SECTION 3.0: AFFECTED ENVIRONMENT

3.1 HYDROLOGY

3.1.1 Characterization of the Watershed

The Allegheny River begins in Potter County, northwestern Pennsylvania, flows northward into New York state, then turns southwest and follows a generally southward course until it converges with the Monongahela River at Pittsburgh. The total length of the Allegheny is approximately 321 miles, and the river drains an area of 11,778 square miles. The majority of the Allegheny River watershed (83%) is in Pennsylvania with the remaining area in New York (USACE, 1993). At Pittsburgh, the Ohio River is formed by the confluence of the Allegheny River from the northeast and the Monongahela River from the southeast. From its origin in Pittsburgh, the Ohio River flows 40 miles northwestward and then westward until it reaches Pennsylvania's border with Ohio and West Virginia, and then flows another 941 miles to Cairo, Illinois, where it meets the Mississippi River. The study area in this report includes the lower 69.5 miles of the Allegheny River, ending at Pittsburgh, and the upper 40 miles of the Ohio River, from Pittsburgh to the Pennsylvania state line. Locations along these rivers are designated as River Miles 0 to 69.5 on the Allegheny River, beginning at Pittsburgh and increasing in the upstream direction, and as River Miles 0 to 40 on the Ohio River, beginning at Pittsburgh and increasing in the downstream direction. A series of low-head navigation dams and locks, eight along the lower Allegheny and four along the upper Ohio River, maintains a minimum depth of nine feet in navigation channels in the pools behind these dams (section 3.1.4). Locations of dams and locks, major tributaries, and other watershed features are shown in Figure 3-1.

Due to the river's unspoiled character in its upper reaches, 85 miles of the Allegheny have been protected under the Wild and Scenic Rivers Act of 1968, legislation invoked when a form of Federal assistance, such as issuance of a 404 Permit, is required for a given project. These 85 designated Allegheny River miles are composed of three discontinuous segments. The first begins at Kinzua Dam at the base of Allegheny Reservoir (river mile 198) and runs downstream about 7 miles to the U.S. Route 6 bridge. The second segment runs from Buckaloons Recreation Area at Irvine, PA, downstream approximately 47 miles to the south end of Alcorn Island, at Oil City, PA. The final segment runs from the sewage treatment plant at Franklin, PA (near river mile 125), downstream approximately 31 miles to Emlenton, PA, ending well upstream of the end of Pool 9's maintained navigation channel. None of these segments is within the Allegheny-Ohio River study area.

Elevations in the affected portions of the Allegheny and Ohio River basins range from over 2,900 feet above mean sea level in the Allegheny Mountains in the southeast portion of the drainage basin to less than 675 feet along the banks of the Ohio River where it leaves western Pennsylvania. The northwestern portion of the Allegheny basin is a mature, glaciated plateau with gentle slopes and many lakes and swamps. Remaining areas of the Allegheny River drainage basin are characterized by rough topography, particularly in the eastern tributary

areas, which arise largely in the western part of the Allegheny Plateau. To the southeast, in the Allegheny Mountain section, the drainage is dominated by several large structural folds that tend about 30 degrees east. The southwestern part of the Allegheny River drainage basin lies within a shallow structural feature called the Pittsburgh-Huntington Basin. It has an elongated axis approximately parallel to the trend of regional folding and the course of the lower Allegheny River, about north 30 degrees east. The Allegheny River enters the structurally folded areas of the Pittsburgh-Huntington basin near East Brady, Pennsylvania, at the upstream limit of the 69.5-mile long slackwater navigation system. The river's valley in these lower 69.5 miles is seldom more than 0.5 mile wide and has precipitous sides that rise to 500-600 feet above the valley floor (USACE, 1993). The lower Allegheny has a relatively low gradient (1.58 feet per mile from Lock and Dam 7, mile 45.7, to the Point at Pittsburgh) and is near sea level (710 feet at Pittsburgh, more than 2,000 navigable miles from the Gulf of Mexico). These factors and the general forest cover of the watershed, have worked to keep the Allegheny approximately at grade, eroding and redepositing sand and gravel locally but generally neither scouring out nor filling up its valley (USACE, 1980).

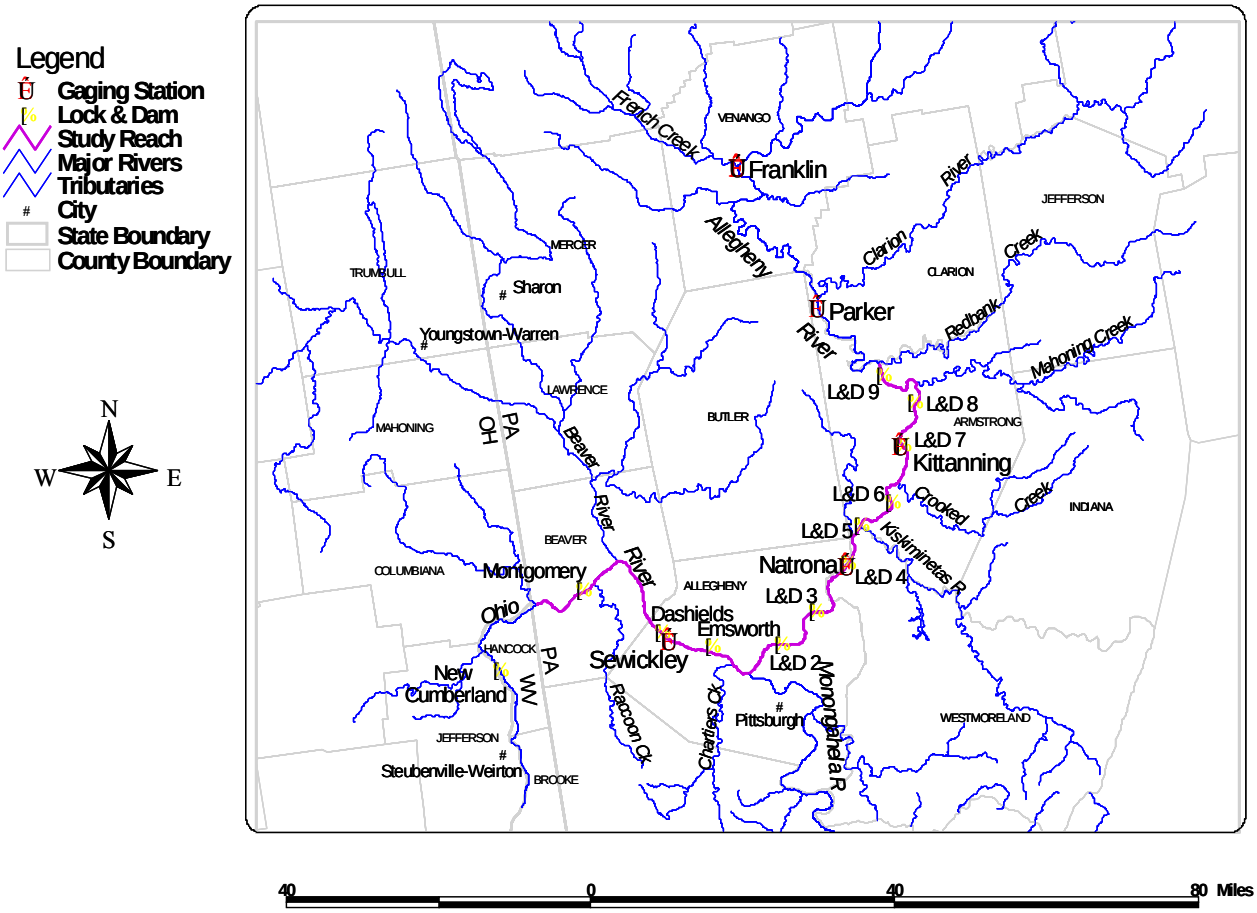


Figure 3-1. Locations of locks and dams, etc.

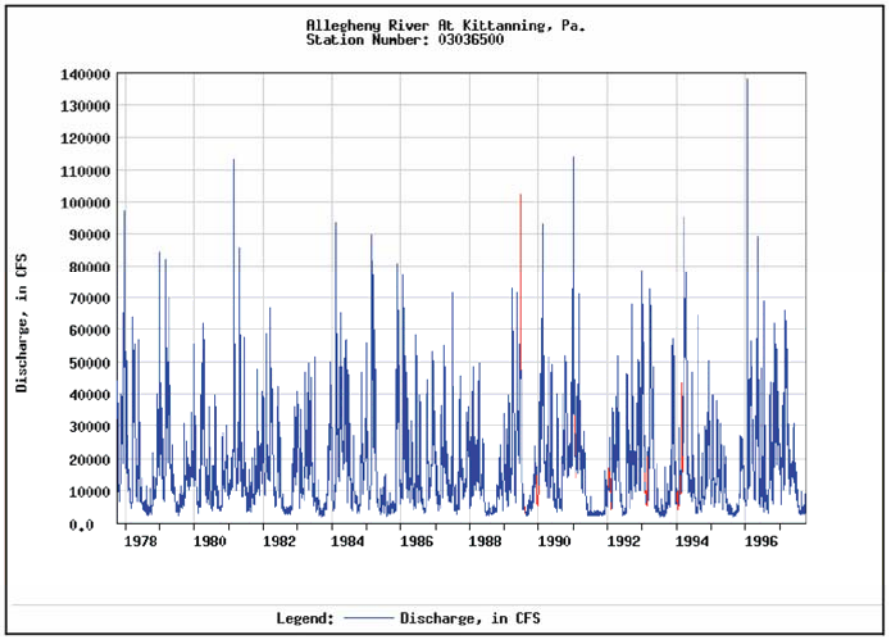
Dredging for commercially valuable substrate has taken place in the Allegheny River since at least the 1920s (USACE, 1980). The river channel material is of commercial value as a result of the region's geologic history. Glaciation of the northern and western portions of the Allegheny River basin produced a high volume of igneometamorphic glacial till and gravel which was concentrated in the river's valley as glaciers receded. According to Gallaher (1973), quoted in USACE (1980), "the Allegheny Valley generally has the coarsest basal alluvium. Its river carried and deposited alluvium composed mostly of sand and gravel obtained from melting, debris-laden glaciers to the north. The original source of this material was from as far away as Canada. In contrast, the sediments deposited at that time by the Monongahela and Youghiogheny Rivers and the Chartiers and Turtle Creeks from the south were mostly clay, silt, and fine sand obtained from rocks exposed in the local drainage systems. The Ohio Valley alluvium is a mixture of that carried by the above streams. It is much coarser than that along the Monongahela River and the smaller tributary streams, but may contain more silt and clay than does the Allegheny Valley alluvium" (USACE, 1980).

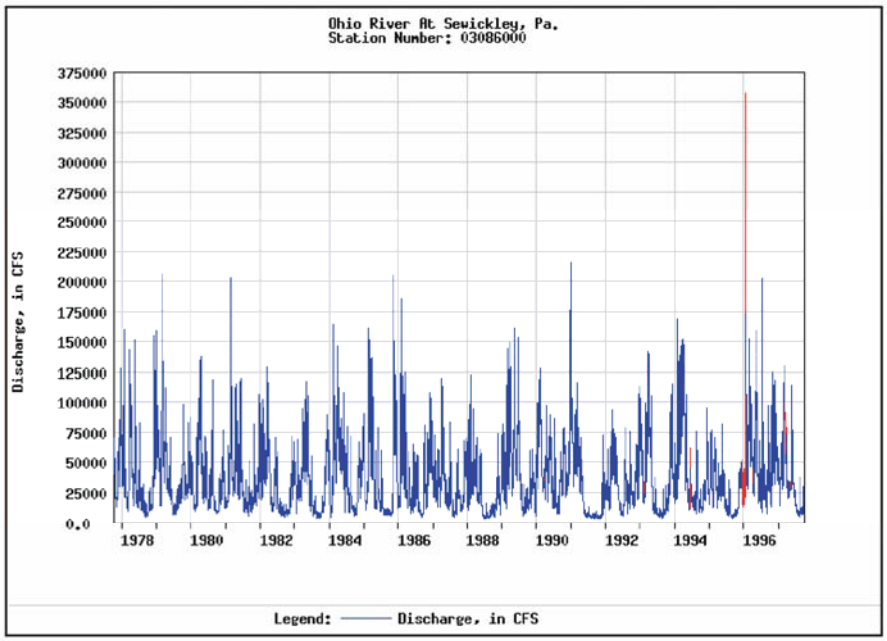
3.1.2 Allegheny River and Ohio River Flow Characteristics

3.1.2.1 Streamflow

Groundwater contribution to stream flow throughout the Allegheny River basin is relatively uniform (USACE, 1993). However, seasonal variations in precipitation and temperature produce highly variable overland runoff, with the result that stream flow in the study area is highly variable. Such discharge variation can be seen in the most recently available 20 years of mean daily discharge data shown graphically in Figure 3-2. At Kittanning (Allegheny mile 45.8, at Lock and Dam 7), the monthly mean flow, averaged over the station's 94-years of flow record, ranges from a low of 5,119 cfs during August to a high of 32,910 cfs during March. These figures represent the average during each respective month of daily mean discharge measurements occurring during that month. However, extremes for the station range from a lowest daily mean flow of 570 cfs, recorded September 15, 1913, to 253,000 cfs recorded March 26, 1913 (Coll and Siwicki, 1998). Both of these daily extremes occurred prior to the construction of flood control reservoirs on tributaries throughout the basin (see section 3.1.2.2). At Sewickley (Ohio River mile 13.3, at Dashields Locks and Dam), the monthly mean flow, averaged over the station's 64 years of flow record, ranges from a low of 11,910 cfs during September to a high of 66,370 cfs during March. Extremes for this station range from a lowest daily mean flow of 2,100 cfs on September 4, 1957, to 465,000 cfs on March 18, 1936 (Coll and Siwicki, 1998). Again, these extremes occurred prior to construction of many of the flood control projects currently in operation in the drainage basin.

Seasonal flow variability patterns in the study area were investigated by examining long-term discharge records for five U.S. Geological Survey gauging stations along the Allegheny and Ohio Rivers, including the Kittanning and Sewickley stations described above as well as stations located at Franklin, Parker, and Natrona, PA (see Figure 3-1). Appendix C summarizes mean flow measurements recorded over periods ranging from 64 to 94 years for these five stations. Data for all five stations show a general seasonal pattern in which highest





Discharge Records

Sources: USGS, 1999a, 1999b.

Figure 3-2

discharges occur during late winter-early spring months, when base flows are augmented by melting ice and snow. In winter months, portions of the rivers freeze, and ice jams can cause local flooding (USACE, 1993). Lowest river discharges typically occur in late summer and early fall (monthly minimums in August-October for these 5 stations). A near 7Q10 (seven consecutive day low flow over a 10-year period on average) was reported at Kittanning and in Montgomery Pool during late July 1999 during a 100-year drought event, although similarly low flows have been recorded for shorter periods of time (1-2 days) on several occasions over the past 20 years.

3.1.2.2 Watershed Hydromodifications Affecting River Flow

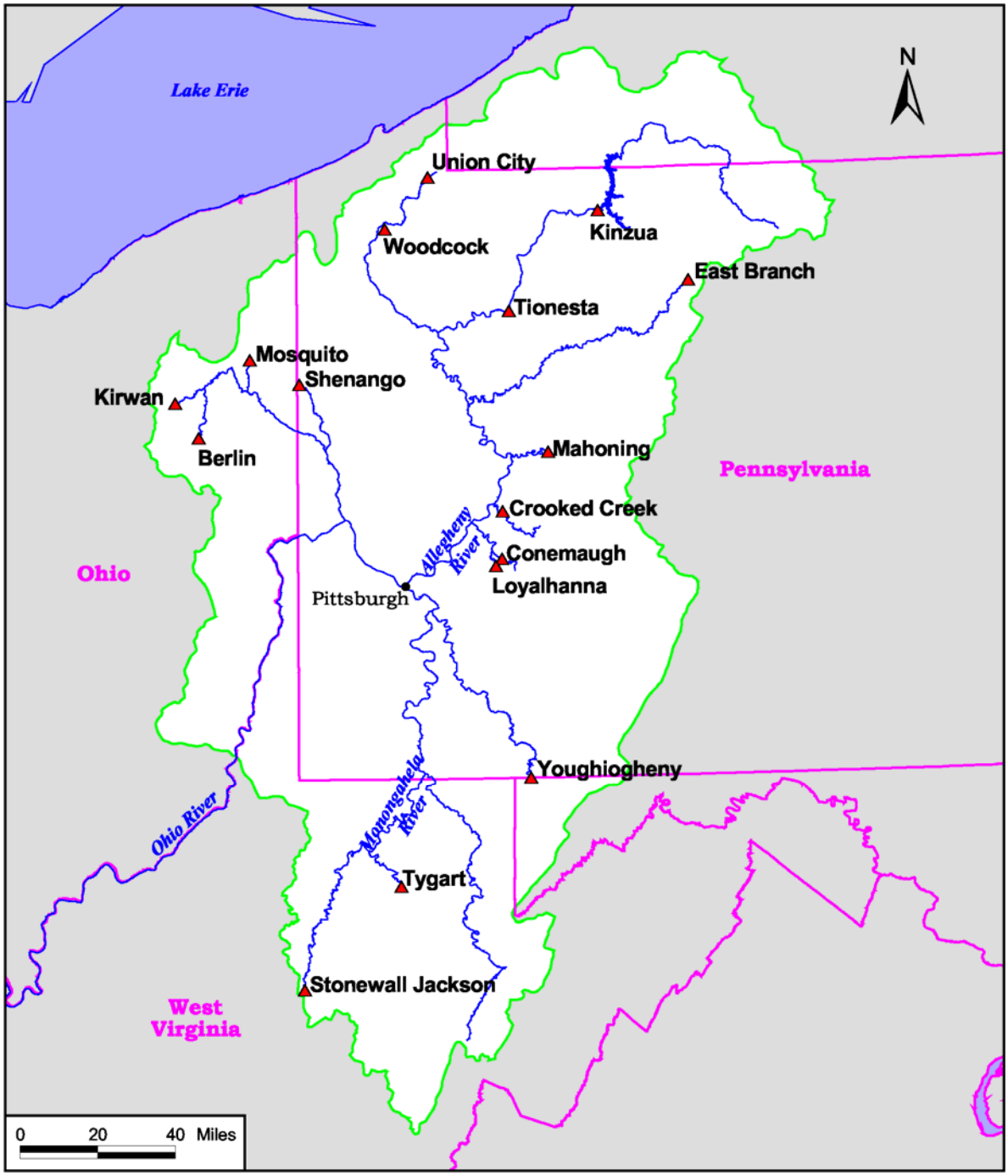
Flow in the Allegheny and Upper Ohio Rivers is affected by numerous flood control and navigation structures. Sixteen water management projects, shown in Figure 3-3, are operated by the USACE primarily for flood control. Of these, all but the Allegheny Reservoir, behind Kinzua Dam, are located on tributary streams. In addition to flood control, three of these reservoirs provide authorized storage allocations for low-flow augmentation for water quality in the lower Allegheny River, dependent upon monitored flow levels at Franklin and Natrona, Pennsylvania (see Figure 3-1). These three reservoirs and their low-flow storage allocations are (USACE, 1993):

- Allegheny Reservoir (Kinzua Dam)—549,000 acre-feet
- Woodcock Creek Lake—4,930 acre-feet
- East Branch Clarion River Lake—64,300 acre-feet

Allegheny Reservoir, with its large volume of storage, is the most effective for maintaining downstream water quality. Privately owned Piney Reservoir on the Clarion River (29 megawatt hydropower generating capacity) also significantly affects the flow and water quality of the Allegheny River. Peaking power generation at Piney Dam can cause substantial flow variation in the Allegheny River (USACE, 1993). Other reservoirs in the Monongahela and Beaver River tributary basins (e.g., Stonewall Jackson, Kirwan, and Shenango) also provide low-flow augmentation for water quality; however, their operations are predicated upon flows in the lower reaches of the tributary streams on which these reservoirs are built and not on flows in the main Ohio River channel (USACE, 1999b).

3.1.2.3 Channel Morphology

Prior to construction of impoundments, the lower Allegheny River consisted of a series of shallow riffles separated by deeper pools (USACE, 1980). The bed material was primarily a gravel-sand mixture. Riffles were formed by bars of coarse cobbles and large boulders, many of which were removed for paving and building stones. Few, if any, of the riffles resulted from an actual outcrop of bedrock strata. Most of the original channel dimensions have been altered as a result of creation of the navigation system. The need for construction of such a navigation system is an indication that the river channel formerly lacked consistent and reliable passages for navigation. Although the overall gradient of 1.58 feet per mile from Kittanning to Pittsburgh has remained unchanged, the 600-foot width at mile 51.5 in Pool 7,



LEGEND

- Flood Control Project
- River
- USACE Pittsburgh District Boundary
- State Boundary

Flood Control Projects

Source: USACE, 1999b.

Figure 3-3

as well as the 950-foot width at the Fort Duquesne highway bridge in Pittsburgh, are consequences of the navigation system. In addition to increased widths, a minimum water depth of nine feet is now maintained in the navigation channel, which is greater than the original depths at riffles. Pools of the channel also have been deepened where necessary to meet the minimum depth required for navigation (USACE, 1980).

Depth data were collected as part of an interagency study taken from a 1990 survey of mussel populations in Allegheny River pools 5 and 6. Sites, however, were not randomly sampled in these pools as the study objective was to sample areas which agency staff considered to be preferable mussel habitat. Thus, depth data from this study are not necessarily representative of the respective pools. In Pool 6, where there was minimal dredging since the 1980s, minimum depths at the 37 mussel sampling sites ranged from 5 feet to 16 feet, while maximum depths ranged from 7 feet to 35 feet. In Pool 5, where there has been continued commercial dredging, minimum depths at 22 of the 23 mussel sampling sites ranged from 7 feet to 20 feet, while maximum depths of those 22 sites ranged from 9 feet to 30 feet. The depths of the remaining Pool 5 site, number 54 at mile 32.7, ranged from 25 to 55 feet (USFWS, 1991).

More recent bathymetric data were collected during August 1998 at representative dredged area sampling sites and in October 1999 at dredged and undredged transects. Depth characterizations were made using a Raytheon recording fathometer to graph the river bottom topography in both studies. In 1998, the bathymetric survey at each sampling site consisted of 3 transects oriented parallel to shore and 3 transects running across the river, resulting in a 6-transect grid which collectively formed a morphological image of each survey location. The dredged areas of the transects appear as troughs with moderately sloping sides. Most of the sampling sites were characterized by a series of furrows, or underwater ridges and valleys. A superimposed dive transect line extending through each bathymetric map showed that sampled depths ranged between 9 and 57 feet. In the 1999 survey, continuous depth recordings were made over a 300 ft length perpendicular to the shore for each transect. Undredged and dredged transects were surveyed in Pools 4, 7, and 8 of the Allegheny River. Undredged, pipeline transects averaged 14 ft deep while dredged transects averaged 33 ft deep.

Existing navigational structures and ongoing navigation maintenance activities, as well as up to 100 years of past commercial dredging activities, have altered the original bathymetric character of the entire study area. Available depth information collected by regulatory agencies (including bathymetry contour data, navigational data, and depth data collected during mussel sampling and water quality monitoring) were combined into a geographical information system in order to derive estimates of depths throughout the entire study area. Appendix D (Figures D-1 to D-12) display available bathymetry information for each navigation pool in the study area. Bathymetry data for Pools 7 and 8 were updated using recent records collected by the applicants. The USACE Pittsburgh District evaluated updating river bathymetry maps for the entire study area using a LIDAR system, an aerial survey technique which can better delineate dredged areas and identify existing shallow

habitat. However, it was determined that the water clarity was not sufficient to utilize this technology.

Overall, the average depth of the rivers is approximately 20 feet, with the Allegheny being generally shallower than the Ohio. Approximately one-quarter of the riverbottom is zero to 10 feet in depth, and another quarter of the riverbottom is from 10 to 20 feet in depth. One-third of the river bottom is from 20 to 30 feet in depth, and 10 percent is from 30 to 40 feet deep. Approximately 1 to 2 percent of the river bottom is between 40 to 50 feet in depth, and a tenth of one percent exceeds 50 feet. Portions of the river which have not been dredged in the main channel (i.e., ~200 feet away from shore) generally range in depth from 10 to 30 feet, with an average depth of approximately 23 feet. Table 3-1 characterizes the hydrology of major study area tributaries.

Table 3-1
Major Tributaries of the Allegheny and Ohio Rivers Study Area

						Discharge data[4]		
Tributary	**River[1]**	**River Mile**	**River Bank**	**Length[2, 3] (mi)**	**Drainage area[2, 4] (mi^2)**	**USGS Gage #**	**Gage Location, miles upstream from mouth**	**Average Discharge (cfs)**
French Creek	Allegheny	124.6	R	117	1,270	03024000	10	2,060
Clarion River	Allegheny	84.5	L	120	1,252	03030500	15	1,806
Redbank Creek	Allegheny	64.0	L	48	605	03032500	7	884
Mahoning Creek	Allegheny	55.5	L	50	425	03036000	20	600
Crooked Creek	Allegheny	40.1	L	58	300	03039000	6.7	421
Kiskiminetas-Conemaugh Rivers	Allegheny	30.2	L	122	1,887	03048500	10	3,103
Buffalo Creek	Allegheny	28.6	R	37	137[5]	03049000	3	193
Monongahela River	Ohio	0.0	L	128	7,386	03085000	11.2	12,610
Chartiers Creek	Ohio	2.6	L	52	2575	03085500	8.9	292
Beaver River	Ohio	25.5	R	---	3,106[5]	03107500	5.5	3,841
Raccoon Creek	Ohio	29.7	L	46	178[5]	03108000	4.2	193

[1](USACE, 1997a, 1997b; USGS, 1974).
[2](Clemenson, 1999a, 1999b).
[3](Shaw, 1984).
[4](Lescinsky, Coll, and Siwicki, 1992; Coll and Siwicki, 1998; most locations affected by upstream regulation).
[5]Drainage area at USGS tributary gage location upstream from tributary mouth.

Commercial sand and gravel dredging has occurred over much of the study area. The average depth of dredged areas is approximately 30 feet below the mean pool surface level. Depths in dredged areas generally ranged from less than 20 feet deep to more than 50 feet deep, with approximately two-thirds of the dredged areas being between 20 to 40 feet deep. One percent of the dredged areas was 50 feet or more in depth (representing approximately 15 acres total).

Dredging activities have increased river-bottom relief through the formation of pockets, troughs, and deeper areas (see Appendix B). The deepest troughs and pockets (reaching 40 to 50 feet in depth) may extend from 50 to nearly 1000 feet in length. Pockets reaching 50 feet or more in depth are relatively small in size and infrequent, representing 1 percent of the dredged areas. Dredged areas with depths ranging from 20 to 40 feet are most frequent and appear as elongated disturbed areas with intermittent troughs and pockets. Some of these disturbed areas may exceed a mile in length and are found primarily within the middle portions of the river channel. Prior to the 1980 Environmental Impact Statement (EIS) for this study area (USACE, 1980), dredging occasionally took place close to river shorelines. After the 1980 EIS was completed, shoreline set-backs were required in dredging permits (see Permit Conditions, Section 2.2) to protect these habitats and minimize bank subsidence. The impacts of changes in channel morphology and hydrology (e.g., flows) due to dredging activities are discussed in Section 4.2.1.

3.1.3 Tributaries

Numerous tributaries drain the landscape of the Allegheny and Upper Ohio River basins, and Table 3-2 summarizes their major characteristics (also see Figure 3-1). Headwaters of most eastern (left bank) Allegheny River tributary streams originate in rugged terrain with high relief and steep slopes. Most tributary drainage patterns are dendritic, following natural drainages dictated by topography. Runoff to the main tributaries can be rapid, causing sudden high flows; consequently, numerous flood control projects have been constructed in the basin (section 3.1.2.2). According to USACE (1980), weathering in the non-glaciated two-thirds of the Allegheny watershed produces fine sand, silt, and clay particles, which are carried as bed load into the main Allegheny River channel, adding to the older, coarser glacial outwash substrate of the mainstem channel. Impoundment structures throughout the watershed (e.g., Figure 3-3, as well as the mainstem navigational dams) impede some sediment transport; however, during high water, tributaries bring in a continuous supply of fines, much of which travels downstream from pool to pool (USACE, 1980).

3.1.4 Channel Modifications/Dams and Locks

In addition to tributary channel modifications for flood control, USACE maintains a series of low head navigation dams on the Lower Allegheny and Upper Ohio Rivers. Eight single-lock, fixed-crest dams are located on the Lower Allegheny, and 4 double-lock dams are on the Upper Ohio (see Figure 3-1). Navigation is normally maintained year round on the lower 52.6 miles of the Allegheny River, while the upper locks (Lock and Dams 8 and 9) are closed during the winter months due to light river traffic and heavy ice conditions. Coal, sand and gravel, and petroleum products are the primary commodities that are transported through the navigation system. There is also heavy recreational boating and fishing (USACE, 1993). Dimensions and characteristics of the 12 navigation pools are summarized in Table 3-2.

Table 3-2
Features of Navigational Locks and Dams in the Allegheny and Ohio Rivers Study Area

	Locks and Dams	River Mile	Pool Eleva-tion (ft)	Pool Length (mi)	Pool Width (ft)	Surface Acres	Construction	Num-ber of Dams	Dam Length (ft)	Num-ber of Locks	River Bank Location of Lock(s)	Size of Lock(s)	Lift (ft)	Annual Traffic
Allegheny River	Lock and Dam 9	62.2	822.2	9.8	765	909	Built 1935-38, opened 1938.	1	950	1	L	Each is 56' w by 360' long	22.0	About 1100 recreational lockages
	Lock and Dam 8	52.6	800.2	9.6	840	977	Built 1928-31, opened 1931.	1	984	1	L		17.9	About 400,000 tons freight (mostly sand and
	Lock and Dam 7	45.7	782.4	6.9	950	795	Built 1928-31, lock opened 1930.	1	916	1	R		22.0	About 100,000 tons freight; 1400 recreational
	Lock and Dam 6	36.3	769.4	9.4	980	1,117	Built 1927-28, opened 1928.	1	1,140	1	R		12.2	About 100,000 tons freight
	Lock and Dam 5	30.4	756.8	5.9	975	697	Built 1920-27, opened 1927.	1	780	1	R		11.8	About 1.3 million tons freight
	Lock and Dam 4	24.2	745.4	6.2	1025	770	Built 1920-27, opened 1927.	1	876	1	R		10.5	About 1.8 million tons freight
	Lock and Dam 3	14.5	734.5	9.7	975	1,146	Built 1932-34, opened 1934.	1	1,346	1	L		13.5	About 3.7 million tons freight
	Lock and Dam 2	6.7	721.0	7.8	937	886	Built 1932-34, opened 1934.	1	1,993	1	L		11.0	About 4.2 million tons freight
Ohio River	Emsworth	6.2	710.0	6.7[2]	937	704	Opened 1921; rebuilt 1935-38; rehabilitated 1981-86.	2	967'--main; 750'--back channel	2 (both on main channel)	R	Each has one Land chamber-110' w by 600' l and one River chamber— 56' w by 360' l	18.0	About 17 million tons freight
	Dashields	13.3	692.0	7.1	1,175	1,011	Built 1927-29, opened 1929.	1	1,585	2	L		10.0	About 19 million tons freight
	Montgomery	32.0	682.0	18.4	1,250	2,788	Built 1932-36, opened 1936.	1	1,379	2	L		17.5	About 20 million tons freight
	New Cumberland	54.4	664.5	23.0	1,325	3,646	Built 1955-61, locks opened 1959.	1	1,315	2	R	See note[3]	20.5	Over 24 million tons freight

[1](Davison, 1999; USACE, 1997a, 1997b, 1999a)
[2]Length up Allegheny arm; total 24.1 mi of Ohio, Allegheny, and Monongahela Rivers
[3]Land chamber--110' w X 600' l; River chamber--110' w X 1200'

The eight Allegheny River navigation dams and Dashields Dam at Ohio River mile 13.3 are fixed crest dams of simple construction consisting of a concrete wall across the river (USACE, 1999a). Each of these dams keeps the river channel upriver of the project at a minimum depth of 9 feet for navigation. Water flowing over this type of dam cannot be controlled locally, thus providing no control over high flows and flooding. Emsworth, Montgomery, and New Cumberland dams are constructed with gates, which permit increased control over the water level in the navigation pool upriver of the dam. Machinery mounted on tall concrete piers moves large chains which lift gates that are hinged into the body of the piers. As the gates are raised or lowered to control the amount of water flowing under them, the upstream pool is maintained at a relatively constant level throughout its length. However, as with the fixed-crest dams, the gated dams cannot be operated to control flood flows. An added benefit derived from the pools formed by all 12 dams is the consistent availability of a source of municipal and industrial water (USACE, 1999a).

One recent proposed project may be relevant to the hydrology of Pool 6. Flashboards were proposed to be installed on Lock and Dam 6 to increase the head for hydroelectric power. This project would have resulted in approximately a 1.5-foot increase in pool depth, particularly during low flow periods. An Environmental Assessment was proposed for this activity and it was determined that the impacts would be too adverse and the project has been abandoned.

3.1.5 Beneficial Uses of Allegheny and Ohio Rivers in the Study Area

Both the Allegheny and Ohio Rivers have multiple beneficial uses, indicative of diverse cultural interests and diverse water resources in these systems. PADEP had designated both rivers as warm water aquatic life uses, which includes protection for fish, invertebrates, plants, and other aquatic species. This use is maintained through a number of water quality standards implemented by PADEP. In addition to aquatic life, both rivers are used for recreational and commercial boating, fishing, public water supplies, industrial process and cooling water, wastewater discharges, and commercial dredging. Water quality issues and aquatic life uses are discussed in Section 3.3 and 3.4 of this document, respectively. Commercial and recreational uses of the river are summarized in Section 3.8. The following summarizes current conditions related to public and industrial water supplies.

Public and Industrial Water Supplies. A number of industrial and public sources withdraw water from the Allegheny and Ohio Rivers for a variety of purposes. According to PADEP sources, there are over 100 locations in the study area in which water withdrawals are permitted. In addition, there are several wells in the study area, adjacent to the rivers, that supply raw drinking water or make-up water for industrial processing and cooling. Groundwater quantity and quality supplied by these wells may be influenced by the river, although the hydrogeological connection may be complex. In general, these wells withdraw groundwater that may originate from river water that percolates through the coluvial sand and gravel aquifer (Anderson et al., 2000).

Recent information collected by USGS, in their National Water Quality Assessment (NAWQA) Program (Anderson et al., 2000) for the Allegheny and Monongahela River Basin

(including the upper Ohio River), indicated that groundwater quality was generally satisfactory for drinking water purposes. Specific groundwater concerns raised in this report included: effects of acid mine drainage (e.g., sulfate, metals, pH) on nearby well fields; elevated nitrates related to agricultural and urban influences; and trace levels of arsenic in the upper part of the Allegheny due to natural geological sources. A number of boroughs, townships, and counties in the study area rely to some extent on wells for drinking water.

3.2 GEOLOGY

3.2.1 Topography

The Allegheny River and the Ohio River (to approximately river mile 400) are located in the Appalachian Plateaus Physiographic Province. A plateau generally means a wide, high area, with flat land and, at least in some places, not sharply pointed mountain peaks or narrow ridges (Schmidt, 1993). However, the terrain of the Appalachian Plateaus Province, especially in southwestern Pennsylvania, is not without relief.

The Appalachian Plateaus Province is characterized by northeast trending folds that parallel the Appalachian Mountains bordering the province to the east. Compared to the Appalachian Mountains, the ridges in the Appalachian Plateaus Province are farther apart, with wider valleys. This rolling landscape continues through western Pennsylvania, into eastern and southern Ohio, and gradually flattens as it continues west into the Central Lowlands and Interior Low Plateaus Physiographic Provinces.

The Appalachian Plateaus Physiographic Province is also characterized by a dendritic pattern of streams and rivers that have dissected the plateau, cutting sharply into its surface creating steep-sided valleys, so that only the accordant summits of the highlands show where the original plateau was (Schmidt, 1993). Within the river reach for this study (from Project Pool Number 9 in the Allegheny River through the New Cumberland Pool in the Ohio River), the riverbanks are characterized by steep to very steep slopes, with some gently sloping terraces around river bends.

Elevations in the Allegheny River range from 2,993 feet on Allegheny Mountain (USACE, 1993) then decrease to approximately 800 feet at Project Pool Number 9, and to 710 feet at the confluence with the Monongahela River in Pittsburgh.

The Ohio River is 981 miles long from Pittsburgh to its junction with the Mississippi River at Cairo, Illinois (USACE, 1981). It drains an area of 203,940 square miles (USACE, 1981). The Ohio River maintains its elevation within the region of influence for this study, only decreasing to 644 feet at the New Cumberland Pool which ends approximately 54 miles down river from Pittsburgh.

3.2.2 Geology

During most of Paleozoic time (570 million to 225 million years ago) the area surrounding Pittsburgh was a trough that received sediments from highlands situated to the east. Often it lay below sea level but, especially in later times, it was a coastal lowland, receiving layers of mud and sand which were deposited as broad deltas. Vegetation on these deltas later became strata of coal. The end result was a blanket of limestone, shale, sandstone, and coal strata up to 16,000 feet thick at Pittsburgh (USACE, 1980), thinning rapidly to the west, and thickening slowly eastward. About 200 to 180 million years ago (during the Jurassic Period), the Appalachian Mountains were uplifted to the east, and the strata of this area were tilted gently downward toward the northwest and arched along the axis of the Nashville-Cincinnati-Findlay Arch. A trough developed with its axis running north 30 degrees east from southwestern West Virginia through Pittsburgh.

Erosion subsequently planed off much of the uplifted sedimentary blanket west of West Virginia, exposing successively older rocks to the west. The uppermost strata, part of the Permian System, were preserved only where they were downwarped in the Appalachian Basin trough. The end result was a watershed underlain by almost flat lying beds of shale and sandstone with relatively minor exposures of limestone and coal. Only in the westernmost 50 miles did outcrops of limestone occupy a major portion of the terrain.

The ancient Paleozoic sedimentation and deformation comprise the first of two significant events in the development of the present reach of the Allegheny River and the Ohio River. The second is the relatively recent multiple glaciation that occurred during the Pleistocene Epoch, which began approximately two million years ago.

Continental glaciers moved southward into northwestern Pennsylvania and into Ohio during at least two stages of glaciation—the Illinoisan (198,000 to 132,000 years ago) and the Wisconsinan (22,000 to 17,000 years ago)—during the Pleistocene Epoch. The last of the glaciers retreated approximately 10,000 years ago. Figure 3-4 shows the farthest advance of the ice sheets; however, no single ice sheet reached this line along its entire length. The Illinoisan glaciation profoundly modified the drainage pattern, relief, and surface geology of the area it covered and of the periglacial zone 50 to 75 miles beyond. The previously northward-flowing Allegheny, and Beaver Rivers, which discharged into Lake Erie, were reversed; several parts of the Ohio River channel were established in their present positions. Enormous floods of meltwater swelled all the south-flowing streams and the Ohio River tens of feet above their present high water levels. Water from the Illinoisan glaciation deposited masses of partially-sorted gravel and sand on what are now uplands in northwestern Pennsylvania. A later glaciation (the Wisconsinan) added to these. The runoff water first cut very deep channelways along the present Allegheny River and Ohio River courses, then filled them with sand and gravel 30 to 40 feet above present levels (USACE, 1980). The Ohio River in many places is flowing on 50 to 100 feet of outwash (USACE, 1980). The Allegheny River flows on 30 to 80 feet of outwash, and has gravel terraces reaching up to 40 feet above low water level (USACE, 1980). The USGS reports that the glacial till deposits may be between 100 and 500 feet thick in the valley floor and river channel of the

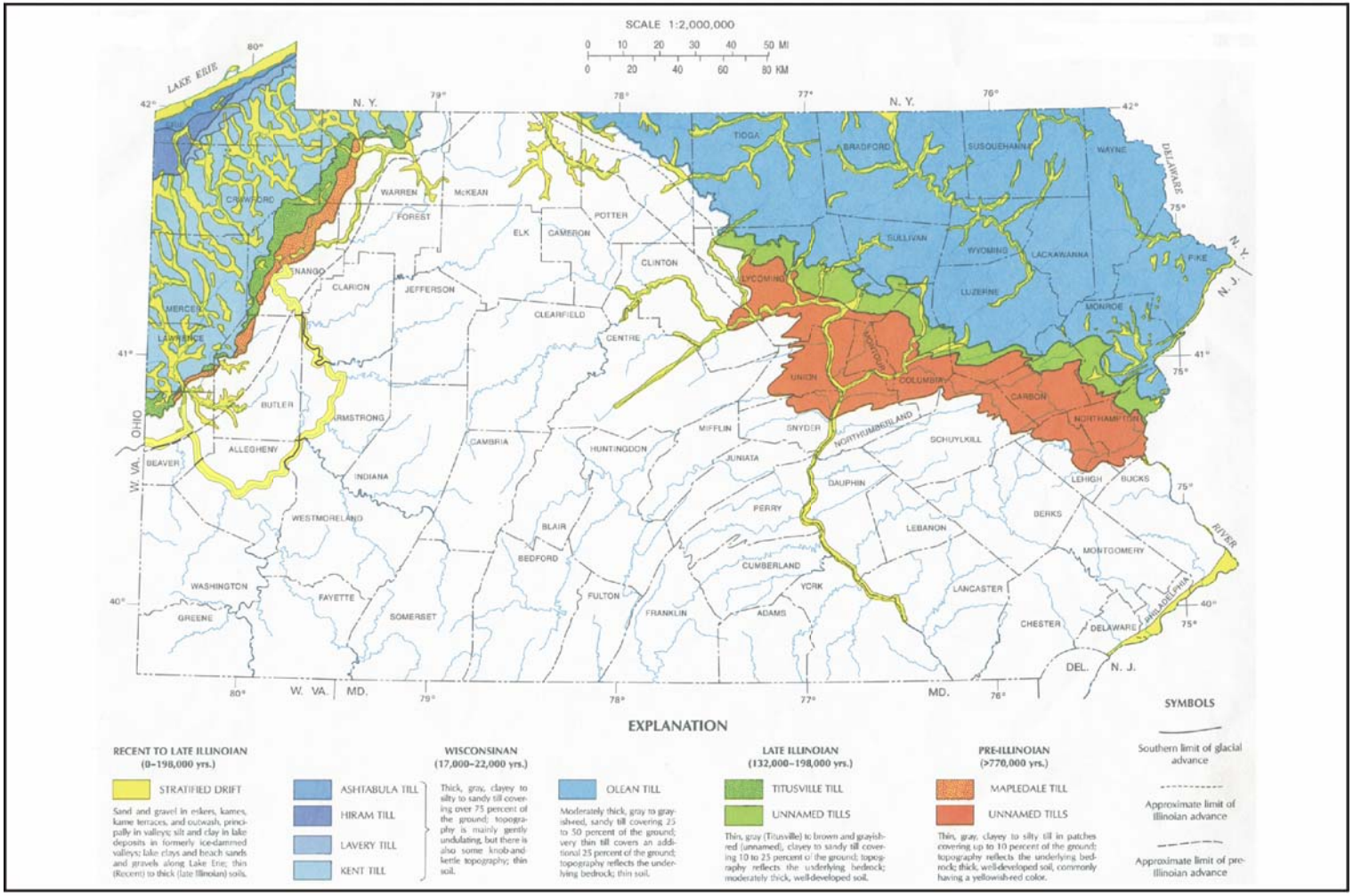
Allegheny and Ohio Rivers within the study area (USGS, 2000). Figure 3-4 also shows the deposition of glacial outwash.

Underlying the Allegheny River in the upper half of its course, beginning in southern New York and continuing into northern Pennsylvania (including Forest, Venango, and Warren counties), is bedrock of Devonian and Mississippian age. The Devonian formations include red sandstone, grey and black shale, limestone, and chert. The Mississippian formations are described as red and grey sandstone, shale, conglomerate, and limestone. A thick series of sandstones, shales, siltstones, and quantities of coal and limestone comprise the Pennsylvanian System, through which flows the lower half of the Allegheny River and the very upper reach of the Ohio River (through the New Cumberland Pool). Laurel Ridge and Chestnut Ridge (in Indiana and Westmoreland counties) are a pair of major anticlines exposing Mississippian rocks to erosion by the Conemaugh River, which flows into the Kiskiminetas River, which in turn is tributary to the Allegheny River. A tour of the Allegheny River reveals few natural outcrops of any bedrock except for occasional sandstone ledges or small cliffs. The softer rocks have weathered to vegetated slopes with exposures limited to gully-bottoms. The only conglomerates occur within the basal Pennsylvanian Pottsville Formation.

Under the prevailing climatic regimen and relief, the bedrock formations occurring in the region weather almost entirely sediments of sand grade and finer. The sandstones usually dissociate to sand; such sandstone cobbles that may break from the outcropping ledges erode rapidly. Abundant fines are produced by weathering of the shales. Coal, economically important though it is, comprises a very small fraction of the whole; it weathers naturally to acid, black soil, and only rarely yields chips firm enough to withstand the weathering and transport to the nearest stream. The limestones usually contain abundant clay, which leads to rapid weathering by a combination of carbonate solution and clay hydrational dilatation. Pottsville conglomerates upon weathering yield quartz pebbles; however, the conglomeratic phases of the Pottsville are usually cemented by silica, which greatly inhibits weathering and dissociation.

The distribution and thickness of coal beds does not perceptibly influence the natural supply of clastics to the Allegheny River, but greatly influences the sites of acid mine drainage, by determining the location of coal mines. However, the access roads, mine dumps, and other surface workings are responsible for greatly increased volumes of fine sediment which wash into the river.

Figures E-1 through E-5, Appendix E, show the surface geology of the counties surrounding the Pittsburgh area and that encompass the river beds of the Allegheny and Ohio Rivers. These counties include Allegheny, Armstrong, Beaver, Butler, and Westmoreland counties. Appendix E describes the geologic formations shown in the counties.



Glacial Ice Advance In Pennsylvania

Source: Commonwealth of Pennsylvania, DCNR, and the Bureau of Topographic and Geological Survey, 1997; O'Neill, 1974.

Figure 3-4

3.2.3 Allegheny and Ohio River Substrate

Of the three major rivers in southwestern Pennsylvania—the Allegheny, the Monongahela, and the Ohio—the substrate of the Allegheny River is unique. The Allegheny River was much closer to the ice margin than the Ohio River, and it received a notably higher proportion of sand and gravel. The meltwater of the glaciers swelled the channelway of the river and deposited the unconsolidated material in the Allegheny River bed. The Quaternary alluvium and Wisconsinan glacial outwash that make up the Allegheny River substrate consist of well-rounded, unweathered pebbles; sharp, angular sand; small amounts of silt and clay; and boulders (O'Neill, 1974). The pebbles and boulders are of many rock types—granite, syenite, gneiss, diroite, gabbro, diabase, quartzite, chert, sandstone, and limestone (O'Neill, 1974). Much of the accompanying fine material was washed into the Ohio River, then into the Mississippi River as far as the Delta. The hard, coarse, and often well-sorted substrate of the Allegheny and Ohio Rivers has important commercial value, especially as a local economical source of durable, non-skid highway construction aggregate, such as Type A sand (fine aggregate) and SRL E gravel (coarse aggregate).

An interagency study conducted in October 1991 in Allegheny Pools 5 and 6 indicated that the substrate in both pools was generally coarse (PFBC, 1997a), however, this was not a random sampling of both pools. This study also determined some variation in particle size with river depth: cobble was most abundant in areas less than 10 feet in depth, although this category also had a relatively high percentage of fines. Mid-depth areas (11-30 feet deep) had generally very clean gravel with lesser amounts of cobble and sand and no silt or clays. Deeper areas (> 30 feet deep) also were dominated by gravels but had larger quantities of silts and clays.

Compared to the Allegheny River, the bed of the Monongahela River is derived from sedimentary rocks exposed in the local drainage, and its substrate tends to be of much finer size. The Monongahela substrate is alluvium deposits of the Quaternary Period consisting of silt, loam, sand, gravel, and clay (O'Neill, 1974). Sandstone cobbles that break from Monongahela River basin outcroppings erode and eventually dissociate to sand. Fines are produced by the weathering of shales and limestones. The limestones usually contain clay, which leads to rapid weathering by a combination of carbonate solution and clay hydrational dilatation. The quality of the material is not as high as that of the deposits in the Allegheny River, and the Monongahela River has a higher percentage of silt, which makes the substrate less commercially valuable.

The Ohio Valley alluvium is a mixture of the material carried by the Allegheny River and the Monongahela River. The bed of the Ohio River tends to be coarser than the Monongahela River, but may contain more silt, clay, and fine sand than the Allegheny River. The material deposited in the upper Ohio channel by the glacial meltwaters via the Allegheny River was mostly sand, with subordinate gravel.

3.2.4 Land Based Sources of Commercially Valuable Aggregate

Within the Pittsburgh Metropolitan Area. High quality glacial deposits are also found in land formations in the Allegheny and Ohio River basins, including around the greater Pittsburgh area. The material was deposited as stratified drift which formed kames, kame terraces, eskers, outwash, and valley trains, or as high- and low-level glacial terraces along the rivers and streams as the waters retreated back from their flood levels (O'Neill, 1974). These deposits are depicted in Figure 3-4. The kames, eskers, and trains consist largely of sand and gravel with minor amounts of interbedded silt and clay (O'Neill, 1974). The low-level terraces are excellent sources for high quality sand and gravel; the high-level terraces contain high-quality sand, but gravel is not of the same quality due to extensive weathering (O'Neill, 1974). However, much of the acreage of these land-based deposits is not accessible due to land use conflicts. In 1974, there was approximately 11,300 acres of land identified as potential exploration areas for aggregate from glacial outwash deposits in Allegheny, Armstrong, Beaver, Butler, Washington, and Westmoreland counties (O'Neill, 1974). Evaluation of the deposits indicated they contained coarse and fine aggregate of quality ranging from Type A to Type C per PennDOT specifications. As 29 years have passed since these deposits were identified, it is likely that the amount of acreage available for exploration and mining has decreased due to previous or current extraction of the deposits, and/or due to changes in land use that now make the land area inaccessible for mining because of zoning regulations, and physical features, such as roads, railroads, dwellings, structures, utilities, wetlands, streams, etc. It is also possible that recent exploration has identified new source areas.

Substitutes for naturally occurring sand and gravel are crushed stone and sand manufactured from stone. Within the Pittsburgh area, limestone from the Loyalhanna formation of Mississippian age in Westmoreland county, and limestone from the Vanport formation of Pennsylvanian age in Armstrong and Butler counties are mined and used as top quality sources of coarse aggregate meeting Type A quality requirements. However, they do not necessarily meet SRL E requirements. In fact, per PennDOT specifications, sand manufactured from limestone may not be used in concrete wearing surfaces. The limestone polishes with wear and creates a smooth, high-skid road surface. Currently, there are no quarries in the Loyalhanna formation that produce Type A fine aggregate (sand), which is used in concrete.

Other formations mined for construction aggregates within the areas surrounding Pittsburgh are the Benwood Limestone of the Monongahela Group, Homewood Sandstone of the Pottsville Group, Kittaning Sandstone of the Allegheny Group, Morgantown Sandstone of the Casselman Formation, and Saltsburg Sandstone of the Glenshaw Formation (see Table E-1, Appendix E for a detailed description). Evaluation of these deposits has revealed them to be less valuable sources for road construction materials than previously discussed glacial deposits and limestones for several reasons. The sandstones and limestones do not have the physical properties to meet SRL E standards, although they can be used as coarse aggregate in base and subbase courses; rapid changes in lithology make the quality of the deposit

inconsistent; and deposits immediately surrounding Pittsburgh may be thin and therefore not economically feasible to mine (O'Neill, 1974). There are no quarries in the limestone and sandstone formations listed here that produce Type A fine aggregate (sand), which is used in concrete.

Within the six-county Pittsburgh area (Allegheny, Armstrong, Beaver, Butler, Washington and Westmoreland counties), currently there is only one natural sand and gravel land-based quarry listed in Bulletin 14 producing coarse aggregate meeting PennDOT SRL E specifications. This quarry is located in Beaver County, near the Ohio border, and mines glacial gravel from kames, kame terraces, eskers, and outwash. The deposits are 20 to 80 feet thick, consisting of approximately 25 percent gravel (O'Neill 1974). This quarry produces sand and gravel ranging in quality from Type A to Type C per PennDOT specifications (PADEP, 1998). However, the portion of the total amount of gravel meeting SRL E is not known, and since this is an older quarry, the amount of remaining reserves at the quarry is not known. There are land-based crushed limestone quarries that produce coarse aggregate PennDOT SRL E specification material, located primarily in Fayette County in the Loyalhanna Formation. These quarries produce crushed limestone and not natural gravel. There are no quarries in the Loyalhanna formation that produce Type A fine aggregate (sand), which is used in concrete.

Within the six-county Pittsburgh area currently there are four natural sand and gravel land based quarries listed in Bulletin 14 producing PennDOT specification Type A fine aggregates. Three of the quarries are located in Armstrong County and one in Beaver County, ranging from 30 to 55 miles away from the City of Pittsburgh. All of the Type A sand being extracted is from kames, kame terraces, eskers, and glacial outwash. These deposits are commonly between 20 to 80 feet thick (O'Neill, 1974). The portion of the total that is Type A sand is not known. Other quarries exist that produce lower quality sand, primarily Type B and Type C sand. There are no crushed stone quarries that produce Type A fine aggregate (sand), which is used in concrete. Currently there are 16 quarries within the six-county Pittsburgh area, all of which do not produce coarse aggregate meeting PennDOT SRL E specifications. This material is used for other purposes, such as subbase in road construction. This aggregate is extracted from deposits of limestone, shale, calcareous shale, siltstone, and some natural gravels. The coarse aggregate ranges in quality from Type A to Type C, however the fine aggregate ranges in quality from Type B to Type C (i.e., not Type A fine aggregate). The amount of remaining reserves at these quarries is not known.

Within the six-county Pittsburgh area, there are currently four sites that are reclaiming slag and ash for use as aggregate. Two blast furnace slag operations are located in Allegheny and Beaver Counties, and two bottom ash (cinders) operations are located in Beaver and Fayette Counties. None of these slag or ash products meet PennDOT specifications for SRL E coarse aggregate or PennDOT specifications for Type A fine aggregate.

Outside the Pittsburgh Metropolitan Area. As seen in Figure 3-4, the continental glaciers covered the northeastern and northwestern corners of Pennsylvania, leaving behind substantial deposits of glacial diamicts and stratified sand and gravel overlying bedrock of

Devonian, Mississippian, and Pennsylvanian age. Glacial diamicts are unconsolidated, nonsorted or poorly sorted, non-layered or vaguely layered deposits consisting of clay, silt, sand, gravel, and boulders (DCNR, 1997). The substrate of the Allegheny and Ohio Rivers is derived from these glacial deposits in northwestern Pennsylvania. As of April 1998, there were four quarries producing coarse aggregate rated SRL E in the northwestern corner of the state, but over 30 quarries mining the same type of glacial deposits were producing SRL E aggregate in the northeast corner of the state (PennDOT, 1998).

There are two reasons for the greater number of land-based quarries in eastern and central Pennsylvania as compared to the western portion of Pennsylvania. First, eastern and central Pennsylvania lack the readily available river-based sources. These areas are representative of a market that can not utilize river-based aggregate. Secondly, the land-based natural sand and gravel reserves of eastern and central Pennsylvania (especially northeastern) are generally of better quality than the natural sand and gravel reserves in western Pennsylvania. This can be shown by the greater number of land-based operations in the eastern and central part of the state producing higher quality aggregate; western land-based operations produce lower quality aggregate (USGS, 2001). The difference in aggregate is a function of the mineral quality of the aggregate itself and not the processing of the aggregate. Processing does not change the inherent quality of the aggregate. Therefore, areas in the eastern and central part of the state are not representative of the aggregate market that exists in the ROI in this project.

The total undeveloped land area of northwest Pennsylvania overlying glacial deposits is approximately 840,000 acres (the actual acreage of mineable deposits is currently unknown), which is 60 times the acreage of the Ohio and Allegheny rivers combined. Therefore, northwest Pennsylvania could potentially be a significant source for SRL E coarse aggregate and Type A sand, if it could be developed in the future. Expansion of mining activity would depend on the extent, thickness, and location of the deposits, zoning laws, surrounding land use, infrastructure, market for the material, and potential to obtain state-permits. To date, several companies have been unsuccessful in obtaining state-permits for the development of land-based quarries in western Pennsylvania for several years (see Alternative 4, Section 4).

Throughout the remainder of Pennsylvania (i.e., not including the northeast and northwest), there are quarries mining SRL E aggregate and Type A sand, but with a noticeable lack of production in the central and northcentral counties (PennDOT, 1998). For SRL E, there are approximately a dozen other suppliers scattered across the southern portion of the state (PennDOT, 1998). The quarries are excavating deposits of quartzite, calcareous sandstone, sandstone, and siltstone. Approximately 30 quarries in southwestern, southeastern, and the southcentral areas of the state are mining Type A sand from deposits of dolomite, limestone, sandstone, siltstone, and quartzite (PennDOT, 1998).

In conclusion, substantial sand and gravel land-based resources, including high-quality SRL E aggregate and Type A sand, can be found throughout northwestern Pennsylvania. These resources are vast enough to supply the needed sand and gravel resources for commercial projects in western Pennsylvania. However, market forces (i.e., the close proximity of river-

based producers to their customers) and difficulties in obtaining land-based permits appears to have limited the development of these resources in western Pennsylvania (further discussed under Alternative 4, Section 4).

Sources Outside Pennsylvania. Industrial mineral companies outside of Pennsylvania can become approved suppliers of aggregate to PennDOT. Suppliers within a reasonable shipping distance of Pittsburgh are located in Ohio, West Virginia, and New York. As of 1998, there were eight quarries in Ohio producing Type A sand meeting PennDOT specifications (PennDOT, 1998). No coarse aggregate producers in Ohio were approved as SRL E. The quarries ranged from 65 to 125 driving miles from downtown Pittsburgh, and produced an approximate total of 3,800,000 tons of sand and gravel in 1996 (Ohio DNR, Division of Geological Survey data). However, the exact tonnage of Type A sand produced from this 3.8 million tons is not known.

As of 2001, two companies located in West Virginia were listed in *Bulletin 14* as an approved supplier of Type A sand (PennDOT, 2001). However, production quantities are not known. No coarse aggregate producers in West Virginia were approved as SRL E. In *Bulletin 14*, the state of New York has 9 companies listed as approved suppliers of SRL E aggregate and 15 companies listed as approved suppliers of Type A sand. The SRL E is mined mostly from glacial gravel, with some coming from sandstone and siltstone deposits. Two of the companies mining SRL E are located in southwestern New York within 150 miles of Pittsburgh, and are considered potential suppliers of SRL E material to southwest Pennsylvania should dredging operations cease production. Exact tonnage produced is not known. The producers of Type A sand in New York are not considered to be potential sources to southwest Pennsylvania due to their distance from the area and due to the proximity and number of suppliers in Pennsylvania, Ohio, and West Virginia.

3.2.5 Production of Commercially Valuable Aggregate by Land Based Sources

Because exact information on levels of production of SRL E, Type A sand, and coarse aggregate was not available for all land based suppliers, statistical estimates were determined for annual production of these three types of materials based on available information. The estimates are based on information obtained from personal communication with land based producers and through the use of a statistical modeling technique (see Section 4.1.9). Should dredging on the Allegheny and Ohio Rivers be prohibited, this lost supply of sand and gravel would need to be replaced by expanding land based quarry production. Table 3-3 lists the estimated 1998 production of SRL E, Type A sand, and coarse aggregate supplied by dredging the rivers. Annual production estimates are also listed for land based operations should their rate of production increase to meet increased demand. The tonnages listed in Table 3-3 do not include what land based quarries currently produce, but rather the estimated unused production capacity of quarries based on the results of modeling and data obtained from land-based quarries. It is assumed that these production levels would be used for the purpose of replacing the river dredged material. A list of suppliers was obtained from *Bulletin 14*, and Figures 2-1 to 2-3 map the locations of these suppliers by type of material produced (SRL E, Type A, and coarse aggregate).

As shown in Table 3-4, aggregate meeting SRL E specifications would have to be shipped from up to 135 miles away (potential range of 70 to 200 miles) before the 680,000 tons produced from dredging would be compensated for. Only 25% of the SRL E supplied by dredging is obtained within a 50-mile radius of Pittsburgh from land based quarries, 70% at a 50 to 100 mile radius, and 100% at a 100 to 150 mile radius (see Table 3-4). Type A sand can be compensated for within a 90 mile distance around Pittsburgh, and coarse aggregate within 40 miles. The impacts associated with obtaining sand and gravel from other sources are discussed in Section 4.4.

Table 3-3
Estimated Production Increase (tons) to Compensate for Loss of Material Produced by Dredging Operations

		Estimated Increased Production Levels of Landbased Operations[1, 2] by Distance from Pittsburgh			
	Dredging Operations	**0-50 miles**	**0-100 miles**	**0-150 miles**	**Total**
SRL E	680,000	163,000	489,000	692,750[3]	700,000
Type A Sand	1,500,000	202,000	1,970,000[4]	---	2,000,000
Coarse Aggregate	1,900,000	4,769,100	---	---	4,800,000

[1] Assumes all quarries are able to increase production by the same percentage, and assumes that no new quarries open.
[2] Includes only producers listed in *Bulletin 14*.
[3] Includes producers in New York.
[4] Includes producers in Ohio.

Table 3-4
Distance Traveled to Replace Production from Dredging with Production by Land Base Operations

	Distance from Pittsburgh		
	0-50 miles	**51-100 miles**	**101-150 miles**
SRL E	24%	72%	100%
Type A Sand	13%	100%	---
Coarse Aggregate	100%	---	---

3.3 SURFACE WATER QUALITY

3.3.1 General Information

There has been a sustained effort by local and federal programs to document water quality conditions within the study area. There are numerous programs and studies that provide insight on current water quality conditions and sources of water quality problems in the study area, the most significant of which are:

- PADEP's 305(b) and 303(d) reports, and various other water resource materials, some developed in association with USGS.

- U.S. EPA Surf-Your-Watershed summaries, which attempt to characterize whole watersheds using multiple environmental quality indicators.

- Ohio River Valley Water Sanitation Commission (ORSANCO) studies/ monitoring programs on the Ohio River and selected major tributaries performed in support of Clean Water Act Section 305(b) reporting requirements.

Water quality conditions are frequently described in terms of their ability to support designated uses, where qualitative and quantitative criteria are used to establish whether use impairment exists. As a part of its mandate to monitor water quality under the Clean Water Act, USEPA used extensive data to evaluate watersheds based on fifteen criteria provided on an EPA web page (http://cfpub.epa.gov/surf/locate/index.cfm). Figures G-1 through G-3, Appendix G, show the current status of the hydrologic units as assessed by USEPA for the Upper Ohio, Lower Allegheny, and Middle Allegheny watersheds. These three watersheds (or hydrologic units) fully enclose the river sections in the study area.

It is important to note that USEPA's "Surf-Your-Watershed" characterizes the entire watershed based on the measured condition of a few waterbodies in the watershed. USEPA has further attempted to generate a single rating for each watershed based on all its criteria. Through this process it has rated the Lower Allegheny watershed as "Less Serious Water Quality Problems" (based on a survey of 11 percent of the watershed's river miles). The Middle Allegheny-Redbank hydrologic unit also has a rating of "Less Serious Water Quality Problems" (based on a survey of 34 percent of the river miles in the watershed). Finally, the Upper Ohio River has a rating of "More Serious Water Quality Problems" (based on a survey of 26 percent of the 260 river miles found in the watershed).

USGS's National Water Quality Assessment (NAWQA) Program recently completed a major sampling and analysis study of the Allegheny and Monongahela River Basins (Anderson et al., 2000). A primary focus of that study was an assessment of current water quality conditions in relation to different land uses. This report notes a general improvement in water quality throughout most of the Allegheny and upper Ohio Rivers as evidenced by some decline in acid mine drainage effects, decreased dissolved solids concentration (also

indicative of decreased acid mine drainage), and increased fish species diversity as compared to the early 1970s.

Major current water quality issues identified in the USGS Report were related to the following conditions:

- Contamination of surface and ground water by acid mine drainage is the most significant source of water quality degradation. More than half of the river miles in the study unit are degraded. Abandoned coal mined areas are a major source of acid mine drainage.
- Degradation of water quality from oil and gas exploration and production, especially from abandoned wells and drilling and production sites, occurs in the upper Allegheny River Basin. Brines, methane, trace elements, and organic compounds are released to both surface water and ground water.
- Surface and ground water contamination by industrial waste or spills near urban areas along the major rivers; organic compounds and toxic trace elements from petroleum products, from storage tanks or pipelines, or from industrial sites are a hazard to aquatic biological communities and to water supply.
- Sedimentation and contamination of surface water by urban runoff, combined stormwater-sewer overflows, and improper domestic or small-locality waste disposal; Nutrients, bacteria, and turbidity affect water supplies in many areas.
- Contamination of surface and ground waters by nutrient loads and pesticides used in agricultural and urban areas can occur in many areas because of the highly mixed land uses in the study area.
- Acid precipitation effects.
- Naturally occurring radiochemicals, especially radon, affecting the quality of ground-water supplies.
- Thermal pollution from discharge of heated water used for cooling power plants, resulting in high temperatures, reduced dissolved oxygen, algal blooms, and growth of pathogens.

Pennsylvania DEP's 305(b) reports (PADEP, 2001) also indicate that there are many urban and nonurban sources of pollutants, as well as diverse land uses that impact these waterbodies. Table 3-5 lists known or suspected problem areas, identified by PADEP and other sources. The Allegheny River above Pool 5 is generally rated as mostly unimpaired in terms of water quality. PADEP also lists several segments of the upper Allegheny River and tributaries to the Allegheny within the study area as impaired for aquatic life uses due to metals from acid mine drainage.

From Pool 3 downstream to New Cumberland Pool on the Ohio River, beneficial uses are listed as impaired due to historical inputs of chlordane (a legacy pesticide no longer in use) and PCBs (discontinued production and use since the mid-1970s). Both compounds have been measured in fish tissue samples collected from this segment of the study area. A Total Maximum Daily Load (TMDL) evaluation has been completed for both compounds in this segment. Current information indicates that water column concentrations are very low

(< 0.03 μg/L) for both parameters. However, fish advisories have been and still are in effect from the lower part of Pool 3 downstream as both chlordane and PCBs bioaccumulate up the food chain (including humans). As a result, people are advised that carp, catfish, and smallmouth and spotted bass should be eaten only in small quantities, or not at all, in the case of the former two species.

Table 3-5
Known or Suspected Sources of Waterbody Degradation

Allegheny River			
Exposed Resource	**Pollutant/ Condition**	**Source Summary**	**Source Name**
Allegheny River in vicinity of Pools 3 and 4	Metals	Acid mine drainage (AMD) from active and abandoned bituminous coal operations	USACE (1993)
Northeastern portion of the watershed	Various	Brines and other oil field wastes	USACE (1993)
Ohio River			
Exposed Resource	**Pollutant/ Condition**	**Source Summary**	**Source Name**
Ohio River (in general)	Various	Non-point sources, combined sewer overflows and industrial discharges	ORSANCO (1998)
Upper-most 100 miles of the Ohio River	Various Petroleums	From 1991-1993 the portion of the Ohio River with the highest frequency of spills	ORSANCO (1998)
Aquatic life in the upper Ohio River	Copper	"most probably caused by acid mine drainage"	ORSANCO (1998)

Existing water quality conditions within the study area provided by the STORET database and other sources were evaluated. Five conventional water quality indicators, all of which are relevant to dredging, were evaluated: 1) water temperature; 2) turbidity; 3) total recoverable copper [Cu]; 4) total recoverable zinc [Zn]; and 5) dissolved oxygen [DO]. Spatial (upstream to downstream) patterns in the data were emphasized over temporal trends because the influences of dredging are probably more strongly correlated with the location along each river than with changes over the short (ten-year) period of record evaluated. Because the water quality monitoring programs produced a large amount of raw data, data reduction was performed to simplify this evaluation. For example, at each sampling site, monitoring data collected at different depths within the water column were combined for each parameter, except DO.

The water quality data used in these analyses were collected during summer months (July, August, and September) when lower flow predominates. The evaluation focused on data collected since the last EIS (USACE, 1980) from approximately 60 locations along the Allegheny and Ohio Rivers. Appendix G, Figure G-4 shows the locations of monitoring sites; each site designation indicates the river ("A" for Allegheny and "O" Ohio) and the river mile (numerical value in the site designation). Figure G-4 also shows the locations of dams in the study area (the designation "L & D" is used to indicate "Lock and Dam").

In addition to data collected previously, this document also incorporates more current water quality data (temperature and DO) collected during the EIS as described in Sections 3.3.2 and 3.3.3 and Appendix G.

3.3.2 Water Temperature

In all, 510 temperature measurements from approximately 50 locations along the Allegheny and Ohio Rivers were obtained from STORET and analyzed (Appendix G, Figure G-5). To demonstrate large scale patterns in the data three values were plotted: 1) the average value of all annual medians for all years at each monitoring site; 2) the lowest annual median observed at each site; and 3) the highest annual median observed at each site. These three values represent the average, cool, and warm year temperatures.

Vertical temperature profiles were also available from measurements taken in dredged areas during the summer of 1998 and 1999, including a PADEP monitoring study in dredged areas of Pools 7 and 8 in the Allegheny River.

Temperature data collected with dissolved oxygen data in early September 1998 for this EIS as part of targeted environmental analyses in previously dredged areas (see Section 2.5), indicated somewhat cooler temperatures in Pools 7-9 on the Allegheny River as compared to lower pools in the study area (mean and standard deviation = 16.9 ± 1.01 and 22.9 ± 0.66 °C for Pools 7-9 and Pools 2-6, respectively). The cooler summer water temperatures in the upper Allegheny River pools are probably a consequence of a more forested watershed with a higher proportion of cooler groundwater recharge water than in the lower Allegheny River pools.

The following conclusions were noted based on the above data:

- Typical summer water surface temperature in the study area is approximately 26 ^{o}C, although during "warm" summers, the average temperature is closer to 30 ^{o}C .

- Temperature generally changes little with depth, even during the summer and in dredged areas. However, during especially warm conditions (e.g., August, 1999), surface temperatures could be as much as 5 ^{o}C warmer than temperatures at 30-40 feet deep.

- Temperature values do not appear to be unusual for a warm water fishery designated use classification.

3.3.3 Dissolved Oxygen

Several different sources of data were used to evaluate dissolved oxygen (DO) conditions in the study area including: (1) STORET data; (2) the 1991 interagency study in Pools 5 and 6; (3) data collected in support of this document; and (4) PADEP data collected during the preparation of this document. DO data are evaluated in terms of PADEP's minimum water quality standard of 5 mg/l, for the protection of aquatic life.

STORET Data. DO measurements collected since 1980 were obtained from STORET and comprised 3,700 data points from 29 locations in the Allegheny and 25 locations in the Ohio River (most data were collected between 1982 and 1992). Much of the data in STORET were collected for ambient monitoring purposes and were therefore collected at fixed stations that are easily accessible (e.g., off bridges) and generally relatively shallow (≤ 20 feet in depth). Only data collected during summer months (July, August, and September) were analyzed in an attempt to evaluate relatively low flow and higher temperature conditions when low DO is likely to occur. The time of sampling typically occurred between mid-morning and mid-afternoon. For each sampling station, depth was used to evaluate where significant stratification in DO values may have occurred. Data were aggregated into 5-ft depth ranges for each sample site.

Tables G-1 through G-4 provide, respectively, the average and minimum reported DO values in the Allegheny and Ohio Rivers. STORET data indicated that as many as three monitoring "sites" could exist at a single location on a river because different agencies have reported results for different "sites" even though they are co-located (e.g., station Ohio 54.0). Data in STORET yielded the following observations:

- With a few exceptions (e.g., Stations A49.8; A53.7; and O44.4), average DO values reported for each depth range were above the 5 mg/l DEP dissolved oxygen standard.

- Stratification with resulting minimum reported DO values below the 5 mg/l standard occurred at six locations in the Allegheny and three locations in the Ohio. These included RM30.6; RM36.5; RM49.8; RM53.7; and RM54.1 in the Allegheny River. At each of these locations, DO measurements < 5 mg/l were observed between 16 and 20 feet in depth. Locations with low DOs in the Ohio River occurred at RM31.3, 28.1, and 6.0. DOs below the state standard at these locations occurred between 26 and 30 feet in depth.

1991 Interagency Study. An interagency study (PFBC, 1997a) conducted in October, 1991 compared dissolved oxygen and depth data at select locations where mussel habitat was believed to be satisfactory in Allegheny River Pools 5 and 6. This study indicated no violations of DEP's dissolved oxygen water quality standard at any site in either pool. Maximum depths for this sampling ranged between 21 and 25 ft in Pool 6 and 32 and 37 ft in

Pool 5. This study also cited previous data collected in July and August 1988 during a relatively warm summer and lower river flows. Those data indicated dissolved oxygen concentrations below the state standard at the tail end of Pool 6 and, to a lesser extent, the tail end of Pool 5 at depths > 25 ft (PFBC, 1997a). Lowest flow for the month preceding this sampling at the Kittanning gage in Pool 6 was 2600 cfs as compared to 2970 cfs prior to the 1991 survey.

Data Collected for this Document. As noted in Section 2.5 of this document, many previously dredged areas were targeted for DO measurements in this EIS because such data were not readily available in STORET or in the 1991 Interagency study. Dissolved oxygen measurements were taken between August and September 1998 (Appendix G, Figure G-6) in depth profiles at 32 previously dredged locations in the Allegheny River (Pools 2-9, and Emsworth) and 17 locations in the Ohio River (Emsworth, Dashields, Montgomery, and New Cumberland pools). Surface water temperature generally ranged between 19 and 24° C during this survey. Two locations in Pool 8 (RM 53.7 and 54.1) exhibited DO below the state standard (3.4 and 1.6 ppm, respectively; Appendix G, Figure G-7). All Ohio River measurements were above 7.9 ppm at maximum depths ranging between 23 and 49 ft. This survey showed little tendency for depth stratification with respect to DO or temperature. As a result, depth explained only a small fraction of the variability in DO measurements collected in this survey ($R^2 = 0.082$). This means that other factors, in addition to depth, caused anoxic conditions to occur. No other differences in DO among sites were observed.

PADEP Survey. A monitoring study was conducted by PADEP in August 1999 during warm summer conditions with surface water temperatures ranging between 28.1 and 30.1° C. This survey indicated DO measures less than the state standard at all eight locations sampled in Pool 8 and at 5 of 6 locations sampled in 7 but not at several locations in Montgomery Pool in the Ohio River (Appendix H). DO was below the state standard at water depths greater than 25-30 ft in general. Follow-up monitoring in mid-August approximately 2-3 weeks after the PADEP study, indicated DO measures below the state standard at 6 of the 8 sites in Pool 8, and none of the 6 sites in Pool 7 (Appendix H). Surface water temperatures were somewhat lower in the latter survey (23.9 - 26.5°C) than that recorded during the PADEP study. Flows for the week preceding the two surveys were 2790 - 3770 and 1930 - 3680, respectively. Both of these studies indicated a DO-depth relationship at some sites in the upper Allegheny, although several similarly deep locations in the Allegheny and Upper Ohio Pools did not exhibit anoxic effects.

3.3.4 Turbidity

Three hundred turbidity measurements, collected at approximately 50 locations along the Allegheny and Ohio Rivers in the STORET database, were analyzed (Appendix G, Figure G-8). These data were predominantly collected during summer months (July, August, and September) when low flow conditions and clearer water typically occur. Limited turbidity data were also available in the PADEP study of select dredged areas in the summer of 1999. For the STORET data, two values were examined: 1) the average value of all annual medians for all years at each monitoring site; and 2) the highest annual median observed at each site.

The average of the annual medians indicates the ambient (non-rainfall) condition, while the highest reported median indicates turbidity during a wet year. For the PADEP study, ranges of values are presented.

The STORET data exhibited the following patterns:

- The average turbidity ranged between 5 and 20 NTU, although in some reaches average turbidity was as high as 140 NTU.

- Generally higher turbidity values were recorded below RM30.6, in Pools 2 and 3 in the Allegheny River as compared to the upper pools. This might be related to large tributaries entering the Allegheny River at and below Pool 4 which are still actively eroding clay-based soils. In addition, barge traffic is generally greater in the lower pools of the Allegheny as compared to the upper pools, which may result in more resuspension of sediments in the water column and higher turbidity.

- There appear to be local influences on turbidity values in the Ohio River in the New Cumberland Pool. Elevated turbidity measurements in this pool might be related to large tributaries and/or barge traffic as well.

Data collected by PADEP in July 1999 yielded turbidity values between 1.6 and 35.9 NTU at locations without active dredging or barge traffic in Pools 7 and 8 on the Allegheny River (Appendix H). Turbidity values were also measured by PADEP at various depths between 320 and 360 yards downstream of an active dredging operation (clamshell dredge) in Pool 8. These data indicated that the highest turbidity values (maximum = 297 NTU) were generally near the water surface at 330-360 yards downstream and directly downstream of the dredge. At another location a similar distance downstream, highest turbidity (≤ 100 NTU) was observed at 20 feet in depth. At several relatively undisturbed locations in Pools 7 and 8, highest turbidity values were often observed near the bottom (as high as 72.4 NTU, RM51.5, Pool 7).

3.3.5 Metals

Copper. Copper was selected to help characterize water quality in the study area because it is known to be a substantial component of the water quality contaminant load throughout the study area (PADEP 1998, 305(b) report) and it is an indicator of industrial and urban pollutants. Copper values above ambient chronic water quality criteria have been measured in 17 percent of the samples collected in waterbodies throughout the Lower Allegheny watershed (USEPA, 1998).

Water hardness was evaluated to interpret potential effects of copper and zinc on aquatic life. The median hardness for all monitoring stations evaluated was approximately 107 mgL^{-1} as $CaCO_3$. However, values as low as 60 and as high as 160 mgL^{-1} as $CaCO_3$ were commonly encountered. For hardness values of 60 and 160 mgL^{-1}, the chronic copper aquatic standards are 6.0 and 13.9 μgL^{-1}, respectively based on current USEPA criteria. For this analysis, the

median hardness value of 107 mgL^{-1} as $CaCO_3$ was used, yielding a chronic copper standard of 9.9 μgL^{-1}.

Another complicating factor in the interpretation of metals data is that total recoverable metal (the form analyzed by resource agencies which comprise nearly all STORET metal data available) is not often an accurate indicator of toxicity potential. USEPA recognized that dissolved or soluble metal is often a better indicator of toxicity potential and that metal water quality criteria should be expressed as dissolved (USEPA, 1994b). Thus, the metal concentration data available through STORET may overestimate toxicity potential within the study area. Finally, measurements were typically made monthly or less frequently at a given location. Therefore, duration of a given metal concentration is not known.

Appendix G, Figure G-9 shows the range of annual average copper values in the study area, downstream to upstream, as compared to the above chronic water quality standard. To demonstrate the large scale patterns in the data, three values are plotted: 1) the average value of all annual medians for all years at each monitoring site; 2) the lowest annual median observed at each site; and 3) the highest annual median observed at each site. Figure G-9 summarizes approximately 200 data points for samples collected during summer months, predominantly between 1985 and 1992.

Based on available STORET data, the following observations were made:

- Average copper values in most of the study area were below 10 μgL^{-1}, or the estimated chronic copper standard.

- Most monitoring sites exhibited peak annual copper levels above this standard. This means that for at least one year in eight years of record, the annual median copper value was above the toxicity standard. For the period of record, maximum observed copper concentrations were highest at the downstream end of the study area in the tail end of New Cumberland and Montgomery Pools (100 and 84 μ/L, respectively). Relatively high maximum concentrations (4 times the chronic criterion) were also observed in Dashields Pool and around RM 24.0 in Allegheny Pool 3.

- Based on data obtained from STORET, it is difficult to identify localized areas with elevated copper levels; the entire study area is susceptible to elevated copper levels.

An ORSANCO study indicated that AMD is a key source of elevated metals (particularly zinc, see below) in the Allegheny and Ohio Rivers, particularly downstream of the confluence with the Kiskiminetas River (Allegheny RM 25). Some improvements in pH and acidity have been measured over time due to AMD controls; however, it is unclear that overall metal or sulfate concentrations have changed. Other potential sources include industrial wastewater discharges, urban runoff, combined sewer overflows, and possibly resuspension of sediment metals following storms or other disturbances.

Zinc. Zinc was also considered to be a reasonable indicator of pollutant impacts in water and is especially relevant in the study area because it is a common component of acid mine drainage, which continues to be a dominant source of water quality degradation in the study area (Anderson et al., 2000).

Based on median hardness for all monitoring stations evaluated in the study area of approximately 107 mgL^{-1} as $CaCO_3$, the zinc chronic toxicity standard used for this comparison was 109 μgL^{-1}. Only 1% of the monitored zinc values in the Upper Ohio and Lower Allegheny watersheds were reported to be at values above the chronic zinc toxicity standard.

Appendix G, Figure G-10 indicates the range of annual average zinc values in the study area, downstream to upstream, as compared to DEP's chronic toxicity standard. To demonstrate the large scale tendencies in the data, three values were plotted: 1) the average value of all annual medians for all years at each monitoring site; 2) the lowest annual median observed at each site; and 3) the highest annual median observed at each site. Figure G-10 summarizes approximately 250 data points for samples collected during summer months, predominantly in 1982 and 1983.

STORET data indicated the following:

- Average zinc values in most of the study area were at or above the estimated zinc aquatic toxicity standard of 109 μgL^{-1}.

- Most monitoring sites experienced peak annual zinc levels greater than 109 μgL^{-1}. Relatively high maximum concentrations were observed at New Cumberland Pool (400-500 μg/L) and at RM 24.0 in Pool 3 (approximately 2000 μg/L).

- Based on the data obtained from STORET, it appeared that the Kiskiminetas River, entering the Allegheny River upstream of Station A24.0, is one of the major sources of zinc.

3.3.6 Sediment Quality

The USEPA performed a national survey of sediment contamination in 1996-1997. It resulted in an assessment of sediment quality that used thresholds of draft sediment quality criteria, sediment quality advisory levels, effects of range-median values, effects of range-low values, probable effects of levels, threshold effects levels, apparent effects thresholds, and several thresholds based on USEPA and Food and Drug Administration (FDA) values. The National Sediment Inventory (NSI) describes the levels of chemical contamination in the bottoms of waterbodies, and develops screening level assessments of the potential for adverse effects on human and ecological health. It should be noted that data used by USEPA for the NSI evaluations may, in many cases, be nearly 20 years old.

Segments or areas of waterbodies in which 10 or more sampling stations or 75 percent of all sampling stations were classified as having possible or probable effects and were designated as areas of probable concern (APC). In these analyses, the NSI found the middle and lower Allegheny watershed HUC's to contain no APC's.

There are two mainstem sample locations: NSI Station Nos. 10691 and 7812 (Figure G-11; Table G-5, Appendix G). The former is in the Allegheny River at New Kensington, PA, and was rated as Tier 1 ("probable" adverse effects) with a variety of pesticides being detected. PADEP and USEPA have limited sediment chemistry data indicating elevated Polychlorinated Biphenyls (PCBs) and the pesticide chlordane from Lock and Dam 3 near Oakmont to the Point in Pittsburgh, as mentioned above.

The sample evaluated from the Ohio River near Ohioview, PA (RM 32.0) showed elevated zinc in a sediment sample, and was considered as Tier 2 (adverse effects possible). Three sub-watershed tributaries, (Figure G-11), were represented by 1, 1, and 26 NSI sample locations, respectively.

Tributaries to the Allegheny and Ohio Rivers (Figure G-11), were assessed by the NSI as having little or no problem with contaminated sediment. Thus, there is little reason to suspect that contaminants are entering the mainstem via these inflows. A tributary to the Ohio River is represented by a total of 26 sampling locations (Figure G-11). Of those samples, 22 (or 85%) were categorized as Tier 2 sites, that is, as having "possible adverse effects" from contaminated sediment. Principal contaminants reported in those samples were metals (zinc, lead, nickel, cesium, and cyanide). However, this subwatershed tributary enters the mainstem 0.5 miles upstream of the state border, and the terminus of the study area. Even if this inflow was contaminated, there would be a low probability of coincidence with dredging activities under consideration.

In general, sediment contamination may be a relatively minor issue because the sediment particle size is fairly large for the most part (sand, gravel, and cobble), which is not likely to readily adsorb or concentrate contaminants (USEPA, 2000; 2001).

In a preliminary evaluation of sediment quality for the study area, sediment toxicity and chemistry analyses were conducted at two sites, one in Pool 5 in the Allegheny River and one in New Cumberland Pool in the Ohio River (Exhibit B). Whole sediment toxicity tests of sediment collected upstream of active dredging indicated little or no toxicity in 10-day tests using either the amphipod *Hyalella azteca* or the midge *Chironomus tentans* as compared to control sediments (Appendix G; Figures G-12, G-13, respectively) although sampling was very limited. Sediment chemical analyses indicated some toxicity or bioaccumulation potential of contaminants at New Cumberland Pool site but not the Pool 5 site (Table G-6). The sediment sample collected from New Cumberland Pool had PAH and lead concentrations slightly in excess of NOAA's toxicity threshold values but not Ontario Ministry of the Environments' Sediment Effect Level (Persaud et al., 1993), suggesting low potential for toxicity. The detection limit for PCBs was not low enough to accurately evaluate toxicity potential of that parameter in these samples. Limited sediment chemistry

data collected by US Geological Survey in 1996 near New Kensington in Pool 3 of the Allegheny River also suggested slight surface sediment contamination at threshold toxicity levels for lead, zinc, copper, DDT metabolites, and PAHs (Anderson et al., 2000). Again, these data represent only a few sites in the study area, sampled only once, and should not be viewed as definitive.

3.3.7 Aquatic Toxicity Evaluations

Ambient Water Toxicity. A preliminary evaluation was conducted at two actively dredged areas during the preparation of this document (see Section 2.5). Acute toxicity tests indicated no effects on organism survival downstream of dredges to either *Ceriodaphnia* or the fathead minnow, both of which are USEPA-approved test species (USEPA, 1993) (Appendix G; Figure G-14). Chronic toxicity tests using *Ceriodaphnia* and fathead minnows also showed no effects on either of the two upstream water samples tested (Appendix G; Figures G-15 and G-16). All test treatments were statistically similar to the controls with the exception of *Ceriodaphnia* reproduction for the downstream sites in the Ohio River; the downstream sites produced significantly more offspring than the upstream site or the controls. Results from these ambient toxicity tests suggest little potential for toxicity in the water column under relatively low flow conditions. However, these tests were conducted only once and at few locations so they should be regarded as preliminary.

Resuspended Metal Bioavailability. As mentioned previously, total metal does not necessarily yield the toxic amount of metal present. Water Effect Ratio (WER) toxicity testing is one direct measure of the bioavailable or toxic metal present (USEPA, 1994). A WER = 1.0 suggests that metal is no more toxic at the site than that given in the EPA criteria. A ratio > 1.0 indicates that the criterion is too conservative; i.e., the metal is less toxic than expected.

After necessary hardness adjustments were made to the laboratory toxicity data to allow both river and laboratory water data evaluation for the same hardness (USEPA, 1994), the Ohio River sample exhibited a WER approximately equal to1.0 for zinc, and a copper WER of 2.92 indicating that the site water has the capacity to buffer the toxic effects of copper by nearly 3 times and that zinc was not significantly buffered as compared to the national criterion (Appendix G; Tables G-7 and G-8). The Allegheny River WER for copper was 1.28, also indicating some buffering capacity of the site water for copper and the WER for zinc was 0.86 indicating normal surface water buffering capacity of the Allegheny River for zinc. Although these determinations of copper and zinc WERs for both rivers were conducted at a screening level (only 1 test using 1 test species), the results suggest that copper is probably not as bioavailable as assumed in the study area and that the criterion could be higher. Results for zinc, however, indicate that there is little potential for 'buffering' effects in the rivers, and that zinc in the water column could be judged on the basis of national and PADEP criteria.

3.4 BIOLOGICAL RESOURCES

Many sources of published or previously available information were used for this section, which are summarized in Table I-1, Appendix I and/or included as literature cited herein. Table I-1 lists researchers, years of collection, location and number of sampling sites, data type, and other data characteristics for the compilation of aquatic resource information. In addition, as noted in Section 2.5 of this document, some biological sampling was also conducted as part of this EIS.

3.4.1 Flora

3.4.1.1 Plankton

Very few studies have focused specifically on phytoplankton and zooplankton of the Allegheny and Ohio Rivers. In general, phytoplankton populations within the study area are environmentally regulated by light, temperature, nutrients and predation by zooplankton. If toxic levels of contaminants are present they may have local and temporary adverse effects on populations. High algal densities or algal blooms indicate excessive nutrients in the water column. The phytoplankton community includes six major groups: Cyanophyta (blue-green algae), Chlorophyta (green algae), Chrysophyta (golden-brown algae), Bacillariophyta (diatoms), Cryptophyta (often associated with algal blooms), and Microflagellates (Appendix I, Table I-2).

The density of algae in the study area was monitored annually during the summer by the U.S. Army Corps of Engineers. During this peak production period, blue-green algae, green algae and diatoms were predominant in most samples. These data should be viewed qualitatively because sampling effort was not consistent across pools or across time. Mean algal densities appeared to be highest in Emsworth Pool and Pools 7 and 8. Densities appeared to be lowest in Pools 3 and 4 and the upper portions of Pool 9. The lower algal densities in Pools 3 and 4 may be attributable to the higher metals and acidity there historically due to the Kiskiminetas River. Compatible data were not available downstream of Ohio River mile 13.5.

The localized patterns of phytoplankton productivity suggest that nutrient availability is a major cause of variation, assuming that light and temperature are consistent throughout the system. Predation regulation by zooplankton or planktivorous fish is a secondary source of variability while the presence of toxic contaminants is probably a less likely source of variation. Local nutrient elevation in Pools 7, 8, and Emsworth are suspected. The suppression of algal productivity in the upper part of Pool 9 may result from nutrient assimilation in upstream reaches and decreased local nutrient input. Other possible causes of lower productivity include excessive light attenuation by local suspended solids concentrations, unusually high predation rates by zooplankton, or local contaminant presence.

3.4.1.2 Periphyton

Very few studies have focused specifically on the periphyton assemblage in the Allegheny and Ohio Rivers. Assemblage information reported by the USACE (1980, 1981) indicated that diatoms (Bacillariophyceae) are predominant in both rivers. Over 95% of the periphyton species in the Ohio River study area was reportedly composed of Bacillariophyceae. Diatoms were similarly dominant in the Allegheny River study area, followed in abundance by a few species of green algae (Chlorophyta: *Oedogonium*, *Pediastrum*, and *Scenedesmus*) and blue-green algae (Cyanophyta: *Lyngbya* and *Oscillatoria*). Diatoms are recognized as the dominant form of periphyton in most rivers that have low-moderate nutrient levels (USEPA, nutrient criteria).

3.4.1.3 Submergent and Emergent Aquatic Plants

Submerged aquatic vegetation (SAV) mapping studies from 1998 (Normandeau Associates, 1998) have indicated that SAV coverages within the study area are generally sparse, and are typically associated with shorezone, tributary confluence, and island margin areas (Appendix I, Figures I-1 to I-7). Emergent vegetation is dominated by water willow (Justicia spp.) and SAVs are primarily Eurasian milfoil (Myriophyllum spp.) and tape grass (Vallisneria spp.). Total coverage of SAVs (by pool) ranged from 0% in Dashields and New Cumberland pools to 20.6% in Allegheny Pool 6 (Table 3-6). Dense growth of SAV (> 70% coverage within zones containing SAVs) was noted in Allegheny Pool 6, immediately adjacent to Ross Island and the Crooked Creek confluence. When present, SAVs in all other pools of the study had typically less than 10% coverage.

3.4.2 Fauna

3.4.2.1 Zooplankton

Zooplankton are subject to variable and sudden fluctuations in population density, and are subject to environmental constraints similar to phytoplankton, with the added requirement of food resource availability. Therefore, zooplankton density typically increases in response to phytoplankton density, which peaks in midsummer. Protozoa, Rotifera and Crustacea compose the bulk of the zooplankton community (Appendix I, Table I-3).
The zooplankton community was monitored monthly at a single station (Ohio River mile 34.8) during the 1970's and ‘80's. Those data indicated that increased turbidity and current from high water conditions had the strongest effects of delaying population peaks and temporarily decreasing total zooplankton densities at the sample station. Peak densities were recorded in midsummer. The community was consistently dominated by Protozoa, with Rotifera second in abundance and Crustacea relatively uncommon. The relative lack of lentic crustacea such as cladocera or copepods is typical of riverine systems, particularly those that have current velocities > 0.5 cm/sec (Wetzel, 1975).

Table 3-6
Submerged Aquatic Vegetation (SAV) Coverage in the Allegheny and Ohio Rivers (Normandeau Associates 1998)

		SAV Coverage Type		Total SAV Coverage	
River	**Pool**	**%**	**Acres**	**% of Pool**	**Acres**
Allegheny	6	< 10%	132.8		
		10-30%	26.9		
		30-70%	11.6		
		> 70%	63.7		
				20.6%	235.0
Allegheny	5	< 10%	7.2		
				1.2%	7.2
Allegheny	4	< 10%	7.1		
				1.0%	7.1
Allegheny	3	< 10%	77.5		
		10-30%	45.2		
		30-70%	6.7		
				11.0%	129.4
Allegheny	2	< 10%	0.2		
		10-30%	5.3		
				0.5%	5.5
Allegheny and Ohio	Emsworth	10-30%	6.2		
				0.3%	6.2
Ohio	Dashields	0%	0		
				0%	0
Ohio	Montgomery	< 10%	18.4		
				0.6%	18.4
Ohio	New Cumberland	0%	0		
				0%	0

3.4.2.2 Benthic Macroinvertebrates

Researchers have studied various aspects of the benthic macroinvertebrate assemblage in the vicinity of the study area; however, much of the resulting information is not available in the peer-reviewed, published literature. Requests for pertinent information, data, and reports (via literature searches, telephone interviews, and formal letters of request) yielded 26 contemporary sources of benthic macroinvertebrate composition/abundance information (Appendix I Table I-1). Much of this information is composed of data collected by Aquatic Systems Corporation, ORSANCO, and the October 1991 interagency study (PFBC, 1997a). Although collection methods varied among researchers (Ponar grab or Hester-Dendy sampling), the compilation of information is suitable for characterizing taxa presence within the study area. In addition to the review of existing information, Ponar sampling (including diver assisted sampling to ensure closure of the ponar) of benthic macroinvertebrates was conducted during this EIS in dredged areas of four pools on the Allegheny and two pools of the Ohio River.

Table 3-7
A Summary of Biological Metrics for Benthic Macroinvertebrate Assemblages of the Allegheny and Ohio Rivers

	Allegheny	Allegheny	Allegheny	Allegheny	Allegheny	Allegheny	Ohio	Ohio	Ohio
Pool	**8**	**6**	**5**	**4**	**3**	**2**	**Dashields**	**Montgomery**	**New Cumber-land**
% Chironomidae	27.57	25.44	18.75	14.71	74.52	75.52	46.85	63.07	11.54
Shannon-Wiener	2.90	2.84	2.36	1.87	1.93	2.12	2.25	2.79	2.90
% EPT	26.64	28.07	65.63	73.53	0.81	2.07	7.03	3.14	0.14
% Ephemeroptera	26.64	27.19	65.63	73.53	0.00	0.66	0.19	0.41	0.04
% Diptera	57.01	29.82	27.08	17.65	74.52	75.52	46.85	63.42	11.72
% Oligochaeta	7.01	35.96	3.13	4.41	3.23	0.66	0.29	2.28	83.97
% Filterers	8.41	1.75	3.13	5.88	0.81	1.58	11.43	15.75	2.68
% Collectors	50.93	87.72	75.00	85.29	89.84	76.18	42.05	70.16	69.77
% Predators	38.32	8.77	18.75	7.35	0.48	0.17	0.10	1.93	4.62
Total taxa	15	17	14	13	12	13	18	27	134
EPT taxa	1	4	3	3	1	3	3	4	17
Diptera taxa	10	6	7	7	6	6	10	16	44
Non-Oligochaeta Taxa	14	16	13	12	12	12	18	26	129
% Dominant Taxon	28.97	35.96	58.33	70.590 .2	59.03	49.13	40.02	33.69	52.07
Hilsenhoff Biotic Index	7.77	8.34	6.46	6.425 .3	9.38	8.90	7.82	9.00	9.51
Tolerant Taxa	5	7	3	5	6	6	5	10	30

Previously collected information (cited in Appendix I Table I-1) yields a total of 213 taxa within the study area, the greatest number of which are in the order Diptera (Appendix I Table I-4). Ranked abundances of taxa reported from the Allegheny River study area suggest that the chironomid *Dicrotendipes*, Oligochaetes (worms), and the Turbellarian *Tricladida* accounted for 68% of macroinvertebrate abundance (Table I-4). The Ohio River macroinvertebrate assemblage in the study area was dominated by Oligochaetes, the Tubificid worm *Limnodrilus*, and the Naidid *Paranais*, collectively comprising 70% of all macroinvertebrates collected (Table I-5).

Structural and functional attributes of the benthic macroinvertebrate assemblage were characterized by tabulating 16 ecological measures or metrics (Table 3-7). Again, these data should be viewed with caution because different sampling methods and sampling effort were used to collect macroinvertebrates in different locations over time. Taxa richness measures, functional feeding group composition, and pollution tolerance metrics were calculated for Allegheny Pools 8, 6, 5, 4, 3, and 2, and for Dashields, Montgomery and New Cumberland Pools in the Ohio River. Taxa richness was consistently low (12-18 taxa) from Allegheny River Pool 8 through Dashields Pool, but increased to 27 and 134 total taxa in Montgomery and New Cumberland Pools, respectively. Macroinvertebrate samples categorized by sampling location within pools did not yield informative results because most samples were collected from mid-pool areas whereas pool head and tail samples were fewer in number, and thus under represented.

Midges (Chironomidae) were the dominant type of benthic invertebrate collected in Allegheny Pools 3 and 2, and in Dashields and Montgomery Pools; mayflies (Ephemeroptera) were rarer in comparison. In contrast, mayflies were abundant in Allegheny Pools 5 and 4 (65 and 73%, respectively) and common in Pools 8 and 6 (26 and 28%, respectively). Most mayflies were of the genus *Hexagenia*, a burrowing mayfly common to large rivers and sandy substrates. *Hexagenia* were common in Allegheny River samples, particularly in dredged area samples (See Section 4.2.4 and Appendix I); however, they were relatively rare (as were all Ephemeropterans) in Ohio River samples (Figure I-8).

Functional feeding group designations, which are indicative of the trophic balance in the assemblage (Merrit and Cummins, 1996), indicated that the majority of individuals collected throughout the study area were collector-gatherers, as expected for large riverine habitats. Tolerance ratings (based on sensitivity to toxics, organic enrichment or low dissolved oxygen) of the taxa collected indicated that most were classified as moderately tolerant. The number of tolerant taxa appeared to increase in the downstream pools of the study area (Montgomery and New Cumberland) (Table 3-7).

Data collected via diver-assisted Ponar sampling (to ensure closure of the ponar) in October 1999 at three undredged, submerged pipeline transects (RM 26.3, Pool 4, RM 47.2, Pool 7, and RM 54.7, Pool 8), indicated low macroinvertebrate densities (average of 5.9 individuals/sq. ft) and relatively few taxa (average of 7 taxa per 300 ft transect), typical of many navigable, large rivers in the U.S. (Ohio EPA, 1998). Depths averaged around 15 ft at these undredged pipeline areas. The dominant taxa were Oligochaetes (worms), the

burrowing mayfly *Hexagenia*, the Asiatic clam *Corbicula* and several Chironomid (midge fly) genera. These results suggest that deeper locations of the study area have relatively sparse macroinvertebrate populations. A similar trend was observed in the Pool 5 and 6 interagency study (PFBC, 1997a).

3.4.2.3 Freshwater Mussels

General Information. Being relatively immobile, freshwater mussels are particularly vulnerable to physical and chemical degradation of waters and sediments. Preferred habitat conditions or habitat requirements of freshwater mussels in large rivers are largely unquantified due to the difficulty of sampling in deep water/channel environments (Holland-Bartels, 1990). Mussel distributions in large rivers have been examined by investigators using diving methods (Thiel, 1981; Duncan and Thiel, 1983; Miller, 1988), but quantitative evaluations of habitat are generally lacking.

Fish hosts are largely responsible for the distribution and zoogeography of unionids. Therefore, mussels are influenced by distributional barriers to their hosts, as well as barriers to their own movements. Dams were recognized as barriers to fish movement as early as the beginning of the twentieth century (Coker, 1914). Numerous researchers have documented the reduction in fish species diversity attributable to the barrier effects of dams (Branson, 1974; Hubbs and Pigg, 1976; Unkenholz, 1986; Alexander, 1987; Stuebner, 1993; Collier et al., 1996). For freshwater mussels, this means that host dispersal may be restricted, and in worst case, hosts are not accessible to mussel glochidia or larvae. The latter scenario has been implicated in the decline of mussels in several areas (Burkhead et al., 1992; Jones, 1991; Suloway et al., 1981). Watters (1996) found that dams as low as one meter in height restricted the distribution of some mussel taxa. Even if fish are not absolutely trapped, the route they must take to surmount dams (and locks) are at best circuitous (Watters, 1995).

Many species of freshwater mussels live in free-flowing waterways, however, some have adapted to lacustrine environments (Watters, 1994). Although environmental requirements are apparently species-specific, a number of generalities have been documented. Sediment type clearly affects distribution patterns. Riverine mussels are generally most successful in stable, coarse sand or sand-gravel mixtures, and are generally absent from substrata with heavy silt loads (Cooper, 1984; Salmon and Green, 1983; Stern, 1983; Way et al., 1990). Apparent differences in substratum preferences may be associated with species-specific differences in optimal water velocities. Mussels are most successful where water velocities are low enough to allow sediment stability, but high enough to prevent excessive siltation (Salmon and Green, 1983; Stern, 1983; Way et al., 1990), making well-oxygenated, course sand and sand-gravel beds optimal habitats for riverine species. Good water quality is also necessary for mussel establishment.

Water depth may or may not affect mussel distribution. Previously collected mussel brailing data compiled for this EIS suggested that water depth might be important with both mussel taxa richness and abundance being highest at approximately 12 feet, and declining at depths greater than 30 ft (Tetra Tech, 1997). Another factor related to the presence of mussels (and

closely related to depth) was distance from shore (Tetra Tech, 1997). Mussel abundance was greatest within 100 feet off-shore, and mussel species richness was highest between 100 and 200 feet from shore as compared to greater distances offshore. Previous analyses of mussel brailing data collected in Allegheny Pools 3, 4, 5, 7, 8 and New Cumberland and Montgomery Pools of the Ohio River in support of dredge permits (a total of 1,348 brail tows, each 200 ft in length at > 270 sites) suggested a relationship between depth (and concurrently, distance from shore) and mussel presence or absence, with substrate type (percent sand and gravel) being a secondary factor (stepwise multiple discriminant analyses, $F = 28.4$, $p < 0.001$ for the model; Tetra Tech, 1997). These data also suggested significantly greater mussel abundance at depths < 20 ft. These relationships, however, should be viewed with caution because the brailing sampling method is inefficient, particularly in deeper water. Although most freshwater mussels have been collected in shallow water habitats, i.e., less than 4-10 m water depths (Mackena and Kautsky, 1988; Salmon and Green, 1983; Stone et al., 1982; Way et al., 1990), this may be a function of differences in sampling efficiency with depth, and/or a reflection of other more direct factors. More recent dive sampling, in the course of developing this document, has suggested that substrate particle size and particle heterogeneity, as well as current velocity, may be the most critical factors affecting mussel distribution in the study area. As these factors are often inversely correlated with depth in the study area, and in many other navigable rivers, depth appears to be a significant factor affecting mussel distribution. However, there are clearly several unknowns regarding habitat factors affecting mussel distribution. Other studies have reported mussels in fairly deep locations (> 50 ft.) if substrate, food availability, and water quality (e.g., oxygen) are satisfactory. To date, the most reliable means to detect appropriate mussel habitat is to sample the mussels through an effective sampling protocol. Many researchers report that, given no recent disturbances, mussels will indicate, through their presence or absence, those areas that are habitable.

Cannalization of drainage systems for navigation or flood control has been shown to limit the abundance and distribution of some mussel species. The compilation of existing brailing data suggested that mussel richness and abundance is highest at the upstream (head) and mid-sections of the pools, and lowest at the downstream (tail) portion of pools (Figure I-9). These data also suggest that peaks in abundance and richness in downstream or tail portions of pools occur at deeper average depths (e.g., 15-20 ft) than in upstream or mid-sections (e.g., 5-15 ft) of Allegheny/Ohio River pools. Mussel diving results in support of dredge permits (Exhibit B; Tetra Tech, 1999) suggested that mussel taxa richness was greatest at the head (upstream) and mid-sections of pools, at depths averaging between 10 and 35 feet (Figure I-10), consistent with data collected previously. However, shallow, nearshore areas were not sampled in these surveys because these are currently restricted from dredging.

Impoundment generally decreases current velocity, resulting in greater accumulation of silt and lower current velocities, both of which can affect the distribution of mussel fauna (Duncan and Thiel, 1983; Parmalee and Klippel, 1984; Starnes and Bogan, 1988; Stern, 1983). However, native mussels have been collected throughout the study area suggesting that at least some species are able to tolerate present conditions in the rivers.

Increased flow velocity and propeller wash, resulting from barge traffic and other commercial traffic, elevate suspended solids, which could interfere with mussel filter feeding and oxygen consumption (Aldridge et al., 1987; Payne and Miller, 1987). Natural predators also can have an impact on mussel populations. For example, muskrats have been observed to consume approximately 37,000 mussels per year in some systems (Watters, 1994). Other mussel predators include fishes, raccoons, and birds. Additionally, mussel growth and reproduction may be inhibited by parasitic infection (i.e., mites, trematodes, leeches, and certain chironomid larvae) or from competition with exotic bivalves such as *Corbicula* (Asiatic clam) and *Dreissena polymorpha* (zebra mussel). The latter species has been implicated in causing the decline of many native freshwater mussel species in the Great Lakes, Tennessee River drainage, the Mississippi River, and parts of the lower Ohio and Missouri Rivers. The effects of zebra mussels on native mussels are both direct (attaching in large masses to the shells of native mussels) and indirect (competing for space and planktonic food). Zebra mussels have been collected in the study area up to Lock 7 on the Allegheny River but do not yet appear to be as established as they are in Lake Erie or in the lower Ohio River.

Site-Specific Information. Freshwater mussel information specifically related to the Allegheny and Ohio River study area was obtained via literature searches, telephone interviews, and formal letters of request. In addition, Pennsylvania Fish and Boat Commission files were reviewed for data relevant to the study area. The compilation of recent mussel resource information yielded a total of 20 applicable surveys (Appendix I Table I-1), most of which were conducted by U.S. Fish and Wildlife Service, Pennsylvania Department of Environmental Protection, and Aquatic Systems Corporation. Most of these data were collected using brailing as the sampling method. Although brailing was thought to be a reasonable qualitative sampling method, recent comparative sampling by PADEP in 1999, has demonstrated that brailing is inefficient, particularly in rockier substrates common in the mid and upper Allegheny River. As a result, mussels were probably under-sampled using brailing and certain species (particularly small or thin-shelled species) may have been undetected. Results from more recent dive sampling, during the development of this EIS, suggest generally a greater number, and wider distribution, of certain species in the study area than previously thought. It is not known whether the apparent increase in mussel species richness is due to improved water quality, better sampling methods, or both.

A systematic survey of mussels over the entire study area has never been performed so it is not possible to statistically compare species diversity, density, or mussel habitat among pools or even different parts of the same pool. However, some general information regarding the mussel fauna in the study area can be presented here.

Compilation of previous studies indicated the presence of 34 mussel species within the study area (Table I-6). A total of 19 species were reported from both the Allegheny River (Table I-7), and the Ohio River (Table I-8). Within the Allegheny River portion, fluted-shells, spikes, and fat muckets accounted for 68% of all mussels collected (Table I-7). Percent abundance in the Ohio River portion was dominated by Mapleleaf, Threeridge, and Asiatic clams, collectively comprising 76% of the total mussels collected (Table I-8).

Diver mussel sampling was conducted in eight previously dredged and adjacent shallow areas of Allegheny Pools 8, 6, 5, and 4, and New Cumberland Pool on the Ohio River in support of this document (see Section 2.5). All sites were dominated by mid- to large-sized individuals (> 60 mm, Exhibit B: Figure 3-49 and Appendix G). Two areas of Pool 6 exhibited the greatest variability in number of individual mussels and taxa richness in that survey. Mile point 39.4 yielded 1 mussel, and Mile Point 43.1 yielded 110 mussels, demonstrating the patchy distribution of mussels. The density of mussels at the two sites was apparently unrelated to depth (8.5 m and 10.1 m), minimum dissolved oxygen, or particle size distribution, but may have been related to spatial orientation in the pool and/or stream velocity. A similar study conducted in October 1999, using dive sampling, collected a total of six species, most of which are commonly collected in the study area, in historically undredged areas (submerged pipelines) in 300 ft transects in Pools 4, 7, and 8 (Exhibit C: Table 3 and Appendix F). The maximum number of mussels collected per 300 ft transect in that survey was 9 at RM 47.1 in Pool 7.

Intensive dive and quadrat sampling conducted by the USFWS and others have reported mussel densities between 3 and $10/m^2$ in moderately deep water (15-30 ft); and > $20/m^2$ in shallow areas (< 10 ft depth) near the East Brady Bridge and further upstream in the non-navigable part of Pool 9 (Appendix I, Table I-9). A USFWS brailing survey conducted in Pools 8 and 9 in August 1996, yielded a total of 360 mussels representing 11 species with over 90% of the brail tows averaging 1.1 mussels/brail run. Densities were comparable in the two pools: 1.3 and 0.9 mussels/brail run in Pools 9 and 8, respectively. Limited diving surveys, also conducted in these two pools by USFWS in 1999, yielded comparable results in terms of abundance and species richness.

In another USFWS survey conducted in September 1990 in Pools 5 and 6 (PFBC, 1997a), 10 species were collected by brailing in both pools together and the number per brail tow was similar in both pools (0.957 and 0.975 in Pools 5 and 6, respectively). Only relatively preferred mussel habitats were sampled in this study - outside bends of the river, head ends of islands, and water less than 25 feet deep. The total number of mussels collected in Pool 6 was greater than that collected in Pool 5, however, there was greater sampling effort (i.e., more brail tows and more preferred habitat area sampled) in Pool 6.

Habitat preferences for the mussel species inhabiting the study area, have not been well-defined for the most part. Furthermore, until recently (1998), there has not been rigorous sampling of mussels, and their habitats within the study area. Available dive sampling data, along with videotaped footage of the bottom habitat (a total of 72 dives as of December 31, 2000) indicated relatively high mussel density and diversity adjacent to Murphy's Island in Pool 5 in <15ft of water, and near RM 58 in Pool 8, in <15 ft of water. Thus far, similar dive sampling in several locations within New Cumberland and Montgomery Pools in the Ohio River, and in Pools 3, 4, 5, and 8 in the Allegheny River, have yielded <10 total mussels and <3 species in 200 ft transects. Since much of these data were collected in support of dredging permits, surveys were performed a minimum of 200 ft offshore and in areas that would otherwise meet current PADEP and ACOE permit conditions. Therefore, the above

data are not necessarily indicative of river-wide conditions in the study area as a whole. However, recent sampling, thus far, supports the assumptions used in the Pool 5 and 6 interagency study (PFBC, 1997a) that mussels may prefer shoreline areas, head ends of islands, and other relatively shallow, undisturbed areas within the study area.

3.4.2.4 Fishes

General Information. The specific microhabitat requirements of each of the families and/or individual species is as varied as the morphological differences between the species. Some demonstrate definite habitat specificity, whereas others are so generalized in habitat requirements that they may be encountered in several habitats. A further complication is that habitats occupied by fishes may differ based on life stage. For example, eggs of a particular species of fish may require flowing water for a successful hatch whereas the larvae need slack water nursery refugia and the juveniles need protective cover. Feeding preferences, or the location of food/prey, may also dictate the habitat utilized by a particular fish species. These factors reflect the complexity of the relationship between specific physical habitat components and fish species.

Despite the inherent complexity of the habitat requirements of fishes, it is possible to identify the primary habitat factors that influence and/or determine the integrity of the fish assemblage. Karr et al. (1986) identified five major environmental factors (abiotic and biotic) that affect aquatic resource integrity including: energy source, water quality/chemical variables, habitat quality, flow regime, and biotic associations. Stressors, either natural or anthropogenic, that affect any of these factors will in turn influence the integrity of the fish assemblage.

Substrate type and availability, flow regime, and silt load are all important elements that could potentially affect the ichthyofauna. These elements are particularly important factors determining breeding success since most fish have fairly well-defined spawning/breeding habits and requirements. The great majority of freshwater fishes spawn on a solid surface and/or in rock or gravel substrata. Other species dig pits in gravel (e.g., the central stoneroller) in which eggs are laid. This requires that the gravel be of a suitable size, and be relatively free of silt and sand. Still other species make piles of small stones (e.g., some chubs and minnows) through which water passes freely, bringing oxygen to buried eggs. In general, species that construct nests or redds are restricted not only with respect to the size of the material of the substratum (which they must be able to manipulate), but they need to be free of silt (and in some cases need intro-gravel flow of water). Many riverine species spawn on gravel or stones but build no nests. This group of fishes generally moves onto clean gravel in swifter/shallower water (than their normal adult habitat) to spawn. There are also several riverine species that “broadcast” buoyant or semi-buoyant eggs into the water column which simply float or are carried downstream during the incubation period. For all breeding guilds of fishes (with the possible exception of broadcast spawners), habitat requirements for a successful spawn can be very restrictive, and consequently, suitable breeding sites may be limited. With most species, including broadcast spawners, “clean” substrates are necessary

for successful incubation, and aberrant loads of silt or suspended solids may have detrimental effects.

Impoundment and decreased peak flows prevent water from inundating floodplains, which in turn reduces the recruitment of spawning gravel from the floodplain, and decreases prime habitat for productive foraging and refuge. Reductions in floodplain inundation can result in decreased species diversity and standing crop of fish (Finger and Stewart, 1987; Pollard et al., 1983; Welcomme and Hagborg, 1977; Wharton et al., 1982; Zalumi, 1970). River navigation also impacts fish populations through operation and maintenance, vessel movement, and associated development. Impoundments create more water area, but limit fish migration and intensify siltation. However, despite these potential problems, fish populations in large U.S. rivers, including the Ohio and Allegheny Rivers, have improved in recent decades because of water pollution abatement and more attention to navigation-fisheries interactions (Nielsen et al., 1986).

Site-Specific Information. The study area, and the Allegheny River in particular, is the result of direct and indirect consequences of glacial action in Illinoian and Wisconsinan times (see Section 3.2.2). Virtually all of the northern and western tributaries of the Allegheny (after it reenters Pennsylvania from New York) were developed in glaciated areas, whereas tributaries to the south and east lie wholly in unglaciated areas (Hocutt and Wiley, 1986). Raney (1938) conducted a cursory examination of Allegheny River fish assemblages in relation to their occurrence on glaciated and nonglaciated areas. Trautman (1957) found this to be an important phenomenon in Ohio, with some species showing distinct habitat preference for glacial till. Generally, the ichthyofauna of the upper Ohio River Basin is composed largely of widespread species, and the basin drainages have diverse faunas but no endemics. Hocutt and Wiley (1986) report 92 native fish taxa, 10 introduced species, 1 euryhaline species, and 0 endemics for the Allegheny River.

Surveys of the Allegheny/Ohio River study area reported in USACE (1980, 1981) yielded 73 fish species representing 15 families. In order to characterize the contemporary ichthyofaunal resources of the Allegheny and Ohio River study area, searches for pertinent information were conducted via literature reviews, telephone interviews, and formal letters of request. An additional search technique involved the review of Pennsylvania Fish and Boat Commission files for data relevant to the study area. Regulations require that all scientific investigators obtain a Scientific Collector's Permit from the Commission to allow the sampling of aquatic fauna. The Commission also requires each researcher to file a report of survey results at the end of each permit year. Those permit report forms were compiled and reviewed as part of the information retrieval process. The compilation of recent aquatic resource information yielded 63 applicable ichthyofaunal survey references (Appendix I, Table I-1). The contemporary survey information indicated the presence of 112 fish species representing 21 families (Table I-10). The majority of the species were in the families Cyprinidae (carps and minnows; 32 species), catostomidae (suckers; 14 species), Ictaluridae (bullhead catfishes; 10 species); Centrarchidae (sunfishes; 13 species), and Percidae (perches; 15 species). The cumulative catch in the Allegheny River study reach was dominated by emerald shiners, bluntnose minnows, and common carp, collectively

comprising 49% of the fish collected (Table I-11). In the Ohio River, gizzard shad, emerald shiners, and channel catfish predominated, accounting for 76% of the total catch (Table I-12).

An examination of the spatial distribution of fishes generally demonstrated increasing species richness with increasing drainage area (Table 3-8). Total species ranged from 26 (upstream) at Allegheny Pool 8, to 86 (downstream) at New Cumberland Pool on the Ohio River. A notable exception to the gradient in species richness was Emsworth Pool, located in the greater Pittsburgh area, where total taxa were reduced to levels approximating the upper Allegheny (e.g., Pool 8). The compiled information did not yield ichthyofaunal information for Allegheny River Pools 7 and 9.

In addition to species richness, nine other fish assemblage indicators (or metrics) were selected to characterize structural and functional attributes of the assemblage (Table 3-8). Fish spawning guilds have been shown to be affected by habitat quality degradation. Fish that exhibit simple spawning behavior and require clean gravel and/or cobble for successful reproduction (i.e., lithophils) appear to be the most environmentally sensitive of the spawning guilds. Simple lithophilic species information (organized by river pool) indicated results similar to the total taxa measure, in that lithophilic species were reduced in Emsworth Pool.

To further examine the potential effects of stressors on the fish assemblage, fishes known to be pollution tolerant or intolerant (i.e., sensitive) were tallied (Table 3-8) (Karr et al., 1986; Ohio EPA, 1987; Barbour et al., 1999). The number of intolerant species was reduced at Pools 8, 4, and Emsworth Pool, and the number of tolerant species increased at the lower Ohio Pools (Dashields, Montgomery, and New Cumberland). Emsworth Pool proved to be an anomalous location, with respect to the metrics examined, ranking lowest for most species richness, composition, and trophic metrics. These observations tend to reflect cumulative stressor effects in the greater Pittsburgh area, i.e., effects of urbanization.

3.4.2.5 Birds

In the state of Pennsylvania, approximately 190 species of birds have breeding populations and approximately 60 additional species are non-breeding but common (Wild Resource Conservation Fund, 1995). Less than a quarter of the species are dependent on aquatic habitats, including wading birds, diving birds, swans, geese, ducks, and kingfishers (Appendix I, Table I-13). A large variety of aquatic birds are found within the Allegheny and Ohio River corridor, where open water, vegetated riparian, beach, running water, and wetland habitat types are found.

Most aquatic bird species are wary of human activity, especially during breeding and rearing seasons. A few, notably mallard ducks and Canada geese, are relatively tolerant of human proximity. Aquatic birds obtain most of their nutrition from aquatic plants and animals, and are therefore dependent on productive aquatic ecosystems. Predatory birds are particularly sensitive to pollutants, because some toxins in the water column biomagnify and may inhibit growth and reproductive functions.

Table 3-8
A Summary of Fish Assemblage Metrics for the Allegheny/Ohio River Study Area, Based on a Compilation of Data Sources

River	Pool	Total Species	Sunfish Species	Sucker Species	Round-bodied Sucker Species	Insecti-vores	Omni-vores	Carni-vores	Intolerant Species	Tolerant Species	Simple Lithophilic Species	(Major Tribu-taries)	(Major Tribu-tary Drainage Area)	Number of Sampling Events)
Allegheny	9	0	0	0	0	0	0	0	0	0	0	3	3172	0
Allegheny	8	26	5	0	0	12	5	8	2	8	3	1	425	1
Allegheny	7	0	0	0	0	0	0	0	0	0	0	0	0	0
Allegheny	6	33	1	8	6	17	4	11	5	2	11	1	300	3
Allegheny	5	34	1	8	6	13	5	14	3	3	11	0	0	3
Allegheny	4	33	3	9	7	13	5	14	2	6	8	2	2024	3
Allegheny	3	44	4	9	7	20	6	17	6	6	11	0	0	10
Allegheny	2	40	3	9	8	16	6	17	4	7	11	0	0	5
Ohio	Emsworth	29	2	2	1	11	6	11	1	7	4	2	7594	4
Ohio	Dashields	68	6	11	8	36	9	20	8	10	14	0	0	26
Ohio	Mont-gomery	67	6	11	7	36	8	21	8	9	14	2	3284	21
Ohio	New Cumber-land	86	7	15	10	46	10	25	11	12	18	0	0	24

3.4.2.6 Mammals

There are 63 species or sub-species of mammals in the entire state of Pennsylvania (Wild Resource Conservation Fund, 1995), including 53 that may inhabit the Allegheny and Ohio River corridors. A list of mammals with ranges including the Allegheny and Ohio River corridors is provided in Appendix I, Table I-14. Smaller mammals such as mice, shrews, moles, rats, squirrels, chipmunks, and bats can ingest sufficient water from small puddles or hillside seeps, dew, and dietary moisture. Even during drought conditions, these small mammals will prefer to drink from narrow and unexposed streambanks as opposed to the more open banks of the river. In addition, small mammals are not dependent on the aquatic biological community or habitat for food or shelter, though bats may feed on the emerging adult forms of aquatic insects. The Northern Water Shrew is adapted for swimming but prefers smaller and colder streams, not large rivers.

Direct exposure to the surface water within the river channel is limited to larger mammals such as muskrats, river otter, mink, beavers, raccoons, whitetailed deer, fox, coyote, weasels, skunks, rabbits, opossums, and ground hogs. Only the muskrats, river otter, mink, beavers, and raccoons have considerable dependence on open water for food or shelter, and raccoons can use smaller water bodies for foraging. Muskrats and raccoons are generally tolerant of human disturbance; beaver are also tolerant, but to a lesser degree. Muskrats and raccoons are omnivorous and beavers are herbivorous. The predatory river otters and mink are intolerant of human activity. Muskrats are well-known predators of bivalves such as native mussels and their feeding areas along the river bank are often examined as part of mussel surveys.

Other larger mammals, like the smaller mammals, can usually find sufficient drinking water within the upland regions adjacent to the river corridor. Because of their size relative to potential predators, they may also be less timid than smaller mammals about drinking at the river's edge during dry periods. Whitetailed deer, fox, coyote, and weasels require larger contiguous natural habitat than the other species mentioned, and are somewhat more wary of human activity.

3.4.3 Federally- and State-listed Threatened and Endangered Aquatic Species and Critical Habitat

Lists of Federally- and state-listed threatened and endangered aquatic species were provided by the U.S. Fish and Wildlife Service (USFWS) (in memos dated 1997, 1999a, see Appendix J). Pennsylvania Fish and Boat Commission (PFBC) (1997a,b, 1999), Pennsylvania Department of Conservation and Natural Resources (PDCNR), and Pennsylvania Natural Diversity Inventory (PNDI) (see Appendix J, Table J-1).

Mussels. As shown in Table J-2, there were seven Federally-listed aquatic species that occur or have historically occurred in the study area. All of these species are freshwater mussels. In addition to the listed species, two species of concern are being considered for addition to the federal candidate list: rayed bean and sheepnose mussel (see Table J-2). Five of the

listed species (fanshell, pink mucket, ring pink, orangefoot pimpleback, and rough pigtoe mussels) are considered extirpated in the State of Pennsylvania, but historically occurred in the study area and currently occur in the Ohio River downstream of the proposed project area as well as in free-flowing tributaries within the navigation system. More recently, the USFWS has added an eighth species of endangered mussel (*Hemistena lata*, the cracking pearlymussel), which is also likely extirpated. The USFWS believes that these species may be rediscovered in the study area as more extensive monitoring efforts are conducted in the future and water quality conditions have improved. The other two federally-listed mussels, the clubshell mussel (*Pleurobema clava*) and Northern riffleshell mussel (*Epioblasma torulosa rangiana*), have been collected upstream of the study area in the French Creek and Allegheny River watersheds in Clarion, Crawford, Erie, Forest, Mercer, Venango, and Warren Counties, PA. Also, three Northern riffleshell mussels have been collected in Pool 8 of the study area, between RM 58 and 59, on two separate occasions. A male and female Northern riffleshell mussel were collected in dive sampling performed by McLaren Hart at RM 58.8 and 58.9, right descending bank, 200 ft. offshore and 10 feet deep. In addition, one male Northern riffleshell mussel was collected in dive sampling performed by USFWS divers at RM 58.85, 150 ft offshore of the right descending bank in approximately 11 ft of water. Additionally, this species has been found at the East Brady Bridge in Pool 9, just above the uppermost limit of the study area. Sampling reported by Smith et al. (2001) at the West Hickory Bridge in the Allegheny River, upstream of the study area, indicated that the riffleshell and the clubshell were the 3rd and 4th most abundant mussel species, respectively, out of 14 species collected in 1999. Stream depth was ≤ 6 feet at the time of sampling according to those researchers.

Available habitat information for the two federally-listed mussel species known to occur, suggests that they are typically associated with moving water with clean gravel or a mix of sand and gravel, and some water current (Watters, 1995; USFWS, 1993). Neither species apparently tolerates very fast current (Smith et al., 2001). The Northern riffleshell has been collected in quieter waters, such as the Great Lakes at a depth of greater than 35 feet on suitable substrate (USFWS, personal communication). The Northern riffleshell mussel prefers firmly packed gravel or sand. Potential habitats within the study area might include islands, nearshore areas, and the head end of pools. Given the slower current velocities common in the navigable pools, preferred habitat of these species may be scarcer in the study area than in the non-navigable portion upstream. The USFWS has not designated critical habitat for this species. Since there has not been extensive dive sampling throughout the study area, it is not known with certainty whether this species occurs in other pools of the Allegheny and Ohio Rivers. Given the potential for endangered mussels to occur in other areas, the USFWS has requested consultation between USACOE and USFWS under the Endangered Species Act.

The study area is thought to have potential habitat for the clubshell mussel. A survey conducted by the U. S. Fish and Wildlife Service collected 1 individual clubshell mussel at river mile 58.3, approximately 85 feet from shore in 13 feet of water. This sampling occurred on July 1, 2004. The clubshell mussel's historical range extends from Michigan to Alabama, and from Illinois to West Virginia (U.S. Fish and Wildlife, Region 3 website).

Currently, it is found in sections of only 12 water bodies in the U.S. Existing populations of the clubshell mussel have been reported northwest of the study area in the Allegheny River, French Creek drainage, Conneaut Outlet, Conneauttee Creek, and LaBoeuf Creek in Venango, Warren, and Crawford Counties, in northwestern Pennsylvania (Watters, 1995). The largest populations of this species thus far, appear to occur in Tippecanoe River, Indiana (Watters, 1995). The USFWS does not provide definitive information concerning this species' habitat or the probability of this species being present in the study area. Given the type of habitat where it is currently found (small to mid-sized free flowing streams that appear to have reasonably consistent base flow and probably do not get exceedingly warm in the summer), it is not clear that the study area, in general, provides habitat for the clubshell mussel. This species is apparently sensitive to impoundments and even low head dams. Watters (1995) noted, for example, that the clubshell might be able to reclaim its original distribution in Big Darby Creek, Ohio, where it once was common, now that a low head dam was removed at the Creek mouth in 1990.

Mussel experts in Pennsylvania recognize 32 additional mussel species that are considered relatively rare in the state, (Table J-2, Appendix J). The USFWS and others have collected the fragile papershell (*Leptodea fragilis*), the Lilliput (*Toxolasma parvus*), the Rayed bean (*Villosa fabalis*), Wabash pigtoe (*Fusconaia flava*), Pink heelsplitter (*Potamilus alatus*), and Mapleleaf (*Quadrula quadrula*) in the study area at various times. Thus, some of these species occur in certain parts of the study area, and may be more widely distributed than previously thought, given more dive sampling since 1996. For example, the fragile papershell mussel (*Leptodea fragilis*), considered a relatively rare state species, has been collected via diving in several locations in the study area (Pools 4, 5, and 6, and relicts in New Cumberland Pool, Ohio River).

By definition, threatened and endangered species are rare, sparsely distributed such that extensive, targeted sampling is required to accurately determine their presence. While there are mussel data for over 1,000 different sampling locations in the study area, most of these data were collected using brailing rather than diving methods. Several investigators have noted that the smaller, thin-shelled threatened or endangered mussel species are under-sampled by brailing because the brail hooks are unlikely to be effective (Watters, 1995; Payne and Miller, 1987). As indicated above, more recent dive surveys have already indicated the presence of mussel species previously thought to be extirpated from the study area. Thus, information regarding the distribution and abundance of mussel species is likely to change in the near future as more of this type of sampling is performed.

Fish. No Federally-listed fish species are expected within the study area (Table J-2). The state list of endangered, threatened and candidate fishes identifies 28 endangered, 15 threatened, and 11 candidate species, many of which have been (or could be) distributed in the Allegheny/Ohio River drainage. Seven endangered species and one candidate (on the state list) are coastal species and/or have never been known from western Pennsylvania, and therefore are not expected to occur in the study area: Shortnose sturgeon (*Ichthyomyzon fossor*), Atlantic sturgeon (*Acipenser oxyrhynchus*), Hickory shad (*Alosa mediocris*), Bridle shiner (*Notropis bifrenatus*), Ironcolor shiner (*Notropis chalybaeus*), Threespine stickleback

(*Gasterosteus aculeatus*), Banded sunfish (*Enneacanthus obesus*), Eastern mudminnow (*Umbra pygmaea*).

3.4.4 Federally- and State-listed Threatened and Endangered Terrestrial Species and Critical Habitat

Lists of Federally- and state-listed threatened and endangered terrestrial species were provided by the USFWS (1997, 1999 and see also Appendix J, Table J-3), PFBC (1996 and updates), PDCNR, and PNDI (2001). The Indiana bat (*Myotis sodalis*) and bald eagle (*Haliaeetus leucocephalus*), both Federally-listed endangered species, were noted within the counties bordering the study area. In addition, a Federally-listed candidate species, the Massasauga rattlesnake (*Sistrurus catenatus*) may also utilize the study area. Based on correspondence with PFBC, USFWS, and PDCNR, including searches of PNDI, seven terrestrial state-listed species (including proposed listed species) may utilize areas within the study area, as presented in Table J-3.

A brief description of the Indiana Bat habitat requirements is presented below.

Mammals. The Indiana Bat (*Myotis sodalis*), a federally-listed endangered mammal, may possibly be found state-wide in suitable habitat in Pennsylvania as part of its summer range. Preferred winter hibernation sites are limestone caves; abandoned coal, limestone, and iron mines; and abandoned tunnels (one colony is currently using an abandoned railroad tunnel). As many as four winter hibernation sites have been identified in the state to date, including sites in Armstrong County, Blair County, and Somerset County (USFWS, 1997; 1999). Summer foraging and roosting habitat is usually forested riparian and floodplain areas, extending to floodplain ridges. Indiana bats may forage for insects over water or floodplain areas in the airspace near foliage of riparian and floodplain trees, as well as near the more densely foliated area near tree tops (USFWS, 1999). Individuals of this species may be present in the study area during summer along forested portions of the Allegheny or Ohio River corridors.

3.5 WETLANDS

Wetlands. USFWS National Wetland Inventory (NWI) maps were used to characterize the locations and types of wetlands occurring between river miles 1 through 70 (Project Pool: Emsworth Dam through Project Pool: Dam 9) on the Allegheny River and river miles 1 through 40 (Project Pool: Emsworth Dam through Project Pool: New Cumberland Dam) on the Ohio River. NWI maps are developed from a database that uses aerial photogrammatic techniques to determine approximate wetland boundaries on large-scale topographic maps. Data compiled on the large-scale maps are transcribed and presented on 1 to 24,000-scale topographic maps. The NWI maps use the Cowardin Classification System (Cowardin et al., 1992) to describe mapping units. Cowardin classifies wetlands into five systems that are based on similar hydrologic, chemical, or biological factors. The five wetland systems characterized in the classification include marine, estuarine, riverine, lacustrine, and palustrine. Riverine, lacustrine and palustrine wetland systems occur within the assessment

area. The systems are further divided into subsystems and classes based on criteria such as vegetation characteristics, water permanence, depth, gradient, water velocity, water chemistry, substrate, and extent of floodplain development. Special modifiers may be applied to describe wetlands and deepwater habitats that have been either created or highly modified by man or beavers.

Because of photo-interpretation problems, map scale, and lack of ground truthing, NWI maps can depict non-wetlands as wetlands or completely miss wetlands in an area. Some of the wetlands shown on the maps may not be jurisdictional based on USACE criteria which require the presence of hydrophytic vegetation, hydric soils, and wetland hydrology to be considered jurisdictional. Smaller (<1 acre) jurisdictional wetlands may not be included on the maps due to mapping techniques and map scales. The NWI maps do give a good approximation of the location and extent of wetlands within the study area on the Allegheny and Ohio Rivers and are useful in the development of a general characterization of wetland resources. The maps should not be used to evaluate potential impacts of proposed activities on specific wetlands. Because the NWI maps provide only a general approximation of the extent and boundary locations of wetlands on and adjacent to the Allegheny and Ohio Rivers, onsite wetland characterizations should be made before conducting any dredging related activities that could potentially adversely impact wetlands. Due to the size of the study area, a map showing the location of wetlands throughout the study area has not been included. Appendix K provides a list of the NWI maps that were used to characterize the resource. Table K-1 provides a characterization of wetlands within the study area based on type, approximate size, and location within the project pools on the Allegheny and Ohio Rivers.

The most common type of wetlands in the study area, both in frequency of occurrence and acreage, is palustrine forested. Most of the palustrine forested wetlands occur on the river banks above normal pool elevation. With the exception of Pool 6 on the Allegheny River, palustrine forested habitats occur most frequently immediately adjacent to the main channel of the Ohio River along the Dashields and Montgomery pools. Several palustrine forested habitats also occur in the river channel associated with islands in Pool 6 (see the discussion of Pool 6 below). Palustrine emergent wetlands are the second most common type of wetlands occurring in the study area. Emergent wetland habitats are mapped most frequently in Pool 6 where they occur both in channel and above the normal pool elevation and in the Montgomery Pool on the Ohio River where they occur on the banks above normal pool elevation. Palustrine scrub shrub wetlands occur adjacent to Pool 7 where they are associated with Limestone Creek; in Pool 6 at two mapped locations both in channel and out of channel in association with palustrine forested wetlands; and at the Montgomery Pool along the river banks in association with palustrine forested habitats. Palustrine open water wetlands occur primarily along the upper reaches of the Allegheny River study area above the normal pool elevation.

Wetlands in Pool 6 were surveyed by USFWS in 1992 based on procedures established in the 1989 Federal Manual for Identifying and Delineating Jurisdictional Wetlands. Approximately 114 acres of wetlands were determined to occur in Pool 6. Table 3-9 presents the wetland type, based on a general Cowardin classification, location, and approximate size

of habitats occurring in Pool 6. Approximately twice the acreage of wetlands shown to occur in Pool 6 on NWI maps were determined to be present based on onsite characterization. The difference in acreage between NWI map review and actual site characterization indicates the importance of performing onsite characterizations prior to conducting activities that could affect wetlands.

There are approximately 42.4 acres of palustrine emergent, 6.9 acres of palustrine scrub shrub, and 63.8 acres of palustrine forested wetlands in Pool 6, based on onsite characterization. There were 71 plant species identified in Pool 6 during the onsite characterization. Dominant vegetation species in the emergent wetlands varied from almost solid stands of reed canary grass (*Phalaris arundinacea*), water willow (*Justicia americana*), and smartweed (*Polygonum punctatum*) to very diverse wetlands in the back channel associated with the Cogley Island complex. Dominant plant species occurring in the back channel wetlands include spotted jewelweed (*Impatiens capensis*), wingstem (*Verbesina alternifolia*), tall coneflower (*Rudbeckia laciniata*), smartweeds, water willow, goldenrods (*Solidage rugosa*), and rice cut grass (*Leersia oryzoides*).

Wetlands occur within the flood pool at various locations throughout the reach of Pool 6. Separation distances between wetlands, or groups of wetlands, based on river miles, range from less than 0.1 miles to approximately 1.0 mile. Based on the 1992 USFWS survey, no wetlands occur between river miles 37.5 and 38.5 or between miles 41.0 and 42.0 in Pool 6. In general, wetlands in the upper reaches of Pool 6 (river miles 41.0 through 45.1) have further separation distances based on river miles. In the lower reaches of Pool 6 around Nicholson Island (river miles 36.8 and 37.5) and Ross Island (river miles 39.5 and 40.2) wetlands occur more frequently with shorter separation distances.

The State of Pennsylvania regulates activities with the potential for having adverse impacts to wetlands through the implementation of requirements established at Title 25, Chapter 105 (Dam Safety and Waterways Management) of the Pennsylvania Code. Permit requirements for activities that could affect wetlands are established at §105.11 of Title 25. Requirements pertaining specifically to wetlands are established at §105.17 through §105.20a of Title 25. Criteria established at §105.18a (permitting of structures and activities in wetlands) require the avoidance and minimization of potential impacts. Practicable alternatives to proposed activities that might impact wetland habitats must be considered. Where impacts to wetlands are not avoidable, mitigation is required. Wetland replacement criteria are established at §105.20a. Potential impacts of proposed instream activities on upstream, downstream, or adjacent habitats (including wetlands) or other uses are considered during the permitting process.

Federal wetland permitting requirements are established under Section 404 of the Clean Water Act for the discharge of dredged or fill material into waters of the U.S., including wetlands. The regulations established at Title 33 of the *Code of Federal Regulations* (CFR) Parts 320-330, prescribe the statutory authorities and general and special policies and procedures applicable to the review of applications for permits. Applicants for permits are

Table 3-9
Wetlands Occurring in Pool 6 Based on Onsite Characterization

Location by River Mile (RM)	Wetland Type	Acres
RM 36.8	PFO	1.8
RM 37	PSS	0.1
RM 36.8-37.3	PEM	3.7
Nickolson Island		
	PFO	11.5
RM 37.5	PEM	2.8
	PSS	0.1
	PFO	14.8
RM 38.5	PEM	0.2
	PSS	0.7
RM 39.1	PFO	0.7
RM 39.5	PFO	2.0
RM 39.5-40.1	PEM	2.8
Ross Island		
	PSS	4.5
	PFO	2.6
RM 40.2	PEM	0.1
RM 40.7	PEM	0.5
	PFO	2.9
RM 41.0	PFO	0.9
RM 42.0-43.4	PEM	1.7
RM 42.4-43.4	PEM	30.6
Cogley Island		
	PFO	25.9
RM 43.7	PEM	0.3
	PFO	0.6
RM 44.4	PFO	0.1
RM 45.1	PSS	0.2

Note:
PEM=Palustrine Emergent Wetland
PFO=Palustrine Forested Wetland

required to avoid, minimize, and mitigate impacts to wetlands. Section 401 of the Clean Water Act also requires applicants to obtain a State water quality certification for activities that may affect water quality in wetlands or other waters of the U.S. USACE is responsible for implementing the policies and procedures established under Section 404 of the Clean Water Act. Before commencing any new work in waters of the United States, a district engineer must be contacted and a permit obtained, as appropriate.

A Memorandum of Understanding between the Pennsylvania Department of Environmental Protection, Bureau of Dams and Waterways Management and USACE has been established to coordinate and streamline the state and federal permitting process in Pennsylvania. The objective of the Memorandum, in addition to streamlining the permitting process, is to ensure

the coordination of federal and state permit application requirements and procedures within the provisions of the laws and regulations of both agencies.

3.6 AIR QUALITY

National Ambient Air Quality Standards (NAAQS) have been established for six "criteria" pollutants (sulfur dioxide, carbon monoxide, ozone, nitrogen oxides, lead, and inhalable particulate matter [PM-10 and PM-2.5]). In general, elevated levels of carbon monoxide and inhalable particulate matter usually relate to localized conditions, such as congested traffic intersections, large point sources, or construction activities. The other pollutants listed commonly result from the interactions of pollutants from a greater number of widely dispersed, regional sources (e.g., a large city containing many stationary and mobile sources). PADEP monitors the concentrations of the criteria pollutants and, where necessary, is responsible for developing State Implementation Plans (SIPs) to ensure that the national standards are achieved and maintained. Areas within the state that fail to meet the NAAQS are designated as "nonattainment areas" and are potentially subject to regulatory enforcement.

The area affected by the proposed continuation of sand and gravel dredging is regulated under a SIP because the Pittsburgh-Beaver Valley air quality region (Allegheny , Beaver, Butler, Fayette, Washington, and Westmoreland Counties) does not meet Clean Air Act standards for all NAAQS pollutants. In the most recent assessment, the Pittsburgh-Beaver Valley area was identified as a non-attainment area for 1-hr ozone, SO_2, and PM-10. In addition, parts of the study area were also non-classified for CO, a parameter of concern in "high traffic density areas within the Central Business District and certain other high traffic density areas" (USEPA, 1999a). Tables 3-10 through 3-12 summarize monitoring data between 1992 and 1997 for existing air quality gage stations in the study area.

Table 3-10
Summarized CO Monitoring Data Within the Study Area

Monitoring Year	Average Detected CO Concentration (ppm)	Number of Observations
1992	4.8	40809
1993	4.2	32266
1994	4.5	32756
1995	4.6	24686
1996	3.2	23717
1997	1.9	11293

Table 3-11
Summarized SO_2 Monitoring Data Within the Study Area

Monitoring Year	Average Detected SO_2 Concentration (ppm)	Number of Observations
1992	0.1834	99971
1993	0.2146	113519
1994	0.2242	107419
1995	0.132	92991
1996	0.1481	109515
1997	0.1343	50798

In general, the air quality trends observed in the study area are similar to those witnessed nationally and can be traced to ongoing regulatory efforts to improve air quality. For example, SO_2 and NO_x reductions are occurring nationally because of the ambitious Acid Rain Program (ARP) initiated in 1995. It is expected that the study area will see significant ambient level reductions of these pollutants because many affected midwest electric utilities are located "upwind" of the study area. Electric utilities were credited in 1997 with producing 64 and 26 percent of the total SO_2 and No_x emissions, respectively, so any new regulations affecting electric utilities should correlate to significant ambient concentration reduction (USEPA, 1999b).

Table 3-12
Summarized Ozone Monitoring Data Within the Study Area

Monitoring Year	Estimated Number of Contraventions for Ozone[1]	Number of Observations
1992	0	1014
1993	3	1269
1994	3	786
1995	14	1452
1996	0.0	1460
1997	2.4	626

1 Ozone contraventions based on statistical evaluation of monitoring results. Fractional values are expected under some circumstances.

The decrease in CO levels in the study area also follows a national reduction trend; nationally there has been a 37% decrease in ambient concentrations between 1987 and 1996. Because transportation provided by on-road and off-road vehicles contribute nationally 57 and 19

percent of the total annual CO emissions, respectively, mobile sources are the major contributor to CO concentrations (USEPA, 1998b). Even though the number of automotive miles is increasing per capita, ambient CO levels are still decreasing in part because of better vehicles, better fuels, and efforts to diminish roadway congestion. Carbon monoxide contraventions are still possible on a local basis particularly where excessive automotive congestion (Level of Service [LOS] D, E, and F) combines with cold weather (inversion prone) periods.

With respect to dredging operations, the primary sources of combustion-type emissions (e.g., CO, VOC and NO_x [ozone precursors], and SO_2) are the large diesel equipment used on the dredges and in transportation vehicles. National estimates for dredger pollutants emissions do not exist, however, USEPA has produced estimates for the six criteria pollutants which include data on surface mining and quarrying.

Table 3-13 lists key source category emissions and compares them with the national emission estimate. Its obvious from these data that when USEPA composed the national emission estimate, surface mining and quarry operations were not judged to be significant (are unreported) for four of the six NAAQS pollutants; VOCs (Ozone precursor), SO_2, NO_x, and CO. In fact, only for inhalable particulates were mining-related activities investigated, and even then were found to be small contributors relative to natural and fugitive sources. The natural and fugitive contributions to ambient inhalable concentrations make up 74 and 52 percent, respectively, of the total 1997 emissions for PM-10 and PM-2.5 respectively. Marine vessels are also consistently a small source of NAAQS pollutants, nationally representing, at most 20% of the emissions produced by on-road diesel trucks (USEPA, 1998b).

Table 3-13
1997 Annual Emission Loads (thousands of short tons)

Pollutant	PM-10	PM-2.5	VOCs (Ozone precursor)	SO_2	NO_2	CO
Surface Mining	17	7	NV	NV	NV	NV
Stone quarrying/ processing	60	27	NV	NV	NV	NV
Marine Vessels	31	22	50	NV	235	85
On-road Diesel Vehicles	163	136	239	84	1,932	1,508
Natural Sources	5,316	797	14	NV	NV	NV
Fugitive Dust	19,429	3,461	1	NV	1	0
Totals	33,581	8,311	19,214	20,369	23,582	87,451

Source: USEPA, 1998b.
NV = no value given by USEPA for this pollutant.

In terms of emissions from local point sources, Table 3-14 lists the summed current annual emissions for permitted point sources in Beaver and Allegheny Counties. These emissions can be compared against those estimated to come from typical dredging operations.

Table 3-14
Annual Emissions for Point Sources for Select Counties in the Pittsburgh Area (tons/yr)

Location/Source Area	PM-10	VOCs (Ozone precursor)	SO_2	NO_2	CO
Beaver County	1,230	1,416	31,824	33,343	35,956
Allegheny County	3,414	2,254	49,001	21,735	8,239
Estimated Dredge Emissions[a]	15	NA	66	492	125

[a] Based on the assumption that eight dredge/processing operations will operate concurrently. Each dredge/processor combination was assumed to emit at levels equal to the average of estimated emission rates provided in two current permit applications: OP-03-00207 and OP-4-00698.
Source: USEPA, 1999b.
TBP = To be prepared based on information anticipated from the dredger community.
NA = Data unavailable

3.7 NOISE

The environment potentially affected by dredging-related operations covers a wide range of land use development and population densities, both of which serve as general indicators of ambient noise levels. The greater the development/density the more likely that multiple noise sources will combine to create an undesirable condition. The study area can be divided into three general areas: 1) the sparsely developed zone of the Allegheny River upstream of New Kensington (river miles 25 to 50), 2) the urbanized waterways around Pittsburgh and its suburbs, and 3) the lightly-developed Ohio River below river mile 10. In the first zone, there are long segments of the Allegheny River which pass through relatively undeveloped areas where the typical population density is less than 100 persons per square mile. In this zone, small towns built adjacent to the river are spaced approximately every 15 to 20 miles.

In the second zone located further downstream between Pittsburgh and New Kensington, development becomes more intensive as the Allegheny River approaches the three river confluence. Population densities adjacent to the river gradually increase from 1,000 to 10,000 persons per square mile. Finally, the third zone (below Carnegie or Ohio river mile 10) the population density adjacent to the Ohio River decreases quickly in the downstream direction and then sustains a density between 100 and 1,000 persons per square mile. For comparison purposes, small town ambient noise levels (DNL or Day-Night Level for 24 hours) typically fall in the 50-55 dB category; levels most prominent in the most upstream and downstream zones. In the middle or more densely populated zone around Pittsburgh, the ambient noise level in active urban centers/industrial settings will tend to be 60-65 dB (FARSANAI, 1992).

The commercial sand and gravel dredging industry is affected by regulations which define what constitutes a noise problem and which set limits on noise generating activities

potentially harmful to workers and the public. The Noise Control Act of 1972 (Public Law 92-574) requires federal agencies to regulate noise that may jeopardize public health or welfare. The Act directs federal agencies to comply with applicable federal, state, interstate, and local noise control regulations. In keeping with the Act, USEPA has provided information on identifiable negative effects of noise, establishing indoor and outdoor noise limits (USEPA, 1974) that protect public health and welfare (e.g., preventing hearing damage, sleep disturbance, and communication disruption). General guidelines have been created to determine if adjacent land uses are compatible and if noise abatement management is required. In summary, the guidelines seek to keep any consistently loud noise sources (sources of 75 dB or higher) from sensitive settings (e.g., hospitals, residential areas, churches) (USEPA, 1981). Noise monitoring of dredging operations was conducted over a two-day period beginning on 23 September 1998, to assess the potential impact of dredging operations on nearby ambient noise levels. The results of this analysis are presented in Section 4.2.8.

3.8 SOCIOECONOMIC CONDITIONS

3.8.1 Economic Development

This section describes the socioeconomic conditions of the three counties, which comprise the economic region of influence (ROI) assessed for this study. An economic ROI encompasses the area in which the predominate impacts of a proposed action would likely take place and defines the geographical boundaries of the analysis. The criteria typically used to define the economic ROI are the residency distribution of affected population (e.g., industry employees); commuting distances and times; and the location of businesses providing goods and services to the affected companies, their personnel, and their dependents.

Based on these criteria and the location of the current dredging activities, the ROI for the social and economic environment is defined as the Pennsylvania Counties of Allegheny, Armstrong, and Westmoreland. The economic ROI covers an area of 2,407 square miles and includes the Pittsburgh Metropolitan Area. In 1998, more than 52 percent of the workers associated with the four commercial river dredging companies lived within the economic area of concern, with a quarter of the total workforce residing in Armstrong County.[1] The remaining workers resided in more than 13 counties surrounding the Pittsburgh area, but with no other jurisdiction outside the economic ROI accounting for more than 3.5 percent of the workforce as residents. Thus, while the worker population was widely distributed, the majority were concentrated in the three ROI counties.

[1] At the time the economic analysis was conducted, four companies comprised the consortium of dredgers that are the subject of this EIS. Recently, the smallest of the four dredgers (Lane Industries) ceased operations, leaving only three active dredgers on the Allegheny and Ohio Rivers in Pennsylvania. The effect of this change on the analysis would be to somewhat lessen the magnitude of the projected economic impacts (See Section 4) of the proposed alternative to eliminate all dredging on the Allegheny and Ohio Rivers in Pennsylvania. However, because the conclusions would not change, the original analysis remains valid.

The socioeconomic indicators used for this study include regional economic development (employment and income), population, and demographic and housing characteristics. Socioeconomic indicators for the economic area of concern are provided for the baseline year of 2000 or the most recent year for which data are available.

3.8.2 Regional Employment and Income

The economic ROI has a diverse economy producing a wide range of goods and services. The economy is almost exclusively nonagricultural-based. Farming accounted for only 0.4 percent of the economic area of concern employment in 2000. As seen in Table 3-15, services, retail trade, government, and manufacturing are the major job producing sectors, which together provided about 73 percent of the jobs in the economic area of concern in 2000. The services sector was the largest source of employment, supplying more than 37 percent of total jobs in the economic area of concern, followed by the retail trade sector with almost 17 percent, then government at 9.4 percent, and manufacturing at 9.3 percent. The manufacture, mining, wholesale trade, and retail trade sectors declined in percentage share of total employment between 1990 and 2000. The services, finance, transportation, and construction sectors increased in percent of total employment over the 10-year period. The civilian labor force in the three-county area decreased from 847,227 in 1990 to 839,556 in 2000, a drop of 0.9 percent.

Table 3-15
Percentage of Pittsburgh Area Employment by Industry (1996)

Farm employment	0.4%
Nonfarm employment	99.6%
Services	37.2%
Retail trade	17.8%
Manufacturing	9.7%
Government	9.7%
Finance, insurance, and real estate	8.4%
Transportation	5.7%
Construction	5.3%
Wholesale trade	4.8%
Ag. services, forestry, fish, and other	0.6%
Mining	0.4%

Source: BEA, 1998.

During the 1990s, the unemployment rate for the ROI ranged from a high of 7.3 percent in 1992 to a low of 5.0 percent in 1996. The unemployment rate for the 3-county area in 2000 was 5.9 percent. Armstrong County had the highest unemployment rate in the ROI, reaching 6.2 percent, followed by Allegheny County at 6.1 percent, and then Westmoreland County at 5.1 percent (US DOC, Census, 2003). The ROI per capita income was $32,299 in 2000, an increase of 53 percent over the 1990 income level of $21,050. Economic area of concern income growth exceeded national income growth. Per capita personal income for the United States was $29,469 in 2000, a 51 percent increase since 1990 (US DOC, BEA, 2002).

3.8.3 Sand and Gravel Industry

The sand and gravel industry, a subsector of the mining industry, extracts and processes materials for use in both construction projects and industrial applications. Although the majority of sand and gravel is used in construction activities, an important portion of the national output is used in specific industrial uses such as glass making, molding, grinding and polishing, and assorted minor uses. Construction sand and gravel is used as concrete aggregates, for road base, asphalt concrete aggregates, construction fill, and snow and ice control. Sand and gravel produced by the commercial river dredgers is almost exclusively used for construction purposes.

The sand and gravel industry produced approximately 1.12 billion metric tons of construction sand and gravel nationally in 2000 and employed approximately 37,500 workers. Pennsylvania ranked 16th nationally in the production of construction sand gravel, producing 17.9 million metric tons in 2000 (USGS, 2001). Construction sand and gravel producers (including both river dredgers and land quarries) in the economic ROI constituted about a third of the State total and more than five percent of the national output. Exact employment levels for all producers (river and land-based producers) are not available, but the sand and gravel workforce associated with river dredging comprises less than 0.1 percent of the total economic ROI workforce. As noted earlier, the entire mining sector provides only 0.4 percent of the ROI employment.

The sand and gravel industry generates additional economic activity through its purchases of goods and services from other sectors within the region. Sand and gravel production in western Pennsylvania is of particular importance to the Allegheny and Ohio River transportation systems and the movement of sand and gravel on the river systems is estimated to generate about 500 direct jobs throughout the region (including counties outside the economic area of concern). The sand and gravel is discharged at river terminals and then transported to producers and used in ready-mix concrete, asphalt, general construction, and further distributed for other construction projects.

Commercial River Dredging Industry Workforce Structure and Salaries. Four companies held dredging permits for the Allegheny and Ohio Rivers within the State of Pennsylvania. During 1998, these firms employed approximately 215 workers directly associated with dredging operations during 1998. Because two of the applicant firms are vertically integrated

and operate asphalt or concrete production facilities, the actual workforce directly dependent on the supply of river-based sand and gravel exceeds 300. Annual wages and salaries averaged about $31,000 for all employees involved in dredging operations during 1998. Total revenues from the sale of sand and gravel approached $30 million for the four applicants. Currently, there are only three active companies in the region.

The commercial river-dredging sector serves as an economic stimulus to the region through its purchases of goods and services, including machinery and energy, and repair and transportation services. The commercial dredging industry also contributes to the public sector through its payment of local and state taxes as well as a royalty payment based on tonnage. The Pennsylvania Fish and Boat Commission received more than $1 million in royalty payments from dredging along the Allegheny River between 1970 and 1980 (monies are earmarked for fish restocking) (USACE, 1980; 1981). However, due to several fee increases in recent years, during 1998 alone, the commercial dredgers paid over $335,000 in royalty fees. The per ton dredging royalty fees have been increased significantly since 1998 (fee was raised from 15 to 30 cents per ton plus an inflation factor). Under the current formula, for example, dredgers would pay at minimum $1.2 million in royalty fees for 4 million dry tons of aggregate production. For future years beyond 2002, the royalty will fluctuate based on the amount equal to the change in the producer price index for sand and gravel from the base year of 2002.

3.8.4 Transportation Infrastructure

3.8.4.1 Land Based Transportation Infrastructure

The ROI contains an extensive network of roadways including interstate and state highways, and secondary and municipal roads. There are over 11,000 miles of roadways within the three-county area including approximately 3,050 miles of road maintained by PennDOT. Traffic volume varies greatly among the three counties with Allegheny County roads having the most traffic volume (25.2 million/day) and Armstrong having the smallest volume of traffic averaging about 1.76 million vehicles per day. Traffic volume in Westmoreland is 9.9 million vehicles per day (PENNDOT, 2002).

3.8.4.2 Waterborne Transportation Infrastructure

The Allegheny and Ohio River system is an important part of the regional economy, allowing access to markets in the Midwest and central United States. The Pittsburgh Port is the largest inland port in the nation and the 12th busiest port, of any kind, in the nation (Port of Pittsburgh, no date). The port contains 37 public river terminal facilities along 200 miles of navigable waters. The terminals handle a wide variety of products including coal, petroleum, steel, sand and gravel, chemicals, and manufactured products. During 2000, the Port handled 53.9 million tons of cargo.

The river system provides local and regional industries with substantial cost savings, due to the low cost of transporting raw materials, intermediate products, and final products by barge

verses land-based vehicles (e.g., rail or trucks). Average cost ranges between $0.005 and $0.01 per ton-mile of cargo moved. This compares to nearly $0.05 for rails and $0.10 for trucks.

The river system activity generates business revenue for the firms supplying services to the cargo and recreational activity on the river system, as well as to industrial users of the river system. Job creation is further increased as a result of inter-industry trade. State and local governments receive addition revenues through fees and taxes (Port of Pittsburgh Commission, 1996).

According to one study, waterway cargo activity in the ten county Port of Pittsburgh Commission District (including Allegheny, Armstrong, Beaver, Clarion, and Westmoreland counties) generated nearly 120,000 jobs, or 12 percent, of the total private sector employment in the District (Port of Pittsburgh Commission, 1996).[1]

River system transportation may also provide an overall reduction in air pollutants and a reduction in traffic congestion, when compared to trucking in the Pittsburgh region (Port of Pittsburgh Commission, 1996). The use of the river system provided the means to maintain the lock and dam system that is utilized by both commercial barge traffic and recreational boaters.

3.8.4.3 Recreational Activities

The Allegheny and Ohio Rivers provide recreational and sightseeing opportunities, including marina services and tour boat operations (ORSANCO et al., 1996) and sport fishing. The Allegheny in particular supports a variety of sport fish, including smallmouth bass and walleye, and less so trout.

Both rivers are used extensively for recreational boating. Within the economic area of concern, there are over ten boating access areas under the ownership or control of the Pennsylvania Fish and Boat Commission. The study area also contains State Parks on the river, including Point State Park, located at the convergence of the Monongahela and Allegheny Rivers, which affords walkers views of Pittsburgh, inland waterways, scenic hillsides, and many bridges. Within the Point State Park and at other locations along the river are numerous biking and nature trails maintained by various conservation and municipal and state park organizations. In addition, the riverfront within Pittsburgh serves as a focal point for many sports and cultural events sponsored by the City of Pittsburgh.

3.8.5 Sociological Environment

3.8.5.1 Demographics

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[1] The Port of Pittsburgh covers 200 miles of waterways and includes 37 river terminals along the Ohio, Allegheny, and Monongahela rivers.

Regional population has declined in all three counties comprising the economic ROI (see Table 3-16). The total ROI population, which was 1,724,051 in 2000, has declined by 3.3 percent from 1990 population levels, but remains more than 10 percent higher than the 1980 population. Most of the population decline has taken place in Allegheny County, whose population decreased by almost 12 percent between 1980 and 2000. Population projections indicate continuing out-migration for the ROI and hence, future growth is expected to be slow compared to other areas of the nation. Table 3-16 shows population trends for the economic ROI from 1980 through 2000.

Although Westmoreland and Armstrong counties are designated rural, the majority of the economic area of concern population lives in urban areas. In fact, 96 percent of the residents of the most populous county, Allegheny, live in urban areas (US DOC, 2003).

Table 3-16
Pittsburgh Area Population

County	1980	1990	1995	2000
Allegheny	1,450,085	1,336,449	1,309,821	1,264,526
Westmoreland	392,294	370,321	376,501	351,005
Armstrong	77,768	73,478	74,569	76,032
ROI Total	1,922,127	1,782,238	1,762,886	1,693,563

Source: USDOC 2003; Pennsylvania Department of Labor and Industry, 1995.

3.8.5.2 Housing

The economic area of concern contained 777,091 housing units in 2000. Ninety-two percent of the units were occupied. The median value of owner occupied housing units for the 3-county area in 2000 ranged from $64,500 in Armstrong County to $90,600 in Westmoreland County. Median monthly rent for apartment units ranged from $395 in Armstrong County to $516 in Allegheny County. (US DOC, Census, 2003).

3.8.6 Environmental Justice

On February 11, 1994, President Clinton issued Executive Order 12898, *Federal Actions to Address Environmental Justice in Minority and Low-Income Populations*. The Executive Order is designed to focus the attention of federal agencies on the human health and environmental conditions in minority communities and low-income communities. Environmental justice analyses are performed to identify potential disproportionately high and adverse impacts from proposed actions and identify alternatives that might mitigate these impacts.

As indicated in Table 3-17, the population is predominantly white. Approximately 12 percent of the population is comprised of racial minorities. Less than one percent of the population is of Hispanic origin (persons of Hispanic origin may be of any race). Only

Allegheny County, which includes the City of Pittsburgh, contains substantial minority populations.

The Census Bureau bases the poverty status of families and individuals on 48 threshold variables, including income, family size, number of family members under 18 and over 65 years of age, and amount spent on food. Twelve and a half percent of the population in the economic area of concern was living below the poverty level in 2000, higher than Pennsylvania's rate of 11 percent (US DOC, Census, 2003).

Table 3-17
ROI Demographics

Race	Allegheny	Armstrong	Westmoreland	ROI Total	Percent
White	1,170,228	72,726	361,055	1,604,009	90%
Black	149,641	513	6,992	157,146	9%
American, Indian, Eskimo	1,443	61	358	1,862	0.1%
Asian or Pacific Islander	12,640	151	1,365	14,156	1%
Other	2,507	27	551	3,085	0.2%
Hispanic Origin	7,749	164	1,166	9,079	1%
Total	1,336,459	73,478	370,321	1,780,258	100%

3.8.7 Protection of Children

Executive Order 13045, *Protection of Children from Environmental Health Risks and Safety Risks,* seeks to protect children from disproportionately incurring environmental health risks or safety risks that might arise as a result of Federal government policies, programs, activities, and standards. Under current conditions, there are no children involved in any dredging activities nor are there any children exposed to safety or environmental health risks associated with dredging activities.

3.8.8 Land Use

Land use data incorporated into the Better Assessment Science Integrating Point and Nonpoint Sources (BASINS; USEPA, 1996) software database were extracted by hydrologic unit (Upper Ohio, Lower Allegheny, Middle Allegheny) and summarized. The land use/land cover data originated at the USGS Geographic Information Retrieval and Analysis System (GIRAS) and represent 1986 conditions. Anderson level II land use classifications are incorporated with these data.

Upper Ohio River. The downstream end of the study area (Ohio River mile 40) approximately bisects the Upper Ohio River watershed. The largest land use category in this unit was forest (43 percent), followed by agricultural land (35 percent) and urban or built-up land (18 percent). Barren land comprised about 2.5 percent of the watershed. The total area of the Upper Ohio River watershed is 1972 square miles.

Lower Allegheny River. Forest land was the largest category (48 percent), followed by agricultural land (26 percent) and urban or built-up land (24 percent) in this part of the study area. Water and barren land areas were essentially identical (1.3 percent and 1.7percent, respectively). The total area of the lower Allegheny River watershed is 478 square miles.

Middle Allegheny River. Forest land was the largest category (59%), followed by agricultural land (33 percent), and barren and urban land (4.4 percent and 2percent, respectively) in this part of the study area. Water areas comprised less than 1% of the watershed, and unclassified land was 1 percent of the watershed. The total area of the middle Allegheny River watershed is 1709 square miles.

3.9 CULTURAL RESOURCES

3.9.1 Prehistoric, Historic, and Archeological Resources

Prehistoric occupation in Pennsylvania is divided into three major periods: the Paleo-Indian Period, dating from ca. 15,000 B.C. to ca. 8,000 B.C., the Archaic Period (ca. 8,000 B.C. to 1,000 B.C.), and the Woodland Period (ca. 1,000 B.C. to A.D. 1600). Paleo-Indian peoples were nomadic hunters and gatherers who lived in small groups and ate wild plants and animals. This Period is distinguished by a low population density with groups residing in seasonal or base camps. The Paleo-Indian Period is also noted for diagnostic fluted projectile points and the exploitation of Pleistocene megafauna. During the Archaic Period the cold, dry environment that existed during the Paleo-Indian Period changed to one that was warmer and wetter. Groups responded to this change, and archaeological evidence shows an increasing use of the new forested environment. Stone axes and fishing paraphernalia appear in larger numbers. Late Archaic sites are more common, indicating an increase in population toward the end of this Period. The Woodland Period is the last before Europeans arrived in the region. Domesticated plants, including corn and bean species, are found at Woodland archaeological sites, and true fired ceramics also appear. Large villages, sometimes fortified with wood palisades, indicate the change from nomadic to more settled life.

Historic Native Americans that lived in the region of the project area, or traversed it, included the Shawnee, and the Turtle and Turkey clans of the Delaware people. These people were decimated by disease and warfare associated with European contact, including the French and Indian War (1753 to 1763), and were displaced in large part by a series of treaties with the U.S. Government (Sipe, 1994). The Treaty of 1768, signed at Fort Stanwix, New York, ceded all land south of the Ohio River and east from the Allegheny River at Kittanning, including a wide strip running diagonally northeast through what was the

province (Bomberger, 1941). By the 19th century, very few of these people lived in the region.

Correspondence regarding the proposed project was sent to the Pennsylvania State Historic Preservation Officer (SHPO), the Bureau for Historic Preservation, for review. Only one resource, the Allegheny River Lock and Dam System, was identified by the SHPO (Carr, personal communication, 1999). The response letter is provided in Appendix L.
There are no other National Register of Historic Places (NRHP) eligible resources, and no cultural resources have been identified within the project area. Seventy-nine archaeological resources identified as eligible for listing on the NRHP, or listed on the NRHP, are located within one mile of the project area in the Pennsylvania counties of Allegheny (15 sites), Armstrong (34 sites), and Beaver (30 sites) (Table L-1, Appendix L). There are none in Westmoreland County. Of the 79 sites, 22 sites are historic, 54 sites are prehistoric, and 3 sites include both historic and prehistoric components. Historic sites range from stone foundations of colonial farm buildings in Beaver County to remains of an historic 18th-century Shawnee town in Allegheny County. Prehistoric sites include isolated projectile points, rockshelters, and burials, the last found in all three counties. None of these resources is located within the project area. The Pennsylvania SHPO has stated that the proposed project will have no effect on any archaeological resources, and that no archaeological investigations are necessary in the project area (Carr, personal communication, 1999).

3.9.2 Historic Architectural Resources

No historic structures are located within the project area. A total of 76 historic structures or districts listed on the NRHP are located within one mile of the project area. These include 56 structures and 7 historic districts in Allegheny County, 2 structures in Armstrong County, 9 structures and 1 historic district in Beaver County, and 2 structures in Westmoreland County (Table L-2, Appendix L). The resources include historic schools, churches, commercial structures, bridges, and buildings, and residential and commercial districts. In a letter regarding the proposed project, the Pennsylvania SHPO identified the Allegheny River Lock and Dam System as being located near the project area. The SHPO stated that the proposed activity would have no effect on the resource (Carr, personal communication, 1999).