tolerance.

Source: ORSANCO, 2004

The composition of the benthic macroinvertebrate population collected from study area pools was dominated by species defined as moderately tolerant, followed by moderately intolerant, and finally tolerant species. The purpose of tolerance/intolerance measures is to provide a representation of relative sensitivity to disturbance or pollution. In addition, large hatches of mayflies have been observed in the City of Pittsburgh, indicating that the water and sediment quality of the three rivers is improving. The presence of mayflies is a good indicator that sediment quality has improved along with water quality. Mayfly nymphs burrow into the sediment; historically, there was an abundance of mayflies in local waterbodies.

13.5.6 Effectiveness of Monitoring Programs, Spill Response Programs, and Precautionary Measures

The purpose of these programs is to monitor water and sediment conditions periodically at defined sample points along the river. Continual monitoring programs provide a tool for the regulatory agencies to track pollution events and can help to identify potential pollution sources.

On January 2, 1988, the largest inland diesel fuel spill occurred at the Ashland Terminal in Floureffe, Pennsylvania. This spill triggered regulatory initiatives for the above ground storage of petroleum and other regulated substances. It also generated requirements for reporting of spills and notification of downstream water users in the event of an emergency. These regulations help to provide a sustainable future for the petroleum storage industry on inland waterways.

Emergency spill response programs are in place in order to quickly facilitate clean up actions when accidents occur that could potentially discharge pollutants to the environment. Recently an accident occurred where a Pennsylvania Department of Transportation truck overturned, spilling a small amount of diesel fuel (approximately 80 gallons) onto the roadway. Emergency response personnel quickly isolated the spill from accessing any area waterways, since the location of the accident was in close proximity to the Allegheny River.

13.6 INTERACTIONS WITH OTHER VALUED ENVIRONMENTAL COMPONENTS (VECS)

The recovery of the Ohio River during the last 50 years has had far-ranging effects on almost every valued environmental component included in this CEA. The history and public perception of water quality conditions in the Ohio River mainstem, in large measure, illustrate the complex interplay between sediment quality and many other VECs including those concerning human communities. During the mid-20th century, when the Ohio River was perceived almost as an open sewer, fish, mussels, and other aquatic organisms declined, recreation suffered, and public health and safety were compromised. As shown on Table 13-10, the sediment quality VEC interacts closely with water quality, fish, mussels, riparian resources (including aquatic macrophytes, wetlands, islands, floodplains, waterbirds, mammals, amphibians, and reptiles), and recreation.

TABLE 13-10
Interactions of Sediment Quality with Other VECs

VEC	Sediment Quality & Potential Impacts	Past/Present Trends	Future Trends	Comments
Water Quality	Water quality and sediment quality are intimately related. Some pollutants in suspended in water can drop from the water column and become a part of the river sediments.	Poor water quality in the past resulted in poor sediment quality in the Ohio River. Water and sediment quality have been improving in the past several decades.	It is assumed that regulations governing discharges to waterways will become more stringent and technologies will advance to more effectively treat waste materials discharged to the rivers.	This will provide a benefit to all aquatic life and human users of the Ohio River.
Fish	Degraded sediment quality has a negative influence on fish populations.	In the past, sediment quality was significantly impaired due to the industrial/urban land use surrounding the river. Due to federal and state regulations, sediment quality conditions have improved.	It is assumed that water and sediment quality standards will become more stringent in the future, further providing a more positive influence on the health of sediment qualities of the river. Therefore, it is assumed that fish populations of the river may continue to improve.	This will provide a benefit to all aquatic life and human users of the Ohio River.

TABLE 13-10 (continued)
Interactions of Sediment Quality with Other VECs

VEC	Sediment Quality & Potential Impacts	Past/Present Trends	Future Trends	Comments
Mussels	Degraded sediment quality has a negative influence on mussel populations.	In the past, sediment quality was significantly impaired due to the industrial/urban land use surrounding the river. Due to federal and state regulations, sediment quality conditions have improved.	It is assumed that water and sediment quality standards will become more stringent in the future, further providing a more positive influence on the health of sediment qualities of the river. Therefore, it is assumed that mussel populations of the river may continue to improve.	This will provide a benefit to all aquatic life and human users of the Ohio River.
Riparian Resources	Healthy riparian resources control pollutants from entering stream flow and contribute to the overall health of the aquatic system.	Riparian resources have traditionally been exploited for human use. The importance of riparian resources as an important component to a healthy stream community has recently become an accepted fact.	It is assumed that greater understanding of the importance of riparian resources will be gained as we move forward. Increased regulations on the use of riparian resources could also occur resulting in greater protection to these habitats.	Improved riparian resources could provide a positive benefit to the sediment quality conditions found in the river.

TABLE 13-10 (continued)
Interactions of Sediment Quality with Other VECs

VEC	Sediment Quality & Potential Impacts	Past/Present Trends	Future Trends	Comments
Recreation	Degraded sediment quality can result in a negative impact on recreational activities such as fishing.	Recreational use of the river in the past has been limited due to poor sediment and water quality. The improved sediment and water quality has led to the utilization of the river for recreational uses.	It is likely that sediment and water quality conditions will continue to improve as regulations become more stringent and technologies advance to treat waste materials. This will likely led to additional use of the river for recreational purposes.	Potential continued growth of urban river-front-oriented development

13.7 INDICATORS OF ENVIRONMENTAL SUSTAINABILITY FOR SEDIMENT QUALITY

Sustainability of the sediment resource is attained when the composite conditions for the selected indicators are such that the attainment of permissible use designations is achieved for essentially all river miles in the project area and diverse populations of aquatic organisms exist in the project area. Further, the conditions of the indicators exceed regulatory thresholds and various governmental programs are in place to control point and nonpoint pollution sources and to emphasize pollution reduction. Importantly, the successful resolution of issues of special concerns is another indication of long-term sustainability. Indicators of sustainability for sediment resources include:

- Substrate compositions;
- Water quality conditions;
- Legacy pollutants;
- Effectiveness of point source and nonpoint source control programs;
- Ability to sustain diverse, healthy populations of aquatic organisms; and
- Effectiveness of spill response, monitoring programs, and other precautionary measures.

13.8 RELEVANT FUTURE ACTIONS AFFECTING SEDIMENT QUALITY

RFFAs for sediment quality were evaluated utilizing a matrix prepared during the scoping process. The matrix was an outgrowth of a similar matrix developed during the preparation of ORMSS. Results of the RFFA evaluation are summarized in Table 13-11.

TABLE 13-11
RFFA Cumulative Effects Matrix for Sediment Quality

RFFA Cumulative Effects Matrix for Upper Ohio River – Sediment Quality					
RFFA[1]	**Time Period[2]**	**Occurrence Probability[3]**	**Location on River[4]**	**Importance[5]**	**Effects[6]**
USACE Actions					
Navigation Investments					
Replacement locks at Emsworth, Dashields, and Montgomery Dams (EDM)	1	H	S	L	+/-
Rehabilitation of EDM dams	1	H	S	L	+/-
Navigation aids - lock & dam signage	A	H	S	L	+/-
Non-structural navigation improvements	A	H	S	L	+/-
L&D operation and maintenance	A	H	S	L	+/-
Approach & channel dredging/disposal	A	H	E	M	-
Environmental design					
environmental sustainability operation actions	A	H	S	L	+/-
Pool maintenance	A	H	E	L	+/-
Sec 107 port development and maintenance dredging	2	L	S	M	-
Ecosystem Restoration					
Fish passage at EDM	1	H	S	L	+/-

TABLE 13-11 (continued)
RFFA Cumulative Effects Matrix for Sediment Quality

RFFA Cumulative Effects Matrix for Upper Ohio River – Sediment Quality					
RFFA[1]	**Time Period[2]**	**Occurrence Probability[3]**	**Location on River[4]**	**Importance[5]**	**Effects[6]**
Actions by Others					
Navigation System Dependent - "But For"					
Commercial navigation					
barge queuing	1	M	E	L	+/-
fleeting areas/barge storage	1	M	E	L	+/-
terminals & multi-modal sites	2	L	S	M	-
barge/tow tech/"green" design	A	M	E	L	+/-
accidents/spills	A	M	E	H	-
Coast Guard navigation aids - const., O&M	A	H	E	L	+/-
Energy					
hydropower on dams	2	M	S	L	+/-
continued operation of coal-fired power plants	A	M	S	M	-
Water-based recreation					
marina development & operation	A	M	S	M	-
commercial boating	A	H	E	M	-
personal boating	A	H	E	L	+/-
River Dependent					
Water supply/discharge					
municipal	A	M	S	H	-
industrial	A	M	S	H	-
Waste water treatment discharges (WWTP)					
onsite systems	A	H	E	H	-
stormwater discharges; CSOs; SSOs	A	H	S	H	-
Marcellus shale gas extraction (water impacts)	A	H	E	H	-
Resource extraction					
instream sand and gravel mining	A	H	E	H	-
Acid mine discharge (AMD)	A	M	E	H	-

TABLE 13-11 (continued)
RFFA Cumulative Effects Matrix for Sediment Quality

RFFA Cumulative Effects Matrix for Upper Ohio River – Sediment Quality					
RFFA[1]	**Time Period[2]**	**Occurrence Probability[3]**	**Location on River[4]**	**Importance[5]**	**Effects[6]**
Actions by Others					
Riverfront/Floodplain Development					
Downtown Pittsburgh					
Ongoing Point State Park improvements	1	H	S	L	+/-
Convention Center riverfront park	1	H	S	L	+/-
residential development/conversions	A	H	S	L	+/-
North Shore development	1	H	S	L	+/-
Pittsburgh South Side					
continued riverfront development	A	H	S	L	+/-
continued South Side Works development	1	H	S	L	+/-
Riverfront trails					
Pittsburgh riverfront trail system	A	H	E	L	+/-
Beaver County trail system	A	M	E	L	+/-
Brownfields redevelopment					
Neville Island	1	H	S	M	+
PL&E, McKees Rocks	2	M	S	M	+
M&B Development	2	M	S	M	+
Fab Tech & Buckeye Pipeline	1	M	S	M	+
J&L site in Aliquippa	1	M	S	M	+
Leetsdale Industrial Park	1	H	S	M	+
Resource Protection/Restoration					
Ohio River Islands Wildlife Refuge System	A	H	S	M	+
Nationwide Rivers Inventory	A	M	S	M	+
Ecosystem restoration	A	M	E	M	+
Cultural resources	A	M	E	L	+/-

TABLE 13-11 (continued)
RFFA Cumulative Effects Matrix for Sediment Quality

RFFA Cumulative Effects Matrix for Upper Ohio River – Sediment Quality					
RFFA[1]	**Time Period[2]**	**Occurrence Probability[3]**	**Location on River[4]**	**Importance[5]**	**Effects[6]**
Actions by Others					
Bridges and Roadways					
Bridge renovations					
Ambridge/Aliquippa Bridge	1	H	S	L	-
Shippingport Bridge	1	H	S	L	-
Rochester Bridge	1	H	S	L	-
McKees Rocks Bridge	1	H	S	L	-
Birmingham Bridge	1	H	S	L	-
Rankin Bridge	1	H	S	L	-
New crossings					
Maglev	2	L	S	L	-
North Shore connector	1	H	S	L	-
Natural Events					
floods	A	M	E	L	+/-
droughts	A	L	E	L	+/-
invasive species	A	H	E	L	+/-
Regulatory Environment					
Phase I & 2 NPDES program	A	H	E	H	+
TMDLs	A	H	E	H	+
ALCOSAN & other consent decrees	A	H	E	H	+
Adaptive management in Sand & Gravel EIS	A	H	E	L	+
Pollution prevention	A	H	E	H	+
USACE permitting programs	A	H	E	H	+

TABLE 13-11 (continued)
RFFA Cumulative Effects Matrix for Sediment Quality

RFFA Cumulative Effects Matrix for Upper Ohio River – Sediment Quality					
RFFA[1]	**Time Period[2]**	**Occurrence Probability[3]**	**Location on River[4]**	**Importance[5]**	**Effects[6]**
Actions by Others					
Regulatory Environment					
Boating safety regulations	A	H	E	M	+
Monitoring programs - PA/ORSANCO	A	H	E	H	+
Environmental awareness education	A	H	E	M	+
Clean Air Act standards	A	H	E	H	+
Clean Water Act standards	A	H	E	H	+
Endangered Species Act (ESA)	A	H	E	M	+
Environmental sustainability practices	A	H	E	M	+

[1] Reasonably Foreseeable Future Actions
[2] Time period in which the RFFA may occur: A = all periods; 1 = within 10 years; 2 = in 10 - 25 years; 3 = in 25 - 60 years
[3] Occurrence probability or likelihood RFFA will happen: H = high; M = medium; L = low
[4] Location or setting on river where RFFA is expected to occur: E = along entire length of river; S = specific location
[5] Importance or impact of action on the VEC: H = high; M = medium; L = low
[6] Effects of action on the VEC: + = positive effect; - = negative effect; +/- = mixed effects

Each of the RFFAs that ranked high or medium in importance to sediment quality is discussed in the following sections. RFFAs that have a low probability of occurring within the upper Ohio River study area or that have no or minimum effect on sediment quality are not considered further in this cumulative effects assessment.

13.8.1 USACE Actions

Approach and channel dredging/disposal and port development and maintenance dredging could result in negative impacts on sediment quality of the upper Ohio River since these types of activities could result in stirring up potentially polluted sediments in the river. Dredging will agitate or remove substrate compositions, which in turn could release legacy pollutants and re-suspend them in the water or transfer them to other locations. By releasing buried pollutants, these pollutants could then negatively affect existing healthy populations of aquatic organisms.

13.8.2 Actions by Others

13.8.2.1 Navigation System Dependent – "But For"

Potential actions by others that may result in negative impacts on sediment quality include development of terminals and multi-modal sites; potential accidents or spills of toxic materials in the river; continued operation of coal-fired power plants; marina development and operation; and commercial boating. New terminals and multi-modal sites provide potential pollutant sources through accidental spills when loading or unloading barges. Accidents or spills along the river associated with commercial boating can potentially contribute hazardous materials directly to the river. The construction of new facilities along the river, regardless of whether they are related to industrial, commercial, or recreational activities, could expand the existing footprints of buildings, piers, and other structures. Additionally, some construction activities could require entering the water on a temporary basis. Sediment could subsequently be disturbed and create impacts related to possible legacy contaminants and aquatic life.

Wastewater discharges associated with operation of coal-fired power plants are a potential source of water/sediment pollution in the river. Marina development and operation could result in the release of potentially polluted sediments in the river. Sediments containing legacy pollutants, if disturbed, could ultimately affect aquatic organisms by entering the food chain at all levels.

13.8.2.2 River Dependent

Some river dependent actions would likely result in negative effects on the sediment quality of the upper Ohio River. New municipal and industrial discharges, as well as new discharges from onsite systems, stormwater systems, CSOs, and SSOs constitute potential sources of sediment pollution. If ineffective point sources and nonpoint source discharges, such as these, add significant levels of pollution, not only would sediment receive additional pollution, but water quality would degrade and aquatic organisms would be threatened. On the other hand, effective discharges could help to improve future water quality and stall further sediment pollution by properly treating water returning to the river system.

Acid mine discharge is an additional pollution source to the river that would result in a negative impact to sediment quality of the river. Although these discharges will be regulated (which will buffer some of the negative influences from these potential sources of pollution), if a large AMD discharge were to occur on the Monongahela River, as predicted by some, this could result in a significant impact to sediment quality. Contaminants associated with AMD could be deposited within aquatic habitat areas, killing existing populations and losing these sites for future populations.

Wastewater discharges to the river from Marcellus shale operations are an additional source of pollution to the river. However, as noted above, these discharges will be regulated under existing and potentially future regulations to minimize environmental impacts as a result of these activities. Existing combined storm system overflows and sanitary system

overflows discharges are sources of pollution to the river. Existing agreements to do away with these types of systems are in place which should minimize the effects of these discharges in the future.

By disturbing material through instream sand and gravel mining, substrates could be disturbed and legacy pollutants in the sediment released. Sediments containing legacy pollutants, if disturbed, could ultimately affect aquatic organisms by entering the food chain at all levels.

13.8.2.3 Riverfront/Floodplain Development

Brownfields redevelopment is a category of riverfront/floodplain development that would provide a positive effect on the sediment quality of the river. Redevelopment of the existing brownfields along the upper Ohio River may result in the removal or isolation of potential contaminants from accessing river flows. There are several brownfields along the upper Ohio River that may be redeveloped.

13.8.2.4 Resource Protection/Restoration

The Ohio River Islands Wildlife Refuge System and Nationwide Rivers Inventory provide positive influences on sediment quality as these activities provide protection to undeveloped habitats or environmentally significant features along the river. Ecosystem restoration would also provide a positive influence on sediment quality by restoring riparian areas.

13.8.2.5 Regulatory Environment

The existing regulatory environment provides protections for sediment quality both directly and indirectly. Programs under the Clean Water Act such as the National Pollution Discharge Elimination System (NPDES) and TMDL programs will provide for improved water quality and subsequently sediment quality conditions of the river through the permitting of discharges and limitations to pollutant discharges to the river. Consent decrees in place to remediate for CSO and SSO discharges should ultimately result in the elimination of such systems. Monitoring programs, such as ORSANCO's, will be continually testing the river and suggesting new regulations as land uses and industries along the river change over time. The Clean Air Act limits the amount of pollutants discharged to the atmosphere which can end up in water and eventually stream sediments. The Endangered Species Act of 1973 provides protection for the habitat of listed species which, for listed mussel species, could result in protection of substrates. USACE permitting programs provide authority to the USACE to review projects for impacts to natural resources and require measures to avoid, minimize, and mitigate for unavoidable impacts. Boater safety regulations can provide a positive influence on sediment quality through minimizing the chances for accidents on the river. Environmental sustainability practices will improve the methods in which projects are planned and constructed. Finally, environmental awareness education will provide the

opportunity to educate the public on the importance of sediment quality to healthy river ecosystems.

13.9 ANALYSIS OF ENVIRONMENTAL SUSTAINABILITY

Sustainability of sediment resources is attained when good sediment quality is found throughout the project area. Indicators of sustainability for sediment resources include substrate compositions and water quality conditions that support aquatic life and biodiversity, legacy pollutants are under control, point source and nonpoint source control programs are effective, and spill response, monitoring programs, and other precautionary measures are effective.

Environmental sustainability is a synergistic process whereby environmental considerations are effectively balanced through the life cycle of project planning, design, construction, operation, and maintenance to improve the quality of life for present and future generations. Accordingly, it represents a test of significance of potential cumulative effects.

13.9.1 Positive Forces Affecting Sediment Quality

The greatest positive force influence on sediment quality has been those beneficial forces working toward improved water quality. Without a doubt, water quality conditions have improved tremendously over the past three or four decades which, in turn, have led to an increase in the amount and types of aquatic life in the river. Point source and nonpoint source pollution control programs are in place and proving to be effective. Spill response and related activities have progressed, as well.

The positive forces that are affecting sediment quality of the upper Ohio River are primarily related to the existing regulatory environment and brownfields redevelopment projects. The water quality and air quality protection regulations provide a positive influence on sediment quality through the regulation of pollutants discharged to the environment. Consent decrees to eliminate CSO and SSO systems will provide a significant positive influence on sediment quality through removing these types of polluting systems from the environment. Monitoring programs to regularly test air and water quality ensure that the entities with permitted discharges are following the conditions of their respective permits. Permitting programs administered by the USACE will protect the health of sediment quality through project evaluation. Environmental sustainability practices will improve the methods that projects are planned for and constructed.

The redevelopment of brownfields along the river provides a potential opportunity for the removal or isolation of potential contaminants from accessing river flows. As brownfields sites are cleaned up for redevelopment, potential sediment pollutants will be either encased or hauled away to appropriate disposal areas. Additionally, the industry that is present along the river has been changing over the years from heavy manufacturing (coke operations and steel manufacturing) to light manufacturing (cleaner, high-tech processing, distribution, and warehousing, as well as commercial developments). This results in a subsequently less impact on sediment quality.

Increased public awareness through environmental education will continue to provide further knowledge of the importance of sediment quality to a healthy, functioning aquatic system. The Ohio River Islands National Wildlife Refuge System and Nationwide Rivers Inventory provide a positive influence on sediment quality through protection of undeveloped or environmentally significant features of the river. The Endangered Species Act provides a positive influence also through protection of habitat for listed species. Ecosystem restoration efforts also provide a positive influence through various habitat restoration projects that may improve sediment quality conditions. The industrial activities along the river have been waning over the years. This provides an additional positive influence on the sediment quality conditions of the river.

13.9.2 Negative Forces Affecting Sediment Quality

The negative forces that are affecting sediment quality of the upper Ohio River are primarily related to wastewater discharges to the river; existing and potential discharges of acid mine drainage; dredging operations for maintenance, development, or sand and gravel extraction from the river; and commercial boating and related activities. Legacy pollutants of the sediment provide an additional negative force on the quality of sediment in the upper Ohio River. Additionally, limited data are available regarding sediment quality of the upper Ohio River.

The influence of wastewater discharges and activities of sand and gravel dredging operations are buffered through existing regulations and potential permit conditions. There are also programs in place to remediate acid mine drainage. Port development and maintenance dredging, as well as marina development and operation, potentially provide additional negative forces on sediment quality, but again these impacts would likely be buffered through permit conditions.

Commercial boating activities, including loading and unloading of barges at terminals or multi-modal sites, also provide potential negative influences on sediment quality. Potential accidents and spills associated with shipping and industry on/along the river provide negative influences on sediment quality. However, emergency response plans/programs are in place in preparation for these potential accidents. Additionally, newer and developing technologies could further minimize the potential for these situations to occur on the river.

13.9.3 Incremental Impacts on EDM

The incremental impacts of improvements at the Emsworth, Dashields, and Montgomery locks and dams will be limited and generally positive. The incremental impacts to sediment quality are anticipated to be limited to the potential disposal of contaminated dredged material from the area of impact.

13.10 DETERMINATION OF SUSTAINABILITY

Three definitions of environmental sustainability were used for the analysis:

- Not sustainable – conditions for the selected indicators do not reflect conditions that would facilitate attainment of acceptable standards or would not maintain existing standards in concert with collective impacts of proposed activities.

- Marginally sustainable – conditions for selected indicators are such that attainment is accomplished for the majority, but not all, of the potentially affected area. However, the conditions are somewhat tenuous both in location and likelihood of occurrences. (In other words, the conditions are borderline for environmental sustainability, and there are uncertainties regarding specific quantitative measures.)

- Sustainable – conditions for selected indicators are such that attainment of acceptable conditions are accomplished for essentially all of the potentially affected area in the project area, and such standards are maintained in concert with foreseeable future activity. Further, conditions exceed regulatory thresholds, and various governmental programs are in place to respond to any potential erosion of values related to sediment quality.

Figure 13-1 illustrates the sustainability for sediment quality. The sustainability of sediment quality can be characterized as follows:

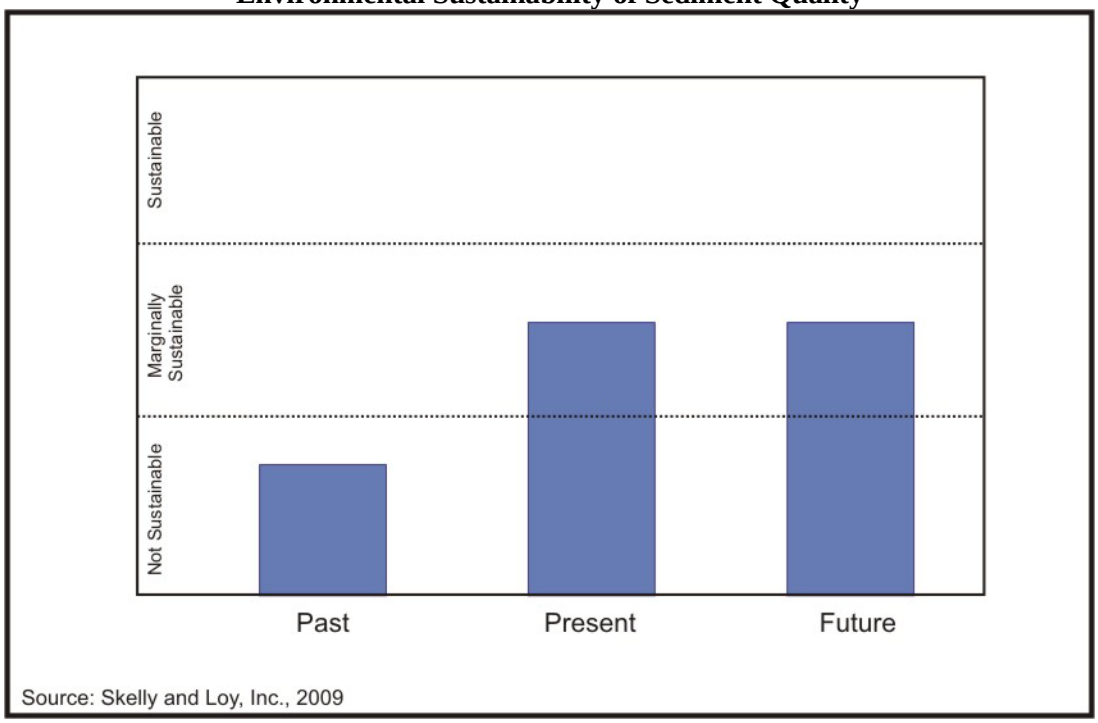
- In the time period prior to 1920, and continuing up to about 1970, the water quality on the Ohio River was in a degraded state characterized by low DO concentrations, low pH levels in the upper river, high bacterial contamination, high nitrogen concentrations, and remobilization of potentially toxic chemicals that had become associated with river sediments. Limited data regarding sediment quality is available from this time period. However, due to the degraded water quality conditions, it is likely that sediment quality was also poor. Essentially no pollution reduction, control, or regulatory programs were in place during this period. Further, declines in mussel populations of the river were also observed. It is likely that poor sediment and water quality were part of the reason for the decline. For these reasons, it can be assumed that the sustainability of sediment quality could be characterized as not sustainable. Primary contributors to these conditions were the largely untreated and uncontrolled point and nonpoint pollutant discharges from growing municipalities, mining, and various types of industries and land uses along the river.

- Following implementation of the programs managed by ORSANCO and the requirements of the Clean Water Act, water quality of the Ohio River has shown a steady improvement in recent decades. Aside from the presence of legacy pollutants, it can be assumed that water quality improvements also indicate that sediment quality conditions are improving. However, fish consumption

advisories related to PCBs continue to be recommended for gamefish from the study area indicating that this continues to be a problem within the upper Ohio River. Populations of mussels have returned, however, indicating improvement to sediment and water quality. Aquatic macroinvertebrate populations collected from sample points within the study area have been dominated by species determined to be moderately tolerant. Also, large hatches of mayflies have been observed in Pittsburgh in recent years indicating that mayfly populations have been on the rebound. Although fish consumption advisories continue, the present conditions of sediment quality indicate that this VEC could be considered marginally sustainable.

- In the future, more stringent regulations regarding discharges to the river are likely to be implemented. Also, sampling methods and technologies will continue to improve. Techniques and methods to remediate sediment pollution may also be developed, but to date, improvements to sediment quality will only occur as water quality improves. Although these developments will move sediment quality toward a sustainable condition, they are indirectly doing so without fully addressing issues specific to river sediment, especially legacy pollutants. Consequently, sediment quality will likely remain as marginally sustainable for the foreseeable future.

FIGURE 13-1
Environmental Sustainability of Sediment Quality



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Chapter 14

SUMMARY AND CONCLUSIONS

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14.1 METHODOLOGY

The Cumulative Effects Assessment (CEA) for the Upper Ohio Navigation Study considered the impacts of past, present, and future actions by the Pittsburgh District, United States Army Corps of Engineers (USACE); other federal, state, and local agencies; and private entities on the upper Ohio River. The Upper Ohio Navigation Study is a congressionally directed feasibility study to investigate opportunities for maintaining and improving commercial navigation on the upper Ohio River consistent with the protection of the environment.

The procedures followed through the course of the study were based on methodologies developed by the Council on Environmental Quality (CEQ) as guidance for conducting cumulative effects assessments. The underlying primary methodologies included trends analysis, matrices, checklists, ecosystem analysis, economic analysis, and social impact analysis. Secondary methodologies included systems diagrams, overlay mapping/GIS, and carrying capacity. CEQ guidance provides distinct steps and different methods for analyzing cumulative effects that can be modified depending on the resource under examination.

The overall framework for the analysis was developed as part of the Ohio River Mainstem Study (ORMSS). The current project is tiering off ORMSS. ”Tiering” refers to the coverage of general matters in broader environmental impact statements with subsequent narrower statements or environmental analyses incorporating by reference the general discussions and concentrating solely on the issues specific to the statement subsequently prepared (40 CFR 1508.28).

Work plans from ORMSS were adapted for the project. The work plans contained definitions, geographic scopes, a synopsis of past and present conditions, timeframes, possible research resources, and other background information. The work plans guided the conduct of all the individual studies throughout the project, assuring consistency in the analytical approaches as different resources were assessed.

Like ORMSS, this study employed a series of matrices that defined reasonably foreseeable future actions (RFFAs) for the project area. Although adjustments were made for this CEA, the fundamental principle remained the same through all three projects: *focus on the resource*. In adapting the RFFA matrix method to the Upper Ohio Navigation Study, the findings of the ORMSS CEA and scoping information from both ORMSS and the Upper Ohio River study were used to help determine RFFAs, valued environmental components (VECs), timeframes, and geographic scopes. This resulted in the identification of 73 RFFAs and 11 VECS. The timeframe for each VEC was consistent throughout, from 1885 to 2070. The geographic scopes varied for each VEC. For some resources, it was as small as the river and its floodplain, for others it was a large as the five-county region surrounding the upper Ohio River.

RFFAs were divided into two primary categories: USACE actions and actions by others. These two categories were further subdivided into the following subcategories:

- USACE Actions – Navigation investments and ecosystem restoration.

- Actions by Others – Navigation system dependent (but for the presence of the system), river dependent, riverfront/flood plain development, resource protection/restoration, bridges and roadways, natural events, and regulatory environment.

The matrices connected RFFAs and their anticipated effects on VECs. To accomplish this, nominal scores (or codes) were assigned to each RFFA that indicated the time period the RFFAs were likely to occur, the occurrence probability, the location on the river, importance, and effects. Scores were based on the following measurements:

- Time Period – all periods, within 10 years, in 10 to 25 years, or in 25 to 60 years;

- Occurrence Probability – high, medium, or low;

- Location on the River – along the entire length of the upper Ohio or at a specific location;

- Importance – high, medium, or low; and

- Effects – positive, negative, or mixed.

The time period, occurrence probability, and location on the river were held constant for all VECs. The importance and effects, however, were different for each VEC. In some

cases, the RFFA would have no impact on a particular VEC. In those cases, the RFFA was deleted from the matrix.

14.2 VALUED ENVIRONMENTAL COMPONENTS (VECs)

Through the initial scoping process, ten VECs were identified. They were water quality/sediment quality, fish, mussels, riparian resources, recreation, transportation and traffic, air quality, health and safety, socioeconomics, and cultural resources. As the project progressed, it was determined that water quality/sediment quality should be separated into two different VECs. While water quality and sediment quality are similar, several members of the interagency working group (IWG) noted that there were many different contributing factors affecting these two resources. Consequently, they were separated to create eleven VECs overall. Brief definitions for each VEC are found in Table 14-1.

TABLE 14-1
Definitions of the Valued Environmental Components (VECs)

VEC	Definition
Water Quality	Physical, chemical, and biological parameters of the aquatic environment; evaluation in relation to human health and aquatic ecological resources
Fish	Fish communities within the Ohio River and its tributaries
Mussels	Mussel communities within the Ohio River and its tributaries
Riparian Resources	Areas between terrestrial and aquatic ecosystems; portions of the channel system and associated features; a shoreline vegetated zone; and a transitional zone to the uplands of the valley wall
Recreation	Recreational fishing, boating, water-skiing, swimming, shoreline hiking, and biking
Transportation and Traffic	The Upper Ohio River Navigation System, shipping volumes, shipping modes, commodities shipped, and intermodal transportation facilities and connections
Air Quality	Ambient or outdoor air that is safe to breathe
Health and Safety	Related to human communities rather than resources and ecosystems; worker health and safety, general population health, and recreational boater safety
Socioeconomics	Human communities, neighborhoods, and other groups
Cultural Resources	Artifacts, records, and material remains associated with or representative of peoples, cultures, human activities or events, either in the past or present.
Sediment Quality	Substrate composition; potential effects of legacy or residual contaminants

Individual analyses were prepared for each VEC. Assessment goals encompassed the evaluation of cumulative effects on the VEC from the incremental impacts of past, present, and future actions. The assessment results were subsequently used to determine the past, present, and future environmental sustainability of the resource. Each analysis included the following:

- Definition of the VEC;
- Objectives/Scope;
- Issues from Scoping;
- Indicators of Environmental Sustainability;
- Laws, Regulations, Ordinances, and Programs;
- Past to Current Baseline Conditions;
- Interactions with Other VECs;
- Relevant Future Actions Affecting the VEC;
- Analysis of Environmental Sustainability;
- Determination of Sustainability; and
- References.

All resources are important, but some are potentially affected more by cumulative impacts than others, especially as they relate to specific actions. Also, the direct impacts of navigation improvements by the USACE potentially impact some resources to a greater degree, both positive and negative. Consequently, of the eleven VECs, fish, mussels, water quality, and sediment quality were determined to be of the highest importance to the USACE. Air quality, recreation, riparian resources, and transportation and traffic were the next level of importance. Cultural resources, health and safety, and socioeconomics were the third level of importance.

14.3 ELEMENTS COMMON TO ALL VECS

Although they represent different resources, the VECs have common frameworks. These commonalities allowed for the development of a cross-referenced table to summarize the connections between the VECs. Thus, the first common element to all VECs was the interconnectedness of the overall legal and policy environment.

After the relationships between the VECS were established, a similar cross-referenced table was prepared identifying the anticipated cumulative effect on the VECs from all actions. The cumulative effect of all past, present, and reasonably foreseeable future actions formed the second common element.

The third element common to each VEC are the indicators of environmental sustainability. The indicators provided both quantitative and qualitative thresholds for

meeting environmental sustainability. Though different indicators were used for each VEC, similar levels of importance were applied to them.

14.3.1 Laws, Regulations, Ordinances, and Programs

Legal measures and government programs are common to all VECs. Table 14-2 lists laws, regulations and programs applicable to the CEA. The primary or secondary relevance of the laws and programs on the VECs is shown by the shading for each cell. Darker shading represents primary relevance and lighter shading represents secondary relevance. Some laws, regulations and programs have low relevance or are not applicable to individual VECS. These are shown by the absence of shading.

TABLE 14-2
Applicable Laws, Regulations, Ordinances, and Programs

Laws, Regulations, Ordinances, Programs	Water Quality	Fish	Mussels	Riparian Resources	Recreation	Transportation and Traffic	Air Quality	Health and Safety	Socioeconomics	Cultural Resources	Sediment Quality
Abandoned Shipwreck Act											
Archaeological & Historic Preservation Act											
Archaeological Resources Protection Act											
Clean Air Act											
Clean Water Act											
Comprehensive Environmental Response, Compensation & Liability Act											
Council on Environmental Quality Policies											
Draft Protocol for Mussels Surveys in the Ohio River											

Laws, Regulations, Ordinances, Programs	Water Quality	Fish	Mussels	Riparian Resources	Recreation	Transportation and Traffic	Air Quality	Health and Safety	Socioeconomics	Cultural Resources	Sediment Quality
Emergency Planning and Community Right to Know Act											
Emergency Wetlands Resources Act											
Endangered Species Act											
Executive Branch No Net Loss Policy											
Executive Order 11988 on Floodplain Management											
Executive Order 11990 on the Protection of Wetlands											
Executive Order 12898 on Environmental Justice											
Executive Order 13112 on Invasive Species											
Executive Order 13274 on Environmental Stewardship and Transportation Infrastructure Projects											
Executive Order 13287 on Preserve America											

Laws, Regulations, Ordinances, Programs	Water Quality	Fish	Mussels	Riparian Resources	Recreation	Transportation and Traffic	Air Quality	Health and Safety	Socioeconomics	Cultural Resources	Sediment Quality
Farm Security & Rural Investment Act											
Federal Water Project Recreation Act											
Fish & Wildlife Act											
Fish & Wildlife Conservation Act											
Fish & Wildlife Coordination Act											
Fish & Wildlife Conservation & Water Resource Developments Coordination											
Flood Control Act											
Hazardous Materials Transportation Act											
Historic Sites, Buildings & Antiquities Act											
Inland Waterways Revenue Act											
Migratory Bird Treaty Act											
National Ambient Air Quality Standards											
National Environmental Policy Act											

Laws, Regulations, Ordinances, Programs	Water Quality	Fish	Mussels	Riparian Resources	Recreation	Transportation and Traffic	Air Quality	Health and Safety	Socioeconomics	Cultural Resources	Sediment Quality
National CSO Control Policy											
National Flood Insurance Act											
National Historic Preservation Act											
National Invasive Species Act											
National Trails System Act											
National Wildlife Refuge System Administration Act											
National Wildlife Refuge System Improvement Act											
Native American Graves Protection and Repatriation Act											
North American Wetlands Conservation Act											
Occupational Safety & Health Act											
Oil Pollution Act											
ORSANCO Monitoring											

Laws, Regulations, Ordinances, Programs	Water Quality	Fish	Mussels	Riparian Resources	Recreation	Transportation and Traffic	Air Quality	Health and Safety	Socioeconomics	Cultural Resources	Sediment Quality
PA Act 67 & 68											
PA Sewage Facilities Act											
PA Stormwater Management Act											
Phase 1 & 2 NPDES Program											
Pollution Prevention Act											
Programmatic Agreement (2009)											
Reclamation Projects Authorization and Adjustments Act											
Recreational Boating Safety Regulations & Programs											
Rivers & Harbors Act											
Safe, Accountable, Efficient Transportation Act: a Legacy for Users											
Safe Drinking Water Act											
Site Remediation Statutes											
Small Navigation Projects											
Spill Response											

Laws, Regulations, Ordinances, Programs	Water Quality	Fish	Mussels	Riparian Resources	Recreation	Transportation and Traffic	Air Quality	Health and Safety	Socioeconomics	Cultural Resources	Sediment Quality
State Cultural Resources Regulations											
State Fish Consumption Advisories											
State Fishing Regulations											
State Water Quality Certification											
Title VI of the Civil Rights Act											
TMDL Program											
Toxic Substances Control Act											
USACE Permitting Statutes											
Water Resources Development Act											

Key to shading: black = primary relevance to VEC; gray = secondary relevance to VEC; white = low or no relevance to VEC

Some patterns emerged after examining the relevant laws, regulations, and programs together with the VECs. Of the laws, regulations, and programs examined for the CEA, over half have primary or secondary relevancy to riparian resources, the largest amount of any of the VECs. Nearly half have relevancy for fish and mussels, with many of the laws regulations, and programs that are of primary importance to fish also having primary importance to mussels. Some of these same laws, regulations, and programs have primary importance to water quality and sediment quality, too. Water quality, fish, mussels, and sediment quality form a cluster with common laws, regulations, and programs affecting these VECs in similar fashion. Some clusters are also formed around the other VECs, but not in the same magnitude. Although of equal importance, this is likely because of the differences between laws, regulations, and programs that address protection of natural resources rather than human communities.

14.3.2 Relevant Future Actions Affecting VECs

The Reasonably Foreseeable Future Actions (RFFAs) expected in the project area are the second element common to all VECs. Table 14-3 shows the RFFAs and the potential cumulative effects of all actions, positive, negative, or mixed. In general, the actions are expected over all time periods within the planning horizon, but some will be completed within 25 years. Their locations on the river are relatively dispersed with some occurring at specific locations, but many occurring over the entire length.

TABLE 14-3
Cumulative Effect of RFFAs

RFFA	Occurrence Probability	Water Quality	Fish	Mussels	Riparian Resources	Recreation	Transportation and Traffic	Air Quality	Health and safety	Socioeconomics	Cultural Resources	Sediment Quality
USACE Actions												
Navigation Investments												
Replacement locks at Emsworth, Dashields, and Montgomery Dams (EDM)	H	+/-	+/-	+/-	+/-	+	+	+/-	+/-	+/-	+/-	+/-
Rehabilitation of EDM dams	H	-	-	+/-	+/-	+	+	+/-	+/-	+/-	+/-	+/-
Navigation aids - lock & dam signage	H	-	+	+	0	+	+	0	+	0	0	+/-
Non-structural navigation improvements	H	-	+	+/-	+/-	+	+/-	0	+	+	0	+/-
L&D operation and maintenance	H	-	-	+/-	+/-	+	+	+/-	+/-	+	+/-	+/-
Approach & channel dredging/disposal	H	-	-	+/-	-	+/-	+/-	-	+/-	+/-	-	-
Environmental design												
environmental sustainability operation actions	H	+	+	+	+	+	+/-	+	+	0	0	+/-
Pool maintenance	H	-	-	+/-	+/-	+	+	-	+/-	+	-	+/-
Sec 107 port development and maintenance dredging	L	-	+/-	-	-	+	+/-	-	+/-	+/-	-	-
Ecosystem Restoration												
Fish passage at EDM	H	+/-	+/-	+	+/-	+	-	0	0	0	+/-	+/-
Actions by Others												
Navigation System Dependent - "But For"												
Commercial navigation												

RFFA	Occurrence Probability	Water Quality	Fish	Mussels	Riparian Resources	Recreation	Transportation and Traffic	Air Quality	Health and safety	Socioeconomics	Cultural Resources	Sediment Quality
barge queuing	M	+/-	-	-	-	-	-	-	+/-	-	0	+/-
fleeting areas/barge storage	M	+/-	-	-	-	-	+	-	+/-	-	0	+/-
terminals & multi-modal sites	L	-	-	+/-	-	-	+	-	+/-	+/-	+/-	-
barge/tow tech/"green" design	M	+/-	+	+	+	+	+/-	+	+	0	0	+/-
accidents/spills	M	-	-	-	-	-	-	0	-	-	-	-
Coast Guard navigation aids - const., O&M	H	+	+	+	+	+	+	0	+	0	0	+/-
Energy												
hydropower on dams	M	-	-	+/-	-	-	+/-	+	+	+/-	+/-	+/-
continued operation of coal-fired power plants	M	-	-	-	-	-	+	-	-	+/-	+/-	-
Water-based recreation												
marina development & operation	M	-	-	-	-	+	-	-	+/-	+/-	-	-
commercial boating	H	-	-	-	+/-	+	+	-	-	+/-	0	-
personal boating	H	-	-	+/-	+/-	+	-	+/-	+/-	+/-	0	+/-
River Dependent												
Water supply / discharge												
municipal	M	-	-	-	-	-	-	0	+/-	+/-	-	-
industrial	M	-	-	-	-	-	-	0	-	+/-	-	-
Waste water treatment discharges (WWTP)												
onsite systems	H	-	-	-	-	-	-	0	+/-	+/-	-	-
stormwater discharges; CSOs; SSOs	H	-	-	-	-	-	-	0	+/-	+/-	+/-	-
Resource extraction												
instream sand and gravel mining	H	-	-	-	-	-	+/-	0	-	+/-	-	-
Acid mine discharge (AMD)	M	-	-	-	-	-	-	0	-	+/-	0	-
Marcellus shale gas extraction (water impacts)	H	-	-	-	-	-	-	0	+/-	+/-	0	-
Riverfront/Floodplain Development												
Downtown Pittsburgh												
Ongoing Point State Park improvements	H	+/-	+	+/-	+/-	+	-	+/-	+/-	0	+/-	+/-
Convention Center riverfront park	H	+/-	+	+/-	+/-	+	-	+/-	+/-	+	+/-	+/-

RFFA	Occurrence Probability	Water Quality	Fish	Mussels	Riparian Resources	Recreation	Transportation and Traffic	Air Quality	Health and safety	Socioeconomics	Cultural Resources	Sediment Quality
residential development/conversions	H	+/-	+	+/-	+/-	+	-	-	+/-	+	0	+/-
North Shore development	H	+/-	+	+/-	+/-	+/-	-	+/-	+/-	+/-	+/-	+/-
Pittsburgh South Side												
continued riverfront development	H	+/-	+	+/-	+/-	+	-	+/-	+/-	+/-	+/-	+/-
continued South Side Works development	H	+/-	+	+/-	+/-	-	-	+/-	+/-	+/-	+/-	+/-
Riverfront trails												
Pittsburgh riverfront trail system	H	+/-	+	+/-	+/-	+	-	+	+/-	+	+/-	+/-
Beaver County trail system	M	+/-	+	+/-	+/-	+	-	+	+/-	+	+/-	+/-
Brownfields redevelopment												
Neville Island	H	+	+	+	+/-	+/-	+/-	+	+/-	+/-	+/-	+
PL&E, McKees Rocks	M	+	+	+	+/-	+/-	+/-	+	+/-	+/-	+/-	+
M&B Development	M	+	+	+	+/-	+/-	+/-	+	+/-	+/-	+/-	+
Fab Tech & Buckeye Pipeline	M	+	+	+	+/-	+/-	+/-	+	+/-	+/-	+/-	+
J&L site in Aliquippa	M	+	+	+	+/-	+/-	+/-	+	+/-	+/-	+/-	+
Leetsdale Industrial Park	H	+	+	+	+/-	+/-	+/-	+	+/-	+/-	+/-	+
Resource Protection/Restoration												
Ohio River Islands Wildlife Refuge System	H	+	+	+	+	+	-	0	+/-	0	+/-	+
Nationwide Rivers Inventory	M	+	+	+/-	+	+	-	0	+/-	0	0	+
Ecosystem restoration	M	+	+	+	+	+	-	0	+/-	0	+/-	+
Cultural resources	M	+/-	+	+/-	+/-	+	-	0	0	0	+	+/-
Bridges and Roadways												
Bridge renovations												
Ambridge/Aliquippa Bridge	H	+/-	+/-	-	+/-	+/-	-	+/-	+/-	+/-	+/-	-
Shippingport Bridge	H	+/-	+/-	-	+/-	+/-	-	+/-	+/-	+/-	+/-	-
Rochester Bridge	H	+/-	+/-	-	+/-	+/-	-	+/-	+/-	+/-	+/-	-
McKees Rocks Bridge	H	+/-	+/-	-	+/-	+/-	-	+/-	+/-	+/-	+/-	-
Birmingham Bridge	H	+/-	+/-	-	+/-	+/-	-	+/-	+/-	+/-	+/-	-
Rankin Bridge	H	+/-	+/-	-	+/-	+/-	-	+/-	+/-	+/-	+/-	-
New crossings												
Maglev	L	-	-	-	-	+/-	-	-	+/-	+/-	+/-	-

RFFA	Occurrence Probability	Water Quality	Fish	Mussels	Riparian Resources	Recreation	Transportation and Traffic	Air Quality	Health and safety	Socioeconomics	Cultural Resources	Sediment Quality
North Shore connector	H	-	0	-	-	+/-	-	-	+/-	+/-	+/-	-
Roadways												
Mon/Fayette Expressway	L	-	0	-	-	+/-	-	-	+/-	+/-	+/-	0
SR 28 widening/ railroad relocation	H	-	-	-	-	+/-	-	-	+/-	+/-	+/-	0
CSX double stack upgrades (National Gateway)	M	-	-	-	-	+/-	-	+	+/-	+/-	+/-	0
Natural Events												
floods	M	-	+/-	-	+	-	-	0	+/-	-	-	+/-
droughts	L	-	-	+	+	-	-	0	+/-	-	0	+/-
invasive species	H	+/-	-	-	-	-	-	0	0	0	0	+/-
Regulatory Environment												
Phase I & 2 NPDES program	H	+	+	+	+	+	+	+	+	+	0	+
TMDLs	H	+	+	+	+	+	-	+	+	+	0	+
ALCOSAN & other consent decrees	H	+	+	+	+	+	+	+	+	+	0	+
Adaptive management in Sand & Gravel EIS	H	+	+	+	+	+	+/-	+	+	0	+/-	+
Pollution prevention	H	+	+	+	+	+	+/-	+	+	+	+	+
USACE permitting programs	H	+	+	+	+	+	-	+	+	+	+/-	+
Boating safety regulations	H	+	+	+/-	+	+	+	0	+	0	0	+
Monitoring programs - PA/ORSANCO	H	+	+	+	+	+	-	+	+	0	0	+
Environmental awareness education	H	+	+	+/-	+	+	-	+	+	0	0	+
Clean Air Act standards	H	+	+	+	+	+	-	+	+	+	0	+
Clean Water Act standards	H	+	+	+	+	+	-	+	+	+	0	+
Endangered Species Act (ESA)	H	+	+	+	+	+	-	0	+	0	0	+
Environmental sustainability practices	H	+	+	+	+	+	-	+	+	+	+/-	+

Occurrence probability: H = high, M = medium, L = low.
Impacts: + = positive. - = negative, +/- = mixed effects, 0 = none.

As noted earlier, the RFFAs fell into two general categories: USACE actions and actions by others. USACE actions were further divided into two subcategories: navigation investments and ecosystem restoration. The actions by others were divided into seven

subcategories, navigation system dependent – "but for," river dependent, riverfront/flood plain development, resource protection/restoration, bridges and roadways, natural events, and regulatory environment.

14.3.2.1 USACE Actions

Navigation Investments

Navigation investments have a high probability of occurring. The impact of these navigation investments will be generally positive. Overall, impacts to recreation resources, transportation and traffic, health and safety, and socioeconomics will be positive. In some situations, temporary impacts to these four VECs will have a mixed effect. Impacts to fish, mussels, riparian resources, cultural resources, and sediment quality will be mixed.

Certain navigation investments have the potential for having a negative impact on water quality and air quality, however. Approach and channel dredging/disposal and port development and maintenance dredging could result in negative impacts on water quality since these types of activities could potentially cause legacy pollutants found in the sediment to be released into the water column. Additionally, these same actions could lead to increased turbidity.

Air quality impacts would result from the construction of new locks and dams. They would be temporary, however, and air quality conditions should return to existing levels following construction. The long-term result would improve traffic flow through the Upper Ohio River Navigation System by allowing larger vessels and barge tows than are now possible to pass through at one time.

Ecosystem Restoration

Ecosystem restoration by the USACE has a high probability of occurring. The long term effect of these projects would be positive, in keeping with their intent. Fish passage strategies to improve connectivity from one pool to the next will be critically important for both fish and mussel sustainability, although it is recognized that undesirable invasive species may also use these passages. Temporary impacts during construction of these projects would potentially occur to natural and cultural resources, but these would be minimized by design and offset by long term benefits. Ecosystem restoration projects will have no impact on air quality, health and safety, and socioeconomics.

14.3.2.2 Actions by Others

Navigation System Dependent – "But For"

These actions would not occur "but for" the presence of the navigation system. The probability of navigation system dependent actions by others occurring will range from low to high. Most of these actions will have negative impacts, primarily because they will conflict with other uses of the river, potentially discharge pollutants into the water, or create

health and safety risks. Although mitigation, design, improved operation practices, and regulatory monitoring may avoid or minimize the potential for negative impacts, the likelihood of negative impacts is still present.

Not all navigation system dependent actions will result in negative impacts, however. Navigation aids and green design would result in improved conditions and positive impacts on most resources. Additionally, some actions will have mixed impacts on all resources, rather than only negative impacts.

River Dependent

River dependent actions will have a medium to high probability of occurring. Because they generally result in discharges to the river, they would have negative impacts. Some positive impacts are expected on health and safety and socioeconomics.

Riverfront/Floodplain Development

Riverfront and floodplain development will generally have a high probability of occurring. Potential impacts will be mixed, though generally considered positive. Trails and parks along the river will provide recreational opportunities and increase environmental awareness. Redevelopment of brownfields would clean existing sites and result in the removal or isolation of potentially contaminated soils from flowing into the river.

Resource Protection/Restoration

Future resource protection or restoration projects have a medium to high probability of occurring. When they do occur, they will generally have a positive effect by protecting resources and helping to strengthen them.

Bridges and Roadways

Bridge and roadway projects potentially impacting the Ohio River have a high probability of occurring. Rehabilitation or construction of bridges and roadways will have mixed effects. While the end result of these actions will have a minimal effect on the environment, temporary negative impacts may occur during construction. Negative impacts would include impacts to existing aquatic habitat and disruption of the riparian corridor. Positive impacts would be improvement to the regional transportation system. Bridge piers would also provide limited shallow water habitat and velocity shelters in the river.

Natural Events

Natural events have a high probability of occurring at infrequent intervals. Natural events occur independently of direct human intervention. The natural environment evolved with periodic floods, droughts, and species succession, however, human intervention has compromised those natural functions. An example of human manipulation of the natural environment is the raising of the floodplains for development. Without a human

environment, the consequences of natural events are generally neutral, with neither positive or negative impacts occurring. When natural events transect human communities, however, there will usually be impacts. Those impacts are more than likely to be negative.

Regulatory Environment

Regulations currently in place will remain in effect for the foreseeable future and, thus, have a high probability of occurring. If existing laws or programs are revised, program requirements are expected to be strengthened. If new laws or programs are put into effect, they are expected to address unforeseen future conditions.

The regulatory environment will continue to have an important impact on resources. For the most part, the impact will be positive, but a few regulations that help to strengthen specific resources sometime have negative consequences on other resources. Also, some regulations, by design, have no effect on some of the resources.

14.3.3 Indicators of Environmental Sustainability

The third element common to each VEC was a specific set of indicators to help determine environmental sustainability. Although different indicators were used for each VEC, they all provided benchmarks for measuring the potential cumulative effects on a given resource. Table 14-4 lists the indicators for all of the VECs.

TABLE 14-4
Indicators of Sustainability

VEC	Potential Indicators of Sustainability
Water Quality	• measures of key water quality parameters, including dissolved oxygen, pH, fecal coliform, turbidity, total suspended solids, and nutrients • level of conformance with state and federal water quality standards, including attainment of permissible use designations • TMDL (total maximum daily load) determination and implementation • effectiveness of specific point source control and nonpoint source control programs • ability to sustain diverse, healthy populations of aquatic organisms • effectiveness of spill response, monitoring programs, and related precautionary measures

VEC	Potential Indicators of Sustainability
Fish	• composition of fish communities, including numbers of intolerant and nonnative species, abundance, and diversity • amount of habitat with stable substrates, adequate depths, suitable currents, and sufficient food supplies • reproductive viability as measured by amount of spawning habitat, genetic connectivity, and numbers of gravid females, and larval individuals • percent of population with abnormalities such as parasites, tumors, ulcers, and fin erosion • water quality measurements such as levels of dissolved oxygen (DO), and pH • level of disturbance from biotic stressors, such as invasive species and from abiotic stressors, such as river traffic
Mussels	• amount of habitat with stable substrates, suitable depths, and currents and connectivity to other mussel populations • measures of water quality parameters important to mussel populations • extent of food supplies to help ensure good growth rates and reproduction • availability of fish hosts to ensure reproductive success and maintain species diversity • extent of disturbance from biotic stressors, such as nonnative mussels and from abiotic stressors, such as river traffic
Riparian Resources	• adequacy of hydrologic connections between riparian areas and adjacent water bodies and uplands • maintenance of normal navigation pool elevations • capacity for water storage in the floodplain • capacity of riparian areas to intercept pollution • integrity of riparian habitats • measures of biodiversity
Recreation	• opportunity • accessibility • experience
Transportation and Traffic	• barge tonnage passing through each lock over time • numbers of terminals and intermodal transfer facilities over time • average queuing times for barge traffic • fuel usage
Air Quality	• national air quality standards under authority of the Clean Air Act (CAA) • primary standards set limits to protect public health, including the health of sensitive populations such as asthmatics, children, and the elderly • secondary standards set limits to protect public welfare, including protection against decreased visibility, damage to animals, crops, vegetation, and buildings
Health and Safety	• spills of oil, fuel, and other hazardous or toxic materials • potential sources of contamination associated with past or present activities (industrial sites, landfills, underground storage tanks) • accidents associated with commercial or recreational boating • health impacts of water quality (boating, swimming, fish consumption)

VEC	Potential Indicators of Sustainability
Socio-economics	• income • educational attainment • mortality rates, life expectancy • labor force participation • environmental justice issues
Cultural Resources	• eligibility for listing in the National Register of Historic Places • identification, recordation, and/or preservation representative of the full temporal range of pre-contact and historic periods • identification, recordation, and/or preservation representative of the wide range of humans and their behaviors
Sediment Quality	• substrate compositions • water quality conditions • legacy pollutants • effectiveness of point source and nonpoint source control programs • ability to sustain diverse, healthy populations of aquatic organisms • effectiveness of spill response, monitoring programs, and other precautionary measures

Some indicators are indicative of the strength, health, and environmental sustainability of similar resources. Indicators frequently overlapped because of the interdependence of these resources with one another.

14.4 INTERACTIONS AMONG VECS

In addition to analyzing past and present conditions together with future trends, the CEA also examined interactions among VECs. Potential interactions were identified as being strong or low to nonexistent. The interactions are shown in Table 14-5. The existence of an interaction between two VECs was based on information presented in the individual VEC analyses supplemented by information found in ORMSS.

TABLE 14-5
Interactions among VECS

VEC	Water Quality	Fish	Mussels	Riparian Resources	Recreation	Transportation and Traffic	Air Quality	Health and Safety	Socioeconomics
Sediment Quality	■	■	■	■	■			■	■
Cultural Resources				■	■	■	■		■
Socioeconomics	■	■	■	■	■	■	■	■	
Health and Safety	■	■			■	■	■		
Air Quality				■	■	■			

VEC	Water Quality	Fish	Mussels	Riparian Resources	Recreation	Transportation and Traffic	Air Quality	Health and Safety	Socioeconomics
Transportation and Traffic									
Recreation									
Riparian Resources									
Mussels									
Fish									

There are strong interactions between most of the VECs, even when they are not initially apparent. Assessment of these interactions assists in identifying the important cause-and-effect relationships between human activities and resources, ecosystems, and human communities. The relationships between and among some VECs are easier to visualize than others. Water quality, fish, riparian resources, and sediment quality are so closely linked that it is difficult to think about one without thinking about the others as part of a complete ecosystem. So too with health and safety, transportation and traffic, air quality and socioeconomics. Impacts to any of these VECS often have consequences to the others regardless of whether they are positive or negative.

Some relationships are not as apparent, however. For example, poor air quality can affect historic structures, causing a deterioration of resources. Another example concerns sediment quality. Legacy pollutants can impact the value of sand and gravel or create the need for special disposal techniques during construction projects.

14.5 ANALYSIS OF ENVIRONMENTAL SUSTAINABILITY

Environmental sustainability balances environmental and economic considerations through the life cycle of project planning, design, construction, operation, and maintenance to improve the quality of life for present and future generations. Accordingly, it represents an ultimate test of significance of potential cumulative effects. Three definitions of environmental sustainability were used for the CEA:

- Not sustainable – conditions for the selected indicators do not reflect conditions that would facilitate attainment of acceptable standards or would not maintain existing standards in concert with collective impacts of proposed activities.

- Marginally sustainable – conditions for selected indicators are such that attainment is accomplished for the majority, but not all, of the potentially affected populations or area. The conditions are somewhat tenuous, however, in location and likelihood of occurrences. (In other words, the conditions are borderline for

environmental sustainability, and there are uncertainties regarding specific quantitative measures.)

- Sustainable – conditions for selected indicators are such that attainment of acceptable conditions are accomplished for essentially all of the potentially affected populations or area, and such standards are maintained in concert with foreseeable future activities. Further, conditions exceed regulatory thresholds, and various governmental programs are in place to respond to any potential erosion of values related to the specific VEC under examination.

Table 14-6 summarizes the findings on environmental sustainability for each VEC. The findings are based on a thorough analysis of past and present conditions as well as an examination of future trends, plans, and the regulatory climate. These findings form the basis for conclusions related to environmental sustainability.

TABLE 14-6
Findings on Environmental Sustainability

Valued Environmental Component (VEC)	Time Period		
	Past	**Present**	**Future**
Water Quality	Not Sustainable	Marginally Sustainable	Sustainable
Fish	Not Sustainable	Sustainable	Sustainable
Mussels	Not Sustainable	Marginally Sustainable	Marginally Sustainable
Riparian Resources	Not Sustainable	Not Sustainable	Not Sustainable
Recreation	Not Sustainable	Sustainable	Sustainable
Transportation and Traffic	Sustainable	Marginally Sustainable	Sustainable
Air Quality	Not Sustainable	Sustainable	Sustainable
Health and Safety	Not Sustainable	Marginally Sustainable	Sustainable
Socioeconomics	Sustainable	Marginally Sustainable	Marginally Sustainable
Cultural Resources	Not Sustainable	Sustainable	Sustainable
Sediment Quality	Not Sustainable	Marginally Sustainable	Sustainable

14.5.1 Water Quality

Until about 1970, the water quality of the upper Ohio River was in a degraded state characterized by low dissolved oxygen concentrations, low pH levels, high bacterial contamination, high nitrogen concentrations, and remobilization of potentially toxic chemicals associated with river sediments. Few pollution reduction, control programs, or regulatory programs were in place during this period and depauparate aquatic populations were observed.

Over the past 30-40 years, programs managed by the Ohio River Valley Water Sanitation Commission (ORSANCO) and enactment of the Clean Water Act have resulted in steady improvements in water quality. Significant water quality improvements have occurred, including DO concentrations typically above the 5.0 mg/L standard, pH levels between the 6.0 to 9.0 standard, and nitrogen concentrations that meet current water quality criteria. Although bacterial contamination associated with nonpoint source pollution, contaminated sediments, and fish consumption advisories remain problematic, water quality improvements have become the norm, not the exception.

Positive forces affecting water quality are existing environmental regulations, a shrinking population, and increasing public awareness of the importance of water quality. Negative forces affecting water quality are wastewater discharges to the river, combined sewer overflows/sanitary sewer overflows (CSOs/SSOs), existing and potential discharges of acid mine drainage, dredging operations, and the development within the remaining riparian areas.

In the past, the sustainability of water quality could be characterized as not sustainable due to the prevalence of untreated and uncontrolled point and nonpoint pollutant discharges. In the present, environmental sustainability is marginally sustainable due to continuing bacterial contamination and chemical remobilization from legacy-contaminated sediments. In the future, existing environmental regulations and water quality standards should allow water quality to reach a sustainable condition.

14.5.2 Fish

In the time period from settlement and continuing to the mid-20th century, degraded conditions of water quality and modification of existing flow regimes through construction of the modern lock and dam system resulted in severe impacts on fish in the upper Ohio River. From the mid-20th century to the late 20th century, water quality conditions began to improve. Awareness of the Ohio River's ecological importance, led to the development of ORSANCO in 1948. The Clean Water Act of 1972, the Endangered Species Act of 1973, and other programs and regulations served as catalysts for improved water quality and allowed fish to redistribute to the river from their upstream refuges. This allowed fish communities to return to earlier and healthier conditions.

Improving water quality is the most important positive force affecting fish. Other positive forces affecting fish include less stress on the river as a result of the decreased number of people living in the area, increasing public awareness of the importance of fish populations to healthy aquatic systems, and a regulatory environment that provides both direct and indirect protections to fish. A smaller human population leads to less domestic waste and less pressure to develop the riparian and wetland habitats that act as filters for water flowing into the river. Increased public awareness together with a supportive regulatory environment enables more people to appreciate the value of the river, which in turn leads to further environmental improvements. Negative forces, however, can affect fish, too. Wastewater discharging to the river, CSOs/SSOs, existing and potential discharges of acid mine drainage, dredging operations, invasive species, and the development of riparian

resources are problems that continue to plague the health and continued stability of fish populations or could present problems in the future.

Consequently, past conditions and a lack of awareness on the importance of fish populations contributed to a not sustainable condition. Subsequent to the creation of ORSANCO and enactment of the Clean Water Act, water quality standards led to improved conditions of the river. Thus, the current status of fish is considered sustainable. In the future, the growing awareness of current and potential threats to fish and improvements to longitudinal connectivity will help fish in the upper Ohio River maintain a sustainable condition.

14.5.3 Mussels

Because they play an important role in the breakdown and compartmentalization of organic matter, mussels are a crucial part of the river's natural filter system. Historically, nearly 80 species of freshwater mussels populated the entire mainstem of the Ohio River. Unfortunately, the industrialization and urbanization of the upper Ohio River during the 19th and 20th centuries severely impacted mussel populations. A recent survey of the Emsworth, Dashields, Montgomery, and New Cumberland pools identified eight species of native mussels within this area (110 live mussels representing six species and two freshly dead species were collected during the investigation).

Positive forces affecting mussels of the upper Ohio River include improved water quality standards; increasing public awareness of the importance of mussel populations to healthy, functioning aquatic systems; and the existing regulatory environment that provides both direct and indirect protections to freshwater mussels. Negative forces continue to affect mussels, however, including wastewater discharges to the river, discharges of acid mine drainage, invasive species, and human manipulation of habitat through maintenance of navigation pools, prop scour and dredging.

Thus, in the time period from settlement to the mid-20th century, mussel populations were not sustainable due to the degraded conditions of water quality and modification of existing flow regimes through construction of the modern lock and dam system. The lack of awareness on the importance that mussel populations have on a healthy river ecosystem and limited knowledge on mussel life cycles contributed to this condition. But as water quality improved as a result of new regulations, and environmental awareness has increased, a re-colonization of freshwater mussels has occurred, suggesting that the current status of mussels is marginally sustainable. In the future, continued improvements to water quality and the growing awareness of the importance of freshwater mussels to the river's ecosystem should see conditions for mussels improve. Nonetheless, mussels are likely to remain marginally sustainable.

14.5.4 Riparian Resources

Human activities have resulted in loss of much of the historic woodlands and native vegetation along the upper Ohio River. Woodlands have been dissected by roads, perforated

by house lots, and fragmented through development patterns. Such processes have changed the appearance of woodlands and affected the ecological functionality of riparian resources.

In the past, fill has been used to elevate the historic floodplain to create development areas that would not be subjected to periodic inundation. The consequence of these past practices has been to minimize the functionality of the area's floodplains. Construction of dams on the Ohio River and the subsequent establishment of navigation pools also inundated many former riparian areas. In some cases, the riparian corridor was able to reestablish itself but not always. Riparian growth was often removed to accommodate development or compromised with non-native species that out-competed the native plants. Despite increased public awareness, riparian resources could continue to erode without direct intervention. Of all the resources examined during this cumulative effects assessment, riparian resources are in the most danger. They will also be the hardest to restore.

From about 1920 to 1950, riparian resources were not sustainable due to floodplain development and the loss of riparian vegetation, the lack of knowledge on the importance of riparian resources to ecosystems, and the absence of any institutional programs to manage or control riparian areas. From 1950 to 2000, unsustainable conditions continued as more riparian areas were lost. Although awareness of the importance of riparian areas has grown and the rate of loss has slowed, riparian resources are unlikely to rebound due to the presence of non-native, invasive species. Even though there are several programs designed to identify and address impacts being caused by invasive species, it is uncertain if the funding will ever be appropriated to address a problem as large as this. Until that happens, riparian resources will remain as not sustainable well into the future.

14.5.5 Recreation

The upper Ohio River is a popular setting for recreation. Interest in the river has produced marinas and landings, trails and parks, special event venues, and entertainment facilities. Events that draw large crowds and activities attract much attention, but solitude and quiet relaxation are some of the most important values associated with river recreation. Opportunities for recreational activities on and along the river have grown steadily since the early 1970s.

Water quality, accessibility, maintenance of recreation facilities, and an expanding selection of recreation choices are the primary factors affecting current trends in recreational activity. While there appear to be no significant impediments to recreation on the upper Ohio River, a shift to different types of recreation seems to be occurring. River oriented recreation in the past was always water based, however, boat registrations and recreational lockages have decreased over the past several years. Public agencies and private organizations are shifting the recreation orientation to the shoreline by actively developing new riverfront parks, greenways, trails, and mixed-use riverfront projects. Hiking along the riverfront, kayaking, and canoeing are growing. With the creation of new hiking trails throughout the region, and an effort to link those trails together, accessibility to river-related recreation has improved tremendously.

Within the project area there are many dramatic natural and urban viewscapes that are positive forces affecting recreation. New trails and parks, together with non-motorized boating, raise environmental awareness which in turn contributes to healthy river corridor habitats. Additionally, rehabilitation of the area's existing bridges and roadways are a positive force affecting the health of recreation resources. By providing a better and safer transportation system throughout the region, accessibility and opportunity for recreational activities are increased.

As the quality of the natural environment continues to improve and additional trails and water-related recreation facilities are constructed, there would appear to be few forces negatively affecting recreation. Conflicts could arise, however, as the current trend from motorized recreation on the river shifts to kayaking, canoeing, and additional shoreline trails. Some elements of redevelopment can also negatively affect recreation. Although there are benefits from using brownfields sites as new commercial or light industry centers, additional development can further cut off access to the river, however, ordinances in place in Pittsburgh guarantee riverfront pedestrian access along the three rivers. Finally, as the population of the area continues to decrease and the average age of the population increases, some recreation pursuits may see a decline. Improvements currently being planned could end up being underutilized if these demographic trends continue or if different types of recreation become popular in future populations.

Prior to 1905 and continuing to about 1970, recreation on the river occurred in a degraded environment due to untreated and uncontrolled pollution discharges. Recreational activities on or near the river did not occur due to both the lack of access to the river and the negative experience. Recreation under these conditions was not sustainable. Currently, improvements to both the opportunity and the experience have raised recreation in the project area to a sustainable level.

The future is likely to remain sustainable. Community planning and development of recreation facilities will continue to expand. Water quality improvements, habitat protection, and restoration efforts will continue to enhance recreation experiences. Although socioeconomic projections show a decreasing population and boat registrations and lockages have declined, an improved standard of living is expected to result in high demand for recreational opportunities.

14.5.6 Transportation and Traffic

With the development of railroads in the mid-19th century and their year-round utility, commercial river traffic declined at a slow but steady pace. Nonetheless, the latter decades of the 19th century and early decades of the 20th century included a period of heavy industrial development along the middle and upper Ohio River that centered on the iron and steel industry in Pittsburgh. Commerce on the river grew steadily through the 1930s and 1940s while development of diesel towboats and larger barges created opportunities for larger scale, more efficient movement of commodities. Since the 1970s, coal has accounted for over 50 percent of the tonnage of commodities shipped on the Ohio River. Coal transport historically has been most prevalent on the upper portion of the Ohio River reaching present levels of

74 percent of the tonnage moved through EDM. The primary markets for coal shipments are domestic electric utility plants. Coal traffic also moves to coal blending facilities, industrial facilities, and coking facilities.

Inland water transportation is both the safest and most cost efficient of all freight modes. Barge transportation is the also the most energy efficient mode for carrying large quantities of bulk commodities, expending one-fourth the energy per ton-mile as rail. Barge transportation results in the lowest air emissions on a ton-mile basis and experiences the least number of accidental spills of all surface transportation modes. The nature of the inland water transportation system, however, limits the type of commodities that may be shipped by barge. Barge traffic, although reliable, is slow, and commodities are limited to those that are not time-sensitive or may be stockpiled. Commodities are also limited to those that may be shipped in bulk, such as coal, gravel, and scrap metal. Destinations of commodities transported by barge are limited to industrial sites or multi-modal transfer sites immediately adjacent to the river. Therefore, the region possesses a mix of water, rail and land-based transportation modes to accommodate cost effective movement of all commodities. Since rail and roads are more ubiquitous, it is the navigation system that makes the transportation within the project area more robust.

The decline of the steel industry in the Pittsburgh region negatively affected barge traffic on the upper Ohio River. The reduction in cost of foreign steel has contributed to the decline of the steel industry and to the resulting decline in steel on the river. Also, the reduced use of coal as an energy source in the manufacturing of steel reduced the demand to transport coal on the river for a period of time.

Prior to 1920, and continuing to about 1950, the transportation network and traffic system within the project area was fully sustainable with very reliable navigation structures, mainline and regional rail system and a good national and local road network. In the time period from 1950 to 2008, due to reliability issues, the condition became marginally sustainable. It is anticipated that improvements with the locks and dams will remove all barriers to achieving full sustainability in the future.

14.5.7 Air Quality

Pittsburgh was known as the “Smoky City” in the 1800s and persisted in that designation through the Pittsburgh Renaissance of the 1950s. Heavy coal burning for industry, railroad engines, residential, and commercial heating combined with local topographical and climatic factors that often produced temperature inversions trapping the smoke pollution in the area. Between 1940 and 1960, much of the dense smoke from the area’s atmosphere was eliminated through local pollution control efforts. By the late 1950s, smoke control legislation led to the elimination of the blatant ash and soot pollution that required street lights to be on at high noon. Nonetheless, high levels of nitrogen and sulfur dioxide and micro-dust pollution continued, especially in river valley mill towns.

Extensive highway development from 1945 through 1970 contributed to the growing popularity of the automobile for personal transportation as well as development of an

extensive commercial trucking industry. Leaded gasoline and diesel fuel from these mobile sources added concentrations of pollutants to the air. Localized impacts of smog (ground level ozone), particulate matter, and lead attracted the most attention during the two decades of debate that preceded national air quality regulations in 1970.

Air quality improved again after Pittsburgh's steel industry experienced a shut down in the early 1980s, taking 120,000 manufacturing jobs from the region. Today, many of these former sites are retail and entertainment complexes. The poor air quality of the past has greatly improved with the demise of the steel industry in the area.

The Clean Air Act Amendments of 1990 (CAAA) further contributed to improved air quality. The CAAA was designed to curb three major threats to the nation's environment and to the health of millions of Americans: acid rain, urban air pollution, and toxic air emissions. In general, regional conditions in the area reflect the national pattern for overall improvement in air quality. The passage of the American Clean Energy and Security Act of 2009, calling for a reduction of carbon dioxide and other greenhouse gases by 20 percent from 2005 levels by 2020 and 83 percent by mid-century, would further result in cleaner emissions and cleaner air in the future. Although existing and future regulations will reduce the emissions from existing coal-fired power plants, their continued operation will continue to have a negative effect on air quality. Fuels used in automobile and diesel vehicles are expected to run cleaner and emit fewer emissions, but will remain a major source of air pollution.

In the time period prior to 1920, and continuing to 1970, the air quality was in a degraded state and considered not sustainable, due largely to untreated and uncontrolled point and nonpoint pollutant discharges from coal fired power plants, other types of industries, and vehicular sources. Following enactment of the Clean Air Act in 1970 and its subsequent amendments, the air quality in the region has shown steady improvement and is currently sustainable. In the future, air quality is expected to remain sustainable.

14.5.8 Health and Safety

Industrial activities located on or near the river may pose public risk from pollution point sources; production and disposal of hazardous wastes; and spills of potentially hazardous or polluting materials associated with transfer, storage, and use of the materials. Past industrial activities have contributed to the creation of contaminated sites and landfills that pose ongoing threats to groundwater, surface water, and public health. When raw materials, products, and wastes are transported by barge, rail, or truck, these materials are subject to potential spillage while in transit, especially when they arrive at material transfer points. Recreational boating on the rivers has resulted in a number of injuries, fatalities, and property damage.

While overall water quality has improved to the point where almost all of the local rivers can support recreational activities and consumptive uses most of the time, temporary impacts can still increase risks. Such impacts may include elevated fecal coliform counts following wet weather, or major spills that threaten drinking water supplies. Additionally,

ongoing effects of past contamination are reflected in fish consumption advisories and remediation costs of contaminated sites.

Since the 1970s, regulatory programs have been put in place that have has a positive affect on health and safety. Laws and programs now in place regulate facilities that process, store, and transport hazardous materials and discharge into the rivers; education requirements for employees that handle hazardous wastes; navigational improvements for both commercial and recreational traffic on the rivers; increase in education of recreational and commercial boaters; and an increase in the number and type of national and statewide fish consumption advisories. As the quality of the natural environment continues to improve and regulatory programs that have been put in place continue, there would appear to be few forces negatively affecting health and safety.

Conflicts could arise, however, if the amount of traffic on the rivers increases and more shorelines are developed, the potential for more spills and accidents could increase. Although regulations regarding sewage and other types of discharges into the rivers have been initiated, there is still a problem with untreated sewage discharging into the rivers, especially during rain events where flow levels are higher than the capacity of treatment facilities.

In the time period prior to 1920 and continuing into the 1970s, health and safety issues represented a broad spectrum of risk factors. Construction and workplace conditions were generally more dangerous than at present; spills and discharges from commercial navigation, river-oriented industries, and untreated municipal effluents contributed to a variety of public health risks; and little or no information was available to advise the public of ambient risk levels associated with river-oriented activity. Thus, health and safety was characterized as not sustainable. Improvements to water quality, reduced risks of spills and faster response, improved workplace safety standards, and effective safety standards for recreational boating have all combined to make the river a safer place. Improved conditions have also contributed to reduce risk factors associated with contact recreation and fish consumption. Problems associated with continued exceedances of biological standards, persistence of some contaminants associated with fish consumption, and mixed signals regarding fish consumption standards, however, have resulted in a current condition of marginally sustainable. With respect to the future as safety standards, education, water quality, and relevant regulations are strengthened further, most issues are expected to reach sustainable conditions.

14.5.9 Socioeconomics

Pittsburgh's location at the confluence of the Monongahela, Allegheny and Ohio rivers served it well during its early years, although railroads came to dominate transportation in the area between 1850 and the early 1900s. After construction of the navigation system between 1885 and 1929, however, river commerce regained its importance, especially as water transport of bulk commodities proved more cost-effective than rail. By the mid-1950s, the Ohio River Navigation System had helped to sustain lower costs for the coal, electric utility, and steel industries.

Unfortunately, the area's population and economic base began to decline in the 1960s. In the late 1970s and early 1980s, over 100,000 steel workers lost their jobs. By 2000, Pittsburgh's population had dropped to levels not seen since before the Second World War. Though population decline and the loss of many industrial operations have continued through today, Pittsburgh is transitioning from manufacturing to a service-based economy.

Positive forces affecting socioeconomics include the infrastructure already in place and the impact improved water quality has had on the area. The area is supported by a fully developed economic infrastructure. This infrastructure includes rail, highway, river, and air transportation, modern communication capabilities, and affordable and reliable utilities. While much of the infrastructure is aging, government, local communities, and individuals have recognized the need to replace old and deficient infrastructure. The social system is also well established, with a generally healthy and technically skilled population and the relatively stable population in the area may actually reduce the demand for additional primary infrastructure.

Additionally, improved water quality has contributed to increased redevelopment of riverfront areas, especially as recreational settings. Growing interest in environmental amenities in residential and commercial settings contributes to community-oriented projects that combine floodplain and habitat enhancement, open space, recreational activities, and stormwater management.

As the area experienced growth in population, jobs, and infrastructure through the 1950s, the socioeconomic climate of the area was sustainable. The general socioeconomic projection for the project area for the present and future, however, is marginally sustainable. Although the region offers a reasonably healthy mix of industrial, commercial, financial, education, and health care services, the declining population is expected to continue its decrease in four of the area's five counties over the next several decades. Additionally, with some exceptions, educational attainment in the area (an indicator of economic health) generally lags behind the states of Ohio, Pennsylvania, and West Virginia.

14.5.10 Cultural Resources

Because consideration of the identification, recordation, and preservation of cultural resources is mandated by laws, sustainability of cultural resources directly follows the evolution of historic preservation legislation. The consequences of laws and regulations have improved the consistency of the identification, recordation, and preservation of cultural resources as well as the total numbers and types of cultural resources that are considered. In addition, private and non-profit historic preservation groups, amateur and professional archaeological societies, and museums have been positive forces in the continued sustainability of cultural resources.

Changing economic conditions and political climates, however, could affect cultural resources, especially through the lessening of protections contained in legislation. In addition, when the economy is not robust, less funding is typically available to historic

preservation groups that contribute to the local and regional sustainability of cultural resources.

The sustainability of cultural resources prior to the implementation of the National Historic Preservation ACT (NHPA) in 1966 was not sustainable. There was little public knowledge of, or interest in, preserving our shared cultural past; no regulatory mechanism to promote or fund historic preservation; and no widespread efforts to identify, record, or preserve cultural resources. With the advent of the NHPA and subsequent legislation, public education, and increased funding mechanisms, the sustainability of cultural resources has increased. Currently, cultural resources are sustainable due to the existence of federal, state, and local legislation providing for the consideration, identification, recordation, and preservation of cultural resources, and an increased public awareness about the importance of preserving cultural resources. The legislation regulating historic preservation will likely continue, and, therefore, additional cultural resources will be identified, recorded, and preserved. Thus, full sustainability will continue.

14.5.11 Sediment Quality

Prior to 1948, less than one percent of the communities along the Ohio River serviced by sewers treated their wastewater. In a heavily industrialized river corridor, the lack of wastewater treatment resulted in significant impacts to sediment quality. Severe negative effects on the river were already evident early in the 20th century. Over the past 30-40 years, however, programs managed by ORSANCO, enactment of the Clean Water Act and subsequent pollution control laws, and the closure of many industrial sites along the river have resulted in improvements in water quality, which have, in turn, led to improved sediment quality.

Positive forces affecting sediment quality include improved water quality, the existing regulatory environment, redevelopment projects, and decreased socioeconomic pressures on the river. Pollutant discharges have become more regulated. Consent decrees currently in place will eliminate CSOs and SSOs and remove these polluting systems from the environment. Monitoring programs ensure that organizations with permitted discharges follow the conditions of their permits. The redevelopment of brownfields along the river provides a potential opportunity for the removal or isolation of potential contaminants from accessing river flows. As brownfields sites are cleaned, potential sediment pollutants are either encased or hauled away to appropriate disposal areas. As industrial activities along the river wane, sediment quality will improve.

Still, negative forces continue to affect sediment quality. Continuing wastewater discharges, acid mine drainage, dredging operations, and commercial boating all slow down improvements. The most critical problem, however, may be the presence of legacy pollutants that could remain in the river for years.

Prior to 1920 up to about 1970, the Ohio River was in a degraded state characterized by low DO concentrations, low pH levels, high bacterial contamination, high nitrogen concentrations, and remobilization of potentially toxic chemicals. Although background data

are limited, it is likely that sediment quality was poor and characterized as not sustainable. Aside from the presence of legacy pollutants, it can be assumed that water quality improvements have resulted in improvements to sediment quality. Specific biological indicators suggest that current conditions could be considered marginally sustainable. More stringent regulations regarding discharges to the river are likely to be implemented in the future and techniques to remediate sediment pollution may also be developed. Consequently, sediment quality will move toward a sustainable condition.

14.6 CONCLUSIONS

The CEA for the Upper Ohio Navigation Study assessed the impacts of navigation investments at the Emsworth, Dashields, and Montgomery locks and dams on 11 VECs. Those VECs were water quality, fish, mussels, riparian resources, recreation, transportation and traffic, air quality, health and safety, socioeconomics, cultural resources, and sediment quality. To determine if there would be a cumulative effect from the study alternatives, the CEA assessed the environmental sustainability of each VEC as an ultimate test for determining the significance of cumulative effects.

The study area is generally moving from not sustainable conditions to sustainable. Of the eleven VECs examined in the CEA, nine were not sustainable in the past. Of those, all but two (riparian resources and mussels) are expected to be sustainable in the future. Conditions in the present remain mixed, however, with one VEC experiencing a not sustainable condition (riparian resources), six VECs experiencing marginally sustainable conditions (water quality, mussels, transportation and traffic, health and safety, socioeconomics, and sediment quality), and four VECs experiencing sustainable conditions (fish, recreation, air quality, and cultural resources). In the future, riparian resources are likely to continue in a not sustainable condition, while mussels and socioeconomics may experience marginally sustainable conditions.

Overall, conditions in the area are improving and the health of the VECS is growing stronger. There are many reasons for this, but the principal factors among them are existing laws, regulations, and programs. These factors are having their intended effects; more environmentally sensitive projects and programs are being designed; changing socioeconomic conditions have resulted in less stress on the environment; educational awareness has increased; and society has shown a greater desire for a better environment. On an incremental basis, the cumulative effects of the proposed improvements associated with the Upper Ohio Navigation Study are not significant and will be generally positive.