EXECUTIVE SUMMARY

Introduction

The Little Nescopeck Creek watershed is located in southern Luzerne County, Pennsylvania. The drainage basin of the Little Nescopeck Creek encompasses approximately 14 square miles and lies within Sugarloaf and Butler Townships, the Borough of Conyngham and a very small portion of Hazel Township. The stream flows from its headwaters in Butler Township approximately 10 miles to its confluence with the Nescopeck Creek in Sybertsville.

The Little Nescopeck Creek, a tributary to Nescopeck Creek, is severely impacted by a water-quality-impaired discharge from the adjacent mined watershed. This project is unique in that the impacted watershed is not directly affected by mining activities. A water level drainage tunnel, the Jeddo, which was constructed to dewater deep mine coal measures in the Eastern Middle Anthracite Field, has interconnected the natural watersheds of the Little Nescopeck and the Hazleton area mining operations. After the collapse of the deep mining industry, the Jeddo Tunnel continues to drain the abandoned mine workings.

The Jeddo Tunnel, which drains 32.24 square miles and discharges an average of 40,000 gallons per minute into the Little Nescopeck Creek, is one of the largest mine water discharges in the anthracite region. Abandoned mine drainage discharge from the Jeddo Tunnel is the major identified source of non-point-source pollution in the Little Nescopeck Creek watershed. Little Nescopeck Creek receives all the flow from the Tunnel. For this reason, significant attention is directed in this plan toward the Jeddo Tunnel system.

The Little Nescopeck Creek is classified as a High Quality-Cold Water Fishery (HQ-CWF) stream above the tunnel discharge, as is Nescopeck Creek upstream from its confluence with the Little Nescopeck. The quality-impaired Little Nescopeck Creek joins Nescopeck Creek, which eventually enters the Susquehanna River near Berwick, Pennsylvania. The impacts of the Little Nescopeck Creek are evident in the Nescopeck Creek, the Susquehanna River and the Chesapeake Bay.

Wildlands Conservancy has received a Pennsylvania Rivers Conservation Program Planning Grant for the Little Nescopeck Creek. A study of the Little Nescopeck Creek and the preparation and publication of a comprehensive Little Nescopeck Creek Watershed Conservation Plan were the intended outcomes of the grant. The Pennsylvania Rivers Conservation Program was created by the Pennsylvania Department of Conservation and Natural Resources (DCNR). The objective of the program is to conserve, restore and enhance Pennsylvania's rivers through partnership, education, awareness and stewardship.

The primary goals of the Little Nescopeck Creek Project are to restore the physical and biological health of the stream; establish management practices to prevent additional degradation of the stream; preserve critical cultural and natural resource areas within the watershed; and, ultimately, have the Little Nescopeck Creek listed on the Pennsylvania Rivers Registry. Inclusion on the Registry will qualify the Little Nescopeck Creek watershed for technical and financial assistance from the state for restoration and improvement projects.

In order for the Little Nescopeck Creek to be included on the Registry, the management plan must identify the historical, cultural, natural and physical resources along the creek. The plan must also characterize the water quality and aquatic life of the stream, as well as identify any problem areas in the watershed. In addition, the plan must contain recommendations for conservation and preservation of the Little Nescopeck Creek based on information collected as part of this project and input from public hearings and informational meetings with municipalities.

Resource Inventory

<u>Physical Resources</u>

Geology: The Little Nescopeck Creek watershed is located in the mountain region of the Valley and Ridge Physiographic Province. The valley-forming Mauch Chunk Formation underlies the majority of the watershed. The absence of limestone in the watershed results in very low levels of alkalinity in the Little Nescopeck and inhibits the creek from buffering its acidic pollution.

Topography: A narrow valley bounded on the north and south by high ridges typifies the watershed. Nescopeck Mountain forms the northern boundary and Buck Mountain forms the southern boundary. Elevations range from 850 feet in the western portion of the valley to 1800 feet at the eastern tip of the watershed boundary along Nescopeck Mountain.

<u>Aquatic Resources</u>

Surface Water: The Little Nescopeck Creek is approximately 10 miles long with a drainage area of about 14 square miles. The creek has 10 unnamed tributaries. Approximately 2.5 miles from its headwaters, the Little Nescopeck receives an average 40,000-gallon-per-minute acidic discharge from the coal-mined watershed to the south via the Jeddo Tunnel. From this point to the confluence with the Nescopeck Creek, the Little Nescopeck is devoid of all aquatic life.

Groundwater: The Mauch Chunk Shale is one of the most productive water-bearing formations in the area. Its low-lying topographic position, between high ridges and a generally shallow water table, make it favorable for groundwater development.

Biological Resources

Flora: The flora of the Little Nescopeck Creek watershed is representative of the Ridge and Valley Province through much of Pennsylvania. Agricultural areas have been utilized for various field and forage crops. The woodland plant community and, ultimately, residential developed areas that have re-vegetated naturally are made up of various hardwoods, conifers, grasses, legumes and both wild and domestic herbaceous plants.

Fauna: Little Nescopeck Creek is classified as a High Quality-Cold Water Fishery above the Jeddo Tunnel and fish and macro-invertebrate sampling has supported that classification. The stream supports native brook trout, sunfish and bass, but, 2.5 miles downstream from the headwaters and throughout the remaining length of the creek, macro-invertebrate and fish communities are non-existent. Herpetological, avian and mammalian studies are included in this management plan.

Cultural Resources

Historical significance: The early history of the watershed is dominated by the Lenni Lenape and traces back to the passage of the Great Southern Trail of the Iroquois. The most significant historical events related to the watershed's current environmental condition revolve around the anthracite mining industry of the Eastern Middle Coalfield. Many of the historical sites and museums in the area surrounding the Little Nescopeck are devoted to early Native American history and to the rise and fall of the anthracite industry.

Socio-economic background: The immediate watershed of the Little Nescopeck is approximately 14 square miles and is dominated by small agricultural lands and suburban developments. Economic resources tied to the watershed are therefore predominantly located in the surrounding areas of Hazleton and Wilkes-Barre. The restoration of clean water as an economic resource for industry, recreation and drinking must be an extremely high priority for all economic development agencies in the region.

Recreational Resources

Currently the area supports modest systems of golf courses and small public parks in various unnatural stages. Due to the environmental condition of the Little Nescopeck, recreational activities such as swimming, boating, canoeing and white water rafting are currently either limited or made inhospitable. Rail-to-Trail conversion projects are becoming increasingly popular in the area.

Institutional Resources

Several government agencies exist to deal with the issues of mining and abandoned mine drainage in Pennsylvania and include the Office of Surface

Mining, the Pennsylvania Department of Environmental Protection (Pa. DEP) Bureau of Mine Reclamation and the Pa. DEP Bureau of Abandoned Mine Reclamation. Programs that exist to address abandoned mine drainage and mine land reclamation issues include the Regional Watershed Support Initiative, the Clean Streams Initiative and the Reclaim PA project.

Several programs and agencies also exist to assist landowners in land preservation and protection goals. Sources of information pertaining to farmland and open space preservation include Wildlands Conservancy, the Bureau of Farmland Protection, the Land Trust Alliance and the Natural Resources Conservation Service.

There are also a number of agencies and programs dedicated to historic preservation, restoration and education, including the Pennsylvania Historic and Museum Commission and Preservation Pennsylvania.

The Little Nescopeck Creek watershed has a strong need for increased citizen involvement in its protection. With the exception of the small grassroots organization Friends of the Nescopeck, there appears to be very little involvement in the Little Nescopeck clean-up effort by the local community.

Watershed Issues

The Jeddo Tunnel

The Jeddo Tunnel is the largest mine drainage tunnel in the Eastern Middle Anthracite Field and is the primary source of acid-mine and fine-grained coal waste pollution to the Little Nescopeck Creek. It drains an approximately 32.24 square mile area underlain by abandoned deep mines and discharges an average of 40,000 gallons of abandoned mine drainage per minute into the Little Nescopeck near its headwaters, affecting the stream for most of its length.

Water Quality

Water quality has been analyzed for the Little Nescopeck and Nescopeck Creeks, the Jeddo Tunnel and the Susquehanna River. The analysis of these samples shows values typical of waters impacted by Abandoned Mine Drainage in eastern Pennsylvania. High acidity levels, high concentrations of sulfide minerals, the absence of significant carbonate minerals and excessively high concentrations of dissolved metals were evident in the water quality analysis. Average values in the Little Nescopeck Creek between 1996 and 1998 include: acidity, 26.63; pH, 4.86; aluminum, 4.03; iron, 2.01; sulfate, 130.87; manganese, 1.83 and zinc, 0.31 mg/L.

Land Use

Predominant land uses include small to mid-sized farms and existing and future suburban housing developments. The area is also covered with several sections of woodlands and the Little Nescopeck and Nescopeck Creeks are well insulated by substantial riparian buffers throughout most of their lengths.

Management Options

❶ Improve Water Quality in the Little Nescopeck Creek and its Tributaries

Abate abandoned mine drainage and restore mine-scarred land. Establish an effective channel network for draining surface water out of the Jeddo Tunnel watershed by re-establishing perimeter drains, constructing new channels outside mined lands, connecting discontinuous drainage ways and reducing their potential for infiltration and filling and sealing closed depressions and pits in the land surface.

Remine and reclaim abandoned mine land that cause abandoned mine drainage by closing and backfilling mine openings, backfilling open pits and eliminating dangerous highwalls. Use Title IV and other SMCRA funding to reclaim priority sites that are causing Acid Mine Drainage.

Control urban non-point source pollution by utilizing both structural and non-structural control methods.

Revise storm water management practices, restore and establish riparian buffers and increase public involvement in non-point and point source pollution control.

❷ Preserve and Protect Valuable Land Resources

Preserve farmland and critical open space by utilizing state, federal and local preservation programs.

Preserve wetlands. They are a very sensitive part of the ecosystem and perform many functions to benefit the Little Nescopeck Creek corridor. Better compliance with wetland regulations is needed to protect these sensitive areas.

Ordinances structured to encourage stewardship of creek resources, protect wellhead areas, protect riparian zones and limit land uses and activities within the stream corridors and floodplains should be created or adopted.

❸ Preserve Historical Resources and Develop Heritage Tourism

Identify and preserve regionally and nationally significant historic sites and landscapes within and related to the Little Nescopeck Creek watershed by supporting watershed heritage tourism and program development.

Conduct a systematic survey of the watershed to identify and list potential national registry sites and structures and utilize the training available from the Bureau of Historic Preservation.

Educate residents of the Little Nescopeck Creek watershed about its heritage and value by reaching out to children, elected officials and key individuals.

Build better communities through preservation by strengthening preservation planning, expanding the use of preservation as an economic development strategy and making technical assistance more available to citizens and local governments.

❹ **Document Water Quality and Biological Characteristics**
Conduct water quality monitoring and regular stream walks through combined efforts of volunteer organizations, educational institutions and individuals in order to monitor physical changes, identify problem areas and note adjustments that should be made in management practices.

Conduct biological monitoring and maintain records of the stream corridor and habitat and vegetative, aquatic and wildlife species present within the corridor in order to recognize and assess threats that may disrupt the balance of the ecosystem.

Establish an efficient system of data management and distribution in order to provide concerned individuals with appropriate contact and reporting information and improve public awareness and communication between conservation groups and educational institutions.

❺ **Enhance and Increase Watershed Recreational Opportunities**
Implement Rails-to-Trails conversion projects by supporting existing projects, conducting feasibility studies regarding potential projects and examining associated economic benefits. Study the feasibility of developing a greenway along the Little Nescopeck Creek corridor.

Develop a comprehensive plan in order to help guide the development of the Bishop Property recreational area in an environmentally sound and educational manner. Address non-point source pollution, erosion and sedimentation in Whispering Willows Park.

❻ **Increase Environmental Awareness, Knowledge, Skills and Stewardship Commitment**
Provide environmental, heritage and cultural education opportunities to school groups, the general public and local government and business leaders by documenting the entire length of the Little Nescopeck Creek and its biological resources, posting educational signs and developing educational materials that promote public environmental awareness.

Clean up the stream corridors within the watershed on a regular basis. Clean-up activities should be utilized in educational efforts and municipalities and local businesses should sponsor public river corridor clean-up days.

Hold frequent and well-advertised public meetings, utilize local newspapers to focus on public relations and stewardship of the Little Nescopeck Creek and hold periodic seminars on environmental topics affecting the Little Nescopeck Creek.

Summary and Conclusions

The Little Nescopeck Creek watershed is a valuable and unique resource. The headwaters of the creek are designated a High Quality-Cold Water Fishery and support a native brown trout population and its riparian corridor provides excellent woodland habitat to a wide variety of wildlife. The management options have been developed in an attempt to restore, preserve and enhance the value of these resources.

The primary source of degradation to the Little Nescopeck Creek involves more than a century of subsurface and surface mining activities that have left a legacy of physical and chemical contamination of mine water draining the Eastern Middle Coalfield through the Jeddo Tunnel and into the Little Nescopeck. The quality of this water has been greatly affected through contact with acid-producing minerals present in the coal and associated rock when exposed to infiltrating water. The water from the Jeddo Tunnel is predominantly acidic and metal concentrations commonly exceed maximum contamination levels. A reduction in abandoned mine drainage at the mouth of the Jeddo Tunnel will decrease the negative impact on the Little Nescopeck and Nescopeck Creeks and the Susquehanna River.

The abatement of abandoned mine drainage to the Little Nescopeck Creek, along with the implementation of other management practices, would provide significant benefits for its numerous resources, including dramatic improvement of water quality and aquatic life, expansion of wildlife habitat and enhanced scenic and recreational value.

The actions called for in the management plan cannot be effectively implemented without proper education of the public. Education is critical to a healthy watershed. Knowledgeable and concerned citizens and institutions must share information with their neighbors and other contacts in order to strengthen the conservation effort on a watershed-wide basis. By establishing partnerships, resources can be shared and utilized more effectively. Partnerships and open lines of communication among concerned institutions and individuals are essential to the successful restoration and preservation of the Little Nescopeck Creek watershed.

1.0 PHYSICAL RESOURCES

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1.1 Location/Description of the Watershed

The Little Nescopeck Creek watershed is located in southern Luzerne County, Pennsylvania. The drainage basin of the Little Nescopeck Creek encompasses approximately 14 square miles and lays within Sugarloaf and Butler Townships the Borough of Conyngham and a very small portion of Hazel Township. The creek flows from its headwaters in Butler Township approximately 10 miles to its confluence with the Nescopeck Creek at Sybertsville (Figure 1).

Figure 2. The Little Nescopeck flows into the Nescopeck Creek.

All of the project area lies within Luzerne County. Luzerne County encompasses approximately 892 square miles, with half the county's landscape presently in a developed state. Increasing amounts of the landscape are becoming subject to human alteration with each passing year, putting increasingly-higher levels of stress on the county's surface and groundwater resources and wildlife habitat. The southeastern part of the county is located in the Lehigh River watershed and the rest lies within the Susquehanna River Basin.

The total study area is approximately 20,000 acres. Butler Township encompasses most of the area with approximately 12,000 acres, followed by Sugarloaf Township with 5000 acres, Conyngham Borough with about 1000 acres and Hazel Township with only a few acres of Buck Mountain in the watershed. The Little Nescopeck Creek watershed includes all of the Little

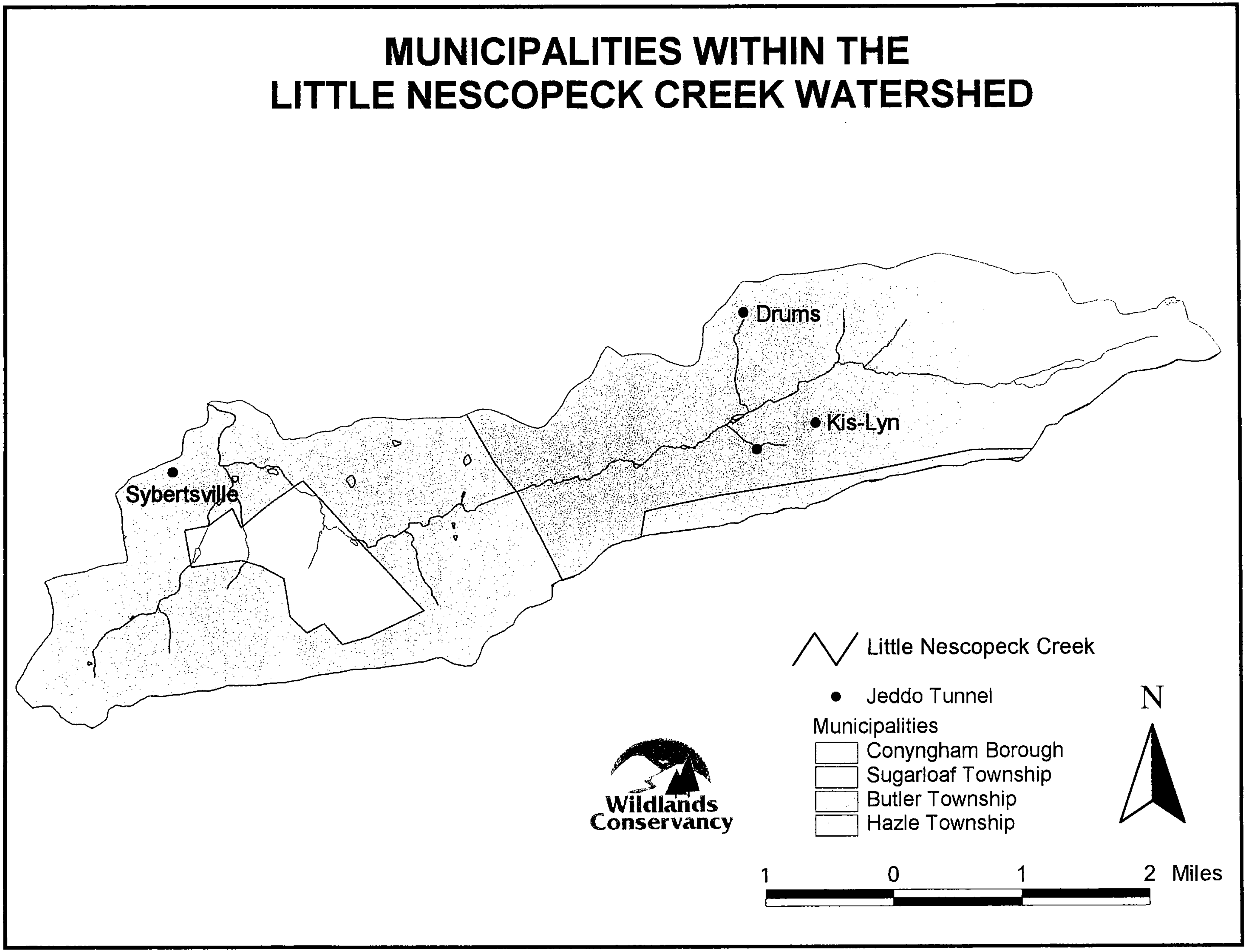

Figure 1. Municipalities of the Watershed

Nescopeck and 10 unnamed tributaries. The total length of the Little Nescopeck Creek, from its headwaters to its confluence with the Nescopeck Creek, is approximately 10 miles. The Little Nescopeck Creek originates in Butler Township. From its headwaters, the creek flows southwesterly into Sugarloaf Township and skirts the edge of Conyngham Borough. From there, the stream bears westerly and joins the Nescopeck Creek in Sugarloaf Township near the village of Sybertsville, immediately adjacent to state Route 93. The ridge known as Nescopeck Mountain towers to the west of the Little Nescopeck Creek watershed. Several tributaries come off its flanks to join the Nescopeck up-stream from its confluence with the Little Nescopeck. The Jeddo Tunnel enters the Little Nescopeck approximately 2.5 miles downstream from its headwaters. The Jeddo Tunnel, which drains more than 30 square miles and discharges an average of 40,000 gallons per minute, is one of the largest mine water discharges in the anthracite region. Abandoned mine drainage discharge from the Jeddo Tunnel is the only identified source of AMD pollution in the watershed. The Little Nescopeck Creek receives all of the flow from the tunnel. Prior to the building of the Jeddo Tunnel, the Little Nescopeck's average width was slightly over 10 feet at points. Presently, however, it has an average width of 30 to 40 feet due to the tunnel discharge, increased storm water runoff, and discharges from the sewage treatment plants in Butler Township and Conyngham Borough.

1.2 Geology and Structure

The water quality characteristics of any watershed are inextricably linked to the underlying geology of the region, and understanding the geology of the Little Nescopeck watershed and the surrounding area is important in developing a management plan for its restoration and preservation.

The dominant exposed rock formation of the Little Nescopeck Creek watershed is the Mauch Chunk Formation of the Mississippian Age, which overlays the vast majority of the watershed. The Pottsville Group of the Mississippian Age is exposed in a very small area in the northwestern tip of the watershed (Figure 3).

The Mauch Chunk Formation underlies the majority of the watershed, forming the valley floor. This formation is composed of gray, coarse-grained sandstone, conglomerate and shale. The Mauch Chunk Formation is also exposed on the flanks of Nescopeck Mountain.

The Pottsville Formation is exposed near the top of Nescopeck Mountain and is composed chiefly of hard, gray quartz conglomerate, coarse-grained sandstone, and shale containing a few thin seams of coal.

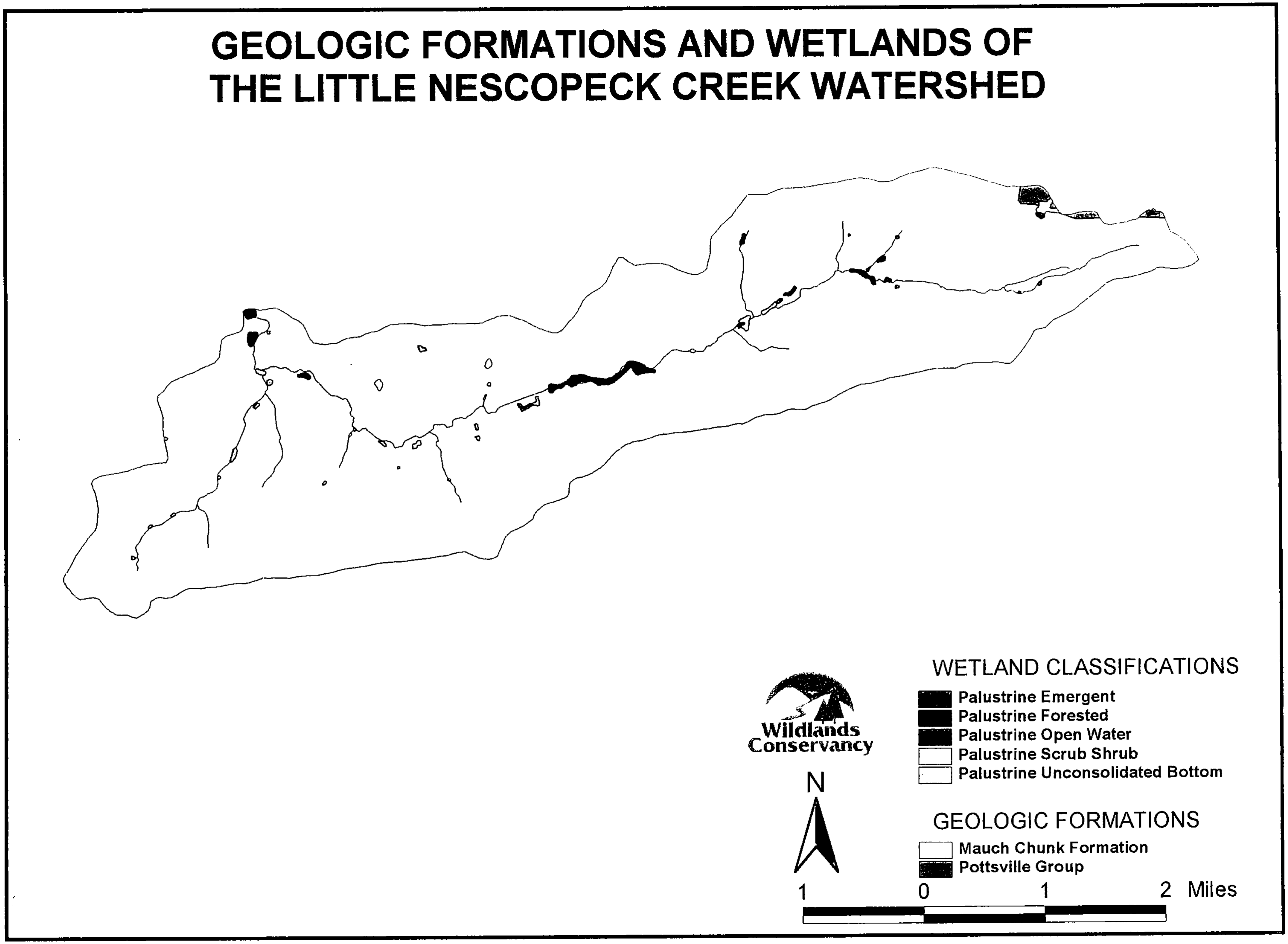

Figure 3. Geologic Formations and Wetllands of the Little Nescopeck Creek Watershed.

Perhaps the most significant geological factor in the Little Nescopeck Creek watershed is the absence of limestone, which results in the very low levels of alkalinity in the creek. This low alkalinity inhibits the Little Nescopeck Creek from buffering the acid drainage of the Jeddo Tunnel and the acidic precipitation it receives (rainfall in the study area had an average pH of 4.95 between 1996-98 (Alan Gregory, written communication)).

The hydrology of the watershed south of the Little Nescopeck is controlled by a mine de-watering system which ultimately discharges into the Jeddo Tunnel and hence the Little Nescopeck Creek. The Little Nescopeck Creek watershed is therefore hydrologically linked to the Hazleton Basin and the Jeddo Tunnel watershed. The geology of this area is significant to the study of the little Nescopeck Creek because the effects of the mining industry and the Jeddo Tunnel are the primary causes of impairment to the creek.

The dominant features of the Jeddo Tunnel watershed's geology were created 345 million years ago during the Carboniferous Period. At that time, a shallow sea covered the watershed and deposited fine-grained sediments that produced the sandstone and shale characteristic of the watershed today. Prehistoric swamps also covered the area for great stretches of time. The vegetation occupying those swamps underwent decomposition and fossilization, forming immense deposits of anthracite coal.

The geologic structure in this area is rather complex, consisting of a series of generally asymmetrical northeast-southwest striking anticlines and synclines. The area has been subject to severe folding and moderate faulting. In some places the rock units are inverted. This folding and faulting has increased the amount of coal available in the area (Nasilowski and Owen, 1998).

Bedrock units exposed in the drainage basin of the Jeddo Tunnel are the Mauch Chunk Formation, the Pottsville Formation and the Llewellyn Formation.

<u>The Mauch Chunk Formation</u> consists of at least 3000 feet of interbedded sandstones, siltstones and conglomerates that are characterized by a dominant red coloration.

<u>The Pottsville Formation</u> in the Eastern Middle Field is predominantly thick-bedded, light gray, oligomictic quartzrose conglomerates that total 250 to 300 feet in thickness. One or two coal beds occur in the finer-grained upper part of the Pottsville (Wildlands/SRBC, 1999).

<u>The Llewellyn Formation</u> is about 1500 feet thick and contains all of the major coal beds of the Eastern Middle Field. Aside from its numerous anthracite themes, it consists primarily of interbedded, dark-gray, carbonaceous sandstones, siltstones, claystones and shales.

The Jeddo watershed, like most of the anthracite region, has a specific hydrologic system resulting from extensive underground mining. Past mining has had the greatest effect on water quality in the study area. Underground (deep) mines, surface (strip) mines, coal breakers and coal refuse piles have left a legacy behind which carries a great burden. Extensive deep mining was done over the past 150 years, leaving the subsurface honeycombed with tunnels that are flooded and causing surface subsidence in some areas. The deep mines varied in size from small operations to large complexes extending several miles. Years ago, when deep mines were prevalent, and in order to mine underground, the Jeddo Tunnel was constructed to de-water mines by gravity flow, thereby allowing the operations to mine at great depths. As the anthracite industry declined the mines were abandoned and pumping ceased. The deeper workings were filled with surface water entering through some of the original openings, through crop falls and strip pits, and with groundwater percolating through undisturbed aquifers. As deep and surface mining exposes the pyretic rock, the flowing water and oxygen begins to react with the pyrite in the shale adjacent to the coal veins. The underground workings filled with water are called "minepools." These minepools overflow and, through the net drainage system, they are collected in one discharge, the Jeddo Tunnel. This discharge has the average magnitude of 40,000 gallons per minute and is polluted with acid and various metals (Hollowell, 1999).

Most of the minepools are contained to various elevations by a system of barrier pillars. Barrier pillars are sections of coal that were left in place underground to separate colliery workings and their water systems. The minepool levels are governed by the elevation of points of overflow to the Jeddo Tunnel drainage system. The existing condition of these barrier pillars is largely unknown. Breaches may have been created in the pillars by "bootleg" deep mine operations and/or geologic structural failure (Hollowell, 1999).

There are nine major minepools in the Hazleton Basin containing great quantities of water, and all of them overflow and discharge Acid Mine Drainage through the Jeddo Tunnel and into the Little Nescopeck Creek. The major minepools are: West Woodside Basin, East Woodside Basin, Harley Colliery Pool, Jeddo No. 7 Fishtail, Jeddo No. 4 Slope B, Cranberry No. 11 Plane Basin, Hazleton Basin, Diamond Basin and the Stockton Basin (Hallowell, 1999).

1.3 Topography of the Little Nescopeck Creek Watershed

The majority of the area of the Little Nescopeck Creek watershed is located in the Upper Susquehanna River Basin and lies in the Appalachian Mountain Section of the Ridge and Valley Province of Pennsylvania. The topography of the watershed is typified by a narrow valley bounded on the north and south by high ridges (Figure 4). Nescopeck Mountain forms the northern boundary with a maximum elevation of 1900 feet and Buck Mountain forms the southern

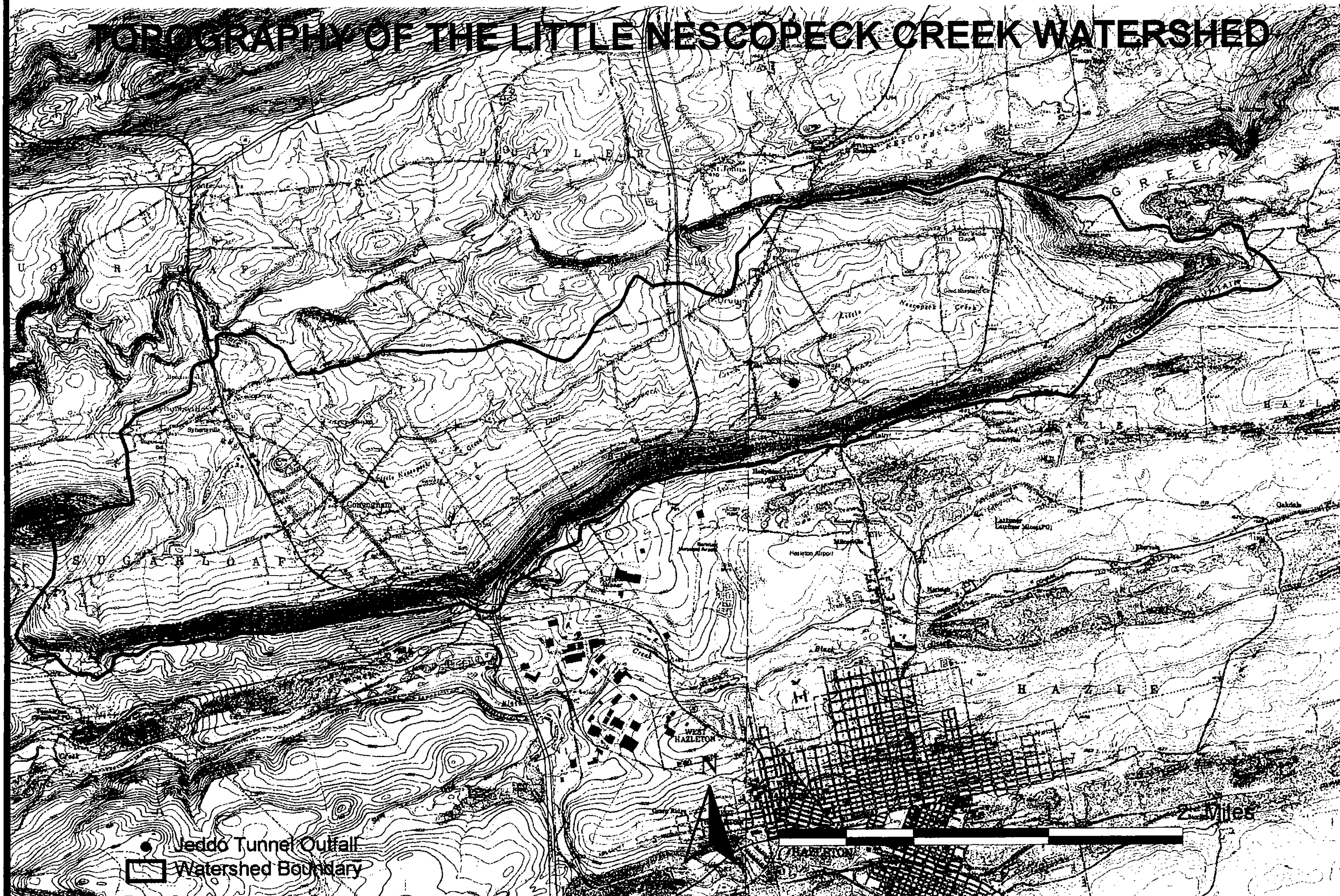

Figure 4. Topography of the Little Nescopeck Creek Watershed.

boundary with elevations between 1700 and 1900 feet. The hydrology of the area south of the Little Nescopeck watershed is controlled by a mine de-watering system which ultimately discharges into the Jeddo Tunnel, and therefore into the Little Nescopeck Creek. The northern part represents a natural local groundwater system that drains directly into the Little Nescopeck Creek and Nescopeck Creek. The Eastern Middle Field coal region lies to the south of the Little Nescopeck watershed area. It should be noted that the Hazleton Basin of this area is in a separate watershed that drains to the Little Nescopeck via the Jeddo Tunnel.

1.4 Soils of the Little Nescopeck Creek Watershed

Soil consists of inorganic mineral particles of differing size (clay, silt and sand), organic matter in various stages of decomposition, numerous species of living organisms and various gases and water. Soils, particularly riparian and wetland soils, contain and support a very high diversity of flora and fauna both above and below the soil surface.

Soil properties change with topographic position. Elevation differences generally mark the boundaries of soils and drainage conditions in stream corridors. Different landforms generally have different types of sediment underlying them. Surface and subsurface drainage patterns also vary with landforms. It is important to identify soil boundaries and to understand the differences in soil properties and functions occurring within a stream corridor in order to identify opportunities and limitations of restoration (Stream Corridor Restoration, 1998).

Soils perform vital functions throughout the landscape. One of the most important functions of soil is to provide a physical, chemical and biological setting for living organisms. Soils support biological activity and diversity for plant and animal productivity. Soils also regulate and partition the flow of water and the storage and cycling of nutrients and other elements in the landscape. They filter, buffer, degrade, immobilize and detoxify organic and inorganic materials and provide the mechanical support living organisms need. These hydrologic, geomorphic and biological functions involve processes that help build and sustain stream corridors (Stream Corridor Restoration, 1998). The soil series identified in the Little Nescopeck Creek watershed are as follows: (Figure 5).

Arnot Series: Consists of shallow, well-drained, nearly-level to steep soils. These soils are on the convex tops and sides of hills, knolls and mountain ridges.

Alluvial Land: A nearly-level to gently-sloping, unconsolidated mixture of variably-textured soil material, gravel and stones. It occurs on narrow floodplains and in upland drainageways.

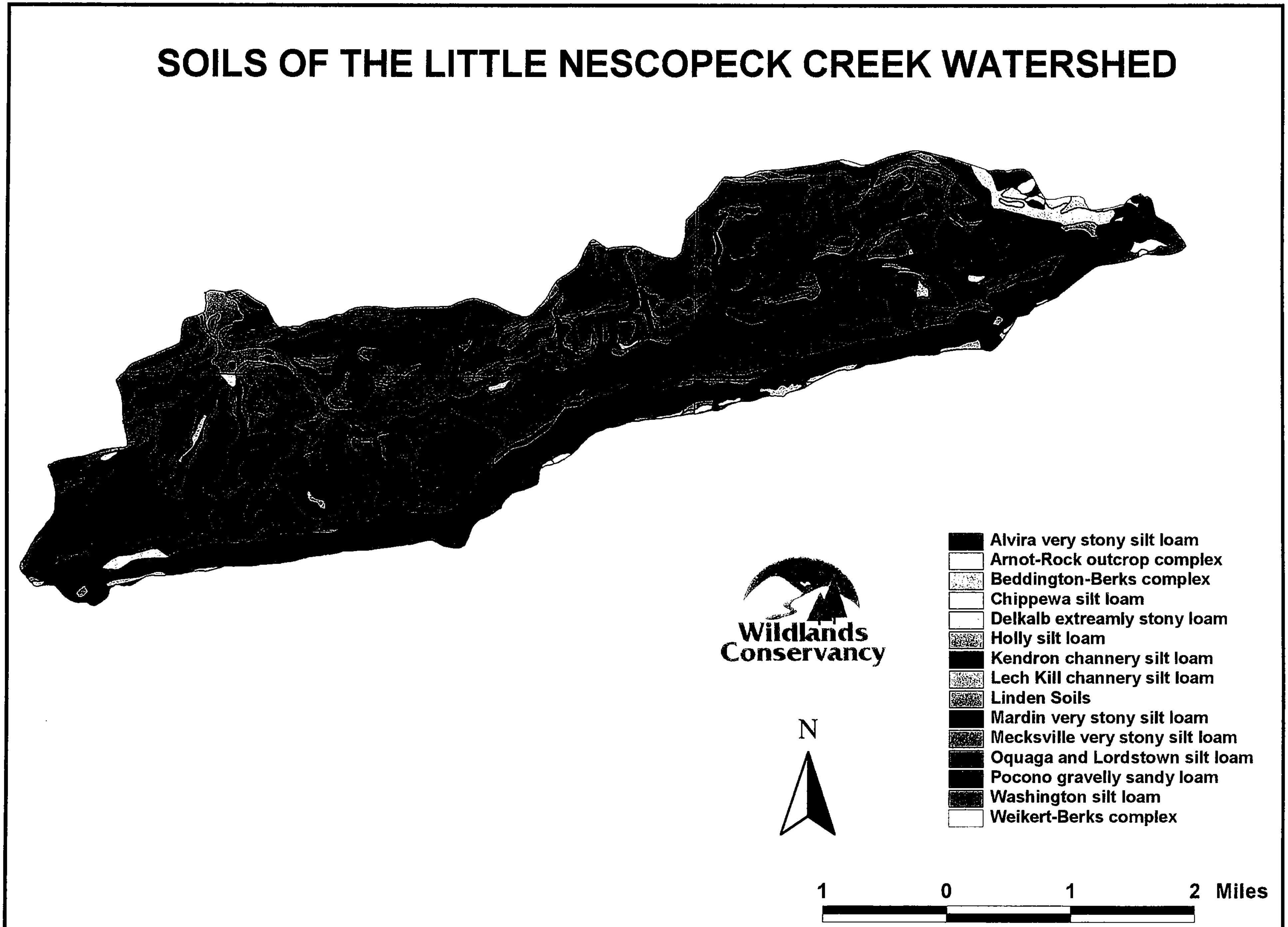

Figure 5. Soils of the watershed.

2.0 AQUATIC RESOURCES

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2.1 Little Nescopeck Watershed Hydrology

2.1.1 Surface Water

The Little Nescopeck Creek is a 3rd order stream with its source in Butler Township at an elevation of 1850 feet, and its mouth near Sybertsville in Sugarloaf Township, at an elevation of 900 feet. The length of the creek is approximately 10 miles with a drainage area of approximately 14 square miles. The creek has 10 minor, unnamed tributaries. Approximately 2.5 miles from its headwaters, the Little Nescopeck receives a 40,000 gallon per minute (gpm) inflow from the Jeddo Tunnel (Figure 6), which drains 32.24 square miles of the coal-mined watershed to the south (Figure 7).

Figure 8. The Little Nescopeck Creek one mile upstream from the Jeddo Tunnel.

2.1.2 Wetlands

Wetlands are those areas that are inundated by surface or ground water with a frequency to support, under normal circumstances, a prevalence of vegetative or aquatic life that requires saturated or seasonally-saturated soil conditions for growth and reproduction. Wetlands can be flooded permanently, seasonally or only intermittently, while some, such as bogs, are rarely flooded, but have soils that are saturated to the surface most of the time. Factors for delineating these

Figure 6. The Jeddo Tunnel outfall as it enters the Little Nescopeck Creek.

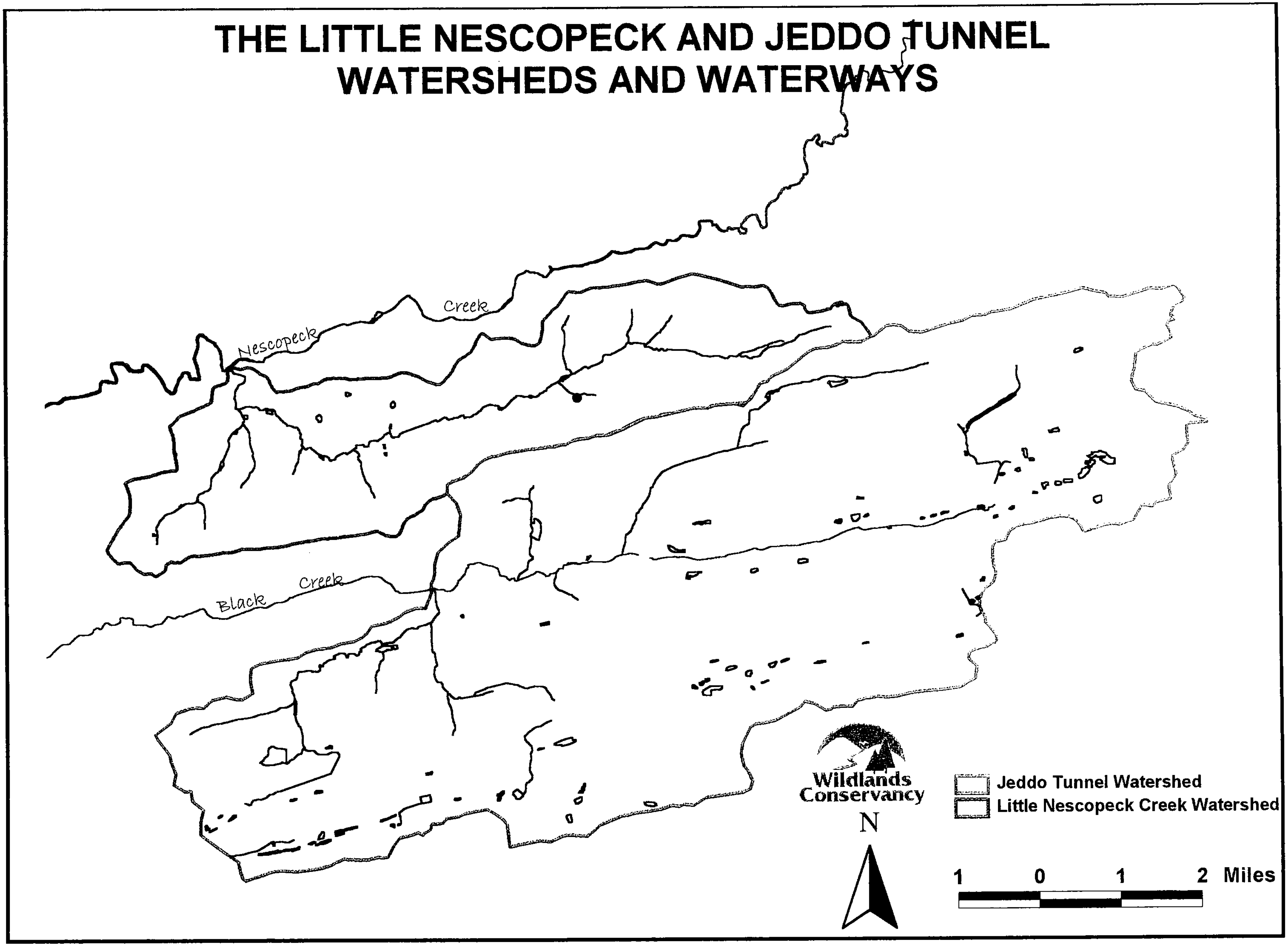

Figure 6. The Little Nescopeck and Jeddo Tunnel Watersheds and Waterways

areas include soil type, existing vegetation and prevalence of surface or groundwater (Wetlands Values and Trends, 1995).

Water quality is frequently improved as it passes through wetlands. Soil microbes, plant litter and living plants actually reduce pollution levels in water. The organic matter in wetland soils absorbs substantial amounts of nutrients and chemical contaminants. Wetlands help to lower overall pollution levels in associated open water areas. Since surface water often seeps into the ground-water aquifers, wetlands may help to maintain the purity of ground water as well (Wetlands Values and Trends, 1995).

It is also critical to preserve wetlands, as their potential to store large amounts of water helps moderate stream flows during both storm events and droughts. Storm water runoff accumulates in wetlands, where it is retained until peak stream flows have passed, and it is then released slowly to the stream. This natural wetland function can help to minimize the extent and duration of peak discharge rates. Chemical and biological processes that occur in wetlands also help to transform deleterious substances like pesticides into less harmful forms for the environment. In addition, wetlands help reduce soil runoff and prevent pollution. Even the best erosion and sedimentation practices allow some soil to leave the field with runoff. Plants in wetlands help slow the movement of water, allowing sediment to drop out. Nutrients such as phosphorus, which cling to the soil, are deposited in the wetland where they can be used by the plants.

Because they are transitional ecological zones, wetland boundaries can be difficult to locate precisely. Various Palustrine wetland areas are located in small patches throughout the entire length of the Little Nescopeck. The largest continuous wetland area is a Palustrine Forested, Broad-leaved deciduous wetland in the center of the watershed along the Creek and is approximately 1.0 mile long and 0.1 miles wide. Small patches of Palustrine Scrub-Shrub Broad-leaved Evergreen and Deciduous wetlands are located in the northeast corner of the watershed. Palustrine Unconsolidated Bottom and Palustrine Forested Broad-leaved Deciduous wetland patches can be found in the northwest corner of the watershed along the creek.

In recent years, wetland legislation has become a dominant topic among land use planners. Due to the severity of disrupting a wetland's special ecosystem, regulation of permitted uses in wetland areas is a highly necessary procedure and is mandated by federal and state authorities. There have been efforts to recognize the ecological benefits of wetlands and to protect them. Specifically, section 404 of the Clean Water Act prohibits unauthorized placement of dredged or fill material into waters of the United States, including most wetlands. The United States Army Corps of Engineers administers this program with EPA oversight. Within Pennsylvania, The Pa. DEP has jurisdiction for the protection of wetlands and stream encroachments under Chapter 105 of the Dam Safety and Encroachment Act of 1978 (Jeffries, 1990).

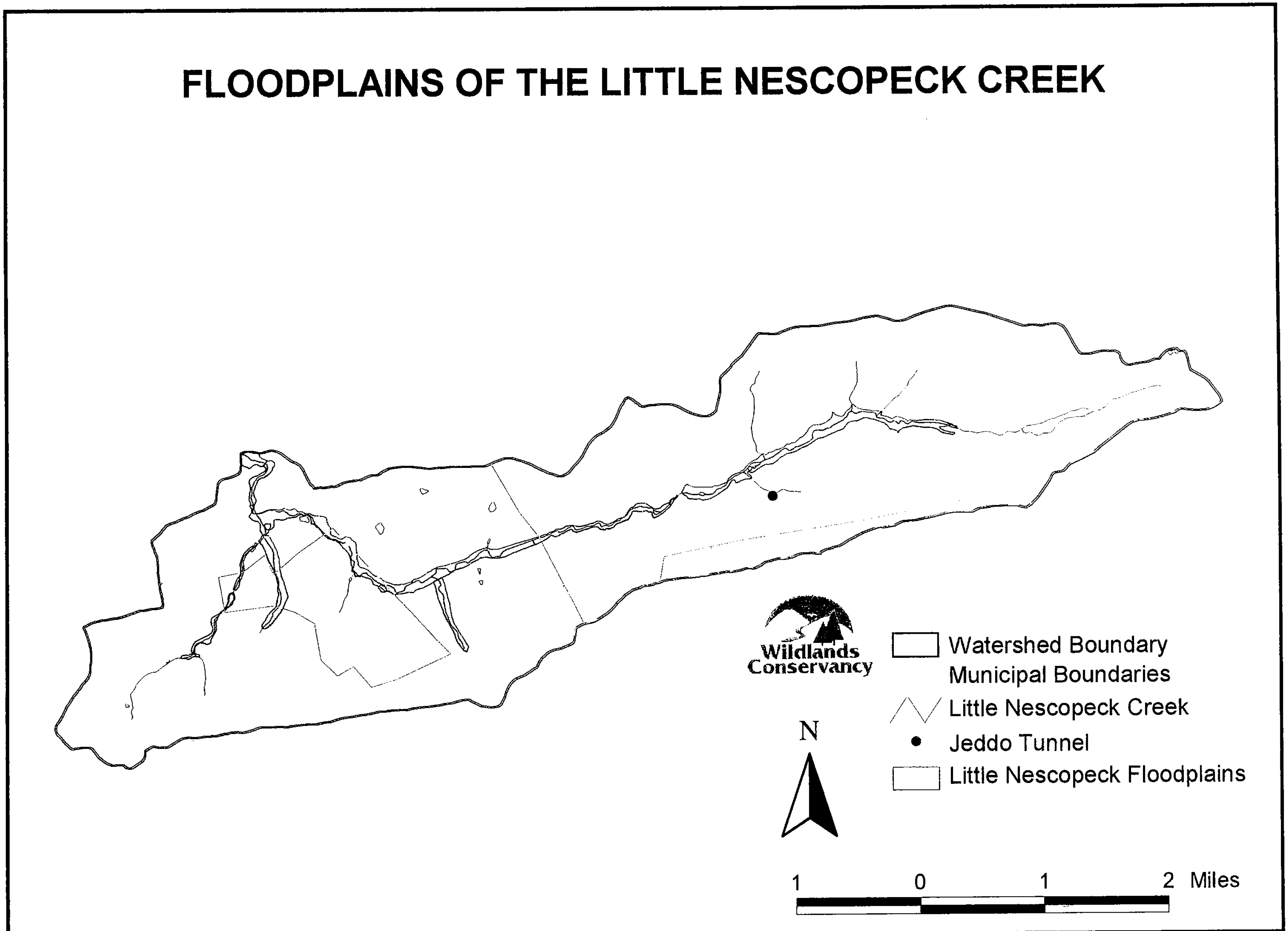

Figure 9. Floodplains of the Little Nescopeck Creek

deposits present in the study area, is chiefly dependent on the size, shape and cementation of its constituent particles and the fracturing of the rock resulting in joints, faults and fractures (Caduto, 1985).

The availability of groundwater for extraction depends on the porosity, topography and the aerial distribution of the drainage basin and precipitation, which is the source of groundwater replenishment. Land use can also become an important factor in the supply of groundwater by controlling infiltration.

2.1.5 Aquifers

Aquifers are natural reservoirs for groundwater used for drinking and irrigation. They act as natural filters and are interconnected with surface water systems in lakes, streams and wetlands. A variety of land use activities have the potential to seriously degrade aquifers, especially in areas where the water table is close to the surface. It is important to identify existing or potential point- and non-point sources of pollution and to plan land use activities according to the threat they impose on water quality. Malfunctioning on-lot septic systems and leaks in sanitary sewer lines located within aquifer regions are examples of non-point source pollution. Agricultural practices and urban activities are sometimes examples of non-point source pollution.

Drilled wells are the major source of water for the smaller communities and in the rural farm and non-farm areas of the watershed. Four potential aquifers are readily accessible to watershed communities. The Pocono and Pottsville Formations are composed of conglomerate and sandstone. These rocks form high, sinuous ridges adjacent to long valleys underlain by the sandstone, siltstone and shale of the Mauch Chunk and Llewellyn Formations. Groundwater flow systems in these rocks grade laterally from confined to unconfined and range in area from less than one to tens of square miles (Becher).

Wells in the Pocono and Llewellyn Formations yield only small supplies of water (15 to 20 gallons per minute). Maximum yields of single wells in the Mauch Chunk and Pottsville Formations are 800 to 400 gallons per minute, respectively (Becher).

The Mauch Chunk Shale is one of the most productive water-bearing formations in northeastern Pennsylvania. Its low-lying topographic position between high ridges and generally-shallow water table make it favorable to groundwater development (Butler Township Comprehensive Plan, 1984).

The fractured, hard sandstone beds of the Pottsville Formation make it a very good water producer. The topographic location and limited exposure of the Pottsville Formation in the watershed make it less available to groundwater development (Butler Township Comprehensive Plan, 1984).

2.1.6 Precipitation

Precipitation varies monthly, seasonally and annually. Precipitation averages about 49 inches per year in the area for the 66-year period from 1932 to 1998 (Tables G4, G5 and G6). A comparison of this average with precipitation in 1996, 1997 and 1998 (Table 1) indicates that precipitation in Hazleton exceeded that average by 11 percent. Precipitation was about average in 1997. For 1998, precipitation was 13 percent below average in the Jeddo Tunnel Basin.

2.1.7 National Pollutant Discharge Elimination Strategy (NPDES) Permits

The Federal Clean Water Act and the Pennsylvania Clean Streams law requires wastewater dischargers to have a permit establishing pollution limits and specifying monitoring and reporting requirements. The federal Clean Water Act requires states to issue National Pollutant Discharge Elimination Strategy (NPDES) permits to any person or municipality wanting to discharge wastewater into the states' waters. NPDES permits regulate household and industrial wastes that are collected in sewers and treated at municipal wastewater treatment plants. Permits also regulate industrial point sources and concentrated animal feeding operations that discharge directly into receiving waters.

Permits regulate discharges with the goals of protecting public health and aquatic life and assuring that every facility treats wastewater. To achieve these ends, permits include the following terms and conditions: site-specific (or effluent) limits; standard and site-specific management; and compliance monitoring and reporting requirements. When and if regulated facilities fail to comply with the provisions of their permits, they may be subject to enforcement actions. DEP and EPA use a variety of techniques to monitor permittees' compliance status, including on-site inspections and review of data submitted by permittees. The NPDES permit is generally valid for a period of five years.

The types of regulated pollutants are:

Conventional Pollutants are contained in the sanitary waster of households, businesses and industries. These pollutants include human wastes, ground-up food from sink disposals and laundry and bath waters. Conventional pollutants include:

Fecal Coliform-These bacteria are found in the digestive tracts of humans and animals; their presence in water indicates the potential presence of pathogenic organisms.

Oil and Grease-These organic substances may include hydrocarbons, fats, oils, waxes and high-molecular fatty acids. Oil and grease may produce sludge solids that are difficult to process.

Toxic Pollutants are particularly harmful to animal or plant life. They are primarily grouped into organics (including pesticides, solvents, polychlorinated biphenyls (PBCs) and metals (including lead, silver, mercury, copper, chromium, zinc, nickel and cadmium).

Non-conventional Pollutants are any additional substances that are not conventional or toxic that may require regulation. These include nutrients such as nitrogen and phosphorous.

There are two permitted discharges that enter into the Little Nescopeck Creek: Butler Township Municipal Authority in Drums and Conyngham Borough Water Authority in Conyngham.

2.2 Hydrology of the Jeddo Tunnel System

As already introduced, the Jeddo Tunnel system contributes an average 40,000 gallons per minute of abandoned mine drainage water to the Little Nescopeck Creek. It is therefore necessary to examine the hydrology of the Jeddo system in addition to that of the Little Nescopeck. The following data, conclusions and remediation suggestions are taken from *Assessment of Conditions Contributing Acid Mine Drainage to the Little Nescopeck Creek Watershed, Luzerne County, Pennsylvania, and Abatement Plan to Mitigate Impaired Water Quality in the Watershed*, a report prepared for Pennsylvania Department of Environmental Protection, Bureau of Watershed Conservation, under Grant #ME96114, by the Susquehanna River Basin Commission and Wildlands Conservancy.

2.2.1 Hydraulic Budget Equation

A water budget analysis for the Jeddo Tunnel system was performed by Paula Ballaron of the Susquehanna River Basin Commission as part of the previously mentioned study. A hydrologic budget is a quantitative expression of the balance between the major components of water moving in and out of the area. In this equation, water that enters the drainage basin as precipitation is balanced against water that leaves the basin as evaporation and stream flow. The time period used is the water year, which is the 12-month period from October1 through September 30. The hydraulic budget is a measure of the total water resource available without depleting storage under natural conditions. A simplified equation for this balance is:

$$P = R_s + R_g + ET + \Delta S$$

where

P is precipitation,

R_s is the surface runoff component of total stream flow,

R_g is the groundwater discharge component of total stream flow (base flow),

ET is water losses (chiefly evaporation and transpiration) and

ΔS is the change in groundwater storage.

Information was available on precipitation and runoff (stream flows and tunnel discharge). The water budget equations were evaluated over a period of time in which the beginning and ending quantity of stored water is approximately equal, so the storage factor in the equation can be ignored. The annual water budgets for the Jeddo Tunnel Basin from 1996 to 1998 are based on a drainage area of 32.5 square miles and are as follows:

Table 1. Annual Water Budget for the Jeddo Tunnel Basin
(in inches)

Water Year	1996	1997	1998	Average
Precipitation	54.25	48.54	42.71	48.50
Surface Runoff	4.07	3.42	2.88	3.46
Base Runoff	36.36	31.89	28.28	32.18
Evapotranspiration	13.82	13.23	11.55	12.87

2.2.2 Runoff

Surface runoff from Black Creek, Little Black Creek, Cranberry Creek and Hazle Creek was estimated from discharge data for the Jeddo Tunnel, based on measurements of flow exiting the basin. Immediately following rainfall events, surface runoff varies from about 5 percent of Tunnel flow during periods to about 11 percent during spring 1998. The relationship between total surface runoff and Tunnel discharge is used to estimate annual surface runoff for the water budget. Average annual surface runoff is estimated to be 9 cfs, the equivalent of 3.46 inches spread across the drainage basin (Table 1).

Of the surface flows leaving the Jeddo Basin, Hazle Creek is the largest, followed in decreasing order by Black Creek, Little Black Creek and Cranberry Creek. Stream flows are not proportional to the drainage area of the sub-basin due to direct and indirect losses to the mines.

Most water leaves the Jeddo Basin through the Jeddo Tunnel. Flow data from the Jeddo Tunnel was obtained from the USGS gaging station on the Little Nescopeck Creek tributary near Freeland.

Winter-Spring precipitation is important for recharging the groundwater and mine-water systems that sustain Tunnel flow. Tunnel discharge responds to precipitation much like stream flow. The average annual discharge from the Jeddo Tunnel is 79.4 cubic feet per second (40,000 gpm) (Table 2). This discharge is equivalent to 32.18 inches spread across the drainage basin.

Total runoff, which includes flow through the Jeddo Tunnel and streams exiting the basin, during the 3-year study period averages about 88 cfs, equivalent to 35.64 inches spread across the drainage basin (Table 1). Precipitation for the same period averages 48.50 inches. Total runoff is 74 percent of precipitation, on average.

Table 2. Base Flow Separations of the Jeddo Tunnel Discharge (flow values in cubic feet per second)

Water Year	1996	1997	1998	Average
Total Discharge	89.6	78.8	69.9	79.4
Direct Runoff	8.2	8.6	4.7	7.2
Mean Base Flow	81.4	70.2	65.2	72.3

2.2.3 Tunnel Discharge

The discharge from the Jeddo Tunnel is comprised of: direct infiltration of precipitation through the mined land; seepage from streams, especially where they cross mined land; stream flow directly entering the mines through cave-ins or other sinks; un-channeled overland runoff and interflow from upland areas and natural groundwater discharge from bedrock aquifers. Both underground and surface mining, with associated subsidence, create surface catchment basins, fractured rock strata and artificial ponding that increases the amount of water discharged by the tunnel. To reduce mine water drainage from the Jeddo basin, measures will have to be taken to control water from entering the surface.

Base flow averaged 72.3 cfs annually from the Jeddo Tunnel Basin (Table 2). This discharge is equivalent to about 29 inches spread over the entire basin. The direct or surface runoff component of tunnel discharge was computed as the difference between total flow and base flow. Surface runoff through the tunnel averaged 7.2 cfs (Table 2), or an equivalent of 3 inches spread over the basin. Base flow discharged through the tunnel accounts for about 81 percent of total runoff in the basin.

A large portion of precipitation infiltrates to the mine workings and to the natural groundwater system through the disturbed land in mined areas, reducing the amount of surface runoff and, conversely, increasing the groundwater discharge. Currently, in the Jeddo Tunnel drainage area, there is easy ingress to precipitation through rock fissures, cave-ins, fissures in outcrops and strippings and numerous sinks. Remedial measures can eliminate many of the direct pathways for the precipitation entering the mines and channel this flow to streams outside the Jeddo basin, which should significantly reduce the direct runoff component of tunnel discharge. According to the Wildlands/SRBC report, these measures could reduce total tunnel discharge by about 11 percent, under average conditions.

Reestablishing perimeter drains that would intercept overland runoff from adjacent ridges would likely further reduce the discharge from the Jeddo Tunnel.

The un-channeled overland runoff currently flows to the mined lands and percolates through the overburden to the flooded mine workings. As such, much of the existing overland runoff may not have been accounted for in the surface runoff component of tunnel discharge.

Uplands surrounding the coal basins comprise about 55 percent of the Jeddo basin. Diverting the runoff contributed by these areas away from the mined lands could potentially reduce tunnel flow another 10 percent, provided the channels are lined to minimize any seepage to the mine-water system from reestablished streams and perimeter drains (SRBC/Wildlands, 1999).

Even after the surface drainage network is restored, infiltration of precipitation on mined lands, the natural groundwater discharge from the bedrock aquifers, and underflow from uplands adjacent to the coal basins will continue to support tunnel flow. During a moderate drought in 1998, when infiltration through the mined lands was minimal, flows declined to 30 to 33 cfs and stabilized. Flows of this magnitude also are typical during late summer and early fall in years with average levels of precipitation. This likely represents natural groundwater discharge, amounting to about 0.9 cubic feet per second per square mile (cfsm), and cannot be reduced by remedial measures.

2.2.4 Evapotranspiration

Water lost to the atmosphere by evaporation from surface bodies of water, wetted surfaces, moist soil and by transpiration of plants commonly constitutes the largest component in the water budget. ET (evapotranspiration) was calculated in the budget as the difference between precipitation and total runoff. The average annual loss to ET is about 13 inches from the basin (Table 1). This loss constitutes 26 percent of average annual precipitation in the basin. The low rate of ET is probably related to the lack of vegetation in the mined areas and the character of the soils. Soils and other overburden in the mined areas allow for rapid infiltration of precipitation. Any water that enters the soils passes quickly below the root zone.

2.2.5 Sub-basin Contributions

Average discharge from the Jeddo Tunnel amounts to 2.463 cfsm, or 1.591 mgd/mi^2. The sub-basins of Black Creek, Little Black Creek, Cranberry Creek and Hazle Creek contribute an average of 30.99 cfs (39 percent), 11.43 cfs (14 percent), 16.31 cfs (26 percent) and 21.01 cfs (21 percent), respectively.

3.0 BIOLOGICAL RESOURCES

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3.1 Flora of the Little Nescopeck Creek Watershed

The flora of the Little Nescopeck Creek Watershed is representative of the Ridge and Valley Province through much of Pennsylvania. Agricultural areas have been utilized for various field and forage crops. The woodland plant community and, ultimately, residentially developed areas that have re-vegetated naturally are made up of various hardwoods, conifers, grasses, legumes and wild and domestic herbaceous plants.

Table 3. Common Plant Species within the Little Nescopeck Watershed
(∅ = exotic species, ◈ = species observed in the riparian zone)
(Source: Alan Gregory, Friends of the Nescopeck)

Common Name	Scientific Name
Hardwoods	
Northern Red Oak ◈	*Quercus rubra*
White Oak ◈	*Quercus alba*
Pin Oak ◈	*Quercus palustris*
Chestnut Oak ◈	*Quercus prinus*
Scrub Oak ◈	*Qercus ilicifolia*
Black Cherry ◈	*Prunus serotina*
Sugar Maple ◈	*Acer saccharum*
Norway Maple ∅◈	*Acer plaanoides*
Mountain Maple ◈	*Acer spiicatum*
Striped Maple ◈	*Acer pensylvanicum*
Black Walnut	*Juglans nigra*
Red Maple ◈	*Acer rubrum*
Shagbark Hickory ◈	*Carya ovata*
Pignut Hickory ◈	*Carya glabra*
White Birch ◈	*Betula papyrifera*
River Birch ◈	*Betula nigra*
Yellow Birch ◈	*Betula lutea*
Gray Birch ◈	*Betula populifolia*
Conifers	
Red Pine	*Pinus resinosa*
Eastern White Pine◈	*Pinus strobus*
White Spruce	*Picea glauca*
Softleaf Pine	*Pinus eclunata*
Eastern Hemlock◈	*Tsunga canadensis*
Norway Spruce ∅◈	*Picea glauca*

Table 3. Continued

<u>Deciduous Trees</u>	
Yellow Poplar	*Lirrodendron tulipifera*
White Ash	*Fraxinus americana*
Eastern Cottonwood	*Populus deltoides*
American Basswood	*Titlia americana*
American Beech◈	*Fagus grandifolia*
Flowering Dogwood◈	*Cornus florida*
Silky Dogwood◈	*Cornus amonum*
<u>Shrubs</u>	
Spice Bush◈	*Lindera benzoin*
Multiflora Rose ∅◈	*Rosa multiflora*
Rhododendron◈	*Rhododendron canadense*
Witch Hazel◈	*Mamamelis virginiana*
Blackberry ◈	*Rubus allegheniensis*
Raspberry◈	*Rubus idaeus*
Sassafras◈	*Sassafras albidum*
<u>Grasses, Weeds and Legumes</u>	
Fescue	*Festuca elatior*
Orchard Grass	*Dactylis glomerata*
Clover	*Trifolium squamosum*
Alfalfa	*Medicago sativa*
Crown Vetch	*Coronilla varia*
Broomsedge	*Andropogon virginicus*
Indiangrass	*Sorghastrum nutans*
Goldenrod	*Solidago canadensis*
Pokeweed	*Phytolacca Americana*
Timothy Grass∅◈	*Phleum pratense*
Crab Grass∅◈	*Digitaria sanguinalis*
Japanese Knotweed ∅◈	*Polygonum cuspidatum*
Quackgrass ∅◈	*Elytriga repens*
Canada Thistle ∅◈	*Cirsium arvense*
Spotted Knapweed ∅◈	*Centaurea maculosa*
Autumn Olive ∅◈	*Elaeagnus umbellata*
<u>Perennials</u>	
Trout Lily◈	*Erythronium americanum*
Skunk Cabbage◈	*Symplocarpus foetidus*
Wild Strawberry◈	*Fragaria virginiana*
Wild Onion◈	*Allium canadense*
Sedges◈	*Carex*
Rushes◈	*Juncus*

The aquatic plant community of the Little Nescopeck Creek is also representative of the commonly found groups of the eastern United States. Included in these groups are water tolerant herbaceous plants found in various riparian habitats, actual aquatic vegetation such as bulrush, duckweed, waterweed and pondweed and various species of algaes.

3.1.1 Streamside Vegetation

Because of increased flow, due mainly to the high-volume discharges of the Jeddo Tunnel, the Little Nescopeck Creek (and the Nescopeck Creek to an extent) has suffered a great deal of bank erosion throughout its run below their confluence. The loss of the riparian buffer in places has exacerbated this erosion.

A riparian buffer is the vegetation found along streamsides, riparian meaning along a stream or river and buffer because it serves as an area of defense between the water and its surrounding land uses. Riparian buffers protect a stream in many ways. First, they provide shade to keep the water temperature at optimal levels for cold-water species. Second, they provide woody and leafy debris and attract insects, serving as either food or shelter for aquatic life. In addition, the roots trap sediment contained in runoff from adjacent lands, thus preventing it from entering the stream and destroying valuable spawning areas and macro-invertebrate habitats. Vegetation also uses nutrients contained in runoff that are essential for plant growth, thereby reducing damaging nutrient loading of streams and also provides structural integrity to stream banks via expansive root systems. Lastly, trees and other streamside vegetation are capable of withdrawing significant amounts of water from the ground, which reduces flooding during times of heavy precipitation.

The riparian zone is characterized by a mixed forest of Flowering Dogwood; Eastern White Pine; Eastern Hemlock; Beech; various Oaks including Northern Red, White, Pin, Chestnut and Scrub; Yellow and Gray Birch; Shagbark and Pignut Hickories; and Maples, including Red, Sugar, Mountain and Striped. Lush areas of Rhododendron, Spicebush, Silky and Red-Twig Dogwood, Sassafras, Common Witch-Hazel, Blackberry and Raspberry characterize the understory of the riparian zone. The forest floor contains various perennials and herbs such as Trout Lily; Wild Strawberry; Skunk Cabbage; Wild Onion; various sedges and rushes; and a wide range of exotics, many of which have quickly invaded streamside areas following disturbance for farming or residential development. These exotics include Multiflora Rose, Spotted Knapweed, Canada Thistle, Timothy Grass, various Crabgrasses, Japanese Knotweed, Norway Maple, Norway Spruce, Autumn Olive and Quackgrass.

The riparian zone along the Little Nescopeck Creek has survived remarkably well to date. Friends of the Nescopeck believe this is due to the fact that there has been little pressure to develop areas close to such a degraded stream. The riparian zone fluctuates in width from zero feet (in pastured land one mile upstream from the Jeddo Tunnel confluence) to 500 feet on the Keystone Job Corps Center property. At Conyngham, the width is reduced to 60 feet on the east side and five feet on the west side, but quickly widens again until it is pinched in adjacent to the Conyngham Borough Authority Wastewater Treatment Plant (just two feet on the west side for more than 200 feet). It again widens to a minimum of 100 feet on both sides through its confluence with the Nescopeck Creek. The headwaters of the stream are in a hilly, wooded area of second-growth Oak-Hickory forest.

Figure 10. Riparian Buffers are intact along much of the Little Nescopeck Creek.

It is important to maintain riparian buffers, as they are perhaps the number one weapon in fighting non-point source pollution and in attaining a healthy, high quality water body. Increasing development in recent years has led to the destruction of and/or encroachment upon riparian buffers protecting the Little Nescopeck. In addition, new challenges facing agricultural producers are driving many to remove streamside vegetation in an effort to cultivate more land.

3.1.2 Invasive and Exotic Vegetation

Hundreds of plant species have been relocated by humans from their native ranges to new areas. Many of the exotic plants that have been introduced, either by accident or by intention, have been beneficial and ecologically benign. But a small percentage have run rampant. Gaining a foothold first in areas disturbed by human activities, these species then move into natural areas where they have not only driven out indigenous species but in the worst cases radically altered the ecosystems they have invaded.

A native plant is one that occurred within the state before settlement by Europeans. Native plants include ferns and clubmosses; grasses, sedges, rushes, and their kin; flowering perennials; annuals; biennials and the woody trees, shrubs and vines. There are over 2100 native plant species known in Pennsylvania (Pa. DCNR, 1998). An introduced or "exotic" plant is one that has been brought in and becomes established. In 1998 there were 1300 species of exotic plants in Pennsylvania (Pa. DCNR, 1998). That is 37% of Pennsylvania's total plant flora, and more introduced plants are identified every year. An "invasive" plant not only becomes established, but spreads aggressively into new areas and environments. Some native plants are aggressive in disturbed areas, but most invasive plants are introduced from other continents, leaving behind pests, diseases, predators and natural controls.

Species that have flourished and spread on their own only after people transported them across barriers they could not otherwise surmount (such as oceans, mountain ranges and deserts) are considered non-natives or exotics. In many areas these plants have overwhelmed the native plants and animals. These species are considered invasive. Exotic species are responsible for most damaging invasions, but a far smaller number of natives also have invaded and degraded new habitats (Marinelli, 1996). Invasives reproduce rapidly and can form stands that exclude nearly all other plants. In the process they damage natural areas, altering ecosystem processes, displacing native species, hybridizing with natives and changing their genetic makeup and supporting other non-native plants, animals and pathogens (Marinelli, 1996).

Some invasive species in the region, such as Norway maples, release toxins to the soil that inhibit growth and reproduction of native species. Invasive trees are often overlooked because they do not have the dense vine or shrub form typical of exotics. The threat of the Norway maple in many regions is unnoticed because most trees are still saplings. However, by the time these saplings mature, the forested land will be composed almost exclusively of Norway maple. Even invasive trees do not provide adequate protection from erosion. These trees prevent the establishment of an herbaceous or shrub layer, leaving much of the soil bare and subject to erosion. The Norway maple is no longer recommended, but a large demand still exists and it continues to be used on a widespread basis (Andropogon Associates, 1991).

In forested areas, trees such as Norway maple (*Acer platanoides*) grow into the canopy, as do vines like Japanese honeysuckle (*Lonicera japonica*), where they shade out or topple trees. In wetlands in the northern third of the United States and southern Canada, purple loosestrife (*Lythrum salicaria*) forms large, dense strands, eliminating the open water areas that waterfowl require and elsewhere displacing native plants that feed and shelter wildlife.

Invasive and exotic species are a major environmental threat to many naturally vegetated regions. Many natural lands, which are becoming more frequently disturbed and fragmented, are increasingly susceptible to invasive and exotic species. When introduced to a new region, invasive vegetation spreads rapidly, overtaking the native habitat. The introduction of just a few invasive species is sufficient to severely limit the diversity of a natural system, especially if that system is also stressed by other environmental factors. Limiting vegetative diversity ultimately limits wildlife diversity, as birds and animals require different vegetative species for cover and food (Andropogon Associates, 1991).

Invasive species were abundantly and widely distributed when they were believed to be quick solutions to erosion problems. These invasive exotics have shallow root systems that spread quickly to provide ground cover for bare slopes. However, these roots do not effectively stabilize soil, and stream banks continue to erode (Andropogon Associates, 1991).

Exotic species threaten the ecology of naturally vegetated areas, as they do not provide proper food and habitat for native wildlife. For example, if an aquatic macro-invertebrate did not evolve feeding on Norway maple leaf litter, it will not be edible to that species now. Therefore, that macro-invertebrate species may relocate or be wiped out of the stream entirely, if it cannot find the feeding material on which it evolved eating. Since macro-invertebrates, diatoms and other microorganisms are basic building blocks in the food chain, a loss of them could disrupt the ecology within the riparian habitat.

Invasive species are a severe problem because there are no means of effectively controlling their spread. Many invasive species are spread very rapidly over great distances by animal and bird dispersal. The only means of control is to eliminate as many existing plants as possible and restrict planting of new species (Andropogon Associates, 1991). No species that is proven to be or even suspected of being a successful invader should be planted.

3.2 Fauna of the Little Nescopeck Creek Watershed

Three main areas of wildlife have been surveyed to date in the riparian zones of the Little Nescopeck Creek and several of its tributaries: herpetological, avian and invertebrate (principally lepidoptera with a focus on butterflies). The following lists resulted from field surveys completed by Alan Gregory from Friends of the Nescopeck between 1991 and 1998 on public and private lands adjacent to the Little Nescopeck Creek.

Biologists from the Pennsylvania Department of Environmental Protection collected benthic macro-invertebrate and fish information from the Little

Nescopeck between June and July 1998. Macro-invertebrates were identified to the lowest taxonomic level easily and confidently achieved. The only locations amenable to collecting fish were those upstream from the Jeddo Tunnel confluence. All other stations were visibly affected by abandoned mine drainage to the point of making fish collecting futile (Pa. DEP Stream Investigation, 1999).

Little Nescopeck Creek is designated as a High Quality Cold Water Fishery (HQ-CWF) and sampling supported that classification. The stream was influenced by input from an upstream pond in its macrobenthic and fish communities; warm water sunfish and bass and plankton filter feeding macrobenthos were present. However, the stream also supports a native brook trout population and an overall macrobenthic community reflective of excellent coldwater conditions. Unfortunately, the Jeddo Tunnel enters the stream approximately 2.5 miles downstream from its headwaters and completely decimates the macrobenthic and fish communities.

In order to develop a fuller understanding of the wildlife associated with the Little Nescopeck Creek, much fieldwork remains.

3.2.1 Aquatic Macro-invertebrates

The aquatic animal community of the Little Nescopeck Creek does not differ from the commonly found species of northeastern lakes and streams. Many different insect populations exist within the aquatic community, including mayflies, stoneflies, caddis flies and various others.

Table 4. Aquatic Macro-invertebrates Found in the Little Nescopeck Creek Upstream from the Jeddo Tunnel
(Data Source: Pennsylvania Department of Environmental Protection)

Common Name	Scientific Name
Sow bugs:	*Isopoda Asellus*
Mayflies:	*Ephemeroptera Ephemerella*
	Ephemeroptera Isonychia
	Ephemeroptera Baetis
	Ephemeroptera Paraleptophlebia
Alder Flies:	*Megalopterea Sialis*
	Megaloptera Nigronia
Beetles:	*Coleoptera Dubriaphia*
	Coleoptera Optioservus
Stone Flies:	*Plecoptera Tallaperla*
	Plecoptera Leuctra

Table 4. Continued

	Plecoptera Perlesta
Caddis Flies:	*Tricoptera Hydropsyche* *Tricoptera Cheumatopsyche* *Tricoptera Dolophilodes* *Tricoptera Rhyacophila* *Tricoptera Glossosoma*
True Flies:	*Diptera Orthocladiinae* *Diptera Tanypodinae* *Diptera Tanytarsini* *Diptera Tipulidae* *Diptera Simulium*
Gastropods:	*Gastropoda gastropoda*

3.2.2 Lepidoptera and Odnata

Many of the following species, particularly among the Odnata, are good indicators of water quality. Their presence in the watershed may only be transitory in some cases. These species may also be utilizing vernal pools and other wetland resources on the Little Nescopeck Creek floodplain. In addition, several species are known to breed in the riparian zone, creek and associated wetlands; they are indicated with an asterisk.

Table 5. Lepidoptera and Odnata Found in the Little Nescopeck Creek Watershed
(Data Source: Alan Gregory, Friends of the Nescopeck)

Common Name	Scientific Name
Lepidoptera (butterflies)	
Black Swallowtail*	*Papilio polyxenes*
Eastern Tiger Swallowtail*	*Papilio glaucus*
Spicebush Swallowtail*	*Papilio troilus*
Cabbage White*	*Pieris rapae*
Clouded Sulphur*	*Colias philodice*
Orange Sulphur*	*Colias eurytheme*
Banded Hairstreak	*Satyrium calanus*
Gray Hairstreak	*Strymon melinus*
Eastern Tailed Blue	*Everes comyntas*
Spring Azure	*Celastrina ladon*
Variegated Fritillary	*Euptoieta claudia*
Great Spangled Fritillary	*Speyeria cybele*

Table 5. Continued

Pearl Crescent	*Phyciodes tharos*
Eastern Comma	*Polygonia comma*
Mourning Cloak	*Nymphalis antiopa*
American Lady	*Vanessa virginiensis*
Painted Lady	*Vanessa cardui*
Red Admiral	*Vanessa atalanta*
Red-spotted Purple	*Limenitis arthemis*
Hackberry Emperor	*Asterocampa celtis*
Northern Pearly-Eye	*Enodia anthedon*
Little Wood Satyr	*Megisto cymela*
Common Wood-nymph	*Ceercyonis pegala*
Monarch	*Danaus plexippus*
Silver-spotted Skipper	*Epargyreus clarus*
Juvenal's Duskywing	*Erynnis juvenalis*
Wild Indigo Duskywing	*Erynnis baptisisiae*
European Skipper*	*Thymelicus lineola*
Northern Broke-Dash	*Wallengrenia egeremet*
Dun Skipper	*Euphyes vestries*
<u>Odnata (dragonflies and damselflies)</u>	
Common Whitetail*	*Libellula lydia*
Great Blue Skimmer	*Libellula vibrans*
Ebony Jewelwing*	*Calopteryx maculata*
Northern Bluet	*Enallagma cyathigerum*
Little Bluet	*Enallagama minusculum*
Common Green Darner*	*Anax junius*
Ruby Meadowhawk	*Suympetrum rubicundulum*

3.2.3 Fish

The Pennsylvania Department of Environmental Protection conducted fish sampling on the Nescopeck Creek basin. This sampling, which took place from 6/30/98 through 7/9/98, was done as a larger investigation that included water chemistry, macro-benthic and fish sample data in order to update the water quality assessment throughout each watershed. Fish sampling was conducted by electro-fishing a stream length judged by the biologist as representative of existing habitat types. Fish were counted and arbitrarily assigned to size classes by relative abundance and age class. The method used makes the data unable to be compared directly between stations.

The fish community in the Little Nescopeck Creek upstream from the Jeddo Tunnel outfall on the sample dates consisted of 8 different taxa. There were not many individuals sampled between these 8 taxa, only 56 in total. The most abundant species by far were the Creek Chub and the White Sucker both considered tolerant fish species and their dominance can be indicative of impacted streams. Only one brook trout individual was found in the creek. Brook trout are considered intolerant species and their presence usually indicates good water quality. The fact that only one individual was found may indicate that the creek was stocked or that water quality is not currently representative of a High Quality-Cold Water Fishery and is not supporting reproducing trout.

Table 6. Fish Found in the Little Nescopeck Creek Upstream from the Jeddo Tunnel
(Data Source: Pennsylvania Department of Environmental Protection, 1998)

Common Name	Scientific Name
Brook Trout	*Salvelinus funtinalis*
White Sucker	*Catostmus commersoni*
Slimy Sculpin	*Cottus cognatus*
Creek Chub	*Semotilus atromaculatus*
Tessellated Darter	*Etheostoma olmstedi*
Largemouth Bass	*Mirropterus salmoides*
Bluegill	*Lepomis macrochirus*
Pumpkinseed	*Lepomis gibbosus*

3.2.4 Amphibians and Reptiles

Table 7. Amphibians and Reptiles Found in the Little Nescopeck Creek Watershed.
(Data Source: Alan Gregory, Friends of the Nescopeck)
(species known to breed in the watershed are noted with an asterisk)

Common Name	Scientific Name
Amphibians	
Spotted Salamander*	*Ambystoma maculatum*
Red-spotted Newt*	*Notophalmus viridescens*
Northern Dusky Salamander*	*Desmognathus fuscus*
Mountain Dusky Salamander	*Desmognathus ochrophaeus*
Northern Two-lined Salamander	*Eurycea bislineata*
Redback Salamander*	*Plethodon cinereus*
Northern Red Salamander	*Peudotriton ruber*
Eastern American Toad*	*Bufo americanus*
Spring Peeper*	*Hyla crucifer*
Eastern Gray Treefrog*	*Hyla versicolor*
Bullfrog*	*Rana catesbeiana*
Northern Green Frog*	*Rana clamintans*

Table 7. Continued

Pickerel Frog*	*Rana palustris*
Wood Frog	*Rana sylvatica*
Reptiles	
Snapping Turtle*	*Chelydra serpentina*
Midland Painted Turtle*	*Chrysemys picta*
Northern Ringneck Snake	*Diadophis punctatus*
Black Rat Snake	*Elaphe obsoleta*
Eastern Milk Snake	*Lampropeltis triangulum*
Northern Water Snake	*Nerodia sipedon*
Eastern Garter Snake	*Thamnopnis sirtalis*
Northern Copperhead	*Agkistrodon contortix*

3.2.5 Birds

Table 8. Birds Found in the Little Nescopeck Creek Watershed
(Data Source: Alan Gregory, Friends of the Nescopeck)
(Species known to breed in the watershed are noted with an asterisk)

Common Name	Scientific Name
Canada Goose*	*Branta Canadensis*
Mallard*	*Anas platyrhynchos*
Wood Duck	*Aix sponsa*
Ring-billed Gull	*Laurus delawarensis*
Great Blue Heron	*Ardea herodias*
Great Egret	*Casmerodius albus*
Green Heron	*Butorides striatus*
Virginia Rail	*Rallus limicola*
Killdeer	*Charadrius vociferous*
American Woodcock	*Philohela minor*
Wild Turkey	*Meleagris gallopavo*
Ruffed Grouse	*Bonasa umbellus*
Ring-necked Pheasant	*Phasianus colchicus*
Sharp-shinned Hawk	*Accipiter striatus*
Cooper's Hawk	*Accipiter cooperii*
Northern Goshawk	*Accipiter gentilis*
Northern Harrier	*Circus cyaneus*
Red-tailed Hawk	*Buteo jamaicensis*
Broad-winged Hawk	*Buteo platypterus*
Osprey	*Pandion haliaetus*
Turkey Vulture	*Cathartes aura*
American Kestrel	*Falco sparverius*
Eastern Screech Owl	*Otus asio*
Great Horned Owl	*Bubo virginianus*

Table 8. Continued

Mourning Dove	*Zenaida macroura*
Rock Dove	*Columba livia*
Ruby-throated Hummingbird	*Archilochus colubris*
Belted Kingfisher	*Megaceryle alcyon*
Pileated Woodpecker	*Dryocopus pileatus*
Northern Flicker*	*Colaptes auratus*
Red-bellied Woodpecker*	*Melanerpes carolinus*
Yellow-bellied Sapsucker	*Sphyrapicus varius*
Downy Woodpecker*	*Picoides pubescens*
Hairy Woodpecker	*Picoides villosus*
Eastern Kingbird	*Tyrannus tyrannus*
Great-crested Flycatcher	*Myiarchus crinitis*
Eastern Phoebe*	*Sayornis phoebe*
Eastern Wood Pewee	*Contupus virens*
Acadian Flycatcher	*Empidonax flaviventrris*
Least Flycatcher	*Empidonax minimus*
Alder Flycatcher*	*Empidonax alnorum*
Horned Lark	*Eremophilia alpestris*
Barn Swallow*	*Hirundo rustica*
Tree Swallow*	*Iridoprocne bicolor*
Rough-winged Swallow*	*Stelgideopteryx ruficollis*
Chimney Swift*	*Chaetura pelagica*
Fish Crow	*Corvus ossifragus*
American Crow*	*Corvus brachyrhynchos*
Blue Jay	*Cyanocitta cristata*
Black-capped Chickadee*	*Parus atricapillus*
Tufted Titmouse*	*Parus bicolor*
White-breasted Nuthatch*	*Sitta carolinensis*
Red-breasted Nuthatch	*Sitta Canadensis*
Brown Creeper	*Certhia familiaris*
House Wren*	*Troglodytes aedon*
Carolina Wren	*Thryothorus ludovicians*
Ruby-crowned Kinglet	*Regulus calendula*
Golden-crowned Kinglet	*Regulus satrapa*
Blue-gray Gnatcatcher	*Polioptila caerulea*
Brown Thrasher	*Toxostoma rufum*
Gray Catbird*	*Dumetella carolinensis*
Northern Mockingbird*	*Mimus polyglottos*
Eastern Bluebird*	*Sialia sialis*
American Robin*	*Turdus migratorius*
Wood Thrush	*Hyocichla mustelina*
Cedar Waxwing	*Bombycilla cedrorum*
Red-eyed Vireo*	*Vireo olivaceus*
Black-throated Green Warbler*	*Dendroica virens*
Black-and-white Warbler	*Mniotilta varia*

Table 8. Continued

Yellow-rumped Warbler	*Dendrocia coronata*
Chestnut-sided Warbler	*Dendrocia pensylvanica*
American Redstart*	*Setophaga ruticilla*
Yellow Warbler	*Dendrocia petechia*
Common Yellowthroat*	*Geothlypis trichas*
Ovenbird*	*Seiurus aurocapillus*
Red-winged Blackbird*	*Agelaius phoeniceus*
Brown-headed Cowbird*	*Molothrus ater*
Common Grackle*	*Quiscalus quiscula*
Bobolink*	*Dolichonyx oryzivorus*
Eastern Meadowlark*	*Stumella magna*
European Starling*	*Sturnis vulgura*
Baltimore Oriole*	*Icterus galbula*
Scarlet Tanager*	*Piranga olvacea*
Dark-eyed Junco	*Junco hyemalis*
Northern Cardinal*	*Cardinalis cardinalis*
House Finch*	*Carpodacus mexicanus*
American Goldfinch*	*Carduelis tristis*
Indigo Bunting*	*Passerina cyanea*
Rose-breasted Grosbeak	*Pheucticus ludovicianus*
Eastern Towhee	*Pipilo erythrophthalmus*
White-throated Sparrow	*Zonotrichia albiocollis*
Chipping Sparrow*	*Spizella passerina*
Field Sparrow	*Spizella pussila*
American Tree Sparrow	*Spizella arborea*
Song Sparrow*	*Melospiza melodia*
House Sparrow*	*Passer domesticus*

3.2.6 Wildlife

Terrestrial animal communities that exist in the watershed are grouped into three general categories. Open wildlife, the first category, consists of various songbirds, rabbits, woodchucks, red fox and numerous ground rodents. Existing woodland wildlife includes wild turkey, ruffed grouse, tree squirrels, gray fox, raccoon, deer and black bear. The third category includes wetland wildlife consisting of ducks, geese, herons, shore birds, muskrat, mink and beaver.

The white-tailed deer is the most abundant large game animal in the watershed. Deer are considered a forest species, but they do not thrive in a mature forest. They prefer a combination of brush or young trees, a few mature trees and small open areas. Much of the watershed has this combination of characteristics, so white-tailed deer are generally well distributed.

The black bear is a common large game animal in Luzerne County. The greatest concentration of bear is in the northwest corner of the county. Cottontail rabbits are plentiful in the watershed and are concentrated in the farming areas. They prefer brushy areas that are interspersed with cropland and grassland. Farms that are reverting to brushland are a good habitat for the cottontail rabbit. The snowshoe hare, a close relative to the cottontail rabbit, is abundant in the more forested areas in the northwestern part of Luzerne County.

The gray squirrel prefers woodlots and forested areas that are interspersed with areas of cropland. Squirrels are distributed throughout the watershed, but they are most concentrated in woodlots near farming areas. The beaver, the muskrat and the raccoon are the principal fur-bearing animals in the watershed. Beaver are concentrated in wetter areas along streams. They prefer wooded areas of aspen and other soft woods adjacent to streams and farm ponds. Raccoons prefer nearly any area that is accessible to streams or water. The woodchuck is a common non-game animal throughout Luzerne County. It is most common in farming areas. Woodchucks prefer open areas where grasses and legumes are grown.

3.2.7 Species of Special Concern

The Pennsylvania Natural Diversity Inventory (PNDI), a cooperative program of the Department of Environmental Protection, The Nature Conservancy and Western Pennsylvania Conservancy, maintains records of the state's rare, endangered or otherwise significant flora and fauna. The species of concern located in the Little Nescopeck Creek watershed and identified through this program are described below. Explanations of all the possible global and state ranks are located in Table 9.

Common Name: **Variable Sedge**
Scientific Name: *Carex Polymorpha*
Global Rank: G3-Vulnerable globally either because very rare and local throughout its range, found only in a restricted range, or because of other factors making it vulnerable to extinction.
State Rank: S2-Imperiled in the state because of rarity or because of some factors making it especially vulnerable to extirpation from the state.

Common Name: **Sand Cherry**
Scientific Name: *Prunus Pumila*
Global Rank: G5-Secure-Common, typically widespread and abundant.
State Rank: S3-Vulnerable in the state either because rare and uncommon, found only in a restricted range, or because of other factors making it vulnerable to extirpation.

Common Name: **Mountain Starwort**
Scientific Name: *Stellaria Borealis*
Global Rank: G5-Secure-Common, typically widespread and abundant.
State Rank: S1-Critically Imperiled in the state because of extreme rarity or because of some factors making it especially vulnerable to extirpation from the state.

Common Name: **Timber Rattlesnake**
Scientific Name: *Crotalus Horridus*
Global Rank: G4-Apparently Secure, uncommon but not rare, and usually widespread. Possible cause for long-term concern.
State Rank: S3-Vulnerable in the state either because rare and uncommon, found only in a restricted range, or because of other factors making it vulnerable to extirpation from the state.

Common Name: **Northern Bat**
Scientific Name: *Myotis Septentrionalis*
Global Rank: G4-Apparently Secure, uncommon but not rare, and usually widespread. Possible cause for long-term concern.
State Rank: S3B-Vulnerable in the state either because rare and uncommon, found only in a restricted range, or because of other factors making it vulnerable to extirpation from the state. There is a breeding population of this bat in the watershed.

TABLE 9. Pa. Natural Diversity Index Classifications

BASIC GLOBAL RANK CODES AND DEFINITIONS

GX **Presumed Extinct** – Believed to be extinct throughout its range. Not located despite intensive searches of historic sites and other appropriate habitat, and virtually no likelihood that it will be rediscovered.

GH **Possibly Extinct** – Known from only historical occurrences. Still some hope of rediscovery.

G1 **Critically Imperiled** – Critically imperiled globally because of extreme rarity or because of some factor(s) making it especially vulnerable to extinction. Typically 5 or fewer occurrences or very few remaining individuals (<1,000) or acres (<2,000) or stream miles (<10).

G2 **Imperiled** – Imperiled globally because of rarity or because of some factor(s) making it very vulnerable to extinction. Typically 6 to 20 occurrences or few remaining individuals (1,000 to 3,000) or acres (2,000 to 10,000) or stream miles (10 to 50).

G3 **Vulnerable** – Vulnerable globally either because very rare and local throughout its range, found only in a restricted range (even if abundant at some locations), or because of other factors making it vulnerable to extinction. Typically 21 to 100 occurrences or between 3,000 and 10,000 individuals.

G4 **Apparently Secure** – Uncommon but not rare, and usually widespread. Possibly cause for long-term concern. Typically more than 100 occurrences and more than 10,000 individuals.

G5 **Secure** – Common, typically widespread and abundant. Typically with considerably more than 100 occurrences and more than 10,000 individuals.

STATE RANK CODES AND DEFINITIONS

SX **Extirpated** – Element is believed to be extirpated from the "state" (or province or other subnational unit).

SH **Historical** – Element occurred historically in the state (with expectation that it may be rediscovered), perhaps having not been verified in the past 20 years, and suspected to be still extant. Naturally, an Element would become SH without such a 20-year delay if the only known occurrences in a state were destroyed or if it had been extensively and

Table 9. Continued

	unsuccessfully looked for. Upon verification of an extant occurrence, SH-ranked Elements would typically receive an S1 rank. The SH rank should be reserved for Elements for which some effort has been made to relocate occurrences, rather than simply ranking all Elements not known from verified extant occurrences with this rank.
S1	**Critically Imperiled** – Critically imperiled in the state because of extreme rarity or because of some factor(s) making it especially vulnerable to extirpation from the state. Typically 5 or fewer occurrences or very few remaining individuals or acres.
S2	**Imperiled** – Imperiled in the state because of rarity or because of some factor(s) making it very vulnerable to extirpation from the state. Typically 6 to 20 occurrences or few remaining individuals or acres.
S3	**Vulnerable** – Vulnerable in the state either because rare and uncommon, or found only in a restricted range (even if abundant at some locations), or because of other factors making it vulnerable to extirpation. Typically 21 to 100 occurrences.
S4	**Apparently Secure** – Uncommon but not rare, and usually widespread in the state. Usually more than 100 occurrences.
S5	**Secure** – Demonstrably widespread, abundant, and secure in the state, and essentially ineradicable under present conditions.
S?	**Unranked** – State rank is not yet assessed.
SU	**Unrankable** – Currently unrankable due to lack of information or due to substantially conflicting information about status or trends. NOTE: Whenever possible, the most likely rank is assigned and a question mark added (e.g., S2?) to express uncertainty, or a range rank (e.g., S2S3) is used to delineate the limits (range) of uncertainty.
S#S#	**Range Rank** – A numeric range rank (e.g., S2S3) is used to indicate the range of uncertainty about the exact status of the Element. Ranges cannot skip more than one rank (e.g., SU should be used rather than S1S4).

4.0 CULTURAL RESOURCES

4.0 CULTURAL RESOURCES

The Little Nescopeck Creek watershed is rich in history, with colonial occupation beginning in the late 18th century. Prior to large-scale coal mining in the Middle Anthracite Basin of lower Luzerne, western Carbon and northern Schuylkill Counties, the Little Nescopeck was assuredly a classic Pennsylvania trout stream. Supporting evidence of the area's former occupation by Native Americans includes major archeological sites in the upper reach of the Nescopeck Creek and the existence of similar sites at Council Cup, a rocky bluff with a near perpendicular cliff along the Susquehanna River just 5 miles northwest of the Nescopeck/Little Nescopeck confluence. Stone artifacts from the region have been dated to at least 10,000 years ago. The Lenni Lenape are believed to have inhabited Pennsylvania during the 1700s along with smaller bands of Shawnees, Nanticokes and Mohicans and the names of towns and rivers in the study area are indicative of this past.

4.1 Settlement History

The history of Luzerne County traces back to passage of the Great Southern Trail of the Iroquois through the valley. Until the 1700s the area was under control of the Six Nations of the Iroquois. Two major trails crossed these lands and served the Delaware, Iroquois and Susquehannocks. The first, called "Warrior's Path," led from the Lehigh Valley at Mauch Chunk to Susquehanna at Berwick. The second led north to the Wyoming Valley near Wilkes-Barre and crossed at present day Hazleton. After 1701 small bands of Shawnees, Nanticokes, Mohicans and Lenni Lenapes were known to have lived on the Susquehanna flats (Klein, 1973).

The early history of the project area was dominated by the Lenni Lenape, who belonged to the Algonquins and covered a more extensive area than any other tribe in the 1600s. The Lenni Lenape were originally a hunter-gatherer tribe who turned to farming approximately 1000 years before the arrival of European colonists in North America. In the valley, American Indians were known primarily as transients prior to colonization and they had only semi-permanent settlements for hunting and fishing. The Indians called their area Twinning, meaning "wilderness." The Algonquins and their ancestors believed that the Earth and its resources should be held in great respect and nurtured and cared for with equal respect. Their stewardship with the land and its wildlife could be seen in their farming, hunting and fishing practices, which left little permanent impact on the land (Klein, 1973).

The Iroquois tribe had fully overrun the Algonquin tribe by the time the Europeans arrived in eastern Pennsylvania. The Lenni Lenape occupied the east coast for several centuries, until Europeans of various nationalities first settled the Little Nescopeck Creek watershed in the mid-18th century. These colonists renamed the Lenni Lenape the "Delaware" and forced them westward. The Indians were pushed out of their lands by the 1750s due to mass numbers of settlers.

On September 25, 1786 Luzerne County was created and named for Chevalier de la Luzerne, French minister to the United States. It is one of the oldest counties in the state and has seen numerous battles during both the French and Indian War (Seven Years War) and the Revolutionary War.

Further settlement of the Valley was spurred by the construction of the Lehigh and Susquehanna Turnpike in 1810. The road passed through the Great Hazle Swamp as it stretched over the mountains between the Lehigh River at Jim Thorpe and the Susquehanna River at Berwick. It provided easy access to the lumber lands of the Susquehanna, which rapidly increased settlement and trade throughout what is now the greater Hazleton area.

With the influx of new settlers, new enterprises such as stores, wagon shops, tanneries, iron foundries and distilleries developed. Throughout the 19th Century, the area grew and prospered.

4.2 Mining History

The watershed of the Little Nescopeck Creek has never been mined and is not underlain by coal. However, the most significant historical events related to its current environmental condition revolve around the anthracite mining industry. Adjacent to the Little Nescopeck watershed in the south is the city of Hazleton and the 32.24 square mile watershed of the Jeddo Tunnel. The Jeddo Tunnel abandoned mine drainage discharge is the major source of impact to the Little Nescopeck Creek. Many of the historical sites and museums in the area surrounding the Little Nescopeck are devoted to the rise and fall of the mining industry.

Coal mining began in Pennsylvania in the mid-1700s to support the colonial iron industry. By the 1800s, Pennsylvania coal was fueling the industrial growth of the country and was the primary fuel source for Pennsylvania's steel industry.

Figure 11. An abandoned coal breaker is a reminder of the fallen mining industry.

The first anthracite finding in the Hazleton area occurred in 1813 just south of Panther Valley at present day Beaver Meadows. The second major recorded discovery was in 1826 by John Charles Fitzgerald, a Conyngham blacksmith. These discoveries brought with them a migration of Welsh and Irish miners in the early nineteenth century. By the 1830s, anthracite was being used extensively in smelting operations in the growing industrial cities to the south and east of Luzerne County.

The need for coal in these cities spurred the growth of the Lehigh Canal and eventually the railroad companies in the region, including the Lehigh Line. Mauch Chunk and Weatherly were important rail towns of the era. Transportation was key to the prosperity of the mining industry. With the opening of the Lehigh Canal in 1829, coal could be shipped out beginning at Mauch Chunk. By 1832 shipments were reaching Easton, Philadelphia and Newark. Canals gave way to railroads in 1834 when the Susquehanna and Lehigh Railroad Company laid tracks from Wilkes-Barre to White Haven on the Luzerne County-Carbon County boundary.

Anthracite and bituminous coal production peaked in 1918 with a combined production of 276 million tons (Report 5000-BK-DEP2274, 1998). Coal's importance continued well into the twentieth century as it provided the energy to fight both World Wars. When the steel industry declined in the late 1940s, coal was redirected into electricity generation. By the mid-1950s the demand for coal began to decline as gas and oil replaced coal furnaces and diesel engines took the place of coal-fired locomotives.

The economic effect of anthracite's decline hit home when veterans returned from World War II to find that no jobs awaited them. In the mid-1940s 20,000 men were working in the mines of the Hazleton area, by 1957 the mines only employed 2300 (Report 5000-BK-DEP2274, 1998). Following the mining years, unemployment rates were high and population was declining.

For the first 200 years, coal was mined with little thought of environmental consequences and without formal regulation. When all available coal was extracted from a mine site, operators would move to another and leave the original mine abandoned, failing to return the earth to its previous condition. Over 15 billion tons of coal were removed from Pennsylvania's ground and 250,000 acres of mine land were left abandoned (Report 5000-BK-DEP2274, 1998). With the decline of the anthracite coal industry and the move from deep mining to surface strip mining, the landscape has borne the brunt of the damage.

4.3 Historical and Archeological Resources

The Native Americans who first inhabited the watershed have greatly contributed to the region's character and culture. Among their legacies are the many place names in use today, such as Nescopeck, Mocanaqua, and Wyoming. They also include the names of waterways themselves. In the language of the Lenni Lenape, Nescopeck means "deep black river" and Susquehanna means "shallow river."

Many Native American relics have been discovered in the Conyngham Valley, and the former Conyngham school building was likely built on an Indian burial ground (Alan Gregory, written communication). In the mid-1990s several people were prosecuted by the Pennsylvania Game Commission for illegally collecting Native American artifacts from state lands in the upper reaches of Nescopeck Creek.

The Sugarloaf Monument is located approximately one-half mile east of the present Borough of Conyngham and is one of the watershed's historic sites. The monument was erected in 1933 in memory of the 13 men killed on September 11, 1780 when a detachment of Captain John Van Etten's Company, Northumberland County Militia, was surprised by a band of Indians and Tories led by the Seneca Chief Roland Montour. The incident became known as the Sugarloaf Massacre.

The mining and use of anthracite coal in the 19th Century was critical to the industrialization of the area. Coal was dominant for more than a century and helped form a distinct culture. Its production and use were the basis for the growth of transportation and manufacturing and led to cultural and social changes of major importance. Many historic places in the region house diverse regional collections highlighting the mines, the canals, the railroads, the mills, the factories, ethnicity and labor.

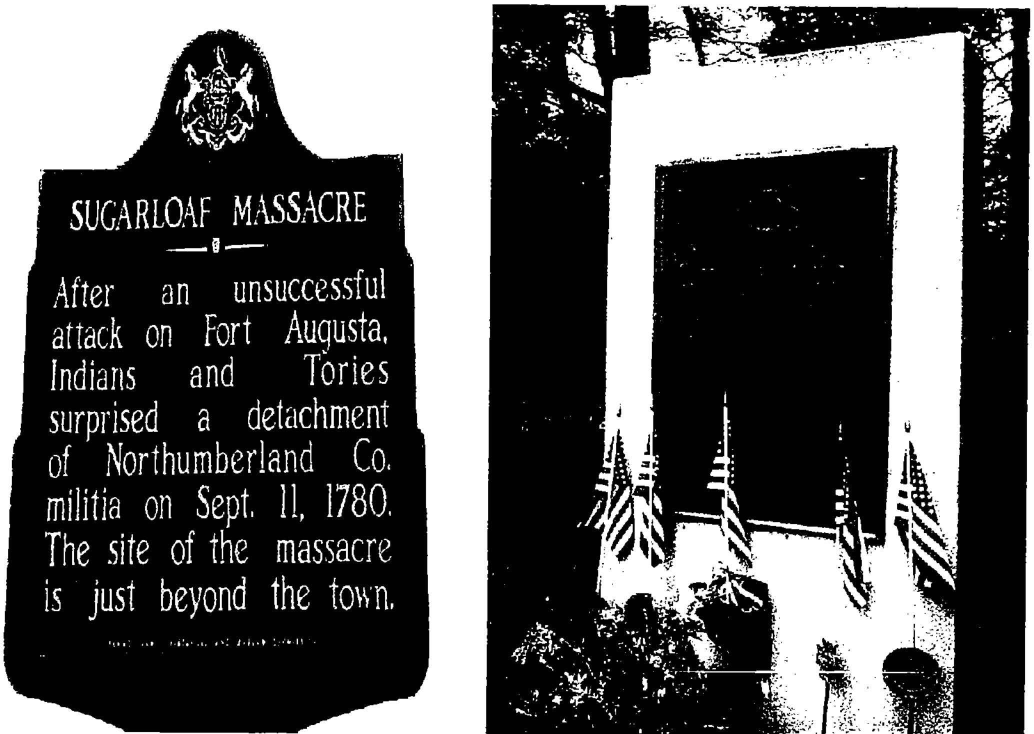

Figure 12. The Sugarloaf Monument. During the Revolutionary War there were many secret Tories and British sympathizers in the Wyoming Valley. In 1780 the Tories and Indians, led by the Seneca Chief Roland Montour, attacked Captain Daniel Klader and his company of 41 men resting near a spring on Buck Mountain. Thirteen of the soldiers were killed and three were taken prisoners. Montour was fatally wounded. One of the watershed's historic sites is the monument dedicated to those massacred.

The abundance of coal in the region brought with it enormous wealth, and many resulting grand structures were built in the areas surrounding the Little Nescopeck watershed. One such structure is the Luzerne County Courthouse, considered one of the most beautiful in the country.

The watershed needs to preserve its remaining historical places (Figure 13), (Table 10). Federal agencies that could assist in these preservation projects as well as a revolving loan program to fund such efforts include the National Park Service, the Advisory Council on Historic Preservation and the U. S. Department of Housing and Urban Development. State agencies that could be helpful include the State Historical Records Advisory Board, the Pennsylvania Historical and Museum Commission and the Pennsylvania Heritage Society.

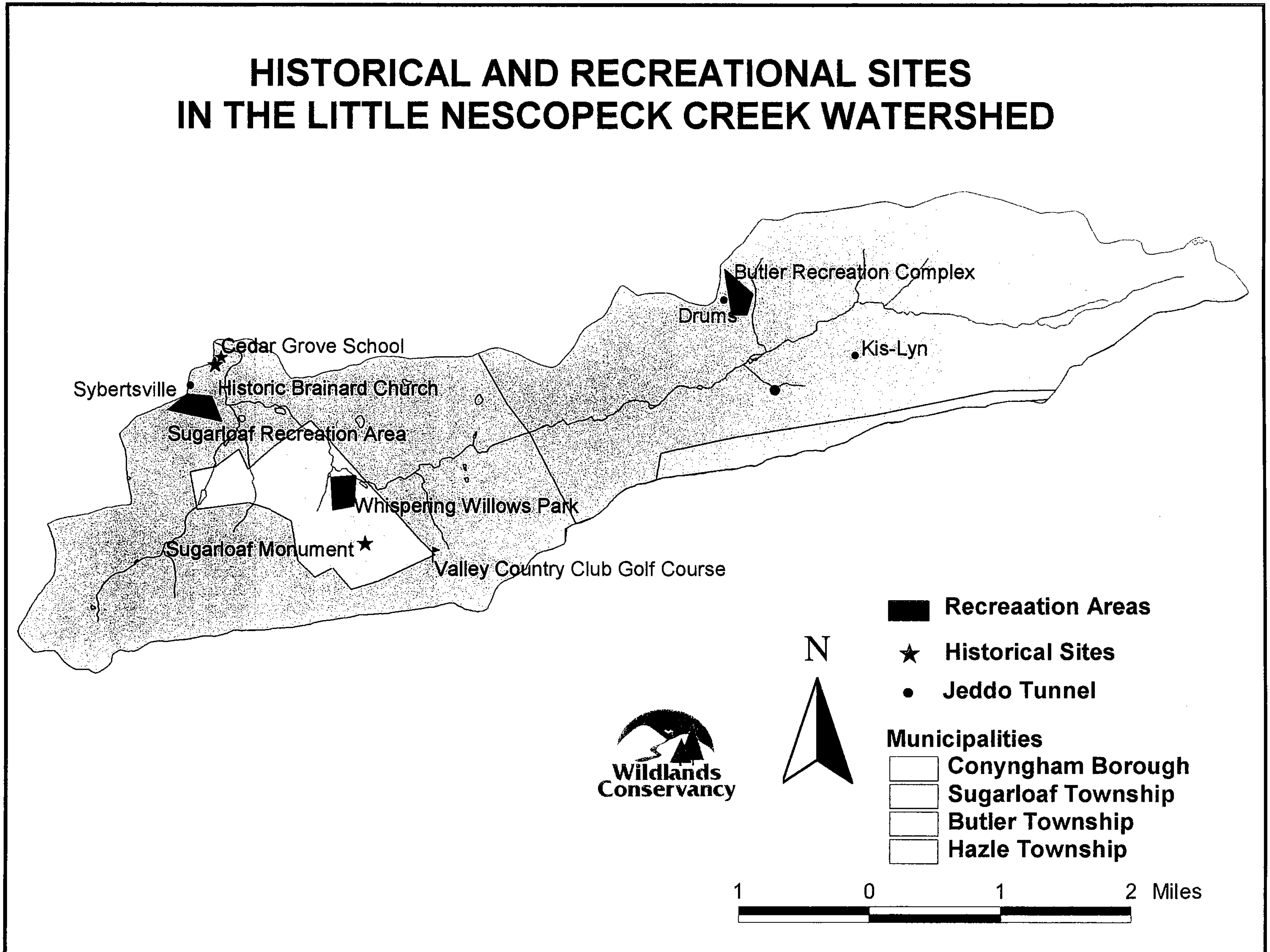

Figure 13. Historical and Recreational Sites of the Watershed

The watershed's cultural resources reflect a strong interaction between religious freedom, immigration, ethnic heritage, occupation and education. Consequently, the region has several heritage organizations related to church and ethnicity.

Figure 14. The Historic Brainerd Church was constructed in 1853 and was named in honor of Reverend David Brainerd, a colonist who arrived in the region in 1649 and became a missionary to the Native Americans in the Nescopeck area. Incidentally Reverend Brainerd became the original founder of Princeton University. The church had fallen into disrepair and was nearly destroyed in 1954 by Hurricane Hazel. It has since been restored by the Historical Brainerd Church Association and with the help of local Boy Scout troops.

Figure 15. The Cedar Grove School is the only original, unaltered one-room schoolhouse in Luzerne County. It was constructed in 1893 and is maintained by the Historical Brainerd Church Association. It was donated by Madeline Pecora Nugent and was relocated from Sybertsville to the land on which the Historic Brainerd Church now also stands. This land was originally owned by Henry Siebert, the pioneer resident for whom the town of Sybertsville was named.

The presence of historical and archeological sites of interest indicates the irreplaceable cultural value found within the watershed. This rich history presents an important argument for preserving and maintaining the exceptional quality of the Little Nescopeck Creek and its drainage basin.

4.4 Jeddo Tunnel History

The Jeddo Mine Tunnel is the largest and best-known drainage tunnel in the Eastern Middle Anthracite Field of eastern Pennsylvania. Its two main tunnels, Tunnel A and Tunnel B, were completed in 1895. Over the years additional tunnels were added which increased the length of the system to nearly six miles (LaRegina, 1988) (Figure 16).

The Black Creek basin, named after the creek of the same name, was among the largest and richest coal reserves in the Eastern Middle Anthracite Field. During the 1850s and 1860s several mining companies began extensive development of the mines in the vicinity of Jeddo, Ebervale and Harleigh. With the advent of strip mining and the need to reduce streambed leakage, Black Creek was relocated to a new channel on the southern edge of the basin. In January 1886, during a period of heavy rainfall and runoff, the Creek broke through its banks and flowed into the Harleigh Mine. The level rose in the mine until it overflowed into the Ebervale Mine and effectively flooded both mines beyond the capacity of the pumps to clear. The mines remained flooded for several years afterward. During this time, John Markle, president of G.B. Markle and Co., and operator of the Jeddo Mine, became interested in dewatering the flooded mines. With the assistance of Thomas McNair, resident engineer of the Lehigh Valley Railroad Co. and Lehigh Valley Coal Co., Markle prepared a plan for dewatering the basin with a drainage tunnel. In December 1890, the Jeddo Tunnel Co. Ltd. was formed to oversee the construction of the Tunnel (LaRegina, 1988).

"The tunnel company, when the work was first conceived, knew they might expect a great deal of trouble from the farmers along the Little Nescopeck Creek, when it was known that the poisonous sulphur water and mine waste from the flooding workings would pour into the creek (McNair, 1951)." Prior to tunnel construction the Little Nescopeck Creek flowed through farms in Butler Valley and furnished the farmers with their entire water supply. If the creek became polluted by the waters of the mine, it would be useless, the livestock could not be watered by it, it could not be used on the fields and there would be danger of the coal dust and mine refuse and depositing it along the then fertile fields that boarder its banks. The Jeddo Tunnel Company realized the concerns of the farmers and decided to send a lawyer, Thomas Mcnair, to purchase the right of way along the banks of the Little Nescopeck Creek from every farmer whose land bordered it except one.

The contract for the actual tunnel construction was awarded to Charles F. King and Co. The project required 250 hard-rock miners and associated laborers and a total of 340,000 pounds of forcite were used to complete the tunnel sections A and B. Tunnel A was completed in June 1895 after four years of construction and is 15,100 feet long. It begins at the bottom of the Ebervale Mammoth Vein slope No. 2 and discharges to Little Nescopeck Creek. Tunnel B extends at

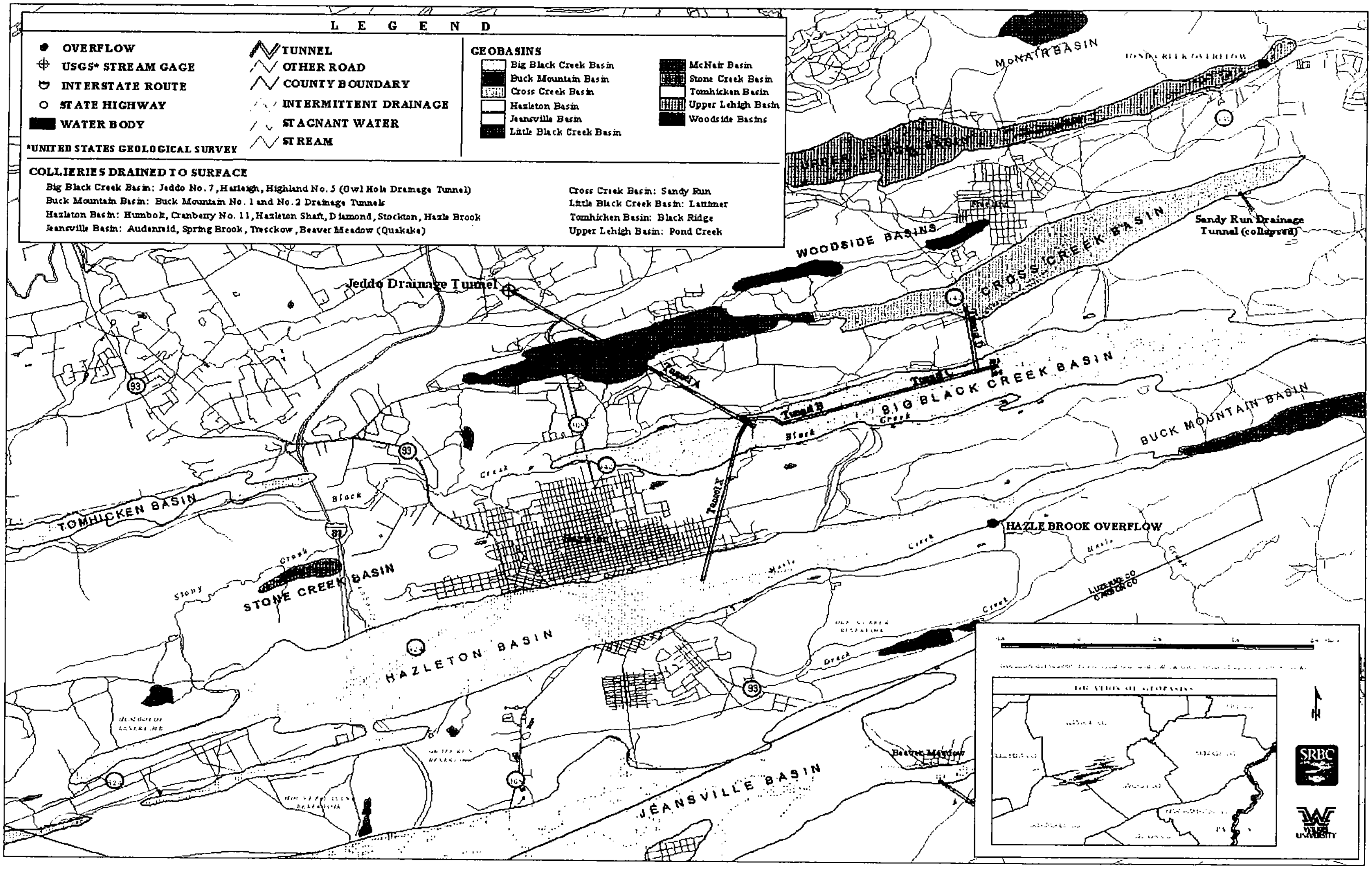

Figure 16. The Jeddo Tunnel Drainage System.

nearly a right angle from Tunnel A and proceeds east for 9800 feet to the Jeddo Mammoth Vein slope No. 9 (La Regina, 1988).

Five work crews of 50 men each were used to drive the tunnel segments in the various directions. In order to avoid serious damage and flooding to the receiving stream (Little Nescopeck Creek) when the mine was tapped, a bore hole was advanced from the surface at the village of Ebervale to provide controlled drainage of the flooded mine workings into the Tunnel. With this method, it was estimated that 8000 gallons per minute would discharge into the tunnel and take nearly two months to drain the workings (LaRegina, 1988).

In the following years, additional tunnels were constructed which extended the drainage area of the Jeddo Tunnel. Tunnel C was completed in 1926 for a total length of 4268 feet and drains the Highland No. 5 mine site to Tunnel B. In 1929, to drain operations at Eckley and Drifton, Tunnel D was driven 4038 feet to drain the Drifton No. 2 mine into Tunnel C. Water that had collected in the western end of the Eckley mine was drained by two drill holes through a barrier pillar into the Highland No. 5 mine. Once drained, tunnels 93 and 96 were driven under the barrier pillar in solid rock. The lengths of the tunnels are 340 and 250 feet respectively. The final addition to the Jeddo Tunnel system was Tunnel X, which was completed in 1934. This tunnel, an extension of Tunnel A, drains the Hazleton Shaft Colliery and has a total length of 9601 feet (LaRegina, 1988).

The Jeddo Tunnel was critically acclaimed as a great success from an engineering standpoint. Newspaper accounts in both *The Philadelphia Press* and *The New York Herald* printed the following account on December 9, 1894 (McNair, 1951):

The Jeddo Tunnel.
Remarkable Feat of Engineering.
Immense Body of Water Held Back
By a Piece of Wood
In Jeddo Tunnel.
Pent up for Seven Years.
Huge Artificial Way of Escape Cut Through
The Solid Rock of a Mountain.
Completion of a Great Tunnel.
Rich Coal Mines in Lower Luzerne That
Were Drowned Out by a Freshet
Will Soon Be Reclaimed
By Man's Ingenuity.

4.5 Economic Resources of the Little Nescopeck Creek Watershed

The direct watershed of the Little Nescopeck Creek is approximately 14 square miles and is dominated by small agricultural lands and suburban developments. Economic resources tied to the watershed are therefore predominantly located in the surrounding areas of Hazleton and Wilkes-Barre.

4.5.1 Industry

The economic structure of the area exemplifies an area where the major industry of mining has essentially been phased out over the years. An influx of non-durable goods manufacturing items have not stabilized the employment base. Currently, the non-manufacturing sector, excluding mining, accounts for the largest employment figure. The wholesale and retail trade sector is where the highest numbers of the labor force are employed. In recent years, non-durable goods manufacturing has declined. Government also provides a substantial number of jobs for the local labor force (www.edcnp.org/stats, 2/1/00).

According to the Regional Economic Information Systems Bureau of Economic Analysis, earnings by persons employed in the area increased 5.9 percent between 1996 and 1997. The largest industries were services, at 25.2 percent of earnings; durable goods manufacturing, 11.5 percent; and retail trade, 10.4 percent. Of the industries that account for at least 5 percent of earnings, the slowest growing is wholesale trade, increasing 2.1 percent; the fastest was finance, insurance and real estate, which increased 15.2 percent.

Information from Regional Economic Information Systems Bureau of Economic Analysis (REISBEA) provided income statistics for Luzerne County. In 1997, Luzerne County had a per capita personal income (PCPI) of $22,527, ranked 22nd in the state. The 1997 PCPI reflected an increase of 4.4 percent from 1996. In 1997 Luzerne County had a total personal income (TPI) of $7,142,149, ranked 12th in the state. The 1997 TPI reflected an increase of 3.3 percent from 1996.

While some surface mining is still occurring in the region adjacent to the Little Nescopeck watershed, coal mining continues to be minor in the overall economic picture. A long-term strike staged by the United Mine Workers of America that began in mid-1998 had largely stopped all remining work on the Mammoth Vein near Ebervale by the Jeddo Coal Company (Pagnotti Enterprises). There are still smaller coal operations nearby that include Continental Coal and Diamond Coal near Pardeesville.

Through 1998, when additional tourism-related business began entering the realm of public discussion (following completion of the Audubon's America Auto Tour linking Jim Thorpe, White Haven, East Side, Rockport and Eckley, and the opening of the Jim Thorpe Landing of the Delaware and Lehigh National Heritage Corridor), the economy of the Hazleton area continued to rely heavily on industrial jobs and low-paying jobs in the service area. CAN-DO operates the

Valmont and Humboldt industrial parks and major companies in these parks include The Dial Corp., PP&L Inc., Hershey Chocolate USA and Allen-Stevens Corp.

4.5.2 Transportation

A solid transportation infrastructure is integral to any economy. A well-developed system of highways, roads and railways exists within the project area and the adjacent watershed that could support local industries and businesses. Major traffic routes traversing the watershed include Interstates 80, 81 and 380, Route 93 and the Pennsylvania Turnpike (Figure 16). The area is only two hours away from metropolitan New York City and Philadelphia.

According to Friends of the Nescopeck, highway traffic through the watershed has quadrupled within the past decade. Despite the many assets this infrastructure provides for the watershed, it can also inflict harm on the Little Nescopeck Creek and other local waterways. Heavy use of roadways leads to the build-up of contaminants and hydrocarbons from exhaust fumes and leaking automotive fluids. These contaminants are then washed from the paved surfaces during precipitation events into storm drains that frequently empty directly into the closest waterway, thus polluting the Little Nescopeck and its tributaries. In addition, frequent accidents causing oil spills often lead to pollution of the Little Nescopeck Creek due to improper clean-ups at the sites of accidents.

4.5.3 Educational Institutions

There are no higher educational institutions within the watershed boundary, but Luzerne County Community College in Nanticoke, Wilkes University and Kings College in Wilkes-Barre and Penn State University Campus in Hazleton are the major institutions in the area surrounding the watershed.

The strong educational institutions in the region are also important economic resources: they train the workforce of the future. More than a dozen area institutions of higher learning in and surrounding the watershed offer training in business, health, law, education, environmental science, engineering, biology, arts and the humanities. Furthermore, the environmental knowledge of college and university science teams is critical to the solution of environmental problems impeding future economic growth in the watershed.

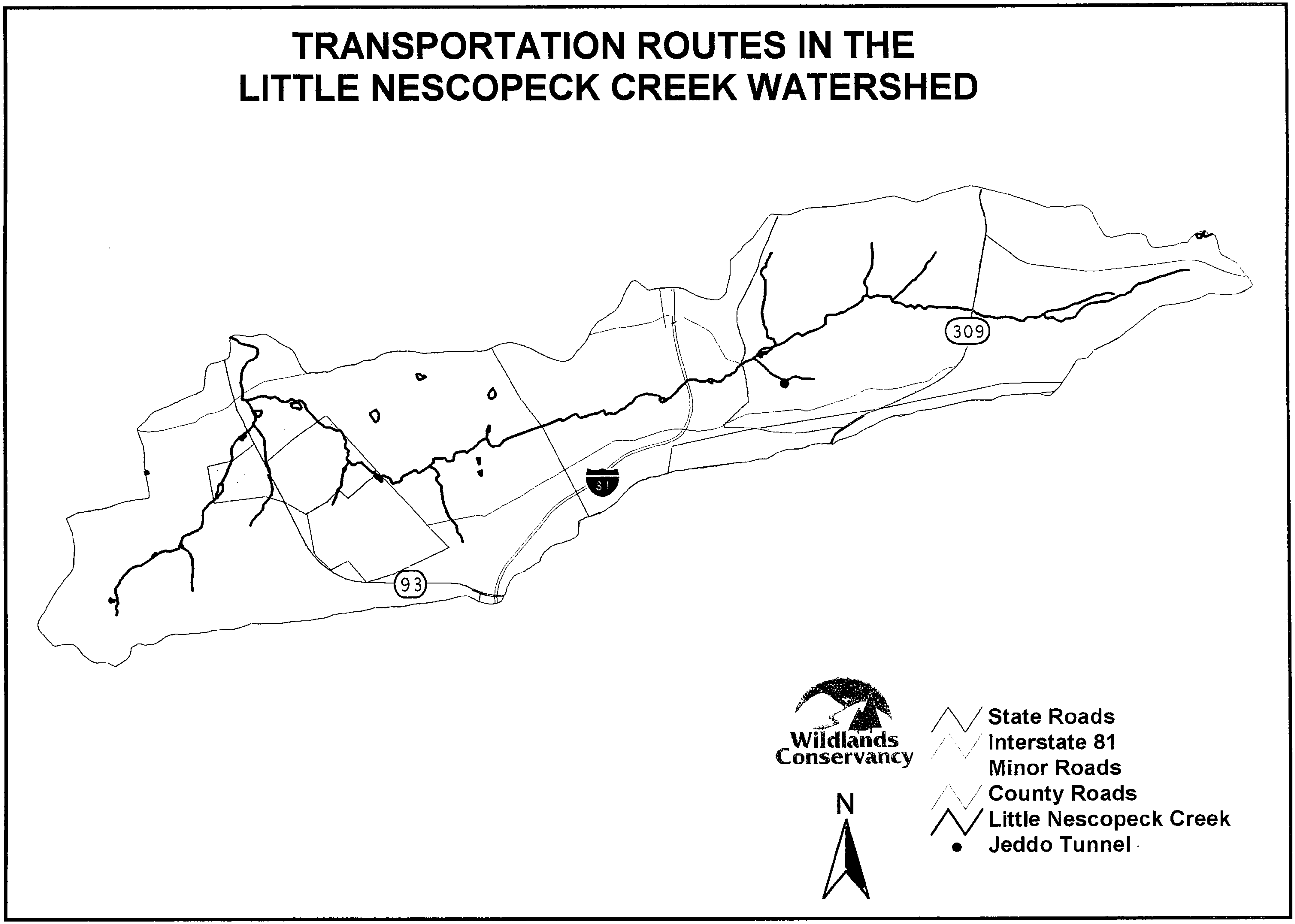

Figure 17. Transportation Routes of the Little Nescopeck Creek Watershed.

4.5.4 Economic Outlook

The watershed has local government, business and industry, education, science and volunteer organizations that are forming collaboratives to rebuild the region in the post-anthracite era. Although the economic decline began decades ago, in many ways the region is just now responding. Despite a network of highways that support economic opportunities and link the region to the eastern seaboard—more than 20 million people live less that four hours away by car—the watershed still lacks its single most important resource needed for economic development: clean water. If it were not for the decades of environmental contamination, clean water could be an abundant, renewable resource that would help spur resurgence in economic prosperity. The restoration of water as an economic resource for industry, recreation and drinking must be an extremely high priority for all economic development agencies in the region.

While there is some economic good news in the 1990s, the key to future prosperity and to a reversal of the trends of the past 60 years lies in establishing sustainable development practices for the stewardship of the natural and cultural resources that are abundant in the region. It also lies in bringing together the watershed's individual communities to recognize their independence and collective strength as an economic and environmental region.

5.0 RECREATIONAL RESOURCES

5.0 RECREATIONAL RESOURCES

The Little Nescopeck Creek or its tributaries provide the backdrop for public recreation in the watershed. Conyngham, Butler and Sugarloaf operate township parks and there are four golf courses in the watershed. The return of clean water to the river basin is the key to unlocking the full potential of the region's recreational resources.

5.1 Existing Recreational Facilities

In Conyngham Borough, in cooperation with the non-profit Conyngham Valley Civic Organization, operates Whispering Willows Park, which borders on the Little Nescopeck Creek. The park includes an outdoor swimming pool that is popular with local children in the summer. Other facilities in the park include tennis and handball courts, a basketball court, picnic pavilions and several Little League baseball fields (Figure 13).

Figure 18. Poor stream management is a critical cause of impairment to the Little Nescopeck Creek. Proper management, such as not mowing to the edges of the bank and allowing a natural vegetation buffer to form would decrease water pollution and erosion. This small unnamed tributary flows through Whispering Willows Park in Conyngham Borough and immediately into the Little Nescopeck.

In Sugarloaf Township, a small play area is maintained next to the district magistrate's office in Sybertsville. Additionally, the township operates a more expansive recreation area adjacent to East County Road, east of Route 93. This facility, which includes Little League baseball fields and a football field, also has an exercise path and picnic pavilion.

Publicly supported recreation in Butler Township is primarily centered around the Butler Township Recreation Complex located behind the Township municipal building on the Butler-Conyngham Road. This site includes baseball and softball fields.

There are four golf courses near the study area. Public courses include Sugarloaf in Black Creek Township and Sand Springs and Edgewood in the Pines in Butler Township. Valley Country Club is a private course in Sugarloaf Township near Conyngham.

Just south of the Little Nescopeck Creek watershed, Hazle Township operates a community park centered on Lake Irene, a small manmade impoundment just north of Black Creek and east of Route 93. The lake is stocked annually by the Pennsylvania Fish and Boat Commission. Community park includes trails and picnic areas. In 1997 more than 50 acres of pitch pine and oak forest was cleared for the creation of additional soccer fields at Community park.

Nearby state parks include Nescopeck State Park, which encompasses land surrounded by State Game Land 187 along the upper reach of Nescopeck Creek, and Hickory Run State Park, in the Lehigh River watershed of Carbon County.

Publicly owned open space in the study area is rare. Not until 1998 have any serious discussions taken place regarding the conversion of abandoned rail corridors in the area into recreational trails with support funding coming from the Department of Conservation and Natural Resources. There are many such opportunities in the area but little public pressure to press forward with such positive initiatives.

5.2 <u>Potential Recreational Assets</u>

The dominating scenic characteristics of the Little Nescopeck Creek watershed are the high green ridges that frame the settled and developed areas. Panoramic views of the rivers and valleys are available from several outlooks. Trails, some dating to Native American times, lace the region and provide scenic walks along rivers and streams, through mountain passes, and over the mountain summits.

Within limits, the waterways already support fishing and boating. The Nescopeck Creek is known for its Class III and IV rapids and is used heavily in spring by canoeing and kayaking enthusiasts from across the northeastern United States. There is, however, room for tremendous growth in water-related recreation.

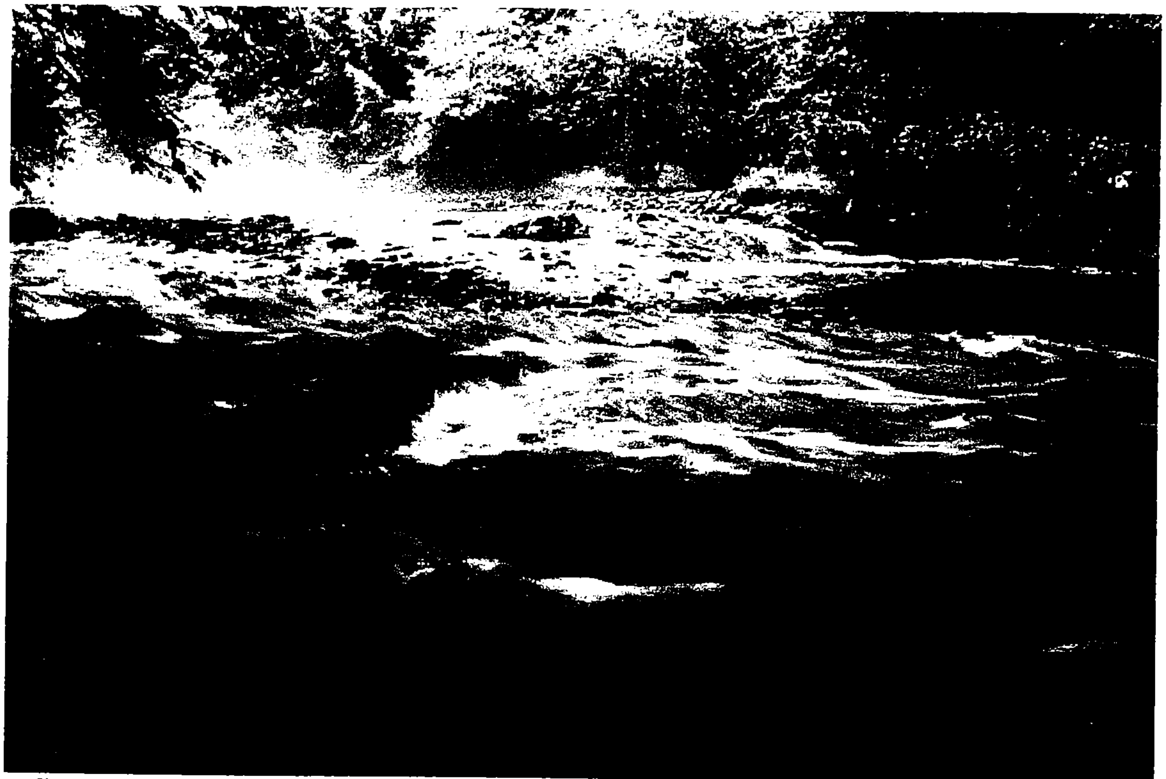

Figure 19. The Nescopeck Creek is frequently traveled by kayakers and canoeists.

In Whispering Willows Park in Conyngham Borough, recreational facilities border the Little Nescopeck Creek. Improvement of the water quality would change a large part of the park from an “off limits” area to an area with increased recreational and educational possibilities.

Another site in Conyngham Borough is known as the Bishop Tract and consists of approximately 24 acres of field and woodlands that are intended for development as a passive outdoor recreation area for provisions for nature study and appreciation. A small section of this site abuts the Little Nescopeck and includes significant wetland areas that feature prominently in future plans for the facility. A cleaner, healthier creek would significantly enhance the area.

Rail-to-trail projects, largely funded with federal assistance, are increasingly popular within the watershed. The developing network of new trails and rail-to-trail projects is becoming increasingly important. When properly constructed, such pathways improve water quality and encourage biodiversity by cleaning up land and creating green space. For wildlife, greenways provide places to live and a safe route connecting different natural areas. They act as buffers along streams and around lakes to preserve water quality and protect the life in the aquatic habitat. For the recreational user, greenways provide trails to walk, hike, bike, boat or tour. They provide connection to other public places and natural areas through a system of corridors. For the pedestrian or bicyclist they provide aesthetic routes for the daily commute. For those interested in cultural and historical heritage, greenways preserve the natural or landscaped settings surrounding important community landmarks.

The Friends of the Nescopeck envision an extensive greenway following the Little Nescopeck Creek corridor. There is also interest among a small group of Hazleton-area citizens to begin rail-to-trail conversions in the area. Additionally political pressure of the State Congress to release state grant money from the Federal Land and Water Conservation Fund shows promise of infusing additional and much needed capital into the region for the creation of recreational facilities and preservation of wild and natural areas.

The presence of acid and heavy metals decimates the aquatic life in the Little Nescopeck and has made its water unhealthy and unsuitable for human use. Due to these conditions, recreational activities such as swimming, boating, canoeing and whitewater rafting are currently either limited or made unappealing and inhospitable. Until clean water is returned to the watershed, the region will not be able to fully recognize its recreational potential.

6.0 INSTITUTIONAL RESOURCES

6.0 INSTITUTIONAL RESOURCES

6.1 Project Partners

An impressive group of people has formed a unique partnership in an effort to clean up and preserve the Little Nescopeck watershed. This list includes Friends of the Nescopeck, a local citizens' group; the Pennsylvania Department of Environmental Protection Bureau of Mining and Reclamation; the DEP's Citizens Volunteer Water Quality Monitoring Program; the U. S. Geological Survey; the Susquehanna River Basin Commission; and Bloomsburg, Wilkes and Pennsylvania State Universities; Kings College and Wildlands Conservancy.

The Susquehanna River Basin Commission was integral in the investigation of mine drainage into the Little Nescopeck Creek and partnered with Wildlands Conservancy to produce the study titled *Assessment of Conditions Contributing Acid Mine Drainage to the Little Nescopeck Creek Watershed, Luzerne County, Pennsylvania, and Abatement Plan to Mitigate Impaired Water Quality in the Watershed.* The Susquehanna River Basin Commission was created as an independent agency by a federal-interstate compact among the states of Maryland, New York, Commonwealth of Pennsylvania and the federal government. As the single federal-interstate water resources agency with basin-wide authority, the Commission's goal is to coordinate the planning, conservation, management, utilization, development and control of basin water resources among the public and private sectors.

Friends of the Nescopeck is a small local group of concerned citizens with the mission of restoring the biological integrity of the Nescopeck Creek while conserving the natural and cultural attributes of the watershed. Friends of the Nescopeck has provided Wildlands Conservancy with invaluable assistance and is committed to continuing citizen-based environmental action in the Little Nescopeck Creek watershed.

Several educational institutions have dedicated resources to addressing mining issues in the Little Nescopeck and Jeddo Tunnel watersheds. These educational institutions include Penn State University's Hazleton Campus, Wilkes University's GeoEnvironmental Sciences and Engineering Department and Bloomsburg University's Department of Geography and Earth Science and Kings College.

6.2 Programs and Agencies

There are numerous federal, state and local agencies that provide funding opportunities and technical assistance regarding environmental, recreational and historical restoration, protection and education. Some of these organizations and their programs are listed here. Appendix I contains more specific information on some programs and also lists contact information for all of the agencies mentioned in this report. More extensive program and agency information can be found in *Wetland and Riparian Stewardship in Pennsylvania, A Guide to Voluntary Options for Landowner, Local Governments and Organizations*, published by the Pa. DEP and the Alliance for the Chesapeake Bay and in *Pennsylvania Stream Releaf, A Plan for Restoring and Conserving Buffers Along Pennsylvania Streams*, published by Pa. DEP and Pa. DCNR. Information can also be obtained by contacting Pa. DEP, Pa. DCNR, Luzerne County NRCS, Luzerne County Conservation District or Wildlands Conservancy.

6.2.1 Mining Issues

Abandoned Mine Drainage has been identified as the principal source of impairment to the Little Nescopeck Creek. Several government agencies exist to deal with the issues of mining and abandoned mine drainage in Pennsylvania and include the Office of Surface Mining, the Pa. DEP Bureau of Mining and Reclamation and the Pa. DEP Bureau of Abandoned Mine Reclamation. More Information, including contacts at these agencies and their programs is located in Appendix I.

The Office of Surface Mining (OSM) is the office of the Interior Department that is responsible for protecting the environment during coal mining and making sure the land is reclaimed afterward. OSM builds partnerships with the governments of the states where coal is mined. The Surface Mining Law gives primary responsibility for regulating surface coal mine reclamation to the states themselves, a responsibility that 24 coal states have chosen to exercise. On federal lands and Indian Reservations and in the coal states that have not set up regulatory programs of their own (Tennessee and Washington), the Office of Surface Mining issues the coal mine permits, conducts the inspections, and handles the enforcement responsibilities.

The Bureau of Mining and Reclamation administers an environmental regulatory program for all mining activities, mine subsidence regulation, mine subsidence insurance, and coal refuse disposal; conducts a program to ensure safe underground bituminous mining and protect certain structures from subsidence; administers a mining license and permit program; administers a regulatory program for the use, storage, and handling of explosives; provides for training, examination, and certification of applicants for blaster's licenses; and administers a loan program for bonding of anthracite underground mines and for mine subsidence. Administers the EPA Watershed Assessment Grant Program, the Areas Unsuitable for Mining Program (UFM), the Small Operator's Assistance Program (SOAP), and the Remining Operator's Assistance Program (ROAP).

The Bureau of Abandoned Mine Reclamation administers and oversees the Abandoned Mine Reclamation Program in Pennsylvania. The bureau is responsible for resolving problems such as mine fires, mine subsidence, dangerous highwalls and other hazards which have resulted from past mining practices, and for abating or treating acid mine drainage from abandoned mines.

Three of the many programs that exist to address abandoned mine drainage and mine land reclamation issues include the Regional Watershed Support Initiative, the Clean Streams Initiative and the Reclaim PA project.

Regional Watershed Support Initiative

The goal of the Regional Watershed Support Initiative is to provide financial support for the formation and activities of watershed groups whose primary focus is acid mine drainage (AMD) abatement and abandoned mine land (AML) reclamation. An additional goal is to support the continuing AMD/AML coordination efforts of the Eastern and Western Pennsylvania Coalitions for Abandoned Mine Reclamation (EPCAMR and WPCAMR).

The EPCAMR and WPCAMR will distribute grants to public and private volunteer groups primarily interested in starting new AMD/AML watershed associations, watershed authorities, or partnerships. Assistance will be targeted to groups that intend to form a new organization, partnership, association, authority or coalition, with the primary goal of assessing and remediating sources of watershed AMD and, by association, AML reclamation.

The Clean Streams Initiative

The Clean Streams Initiative is a broad-based citizen/industry/government program working to eliminate acid mine drainage from abandoned coal mines. Using a combination of private and governmental resources, the initiative facilitates and coordinates citizen groups, university researchers, the coal industry, corporations, the environmental community, and local, state, and federal government agencies that are involved in cleaning up streams polluted by mine drainage.

Reclaim PA

Reclaim PA is DEP's new initiative designed to maximize reclamation of the state's quarter million acres of abandoned mineral extraction lands. Pennsylvania is striving for complete reclamation of its abandoned mines and plugging of its orphaned wells. DEP developed concepts to make abandoned mine reclamation easier. These concepts, collectively called Reclaim PA, include legislative, policy and management initiatives designed to enhance mine operator, volunteer and DEP reclamation efforts. Reclaim PA has the following four objectives: to encourage private and public participation in abandoned mine reclamation efforts; to improve reclamation efficiency through better communication between reclamation partners; to increase reclamation by reducing remining risks; and to maximize reclamation funding by expanding existing sources and exploring new sources.

6.2.2 Land Protection Issues

The Little Nescopeck Creek watershed is home to fertile farmlands, woodlands and critical open spaces. Preserving these valuable resources must become a top priority in the efforts to protect the Little Nescopeck Creek and its watershed. Several programs and agencies exist to assist landowners in land preservation goals. Sources of information pertaining to farmland and open space preservation include Wildlands Conservancy, the Bureau of Farmland Protection and the Land Trust Alliance. Contact information for these agencies and more detailed descriptions of their programs is located in Appendix I.

In addition to land preservation programs, there are several technical and funding assistance programs and agencies dedicated to the implementation of agricultural best management practices. Examples of these programs include streambank fencing incentives and nutrient management programs. The Natural Resource Conservation Service is an authoritative source of information concerning agricultural best management practice implementation programs.

County conservation districts are subdivisions of local government that provide the link between citizens and the local, state and federal natural resource management programs. Conservation Districts provide environmental education; technical assistance related to streams, lakes and wetlands, erosion and sedimentation, nutrient management on farms, mine reclamation land and stormwater management; coordination and facilitation of watershed management; and farmland preservation. Contact information for the Luzerne County Conservation District is located in Appendix I.

6.2.3 Historic Preservation

Pennsylvania Historical and Museum Commission

The Pennsylvania Historic Museum Commission (PHMC) is a resource of historical information concerning the watershed and has several preservation and education programs. PHMC provides technical support and grants to enhance historical museums and sites around the state, including the Pennsylvania History and Museum Grant Program, the Certified Local Government Grant Program and the Keystone Historic Preservation Grant Program.

The Commission's Bureau for Historic Preservation administers all official state historic preservation programs and activities. These include maintaining the Commonwealth's cultural resource inventory, preparing a state preservation plan, nominating properties to the National Register of Historic Places, reviewing state and federal government undertakings for effects on cultural resources, assisting in certifying historic building rehabilitation projects seeking federal tax incentives, conducting archaeological investigations, overseeing the designation of historic districts under municipal ordinances, advising local governments on preservation issues, providing grants to local governments, historical and cultural institutions, and preservation organizations to restore historic buildings, to conduct cultural resource surveys, to write National Register nominations, and to assist with heritage educational programs and exhibits.

Pennsylvania municipalities have authority to protect historic properties under municipal ordinances. Information is available for municipalities that are seeking to establish preservation ordinances. The Bureau manages the Certified Local Government (CLG) grants that enable municipalities to expand their preservation activities. The Bureau conducts regular workshops for Certified Local Governments.

Extensive architectural and technical guidance is available for repair and maintenance of historic buildings. This includes the complete Preservation Briefs series published by the National Park Service as well as other printed material. Information is also available on the 20% federal rehabilitation tax credit (RTC) that is available for qualified historic building.

The PHMC has a comprehensive grants program to further the presentation and interpretation of Pennsylvania history by local, county, and regional historical and museum organizations, to preserve local historic records and documents, to prepare exhibits, to do research on local history, to support local historic preservation efforts, to restore or rehabilitate historic buildings owned by local governments or non-profit organizations, and to assist local governments that have municipal preservation ordinances.

Preservation Pennsylvania

Preservation Pennsylvania, through creative partnerships, targeted educational and advocacy programs, advisory assistance, and special projects, assists Pennsylvania communities to protect and utilize the historic resources they want to preserve for the future. Preservation Pennsylvania is a private non-profit organization dedicated to the protection of historically and architecturally significant properties. In its capacity as the statewide historic preservation organization for Pennsylvania, Preservation Pennsylvania acts as a resource for and provides expertise to the many local and regional preservation organizations and agencies throughout the Commonwealth. Preservation Pennsylvania regularly responds to requests for information and assistance on a wide range of technical preservation issues.

6.2.4 State Funding Opportunities

Growing Greener

Under the Growing Greener Program, the Department of Environmental Protection is authorized to give grants to support local projects that protect and restore watersheds. These projects can include: watershed assessments and development of watershed restoration or protection plans; implementation of watershed restoration or protections projects; construction of mine drainage remediation systems; reclamation of any previously mined lands; and demonstration/education projects and outreach activities.

These grants are made available to a variety of eligible applicants, including: counties, authorities and other municipalities; county conservation districts;

watershed organizations; and other organizations involved in the restoration and protection of Pennsylvania's environment.

Keystone Fund

Administered by the Department of Conservation and Natural Resources, this program provides financial assistance to municipalities and organizations for the planning, acquisition, development and/or rehabilitation of public park, recreation and conservation areas and facilities, rails-to-trails projects and rivers conservation projects. Keystone programs include the Community Grant Program, the Rails-to-Trails Grant Program, the Rivers Conservation Grant Program and the Land Trust Program.

Pennsylvania Recreational Trails Program

Administered by the Department of Conservation and Natural Resources, this program provides grants for trail-related projects. Eligible projects include the redesign or relocation of trails to minimize impact to the natural environment; urban trail linkages, maintenance of existing trails, development of trail-side or trail-head facilities and acquisition of easements for trails.

Wetland Restoration/Creation Site Registry

Administered by the Department of Environmental Protection, the purpose of this registry is to link property owners who desire to have wetlands created or restored on their property with individuals who are required to replace wetlands as a result of permitting actions authorized by the Department of Environmental Protection.

Statewide Non-point Source Pollution Program

Created under the Federal Clean Water Act-Section 319 Non-point Source Implementation Grants, the purpose of the program is to provide grants for local non-point source pollution projects. Watershed Assessments, watershed projects and projects of statewide importance are the three project categories eligible for funding. The following non-point source categories can be addressed: agriculture, silviculture, construction, urban runoff, resource extraction, on-lot septic systems and hydrologic/habitat modification. Contact thee Pa. DEP Bureau of Watershed Conservation, Non-point source Management Section for more information.

6.2.5 Watershed Residents

The growth of watershed associations is increasing in Pennsylvania, utilizing dedicated people and local resources to address water quality and a variety of pollution concerns. These associations represent a significant change in the way water quality is approached and present a more-committed, long-term solution for monitoring and sustaining a focus in the watershed. It is hoped that these successful efforts will prove useful to newly-formed watershed associations and serve to inspire greater pollution prevention measures.

The Little Nescopeck has a strong need for increased citizen involvement in its protection. With the exception of the Friends of the Nescopeck, there appears to be very little involvement in the Little Nescopeck clean-up effort by the local community. Local community support and involvement is an essential component of any watershed program. Through the coordination among federal, state, county and local groups, a unified and comprehensive approach to remediate abandoned mine drainage water quality problems and other watershed issues can be developed.

The opportunities for partnerships are virtually endless. The key to developing effective partnerships is communication. Open communication should provide each institution with knowledge about other potential and ongoing projects and grant opportunities within the watershed. This would allow them to make sound decisions regarding the planning of future projects and the desired level of involvement with current projects. The results of projects should be shared among institutions to educate people outside the responsible organization and to ensure that duplicate or excessive work is not performed.

7.0 ABANDONED MINE DRAINAGE

7.0 ABANDONED MINE DRAINAGE

7.1 Drainage Tunnels

The following section about mine drainage tunnels is adapted from *The Mine Drainage Tunnels of the Eastern Middle Anthracite Field,* by James A. LaRegina, 1988.

The early mining companies used several techniques to minimize the amount of water entering the mines. Sidehill ditches were dug on the flanks of the ridges surrounding the mine basin in order to collect and divert surface water runoff around the coal outcrops where it could easily enter the mine. Wooded flumes were built to carry the creeks that crossed the mine basin, thus minimizing streambed leakage into the mine. Some creeks were purposely seeded with silt in an attempt to make the streambed impervious. These techniques only served to minimize the amount of water entering the mine. Direct precipitation and groundwater infiltration from adjacent areas necessitated the use of stream-driven pumps to bring the mine water to the surface.

As the mines continued to meet the demand of a rapidly industrializing country for more coal, the miners followed the coal deeper into the ground. Strip mining, first introduced in the 1870s, saw greater use. The increased depth of the mines, coupled with increased infiltration due to strip mining, resulted in the need for greater pumping capabilities. Sudden influxes of water from storm events, snowmelt or subsidence near a creek channel often required shutting down the mine until the water could be pumped out. Pump maintenance was another concern due to the corrosive nature of mine drainage. These factors contributed to an increase in operating costs.

The solution to this problem was the mine drainage tunnel. There are 11 drainage tunnels in the Eastern Middle Field, more than in any other anthracite field in Pennsylvania. These tunnels are not to be confused with mine workings, which were driven in coal as part of the mining process. Mine drainage tunnels are rock tunnels generally driven cross-strike for the purpose of conveying mine drainage to a surface stream outside of the coal measures. In some instances, if the geometry of the basin was favorable, the tunnels tapped the lowest point in the mine and provided gravity drainage that allowed the mine to be dewatered without pumping. Other tunnels, coupled with pumping systems, operated as drainage levels. A drainage level is a horizontal tunnel that intersects the surfaces and serves as a conduit for a pump discharge. These tunnels reduced the head against which a pump had to work to reach the surface.

To understand why mine drainage tunnels were commonly used in the Eastern Middle Field, two of its characteristics should be examined. First, most of the coal basins are perched above or nearly above the elevation of the surface drainage networks in the surrounding non-coal valleys. Thus, it was feasible in many cases to drive a tunnel with sufficient gradient to drain most, if not all, of each individual mine by gravity. In the three other anthracite fields, the coal measures extended well below the elevation of the local surface drainage networks. Secondly, the discontinuous nature of the basins in the Eastern Middle Field has, in effect, hydrologically isolated each basin. Thus, individual tunnels were constructed to dewater the individual basins.

7.2 Abandoned Mine Drainage Formation

Abandoned Mine Drainage (AMD) can be defined as surface water that emanates from an area disturbed by mining activities. The quantity and chemical composition of mine drainage is the result of the interplay of a variety of geological, climatological and biological factors. Chemical changes may include the additions of acids, metals, sulfates and other dissolved solids. Physical changes include the addition of silt and sediment, as well as alteration of temperature. Problematic mine drainage forms when water and air contact certain pyretic bearing minerals in rocks associated with mining. Pyrite and other iron-sulfide minerals react with water and oxygen to form acid, which then dissolves other minerals in the rocks associated with coal. Acid Mine Drainage is typically characterized by low pH (less than 6.0) and elevated levels of sulfate, acidity and other metals—such as iron, magnesium, manganese and aluminum. These constituents often cause stream bottoms to become coated, most noticeably by iron, which results in visible reddish-orange stains termed "yellow-boy" (Zielinski).

The geology of coalfield areas can have significant impacts on AMD production and discharge for all types of mining. Coal deposits formed as decaying organic matter accumulated in ancient swamps and were subsequently buried under layers of sediments. This depositional environment and other post-depositional factors cause the differences between coal ranks (anthracite, bituminous and lignite) and the tendency for some rocks to produce AMD when mined.

Abandoned Mine Drainage can be a product of both surface and underground coal mining operations and the waste piles associated with coal cleaning plants. In surface mining, the solid rocks overlying the coal, or overburden, are removed, and in the process broken into large and small rock fragments which are replaced in the mining pit after coal removal. This exposes the acid forming minerals in some rocks to water and air, resulting in a high probability of AMD formations if such minerals are present in sufficient quantity. In underground mining, large reservoirs of AMD may form in the cavern-like passageways below the earth's surface. Groundwater movement through the mineral-bearing rocks, creating more AMD, constantly replenishes these reservoirs. The water from these minepools seeps through the hillsides or gushes from abandoned mine entries, entering the streams and depositing the metal-rich precipitates on everything in the downstream path. Coal cleaning refuse piles often contain excessive amounts of pyretic materials and water flowing through the piles will become acidic.

Mine drainage discharges can be as small as a tiny trickle, or they may be huge torrents of thousands of gallons per minute. If the receiving stream does not contain sufficient alkalinity to neutralize any added acid, its water quality may be adversely impacted and the stream's uses will be limited. Even if the stream has sufficient alkalinity to improve the pH, iron and/or aluminum precipitation may occur.

7.3 Abandoned Mine Drainage Treatment and Elimination Technology

Preventing acid drainage from surface mines requires the elimination of water movement through acid material. Separating and covering acid-forming materials with non-toxic soil, grading the surface to divert water away from the reclaimed areas and planting grasses and trees to stabilize the soil accomplish this. Water flowing from the restoration may also be treated to improve its quality before it enters nearby streams.

Most acid drainage originates in abandoned underground coalmines and is carried by surface or groundwater into nearby streams. Filling or sealing the old shafts to eliminate acid production is expensive, and results are inconsistent. For this reason, water treatment has been the most practical solution to the problem (Michaud, 1994).

Methods of water treatment used to eliminate acid mine drainage from abandoned underground mines can be grouped into two types. The most common method is chemical treatment. Called "active" treatment because it requires constant maintenance, this method usually involves neutralizing acid-polluted water with hydrated lime or crushed limestone. This treatment reduces acidity and significantly decreases iron and other metals. However, it is expensive to construct and operate and is considered a temporary measure because the acid drainage problem has not been permanently eliminated. The second treatment method is called biological, or "passive," control. This technology involves the construction of a treatment system that is more permanent and requires little or no maintenance. Passive control measures involve the use of anoxic drains, limestone rock channels, alkaline recharge of groundwater and diversion of drainage through man-made wetlands or other settling structures. Passive treatment systems are relatively inexpensive to construct and have been very successful on some small discharges of acid drainage (Michaud, 1994).

7.3.1 Prevention and Minimization of AMD Formation

For the formation of AMD, three components are required: sulfur-bearing material, water and air. Certain bacteria also act to catalyze the oxidation of the pyrite. If any one of these components can be eliminated, AMD generation will not occur.

At active surface mining operations, the volume of surface runoff entering the site can be minimized by using perimeter diversion ditches, by relocating stream channels and by grouting or lining streambeds to prevent water loss to the spoil. Sealing the spoil piles with an impermeable capping material such as fly ash, cemented fly ash, clay or geopolymers can minimize infiltration of surface runoff and air. The optimization of the long-term effectiveness of these capping materials is presently being investigated by a number of research groups. Where conditions are suitable, pyretic spoil can also be effectively isolated from oxygen by placing it underwater in flooded pits, or by encapsulation with an impervious material (Michaud, 1996).

In underground operations, grouting of fractured overburden can be used to prevent the infiltration of surface water into the mine workings. Research is also being carried out to determine the effectiveness of injecting alkaline materials such as cemented fly ash into the underground workings. This could reduce the formation of AMD by coating the surface of the reactive pyrite. Because fly ash is a waste product from the power generation industry, it is inexpensive—this usage could provide a beneficial means of disposing of ash (Michaud, 1996).

Several methods are presently being investigated for their ability to inhibit AMD formation or to treat it in situ. When added to pyretic material, phosphate can form an extremely insoluble surface coating of ferric phosphate, thereby inhibiting the AMD formation reactions. Although very effective in the laboratory, the practicality and economics of this method in the field have yet to be demonstrated (Michaud, 1996).

AMD generation can also be inhibited by the addition of bactericides or surfactants to the pyretic spoil. This technique is, however, expensive and not permanent. The addition of alkaline substances like limestone to the spoil material by mixing or layering can be used to neutralize acidity and to inhibit the acid-forming reactions. However, unless integrated with an ongoing spoiling operation, the cost of excessive material movement may be prohibitive. Alkaline solutions or slurries can also be injected into the spoil material, or the surface drainage diverted through ponds filled with alkaline material. This method can temporarily inhibit the acid-forming reaction and neutralize the AMD (Sobek, 1990).

7.3.2 Passive Treatment After AMD Formation

<u>Constructed Wetlands:</u>

Passing AMD through wetlands (natural or constructed) can decrease the concentration of dissolved metals in the water, decrease acidity and trap sediment. The basic mechanisms identified for the retention of metals include the accumulation of metals in living plants and in the organic substrate, the exchange and organic complexion reactions with the substrate and chemical and microbiological oxidation and reduction reactions that lead to precipitation.

There are aerobic and anaerobic constructed wetlands. Aerobic systems consist of wetlands of cattails or more diverse vegetation growing in a clay soil or mine spoil substrate. These conditions increase levels of oxygen in the substrate, and promote oxidation and precipitation of metals. Anaerobic wetlands are constructed with a thicker organic substrate composed of organic material such as hay, manure, peat moss or mushroom compost. The main purpose of this design is to create an environment where oxygen content is restricted in order to promote the anaerobic sulfate reduction of metals (Watzlaf, 1995).

Anoxic Limestone Drains (ALD):

The theory of Anoxic Limestone Drains (ALDs) is quite simple. Acid Mine Drainage is passed through a bed of limestone gravel that is buried to limit the input of oxygen. As the AMD dissolves the limestone, the pH rises and bicarbonate alkalinity is added to the water. This promotes metals precipitation in subsequent ponds or wetlands. Anoxic conditions within the limestone prevent iron oxidation and limestone armoring. However, the use of ALDs is not suitable under certain water chemistry conditions. Ferric iron and aluminum both precipitate within an ALD, decreasing performance by armoring limestone and plugging flow paths. It is also possible that a properly designed and constructed ALD will not generate sufficient alkalinity to completely neutralize acidic water due to limited limestone solubility. Water chemistry that appears similar based on evaluation of standard Acid Mine Drainage analytes may generate dissimilar alkalinity concentrations (Hedin, 1994)

Diversion Wells:

A typical diversion well consists of a cylinder or vertical tank of metal or concrete filled with sand-sized limestone. This well may be erected in or beside a stream or may be sunk into the ground by a stream. A large pipe enters vertically down the center of the well and ends shortly above the bottom. Water is fed to the pipe from an upstream dam or deep mine portal. The water flows down the pipe, exits the pipe near the bottom of the well, and then flows up through the limestone in the well, thereby fluidizing the bed of limestone in the well. The acid water dissolves the limestone for alkalinity generation, and metal flocs produced by hydrolysis and neutralization reactions are flushed through the system by water flow out the top of the well. The churning action of the fluidized limestone also aids in limestone dissolution and helps remove iron oxide coatings so that fresh limestone surfaces are always exposed. Metal flocs suspended in the water are precipitated in a downstream pond (Hedin, 1994).

Limestone Sand Treatment:

Sand-sized limestone may also be directly dumped into AMD streams at various locations in watersheds. The sand is picked up by the stream flow and redistributed downstream, furnishing neutralization of acid as the stream moves the limestone through the streambed. The limestone in the streambed reacts with acid in the stream, causing neutralization. Coating of limestone particles with iron oxides can occur, but the agitation and scouring of limestone in the streambed keep fresh surfaces available for reaction (Robb, 1994).

Limestone Ponds:

Limestone ponds are a new passive treatment idea in which a pond is constructed on the upwelling of an AMD seep or underground water discharge point. Limestone is placed in the bottom of the pond and the water flows upward through the limestone. The pond is sized and designed to retain water for 1 or 2 days for limestone dissolution, and to keep the seep and limestone under water (Robb, 1994).

Open Limestone Channels:

Open Limestone Channels (OLCs) introduce alkalinity to acid water by the use of open channels or ditches lined with limestone. AMD is introduced to the channel and is treated by limestone dissolution. OLCs neutralize acidity in AMD as long as open channels are constructed of sufficient length to maintain contact time between the limestone and acid water. Open Limestone Channels show promise for neutralizing AMD in watershed restoration projects and abandoned mine land reclamation projects where one-time installation costs are incurred, little or no maintenance is required and systems do not have to meet specific water quality standards (Ziemkiewicz, 1994).

Successive Alkalinity Producing Systems:

Successive Alkalinity Producing Systems (SAPS) combine the use of an Anoxic Limestone Drain and an organic substrate into one system. Oxygen concentrations in AMD are often a design limitation for ALDs. In situations where the dissolved oxygen concentrations are above 1 or 2 mg/L, the water can be introduced into a pond with the following design. Acid water is ponded over organic compost, which is underlain by limestone. Below the limestone is a series of drainage pipes that convey the water into an aerobic pond where metals are precipitated. The hydraulic head drives ponded water through the anaerobic organic compost, where oxygen stripping as well as iron and sulfate reduction can occur prior to water entry into the limestone. Water with high metal loads can be successively cycled through additional SAPS. Iron and aluminum clogging of limestone and pipes can be removed by flushing the system (Robb, 1994).

Bioremediation:

Bioremediation of soil and water involves the use of microorganisms to convert contaminants to less harmful species in order to remediate contaminated sites. Microorganisms can aid or accelerate metal oxidation reactions and cause metal hydroxide precipitation. Other organisms can promote metal reduction and aid in the formation and precipitation of metal sulfides. Reduction processes can raise pH, generate alkalinity and remove metals from AMD solutions. In most cases, bioremediation of AMD has occurred in designed systems like anaerobic wetlands where oxidation and reduction reactions are augmented by special organic substrates and limestone (Robb, 1994).

7.4 Remining

Remining is the process of returning to abandoned surface or underground mines for further coal removal. Where AMD occurs, remining reduces acid loads by: decreasing infiltration rates, covering acid-producing materials and removing the remaining coal, which is the source of most pyrite. In 1992 the Surface Mine Conservation and Reclamation Act (SMCRA) was amended to provide incentives for the active coal industry to remine abandoned mine lands.

Actively remining previously abandoned surface or deep mines is the most efficient way to reclaim abandoned mine lands at no cost to taxpayers (Report 5000-BK-DEP2274, 1998). Mine operators who mine abandoned areas must then restore the land to current reclamation standards. The Department of Environmental Protection offers many incentives to mine operators who engage in remining.

7.5 Reclamation

Abandoned mine reclamation refers to the process of cleaning up environmental pollutants and safety hazards associated with a site and returning the land to a productive condition.

In 1977 Congress introduced the federal Surface Mining Control and Reclamation Act (SMCRA). As a result, coal-producing states were required to update their mining regulations if they wished to retain primary responsibility (primacy) for regulating their surface mining industry. SMCRA mandated that all active coal operators must return the lands they mine back to their original contour and post bonds to guarantee the work will be done within a specific amount of time after active mining ceases. Should an operator fail to undertake reclamation, the state would then use the financial guarantee to pay a contractor to do it. In addition, the act established the Abandoned Mine Reclamation Fund by imposing a fee on active mine operators based on the tonnage of coal removed. The trust fund, administered by the Office of Surface Mining and Enforcement (OSM), is used to reclaim mine lands abandoned prior to 1977. An amendment to SMCRA also allows states to put aside grant money specifically for treating mine drainage.

Since the early 1980s, under the Reclamation-In-Lieu of Civil Penalties Program, DEP has routinely allowed operators to perform reclamation instead of paying civil penalties assessed for active permit violations. The reclamation performed is always more valuable than the actual assessed civil penalty and the activity cannot address the operation's legal responsibility (Report 5000-BK-DEP2274, 1998). DEP's District Mining offices have used this program to facilitate many types of abandoned mine reclamation, including abandoned surface mine reclamation, deep mine sealing and reclamation, mine drainage remediation projects and control of surface subsidence due to abandoned deep mine operations.

7.6 Bond Forfeiture

Bond forfeiture is the final enforcement action against an operator who is unwilling or unable to complete the reclamation of a site. When a forfeiture occurs, the government assumes the responsibility of reclaiming the abandoned mine. Additionally, operators who fail to reclaim their mines can never receive another mining permit -- not only in Pennsylvania, but in the United States.

7.7 Water Management

Diverting surface water from the spoil above the site to decrease the amount of water entering the mined area is highly recommended in acid-producing areas (Skousen, 1992). Channeling surface waters or mine waters to control volume, direction and contact time can be used to minimize the effects of acid mine drainage on receiving streams. The diversion of water from mining areas and from acid-producing materials is an abatement technique used in both surface and underground mines. Surface diversion of runoff involves the construction of drainage ditches to move surface water quickly off the site before infiltration or to limit its movement into disturbed areas. The diversion is accomplished either by ditching on the uphill side of the surface mines or by providing new channels or impervious channels for existing surface streams to convey water across the disturbed area (Skousen, 1992). Because the discharge of the Jeddo Tunnel is so large (40,000 gpm), surface water diversion methods are highly recommended and are essentially the only viable AMD abatement techniques for the watershed.

7.8 Acid Mine Drainage and Aquatic Life

The first visual observation of the effects of acid mine drainage pollution was probably the red-yellow precipitates of iron hydroxide ($Fe(OH_3)$) and the eradication of fish and other aquatic life from the water systems (Zielinski).

Acidification of aquatic ecosystems is a problem that has received renewed attention, with the current focus on the environment. Acid mine drainage involves the element of sulfur and its conversion to sulfuric acid. Acid mine drainage has destroyed countless aquatic ecosystems in coal mining areas, frequently resulting in impaired water quality and loss of virtually all desirable forms of life (Zielinski).

A qualitative biological examination of a stream contaminated by acid mine drainage may reveal that cattails (Typha sp.), mosses and other vascular plants are not found. Dense flowing mats of green algae (Ulothrix) are common along with Euglena and may color stream beds dark green. Other species of green algae and diatoms are frequently found. In severely contaminated streams, no life will be found. Further from the point source of pollution, midges, alderflies, crane flies and caddis flies may be found. Fish are absent from streams with a pH of 4.5 or lower (Zielinski).

Most aquatic organisms have a well-defined range for pH. Death of organisms is believed to be due to a combination of respiratory and osmoregulatory failure. Sub-lethal elevations in acidity may adversely affect growth rate and reproduction of fish. Mayflies and other insects will be absent at such low pH levels, and the creek is likely to be devoid of fish and frogs as well. Furthermore, the majority of eggs lain at this site, if any species are present to produce them, will be incapable of hatching.

At pH levels this low, metals such as aluminum and lead are released in forms that are toxic to aquatic life. Toxics in water tend to attach to suspended particles, drop to the bottom, and then re-suspend during storms. Toxics lower reproductive success and stress the health of aquatic animals. When toxics accumulate in the tissues of fish and shellfish, they pose a threat to human health. Toxics may also seep into the water table and contaminate vast amounts of groundwater. These toxic heavy metals are soluble in acidic waters. Raising the pH of the system would reduce metal concentrations in the aqueous form, which is the most readily available to aquatic life (Zielinski).

Conversion of the iron to ferric hydroxide ($Fe(OH)_3$) produces a bottom coating in the stream known as "yellow-boy." This physical pollutant may decrease oxygen availability to the biota during its formation, cover gills and body surfaces, smother eggs and blanket bottom habitat. In addition, iron particles in suspensions can reduce photosynthesis by covering the surfaces of plants, further inhibiting the penetration of light (Zielinski).

Between June and July 1998 chemical, coliform, macro-benthic and fish samples were collected by the Pa. DEP Water Management Program from Nescopeck and Little Nescopeck Creek in an attempt to update the water quality assessment throughout the watershed. Table 11 summarizes the toxicity levels measured at sites throughout the Nescopeck and Little Nescopeck Creeks and their relationship to aquatic life.

Table 11. Analysis of Selected Parameters for Chronic and Acute Toxicity to Aquatic Life Based Upon Measured Stream Hardness

(Shaded areas exceed one or both criteria)
Data Source: PA DEP, June-July 1998

	Copper (µg/L)			Lead (µg/L)			Zinc (µg/L)		
SITE	CCC	CMC	Conc.	CCC	CMC	Conc.	CCC	CMC	Conc.
1	2.60	3.34	<10.00	0.33	8.56	<1.00	23.62	26.08	<10.00
2	4.58	6.24	<10.00	0.78	19.91	<1.00	41.43	45.74	<10.00
3	9.67	14.20	36.00	2.36	60.48	3.30	86.80	95.84	621.00
4	27.28	44.56	33.00	11.05	283.66	3.20	242.81	268.08	606.00
5	28.50	46.76	31.00	11.80	302.80	2.90	253.60	279.99	486.00
6	27.28	45.19	29.00	11.27	289.11	2.80	245.90	271.49	466.00
7	15.47	23.85	13.00	4.75	121.89	1.50	138.39	152.80	206.00
8	13.13	19.89	12.00	3.72	95.39	1.20	117.56	129.79	169.00
9	11.92	17.89	12.00	3.22	1.20	1.20	106.89	118.01	162.00

CCC: Criteria Continuous Concentration for fish and aquatic life
CMC: Criteria Maximum Concentration for fish and aquatic life
Conc.: Measured in-stream concentration

Monitoring Site	Location Description (maps located in Appendix C)
1	Little Nescopeck Creek: Up bridge on T341, approximately 500 feet upstream from the Jeddo Tunnel
2	Jeddo Tunnel: upstream from the confluence with the Little Nescopeck
3	Little Nescopeck Creek: Approximately 220 feet downstream from the Jeddo Tunnel
4	Little Nescopeck Creek: Approximately 500 feet upstream from Conyngham Sewage Treatment Plant
5	Little Nescopeck Creek: At bridge, approximately five miles upstream from the mouth
6	Nescopeck Creek: Approximately 500 feet upstream from the Little Nescopeck confluence
7	Nescopeck Creek: At the bridge on Route 93, directly after the confluence with the Little Nescopeck
8	Nescopeck Creek: Approximately 0.5 miles upstream from the Black Creek confluence
9	Nescopeck Creek: At the bridge on T381, one mile downstream from the mouth of Black Creek

7.9 The Jeddo Tunnel

There are 11 drainage tunnels in the Eastern Middle Anthracite field, more than in any other anthracite field in Pennsylvania. The largest and best-known drainage tunnel in this area is the Jeddo Tunnel system. This drainage system involves four major coal basins: Big Black Creek, Little Black Creek, Cross Creek and Hazleton. The Jeddo is composed of two major tunnels, Tunnel A and Tunnel B and three minor tunnels, C, D and X, which drain the mines in the Hollywood, Minesville, Lattimer, Drifton, Sandy Run, Harleigh, Ebervale, Eckley, Humbolt, Harwood, Cranberry and Stockton areas (Figure 20). The Jeddo Tunnel drains all of these mine areas into the Little Nescopeck Creek. This tunnel is the primary source of acid-mine and fine-grained coal waste black water pollution to the Little Nescopeck Creek.

Figure 21. The Jeddo Tunnel outflow, the only identified major non-point source pollution to the Little Nescopeck Creek.

The majority of the fieldwork associated with developing this management plan has focused on the outflow of the Jeddo Mine Tunnel. Construction on the tunnel began in 1891, was finally completed in 1934 and was designed to dewater deep mine anthracite workings. After the collapse of the deep mining industry in 1955, it continued to drain the abandoned workings. When abandoned, the mines discharge poor quality water that shows little improvement with time. The Jeddo Tunnel discharge has shown some water quality improvement since the mines in the systems were abandoned but is still very acidic.

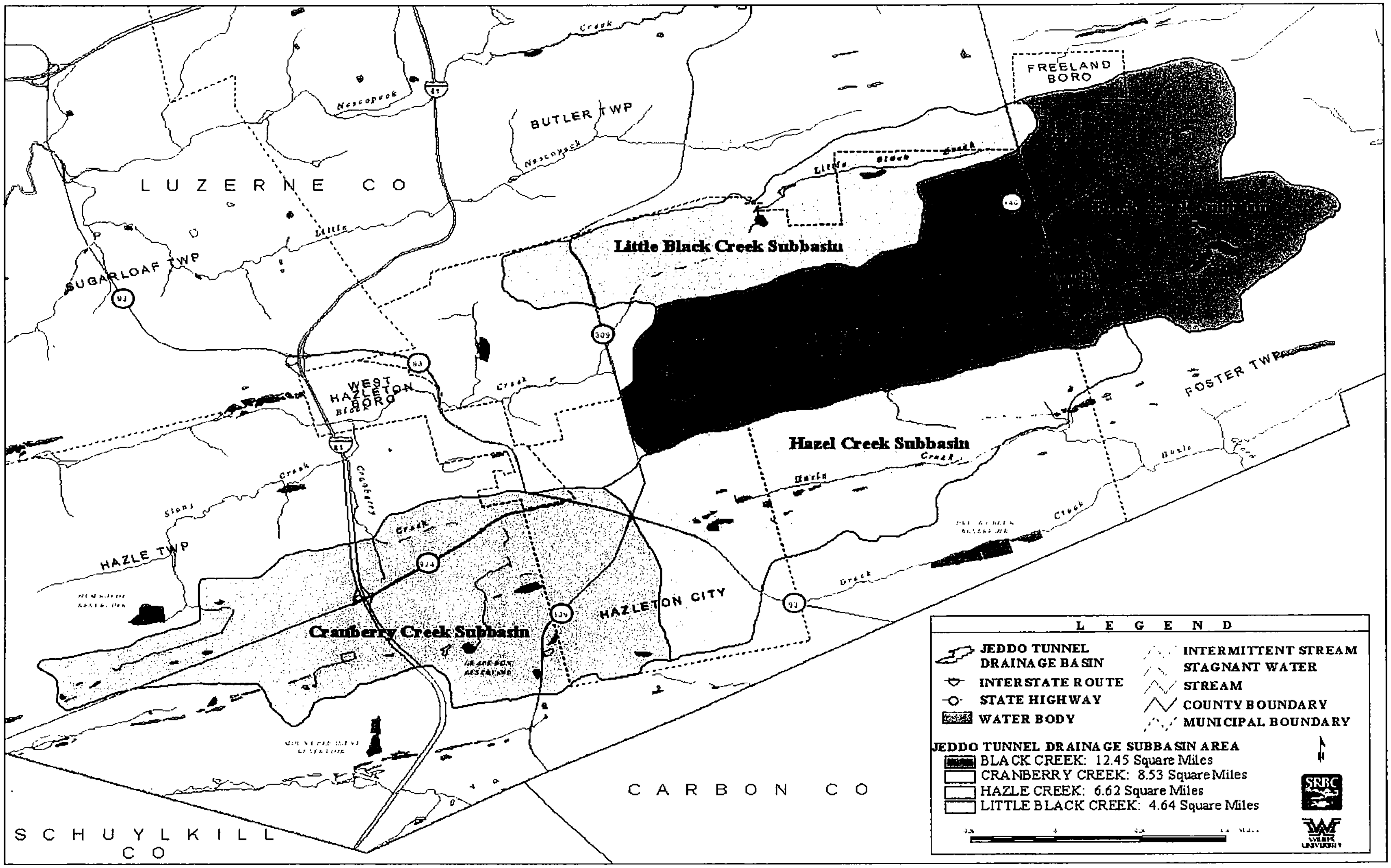

Figure 20. Subbasins of the Jeddo Tunnel Drainage Basin.

The Jeddo is a gravity discharge point for an approximately 32.24 square mile area underlain by abandoned deep mines in the Hazelton area of the Eastern Middle Anthracite Field. Since the completion of the initial rock tunnels and subsequent connecting tunnels and slopes and the loss of an effective perimeter drain system, the Jeddo Tunnel collects and discharges more than half of the precipitation received in the drainage area. The tunnel discharges an average of 40,000 gallons per minute of acid mine drainage and suspended coal dust into the Little Nescopeck Creek near its headwaters and affects the stream for most of its length. It also affects the Nescopeck Creek and the Susquehanna River and eventually the Chesapeake Bay. According to the Susquehanna River Basin Commission, the Nescopeck Creek contributes over 90,000 pounds of acid per day to the Susquehanna River and 20% of the sediment discharged to the Susquehanna is associated with coal mining operations. About 300,000 tons are dredged from the River and the remaining 90,000 tons are transported to the Chesapeake Bay annually.

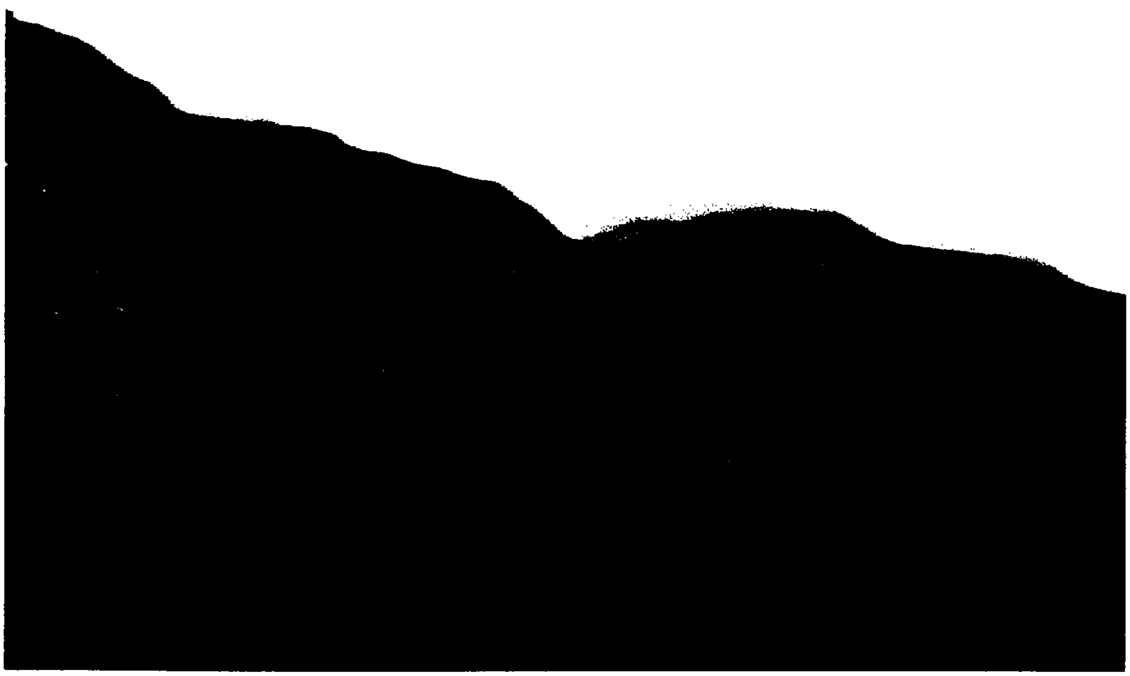

Figure 22. The coal dust and sediment rich in heavy metals is discharged from the Jeddo Tunnel and is deposited along the banks of the Little Nescopeck Creek throughout nearly all of its length.

Nescopeck Creek contains a high level of biodiversity and is classified as a High Quality Cold Water Fishery (HQ-CWF) above the point where it is joined by the Little Nescopeck Creek. Below this point, stream quality is severely degraded by mine drainage. The Jeddo Tunnel discharge kills all aquatic life in the Little

Nescopeck Creek below the confluence and, in turn, kills aquatic life in Nescopeck Creek below its confluence with the Little Nescopeck.

Figure 23. The Nescopeck Creek is a High-Quality Cold Water Fishery above its confluence with the Little Nescopeck Creek.

8.0 WATERSHED ISSUES

8.0 WATERSHED ISSUES

8.1 Water Quality

Water quality testing in the Little Nescopeck and Nescopeck Creeks and at the Jeddo Tunnel was conducted by the Pennsylvania Department of Environmental Protection between June and July of 1998 (Appendix C). Testing was performed in an attempt to update the water quality assessment throughout the watershed. The Pa. DEP also collected water quality data for the Jeddo Tunnel outflow from April 1995 through June 1998 (Appendix F). In addition, Friends of the Nescopeck collected water samples on the Nescopeck Creek and at the Jeddo Tunnel from November 1996 through October 1998 (Appendix E), and along the Little Nescopeck and Nescopeck Creeks and Susquehanna River on a weekly basis from November of 1996 to January 1997 (Appendix D). The analysis of these samples shows values typical of waters impacted by mine drainage in eastern Pennsylvania.

Data analysis and collection involving the Jeddo Tunnel outfall and the Nescopeck Creek illustrates change and stability of water quality throughout a three-year period. Data analysis and collection focused on the Little Nescopeck Creek involved only a one-month collection period and illustrates the changes in water quality throughout the lengths of the Little Nescopeck and Nescopeck Creeks.

8.1.1 Review of Existing Water Quality Reports

Evaluating the health of the Little Nescopeck Creek greatly depends upon the condition of the Creek prior to the study period. Previous studies provide a comparison for determining if the water quality and habitat conditions are improving or deteriorating.

The Jeddo Tunnel, not the Little Nescopeck or Nescopeck Creek, was mostly the subject of engineering and environmental interests. Ash and others (1949, 1950) monitored the flow and quality of discharge. In the early 1970s, the Jeddo Tunnel was a subject of a study conducted by the Hazleton City Authority to determine the feasibility of using its water as a supply source for the City of Hazleton. In 1975 and 1991, USGS monitored the flow and water quality of the Jeddo Tunnel as part of a Water Resources Investigation (Report 95-4243). Between 1995 and 1998 The Jeddo Tunnel was under study by Wildlands Conservancy, the Susquehanna River Basin Commission and Bloomsburg University to research and document hydrologic behavior of features contributing to subsurface mine pool water in the deep mines of the Eastern Middle Anthracite Field.

Existing water quality data for the Jeddo Tunnel is extensive enough to make some observations regarding the changes in quality over the past 20 years. A significant rise in pH and comparable drop in total acidity can be seen from 1978 through 1998 (Figures H1 and H2). During this period, sulfate and iron concentrations in the Jeddo Tunnel outflow have undergone a significant decrease (Figure H3). Manganese and aluminum concentrations were measured from 1986 to 1998 and also underwent a significant decrease (Figures H5 and H6). The Jeddo Tunnel discharge has shown some water quality improvement since the mines in the system were abandoned in 1961. The discharge, however, is still very acidic and negatively impacts the Little Nescopeck Creek.

Intensive studies of the Little Nescopeck and Nescopeck were not conducted prior to the start of this project. The earliest water quality data existing for these sites is from 1996. Detailed analysis of this data is contained in the following water quality sections 8.1.3 and 8.1.4.

8.1.2 Jeddo Tunnel Water Quality

The Jeddo Tunnel discharge is the major source of contamination in the Little Nescopeck Creek. The Pennsylvania Department of Environmental Protection monitored the quality of water discharged monthly. Water samples were collected by volunteers from Friends of the Nescopeck and analyzed by the Pa. DEP (Appendix F). The agency has concentration data for the Jeddo Tunnel outflow from April 1995 through June 1998 (Appendix G) and Wildlands Conservancy calculated annual loads of acidity, alkalinity, iron, sulfate, manganese, aluminum, magnesium and zinc for these years (Table G1).

The data and analysis in the following section was published in the report compiled by Wildlands Conservancy and the Susquehanna River Basin Commission for the Pennsylvania Department of Environmental Protection, Bureau of Watershed Conservation. The analyses show values typical of surface waters affected by acid mine drainage in eastern Pennsylvania. The water discharge can be characterized as predominantly acidic, with elevated levels of dissolved metals such as iron, manganese, magnesium and aluminum.

The pH of the discharge ranged from approximately 3.6 to 5.0 on one occasion and averaged approximately 4.3 (Figure F1). Acidity levels from the Jeddo Tunnel were highest during late summer and early fall. Comparing water quality data to discharge rates has shown that, as flow rises, the pH increases, and as flow decreases, so does the pH (Figure G1).

High concentrations of sulfide minerals and the absence of significant carbonate minerals in the bedrock result in high acidity and low alkalinity, respectively (Figures F2 and F3). Alkalinity (also referred to as buffering capacity) refers to the amount of carbonate present that could neutralize acidity. Acidic pollution will reduce the pH of a system with low alkalinity much more rapidly than it would a well-buffered system. In effect, the Jeddo discharge is relatively incapable of stabilizing its pH and is impacted by acidic contamination.

The most dominant cation in solution is magnesium, having an average concentration of approximately 52 milligrams per liter (mg/L) (Figure F4). This was closely followed by calcium, with an average concentration of approximately 35 mg/L (Figure F5), and to a lesser degree by sodium (12 mg/L) and potassium (2.2 mg/L) (Figures F6 and F7). The dominant anion found in solution was sulfate, which results from the oxidation of pyretic materials. The average concentrations of sulfate and chloride were approximately 284 mg/L and 13.5 mg/L respectively (Figures F8 and F9). These constituents all fluctuated inversely with flow rates (Figures G1-8) and most peak concentrations occurred between July and November, when the flow is at its lowest (Figure F1-15).

Excessively high concentrations of dissolved metals also were identified as a characteristic of the Jeddo discharge. Iron was present in concentrations ranging from 2 to 90 mg/L, with an average of approximately 9 mg/L (Figure F10). For comparison, the suggested maximum contaminant level (MCL) for iron in municipal water systems is 0.3 mg/L. Similarly, manganese exceeded the suggested MCL of 0.05 mg/L, with an average concentration of approximately 4.2 mg/L. The range for manganese was from 1.4 to 6.8 mg/L (Figure F11). Aluminum concentrations ranged from 2.5 to 44 mg/L, exceeding the recommended MCL of 0.05 to 0.2 mg/L (Figure F12). Zinc concentrations averaged 0.7 mg/L, which is near maximum recommended levels (Figure F13).

Total solids in the Jeddo Tunnel outflow range from 265 to approximately 6800 mg/L, with an average of 900 mg/L (Figure F14). Suspended solids contribute an average of approximately 125 mg/L to the total solids concentration; the remainder is comprised of dissolved solids.

The average specific conductance of the Jeddo discharge is approximately 728 micromhos/cm (Figure F15). Specific conductance is a measure of the capacity of water to conduct an electrical current and it varies with concentration and degree of ionization of the constituents. Specific conductance is commonly used in the field to obtain a rapid estimate of the approximate dissolved-solids content of water.

Table 12 displays water quality concentrations at the Jeddo Tunnel outflow over time. During the 3-year study period between 1996 and 1998, alkalinity and pH were both elevated and total acidity decreased. In 1996 pH averaged 4.37 and 4.43 in 1998. Corresponding to this increase, alkalinity was raised from 7.95 mg/L in 1996 to 8.42 mg/L in 1998 and total acidity decreased from 73.36 mg/L to 65.71 mg/L over the time period. Specific conductance, measured at an average of 699.63 in 1996, was raised to 753.33 microhoms/cm in 1998. Total, suspended and dissolved solids all decreased during this period. The change over time in concentration of other parameters fluctuates. Magnesium, sodium and chloride all underwent slight elevations in concentration while potassium, iron, zinc and aluminum decreased slightly and calcium sulfate and manganese underwent little to no change.

8.1.3 Little Nescopeck Creek Water Quality

The water quality of the Little Nescopeck Creek is greatly influenced by the mine drainage discharged from the Jeddo Tunnel. Impacts of the Jeddo include a lower pH, increased acidity, increased specific conductance, increased rates of flow, increased total hardness and elevated levels of heavy metals. These findings were supported by water quality data collected by Friends of the Nescopeck and by the Pennsylvania Department of Environmental Protection. The water quality data referred to in this section was obtained from the Pennsylvania Department of Environmental Protection and published in a Stream Investigation Report regarding the Nescopeck and Little Nescopeck Creeks (Appendix C).

Water quality data was collected and analyzed by the Pennsylvania Department of Environmental Protection's Water Management Program over the period from June 1998 through July 1998 (Table C2). The Pa. DEP's monitoring sites included four sites along the Nescopeck Creek, four sites along the Little Nescopeck and the Jeddo Tunnel outflow (Figure C1).

The pH in the Little Nescopeck before the Jeddo Tunnel averaged 6.2 and 4.5 after the Tunnel, according to the Pa. DEP (Figure C2). Comparing pH data to flow data upstream and downstream from the Jeddo Tunnel shows an inverse correlation. While the pH decreased, the rate of flow increased from 2.18 cfs before the Jeddo Tunnel to an average of approximately 60.02 cfs after the Jeddo (Figure C3).

The specific conductance of the Little Nescopeck Creek was measured at 178.30 micromhos/cm above the Jeddo Tunnel and averaged approximately 446.13 micromhos/cm downstream from the tunnel (Figure C4). Specific conductance can be used to estimate the concentration of dissolved solids in a body of water. Typically suspended solids include items such as soil, algal cells and plant particles. High levels of suspended solids may smother aquatic organisms.

Table 12. Annual Average Water Quality Concentrations at the Jeddo Tunnel and in the Nescopeck Creek, mg/L

	JEDDO TUNNEL			NESCOPECK CREEK		
Date	1996	1997	1998	1996	1997	1998
Specific Conductance	699.63	696.53	753.33	277.57	412.77	473.32
pH	4.37	4.39	4.43	4.99	4.77	4.81
Alkalinity	7.95	8.20	8.42	10.31	10.20	10.15
Total Solids	951.07	785.95	716.81	369.43	359.43	458.57
Suspended Solids	764.61	760.43	685.46	350.29	345.67	445.62
Total Dissolved Solids	189.38	29.00	12.73	20.57	13.56	13.09
Calcium	35.98	34.41	36.39	14.04	22.76	24.00
Magnesium	54.84	55.41	58.60	17.39	27.75	32.57
Sodium	10.20	12.24	13.59	7.44	11.53	11.71
Potassium	2.54	1.80	1.74	1.37	1.41	1.52
Chloride	12.12	15.79	17.71	10.71	18.49	18.05
Sulfate	286.58	247.65	286.23	80.86	131.33	180.43
Iron	12.86	3.58	3.29	3.56	1.18	1.30
Manganese	4.22	4.33	4.23	1.15	2.06	2.27
Zinc	0.70	0.68	0.65	0.21	0.36	0.35
Aluminum	13.16	9.73	9.40	2.95	4.25	4.88
Total Acidity	73.36	71.91	65.71	17.29	33.18	29.43

Figure 24. The water of the Jeddo Tunnel discharge, with excessively high concentrations of dissolved solids, heavy metals and coal dust, mixes with the water of the Little Nescopeck Creek.

The Jeddo Tunnel produces severely elevated levels of dissolved metals in the Little Nescopeck. Upstream from the Jeddo Tunnel, the average concentration of manganese is approximately 108.00 µg/L. Throughout the Little Nescopeck below the Jeddo, manganese concentrations average approximately 3320 µg/L and aluminum concentrations rose from less than 200 µg/L to an average of approximately 7470 µg/L (Figure C5). Iron concentrations are also elevated. Upstream from the tunnel, iron in the Little Nescopeck averaged 380.00 µg/L. Downstream from the discharge, the creek's average iron concentration was approximately 1946.67 µg/L (Figure C6). Nickel and zinc concentrations in the Little Nescopeck also rose significantly from upstream to downstream from the Jeddo Tunnel. Nickel concentrations rose from less than 50.00 µg/L prior to the tunnel to an average of 144.00 µg/L throughout the Little Nescopeck and zinc concentrations were elevated from less than 10 µg/L to 519 µg/L (Figure C7). Concentrations of heavy metals this high are detrimental to aquatic life. By raising the water's pH, metals in their aqueous form, the form most readily available to aquatic life, would be reduced.

Organic pollutants were measured by Pa. DEP (Figure C8). Nitrate concentration decreased significantly below the Jeddo confluence and rose slightly farther downstream and throughout the Nescopeck. Ammonia concentrations in the Little Nescopeck were elevated slightly below the Jeddo confluence compared to above and reached a maximum about five miles before its confluence with the Nescopeck. Phosphorus and nitrite did not undergo measurable changes in concentration throughout the watershed. Magnesium and calcium are the dominant cations in the Little Nescopeck. Manganese concentration was measured at 3.42 mg/L prior to the Jeddo Tunnel and averaged 53.43 mg/L below it. The calcium concentration in the Little Nescopeck above the Jeddo was 16.20 mg/L and averaged 32.47 mg/L throughout the rest of the creek (Figure C9).

Elevated concentrations of sulfide minerals in the Little Nescopeck, along with decreased carbonate materials, result in highly acidic conditions and limited buffering capacity (Figures C10 and C11). Sulfate concentrations in the Little Nescopeck averaged less than 10.00 mg/L upstream from the Jeddo Tunnel and approximately 257 mg/L throughout the Creek downstream from the discharge (Figure C12). Total calcium carbonate in the Little Nescopeck was measured at 33.00 mg/L above the Jeddo and averaged 272.00 mg/L below the Tunnel (Figure C13). These data represent the incapability of the Little Nescopeck to stabilize its pH through natural buffering mechanisms.

8.1.4 Nescopeck Creek Water Quality

The water quality of the Nescopeck Creek is greatly influenced by mine drainage discharging from the Jeddo Tunnel. Impacts of the Jeddo Tunnel discharge on Nescopeck Creek include a lower pH, increased acidity, elevated levels of heavy metals, increased specific conductivity and increased concentration of suspended solids.

Water samples were collected from November 1996 to October 1998 by Friends of the Nescopeck for analysis by the Pa. DEP (Appendix E). The water chemistry data was analyzed to determine their relationship to flow and other environmental factors. The information in this section was previously published in the report compiled by Wildlands Conservancy and the Susquehanna River Basin Commission for the Pennsylvania Department of Environmental Protection, Bureau of Watershed Conservation.

The pH in the Nescopeck averages approximately 4.8 and ranged from 4.5 to 5.8 over the period of record (Figure E1). These values are slightly higher than the values measured at the Jeddo Tunnel discharge. The increased acidity in the Nescopeck Creek downstream from the discharge is an impact of the Jeddo Tunnel. The lowest pH values were recorded during the summer and fall months and the highest values were recorded in the spring and winter. Reduced levels of acidity entering the system help prevent the pH from dropping below levels present in the outflow from the tunnel. Acidity levels dropped from an average of 74 mg/L at the Tunnel to 30 mg/L in Nescopeck Creek (Figure E2).

Despite the drop in acidity, the Creek's pH remains low, and the alkalinity has not improved significantly. The average alkalinity of the system was raised by 2 mg/L (to 10 or 11 mg/L) from the tunnel discharge to Nescopeck Creek and is still not sufficient to stabilize pH against acidic contamination (Figure E3).

The distribution of dominant cations and anions in solution in Nescopeck Creek was similar to that in the Jeddo Tunnel discharge. Magnesium remains the dominant cation, although the average concentration decreased from approximately 52 to 28 mg/L (Figure E4). The next most abundant cation was calcium, with an average concentration of 22.15 mg/L (Figure E5), followed by sodium and potassium (Figures E6 and E7).

Sulfate was the dominant anion, having an average concentration of approximately 140 mg/L (Figure E8). This concentration has decreased significantly from the level at the tunnel outflow, and is now well below the suggested MCL for sulfate. Contrary to the other constituents, the concentration of chloride in the Nescopeck Creek increased from that of the Jeddo Tunnel. Chloride concentrations ranged from 7 to 55 mg/L, with an average of 17.3 mg/L (Figure E9). These increases were probably due to discharges from the wastewater treatment plants.

Dissolved metal concentrations remain a problem in the Nescopeck Creek downstream from its confluence with Little Nescopeck Creek. Although iron concentrations decreased significantly to an average of approximately 1.43 mg/L (Figure E10), the average is still well above the suggested MCL of 0.3 mg/L. Manganese values were also lower in the Nescopeck Creek than at the tunnel discharge, but are in excess of the suggested MCL of 0.05 mg/L. Manganese concentrations ranged from 0.6 to 4 mg/L, with an average of 2.02 mg/L (Figure E11). Aluminum concentrations also were elevated, with a range from 0.2 to 8.21 mg/L, and averaged approximately 4.23 mg/L (Figure E12). Zinc concentrations were below suggested limits, with an average of approximately 0.34 mg/L, which was down from an average of 0.7 mg/L in the Jeddo Tunnel discharge (Figure E13).

The average concentration of total solids in the Nescopeck Creek was less than half of that from the Jeddo Tunnel. Total solids ranged from 20 to 1200 mg/L, with an average of 388 mg/L (Figure E14). Contrary to analysis at the Jeddo Tunnel, suspended solids composed the majority of the total solids concentration. Suspended solids ranged in concentration from 0 to 1190 mg/L, with an average of approximately 374 mg/L (Figure E15).

Dissolved solids concentrations were very low in Nescopeck Creek in comparison to the Jeddo Tunnel discharge. The concentration of dissolved solids averaged approximately 17.6 mg/L (Figure E16). The specific conductance of the Nescopeck Creek decreased approximately 300 micromhos/cm, with an average of 417 μmhos/cm (Figure E17). The lower concentrations are the result of dilution due to flows in the Nescopeck Creek, as well as from the precipitation of various metals in the sediment of the stream, thus removing them from solution.

According to data collected and analyzed by the Friends of the Nescopeck from sites throughout the Susquehanna River and Nescopeck and Little Nescopeck Creeks between November 1996 and January 1997 (Appendix D), sulfate, iron, manganese and calcium carbonate all underwent similar changes in concentration through the waterways (Figures D2-D6). At monitoring sites on the Little Nescopeck above the Jeddo Tunnel water quality analysis indicates normal conditions. At the Jeddo Tunnel outfall concentrations of measured parameters are extremely elevated. Throughout the remainder of the Little Nescopeck concentrations gradually decrease but remain well above toxicity levels. Water quality on the Nescopeck upstream from the Little Nescopeck confluence was normal, with measured concentrations resembling those on the Little Nescopeck upstream from the Jeddo Tunnel. Below the Little Nescopeck confluence, concentrations of the measured parameters were again dramatically elevated to nearly 50 percent of the levels measured in the lower Little Nescopeck, still being well above toxicity levels. This trend is exhibited in the Susquehanna River as well. Concentrations of sulfate, resulting in acidic conditions increase sharply below the Nescopeck Creek confluence from 14.25 mg/L to 76.17 mg/L (Figure D2). Calcium carbonate, associated with the River's ability to buffer acidic water, decreased from 28.33 mg/L to 19.50 mg/L (Figure D4). These conditions result in lowered pH in the Susquehanna River.

In Table 12 changes in Nescopeck Creek water quality are shown over a 3-year period between 1996 and 1998. In contrast to the Jeddo Tunnel outflow, Nescopeck Creek underwent an increase in acidity while pH and alkalinity were reduced. Total acidity was raised from 17.29 to 29.43 mg/L during the time period and alkalinity decreased slightly from 10.31 to 10.15 mg/L. The pH in Nescopeck Creek was reduced slightly from 4.99 to 4.81 between 1996 and 1998. As in the Jeddo tunnel outfall, specific conductance increased from 277.57 to 473.32 micromhos/cm and total, suspended and dissolved solids all decreased. All other measured parameters, excluding iron, which decreased, underwent significant elevations in concentration.

8.2 State of the Susquehanna and the Chesapeake Bay

The Susquehanna River is 444 miles long, has a 13 million acre drainage basin and contributes 19 million gallons of fresh water to the Chesapeake Bay every minute. Its watershed is the second largest in the eastern United States, encompassing more than half the state of Pennsylvania (Horton, 1991).

Though broad, the Susquehanna is not a deep river and is not suited to commercial navigation. Nevertheless people use the Susquehanna in a variety of ways: it turns turbines in several hydroelectric plants, cools the uranium rods in nuclear power plants, provides drinking water for millions, and is a recreation spot for canoeists and sport fishermen.

The Susquehanna's pollutants fall into three broad categories: nutrients, sediments and toxics. Nutrients include nitrogen and phosphorus, which are applied to crops in fertilizer and manure and can be found in the discharges of sewage treatment plants. Altogether, the nutrients that are introduced into the Susquehanna make up 21 percent of the phosphorus and 40 percent of the nitrogen that is found in the Chesapeake Bay (Horton, 1991). Once in the water, nitrogen and phosphorus can stimulate excess algal growth. As the algae die and settle to the bottom of the river or bay, they decay and consume the oxygen needed by fish and other aquatic life. Thick growth of algae also cuts down on the amount of sunlight in the water, which inhibits the growth of the submerged aquatic plants needed by animals for food and shelter.

The second major pollutant in the Susquehanna is sediment. The land in the lower Susquehanna basin is intensively farmed, and conventional tillage, where the soil is disturbed at the time of planting and harvesting, is a common practice. The net result of the associated erosion is an increase in sediment, which clouds the water, results in elevated water temperatures, blocks sunlight and cloaks fish spawning habitat in layers of silt.

In addition to excess nutrients and sediment, 12,531 pounds of toxic metals flow through the Susquehanna each day, according to the EPA's Chesapeake Bay management study (Report E1H98-03-0208-9100467, 1989). Toxic metals in the River include cadmium, chromium, copper, iron, manganese, nickel and zinc. Industry and municipal wastewater treatment plants discharge toxics including metals and chlorinated organic compounds into the water, while the atmosphere and urban storm water runoff from city streets can add lead and zinc to the toxic mix. Farms can also contribute toxics to the Susquehanna in the form of pesticides and herbicides.

The Acid Mine Drainage pollution of the Little Nescopeck Creek and the Nescopeck Creek is a significant factor in the degraded health of the Chesapeake Bay and the Susquehanna River. More than 70% of the pollution entering the Susquehanna River from the Middle Susquehanna Basin (where the Nescopeck and Little Nescopeck Creeks are located) is attributed to Acid Mine Drainage. Of this 70%, nearly 39% of the pollution is related to decreased pH and over 17% involves the addition of mining-associated heavy metals (www.srbc.net/subbasins). Specifically, the Jeddo Tunnel contributes 100,800 lbs. of acid/day to the Little Nescopeck, essentially all of which is received by the Nescopeck Creek. The Nescopeck in turn delivers nearly 90,000 pounds of this acid pollution into the Susquehanna River each day (Susquehanna River Basin Commission, 1973).

Figure 25. The Nescopeck Creek as it flows into the Susquehanna River near Berwick, Pennsylvania.

The rehabilitation of the Nescopeck and Little Nescopeck Creeks is one of many critical efforts underway to improve the state of the Chesapeake Bay. One of the greatest political challenges to the restoration of the Chesapeake Bay is that the water quality of Maryland's bay, and to a lesser extent Virginia's portion, is greatly affected by the principal river of Pennsylvania, which borders not one square foot of the Chesapeake. Large sections of the Bay's waters are not likely to respond adequately to cleanup efforts in Maryland and Virginia without help from Pennsylvania. Water quality trends to date in the Susquehanna range from quite modest improvements to worsening (Horton, 1991). The future of the Susquehanna cleanup and the Chesapeake's are heavily tied to success in controlling pollution in Pennsylvania's waterways.

8.3 Land Use

Upon visual observation of the entire Little Nescopeck Creek watershed, it can be concluded that predominant land uses include small to mid-sized agricultural lots and existing and future suburban housing developments. The area is also covered with several sections of woodlands and the Little Nescopeck and Nescopeck Creeks are well insulated by substantial riparian buffers nearly throughout their entire lengths.

Figure 26. The Little Nescopeck Creek is largely hidden from view by its substantial riparian buffer. Adopting ordinances protecting and enhancing vegetative buffers along the Creek will help ensure its protection from surrounding land uses.

8.3.1 Agriculture

Farming accounts for only about 15 percent of the land area in Luzerne County and has a less dominant role than industry in the general economy. According to the 1969 U. S. Census on Agriculture, both the number of farms and the commodities produced on farms are on the decline while the average size of farms is increasing (Luzerne County Soils Survey, 1992).

Forests and cropland represent more than half of the land in the watershed. Active farmland is found south of Route 80 on both sides of Route 81, predominantly to the west. East of Route 81, farmland is located outside the villages of Drums, Kis-Lyn and Saint Johns; west of Route 309 and adjacent to County Route 31. In recent decades, urban and suburban expansion has consumed prime agricultural land and pushed out farming activity to less productive areas. The result is decreased crop yield and increased erosion and sedimentation with adverse effects on water quality and supply. The region, therefore, has a need for strong local zoning and other farmland preservation programs to maintain agricultural resources and other green space within the watershed.

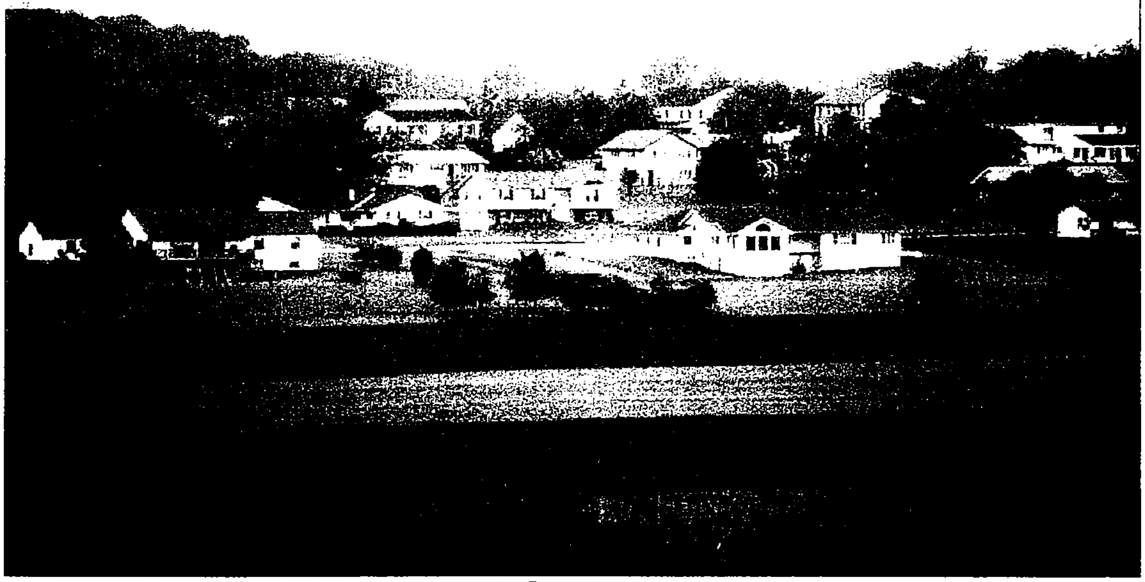

Figure 27. The Little Nescopeck Creek watershed is home to both fertile farmland, critical open space and suburban development.

Agricultural activities have generally resulted in encroachment on stream corridors with significant changes to the structure and mix of functions usually found in stable systems. In order to minimize the negative impacts of agriculture on the Little Nescopeck Creek, Best Management Practices (BMPs) should be implemented on existing farmland. Best Management Practices include streamside fencing, planting cover crops, maintenance of riparian buffers and nutrient management. Fencing livestock from streams keeps manure and urine out of the stream and prevents erosion of the banks that causes siltation. Planting cover crops such as winter rye or wheat or similar vegetation will help to hold soil in place during winter and will also remove nutrients left over in the soil after the primary crop is harvested. Establishing buffer strips of forest between farms and all waterways helps to stop runoff of nutrients and soil, shades streams so they do not get too hot and provides wildlife habitat. Practicing nutrient management is aimed at putting no more nutrients on the land than the crops can use and thus reducing pollution runoff.

Figure 28. This small tributary runs through agricultural areas before entering the Little Nescopeck Creek. One best management practice involves protecting a stream by excluding livestock and establishing buffer vegetation to filter runoff.

8.3.2 Suburban Development

The pressures of urbanization are stressing the watershed. Changes in land use have accompanied this population growth. Areas of forest as well as cropland and pasture have all decreased, while the amount of space taken up by homes and businesses increased. All of these kinds of land use, except uncut forests, contribute to river pollution.

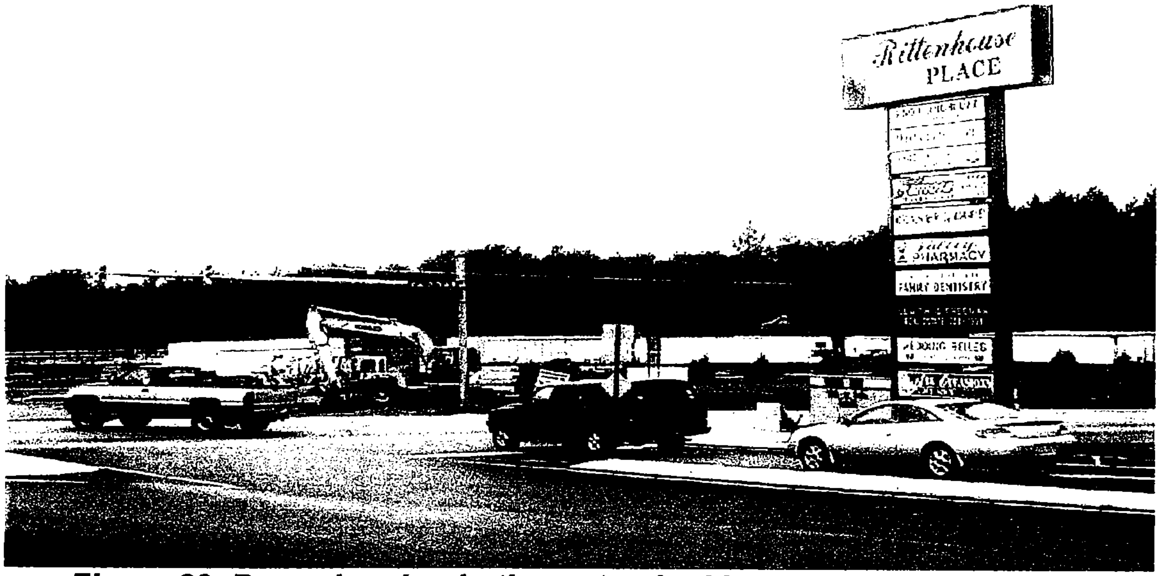

Figure 29. Poor planning in the watershed has resulted in sporadic development that is encroaching on the natural landscape instead of being focused around a central urbanized area.

Development within the watershed has led to pollution of groundwater resources through leaking septic systems or through the discharge of raw sewage during storm events directly into the stream due to overloaded sewage treatment plants and sewer lines.

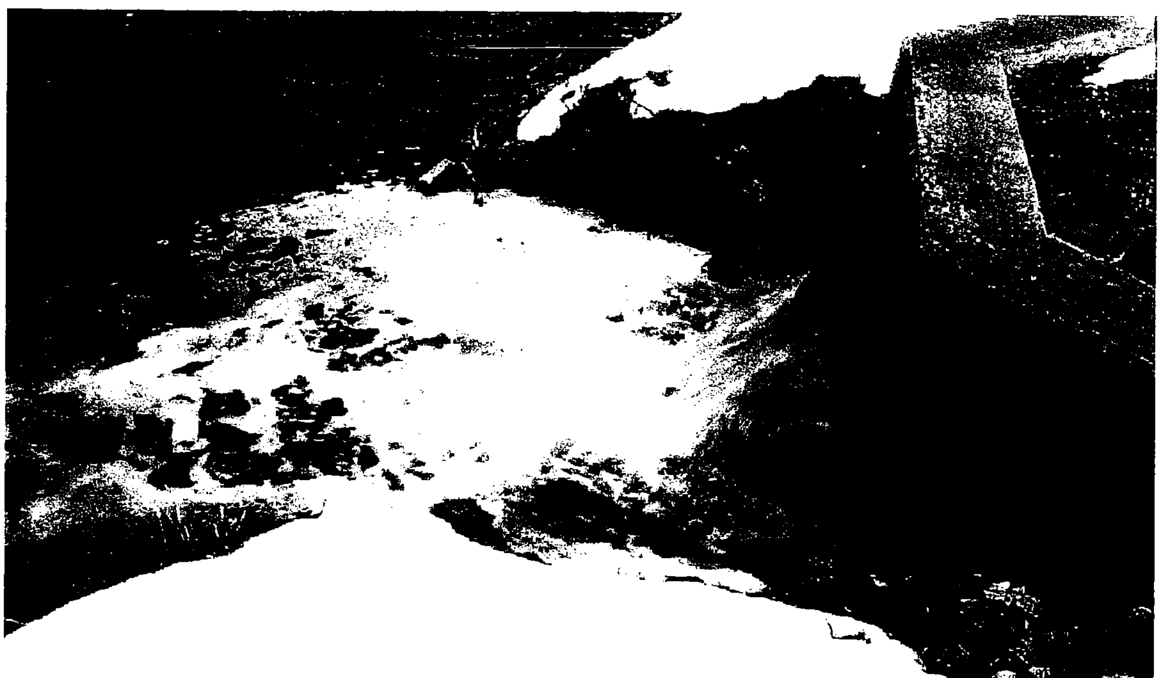

Figure 30. The Conyngham Borough Sewage Treatment Plant outflow as it enters into the Little Nescopeck Creek.

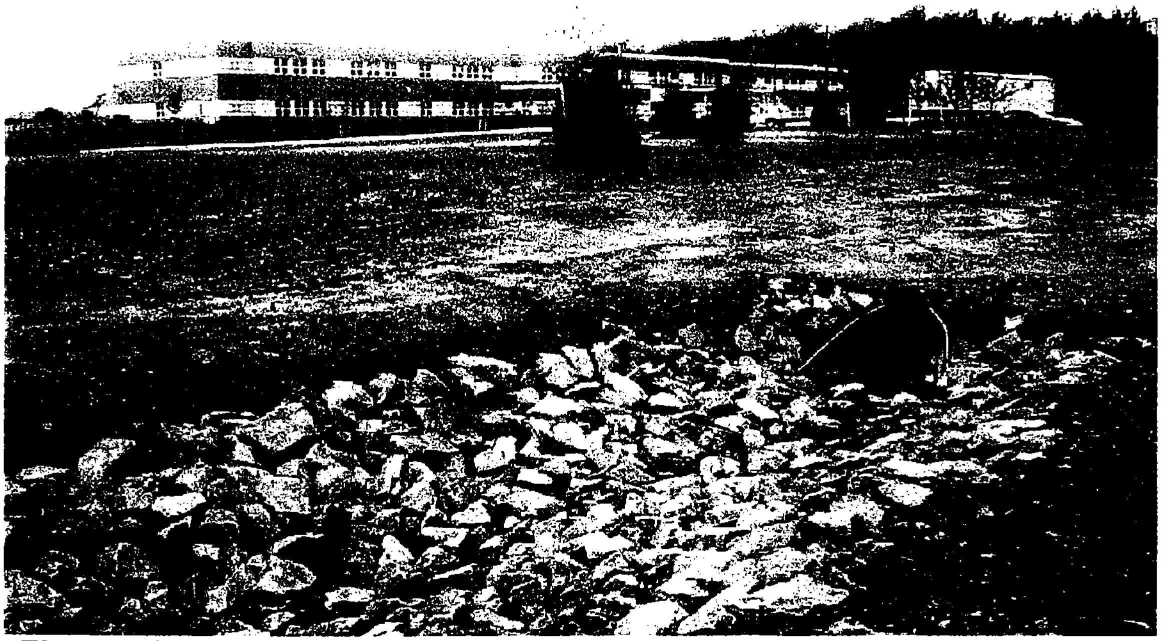

Figure 31. Storm water discharges are another symptom of development. This discharge from the newly constructed Drums Elementary School picks up great amounts of sediment and flows into the Little Nescopeck Creek.

The increasing level of suburban development (largely housing) is also increasing the level of non-point source pollution entering Little Nescopeck Creek (hydrocarbons, road silt, nutrient runoff, etc.). Table 13 lists the population growth and decline of townships and other municipalities in the study area.

Figure 32. New suburban developments are being planned and constructed throughout the once open spaces of the watershed.

Table 13. Population Growth and Decline in the Watersheds

	1970	1980	1990	1998
Little Nescopeck Creek Watershed				
Butler Township	3762	5537	6020	6180
Sugarloaf Township	2035	3202	3534	3722
Conyngham	1850	2242	2060	1979
Jeddo Tunnel Watershed				
Foster Township	2594	3258	3371	3429
Hazle Township	7691	9495	9323	9283
Freeland	4784	4285	3909	3522
Nescopeck Borough	1897	1768	1651	1511
West Hazleton	6059	4871	4136	3775

A concern of Wildlands Conservancy is that if the Little Nescopeck Creek is restored to a more pristine state, development will quickly follow. In its present state, the Little Nescopeck remains largely avoided by development. But, the municipalities of the watershed desire improved water quality because they believe it would tend to support higher-quality residential development. Increasing residential development is considered desirable to the municipalities of the watershed because they have no industrial base and a very limited commercial base and must therefore expand their residential tax base in order to remain viable.

Because of the existing impairments to the Little Nescopeck Creek, there is currently little incentive to maintain the land along its banks, which has left its invaluable riparian zones largely intact. Watershed municipalities believe that improved water quality would stimulate improved maintenance along banks and result in a higher quality environment. In contrast, Wildlands Conservancy and environmental groups like Friends of the Nescopeck would like to conserve and enhance the natural state of the stream corridor because of the numerous benefits to water quality it provides.

8.3.3 Woodlands

Forested lands of the watershed result in cleaner, clearer water flowing through the creek than any other use to which we put land. The amount of forested land in the watershed is on the decline, falling to both development and agriculture, and there are no prospects in the foreseeable future for reversing it (Horton, 1991).

Although more woodland is always better than less, the location and distribution of those woodlands is perhaps more critical than overall acreage. Forests growing between streams and land uses like farms and developments will trap, filter and detoxify runoff before it reaches the water. In addition, and perhaps most importantly to the Little Nescopeck, they appear to increase the pH of the runoff. These streamside locations are where forest has the greatest beneficial impact on water quality (Horton, 1991).

Luzerne County originally had a dense cover of trees, but clearing for housing and farming and cutting for commercial purposes eliminated all virgin stands. Now the woodland, which occupies 74 percent of the land area, consists of second- and third-growth stands (Luzerne County Soil Survey, 1992).

Almost one-half of the Little Nescopeck Creek watershed consists of wooded lands. They cover essentially undeveloped areas outside of farms and urbanized lands. Woodland is associated with the mountainous region north of Route 80 and east of Route 309 and to a lesser degree in the southwest corner adjacent to Route 81. Woodland areas provide a varied and rich environment of many kinds of plants and animals. They protect and conserve important resources such as aquifers and soils and act as buffers to the sights and sounds of urbanization. Woodlands also provide attractive aesthetic value. The Nescopeck and Little Nescopeck Creeks are almost entirely surrounded by woodland riparian buffers that span up to 500 feet on either side, causing the creeks to be predominantly hidden from view and buffered from NPS pollution.

8.3.4 Surrounding Landscape

The area outside the Little Nescopeck watershed around Hazleton dramatically illustrates the differences in landscape, human settlement and modern lifestyles between the lands scarred by mining and those lands left undisturbed.

The low rolling Pocono Mountains of the north were originally covered with tremendous white pine, oak and other hardwoods. These have been lumbered off or killed by pollution and the landscape has been churned as a result of deep mining, and more recently strip mining. There are mining waste piles near every underground source of coal. The State's Department of Environmental Protection estimates that there are nearly 6000 abandoned mine sites. Now the culm piles support only birch and aspen trees that tolerate the unfriendly soils.

Coal and transportation companies claimed land in the anthracite regions in huge blocks. Housing was built, frequently by the companies, in concentrated communities so as to stay clear of the mining operations. The houses in sections of a town tend to be similar, reflecting company policy and the close dates of construction. Only with the decline of coal mining have homes spread out along the roads. The underground coal mining operations determined the town layout of Hazleton. Outside the town vast open landscape is still uninhabited, but controlled by the coal and transportation companies and their successors.

With the decline of the anthracite industry and the move from deep mining to surface strip mining, the landscape has shouldered the brunt of the damage. Huge culm banks, abandoned and rusting breakers, trucks and equipment, and city trash now litter the area. Many once-active railroad right-of-ways have been abandoned and await rails-to-trails conversions.

The southern region was settled in farms of 100 to 500 acres. The towns were located at the junction of transportation routes. As the population grew, the farms were broken up first by selling off house lots along roads and then by turning acreage over to tract developers. Thus, housing tends to sprawl over the landscape.

8.3.5 Current Mining Activity

Rehabilitation of the landscape surrounding the Little Nescopeck Creek watershed and the Little Nescopeck and Nescopeck Creeks themselves depends heavily on the present and future mining activities to the south. There are 21 permitted anthracite-mining operations in the Jeddo Tunnel watershed, 18 of which are active (Figure 33 and Table 14). The active operations consist of eight surface mining operations and 10 refuse-reprocessing operations. The remaining operations are either inactive or have not yet started. There are no active underground mines in the Eastern Middle Anthracite Field.

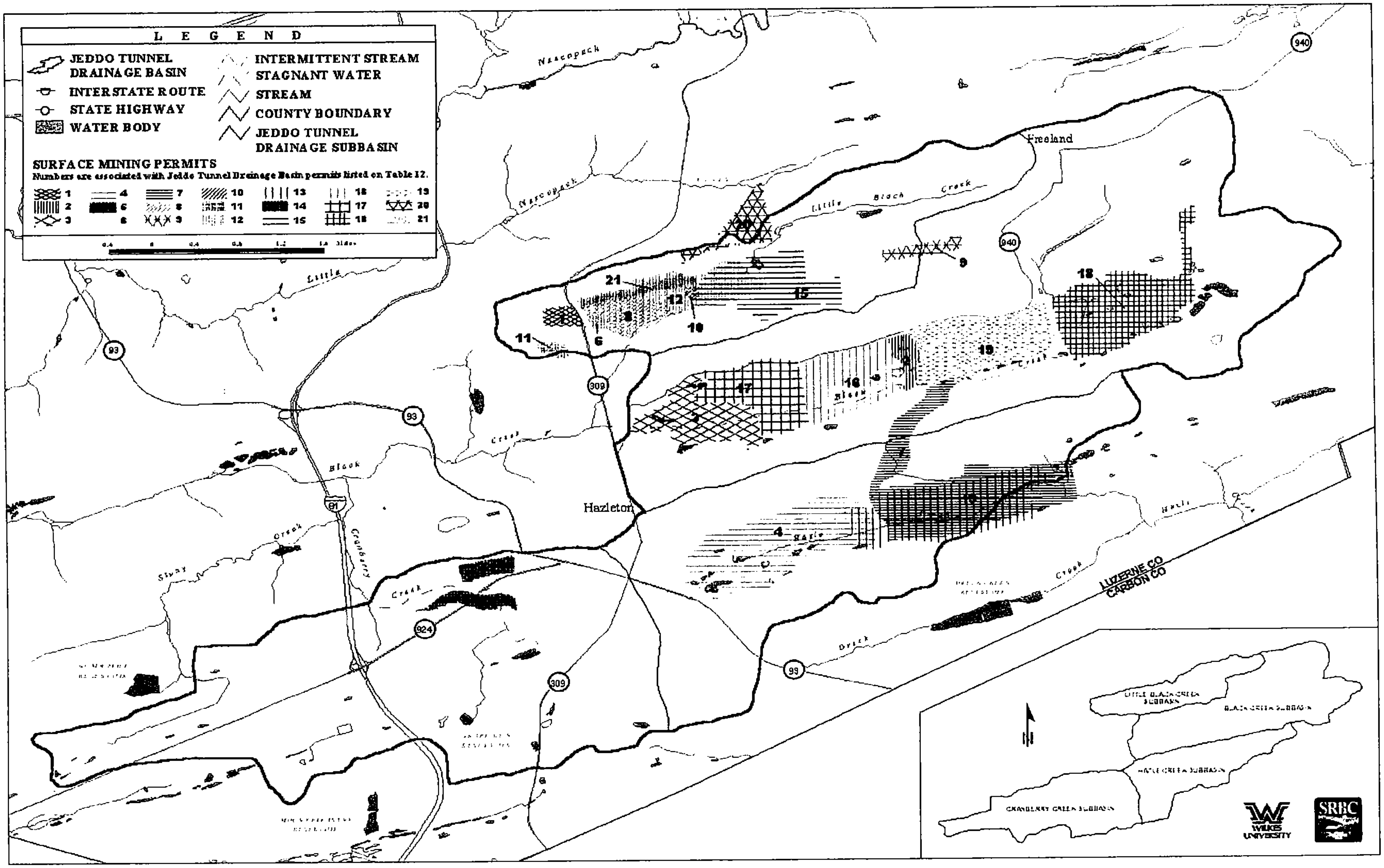

Figure 33. Locations of Current Surface Mining Permits.

Table 14. List of Mining Permits in the Jeddo Tunnel Basin.

Area Number	Name of Operator	Permit Number	Company
1	JMW-Milnesville No. 7 Op.	40980104	JMW Enterprises, Inc.
2	Jeddo Highland Basin West	40663027	Jeddo Highland Coal Company
3	Jeddo Highland Jeddo H7	40663013	Jeddo Highland Coal Company
4	Hazleton Shaft West Op.	40663023	Pagnotti Enterprises, Inc.
5	Jeddo Highland Cranberry	40793211	Jeddo Highland Coal Company
6	Lattimer Refuse Bank (Diamond)	40940202	Diamond Coal Company
7	Gowen Mine Stockton Op.	40663024	Coal Contractors, Inc.
8	Lattimer Plant Op.	40830202	Rossi Excavating Company
9	Drifton West Op.	40890101	Brook Contracting Corporation
10	Lattimer Center Bank	40910201	Diamond Coal Company
11	Milnesville Mine Op.	40930201	Lonzetta Trucking Company
12	Lattimer Basin Mine	40930102	Diamond Coal Company
13	Stockton Strip Mine	40743011	Diamond Coal Company
14	Hardwood Refuse Bank	40980201	Bonner Shale Company
15	Continental Mine Oper.	40930202	Rossi Excavating Corporation
16	Jeddo C.R.D.A. No. 2	40663026	Pacton Corporation
17	Jeddo C.R.D.A. No. 1	40663025	Pacton Corporation
18	Highland S. Mine Op.	40663029	Pagnotti Enterprises, Inc.
19	Jeddo Basin East	40663028	Pagnotti Enterprises, Inc.
20	Kelly No. 1	40850103	Kelly Investors, Inc.
21	Penny's Bank	40840203	Rossi Excavating Corporation

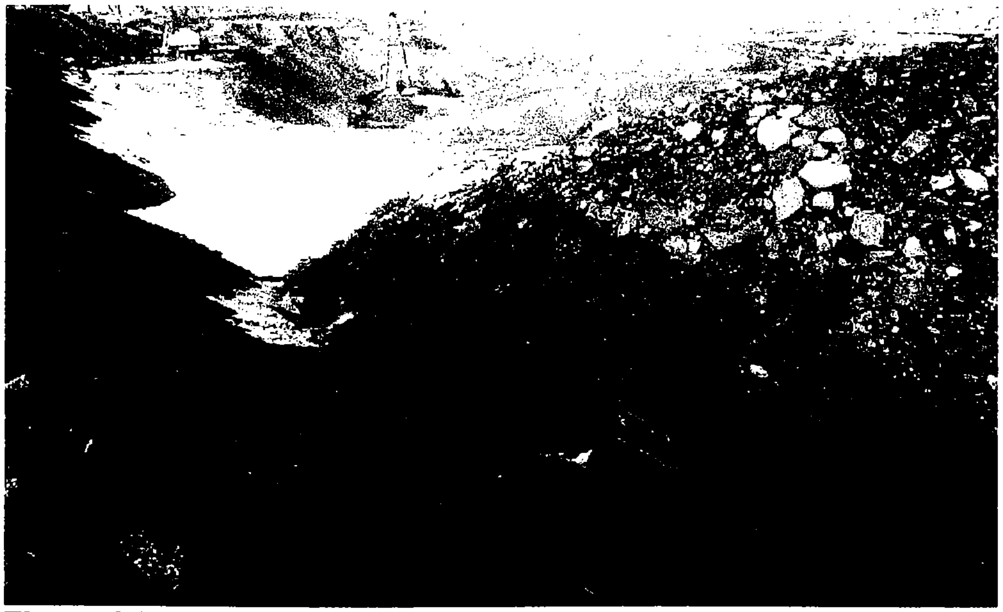

Figure 34. All current surface mining activity in the Jeddo Tunnel watershed involves remining.

All current mining operations will be reclaiming open pits in accordance with their permits. Additionally, the plans for reclamation indicate two operators also will reestablish parts of Hazle Creek and Jeddo Highland Cranberry Creek (Colleen Stutzman, Pa. DEP-Pottsville, written communication).

The Jeddo Tunnel system accepts surface- and groundwater drainage from Hazleton and several surrounding small mining communities. The majority of correctable flow to the tunnel system occurs through several large sinks and open shafts and breached or discontinuous perimeter drains. To effectively remediate the impacts of the Jeddo Tunnel discharge, there has to be a clear understanding of the current environmental conditions of the drainage area in which the tunnel receives its water. This was accomplished through background literature research, aerial photography, existing mapping, water quality data collection and field reconnaissance as part of the Wildlands/SRBC Assessment.

8.3.6 Current Areas of Remediation

The Wildlands/SRBC investigation, with field observations from Bloomsburg University, of the Jeddo Tunnel system identified several areas of immediate concern. Some actions already have been taken during the study period to reduce the impact of these areas on the Jeddo Tunnel system (Wildlands/SRBC Report, 1999).

Blackwater discharges — An active mine operator was identified as contributing to the "blackwater discharges" from the Jeddo Tunnel in 1998. Pa. DEP Pottsville District Mining Office investigated and took compliance and enforcement actions that resulted in remedial water-handling measures. These actions have been largely successful.

As an outgrowth of the investigation at coal preparation sites, one of the operators entered into a Reclamation in-lieu of Civil Penalty Agreement that resulted in the abatement of a subsidence area identified during field reconnaissance. With the abatement project completed and improved water handling procedures in place, the intensity and duration of blackwater discharges has been reduced dramatically.

Perimeter drain near Humboldt — An existing perimeter drain runs on the north side of the Western Hazleton Coal Basin. This channel is intact and transports water until it gets to P-148, the access road to the Hazleton Reservoir. No culverts had been installed under the road and the water entered sinks at P-456 and P-161.

At this location, 30 feet of culvert was installed to channel the water under the road connecting the western and eastern segments of the perimeter drain. This project, which cost approximately $7500, is largely successful. The perimeter drain along the northern side of the Western Hazleton Coal Basin now effectively transports water out of the Jeddo Tunnel Basin. Further work, including lining the existing channel in the area of restoration, is planned for this site.

Black Creek channel from Pa. Route 940 eastward — The existing Black Creek channel is restricted in certain locations and does not allow for positive drainage. The blockages from a 1000-foot section of this channel were removed. This restoration project has allowed water in Black Creek to effectively exit the Jeddo basin.

8.3.7 Priority of Remediation Options

To facilitate mining, extreme measures were taken to keep water out of the deep mines. This was accomplished by several means. Side hill ditches were constructed to catch runoff from the hillsides and direct it away from the mined areas. Log or steel flumes were constructed to carry surface water over and around the mined areas to reduce the amount of water infiltrating to the deep mines. Additionally, gravity drainage tunnels were constructed to dewater deep anthracite mine workings.

During the peak of anthracite deep mining, these devices were constructed and maintained to transport surface water out of the basin and prevent it from entering the mine workings. Since the collapse of the deep mining in the Eastern Middle field in the 1950s, many of these devices were removed or currently do not function.

Several continuous perimeter drains still exist in the Jeddo Tunnel Basin. Others are discontinuous, breached by sinks or otherwise truncated. Field reconnaissance completed for this project traced several of these channels and identified sinks where surface water directly enters the mines. To reduce the amount of water entering the mines, there is a need to reestablish perimeter drains, construct new channels outside mined lands, connect discontinuous drainageways, improve these drains by reducing the potential for infiltration, and fill and seal closed depressions in the land surface caused by internal collapse (sinks).

Field reconnaissance conducted by Wildlands Conservancy documented hydrologic features and problems, including the source and destination of storm water, sewage and local runoff within the Jeddo system and possible sources of "blackwater" events. Global positioning system (GPS) technology for accurate location data and geographic information system (GIS) analysis of hydrologic features was subcontracted through Wilkes University. SRBC used USGS streamflow data, available local precipitation data, estimated areas draining to the Jeddo Tunnel and flow measurements of larger surface flows to develop a hydrologic budget. Potential sites for flow measurements where flow entering the mines could be diverted were identified and methods to reduce direct infiltration to the mine drainage system were identified (Dr. Duane Braun, Bloomsburg University, written communication, April 1997). This information was analyzed by the Conservancy and Pa. DEP in order to determine what and where restoration options should occur.

To facilitate the restoration of the surface-water drainage system in the Jeddo Tunnel watershed, sites were grouped according to coal basin and ranked according to overall environmental benefit, once restoration is complete. The criteria were the amount of water entering the mines at the site; the size of the drainage area contributing to the site; water quality, with regard to sewage; and the amount of earth moving required for remediation. The ranking system does not consider property ownership or current mining status.

The ranking takes into account the current adverse environmental impact to the Jeddo Tunnel discharge and, consequently, the overall benefit from the proposed remediation option. During the ranking process, each subbasin was evaluated holistically, and the most effective sequence of actions is proposed. This is necessary because many of the remediation options listed depend on other sites of remediation taking place first, the goal being to establish an effective channel network for draining surface water out of the Jeddo Tunnel Watershed.

These specific remediation options are detailed and mapped in Appendix A and are grouped by sub-basin. In addition to the restoration of these particular sites, the following activities should be completed:

- Remining and reclamation of abandoned mine lands causing AMD;
- Use of Title IV and other SMCRA funding to reclaim priority sites that are causing AMD;

- Use of forfeited reclamation bonds to reclaim those sites, and Reclamation In-Lieu of Penalty funding from active industry;
- Increase public awareness through local environmental organizations;
- Use of partnerships to facilitate and monitor restoration activities;
- Selection of proven and innovative technologies to reduce the pollutant loads of the Jeddo Tunnel discharge; and
- Prevention of the sewage inflow into the Jeddo drainage system.

With the completion of the above-mentioned activities, the impact of the Jeddo Tunnel discharge on its receiving stream should be reduced dramatically.
In an effort to examine local municipality issues, Wildlands Conservancy held individual meetings with Sugarloaf and Butler Townships and Conyngham Borough throughout the summer of 2000. While each of the municipalities expressed general support for the clean-up effort of the Little Nescopeck Creek, some concerns and issues were expressed.

8.4 Municipal Concerns

In an effort to examine local municipality issues, Wildlands Conservancy held individual meetings with Sugarloaf and Butler Townships and Conyngham Borough throughout 2000. While each of the municipalities expressed general support for the clean-up effort of the Little Nescopeck Creek, some specific concerns and issues were expressed.

<u>Stormwater Management</u>

Because there are several stormwater problems currently existing in the watershed, any plan involving the Little Nescopeck Creek should be evaluated with respect to its effect on stormwater. Concerns about the nature and degree of any possible stormwater problems that may result in the municipalities lower in the watershed from upstream improvements. Municipalities of the watershed believe a comprehensive stormwater study would be of enormous value.

<u>Financial</u>

Watershed municipalities feel that fiscal constraints would seriously limit municipal involvement in any restoration projects.

<u>Tributaries</u>

Any plans involving the Little Nescopeck Creek would also need to address the pollution introduced by several tributaries within the watershed.

<u>Feasibility</u>

There is a certain amount of skepticism about the possibility of restoring the creek in a cost-effective manner and within a realistic time frame. Municipalities are also skeptical about the effectiveness and capability of current technology.

9.0 MANAGEMENT OPTIONS

9.0 MANAGEMENT OPTIONS

The recommendations that follow have been based upon the preliminary findings from literature reviews, field and laboratory studies and suggestions and concerns broached by municipal leaders, conservation groups and other interested organizations and individuals.

These recommendations were also developed in accordance with the primary goals of the Little Nescopeck Watershed project. Those goals were to restore physical and biological health of the creek; establish management practices to prevent additional degradation of the stream; to preserve critical cultural and natural resources within the watershed and to have Little Nescopeck Creek listed on the Pennsylvania Rivers Conservation Registry.

Due to the wide variety, broad scope and large scale of several potential projects and suggested recommendations, it should be recognized that this is a long-term plan for remediation and ongoing management of the watershed. In order to facilitate implementation, an action plan containing a list of projects selected from the following recommendations along with possible implementation dates has been devised.

GOAL 1. IMPROVE WATER QUALITY IN THE LITTLE NESCOPECK CREEK AND ITS TRIBUTARIES

Objective 1.1 Abate Abandoned Mine Drainage

⇒*To improve the water quality of the Little Nescopeck Creek watershed, the Jeddo Tunnel Mine Discharge must be significantly reduced by discharge volume and discharge loads.*

Recommendation: Use Innovative Technologies to Treat Abandoned Mine Drainage.

Recommendation: Establish an effective channel network for draining surface water out of the Jeddo Tunnel watershed.

▶During field investigations by Wildlands Conservancy and Susquehanna River Basin Commission and Bloomsburg and Wilkes Universities, points of interest were identified within each coal basin that could potentially reduce the infiltration to the underground workings drained by the Jeddo Tunnel. Specific rehabilitation plans for these sites are contained in the report on the Jeddo Tunnel and are also listed in this management plan. Restoration of these sites includes:

- Re-establishing perimeter drains
- Constructing new channels outside mined lands
- Connecting discontinuous drainage ways
- Improving these drains by reducing the potential for infiltration
- Filling and sealing closed depressions in the land surface caused by internal collapse

Recommendation: Restore Mine Scarred Land.

►Remine and reclaim abandoned mine lands that cause Acid Mine Drainage. Reclamation projects include closing and backfilling mine openings, backfilling open pits and eliminating dangerous highwalls.

►Use Title IV and other SMCRA funding to reclaim priority sites that are causing Acid Mine Drainage. Title IV of the Surface Mining Control and Reclamation Act of 1977 is a federal grants program available from the U. S. Department of the Interior, Office of Surface Mining Reclamation and Enforcement (OSM).

►Use forfeited reclamation bonds to reclaim those sites, and Reclamation In-Lieu of Penalty funding from active industry. Bond forfeiture is the final enforcement action against an operator who is unwilling or unable to complete the reclamation of a site. During bond forfeiture, the government assumes the responsibility of reclaiming the mine and the operator permanently loses mining privileges.

Objective 1.2 Abate Agricultural Non-Point Source Pollution

Recommendation: Apply Best Management Practices to Keep Agricultural Pollutants Out of Waterways.

Recommendation: Apply Best Management Practices to Reduce Nutrients Being Applied to Agricultural Land.

Recommendation: Apply Appropriate Best Management Practices to the Agricultural Lands Along the Little Nescopeck Creek.

- Plant riparian buffers on the farms that are significant sources of erosion and sedimentation.
- Construct cattle crossings and streamside fences on farms where animals have unrestricted access to waterways.

Objective 1.3 Control Urban Non-Point Source Pollution

Recommendation: Utilize Non-structural Methods to Control Urban Runoff.

►Land use controls may be necessary along with structural measures in order for a jurisdiction to meet its water quality goals.

►Land use controls can be a cost-effective means to control urban runoff. They have a maintenance cost/multiple use advantage over structural BMPs in many cases and should be employed in redevelopment situations where appropriate.

►Strategies for implementing land use controls may include limits on impervious surfaces, encouragement for the preservation of open space, and promotion of cluster development.

►The use of nonstructural best management practices for controlling urban non-point source pollution can also be required as a condition of development approval.

►Use public rights-of way as an opportunity for runoff controls such as wet ponds, vegetated swales or meandering vegetated channels. This would include the use of land under bridges and overpasses, the median strips of roads and highways, and the exit ramp rights-of-way off major roads.

►Use zoning to control the type of development or redevelopment allowed within community boundaries. Examples of zoning controls that can be used to protect water resources include:

- cluster development: constructing dwellings close together to preserve open space
- down-zoning: changing an established zone to require a lower density
- conditional zoning: allowing certain activities only under specified conditions that protect water resources
- overlay zoning: placing additional zoning requirements on an area that is already zoned for a specific activity of use; through the use of resource overlay zoning, high pollution activities can be controlled in sensitive areas
- open space preservation: protecting open space and buffer zones near water bodies, i.e. greenways or riparian corridors

Objective 1.3 Control Urban Non-Point Source Pollution

Recommendation: **Utilize Non-structural Methods to Control Urban Runoff.**

►In areas where impervious materials cover almost one hundred percent of the surface, conventional BMPs requiring large amounts of land and good soil conditions are usually not feasible. These types of BMPs include dry ponds, wet ponds, constructed wetlands and various sorts of infiltration devices.

►On sites where standard BMPs are not feasible, consider the use of unconventional or innovative BMPs sometimes known as "ultra-urban" BMPs.

These systems are designed to function by gravity flow between components. They include:

- Sand filtration systems
- Underground sand filters consisting of multiple chambers
- Surface sand filters such as double trench systems
- Peat/sand filtration systems

Recommendation: Make Funding Available to Ensure the Proper Maintenance and Operation of Sewage Treatment Facilities within the Little Nescopeck Creek Watershed.

►Funding should be made available to access current sewage collection systems in order to reduce leakage and infiltration.

Recommendation: Encourage Municipalities to Adopt Sewage Management Programs for Areas with High Potential for On-lot Systems.

Recommendation: Promote Proper Operation and Maintenance Practices for On-lot Septic Systems.

Recommendation: Provide Educational Opportunities for Owners of On-lot Septic Systems.

Recommendation: Provide Funding to Conduct Workshops for On-lot Septic System Owners About Proper Maintenance and Cleaning Procedures.

Recommendation: Provide In-stream Habitat Improvements to the Little Nescopeck Creek and its Tributaries Where Necessary.

Recommendation: Replace/Revise Improper Stream Devices and Management Practices throughout the Little Nescopeck Creek and its Tributaries.

Objective 1.4 Revise Storm Water Management Practices

⇒ *In addition to protecting the Little Nescopeck Creek, reducing frequency and magnitude of flood damage is a major concern to the watershed. Rapid population growth and increased development have led to the disturbance and alteration of the Little Nescopeck Creek watershed and floodplains. While flooding is a natural event, alteration of the watershed has increased both the frequency of and the damage caused by flooding. Minimizing the adverse impacts of flooding occurrences is a realistic goal.*

Recommendation: Implement Best Management Practices for Controlling Stormwater Quantity and Quality.

►Properly managing the quality of stormwater runoff is equally as important as managing the quantity of runoff and is strongly advised. Following BMPs for stormwater quality and quantity management would:

- Protect Little Nescopeck Creek from the damaging impacts of stormwater runoff directly entering the stream,
- Improve water quality of Little Nescopeck Creek by improving quality of stormwater discharges
- Reduce frequency and magnitude of flooding events, and
- Minimize potential flood damage and cost.

Recommendation: Direct Discharges from Storm Drains to Little Nescopeck Creek Should be Avoided at All Cost. Also, Permeable Surfaces Should be Preserved Whenever Possible, as they Will Absorb Overland Flow, thus Distributing the Peak Discharge Over a Greater Length of Time at a Lower Stream Height.

Recommendation: Storm Water Runoff Should be Converted to Sheet Flow Over a Porous Medium or Channeled to an Infiltration Structure, Such as a Sedimentation Pond or Trench that Directs Runoff into the Ground Rather than Directly into the Little Nescopeck Creek.

► Directing water through or over a porous medium that is naturally vegetated would not only increase infiltration, but also filter out pollutants and cool the water before it enters the creek. This process would greatly reduce non-point source pollution and thermal pollution typically caused by stormwater runoff. If natural areas are not available for stormwater management purposes, infiltration structures are recommended.

Recommendation: Implement Stormwater Best Management Practices. Some of these Practices Include:

- Replace existing open throated city inlets.
- Maintain and inspect detention basins.
- Implement regular street sweeping and leaf removal.
- Clean stormwater inlets and catchment basins.
- Monitor and control pollutants from permitted sites.
- Clean-up snow dump sites.
- Review BMPs on an annual basis.

►In order for best management practices to be successful in the long term, they must be re-evaluated to see if they are still effective, need modification, need updating, etc. Consideration must also be given to adding new BMPs or possibly deleting nonproductive BMPs.

Objective 1.5 Restore and Establish Riparian Buffers

Recommendation: Devising or Adopting an Ordinance Such as the "Riparian Corridor Conservation District, 1995" Created by the Montgomery County Planning Commission is an Excellent Way to Approach Restoration of Riparian Buffers.

Recommendation: Provide Educational Programs and Opportunities for Land Owners to Learn About the Benefits of Riparian Buffers and How they Improve Water Quality.

Recommendation: Provide Technical Assistance to Land Owners for Dealing with Riparian Issues and Encourage Voluntary Planting of Streamside Vegetation.

Recommendation: Use Public Lands to Demonstrate Proper Riparian Buffer Management.

Objective 1.6 Increase Public Involvement in Non-Point Source Pollution Control

Recommendation: Expand Opportunities for Public Involvement in Non-point Source Control.

►Over the past 25 years, communities have played an important role in addressing non-point source (NPS) pollution, the Nation's leading source of water quality problems.

►Coordinate with federal, state and local environmental programs and initiatives to increase the success of community-based NPS control efforts.

►To learn about and help control NPS pollution, local citizens should contact the community-based organizations and environmental agencies in their area. These groups often have information about how citizens can get involved in NPS control activities.

Recommendation: Expand Volunteer Monitoring.

Recommendation: Provide Resources and Technical Assistance to the Retired Senior Volunteer Program (RSVP) and the Environmental Alliance for Senior Involvement (EASI) Monitoring Programs.

►Organize local groups of volunteers of all skill levels to gather water quality data. This information can help the government agencies understand the magnitude of NPS pollution.

Recommendation: Promote Ecological Restoration Projects.

►Provide ecological restoration opportunities for the public to help out with a wide variety of projects, such as tree planting and bank stabilization in both urban and rural areas. Restoration efforts should focus on degraded waters or habitats that have significant economic or ecological value.

Recommendation: Increase Educational Activities.

►Integrate NPS pollution curricula into classroom activities. The U.S. Environmental Protection Agency (EPA), federal and state agencies, private groups and nonprofit organizations offer area educators a wide variety of materials.

►Students can start on an NPS control project in the primary grades and carry their work through to the intermediate and secondary levels.

Recommendation: Conserve Water.

►Using technologies that limit water use in the bathroom, kitchen, laundry room, lawn, driveway and garden can reduce the demand on existing water supplies and limit the amount of water runoff. Government agencies, utilities and hardware stores have information about products that help households conserve water.

Recommendation: Manage Household Water.

►Learning to limit NPS pollution at the household level can reduce the overall impacts of NPS pollution on water quality.

►Households can irrigate during cooler hours of the day, limit fertilizer applications to lawns and gardens and properly store chemicals to reduce runoff and keep runoff clean.

►Households can replace impervious surfaces with more porous materials.

► Chemicals and oils should not be poured into sewers, where they can result in major water quality problems.

►Pet wastes, a significant source of nutrient contamination, should be disposed of properly.

Recommendation: Increase Involvement in Public Meetings and Hearings.

►Decisions made during public hearings on stormwater permitting and town planning can determine a community's capability to manage NPS pollution over the long term. Laws or regulations may require federal, state or local agencies to hold public hearings when permits are issued or when town plans are formed. Notices about hearings often appear in the newspaper or in government office buildings.

Recommendation: Form Community Organizations.

►Form community organizations to protect local natural resources. These community-based groups provide citizens with information about upcoming environmental events in their watershed, such as ecological restoration, volunteer monitoring and public meetings.

Recommendation: Provide Funding and Technical Assistance to Friends of the Nescopeck and other community groups dedicated to the Little Nescopeck Creek Watershed.

►Watershed-level associations are particularly effective in addressing a wide range of NPS pollution problems.

GOAL 2. PRESERVE AND PROTECT SIGNIFICANT AND VALUABLE LAND RESOURCES

Objective 2.1 Preserve Farmland and Open Space

⇒ *The Little Nescopeck Creek watershed is home to both fertile farmland and critical open spaces. Preserving these valuable resources should be a top priority and many government programs and land trusts exist to provide assistance for preservation activities.*

Recommendation: Utilize the Following Conservation Techniques to Preserve Farmland and Critical Open Space.

- ❑ Agricultural Conservation Easement—a permanent legal agreement between a landowner and a governmental agency or nonprofit land trust that stipulates that the land must always be available for agricultural use

- ❑ Agricultural Security Areas—participating farmers are entitled to special consideration from local and state governing bodies, thus encouraging the continuing use of the land for productive agricultural purposes.

- Bargain Sale—sale of land or an easement to a nonprofit land trust, a governmental agency or a municipality at a negotiated price less than the fair market value. Seller may obtain certain tax advantages in such a transaction.

- Conservation Easement—the same as an agricultural easement, but emphasis may also be on open space, historic and scenic values and wildlife conservation, as well as on the protected farmland. Landowners may obtain certain tax advantages in such a transaction.

- Clean and Green—a law allowing farmers and landowners to be assessed and taxed on the actual-use value of the land as opposed to the highest-and-best use.

- Limited Development—a concept where a farmer/landowner develops a relatively small portion of his/her land while preserving the major portion by means of a donation of land or conservation easement.

- Purchase of Development Rights (PDR)—the acquisition of the right to develop a landowner's land by a public corporation, government agency or nonprofit trust. Once development rights are sold, a conservation easement is placed on the property.

- Transfer of Development Rights (TDR)—a program in which local governments have the authority to provide for the transfer of development rights from one portion of the community to another portion of the community.

Recommendation: Municipal and County Governments Should Designate Funds to be Used to Purchase Development Rights From Interested Landowners Who Own Property Either Immediately Adjacent the Little Nescopeck and its Tributaries or Adjacent to Preserved Farms and Parkland in Order to Create Large Continuous Blocks of Preserved Land.

Recommendation: Municipal and County Governments Should Work to Educate Landowners About Land Preservation Options.

► In order to benefit from financial assistance programs for farmland and open space preservation, it is critical to improve communication between the agricultural and land owning community and the appropriate agencies to find the sources of funding for acquisition and preservation of these valuable resources.

Recommendation: Wildlands Conservancy, the Bureau of Farmland Protection and the Land Trust Alliance Should Make Information About Farmland Preservation to Watershed Land Owners.

Recommendation: Support the Reuse and Revitalization of "Brown Fields" in the Little Nescopeck Creek Watershed.

Objective 2.2 Preserve Wetlands

⇒ *Wetlands are a very sensitive part of the ecosystem and perform many functions that benefit the Little Nescopeck Corridor. Most of the wetlands within the Jordan watershed are small in size and are therefore often overlooked during development planning. Studies in recent years have found that wetlands are a critical part of the ecosystem that, if managed properly, can provide many benefits for the community.*

Recommendation: Preserve and/or Protect the Wetlands of the Little Nescopeck Creek Watershed.

Recommendation: Municipalities Should Implement Wetland Buffer Ordinances.

▶Better compliance with wetland regulations is needed to protect these highly sensitive areas. Regulations currently exist to protect wetlands from construction and development. Once a wetland is lost or destroyed, it is gone forever. "No net loss" practices, which require the construction of new wetlands to replace those that have been destroyed, are not sufficient to preserve the benefits that were originally provided. Artificial wetlands often do not have the same hydrologic properties and vegetative species of the destroyed wetland, thus limiting the functions of the new wetland and not achieving the objectives of the "no net loss" philosophy.

Recommendation: Gain Support to Save Wetlands From Development by Educating the Community on the Benefits they Provide.

Recommendation: Wetlands Should be Incorporated into Development Plans as Scenic or Passive Recreational Space and Special Care Should be Devoted to Ensure that the Natural Functions of the Wetland are Not Disturbed.

Objective 2.3 Revise Municipal Ordinances

⇒ *The creation or adoption of ordinances structured to encourage stewardship of watershed resources, protect wellhead areas, and limit land uses and activities within stream corridors and floodplains, would make great strides toward achieving the goal of preserving valuable stream resources. These ordinances would serve to preserve such resources as water supplies, wooded regions, wildlife, and aquatic habitats.*

Recommendation: This Riparian Ordinance is Preferred and Recommended Over Revisions of Current Floodplain Provisions as it Provides Better Protection for the Floodplains of the Little Nescopeck. This Ordinance Would Apply Regulations to Enhance and Preserve Vegetative Buffers Along the Creek. The Ordinance Achieves this Objective by Creating a Zoning Overlay District Based on Forest Service Calculations.

Recommendation: Other Types of Buffer Ordinances to Consider Include Fixed Widths and Separate Zoning Districts. If a Fixed Buffer Ordinance is Desired, a Minimum of 50 Feet is Recommended, with the Potential to be Expanded if Critical Areas Extend Beyond those 50 Feet. The Forest Service Standard for Buffer Zones is Presently Set at 75 Feet.

Recommendation: Adopting an Ordinance to Protect Groundwater Supplies is Strongly Advised. A Wellhead Protection Ordinance is Highly Recommended for the Purpose of Protecting Groundwater Supplies. Locating Sufficient Public Water Supplies is Becoming Increasingly Difficult as More Aquifers are Being Contaminated as a Result of Population Growth and Development.

Recommendation: A Cooperative Effort Among Municipalities is Encouraged to Devise a Common Ordinance(s) to Preserve Little Nescopeck Creek Resources. Such an Effort would be More Beneficial and Efficient than Each Municipality Working Individually. Common Ordinances would be Easier to Implement and Enforce than Several Different Ones Throughout the Watershed.

Recommendation: Provide Municipal Officials with Educational Workshops and Programs Concerning Environmentally-beneficial Zoning and Ordinances.

Recommendation: Municipalities Should Adopt Environmentally-beneficial Ordinances.

GOAL 3. PRESERVE HISTORICAL RESOURCES AND DEVELOP HERITAGE TOURISM

⇒The historic resources of the Little Nescopeck Creek watershed are unique and valuable. Preservation must therefore become a more integral part of public and private decision-making.

Objective 3.1 Identify and Preserve Regionally and Nationally Significant Historic Sites and Landscapes within and Related to the Jordan Creek Watershed.

Recommendation: Identify and Preserve Regionally and Nationally Significant Historic Sites and Landscapes Within and Related to the Little Nescopeck Creek Watershed.

Recommendation: Support Watershed Heritage Tourism Development.

Recommendation: At the Point Where L.R. 3034 Crosses the Little Nescopeck Stands a Stone Arched Bridge that has been Saved from Replacement. The Bridge is One of the Most Historically Significant Historical Sites Remaining in the Watershed. Placing this Structure on the National Registry of Historic Places and Providing Stream Bank Improvements are Recommended.

Recommendation: Working with Luzerne County and the Wyoming Historical and Geological Society, Create and Maintain a Collection of Historical Documents, Photographs, Paintings, etc. of the Little Nescopeck Creek and its Watershed.

Recommendation: Working with Luzerne County and the Wyoming Historical and Geological Society, Publish Heritage Resource Publications that Focus on the Important Role that the Little Nescopeck Creek Played in the Development of Luzerne County, Pennsylvania and the Nation.

Recommendation: Conduct a Systematic Survey of the Watershed and Surrounding Area to Identify and List Potential National Registry Sites and Structures, Which Should Include But Not Be Limited to the Following:

- Saint Peter and Paul Lutheran Church
- The Lattimer Massacre Monument
- Saint Joseph's Church
- The Sugarloaf Monument
- Nescopeck Indian Village
- Historical Brainard Church
- The Sweetland Homestead
- Wyoming Historical and Geological Society's Bishop Memorial Library
- Stone Bridge (where L.R. 3034 crosses the Little Nescopeck)

►The criteria used to evaluate a site or structure for inclusion in the National register of Historic Places state that a site/structure must have:

- an association with events that have shaped history;
- an association with a significant person;
- possession of "distinctive characteristics" from a certain type of construction or time period, the work of a master, or high artistic value; or
- yielding or potential yielding of information.

►The Bureau for Historic Preservation offers ongoing training workshops on getting properties listed on the National Register of Historic Places, applying for state grants and administering local historic districts.

Recommendation: Provide Assistance to the Bureau for Historic Preservation to Offer Ongoing Training Workshops on Getting Properties Listed on the National Register of Historic Places and Applying for State Grants and Administering Local Historic Districts.

Objective 3.2 Educate Residents of the Watershed About its Heritage and Value.

⇒ *The following recommendations were provided by the Pennsylvania Historical Museum Commission.*

Recommendation: Bring Heritage Alive for Children.

- Work with the Secretary of Education and others to see that Pennsylvania history, historic preservation and archeology are expanded in school curriculums.

- Provide workshops and challenge grants for teachers. Work with partners to launch a new workshop series for teachers focusing on Pennsylvania history and heritage related topics. Initiate a small grant program to encourage teachers to develop new heritage education materials.

- Work with middle schools, high schools and community colleges to interest students at these levels in history preservation. Specific ideas to be explored include internships, preservation-related job fairs and expansion of Pennsylvania History Day programs in collaboration with the Pennsylvania Council for Social Studies and Penn State University.

Recommendation: Get the Preservation Message Out.

- Develop a clear message about the importance of history and preservation to the state's citizens, economy and quality of life. Specific elements to emphasize include the unique role Pennsylvania has played in our nation's history, how preservation of the heritage contributes to the state's economy and the importance of understanding our diverse heritage in an increasingly multicultural society.

- Design and implement a campaign to get the preservation message out. Major elements can be media campaigns, expansion of the historical marker program and working with the Pennsylvania Department of Transportation to promote history exhibits at highway welcome centers.

- Maximize the public benefit of federal and state mandated historic preservation and archaeological compliance projects by building public education activities into every project.

Recommendation: Reach Out to Elected Officials and Key Professionals in the Public and Private Sector.

- Provide more educational materials and events directed at state and local officials, including making presentations at annual conferences and events they attend, inviting them to workshops designed specifically for them and providing briefings on request.

- Provide more educational materials and events directed at public and private sector professionals involved in law, planning, real estate and land development. Create technical assistance materials and offer workshops directed at these professionals.

- Develop a leadership institute for historic preservation. This will be directed at leaders in preservation non-profits, historical societies, heritage parks and other organizations and individuals interested in building their expertise in preservation practice.

Objective 3.3 Build Better Communities Through Preservation.

⇒ *The following recommendations were provided by the Pennsylvania Historical Museum Commission.*

Recommendation: Strengthen and Expand Preservation Planning at the Local and Regional Levels.

- Support getting more historical and archeological resources inventoried, protected and incorporated into local comprehensive plans and zoning ordinances. Expand the Certified Local Government Program and increase financial and technical assistance.

- Develop model ordinances, design guidelines and prepare case studies to support preservation and sound land use planning.

- Work to strengthen local and regional planning legislation at the state level. This includes working with business, civic and environmental organizations to promote sound planning and regional cooperation and making changes to the Municipalities Planning Code. It would also include taking steps to clarify and simplify the historic designation process at the local level and recommend legislative change if necessary.

Recommendation: Expand the Use of Preservation as an Economic Development Strategy.

- Maximize use of existing programs like Keystone Opportunity Zones and Community Development Block Grants to revitalize historic communities. Work in close collaboration with state and local governments, businesses and community development corporations to encourage communities to apply for designation and funding under these programs.

- Work with a wide range of state and local partners to develop heritage tourism potential in communities across the watershed.

- Continue to support studies on the economic impacts of preservation and get the findings out into the communities.

- Promote flexible building code interpretation and streamlining of local approval processes to facilitate rehabilitation of historic properties.

- Promote the use of federal tax credits, state and federal grants and T-21 transportation enhancement funds to revitalize historic communities by providing information and assistance regarding applying for funds.

Recommendation: Make Technical Assistance More Available and Useful to Citizens and Local Governments.

- Develop user-friendly technical assistance materials. This will include establishing a clearing-house of information on preservation-related grants, incentives, techniques, regulations, contractors and consultants.

- Develop a technical assistance outreach program. This will include outreach efforts directed at historic property owners, non-profit organizations and local governments.

- Put state and local historical resource data on a Geographic Information System (GIS) available via the Internet. This will provide important information for individuals, local governments and the development community during planning and development decisions.

GOAL 4. DOCUMENT WATER QUALITY AND BIOLOGICAL CHARACTERISTICS

⇒ *Maintaining records of the condition of the stream corridor habitat and the vegetative, aquatic and wildlife species present in the corridor is essential to recognizing and assessing threats that may disrupt the balance of the ecosystem.*

Objective 4.1 Conduct Water Quality Sampling and Analysis.

Recommendation: Wildlands Conservancy, Friends of the Nescopeck, Volunteer Organizations, Educational Institutions and Other Watershed Interest Groups or Individuals should Combine Efforts to Continue Water Sampling and Analysis of the Little Nescopeck Creek on a Regular Basis to:

- Identify problem areas on which to focus remediation
- Monitor and document changes in overall health of the watershed while providing background information for future studies and projects
- Note adjustments that should be made in management practices

Recommendation: Stream walks should also be Preformed Annually through a Cooperative Effort as Mentioned Above in Order to Monitor Physical Changes within the Watershed Such as Sedimentation, Stream Sank Stabilization and Vegetative Cover.

Recommendation: Provide Funding to Reactivate the USGS Monitoring Gage (01538510) at the Jeddo Tunnel Outfall to Assist in the Collection of Water Quality Information.

Objective 4.2 Conduct Biological Monitoring.

⇒ *Maintaining records of the condition of the stream corridor habitat and the vegetative, aquatic, and wildlife species present within the corridor, is essential in recognizing and assessing threats that may disrupt the balance of the ecosystem.*

Recommendation: Working with Area Watershed Groups and Educational Institutions, Conduct Needed Research on the Flora and Fauna of the Little Nescopeck Creek Watershed, i.e., Mammal, Bird, Fish, Macro-invertebrate and Native Tree/Shrub and Wildflower Inventories.

Recommendation: Stewardship or Stream Watch Programs Staffed by Volunteers Could Survey or Maintain Stream Corridor Vegetation. Educational Youth Programs Could Also Accomplish This.

Recommendation: Provide Resources, Equipment and Expertise for Area School Districts, Colleges and Watershed Groups Interested in Conducting Monitoring on the Little Nescopeck Creek and its Tributaries.

Recommendation: Encourage Inventories of Vegetative Communities to:

- Identify native and non-native plant species

- Identify where invasive or exotic species are overtaking native vegetation
- Identify where riparian buffers are present and absent

Recommendation: Conduct Periodic Macro-invertebrate Sampling to:

- Provide additional support for water quality monitoring data
- Assess the diversity and abundance of aquatic life serving as the base of the food chain

Recommendation: A Cooperative Effort should be Developed to Inventory the Watershed to Locate and Identify the Presence of any Threatened or Endangered Species of Flora and Fauna.

Objective 4.3 Provide Efficient Data Management and Distribution.

⇒ *A central clearinghouse for data acquired on the Little Nescopeck Creek, through professional and volunteer monitoring and inventory efforts, could greatly improve public awareness and communication between key conservation groups.*

⇒ *With the formation of a central database, a concerned individual would know the appropriate contact for reporting or investigating important information. This would ease information distribution and management decision-making because information collected by various organizations would all be in one location. This location could also be used as a site for meetings concerning ventures that impact the creek.*

Recommendation: Make this Management Plan Document Available to Local Libraries, Universities and Watershed Groups.

Recommendation: Create a Website that Would House a Copy of the Little Nescopeck Creek Watershed Management Plan and Progress being Made on its Implementation, Upcoming Projects and Events, Recreational Opportunities, Historic Sites of Interest and Pertinent Water Quality and Environmental Information.

Recommendation: Develop a System for Entering and Displaying Data on the Internet. This Would Provide an Excellent and Efficient Means of Improving Communication and Providing Easy Access to Data by Almost any Interested Party.

GOAL 5. ENHANCE AND INCREASE WATERSHED RECREATIONAL OPPORTUNITIES

⇒ *Increasing population in the municipalities means there is a greater need for recreational opportunities. Outdoor recreation is not only a valuable public resource, it can also serve to increase awareness of the need for open space and environmental conservation.*

Objective 5.1 Implement Rails-to-Trails Conversion Projects.

Recommendation: Support Existing and Potential Watershed Rails-to-Trails Projects.

►Rail-to-trail projects, largely funded with federal assistance, are increasingly popular within the watershed. When properly constructed, such pathways improve water quality and encourage biodiversity by cleaning up land and creating green space. With appropriate planning, these projects also educate and encourage cultural preservation. Organizations currently involved in greenway creation are:

- Friends of the Nescopeck
- The Anthracite Scenic Trails Association
- The Pennsylvania Environmental Council
- Wilkes University
- Delaware and Lehigh Canal National Heritage Corridor Commission
- Luzerne County Trails Advisory Council

Recommendation: Conduct a Feasibility Study to Assess the Extent of Abandoned Rail Lines, the Possibilities of Linking the Lines, and the Costs Associated with Acquiring the Necessary Lands or Easements and Converting and Maintaining them as Usable Trails.

Recommendation: Examine the Economic Benefits of Rails-to-Trails Projects.

►Converting abandoned rail lines within the watershed to trails and greenways would be an excellent means of stimulating local economy and providing the community with diverse opportunities for exercise and recreation. Economic Benefits for communities include:

- The possibility of increased local tax revenues due to increased property values,
- Stronger support of recreation-oriented business due to spending by trail users on related activities,

- New opportunities for business and commercial activities such as restaurants and bike and ski rental shops, and
- Greenways along trail that can reduce public expenditures by lowering flood and other natural hazard costs.

Recommendation: Educational signs Posted Along the Greenway Trails or the Riparian Buffer can Enhance the Experience of Using the Greenway While Providing Information about Ecology, Natural History and Conservation.

Recommendation: Stewardship or Stream Watch Programs Staffed by Volunteers Could Survey or Maintain Stream Corridor Vegetation. Education Youth Programs Could also Accomplish This.

Objective 5.2 Improve and Expand Watershed Recreational Facilities.

Recommendation: Municipal Parks Should Serve as Models Demonstrating Land Management Practices that Protect Natural Resources.

►The parks could distribute informational pamphlets relating to river conservation and best management practices, or set up informational displays.

Recommendation: Conduct Studies of Existing Streamside Parks in the Watershed in Order to Guide Future Environmental Improvements in these Parks. One Park Bordering a Tributary to the Little Nescopeck Creek that is in Need of Environmental Improvements/Restoration is Whispering Willows Park in Conyngham Borough.

Recommendation: Provide Access to the Little Nescopeck Creek and its Tributaries for Recreational Activities.

Recommendation: Maintain and Develop Nature-based Recreational Areas.

►An example is the nature trail at the Bishop Property in Conyngham Borough. Three interconnected trails will be constructed of natural materials and feature information signs and exercise stations. Such an area would also be ideal for environmental education signage.

Recommendation: Re-establish or Improve Riparian Corridors through Watershed Recreational Areas.

Recommendation: Recreational Projects that are Cooperative Between Municipalities Save Townships Resources and Finances and Allow for Larger and More Diverse Complexes.

►Potential for such a project exists between Sugarloaf Township and Conyngham Borough at the development site for the new municipal services complex, which is bisected by the Little Nescopeck. This area is also an opportunity to create natural environment recreation.

Recommendation: Working with State, County and Local Recreational Agencies, Form a Watershed Recreation Task Group to Coordinate Planning for and Development and Operation of Recreational Facilities Within the Watershed.

Objective 5.3 Clean Up the Stream Corridors Within the Watershed.

⇒ *Areas within the Little Nescopeck Creek corridor are littered with trash. A clean creek corridor is aesthetically pleasing, scenic and attractive, and is more inviting to recreational users than a creek that is uncared for.*

Recommendation: The Scattered Trash Should be Picked Up on a Regular Basis and Prevention Measures Put in Place.

Recommendation: Develop Strong Public Education Programs. Encourage Residents to Use the Waterways Responsibly, and Feel a Sense of Ownership in Order Help to Prevent Littering.

Recommendation: "No Littering/Dumping" Signs Warning People of Significant Monetary Fines Should be Posted Throughout the Watershed.

Recommendation: Use Clean Up Activities to Aid Educational Efforts; Use Education Programs to Promote Clean Up.

►Cleanup efforts involve volunteers and develop public commitment, thus stimulating future stream conservation efforts. Promotional and education projects should be undertaken before cleanup events take place.

Recommendation: Municipalities Should Sponsor Public River Corridor Cleanup Days, Which Also Provide an Opportunity for Education. After the More Extensive Initial Cleanups, Maintenance Could be Provided by Regular (perhaps yearly) Cleanup Days or by Offering Sponsorships Similar to Roadside Maintenance Programs.

Recommendation: The Business Community can Spearhead Regular Cleanup Activities by Donating Advertising and Employee Time. Cleanup Efforts Should Also Encourage Joint Voluntary Public-Private Efforts for Trash Removal.

GOAL 6. INCREASE ENVIRONMENTAL AWARENESS, KNOWLEDGE, SKILLS AND STEWARDSHIP COMMITMENT AMONG THOSE LIVING IN THE LITTLE NESCOPECK CREEK WATERSHED.

⇒ *Inform residents, business owners, recreational users and others about the need for protection. Widespread and increased awareness is one of the most important factors contributing to the success of natural resource protection programs. In order to be successful, education programs must include homeowners and residents, commercial landowners, developers, public agencies and young people.*

<u>Objective 6.1 Provide Environmental, Heritage and Cultural Education Opportunities for School Groups, the General Public and Local Government and Business Leaders that will Provide:</u>

- an understanding that those who live and work in the Little Nescopeck Creek Watershed are an inseparable part of its ecosystem and whatever humans do or do not do will alter the health of the watershed;
- a basic knowledge of the natural laws which govern the environment of the Little Nescopeck Creek watershed; of the skills needed to solve its environmental problems; and recognition of each individual's responsibility to find solutions to the environmental problems of the watershed;
- the development of a stewardship ethic that leads to the conservation of the Little Nescopeck Creek watershed's natural, historical and cultural heritage and to the correction and prevention of environmental degradation in the watershed.

Recommendation: Create and Support the Efforts of Friends of the Nescopeck and any Other Watershed Citizen's Organizations.

Recommendation: Working with Friends of the Nescopeck, Wilkes University, Kings College, Penn State University and Luzerne County Community College, Conduct Needed Research on the Flora and Fauna of the Nescopeck Creek Watershed, i.e., Mammal, Bird, Fish, Native Tree/Shrub and Wildflower inventories.

Recommendation: Provide Educational Programming that Will Familiarize All Members of the Little Nescopeck Creek Watershed Community with Best Management Practices (BMPs) for General Stream Care.

Recommendation: Work with Local Educational Institutions to Develop Student Projects Involving the Little Nescopeck Creek.

Recommendation: Document the Entire Length of the Little Nescopeck Creek and its Tributaries Using Video, Photos and Written Descriptions of Significant Sites for Use in Planning and Educational Efforts.

Recommendation: Develop Books, Brochures, Guides, Videos, Tours, etc. that Will be used to Promote Public Awareness of the Natural, Recreational and Heritage Resources of the Little Nescopeck Creek Watershed and of the Efforts Underway for the Implementation of this Plan.

Recommendation: Develop and Post Educational Signs at Critical Sites Along the Creek at Key Locations Such as Stream Crossings and Recreational Sites Throughout the Watershed to Increase Public Awareness of Threats to the Little Nescopeck.

Recommendation: Post Signs at Every Major Stream Crossing Identifying the Name of the Water Body.

Objective 6.2 Hold Frequent and Well-Advertised Public Forums.

Recommendation: Articles and Editorials in Local Newspapers Should be Developed with a Focus on Public Relations and Public Stewardship of the Little Nescopeck Creek.

Recommendation: In Addition to School Curricula, Ongoing Efforts Should Include a Regular Environmental Newsletter or a Column in Local Newspapers.

Recommendation: Periodic Efforts Might Include Occasional Seminars on Environmental Topics Affecting the Little Nescopeck Creek.

►Programs on topics like Abandoned Mine Drainage and Best Management Practices could be open to the public and presented at area educational institutions like the Penn State Hazelton campus. Coverage and advertisement of these programs in local newspapers could improve public attendance.

Recommendation: Promote the Formation of Environmental Advisory Councils in each of the Watershed Municipalities.

►These councils would become advocates for the Little Nescopeck Creek, its tributaries and the natural resources of the watershed and would promote environmental responsible municipal planning and decision-making.

Recommendation: Work With the Penn State Cooperative Extension and NRCS to Promote Education of Farms About Best Management Practices.

►Education leads to increased awareness and awareness leads to increased involvement. Municipalities can take advantage of the interest raised through education programs by developing subsequent stewardship programs. With coordination and oversight from public agencies, land owners and other residents can be encouraged to adopt some of the tasks recommended by this management plan.

10.0 CONCLUSION

The Little Nescopeck Creek watershed is located in southern Luzerne County, Pennsylvania. The drainage basin of the Little Nescopeck Creek encompasses approximately 14 square miles and lies within Sugarloaf and Butler Townships, the Borough of Conyngham and a very small portion of Hazel Township. The stream flows from its headwaters in Butler Township approximately 10 miles to its confluence with the Nescopeck Creek in Sybertsville.

The Little Nescopeck Creek, a tributary to Nescopeck Creek, is severely impacted by a water-quality-impaired discharge from the adjacent mined watershed. This project is unique in that the impacted watershed is not directly affected by mining activities. A water level drainage tunnel, the Jeddo, which was constructed to dewater deep mined coal measures in the Eastern Middle Anthracite Field, has interconnected the natural watersheds of the Little Nescopeck and the Hazleton mining operations. After the collapse of the deep mining industry, the Jeddo Tunnel continues to drain the abandoned mine workings.

The Jeddo Tunnel, which drains approximately 32.24 square miles and discharges an average of 40,000 gallons per minute into the Little Nescopeck Creek, is one of the largest mine water discharges in the anthracite region. Acid mine drainage discharge from the Jeddo Tunnel is the only identified source of major non-point-source pollution in the Little Nescopeck Creek watershed. Little Nescopeck Creek receives all the flow from the Tunnel. For this reason, significant attention is directed in this plan toward the Jeddo Tunnel system.

The Little Nescopeck Creek is classified as a High Quality-Cold Water stream above the tunnel discharge, as is Nescopeck Creek upstream from its confluence with the Little Nescopeck. The quality-impaired Little Nescopeck Creek joins Nescopeck Creek, which eventually enters the Susquehanna River near Berwick, Pennsylvania. The impacts of the Little Nescopeck Creek are evident in the Nescopeck Creek, the Susquehanna River and the Chesapeake Bay.

Wildlands Conservancy received a Pennsylvania Rivers Conservation Program Planning Grant for the Little Nescopeck Creek. A study of the Little Nescopeck Creek and the preparation and publication of a comprehensive Little Nescopeck Creek Watershed Conservation Plan were the intended outcomes of the grant. The Pennsylvania Rivers Conservation Program was created by the Pennsylvania Department of Conservation and Natural Resources (DCNR). The objective of the program is to conserve, restore and enhance Pennsylvania's rivers through partnership, education, awareness and stewardship.

This conservation plan has identified the historical, cultural, natural and physical resources in the watershed, characterizes the water quality and aquatic life of the stream and has identified problem areas in the watershed. The plan also contains recommendations for conservation and preservation of the Little Nescopeck Creek based on information collected as part of this project and on input from public hearings and informational meetings with municipalities and the watershed community.

The Little Nescopeck Creek watershed and its resources have been treasured by many since the first Native Americans and European immigrants discovered the region. Through the years, the mining industry, along with population growth and associated suburban development have eliminated, destroyed or altered the valuable watershed. Future growth of the watershed will put increased pressure on the remaining resources. How municipalities choose to handle these pressures will impact not only the health of the watershed, but also the well-being of its residents.

Many of the obstacles and challenges involved in the restoration of the Little Nescopeck Creek need to be centered around the Abandoned Mine Drainage issues of the Hazelton Basin and the Jeddo Tunnel. In addition, the challenge for communities of the watershed will be conduct development in an ecologically sound and responsible manner, minimizing urban sprawl and its impacts. Restoring riparian buffers along the Little Nescopeck and protecting those that are currently intact is critical to conserving watershed resources and improving water habitat and quality.

The keys to achieving the goals of this project are education and communication. Knowledgeable citizens and organizations must continue to educate property owners, businesses and political leaders on the issues raised in this report. Communication between property owners and institutions must be established in order for the watershed to benefit from conservation and preservation programs as well as the efficient use of its resources.

This management plan should be used as a tool to build partnerships and as a guide to develop concerted efforts for future preservation, protection and enhancement of the resources of the Little Nescopeck Creek watershed.

APPENDIX A

RESTORATION OPTIONS FOR THE REHABILITATION OF THE JEDDO MINE TUNNEL WATERSHED

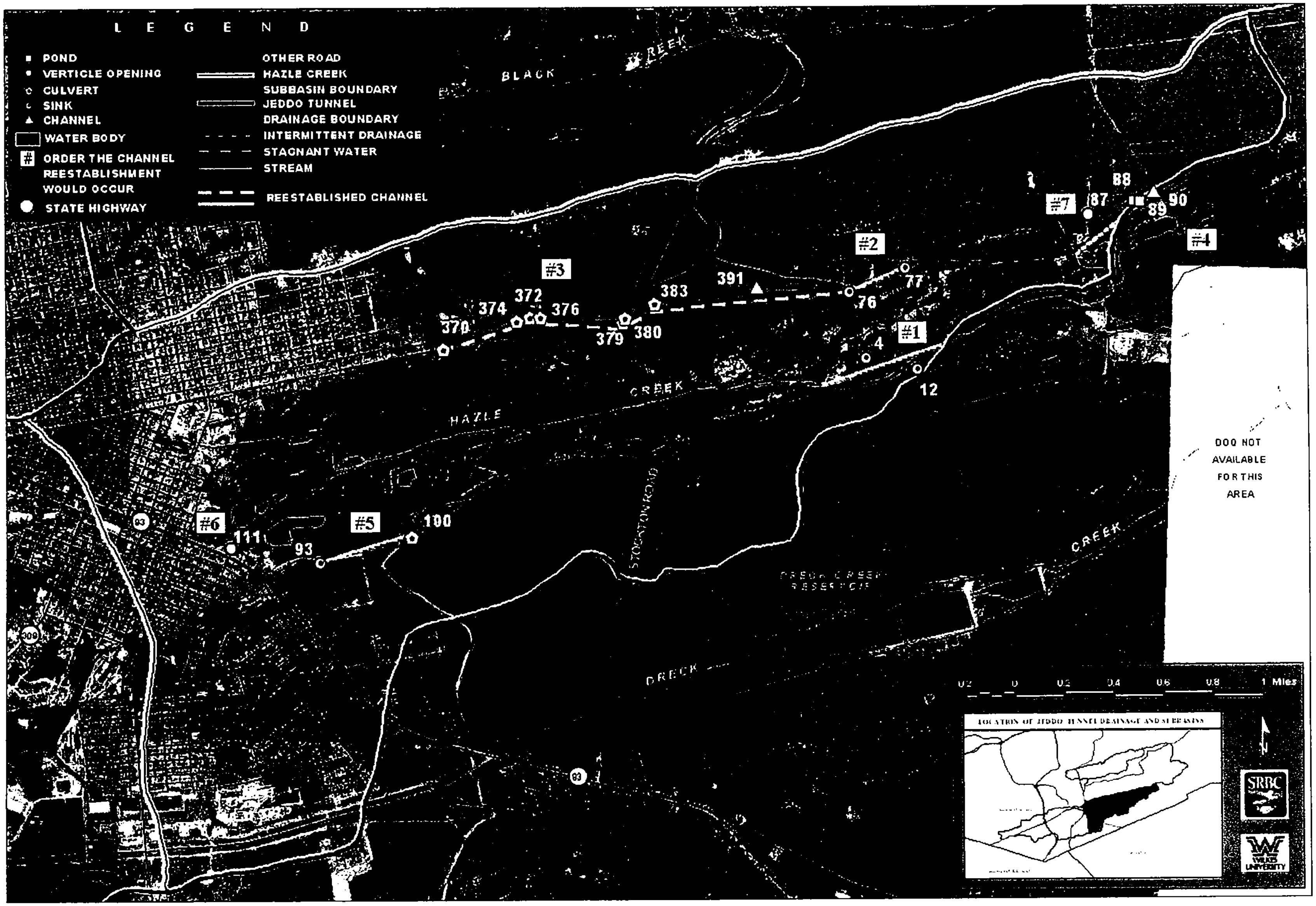

Figure A1. Digital Orthophotographs of Hazel Creek Subbasin.

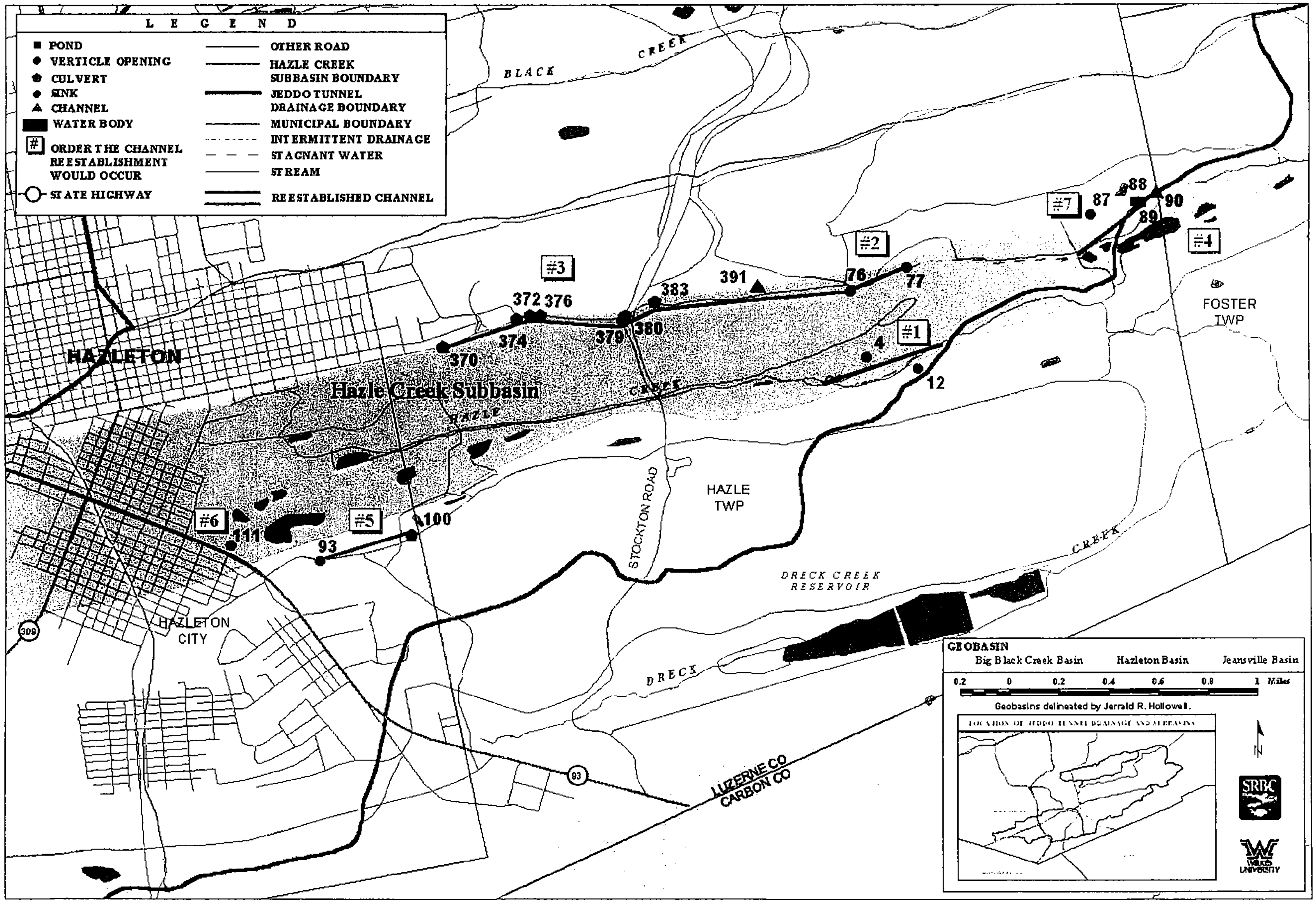

Figure A2. Future Surface Hydrology in the Hazel Creek Subbasin, (Wildlands/SRBC, 1999)

EASTERN HAZLETON COAL BASIN—HAZLE CREEK DRAINAGE

The eastern portion of the Hazleton Basin covers an area approximately 6.62 miles, which represents 21 percent of the current Jeddo Tunnel drainage area. This area has been extensively mined and there are several active permits within the basin. This area was originally drained by Hazle Creek, a tributary of the Lehigh River.

During the initial field investigation, several points of interest were identified within this basin that could potentially reduce the infiltration to the flooded mine workings, which is drained by the Jeddo Tunnel. This information was collected and analyzed to determine what and where restoration options should occur.

The restoration of Hazleton basin will require work at four sites in the perimeter drain system and four sites of sinks or other features that are contributing surface water into the Jeddo drainage system. Sites are listed in order of priority, based on impact to the system and on overall environmental benefit.

Location: Hazle Creek 0.6 miles east of Stockton Road
GPS ID Number: P-4
Coal Basin: Eastern Hazleton Coal Basin
Hydrologic Basin: Hazle Creek
Quadrangle: Hazleton
Municipality: Hazle Township
Aerial Photo Number: 9A-5

Description of the Problem Area: The Hazle Creek channel has been interrupted by mining (see map) approximately 0.6 miles east of Stockton Road. All of the water transported by the creek is diverted into this location and enters the mine workings through the subsidence area identified in this study as GPS-4. This is most likely the largest of all problems within the drainage area of the Jeddo Tunnel. Although the drainage area of the sink is quite large, the majority of the drainage is mined, resulting in reduced stream flow to Hazle Creek. The majority of the water entering this sink is a direct result of runoff from the city of Hazleton.

Restoration Options: The reestablishment of the Hazle Creek channel would significantly reduce the inflow of water to the Jeddo Tunnel system. A new channel of approximately 2,650 feet in length would need to be constructed, and a large pit adjacent to the railroad tracks would have to be filled to effectively keep the water out of P-4. By constructing this channel with the proper lining and grade, the existing Hazle Creek channel would effectively transport water out of the Jeddo Tunnel Basin.

Restoration Limitations: This restoration option is limited primarily in the fact that Hazle Creek transports significant amounts of water impacted by a sewage overflow in the City of Hazleton. The sewage outflow (Show Map GPS #) entering into Hazle Creek needs to be addressed before this channel can be restored and water can be put onto the surface. The cost of this restoration could be the most significant out of all of the restoration options, but the environmental gain also may be the most significant.

Next Step to Facilitate Restoration/Cost:

1. Determine the feasibility of removing the sewage impact from Hazle Creek;
2. Determine the amount of fill require to bring channel up to required grade; and
3. Determine the most effective way to line the new channel to reduce infiltration.

Location: North Perimeter Drain of Hazle Creek Basin
GPS ID Number: P-76 and P-77
Coal Basin: Eastern Hazleton Coal Basin
Hydrologic Basin: Hazle Creek
Quadrangle: Hazleton
Municipality: Hazle Township
Aerial Photo Number: 9A-5

Description of the Problem Area: The perimeter drain on the north side of Hazleton basin is continuous and parallels the north side of Hazlebrook Road until the channel is taken under Hazlebrook road through a culvert. This culvert seems to be of recent construction, and the water exiting the culvert was deliberately designed to enter the sink found at point P-76. Overflow from this channel continues down L-3 Line–3 to where it enters the sink found at point P-77. The area just east of P-77 is the largest area in need of repair. It must be noted that the perimeter drain east of P-77 is not effectively draining the entirety of the area east of P-77 due to a mining pit on its northern side. A smaller secondary perimeter drain effectively takes drainage from the western side of this mining pit and flows westward into the primary perimeter drain. On the eastern side of this mining pit, a breech in the secondary perimeter drain allows the eastward flowing drainage to enter the mining pit.

Restoration Options: Construct a channel from P-76 1,318 feet to P-77. While overall topography should permit the reestablishment of a perimeter drain at this location, the area, including the sink at P-77, needs to be filled and graded. East of this location is the functioning perimeter drain. The drain is intact from this point eastward and flows into Hazle Creek at Ashmore Yards, and thus exits the Jeddo Tunnel Basin. Repairs made to the secondary perimeter drain east of P-77 would allow this perimeter drain to operate more effectively.

Restoration Limitations: The only limitation for this restoration project is the amount of material that would be needed to fill in and grade P-77.

Next Step to facilitate Restoration/Cost:

1. Determine the amount of fill required to bring P-77 up to required grade; and
2. Determine the most effective way to line the new channel to reduce infiltration.

Location: North side of Hazle Creek Basin
GPS ID Number: P-370 to P-383, P-391
Coal Basin: Eastern Hazleton Coal Basin
Hydrologic Basin: Hazle Creek
Quadrangle: Hazleton
Municipality: Hazle Township
Aerial Photo Number: 10A-7 & 9A-5

Description of the Problem Area: The perimeter drain that used to carry surface water to Hazle Creek needs to be reestablished. Currently, the water is just infiltrating into the mine workings.

Restoration Options: Reestablishment of 3,955 feet of drainage channel from the border of Hazleton to Stockton Road. Then extend the perimeter drain east 4,928 feet (culvert under Stockton Road would be needed) along the north side of Hazle Creek Basin and connect it with the channel located at P-391, thus connecting it with the perimeter drain associated with P-76 and P-77.

Restoration Limitations: The restoration project would require significant reestablishment of perimeter drains. This project would need to be completed after the breach in the perimeter drain east of Stockton Road P-76 and P-77 was connected.

Next Step to Facilitate Restoration/Cost:

1. Determine the condition of existing perimeter drain west and east of Stockton Road; and
2. Determine the feasibility of constructing a perimeter drain along the north side of the Hazle Creek Basin.

Location: Hazle Creek north side of the Basin
GPS ID Number: P-88 to P-90
Coal Basin: Eastern Hazleton Coal Basin
Hydrologic Basin: Hazle Creek
Quadrangle: Hazleton
Municipality: Hazle Township
Aerial Photo Number: 9A-5

Description of the Problem Area: The perimeter drain that used to carry surface water to Hazle Creek needs to be reestablished. Currently, the water is just infiltrating into the mine workings.

Restoration Options: Reestablish 1,727 feet of drainage channel from the village of Hazlebrook westward along-side the railroad to the existing culvert under the railroad that connects to Hazle Creek at P-82. A culvert may be necessary to transport water across the road. Currently, the water washes out the road.

Restoration Limitations: None.

Next Step to Facilitate Restoration/Cost:

1. Determine the condition of existing perimeter drain.

Location: Channel south of the main Hazle Creek channel just East of Hazleton
GPS ID Number: P-93, P-25, P-101
Coal Basin: Eastern Hazleton Coal Basin
Hydrologic Basin: Hazle Creek
Quadrangle: Hazleton
Municipality: Hazle Township
Aerial Photo Number: 10A-6

Description of the Problem Area: Surface water is entering the sink located at P-93. The hole, which is 4' X 3', allows surface water to enter into the mine workings. Overall, the contribution of this point to the Jeddo Tunnel system is quite small. The drainage area of this sink is confined to the immediate area adjacent to the strip pit. However, this is a headwaters area for Hazle Creek, so any channel reconstruction also should include this point.

Restoration Options: Fill in P-93 and reestablish 2,060 feet of channel and connect it with an already existing channel that transports water at P-101. This channel currently transports water to the large pond located at P-25. This pond could be breached in the northeast corner and could be reconnected with the Hazle Creek channel immediately north of the pond.

Restoration Limitations: This restoration project would need to be completed after Hazle Creek channel was reestablished downstream at P-4.

Next Step to Facilitate Restoration/Cost:

1. Determine whether or not the pond could be breached, and if sufficient grade is present to bring the water into Hazle Creek.

Location: Western end of Hazle Creek Basin just east of Pa. Route 93
GPS ID Number: P-111
Coal Basin: Eastern Hazleton Coal Basin
Hydrologic Basin: Hazle Creek
Quadrangle: Hazleton
Municipality: Hazleton
Aerial Photo Number: 10A-6

Description of the Problem Area: P-111 is located in the western end of Hazle Creek Basin, just east of Pa. Route 93, behind the electrical supply building. Here a large opening exists, which is an immediate safety hazard due to its proximity to Hazleton. Drainage from the east is channeled down a cement flume and discharges into the large opening. Overall, the contribution of this point to the Jeddo Tunnel system is quite small. However, this area does constitute a safety hazard and is contributing some water to the Jeddo Mine system.

Restoration Options: Seal the opening and return the area to its original contour. Backfilling of the area will require a significant amount of material. However, this area poses a potential safety hazard, with its proximity to Hazleton.

Restoration Limitations: The only limitation for this restoration project is the amount of material that would be needed to fill in and grade P-111.

Next Step to Facilitate Restoration/Cost:

1. Determine the amount of fill required to bring P-111 up to required grade; and
2. Determine the most effective way to seal off the opening and reduce water from entering into the opening.

Location: North side of Hazle Creek Basin 0.5 miles north of Ashmore Yards
GPS ID Number: P-87
Coal Basin: Eastern Hazleton Coal Basin
Hydrologic Basin: Hazle Creek
Quadrangle: Hazleton
Municipality: Hazle Township
Aerial Photo Number: 9A-5

Description of the Problem Area: Surface water enters this sink, which is located on the power line just north of the perimeter drain on the north side of the Hazle Creek Basin. Overall, the contribution of this point to the Jeddo Tunnel system is quite small.

Restoration Options: Backfilling of the pit to its original contour should resolve the infiltration at this point. After the area is filled, the area should be reexamined to determine if the water is entering at any other point. The water, if possible, should be directed south along the power line approximately 1,000 feet and connected with the existing perimeter drain at P-88.

Restoration Limitations: The only limitation for this restoration project is the amount of material that would be needed to fill in and grade P-12. If restoration at this location is completed before the reestablishment of Hazle Creek, the water from this location should be directed into the existing perimeter drain east of P-4.

Next Step to Facilitate Restoration/Cost:

1. Determine the amount of fill required to bring P-87 up to required grade; and
2. Determine where the water will go after this area is filled in, and then take the appropriate steps to ensure that this water enters the perimeter drain on the north side of Hazle Creek Basin.

Location: Hazle Creek 0.7 from Stockton Road
GPS ID Number: P-12
Coal Basin: Eastern Hazleton Coal Basin
Hydrologic Basin: Hazle Creek
Quadrangle: Hazleton
Municipality: Hazle Township
Aerial Photo Number: 9A-5

Description of the Problem Area: P-12 is located in the Hazleton basin, just south and east of point P-4. Surface water is entering this settling area and infiltrating into the mine workings, which is drained by the Jeddo Tunnel. Overall, the contribution of this point to the Jeddo Tunnel system is quite small. The drainage area of this sink is confined to the immediate area adjacent to the strip pit.

Restoration Options: Backfilling of the pit to its original contour should resolve the infiltration at this point. However, the water should be directed east of P-4 until the channel of Hazle Creek can be reestablished.

Restoration Limitations: The only limitation for this restoration project is the amount of material that would be needed to fill in and grade P-12. If restoration at this location is completed before the reestablishment of Hazle Creek, the water from this location should be directed into the existing perimeter drain east of P-4.

Next Step to Facilitate Restoration/Cost:

1. Determine the amount of fill required to bring P-12 up to required grade; and
2. Determine the most effective way to take runoff and direct it into the Hazle Creek channel east of P-4.

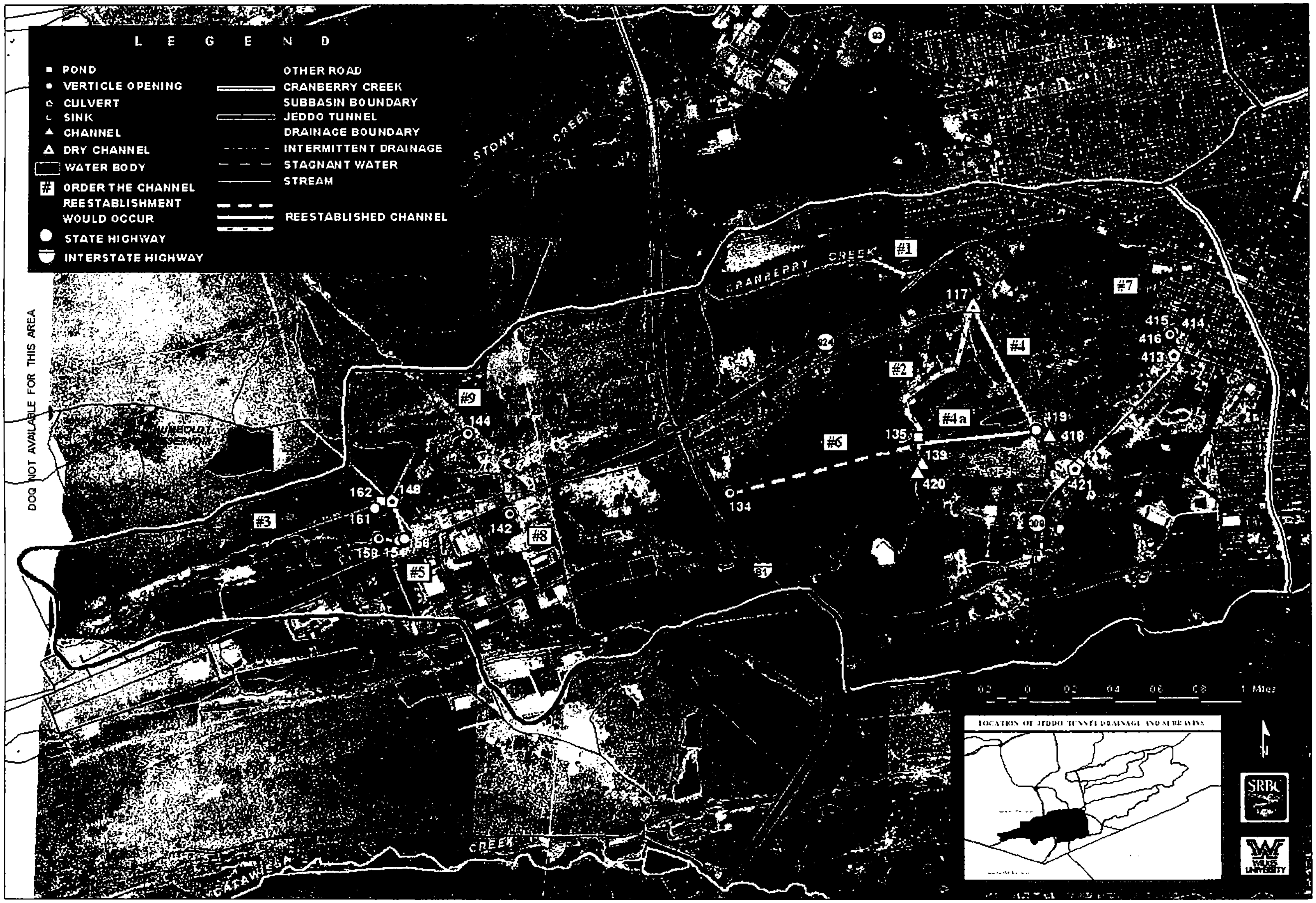

Figure A3. Digital Orthophotgraphs of Cranberry Creek Subbasin, (Wildlands/SRBC, 1999)

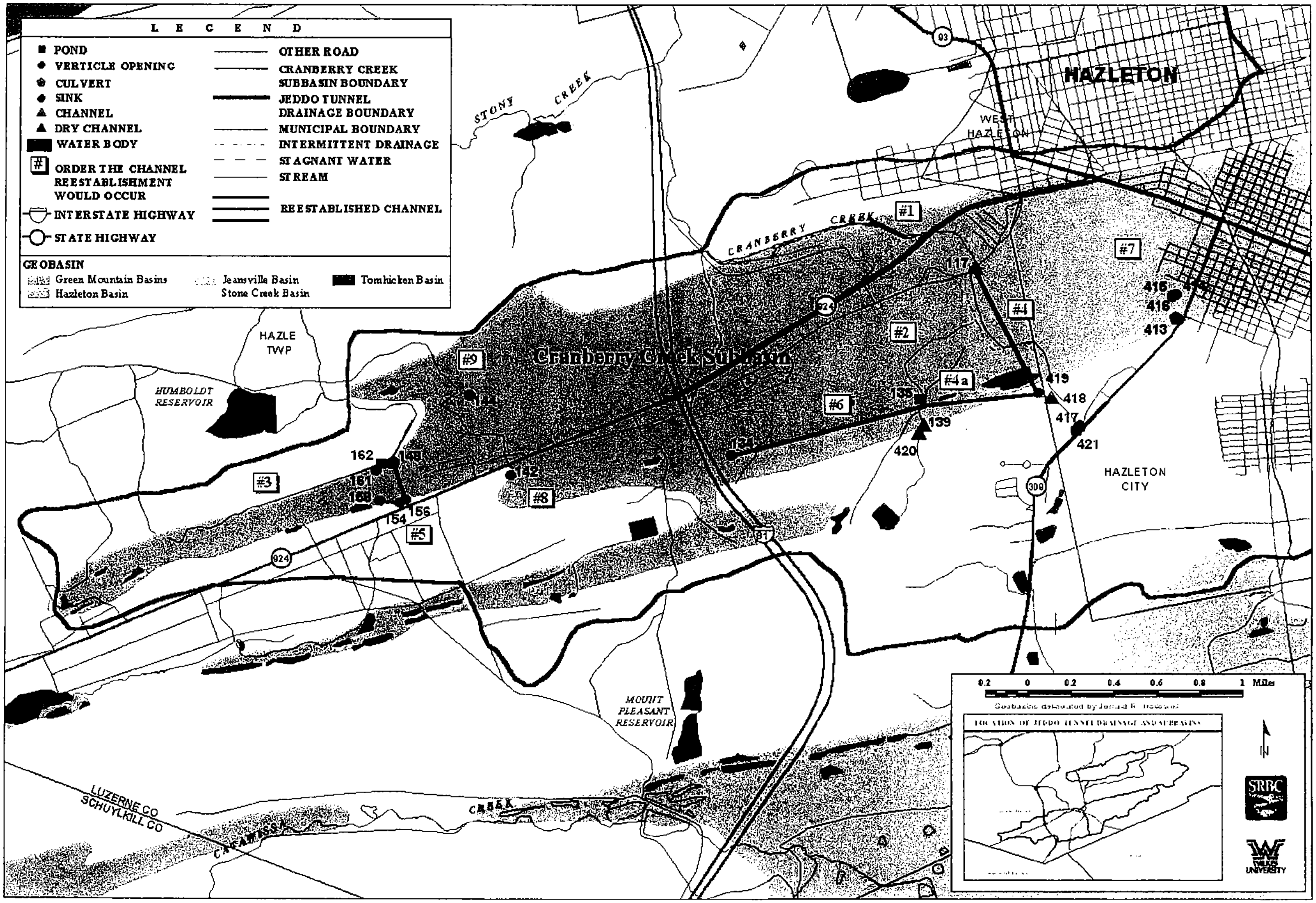

Figure A4. Future Surface Hydrology in the Cranberry Creek Subbasin, (Wildlands, SRBC, 1999)

WESTERN HAZLETON COAL BASIN—
CRANBERRY CREEK DRAINAGE

The Western Hazleton Coal Basin covers an area approximately 8.53 square miles, which represents 26 percent of the current Jeddo Tunnel drainage area. This area has been extensively mined, and there are several active surface mining permits within the basin. This area was originally drained by Cranberry Creek, a tributary of Black Creek.

During the initial field investigation, several points of interest were identified within this basin that could potentially reduce the infiltration to the mine workings drained by the Jeddo Tunnel. This information was collected and analyzed to determine what and where restoration should occur.

The restoration of the Western Hazleton Coal Basin will require work at six sites in the perimeter drain system and three sites of sinks or other features that are contributing surface water into the Jeddo system. Sites are listed in order of priority based on impact to the system and on environmental benefit.

Location: Cranberry Creek downstream of Rte 924
GPS ID Number: P-122 and P-123
Coal Basin: Western Hazleton Coal Basin
Hydrologic Basin: Cranberry Creek
Quadrangle: Conyngham
Municipality: Hazle Township
Aerial Photo Number: 11A-6

Description of the Problem Area: The Cranberry Creek channel, immediately downstream of Pa. Route 924, is diverted into a large settling area at P-123. The drainage from Cranberry Creek is diverted into this area and, subsequently, infiltrates to the mine workings.

Restoration Options: Reestablish channel from Pa. Route 924 to existing Cranberry Creek channel, approximately 944 feet. This would prohibit drainage from entering the sink at P-123 and allow the surface water to continue in the existing Cranberry Creek channel, and thus exit the basin. Some channel "cleaning out" may be necessary in the western portion of the channel as it approaches the railroad bridge.

Restoration Limitations: A new permit has been issued for this area. We need to evaluate if this restoration project is part of the restoration goals under the new permit. Also, a restoration project proposal from Representative Todd Eachus to use the area east of Pa. Route 924, and eventually west of Pa. Route 924, needs to be evaluated and incorporated with the restoration options discussed in this report. Also, sewage from P-455 is entering Cranberry Creek channel and would need to be addressed before the surface water would be allowed to enter into Cranberry Creek..

Next Step to Facilitate Restoration/Cost:

1. Determine if the new permit issued in this area will cover the restoration options identified in this report; and
2. Make sure the proposed development in this area contains sufficient drainage channels to carry the water into Cranberry Creek and out of the Jeddo Tunnel drainage basin.

Location: Headwaters of Cranberry Creek downstream of Grape Run Reservoir
GPS ID Number: P-420, P-135, P-136, P-138, P-139, P-137
Coal Basin: Western Hazleton Coal Basin
Hydrologic Basin: Cranberry Creek
Quadrangle: Conyngham
Municipality: Hazle Township
Aerial Photo Number: 11A-6

Description of the Problem Area: The channel from Grape Run Reservoir presently drops into a strip pit just northeast of the junkyard.

Restoration Options: Reestablish channel downstream of Grape Run Reservoir and fill in the sink at P-136, then construct a channel from P-137 to Cranberry Creek. The length of the restoration is 4,408 feet. This would prevent the water leaving Grape Run Reservoir from entering a sink at P-136 and connect this headwaters area with the rest of Cranberry Creek.

Restoration Limitations: The amount of material and construction of a channel from P-137 to P-117 will be significant. This project could only be completed after Cranberry Creek was reestablished at P-122. Also, the channel from P-117 to P-122 would need to be assessed to determine if it could handle the additional discharge. This area is between P-117 and P-122 and may be part of a restoration project proposal from Representative Todd Eachus to reclaim and use the area east of Pa. Route 924. Any work completed at this site needs to be evaluated and incorporated with the restoration options discussed in this report.

Next Step to Facilitate Restoration/Cost:

1. Determine if the new permit issued in this area will cover the restoration options identified in this report;
2. Make sure that the proposed development in this area will contain sufficient drainage channels to carry the water from Grape Run Reservoir to Cranberry Creek and out of the Jeddo Tunnel drainage basin; and
3. Determine the condition of the channel below this point at Grape Run Reservoir to ensure that it can handle the additional flow.

Location: Perimeter drain northwest side Western Hazleton Coal Basin near Humbold
GPS ID Number: P-148, P-161 and P-162
Coal Basin: Western Hazleton Coal Basin
Hydrologic Basin: Cranberry Creek
Quadrangle: Conyngham
Municipality: Hazle Township
Aerial Photo Number: 13A-5

Description of the Problem Area: The existing perimeter drain runs on the north side of the Western Hazleton Coal Basin from P-148 westward approximately 5,495 feet. This channel is intact and transports water until it gets to P-162. At this point, inadequate culverts were installed, and the water entered into sinks at P-456 and P-161.

Restoration Options: Repair and extend the existing coal basin perimeter drain channel west of the village of Humbold. This channel diverts the drainage from the western-most part of the Hazleton Coal Basin to Stony Creek, east of the Humbold Reservoir. Construct approximately 43 feet of channel and culvert under the Humbold Reservoir Road to carry water to the east side of the road, and allow the water to continue in the existing perimeter drain and effectively out of the Jeddo basin.

Restoration Limitations: This project has been completed.

Next Step to Facilitate Restoration/Cost:

1. Determine the most effective way to line the new channel to reduce infiltration; and
2. Determine the condition of the channel below this point to determine if the channel can handle the additional flow.

Location: West of Pa. Route 309 and east of junkyard
GPS ID Number: P-419, P-418, P-421 and P-417
Coal Basin: Western Hazleton Coal Basin
Hydrologic Basin: Cranberry Creek
Quadrangle: Hazleton
Municipality: Hazleton
Aerial Photo Number: 11A-6

Description of the Problem Area: Drainage from Pa. Route 309 at P-417 flows in a channel and is directed towards a sink located at P-419 and filtered into the mine workings.

Restoration Options: Fill in the sink at P-419 and construct a channel from this point westward 2,856 feet to P-136, or construct a channel from P-419 3,520 feet to P-117. Either of these two restoration options would allow this water to exit the Jeddo basin. The option with the best grade or least cost should be completed.

Restoration Limitations: Either channel constructed would require considerable earthmoving. Further investigation is needed to determine which restoration option is best for this area. This project could not be completed until the other restoration projects located downstream would be completed.

Next Step to Facilitate Restoration/Cost:

1. Additional field investigation is needed to determine which of the above restoration options is feasible; and
2. The cost of the project should be considered before construction, due to the limited amount of water that would be diverted from this project.

Location: Cranberry Creek north of 924 near Humbold
GPS ID Number: P-148, P-158, P-154, and P-156
Coal Basin: Western Hazleton Coal Basin
Hydrologic Basin: Cranberry Creek
Quadrangle: Conyngham
Municipality: Hazle Township
Aerial Photo Number: 13A-5

Description of the Problem Area: Pa. Route 924 enters three sinks at P-158, P-154, and P-156. The runoff that is directed from Pa. Route 924 is diverted to these sinks and infiltrates to the mine workings.

Restoration Options: Fill in the sinks at P-154, P-158, and P-156 and construct a drain along the north side of Pa. Route 924. Construct a new channel 1,606 feet from P-156 to P-148, and connect it with the existing perimeter drain on the north side of the basin.

Restoration Limitations: This channel would prevent flow from Pa. Route 924 from entering the sinks. However, further investigation is needed to ensure that sufficient grade is present to promote positive drainage.

Next Step to Facilitate Restoration/Cost:

1. Determine whether or not this restoration option is feasible.

Location:	Cranberry Creek southeast of I-81 and Pa. Route 924 interchange
GPS ID Number:	P-135, P-134 and P-137
Coal Basin:	Western Hazleton Coal Basin
Hydrologic Basin:	Cranberry Creek
Quadrangle:	Conyngham
Municipality:	Hazle Township
Aerial Photo Number:	12A-7 and 11A-6

Description of the Problem Area: Drainage from P-132 and surrounding area and ponds drains into a sink located at P-134.

Restoration Options: Fill in the sink at P-134, reestablish a drainage channel from this point eastward 4,845 feet, and connect the channel at P-137.

Restoration Limitations: This channel would flow eastward for approximately 4,845 feet. Further field investigation is needed to determine if this restoration option would adequately transport the water from P-134 to P-137

Next Step to Facilitate Restoration/Cost:

1. Determine the most effective way to line the new channel to reduce infiltration;
2. Determine the condition of the channel east of P-134 to ensure that the channel can handle the additional flow; and
3. Determine whether or not this restoration option is feasible.

Location: Southwest portion of Hazleton just off of Pa. Route 309 (Beltway Diner)
GPS ID Number: P-413, P-414, P-415 and P-416
Coal Basin: Western Hazleton Coal Basin
Hydrologic Basin: Cranberry Creek
Quadrangle: Hazleton
Municipality: Hazleton
Aerial Photo Number: 11A-6

Description of the Problem Area: Drainage from Pa. Route 309 and surrounding area is channeled into a large sink at P-414 and secondary sinks at P-415 and P-416. This water enters into the mine workings from these locations.

Restoration Options: Fill in the sinks at P-414, P-415, and P-416. After the sinks are filled, further investigation is required to determine if the water will enter at another point or if a channel can be constructed to convey the water into Cranberry Creek.

Restoration Limitations: This restoration project is limited because of the options available to construct adequate means to convey the water out of the basin. Further investigation will be required to determine the best remediation strategy for this location.

Next Step to Facilitate Restoration/Cost:

1. Determine whether or not this restoration option is feasible; and
2. Determine where the water will go after these sinks are filled in.

Location: North Pa. Route 924 near Humbold
GPS ID Number: P-144
Coal Basin: Western Hazleton Coal Basin
Hydrologic Basin: Cranberry Creek
Quadrangle: Conyngham
Municipality: Hazle Township
Aerial Photo Number: 13A-5

Description of the Problem Area: A vertical opening exists at P-144. Overall, the contribution of this point to the Jeddo Tunnel system is quite small. However, this site does pose a safety concern.

Restoration Options: Seal the vertical opening.

Restoration Limitations: None.

Next Step to Facilitate Restoration/Cost:

1. Determine if this project is listed in BAMR's inventory of health and safety concerns.

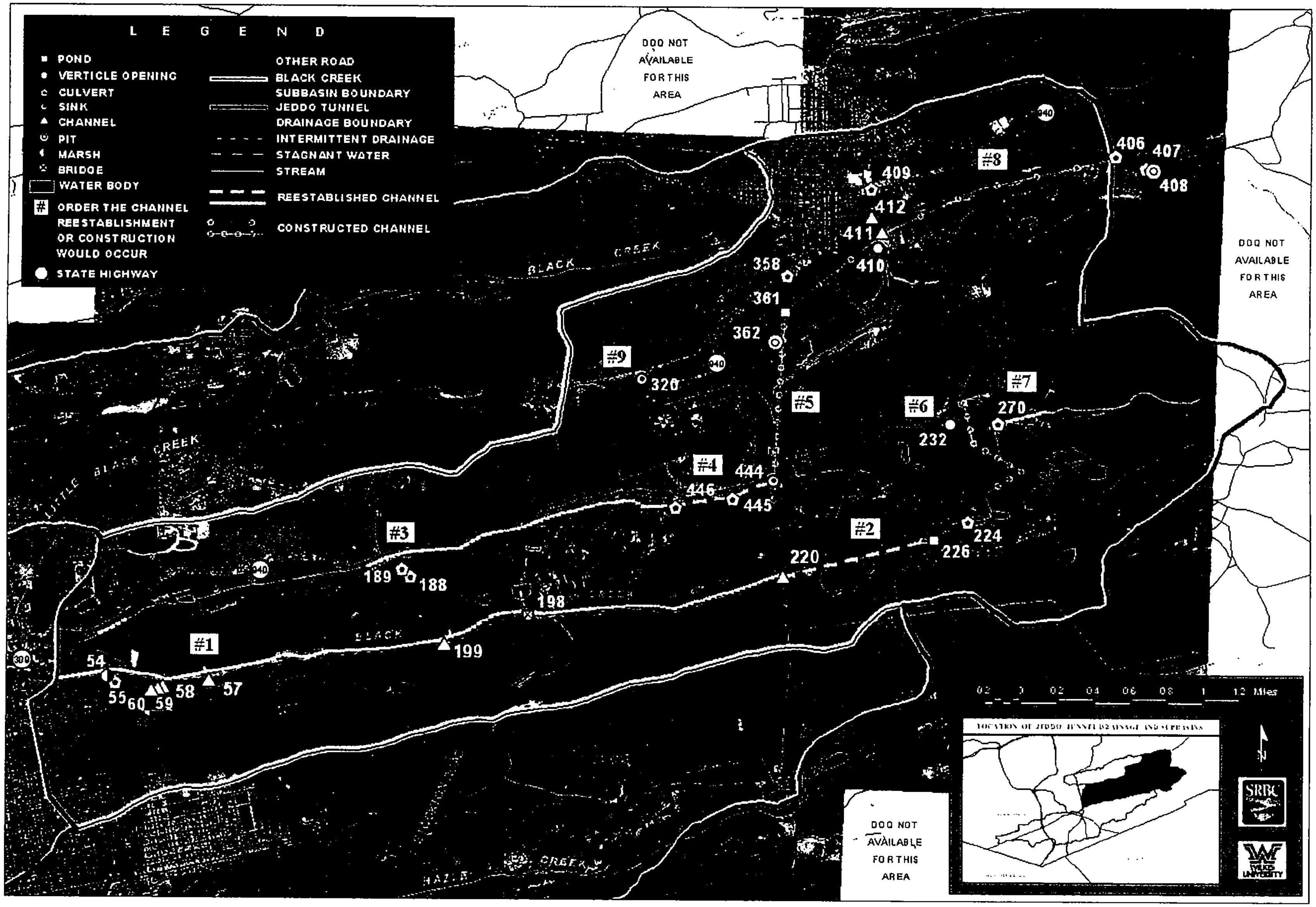

Figure A5. Digital Orthophotograps of Black Creek Subbasin, (Wildlands/SRBC, 1999)

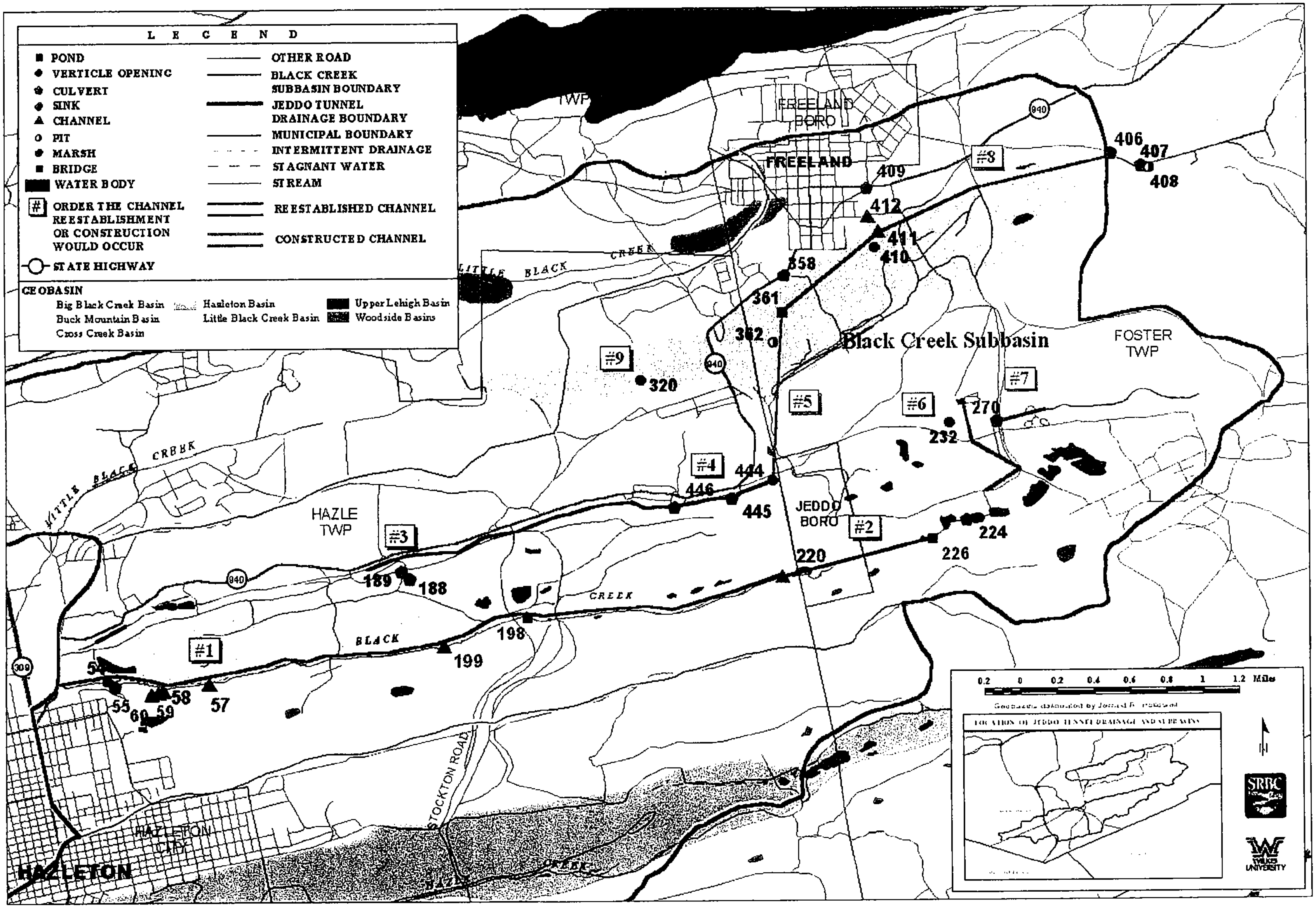

Figure A6. Future Surface Hydrology in the Black Creek Subbasin, (Wildlands/SRBC, 1999)

BLACK CREEK COAL BASIN—
BLACK CREEK DRAINAGE

The Black Creek Coal Basin covers an area 12.45 square miles, which represents 39 percent of the current Jeddo Tunnel drainage area.. The coal basin has been extensively mined and there are several active surface mining permits within the basin. The area was originally drained by Black Creek, a tributary of Nescopeck Creek.

During the initial field investigation, several points of interest were identified within the basin that could potentially reduce the infiltration to the mine workings drained by the Jeddo Tunnel. This information was collected and analyzed to determine what and where restoration should occur. A majority of the infiltration points in this basin are associated directly with the Black Creek channel itself.

The restoration of the Black Creek Coal Basin will require work at seven sites in the perimeter drain system and two sites of sinks or other features that are contributing surface water into the Jeddo Tunnel system. Sites are listed in order of priority, based on impact to the system and on environmental benefit.

Location: Black Creek from 940 eastward to 1.25 miles east of Stockton Road
GPS ID Number: P-54, P-55, P-53, P-61, P-60, P-58, P-59, P-57, P-206, P-207, P-204, P-203, P-209, P-201, P-200, P-199, P-198
Coal Basin: Black Creek Coal Basin
Hydrologic Basin: Black Creek
Quadrangle: Hazleton
Municipality: Hazle Township
Aerial Photo Number: 10A-8 & 9A-7

Description of the Problem Area: Black Creek is blocked up in certain locations, and does not allow for positive drainage. The area of concern extends from Pa. Route 940 eastward to approximately 1.25 miles east of Stockton Road.

Restoration Options: Repair and take out the existing blockages, and line the existing Black Creek stream channel to promote positive drainage out of the basin.

Restoration Limitations: Any project associated with increasing the discharge in the Black Creek channel needs to look at the impacts of the restricted channel as Black Creek flows under the mall between Pa. Routes 940 and 309.

Next Step to Facilitate Restoration/Cost:

1. Determine the most effective way to line the new channel to reduce infiltration;
2. Determine the impact of increased discharge on the channel restriction located at the mall; and
3. Determine the location and extent of each blockage in the Black Creek channel.

Location: Black Creek from power line eastward to the railroad
GPS ID Number: P-224, P-226, P-220
Coal Basin: Black Creek Coal Basin
Hydrologic Basin: Black Creek
Quadrangle: Hazleton
Municipality: Hazle Township
Aerial Photo Number: 8A-6

Description of the Problem Area: The Black Creek channel exists in this area, but is discontinuous. We need to reconnect the segments of Black Creek channel between several ponds that exist between the railroad tracks and the power line to the west.

Restoration Options: Reestablish the Black Creek drainage channel from the power line P-220 4,506 feet eastward to P-226, which is the outlet from the last ponds. These ponds are connected with existing channels all the way west under the railroad embankment to P-222. A settling pond will be necessary to capture the fine-grained coal waste presently being transported from upstream of the railroad embankment. Also, it is believed that water is entering the mine workings from under the railroad culvert. This culvert should be relined to ensure positive drainage.

Restoration Limitations: Any project associated with increasing the discharge in the Black Creek channel needs to look at the impacts of the restricted channel as Black Creek flows under the mall between Pa. Routes 940 and 309.

Next Step to Facilitate Restoration/Cost:

1. Determine the most effective way to line the new channel to reduce infiltration; and
2. Determine the impact of increased discharge on the channel restriction located at the mall.

Location: North side of Black Creek Coal Basin Ebervale to Pa. Route 940 bridge
GPS ID Number: P-188, P-189, 2P-13-outlet from ponds
Coal Basin: Black Creek Coal Basin
Hydrologic Basin: Black Creek
Quadrangle: Hazleton
Municipality: Hazle Township
Aerial Photo Number: 10A-8

Description of the Problem Area: The Black Creek channel exists in this area but is discontinuous and does not transport water out of the basin.

Restoration Options: Reestablish a perimeter drain along the north side of the coal basin from the point just east of the Pa. Route 940 bridge where a channel does exist—946 feet to the existing perimeter drain.

Restoration Limitations: Any project associated with increasing the discharge in the Black Creek channel needs to look at the impacts of the restricted channel as Black Creek flows under the mall between Pa. Routes 940 and 309. An alternate option is to take the water north of the mall and run it through an existing wetlands, pipe it under the used car lot between Pa. Routes 940 and 309, and have it enter Black Creek below the mall, thus avoiding the restricted channel at the mall.

Next Step to Facilitate Restoration/Cost:

1. Determine the most effective way to line the new channel to reduce infiltration;
2. Determine the impact of increased discharge on the channel restriction located at the mall if the alternate option is not feasible; and
3. Determine the impact of increased discharge from the development north of Pa. Route 940 on the existing perimeter drain.

Location: North side of Black Creek Coal Basin near Ebervale
GPS ID Number: P-444, P-136, P-445, P-446, P-451
Coal Basin: Black Creek Coal Basin
Hydrologic Basin: Black Creek
Quadrangle: Hazleton
Municipality: Hazle Township
Aerial Photo Number: 9A-7

Description of the Problem Area: The lack of an effectively-working perimeter drain immediately south of Ebervale has allowed surface water to enter the mine workings at several locations. The first of these is P-444 and then at multiple points extending westward along the south side of Ebervale.

Restoration Options: Establish a perimeter drain along the north side of the coal basin from P-444, near Jeddo, westward to Oakdale, a total of 17,448 feet. This perimeter drain needs to be extended westward to LP3's office and connect with the existing perimeter drain from that location westward and out of the basin.

Restoration Limitations: Any project associated with increasing the discharge in the Black Creek channel needs to look at the impacts of the restricted channel as Black Creek flows under the mall between Pa. Routes 940 and 309. This restoration option could require significant amounts of fill in order to reestablish this perimeter drain.

Next Step to Facilitate Restoration/Cost:

1. Determine the most effective way to line the new channel to reduce infiltration;
2. Determine the impact of increased discharge on the channel restriction located at the mall; and
3. Determine the scale of this project, because it may require significant amounts of fill to reestablish the perimeter drain.

Location: Cross Creek Coal Basin near Freeland
GPS ID Number: P-358 (sewage point discharge), P-361 (large sink with sewage), and P-362 (secondary sink below P-361)
Coal Basin: Black Creek Coal Basin
Hydrologic Basin: Black Creek
Quadrangle: Freeland
Municipality: Foster Township
Aerial Photo Number: 9A-7 & 9A-8

Description of the Problem Area: Surface-water runoff and sewage from the Borough of Freeland enters two sinks, P-361 and P-362, and the water infiltrates into the mine workings.

Restoration Options: Construct a perimeter channel along the north side of the Cross Creek Coal Basin from the south edge of Freeland. Fill in the sinks at P-361 and P-362 and construct a channel approximately 4,915 feet from P-362 southward along Pa. Route 940, and connect it with the perimeter drain that will need to be constructed at P-444.

Restoration Limitations: Any project associated with increasing the discharge in the Black Creek channel needs to look at the impacts of the restricted channel as Black Creek flows under the mall between Pa. Routes 940 and 309. The water entering these two sinks contains significant amounts of sewage. This issue would have to be addressed before this water was allowed to remain on the surface. The channel restoration at P-444 and the perimeter drain running westward from this point would have to be constructed first.

Next Step to Facilitate Restoration/Cost:

1. Determine if the sewage upgrades planned for this area will incorporate the problem areas identified during our initial field investigation;
2. Determine the feasibility of constructing this new channel;
3. Determine the most effective way to line the new channel to reduce infiltration; and
4. Determine the impact of increased discharge on the channel restriction located at the mall.

Location: North side of Black Creek Coal Basin West of Jeddo
GPS ID Number: P-232
Coal Basin: Black Creek Coal Basin
Hydrologic Basin: Black Creek
Quadrangle: Hazleton
Municipality: Hazle Township
Aerial Photo Number: 8A-6

Description of the Problem Area: P-232 is a sink where water is entering the mine workings. The area has a concrete foundation and is possibly an old shaft of some other structure associated with past mining activity. Water from an upstream pond and the surrounding wooded area enters this point and infiltrates to the mine workings.

Restoration Options: Construct a channel from P-232 approximately 1,232 feet to P-265, where a channel does exist. The channel runs southward along the road for a distance of 1,576 feet. A new channel then would need to be constructed from P-263 westward for approximately 1,162 feet and connect with the existing channel at P-222.

Restoration Limitations: Any project associated with increasing the discharge in the Black Creek channel needs to look at the impacts of the restricted channel as Black Creek flows under the mall between Pa. Routes 940 and 309. This project would have to be completed after the channel from P-226 to P-220 was constructed. Further investigation may be required to ensure the success of this restoration project.

Next Step to Facilitate Restoration/Cost:

1. Determine the feasibility of constructing this new channel;
2. Determine the most effective way to line the new channel to reduce infiltration;
3. Determine if the amount of water entering the point at P-232 warrants this extensive restoration project; and
4. Determine the impact of increased discharge on the channel restriction located at the mall.

Location: Northeast corner of Black Creek Coal Basin
GPS ID Number: P-245, P-270, and L97-6
Coal Basin: Black Creek Coal Basin
Hydrologic Basin: Black Creek
Quadrangle: Hazleton
Municipality: Foster Township
Aerial Photo Number: 8A-6

Description of the Problem Area: Surface water from the surrounding area and wetlands flows down the power line and enters a large sink at P-245.

Restoration Options: A perimeter drain exists directly to the east of the area, where the water is leaving the wetlands and crossing onto the power line. This existing perimeter drain could be extended westward approximately 1,439 feet to P-270. This perimeter drain would capture drainage from the wetland area and transport it to P-270, which is connected by existing channels to P-265.

Restoration Limitations: Any project associated with increasing the discharge in the Black Creek channel needs to look at the impacts of the restricted channel as Black Creek flows under the mall between Pa. Routes 940 and 309. This project would have to be completed after the channels from P-226 to P-220 and from P-265 to P-222 are constructed. This restoration option also would require the movement of a large culm pile directly west of the wetlands and in direct line of the proposed channel. Further investigation may be required to ensure the success of this restoration project.

Next Step to Facilitate Restoration/Cost:

1. Determine the feasibility of constructing this new channel;
2. Determine the most effective way to line the new channel to reduce infiltration; and
3. Determine the impact of increased discharge on the channel restriction located at the mall.

Location: Cross Creek Coal basin near Freeland
GPS ID Number: P-406 through P-412
Coal Basin: Cross Creek Coal Basin
Hydrologic Basin: Black Creek
Quadrangle: Freeland
Municipality: Foster Township
Aerial Photo Number: 8A-8 & 9A-8

Description of the Problem Area: The absence of an effectively-working perimeter drain in this area southeast of Freeland has allowed several areas where surface water is entering the mine workings to occur.

Restoration Options: Construct a perimeter channel along the north side of the Cross Creek Coal Basin from P-406 westward approximately 10,807 feet to the south edge of Freeland. This channel then could be extended westward and connect with the perimeter drain proposed from P-362. This drain also would catch drainage, which is currently entering a sink at P-410.

Restoration Limitations: Any project associated with increasing the discharge in the Black Creek channel needs to look at the impacts of the restricted channel as Black Creek flows under the mall between Pa. Routes 940 and 309. This project would have to be completed after the channel from P-362 was constructed, the channel at P-444 was restored, and the perimeter drain running westward from this point was constructed. This project will require significant amounts of fill material and channel construction. Further investigation may be required to ensure the success of this restoration project.

Next Step to Facilitate Restoration/Cost:

1. Determine the feasibility of constructing this new channel;
2. Determine the most effective way to line the new channel to reduce infiltration; and
3. Determine the impact of increased discharge on the channel restriction located at the mall.

Location: Black Creek Coal Basin southwest of Freeland
GPS ID Number: P-320
Coal Basin: Black Creek Coal Basin
Hydrologic Basin: Black Creek
Quadrangle: Hazleton/Freeland
Municipality: Hazle Township
Aerial Photo Number: 9A-8

Description of the Problem Area: Surface water is entering this sink that is located in a small mined area southwest of Freeland. Overall the contribution of this point to the Jeddo Tunnel system is quite small.

Restoration Options: Backfilling of the pit to its original contour should resolve the infiltration at this point. After the area is filled, the area should be reexamined to determine if the water is entering at any other point.

Restoration Limitations: The only limitation for this restoration project is the amount of material that would be needed to fill in and grade P-320.

Next Step to Facilitate Restoration/Cost:

1. Determine the amount of fill required to bring P-320 up to required grade;
2. Determine if the cost of the project is worth the small environmental gain expected from the project; and
3. Determine where the water will go after this area is reclaimed.

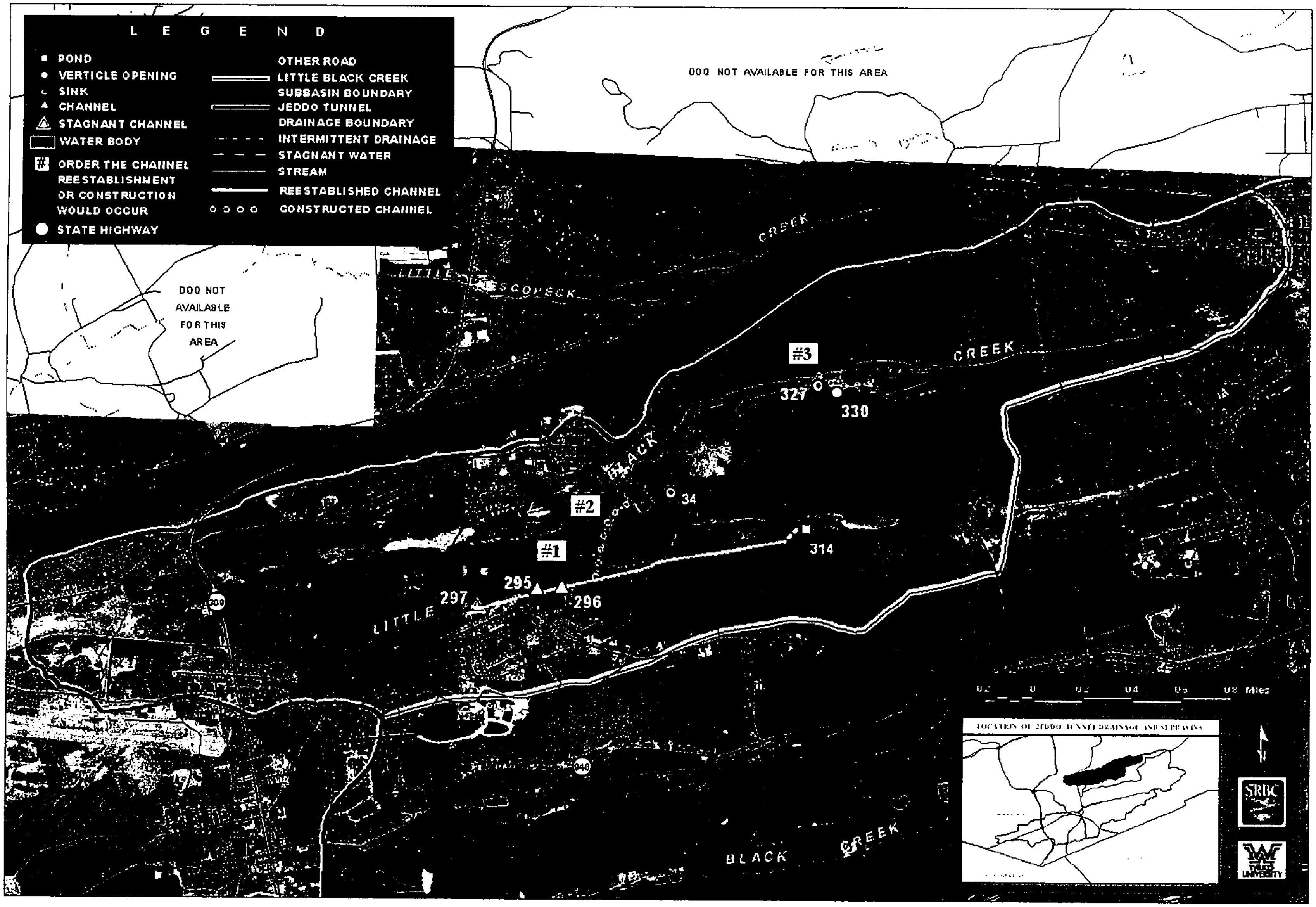

Figure A7. Digital Orthophotographs of the Little Black Creek Subbasin, (Wildlands/SRBC, 1999)

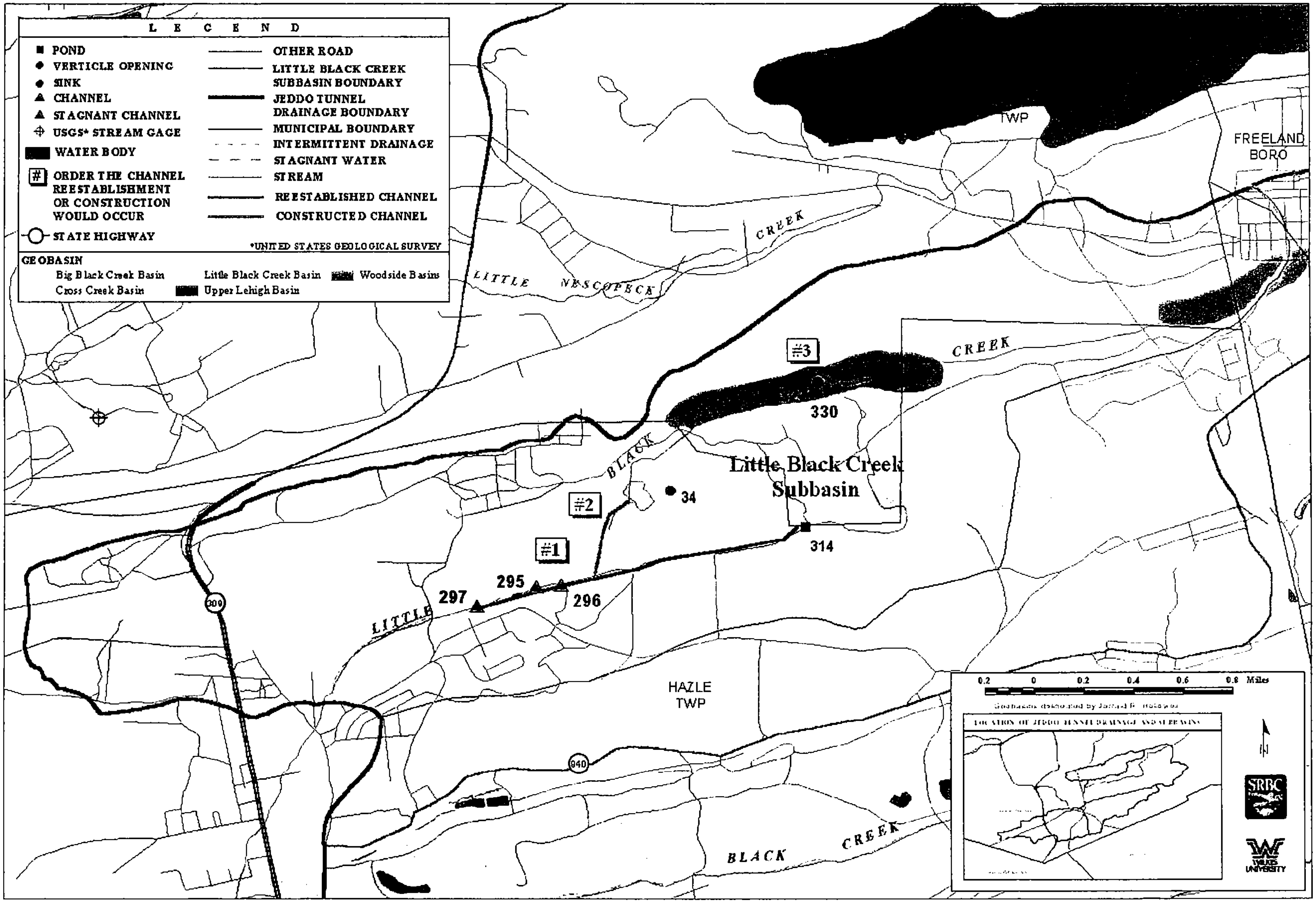

Figure A8. Future Surface Hydrology of the Little Black Creek Subbasin, (Wildlands/SRBC, 1999)

Map of Little Black Creek Coal Basin/Little Black Creek Drainage Basin

LITTLE BLACK CREEK COAL BASIN—
LITTLE BLACK CREEK DRAINAGE

The Little Black Creek Coal Basin covers an area of 4.64 square miles, which represents 14 percent of the current Jeddo Tunnel drainage area.. This coal basin has been extensively mined, and there are several active surface mining permits within the basin. The area was originally drained by Little Black Creek, a tributary of Nescopeck Creek.

During the initial field investigation, several points of interest were identified within this basin that could potentially reduce the infiltration to the mine workings drained by the Jeddo Tunnel. This information was collected and analyzed to determine what and where restoration options should occur. A majority of the infiltration points in this basin are associated directly with the Little Black Creek channel itself.

The restoration of the Little Black Creek Coal Basin will require work at three sites in the perimeter drain system. Sites are listed in order of priority, based on impact to the system and on environmental benefit.

Location: Little Black Creek Coal Basin near Lattimer
GPS ID Number: P-294, P-296, P-295, P-297
Coal Basin: Little Black Creek Coal Basin
Hydrologic Basin: Little Black Creek
Quadrangle: Hazleton
Municipality: Hazle Township
Aerial Photo Number: 10A-8

Description of the Problem Area: The perimeter drain along the southern edge of Little Black Creek Coal Basin contains several blockages and currently cannot transport water. A major channel block exists at P-297. At this point, the water would have to be piped under the existing parking lot, in order for the channel to extend to P-298, where the channel is intact and does transport water.

Restoration Options: Remove blockages from the existing perimeter drain channel on the south side of the basin in the Lattimer area. The area where the blockages occur is about 7,054 feet in length. There are roughly five or six blockages in the channel before you get to point P-297, where a major channel block exists. At this point, the water would have to be piped under the existing parking lot, in order for the channel to extend to P-298, where the channel is intact and does transport water. This channel will be extended eastward to drain the ponds at P-314 at the headwaters of Little Black Creek. Some backfilling of pits may be necessary to construct the channel from P-314 westward to the existing channel.

Restoration Limitations: Point P-297 is a potential area of concern. The existing channel has been filled, and a parking lot has been built over the existing channel. If this section on the channel cannot be restored, the water will not effectively leave the basin, and any work completed to remove the blockages upstream will not transport water out of the basin. The amount of fill material that may be necessary to connect the ponds at P-314 to the existing perimeter drain may be significant. This project can only be completed after the blockages are removed from the perimeter drain. Condition of old Little Black Creek channel from Pa. Routes 940 to 309 would have to be checked and constrictions removed.

Next Step to Facilitate Restoration/Cost:

1. Determine the most effective way to line the new channel to reduce infiltration;
2. Determine if the section of channel at P-298 can be passed before any blockages are removed;
3. Determine if the large ponds to the east of the channel can be connected once the blockages from the channel are removed; and
4. Determine the condition of old Little Black Creek channel from Pa. Route 940 to Pa. Route 309 and remove any constrictions.

Location: Woodside Coal Basin east of Pardeesville
GPS ID Number: P-34
Coal Basin: Woodside Coal Basin
Hydrologic Basin: Little Black Creek
Quadrangle: Freeland
Municipality: Hazle Township/Butler Township
Aerial Photo Number: 10A-8

Description of the Problem Area: Drainage from the Woodside Coal Basin passes through several large ponds and is diverted into a large sink located at P-34.

Restoration Options: A diversion channel would be necessary, going westward along the south edge of Pardeesville and then turning southward 1,822 feet across the Little Black Creek Coal Basin to the west end of Lattimer. At that point, a new channel would connect with the existing perimeter channel. This would require considerable backfilling of the existing pit, but there are two large waste banks on either side of the pit that could be directly pushed into the pit. (It would require a lot of material to cross Little Black Creek Coal Basin, but initial field investigation shows that enough grade would exist in the channel to create positive flow.)

Restoration limitations: This project would require considerable earthmoving to cross the existing Little Black Creek Coal Basin. This project also would be dependent on the reconnection and blockage removal of the Little Black Creek channel.

Next Step to Facilitate Restoration/Cost:

1. Determine the most effective way to line the new channel to reduce infiltration; and
2. Determine the feasibility of constructing a channel across the Little Black Creek Basin.

Location: Woodside Coal Basin east of Pardeesville
GPS ID Number: P-327, P-330
Coal Basin: Woodside Coal Basin
Hydrologic Basin: Little Black Creek
Quadrangle: Freeland
Municipality: Hazle Township/Butler Township
Aerial Photo Number: 9A-8

Description of the Problem Area: Drainage from a pond at the headwater of the Woodside Coal Basin is partially diverted into two large sinks, P-327 and P-330.

Restoration Options: Fill in the two areas of infiltration and establish a channel from this area 1,181 feet to the existing channel that transports water from the pond at P-324 to the pond at P-331.

Restoration Limitations: This project would need to be completed after the drainage from Woodside basin has been successfully transported across the Little Black Creek Coal Basin.

Next Step to Facilitate Restoration/Cost:

1. Determine the most effective way to line the new channel to reduce infiltration; and
2. Determine the feasibility of filling in and diverting the water from P-327 and P-330.

APPENDIX B

EXPLANATION OF WATER QUALITY PARAMETERS

Explanation of Water Quality Parameters

pH

Background: pH is based on a scale from 0 to 14. On this scale, 0 is the most acidic value, and 14 is the most alkaline value. Seven would be neutral. A change of one pH unit represents a 10-fold change in acidity or alkalinity. Type of bedrock and other natural conditions may affect pH readings. For instance, streams underlain by limestone may reach a pH as high as 9. In addition, abundance of algae may cause pH to become more acidic after sundown, and then increase after dawn due to changes in carbon dioxide concentrations. However, abnormal pH values may be indicative of pollution.

Sources of Abnormal Readings: Sources of abnormal readings include acid mine drainage, industrial effluent, acid rain, sewage lagoons, and livestock containment areas. Sources of alkaline conditions include concrete plants, water treatment plants, and raw sewage.

Standards: pH levels between 6.5 and 8.2 are optimal for most aquatic organisms. The DEP Water Quality Standard for pH is between 6 and 9.

SPECIFIC CONDUCTANCE

Background: The specific conductance of a stream measures the quantity of ions in the water, or the ability of the water to conduct an electrical current. Conductivity is typically measured in microhoms. Geologic formations have significant impact on the specific conductance of a stream. Streams flowing through carbonate bedrocks often yield high conductivity. Specific conductance values typically have a direct relationship to total dissolved solids (TDS), which is the concentration of dissolved materials, such as salts, found in the water.

Sources of Abnormal Readings: A specific conductance or TDS value falling outside the normal range for a site may be caused by almost any pollutant. Point-source discharges as well as storm water runoff may be contributors to excessive readings. Basically these testing parameters serve as a check to make sure pollutants are not being overlooked that are not part of the regular sampling routine.

ALKALINITY

Background: Alkalinity measures the ability of a stream to resist changes in pH. This property is often referred to as the buffering capacity of a stream. Buffering capacity is important because it allows a stream to assimilate acidic pollution or contamination. Like specific conductance, alkalinity is greatly determined by the type of underlying bedrock and also the soil type through which the water flows.

Source of Abnormal Readings: Alkalinity values in excess of what bedrock types indicate as normal may be a result of sewage, livestock wastes, and/or the production of concrete. Very low readings may be due to heavy rains or other acidic contamination. Abrupt changes in alkalinity may signify pollution.

Standards: Alkalinity levels between 100 and 200 mg/l provide ideal buffering within a stream. Endurable pH levels may be maintained at this level of alkalinity, and aquatic life may be protected from acidic shock. This occurs when there is a sudden decrease in pH to which aquatic life can not rapidly adapt for survival.

TOTAL HARDNESS

Background: Total hardness tests usually measure the calcium and magnesium carbonate concentration in a water sample. These are the major components of hardness, which is the amount of dissolved minerals in water. Minerals are dissolved from bedrock and soil as water passes through them. The calcium component of hardness is very important to aquatic life as it is used for the cell walls of plants and the shells and bones of aquatic organisms. However, high levels of hardness can cause precipitation and deposition of calcium carbonate on the stream bottom, which disrupts normal stream activity. Water with high hardness may also cause plumbing problems. Hard water also aids buffering capacity as heavy metals and other toxic compounds may be more detrimental in soft water than in hard water.

Sources of Abnormal Readings: High hardness values are often associated with limestone formations.

Standards: Optimal values of hardness for aquatic life range from 100 to 200 mg/L. At levels above 250 mg/L, calcium carbonate will begin to precipitate. Hardness values should be slightly higher than alkalinity values. If there is a major difference between the two values, chloride and sulfate ions may be present.

SULFATE

Background: Sulfur is commonly found as a component of sedimentary and igneous rocks in the form of metallic sulfides. Sulfides are oxidized upon contact with aerated water, producing sulfate ions in solution. The combustion of fuel and ore-smelting processes are major anthropocentric causes of sulfate found in natural waters. Sulfides may also be present in soils that are oxidized through natural processes or organic waste treatment. Sulfate also occurs in evaporite sediments such as anhydrite and gypsum.

Sources of Abnormal Readings: Excessively high sulfate readings are often associated with mine drainage. The oxidation of minerals such as pyrite is the main culprit. High sulfate as well as chloride concentrations may be found in residual runoff from irrigated areas due to water that was lost through evapotranspiration.

Standards: The drinking water standard for sulfate is 250 mg/L. Beyond this point, sulfate levels may cause illness in humans.

IRON
Background: Although iron is the second most abundant metallic element on the earth, concentrations in water are generally small. Iron is an essential element in the metabolism of animals and plants. If present in water in excessive amounts, however, it forms red oxyhydroxide precipitates.

Sources of Abnormal Readings: Lower pH and higher iron concentration can occur in coal mine drainage water.

Standards: A recommended upper limit for iron in public water supplies is 0.3 mg/L.

CHLORIDE
Background: Chloride is contained in rock and soil, the wastes of animals and stems from the decomposition of living things. The value of chloride, for the purpose of water quality monitoring, is its role as an indicator of other substances. Traced to its source, it frequently leads to other, more serious, problems.

Sources of Abnormal Readings: Street salting, sewage, failing septic systems, landfills, various industries.

Standards: Levels of 0-16 mg/L are considered normal, levels of 17-36 mg/L are suspect and levels greater than 36 mg/L are considered to be a problem. Above 400 mg/L chloride may be toxic to aquatic life.

MANGANESE
Background: Manganese is an essential element for both plant and animal life, is an undesirable impurity in water supplies, and tends to deposit black oxide stains.

Sources of Abnormal Readings: Manganese is often present to the extent of more than 1 mg/L in streams that have received acid drainage from coal mines.

Standards: The recommended upper limit for manganese in public water supplies is 0.05 mg/L.

CALCIUM
Background: Calcium is the most abundant of the alkaline-earth metals and is a major constituent of many common rock minerals. It is an essential element for plant and animal life and is a major component of the solutes in most natural water.

Sources of Abnormal Readings: Calcium is generally a predominant cation in river waters. Measured pH in river water is generally not well correlated with calcium concentration.

Standards: The average concentration of calcium in river water is between 13.4 and 15 mg/L.

POTASSIUM

Background: Potassium is an essential element in both plants and animals. Maintenance of optimum soil fertility entails providing a supply of available potassium. The element is present in plant material and is lost by crop harvesting and removal as well as by leaching and runoff acting on organic residues.

Sources of Abnormal Readings: Biological factors may be important in controlling the availability of potassium for solution in river and ground water. At times of relatively high water discharge many streams carry potassium concentrations nearly as high as they do at times of low discharge. This may be the result of soil leaching by runoff.

Standards: Concentrations more than a few tens of mg/L are unusual except in water having high dissolved-solids concentrations.

ALUMINUM

Background: Aluminum rarely occurs in solution in natural water in concentrations greater than a few tenths or hundreds of a milligram per liter. The exceptions are mostly waters of a very low pH. The dissolved aluminum in waters having low pH has a deleterious effect on fish and some other forms of aquatic life.

Sources of Abnormal Readings: Water having a pH below 4.0, like water draining from abandoned mines, may contain several hundred or even several thousand milligrams of aluminum per liter. Elevated aluminum concentrations have also been observed in runoff and lake waters in areas affected by low pH precipitation.

Standards: Water having a pH below 4.0 may contain several thousand milligrams of aluminum per liter. Occasional reported concentrations of 1.0 mg/L or more having a neutral pH and no unusual complexing ions probably represents particulate material.

ZINC

Background: Zinc is essential in plant and animal metabolism, but water is not a significant source of the element in the dietary sense. It has about the same abundance in crustal rocks as copper or nickel and is thus fairly common. Zinc can be considered an undesirable contaminant for some species of aquatic life.

Sources of Abnormal Readings: Streams affected by acid mine drainage commonly contain 100µg/L or more. Modern industry has several applications for zinc and has helped to widely distribute in water.

Standards: 5 mg/L is considered the upper limit for zinc because above this limit it can be detected by taste. Concentrations in river water range from 5 to 45 µg/L.

SUSPENDED SOLIDS

Background: Includes all particles in water that will not pass through a filter having openings of .45 microns in diameter. Typically suspended solids include items such as soil, algal cells and plant particles. High levels of suspended solids may smother aquatic organisms.

Sources of Abnormal Readings: High suspended solids may occur below sewage treatment plants, construction sites and farms where erosion rates are high, various industries and below algal-choked lakes.

Standards: It is recommended that suspended solids not exceed 25 mg/L. Unpolluted streams usually have concentrations less than 10 mg/L.

TEMPERATURE

Background: Temperature is a key determinant of what species can survive in a particular environment. Although temperature preferences vary widely among species, they do have one commonality. All species are negatively impacted by rapid fluctuations in temperature.

Sources of Abnormal Readings: Discharges of coolant and waste waters from industrial or utility plants, runoff from heated surfaces such as pavement and roofs, and lack of stream cover to provide shading are among the top sources of thermal pollution.

Standards: Life and the reproductive necessities for trout are the target standards for water temperature. Growth is impaired in an adult brook trout at temperatures above 66°F or about 19°C. Death of brook trout will occur at temperatures above 75°F or about 24°C. DEP Water Quality Standards dictate a temperature no greater than 66°F for a high quality, cold water fishery (HQCWF). There should also be no fluctuation greater than 2°F in a one-hour period.

DISSOLVED OXYGEN

Background: Dissolved oxygen is absorbed from the atmosphere and its concentration is related to the temperature and density of the water. Cold water can hold more oxygen than warm water. Therefore low values can sometimes be attributed to shallow, poorly-shaded water, which can cause warming and decrease the amount of oxygen the water can hold. Plant life also influences dissolved oxygen content. Plant life may cause a diurnal fluctuation in DO levels. During the day, while plants are undergoing photosynthesis, they emit oxygen to the stream. However, the DO level will drop at night while the plants are not producing oxygen, but fish and other aquatic life are still consuming it. The result is a drop in DO at night, reaching a minimum just before dawn, then rising to a peak by late afternoon. Thus, plant life may have a dramatic impact on DO levels.

Sources of Abnormal Readings: In areas of dense algae growth, DO levels are likely to drop significantly at night or increase excessively during the day. Low readings may also be indicative of pollutants, such as inadequately treated sewage, introduced to the water supply that consume the available oxygen so that it is not available to aquatic life. Bacteria are capable of consuming large quantities of oxygen during the decomposition of organic material. High DO levels may occur where turbulent conditions increase the natural aeration of the stream.

Standards: For unimpaired production, trout require a dissolved oxygen (DO) level of at least 7 mg/L, which is the minimum water quality standard set by the DEP for a high quality, cold-water fishery (HQCWF) such as the Little Nescopeck Creek.

NITROGEN

Background: Nitrogen exists in several forms in the aquatic environment. Nitrate is the most completely oxidized state of nitrogen commonly found in water, and is the most readily available state utilized for plant growth. Since nitrate plays a key role in stimulating plant growth, it is heavily used as a nutrient component of fertilizer. High nitrate levels in streams cause excessive plant and algae growth and promote a deteriorating process called eutrophication.

Sources of Abnormal Readings: Fertilizer runoff resulting from improper application, human and animal wastes from failing septic systems and livestock confinement areas, and decomposing organic matter are all causes for elevated nitrate readings.

Standards: Unpolluted waters will normally have a nitrate level less than 1 mg/L. The DEP water quality standard for nitrate is 10 mg/L. At higher concentrations water is unsafe to drink due to the possible presence of altered forms of nitrite, which may cause serious illness to both man and wildlife.

ORTHO-PHOSPHATE

Background: Ortho-phosphate is just one form of phosphorus found in natural waters. This is the tested form of phosphate because it is the form of phosphate used in fertilizer and applied to agricultural fields and residential lawns. Other forms of phosphorus found in natural waters that have not been tested include polyphosphates, and organically-bound phosphates. Phosphates naturally found in water are derived from decomposing organic material and leaching of phosphorus-rich bedrock. Like nitrates, phosphates negatively impact water by causing accelerated rates of eutrophication.

<u>Sources of Abnormal Readings</u>: Fertilizer runoff; human and animal waste from failing septic systems, sewage treatment plants, and livestock confinement areas; mass quantities of decomposing organic matter; industrial effluent; and detergent wastewater are all possible sources of elevated phosphate levels. Detergent wastewaters are responsible for approximately half of the phosphates polluting natural waters.

<u>Standards</u>: Phosphate levels below 0.03 mg/l are generally considered to be unpolluted. Levels between 0.03 and 0.1 mg/l are sufficient to stimulate plant growth. The critical level for avoiding accelerated eutrophication is 0.1 mg/L. Levels above 0.1 mg/l are considered problem areas. There has not been a standard set for safe drinking water because humans can tolerate extremely high levels before it even takes effect on the digestive system.

APPENDIX C

NESCOPECK AND LITTLE NESCOPECK CREEKS WATER QUALITY DATA

Water Quality Data at the Jeddo Tunnel and throughout the Nescopeck and Little Nescopeck Creeks (July 1998)

Parameter	Concentration	1	2	3	4	5	6	7	8	9
Specific Conductance	µmohms	178.30	729.00	704.00	668.00	663.00	77.30	365.00	329.00	300.00
pH	-	6.20	4.40	4.40	4.60	4.60	6.50	4.90	4.90	4.90
Total Alkalinity	mg/L CaCO3	19 (est.)	0.00	0.00	1.60	1.80	10.00	2.60	2.80	2.80
Total Acidity	mg/L	0.00	64.00	60.00	52.00	45.00	0.00	22.00	22.00	15.40
Flow	cfs	2.18	48.40	58.06	63.10	58.96	43.85	128.93	139.86	191.54
Ammonia	mg/L NH3	0.02	0.07	0.07	0.10	0.20	0.02	0.10	0.07	0.22
Nitrite	mg/L NO2	<0.01	<0.01	<0.01	<0.01	<0.01	0.02	<0.01	<0.01	<0.01
Nitrate	mg/L NO3	1.51	0.17	0.17	0.43	0.43	0.48	0.45	0.75	1.07
Phosphorous	mg/L P	<0.02	<0.02	<0.02	0.02	0.02	0.02	0.02	0.02	0.04
Total Hardness	mg/L CaCO3	33.00	79.00	79.00	280.00	270.00	17.00	137.00	113.00	101.00
Total Calcium	mg/L Ca	16.20	37.70	31.90	32.90	32.60	10.00	17.60	16.50	14.80
Total Magnesium	mg/L Mg	3.42	64.60	64.60	48.00	47.40	1.17	22.90	22.90	16.80
Total Sulfate	mg/L SO4	<10.00	274.00	285.00	243.00	244.00	11.00	131.00	131.00	93.00
Iron	ug/L Fe	380.00	2510.00	2480.00	1730.00	1630.00	284.00	854.00	854.00	628.00
Manganese	ug/L Mn	108.00	3960.00	3730.00	3170.00	3060.00	25.00	1300.00	1300.00	977.00
Nickel	ug/L Ni	<50.00	183.00	151.00	143.00	138.00	<50.00	64.00	64.00	<50.00
Zinc	ug/L Zn	<10.00	621.00	606.00	486.00	466.00	<10.00	206.00	206.00	162.00
Aluminum	ug/L Al	<200.00	8770.00	8510.00	7110.00	6790.00	<200.00	2930.00	2930.00	1900.00

Table C2. Pa. DEP Water Quality, July 1998

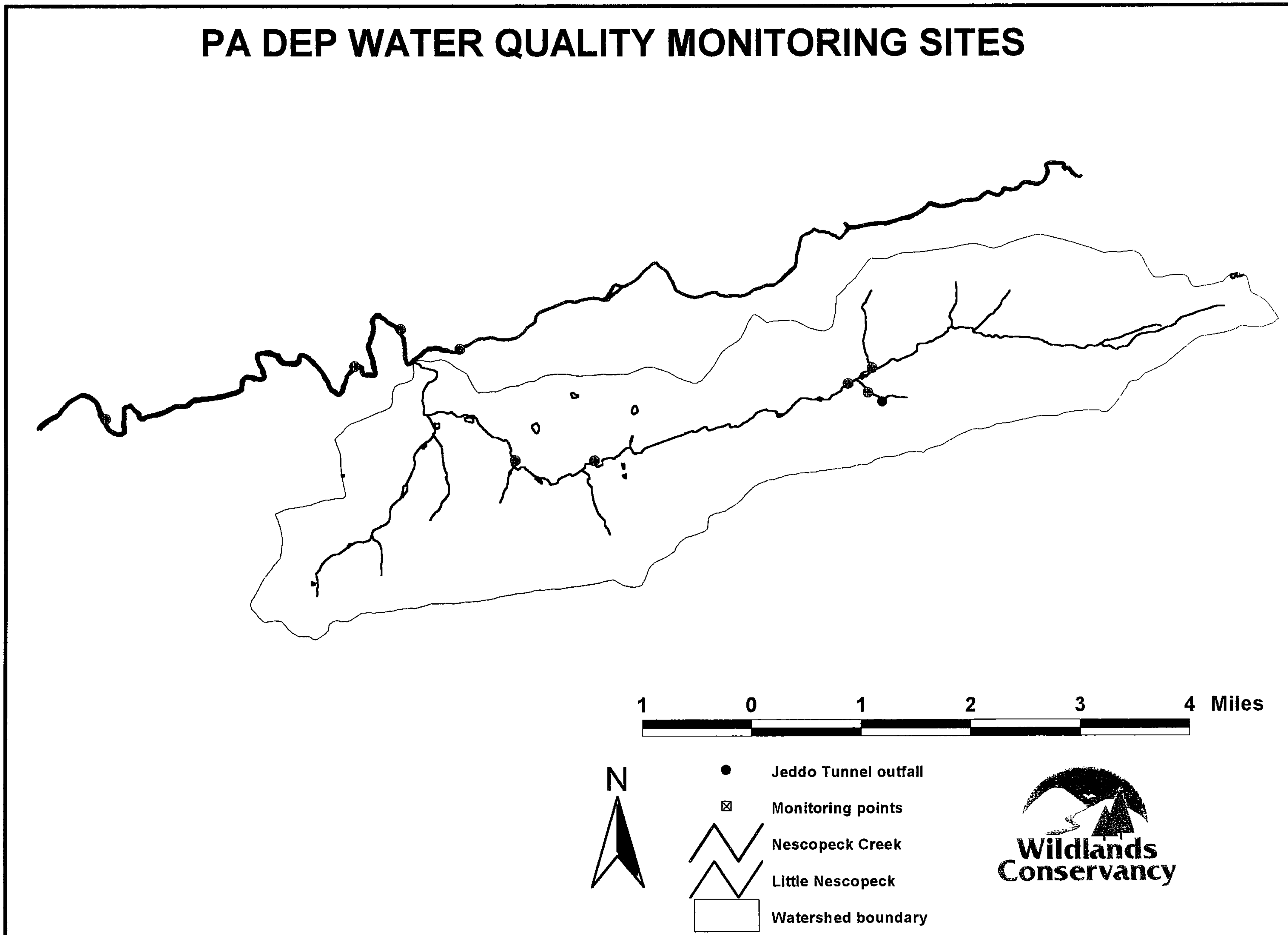

Figure C1. Pa. DEP Water Quality Monitoring Sites

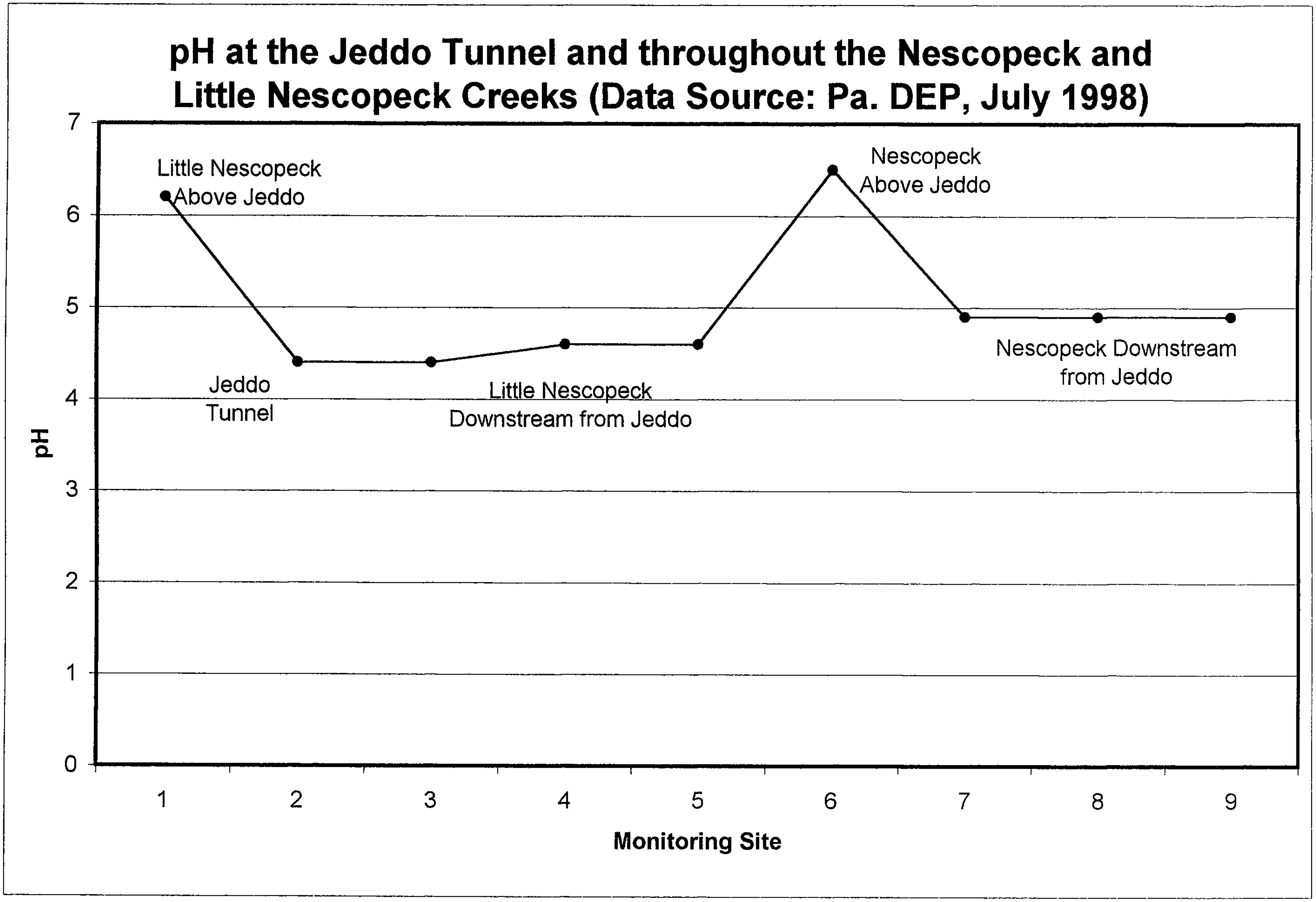

Figure C2. Pa. DEP pH, July 1998

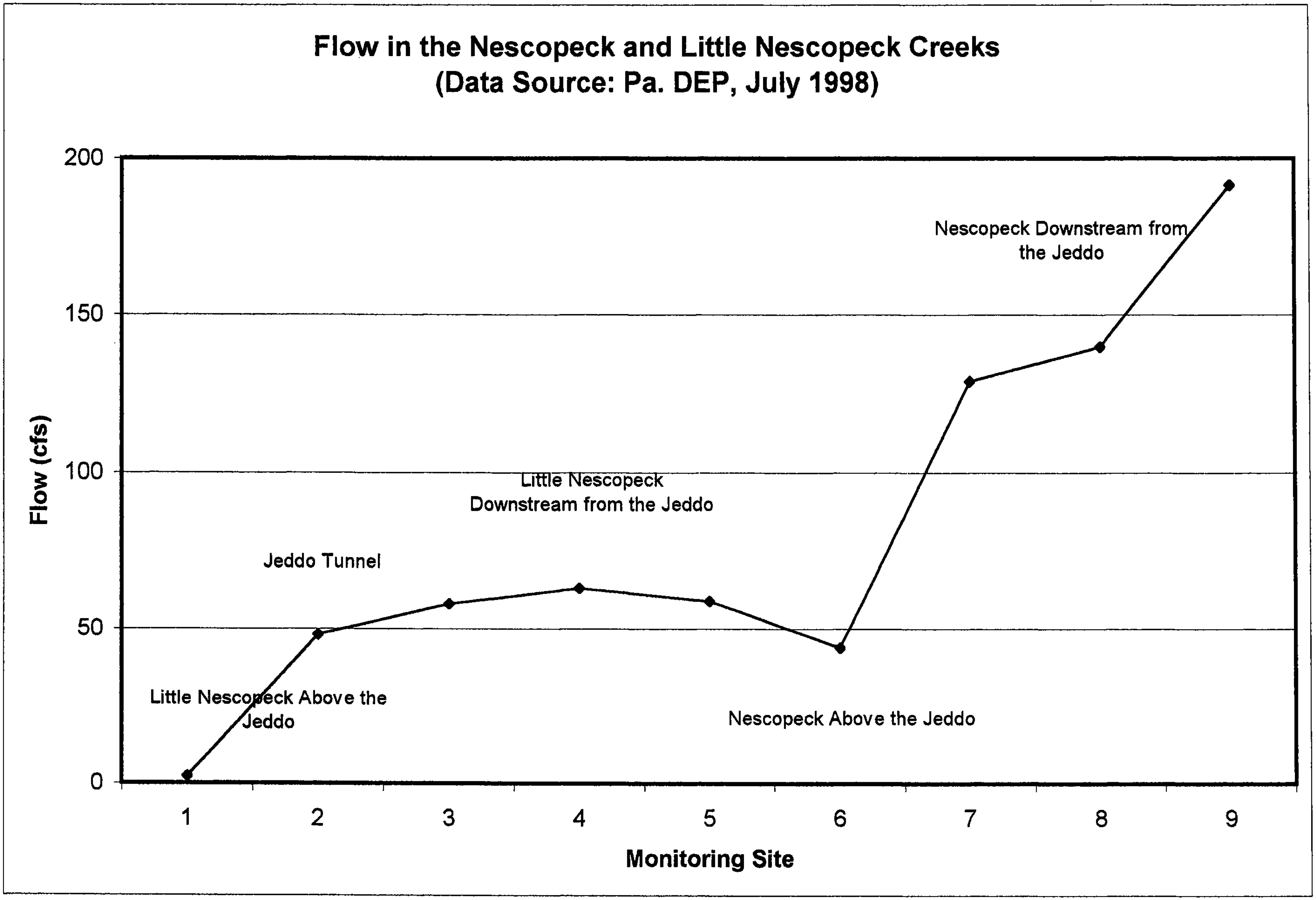

Figure C3. Pa. DEP Flow, July 1998

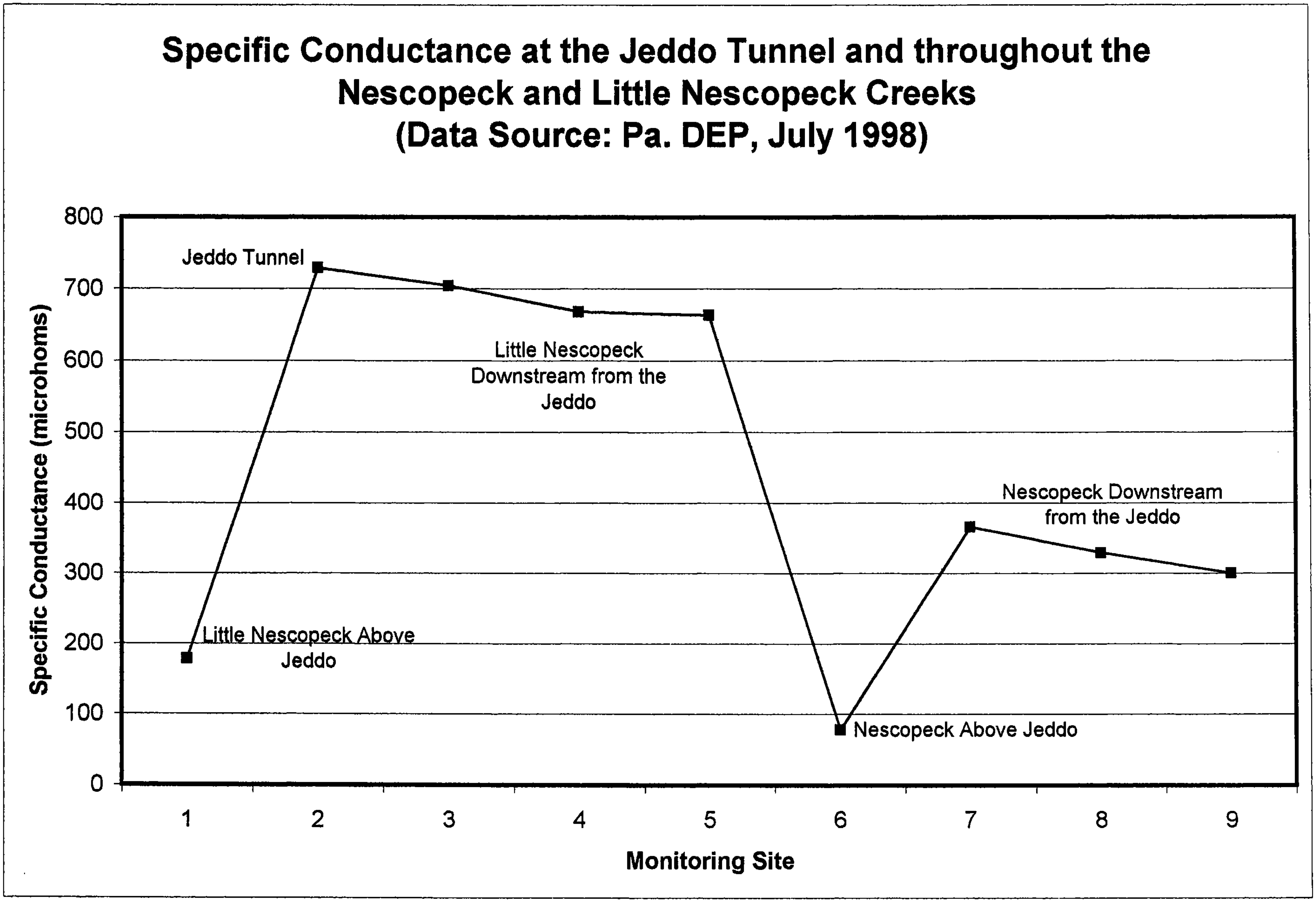

Figure C4. Pa. DEP Specific Conductance, July 1998

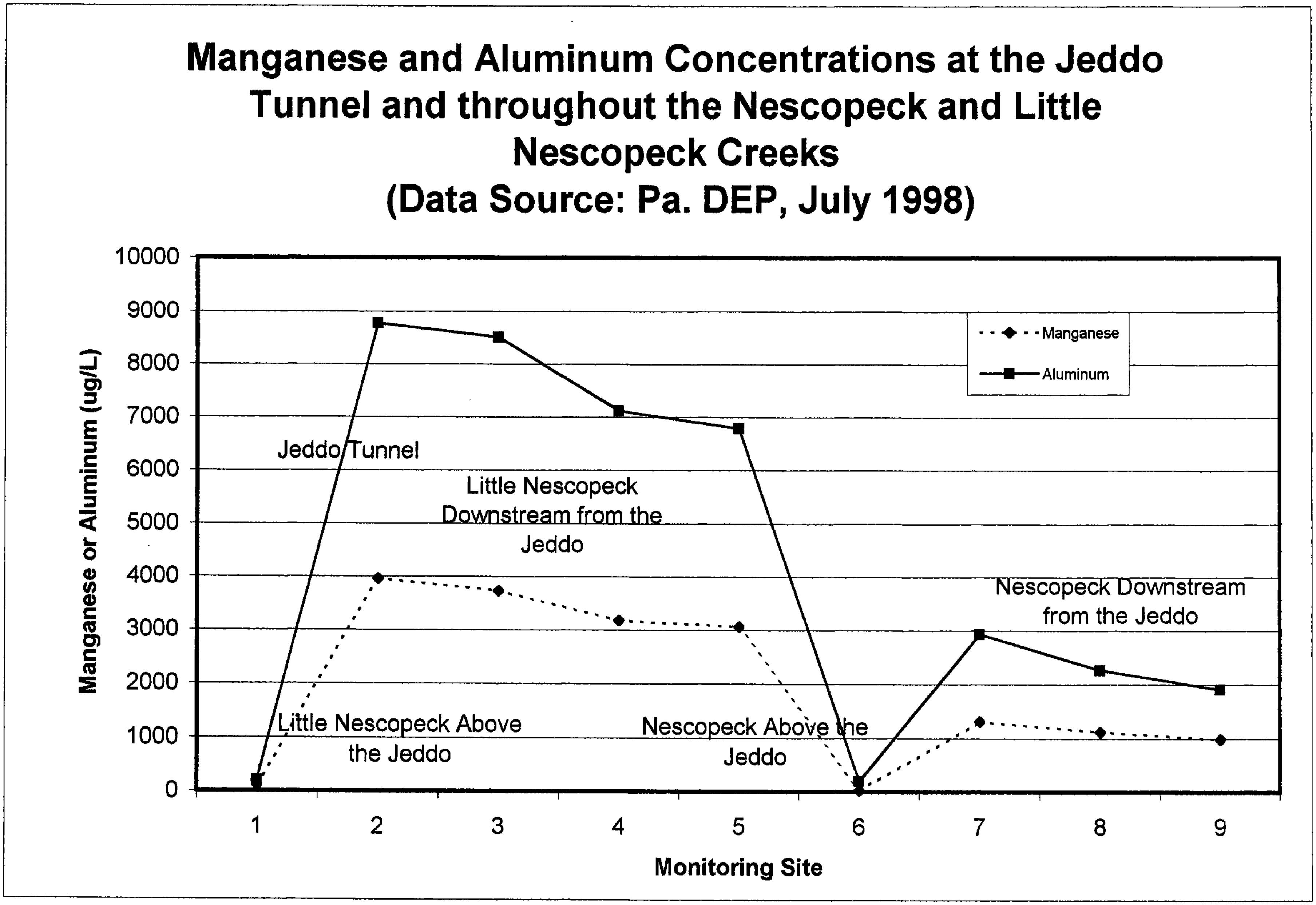

Figure C5. Pa. DEP Aluminum and manganese, July 1998

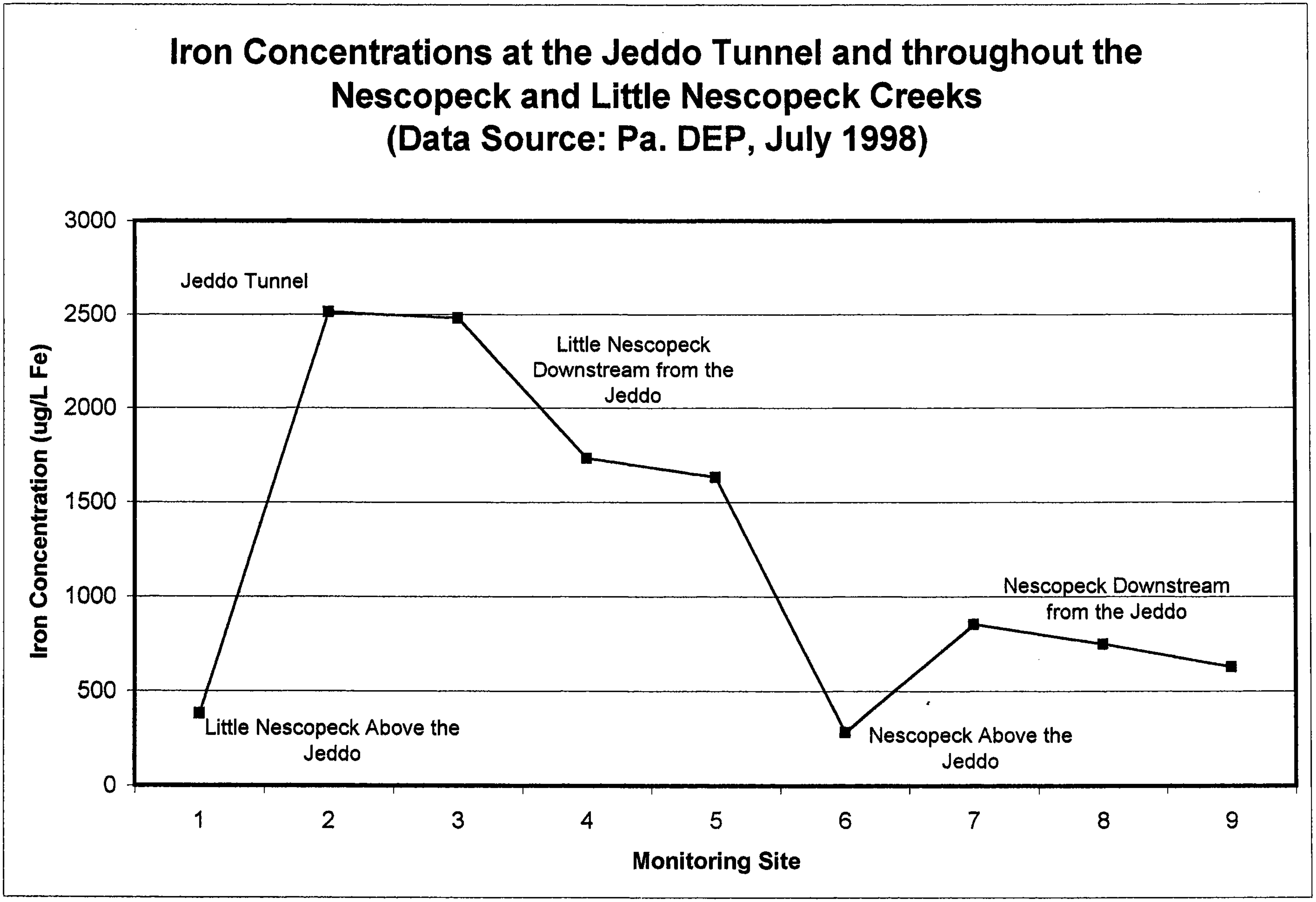

Figure C6. Pa. DEP Iron, July 1998

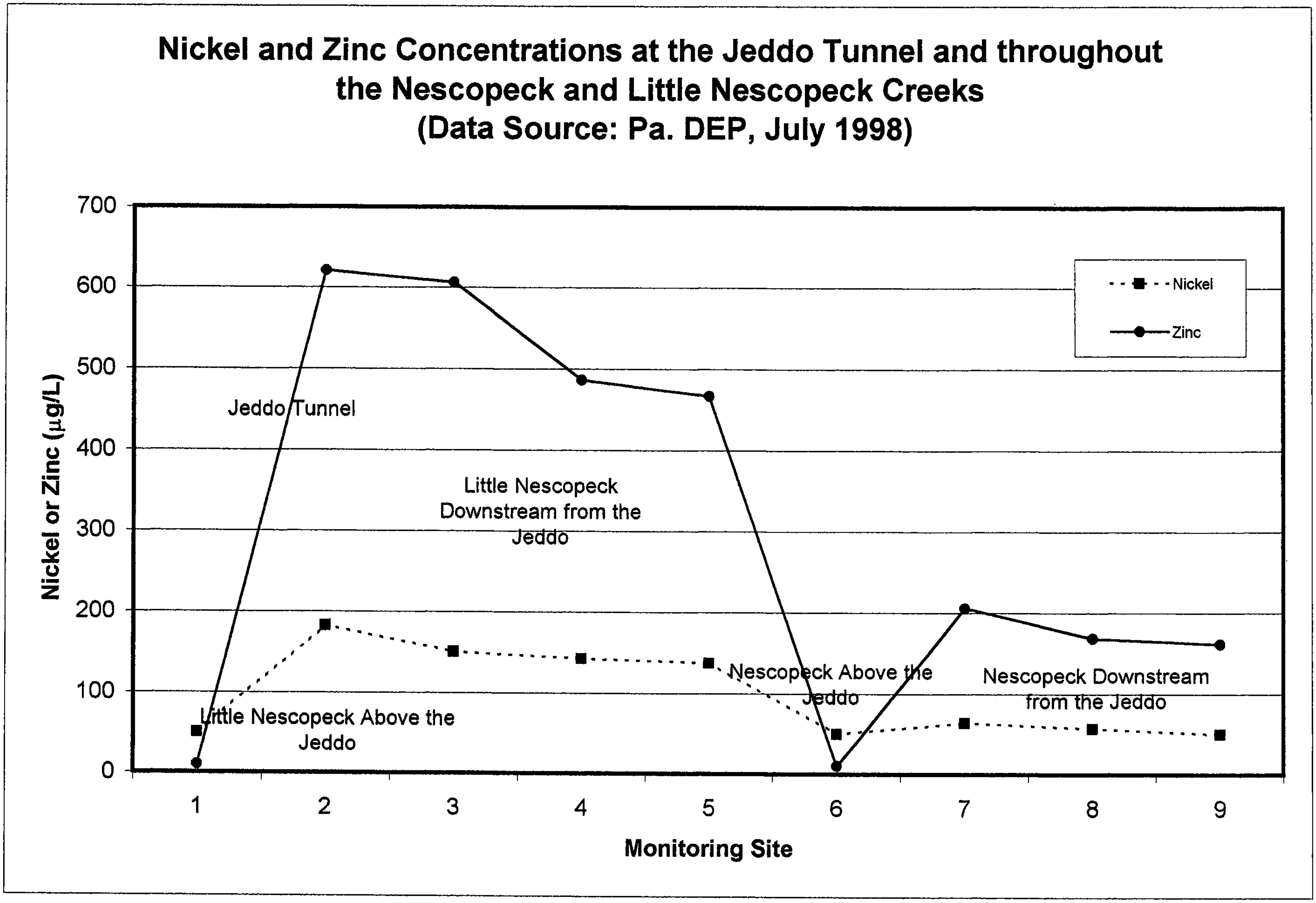

Figure C7. Pa. DEP Nickel and Zinc, July 1998

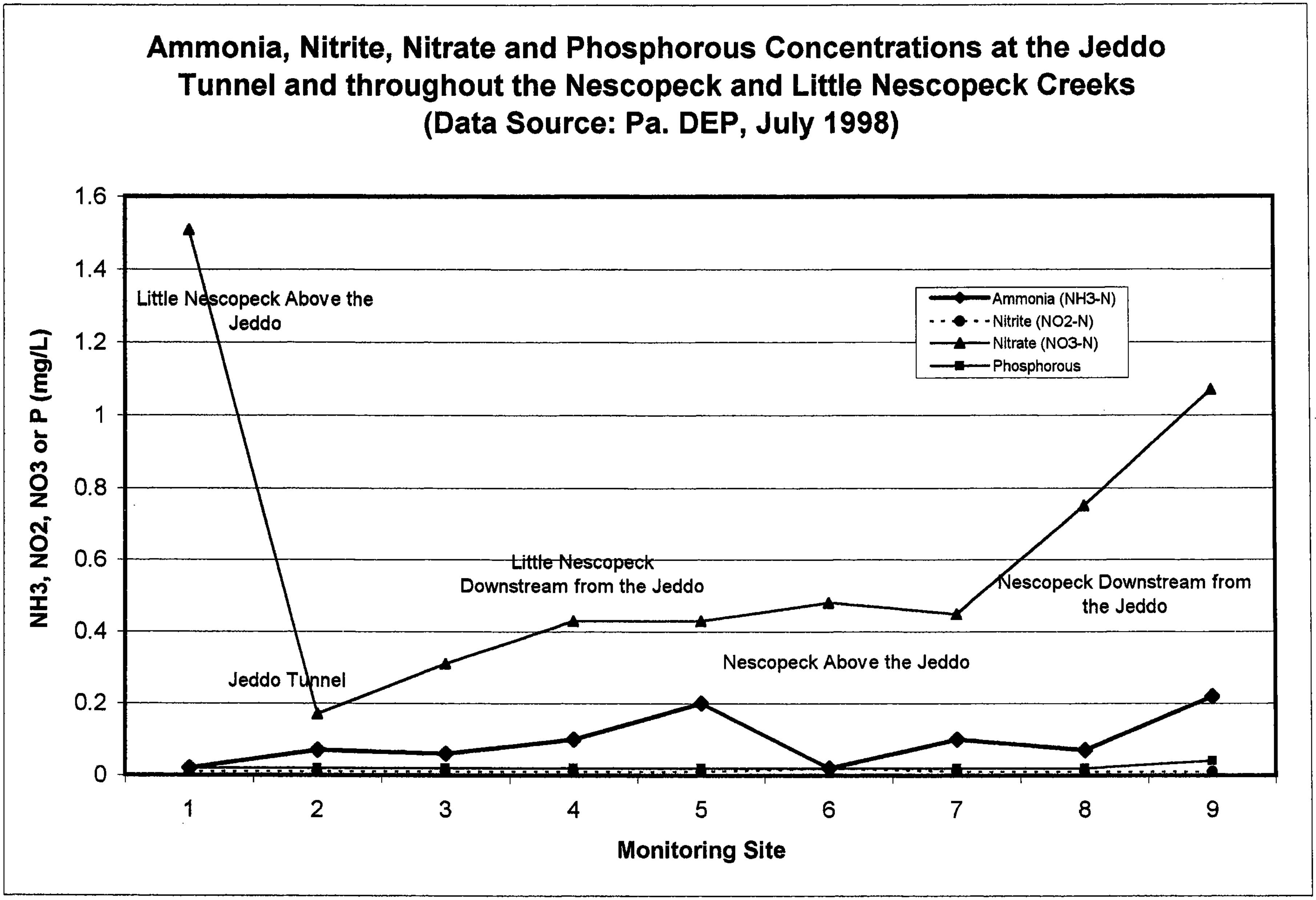

Figure C8. Pa. DEP Organics, July 1998

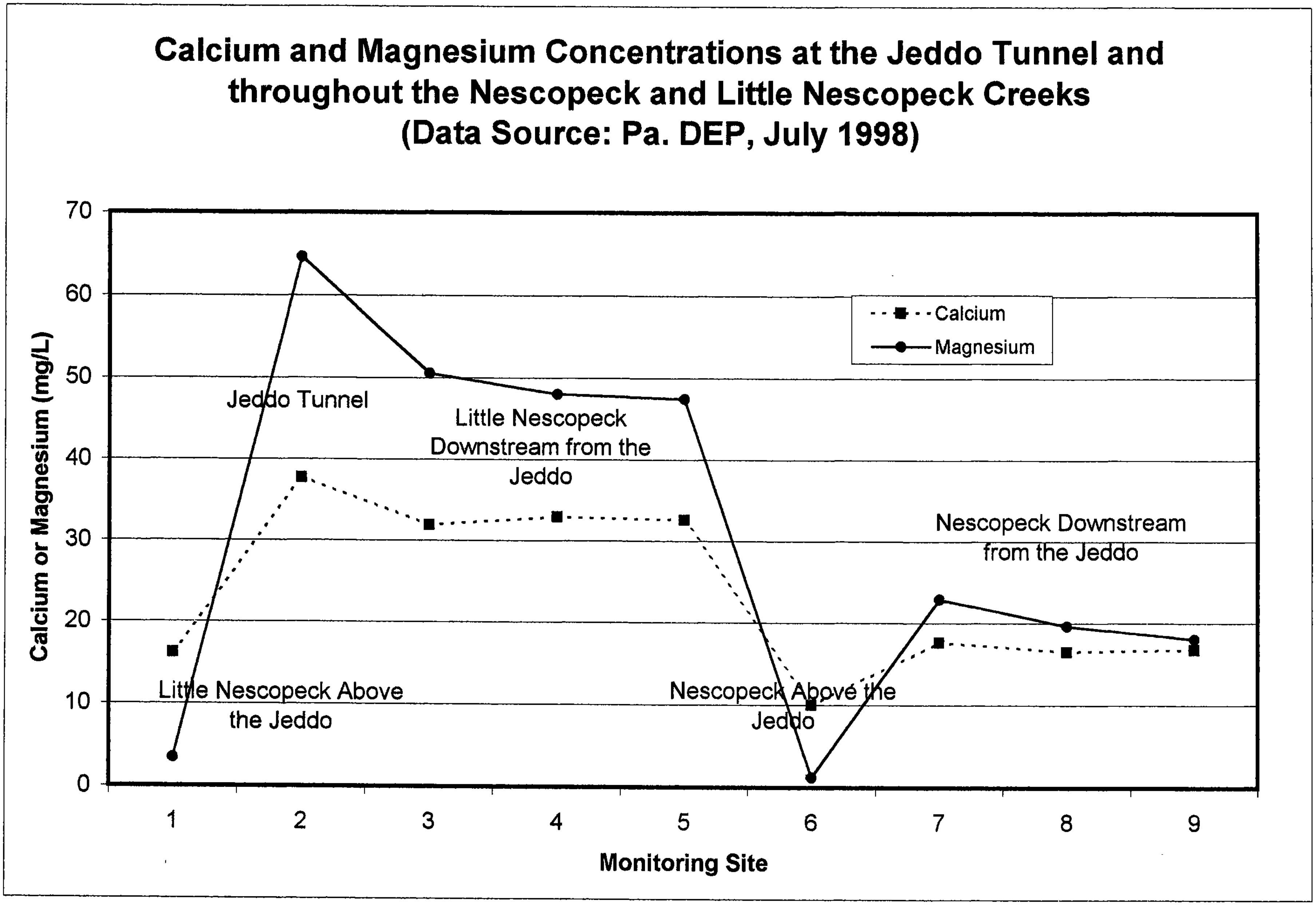

Figure C9. Pa. DEP Calcium and Magnesium, July 1998

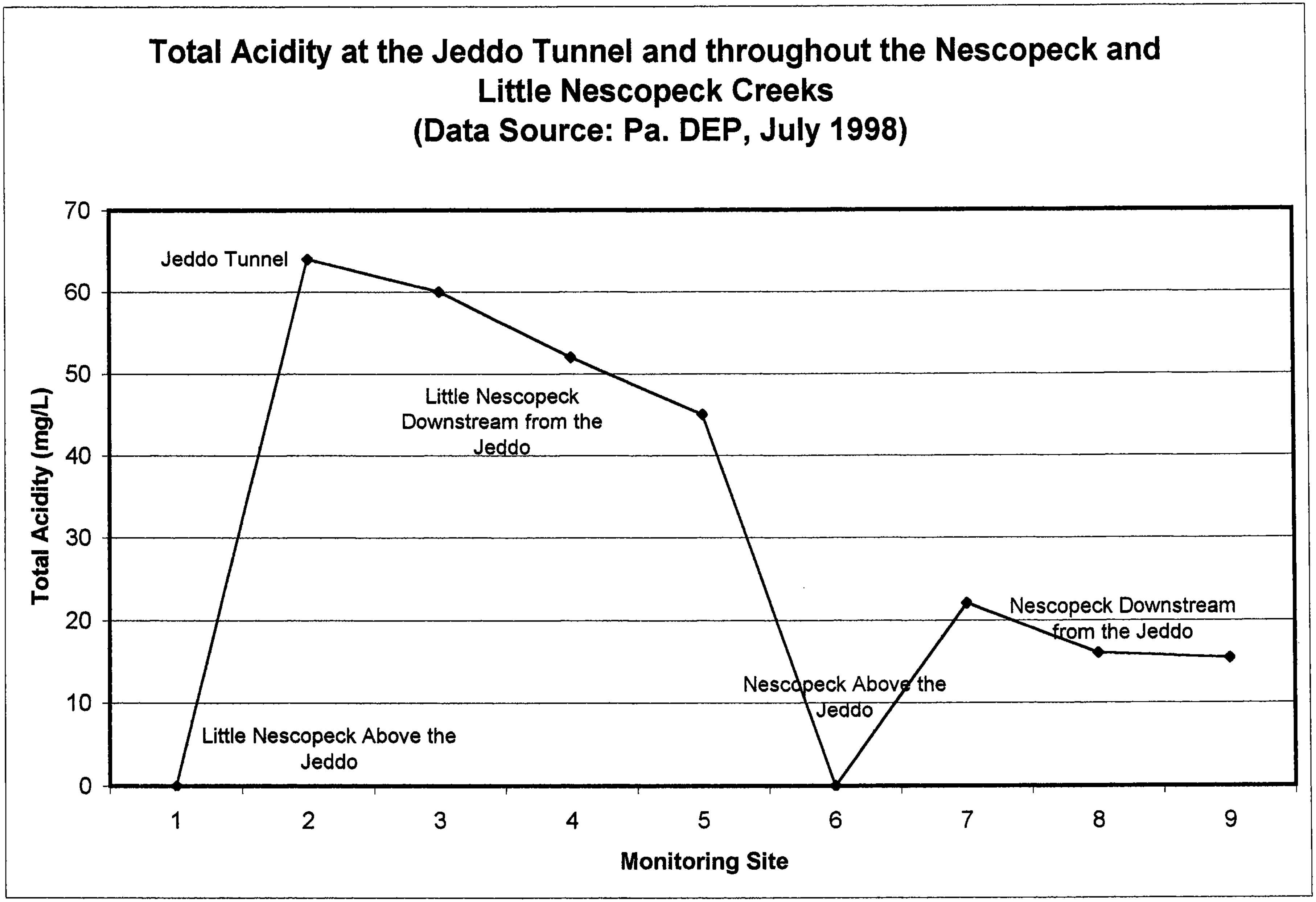

Figure C10. Pa. DEP Acidity, July 1998

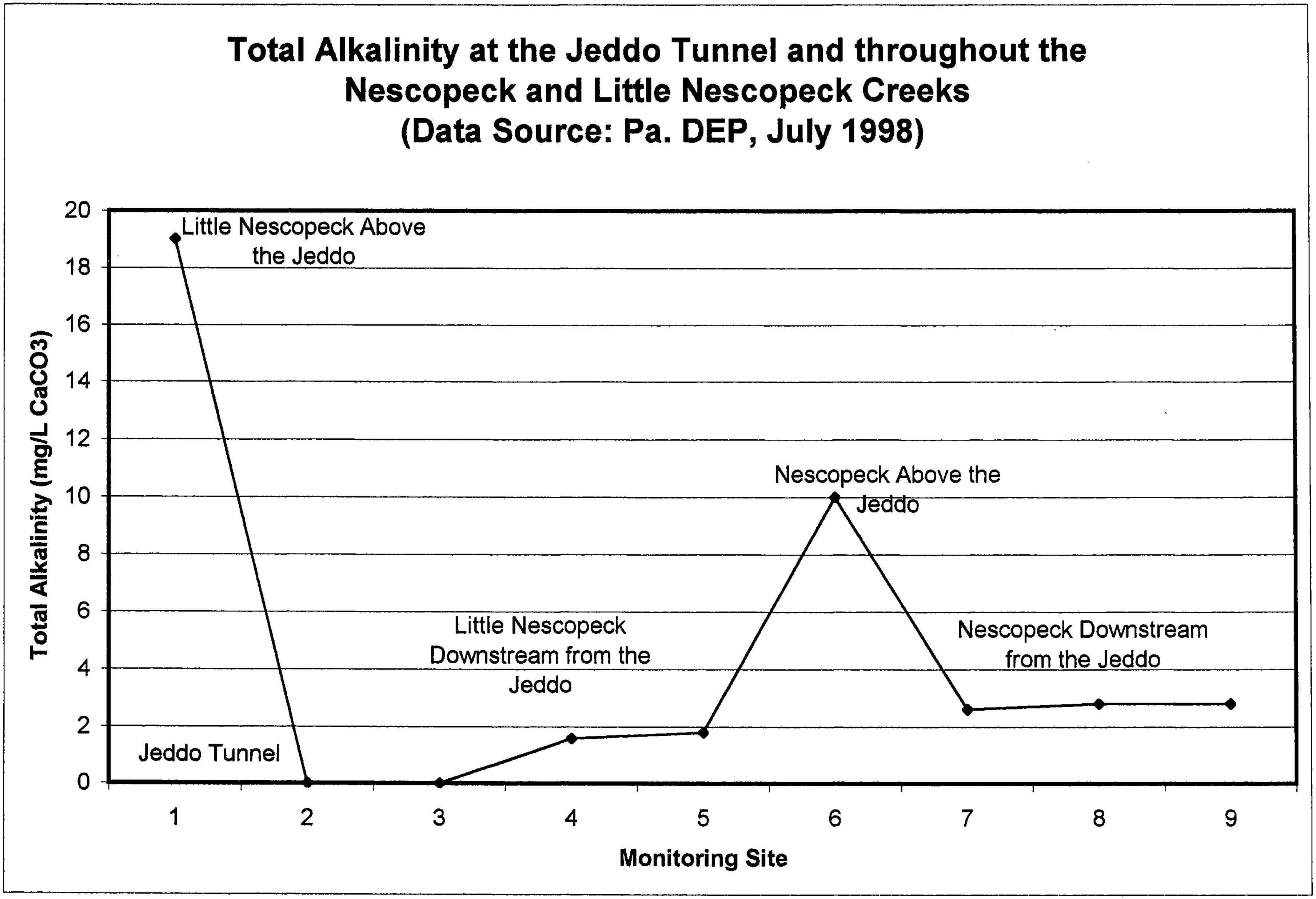

Figure C11. Pa. DEP Alkalinty, July 1998

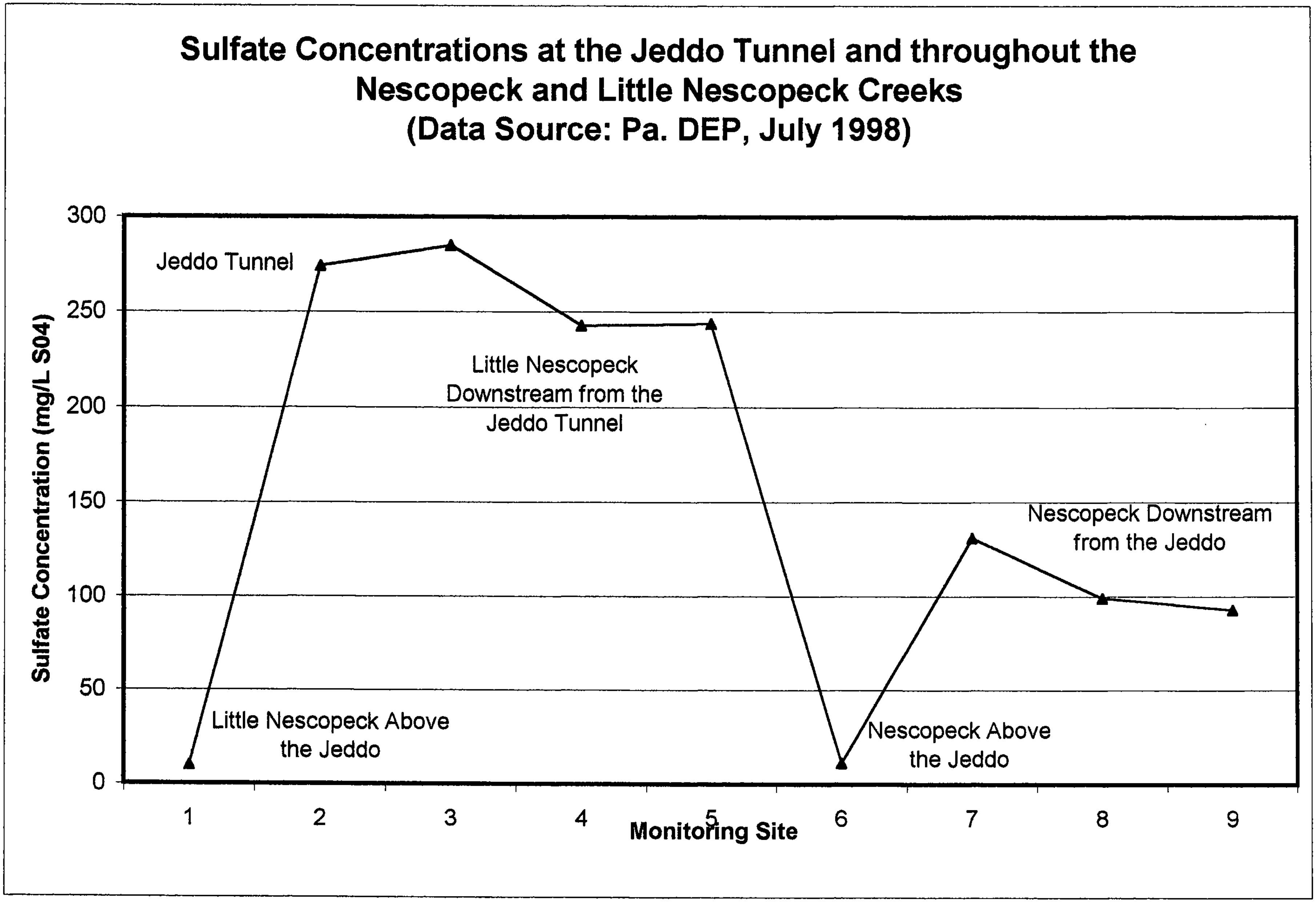

Figure C12. Pa. DEP Sulfate, July 1998

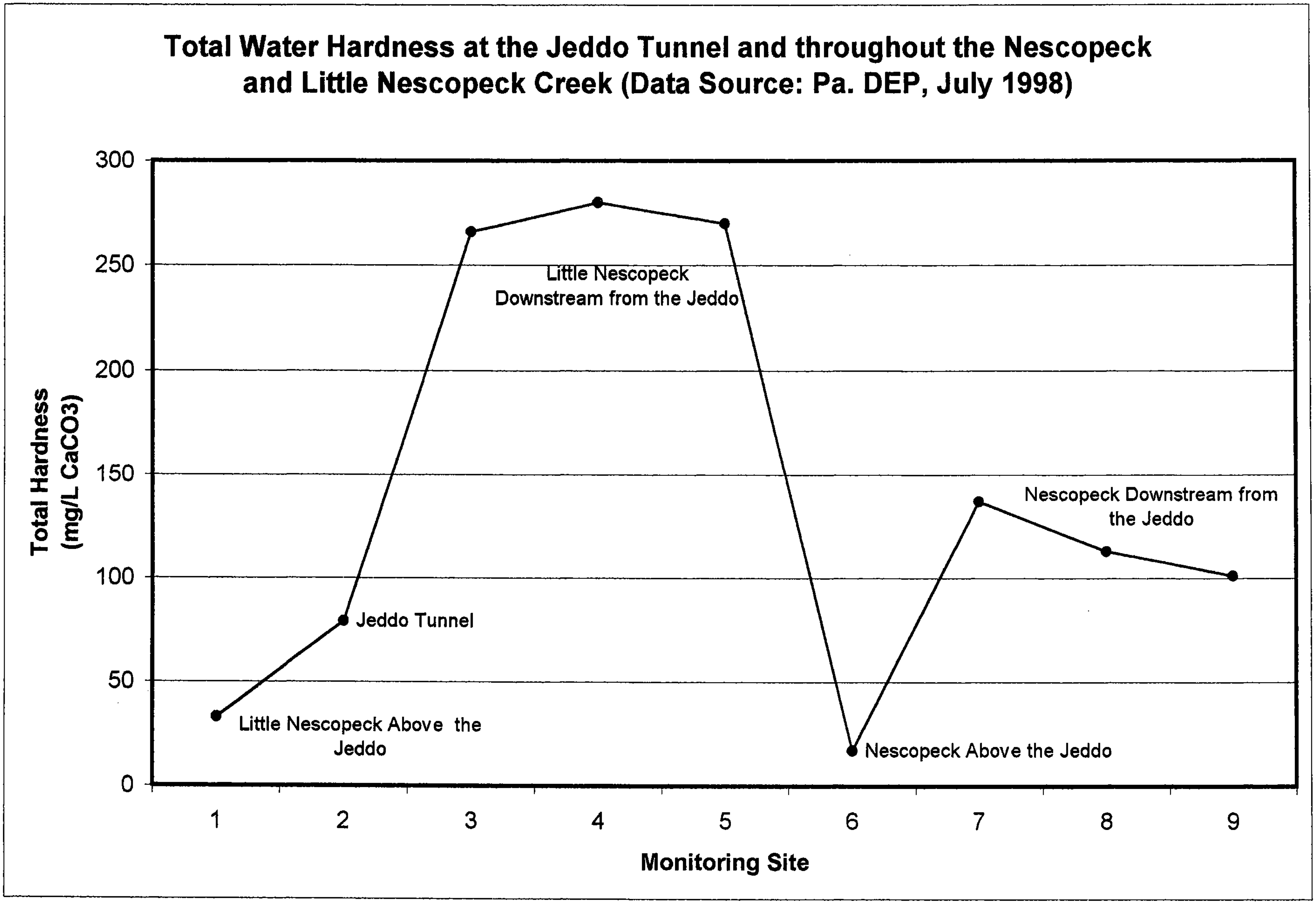

Figure C13. Pa. DEP Hardness, July 1998

APPENDIX D

NESCOPECK AND LITTLE NESCOPECK CREEKS AND SUSQUEHANNA RIVER WATER QUALITY DATA

Table D1. Friends of the Nescopeck Water Quality Monitoring Sites

1. Little Nescopeck Creek: 100 yards above the Jeddo Tunnel confluence
2. Jeddo Tunnel: 20 yards below the Jeddo Tunnel outfall
3. Little Nescopeck Creek: 50 yards above the Conyngham Borough Sewage Treatment Plant
4. Little Nescopeck Creek: at East County Road Bridge
5. Little Nescopeck Creek: 200 yards above the Nescopeck Creek confluence
6. Nescopeck Creek: 400 yards above the Little Nescopeck confluence
7. Nescopeck Creek: directly after the Little Nescopeck confluence, Route 93
8. Susquehanna River: 0.5 miles above the Nescopeck Creek confluence, at Nescopeck Park
9. Susquehanna River: directly below the Nescopeck Creek confluence
10. Susquehanna River: Mifflinville Bridge, approximately 0.5 miles below the Nescopeck confluence

Table D2.. Friends of the Nescopeck Water Quality, November 1996-January 1997

Concentrations throughout the Susquehanna River and
Nescopeck and Little Nescopeck Creeks
Data Source: Friends of the Nescopeck

CALCIUM HARDNESS, mg/L

	1	2	3	4	5	6	7	8	9	10
1/21/97	27.00	50.00	50.00	42.00	34.00	8.00	30.00	44.00	24.00	44.00
12/17/96	0.90	39.00	4.25	3.75	2.80	6.00	21.00	21.00	16.00	21.00
12/10/96	16.00	42.00	32.00	36.00	34.00	7.00	22.00	24.00	17.00	22.00
12/3/96	17.00	32.00	39.00	32.00	42.00	5.00	11.00	19.00	16.00	22.00
11/26/96	16.00	42.00	36.00	39.00	44.00	6.00	18.00	26.00	22.00	28.00
11/19/96	18.00	47.00	44.00	44.00	39.00	7.50	24.00	36.00	22.00	32.00
AVERAGE	15.82	42.00	34.21	32.79	32.63	6.58	21.00	28.33	19.50	28.17

IRON, mg/L

	1	2	3	4	5	6	7	8	9	10
1/21/97	0.03	0.12	0.95	0.39	0.20	0.02	0.08	0.09	0.05	8.00
12/17/96	0.03	0.22	0.05	0.04	0.03	0.05	0.03	0.04	0.03	0.03
12/10/96	0.04	0.08	0.04	0.05	0.02	0.02	0.05	0.05	0.04	0.04
12/3/96	0.05	1.15	1.02	1.11	0.96	0.08	0.35	0.08	0.05	0.07
11/26/96	0.11	0.44	0.38	0.24	0.22	0.10	0.16	0.11	0.08	0.10
11/19/96	0.08	0.84	0.77	0.58	0.56	0.11	0.28	0.13	0.14	0.09
AVERAGE	0.06	0.48	0.54	0.40	0.33	0.06	0.16	0.08	0.07	0.07

MANGANESE, mg/L

	1	2	3	4	5	6	7	8	9	10
1/21/97	0.00	5.00	4.40	4.10	4.10	0.00	2.15	0.00	1.85	0.45
12/17/96	0.90	4.50	4.25	3.75	2.80	0.45	0.30	1.50	1.10	0.75
12/10/96	1.35	5.00	4.40	3.75	3.95	1.10	1.85	2.15	1.65	1.50
12/3/96	1.20	4.25	3.45	3.10	3.45	0.00	2.60	0.60	1.35	0.90
11/26/96	0.60	5.15	4.80	4.25	3.75	0.90	2.00	0.90	2.30	1.20
11/19/96	0.60	5.00	5.00	4.80	4.60	0.60	2.60	0.90	2.45	1.10
AVERAGE	0.78	4.82	4.38	3.96	3.78	0.51	1.92	1.01	1.78	0.98

SULFATE, mg/L

	1	2	3	4	5	6	7	8	9	10
1/21/97	8.50	236.00	200.00	226.00	192.00	6.00	110.00	34.00	88.00	48.00
12/17/96	6.00	175.00	158.00	151.00	132.00	3.00	50.00	6.00	48.00	10.00
12/10/96	9.00	254.00	236.00	192.00	214.00	4.00	92.00	8.00	75.00	23.00
12/3/96	8.00	158.00	184.00	151.00	167.00	4.70	59.00	5.50	50.00	10.00
11/26/96	8.00	228.00	214.00	226.00	214.00	4.70	98.00	18.00	98.00	36.00
11/19/96	7.00	196.00	184.00	244.00	214.00	4.00	188.00	14.00	98.00	30.00
AVERAGE	7.75	207.83	196.00	198.33	188.83	4.40	99.50	14.25	76.17	26.17

Table D2.. Friends of the Nescopeck Water Quality, November 1996-January 1997

NITRATE, mg/L

	1	2	3	4	5	6	7	8	9	10
1/21/97	1.00	0.18	0.29	0.52	0.49	0.72	0.72	0.79	0.96	0.67
12/17/96	0.86	0.23	0.29	0.48	0.52	0.39	0.51	0.47	0.60	0.60
12/10/96	1.04	0.18	0.25	0.45	0.52	0.39	0.65	0.72	0.72	0.77
12/3/96	1.22	0.19	0.33	0.41	0.43	0.27	0.56	0.42	0.47	0.49
11/26/96	0.53	0.22	0.23	0.39	0.47	0.31	0.51	0.84	1.00	0.92
11/19/96	1.22	0.22	0.25	0.31	0.36	0.36	0.47	0.82	0.96	0.77
AVERAGE	0.98	0.20	0.27	0.43	0.47	0.41	0.57	0.68	0.79	0.70

ORTHOPHOSPHATE, mg/L

	1	2	3	4	5	6	7	8	9	10
1/21/97	0.00	0.05	0.09	0.11	0.13	0.13	0.05	0.18	0.36	0.13
12/17/96	0.09	0.20	0.13	0.45	0.23	0.11	0.54	0.11	0.09	0.27
12/10/96	0.11	0.23	0.11	0.11	0.18	0.05	0.09	0.07	0.13	0.59
12/3/96	0.13	0.27	0.25	0.25	0.33	0.13	0.15	0.27	0.23	0.42
11/26/96	0.18	0.23	0.25	0.23	0.42	0.48	0.23	0.23	0.23	0.36
11/19/96	0.04	0.07	0.09	0.11	0.20	0.02	0.05	0.15	0.33	0.09
AVERAGE	0.09	0.18	0.15	0.21	0.25	0.15	0.19	0.17	0.23	0.31

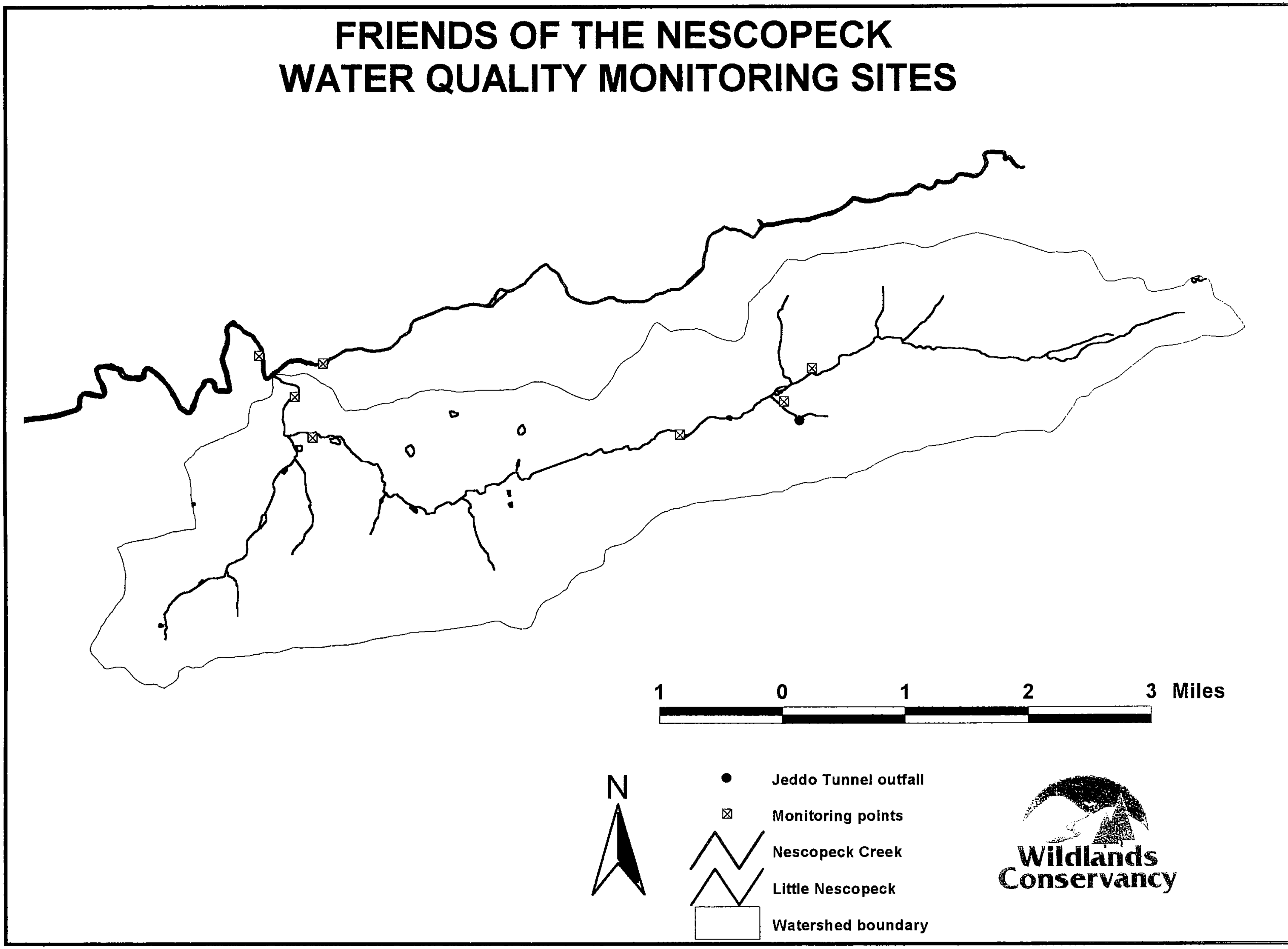

Figure D1. Locations of Friends of the Nescopeck Water Quality Monitoring Sites

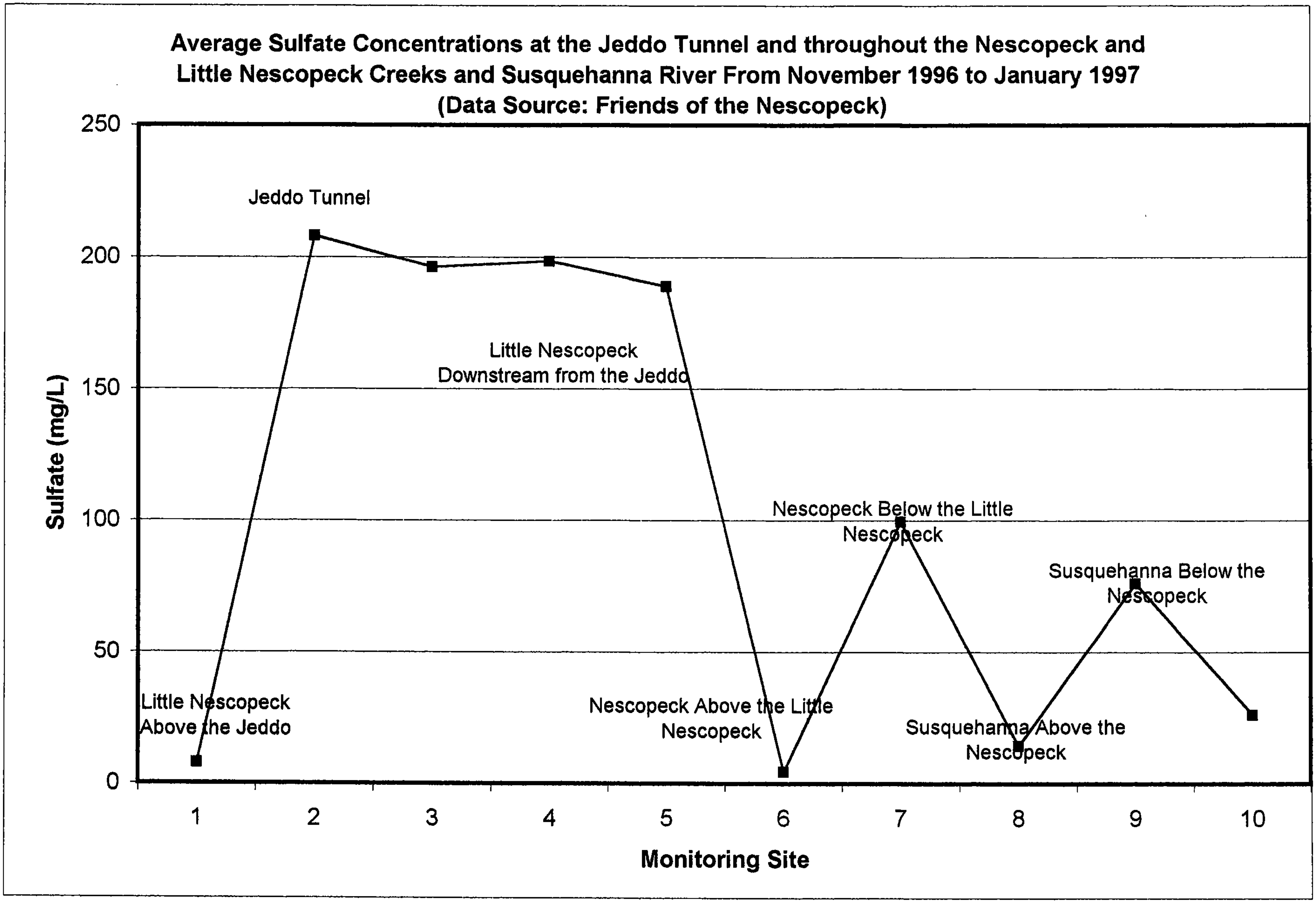

Figure D2. Friends of the Nescopeck Sulfate

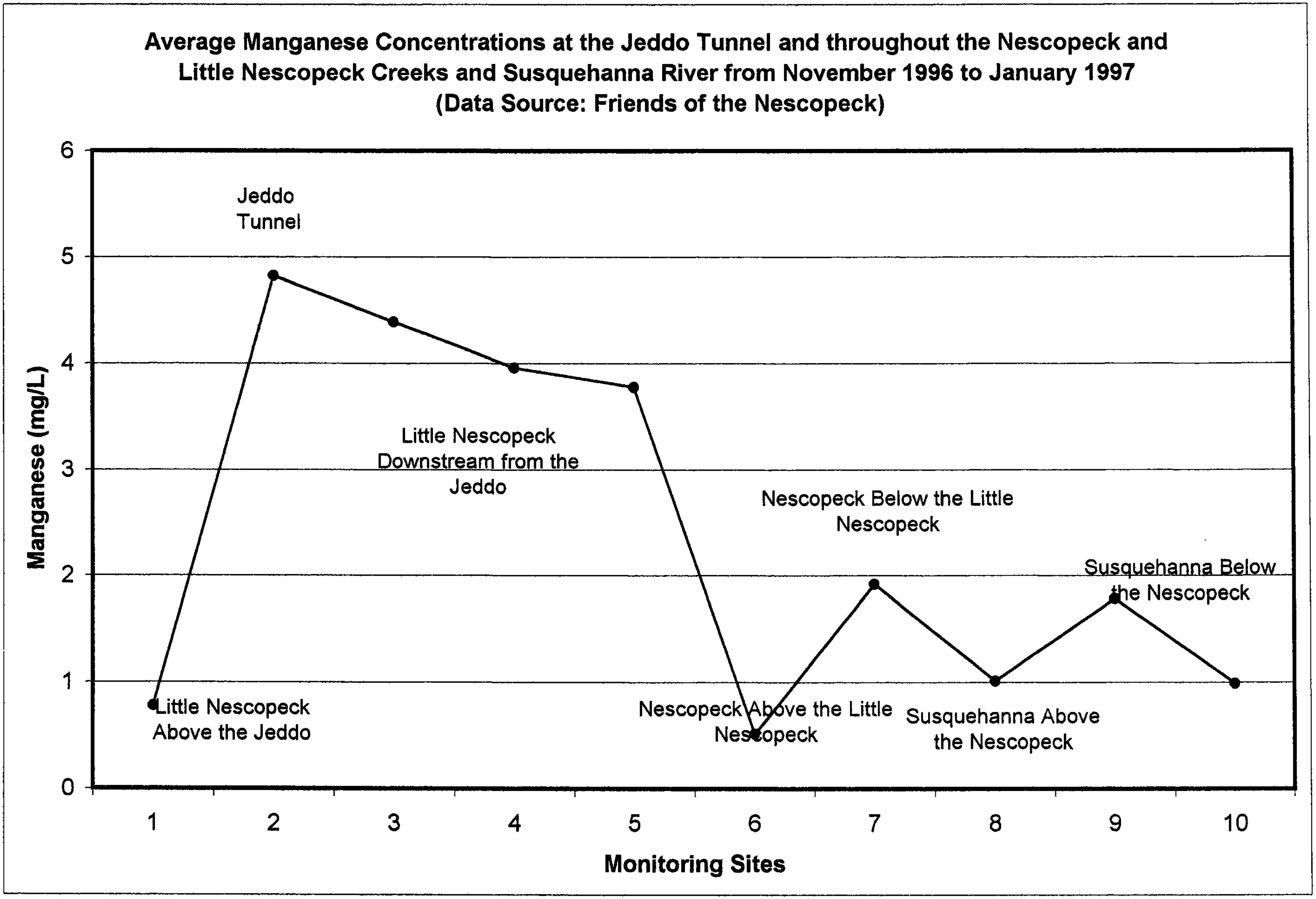

Figure D3. Friends of the Nescopeck Manganese

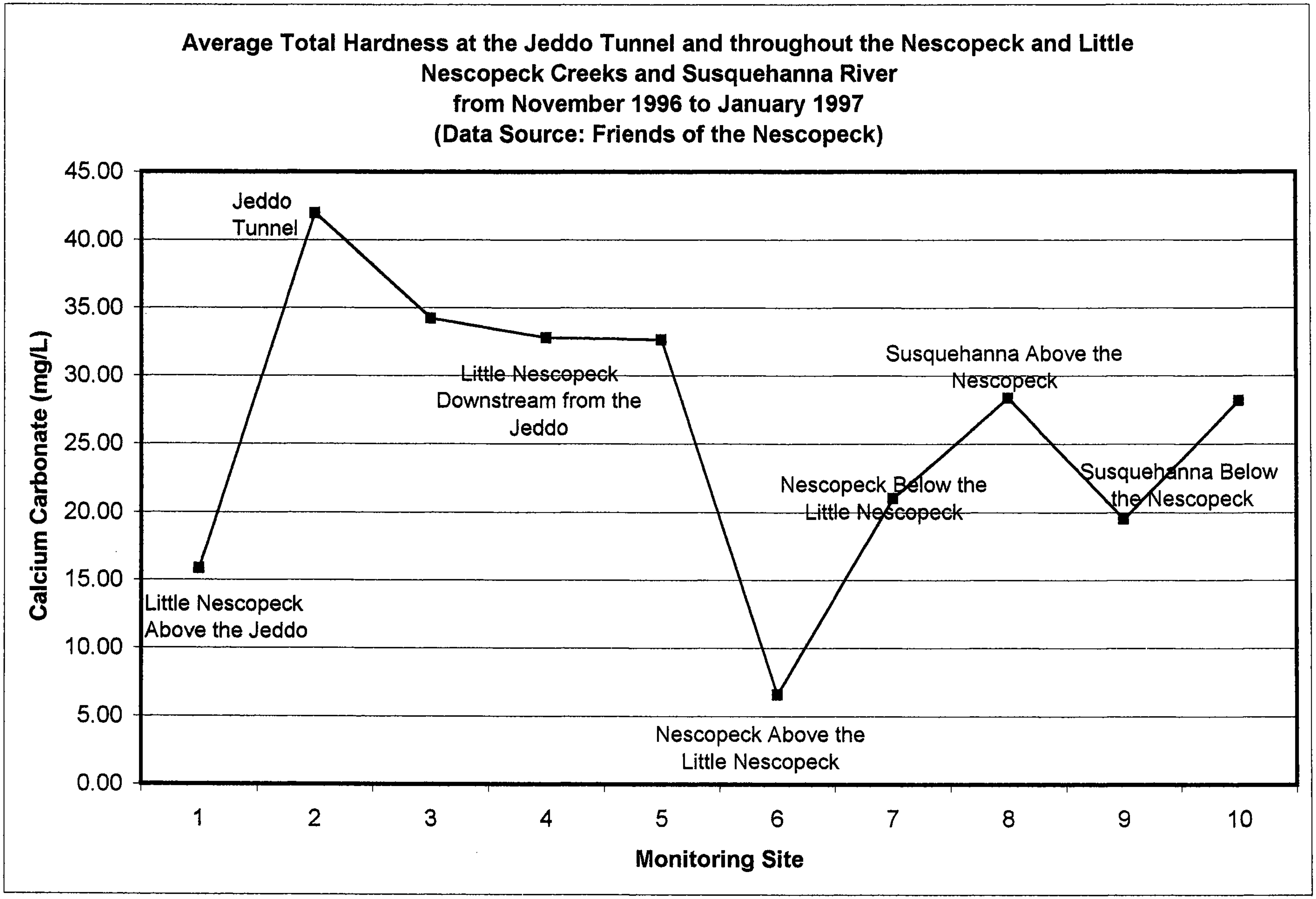

Figure D4. Friends of the Nescopeck Hardness

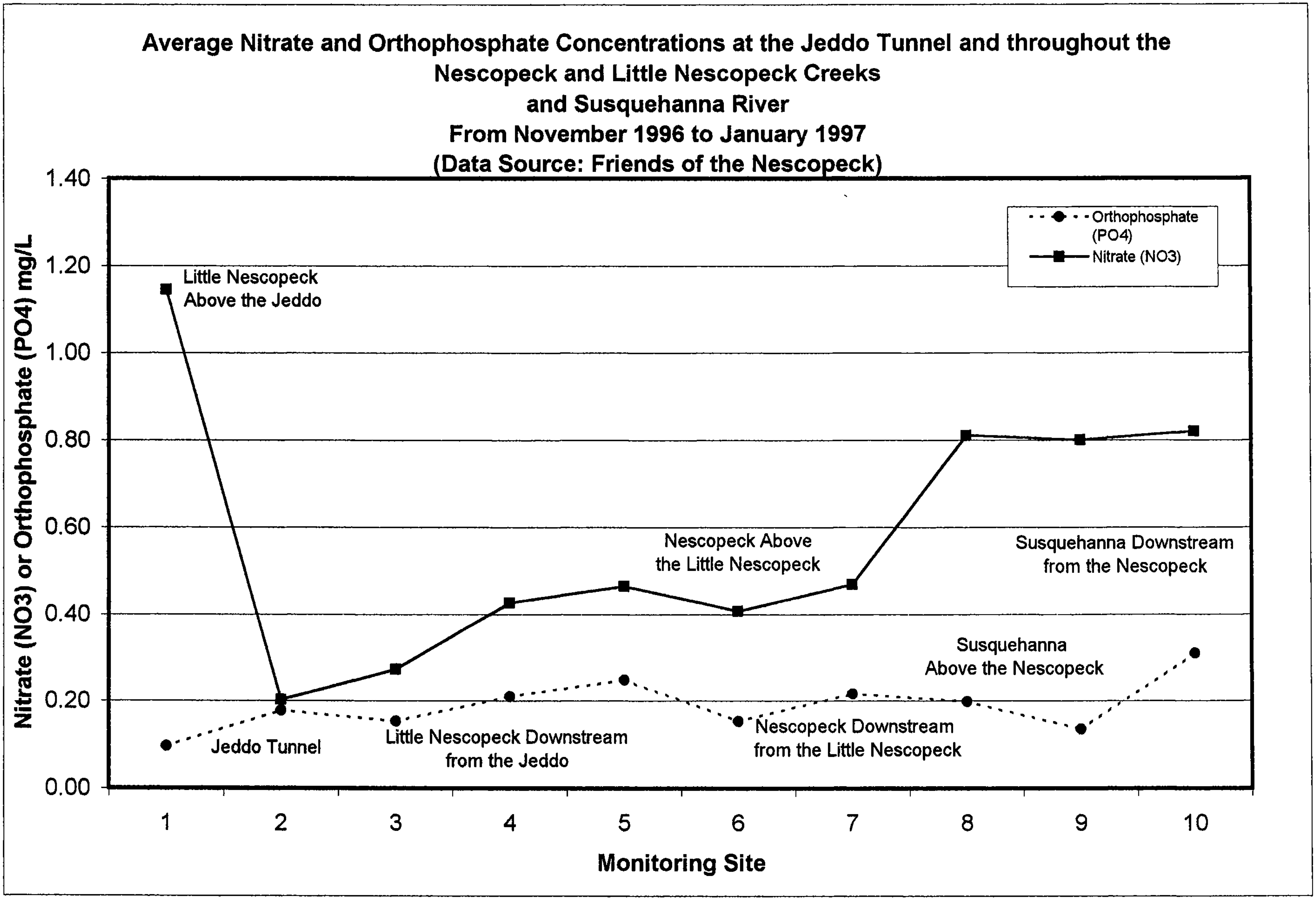

Figure D5. Friends of the Nescopeck, Nitrate and Orthophosphate

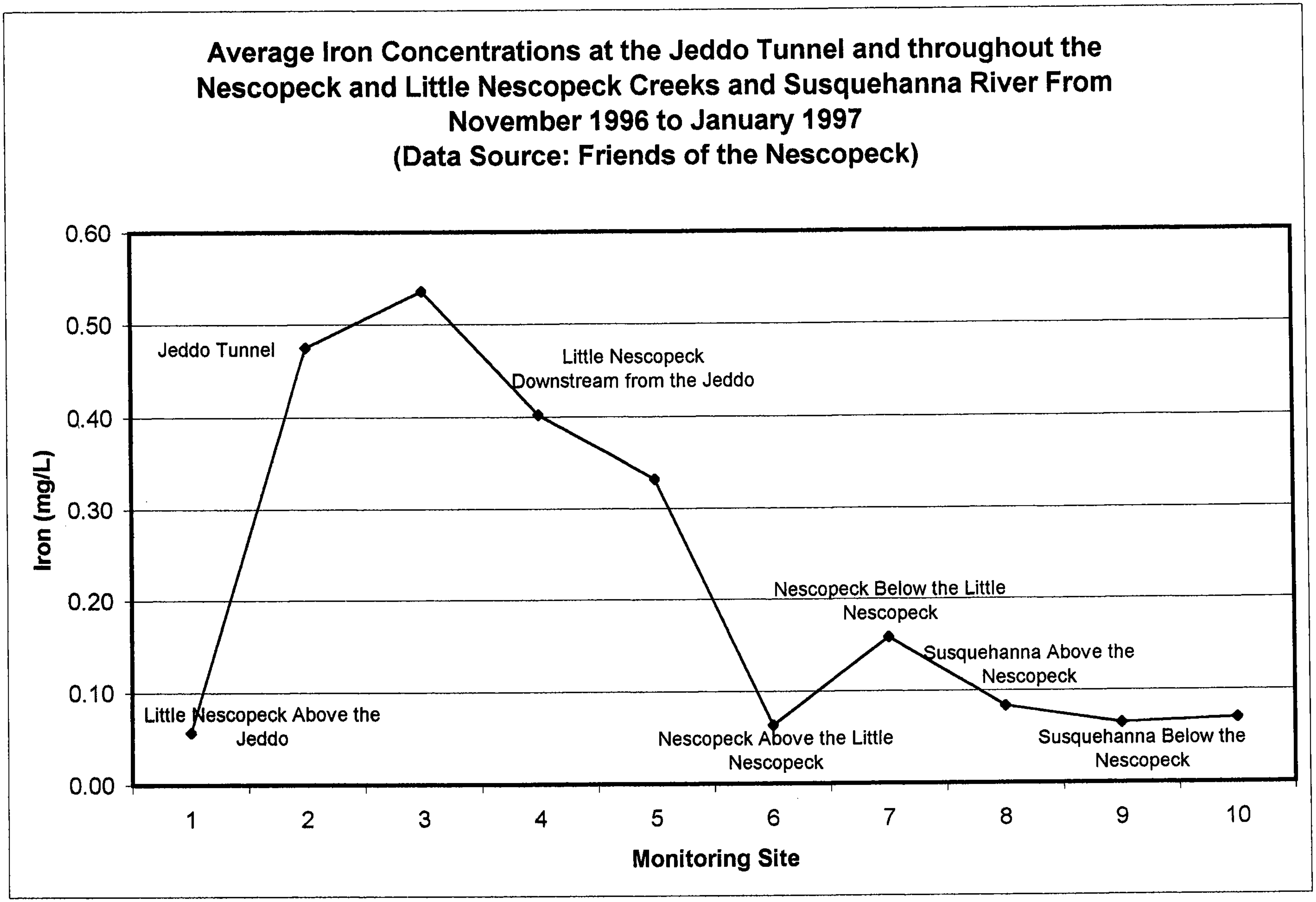

Figure D6. Friends of the Nescopeck Iron

APPENDIX E

NESCOPECK CREEK WATER QUALITY DATA

Table E1. Nescopeck Creek Water Quality, 1996-98 *(sample collected by Friends of Nescopeck, analyzed by Pa. DEP)—Continued*

Sample Date	Sodium	Potassium	Chloride	Sulfate	Iron	Manganese	Zinc	Aluminum	Total Acidity, Hot
					mg/l				
11/05/96	6.30	1.93	6.3	154	33.800	1.930	0.314	5.08	34.00
11/12/96	4.86	1.20	9.0	38	2.000	0.867	0.147	2.37	12.80
11/19/96	7.10	1.29	9.0	114	15.500	1.610	0.282	3.82	18.60
11/26/96	7.76	1.62	12.0	122	2.460	1.260	0.177	3.65	15.40
12/10/96	8.29	1.21	12.0	90	1.180	1.160	0.206	2.78	15.60
12/03/96	5.06	0.96	7.0	62	1.770	0.679	0.183	2.10	10.20
12/17/96	7.23	1.06	12.0	32	0.954	0.779	0.141	1.75	11.20
12/24/96	8.88	1.56	12.0	92	1.070	1.320	0.246	2.98	28.00
12/31/96	7.75	1.91	11.0	54	1.960	1.240	0.224	3.56	22.00
01/07/97	8.23	1.55	13.0	89	2.350	1.570	0.287	4.25	140.00
01/14/97	7.79	1.31	12.0	154	1.040	1.810	0.330	3.32	34.00
01/21/97	7.44	1.15	13.0	139	0.995	1.830	0.324	3.44	28.00
01/28/97	32.60	2.02	55.0	61	2.450	1.070	0.181	3.09	17.40
02/04/97	11.90	2.01	17.0	255	3.620	3.840	0.606	8.21	90.00
02/11/97	11.60	1.09	18.0	131	0.898	1.450	0.236	3.13	22.00
02/18/97	7.02	1.16	20.0	71	0.933	1.450	0.242	2.77	24.00
02/25/97	8.61	1.14	15.0	70	0.804	1.070	0.185	2.45	19.80
03/04/97	13.20	0.94	20.0	200	0.907	1.200	0.211	2.78	18.80
03/11/97	12.30	1.00	18.0	72	0.783	1.050	0.185	2.50	18.40
03/18/97	12.40	1.10	20.0	78	0.860	1.190	0.206	2.80	52.00
03/25/97	10.10	1.25	17.0	95	0.815	1.390	0.239	3.01	24.00
04/08/97	10.70	1.23	18.0	50	0.811	0.938	0.171	2.22	13.40
04/01/97	19.10	1.12	33.0	41	0.745	0.661	0.120	1.52	6.80
04/15/97	10.40	1.19	17.0	74	0.853	1.410	0.244	3.11	15.60
04/29/97	9.74	1.20	16.0	93	0.821	1.360	0.226	2.78	17.40
05/06/97	9.82	0.99	16.0	94	0.815	1.390	0.200	2.96	19.40
06/10/97	9.83	1.12	14.0	121	0.929	1.730	0.258	3.73	20.00
06/17/97	10.10	1.02	16.0	119	1.420	2.120	0.327	4.70	36.00
06/24/97	14.50	1.36	16.0	160	1.230	2.450	0.366	5.15	34.00
07/01/97	10.70	1.28	15.0	178	1.160	3.050	0.428	6.15	38.00
07/08/97	11.00	1.57	16.0	177	1.350	2.680	0.383	5.47	7.60

Table E1. ***Nescopeck Creek Water Quality, 1996-98*** *(sample collected by Friends of Nescopeck, analyzed by Pa. DEP)—Continued*

Sample Date	Sodium	Potassium	Chloride	Sulfate	Iron	Manganese	Zinc	Aluminum	Total Acidity, Hot
	mg/l								
07/15/97	12.30	1.60	15.0	161	1.110	2.840	0.419	5.72	38.00
07/22/97	12.00	2.30	18.0	201	1.230	3.210	0.455	6.50	46.00
07/29/97	11.50	1.60	18.0	176	1.310	3.090	0.445	6.50	42.00
08/05/97	10.10	1.67	19.0	189	1.300	2.790	0.390	5.78	46.00
08/12/97	13.90	1.82	18.0	232	1.100	3.990	0.547	7.97	54.00
08/19/97	10.90	1.49	15.0	103	2.290	1.550	0.236	3.39	26.00
08/26/97	11.10	1.59	18.0	150	1.770	2.530	0.396	5.53	34.00
09/02/97	10.80	1.45	15.0	123	1.520	1.710	0.274	3.97	18.20
09/09/97	10.20	1.27	17.0	58	1.260	2.800	0.427	5.97	46.00
09/16/97	9.77	0.85	15.0	147	1.410	1.990	0.309	4.53	32.00
09/23/97	11.60	1.93	17.0	237	2.090	3.080	0.479	6.83	42.00
09/30/97	11.40	1.36	17.0	134	1.170	2.680	0.408	5.82	38.00
10/07/97	10.60	1.51	17.0	223	1.150	3.150	0.445	6.78	50.00
10/14/97	11.20	1.69	18.0	201	0.558	3.510	0.500	0.70	44.00
10/21/97	10.60	1.55	18.0	196	0.904	3.470	2.430	6.78	48.00
10/28/97	10.30	1.42	18.0	126	0.646	2.440	0.337	5.11	34.00
11/04/97	10.70	1.51	17.0	137	0.710	1.980	0.272	4.17	26.00
11/18/97	12.00	1.50	22.0	112	0.938	1.770	0.256	3.74	28.00
12/02/97	9.36	1.22	17.0	92	0.729	0.933	0.144	2.12	15.40
12/09/97	10.30	1.09	16.0	87	0.781	1.620	0.310	3.40	24.00
12/16/97	12.60	1.19	21.0	104	0.913	1.720	0.260	3.67	22.00
12/30/97	13.70	2.36	30.0	55	0.811	1.300	0.188	2.90	12.40
01/06/98	13.10	1.06	27.0	50	1.080	0.730	0.110	1.74	8.60
05/12/98	10.00	0.95	15.0	36	0.901	0.607	0.108	1.57	6.20
05/19/98	10.10			583	0.916	1.470		3.36	20.00
05/26/98	10.20	1.23	16.0	185	0.856	1.850	0.312	4.03	26.00
06/02/98	10.70	1.37	16.0	146	0.871	1.890	0.321	4.08	26.00
06/09/98	12.90	1.38	18.0	147	1.170	2.230	0.359	4.67	30.00
06/16/98	9.87	1.11	14.0	82	0.728	1.050	0.169	2.28	16.00
06/23/98	8.89	1.29	15.0	104	0.995	1.500	0.234	3.32	24.00
06/30/98	10.50	1.47	16.0	152	1.310	1.820	0.287	4.17	28.00

Table E1. ***Nescopeck Creek Water Quality, 1996-98*** *(sample collected by Friends of Nescopeck, analyzed by Pa. DEP)—Continued*

Sample Date	Sodium	Potassium	Chloride	Sulfate	Iron	Manganese	Zinc	Aluminum	Total Acidity, Hot
	mg/l								
07/06/98	11.5	1.45	17	172	1.14	2.25	0.348	4.76	28
07/14/98	11.1	1.56	17	143	1.15	2.26	0.357	4.53	34
07/21/98	10.6	1.44	17	168	1.09	2.39	0.35	4.8	32
07/28/98	11.4	1.52	18	227	1.28	2.87	0.422	6.05	36
08/04/98	11.6	1.46	18	205	1.15	2.82	0.411	6.18	38
08/11/98	13.5	2.01	23	154	1.09	2.12	0.289	4.19	24
08/18/98	12.4	1.07	19	177	0.902	2.7	0.389	5.85	38
08/24/98	13.2	2.21	20	146	1.34	3.3	0.455	7.17	40
09/01/98	13.1	1.78	19	254	1.45	3.16	0.477	6.54	32
09/08/98	12.9	2.38	20	59	3.92	1.96	0.282	5.44	20
09/15/98	11.7	1.51	18	242	1.53	2.7	0.403	5.63	30
09/22/98	12.8	1.89	18	199	1.44	3.07	0.419	5.86	36
09/29/98	13.7	1.78	20	211	1.15	3.46	0.478	7.21	40
10/06/98	12.8	1.6	19	253	1.09	2.88	0.434	6.02	36
10/13/98	10.6	1.34	16	148	1.36	2.18	0.35	4.59	28
10/27/98	11.4	1.54	15	171	1.15	2.73	0.426	0.2	34

Table E2. Nescopeck Creek Water Quality, Annual Average Concentrations, 1996-98 *(samples collected by Friends of Nescopeck, analyzed by Pa. DEP)*

Sample Date	Specific Conductance	pH	Alkalinity	Residue, Total Solids	Residue, Dissolved/105 Suspended	Residue, Total Nonfilterable Dissolved	Calcium	Magnesium	Sodium
	µmhos/cm		mg/l						
1996[1]	277.57	4.99	10.31	369.43	350.29	20.57	14.04	17.39	7.44
1997	412.77	4.77	10.20	359.43	345.67	13.56	22.76	27.75	11.53
1998	473.32	4.81	10.15	458.57	445.62	13.09	24.00	32.57	11.71

Sample Date	Potassium	Chloride	Sulfate	Iron	Manganese	Zinc	Aluminum	Total Acidity, Hot
	mg/l							
1996	1.37	10.71	80.86	3.56	1.15	0.21	2.95	17.29
1997	1.41	18.49	131.33	1.18	2.06	0.36	4.25	33.18
1998	1.52	18.05	180.43	1.30	2.27	0.35	4.88	29.43

[1] Only seven sets of data were collected in 1996.

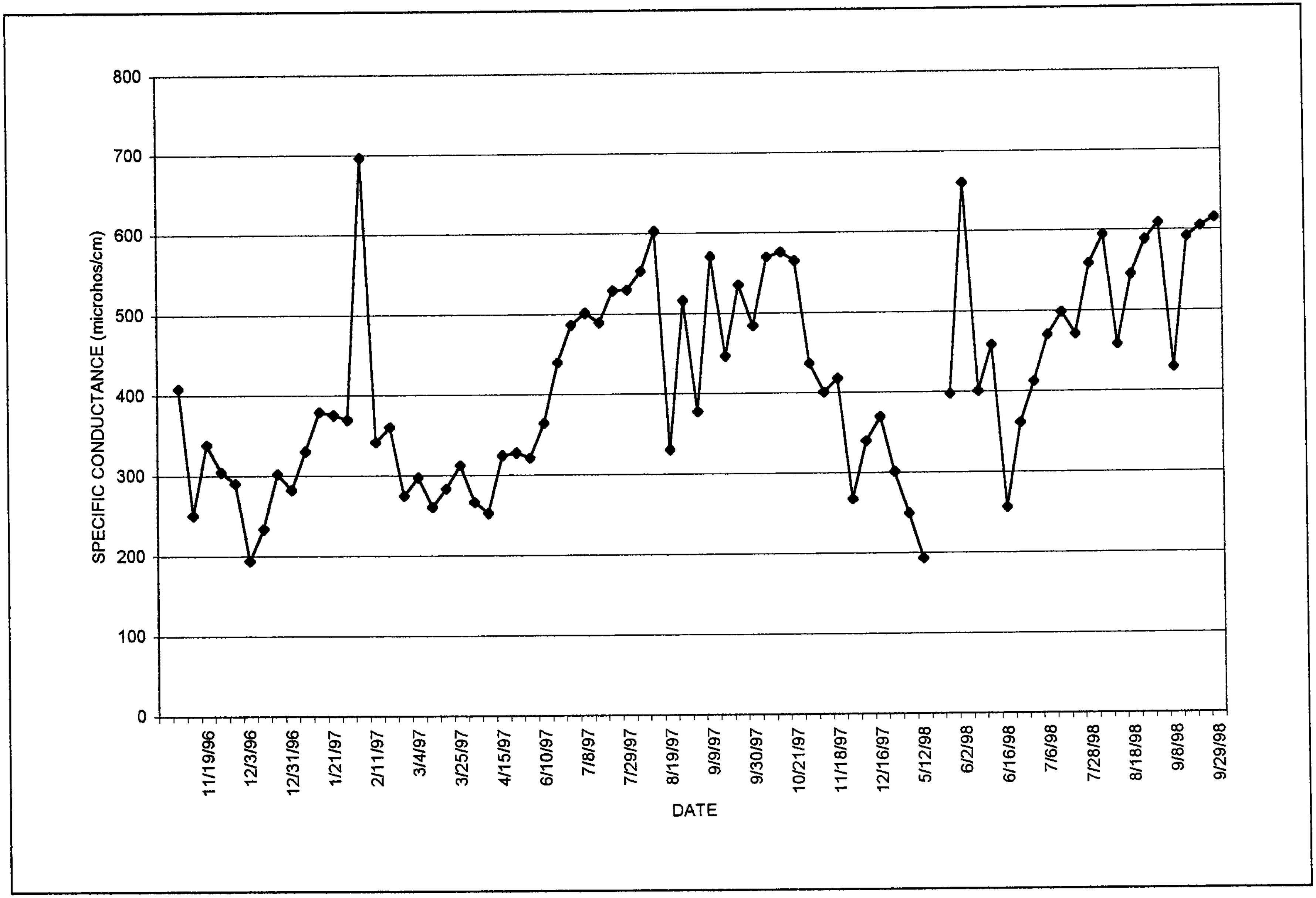

Figure E1. Nescopeck Creek Specific Conductance, 1996-98

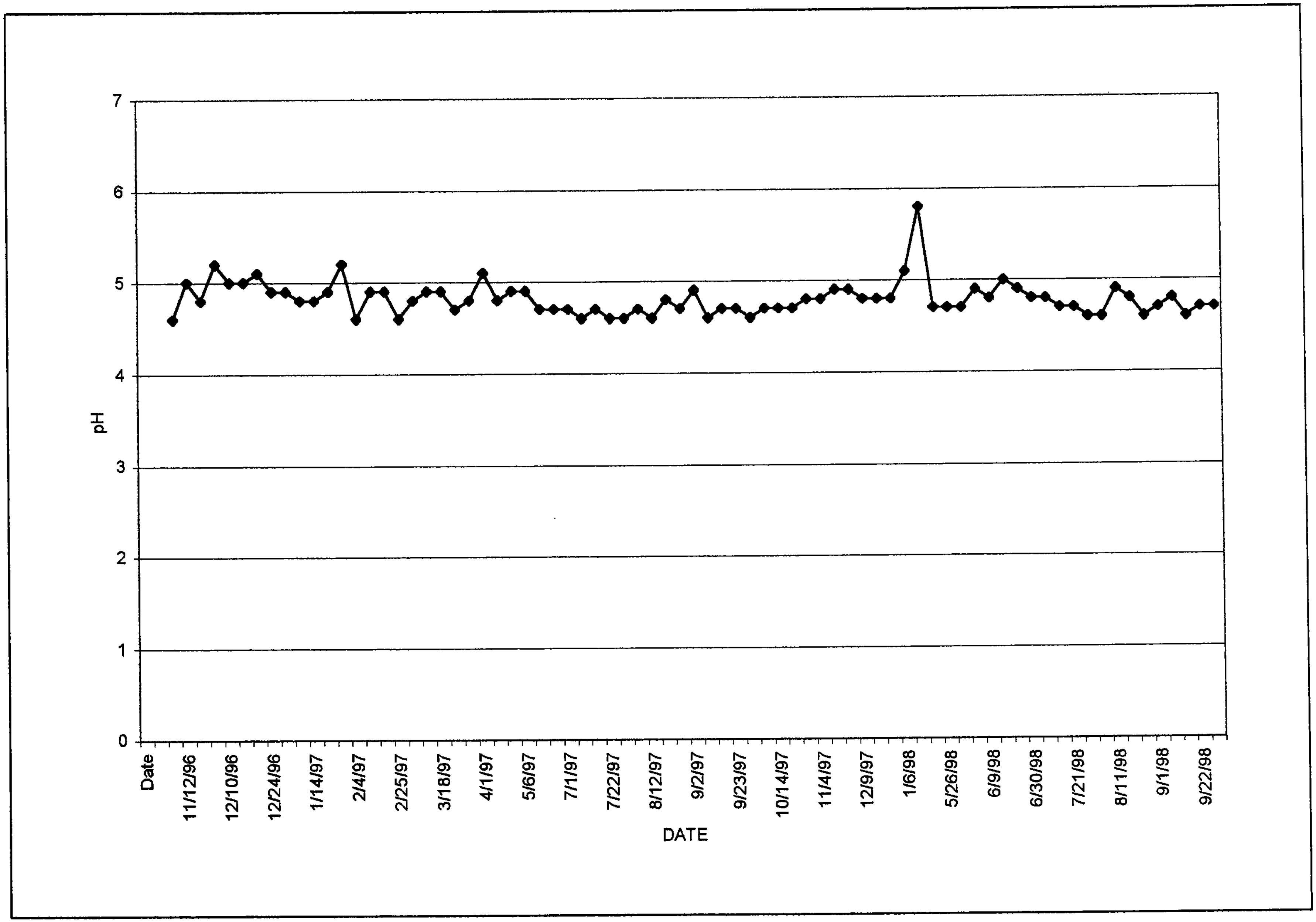

Figure E2. Nescopeck Creek pH, 1996-98

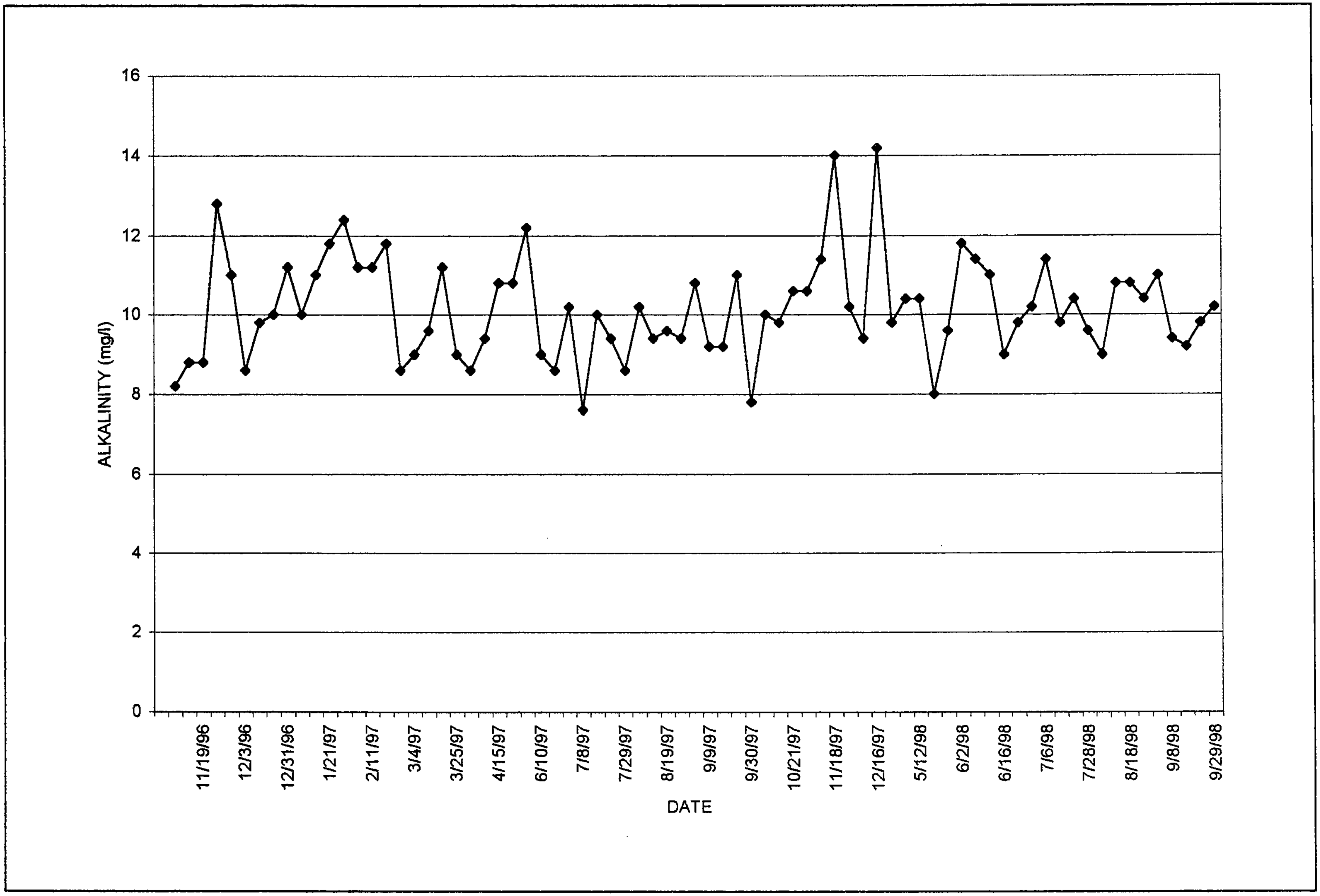

Figure E3. Nescopeck Creek Alkaline Concentrations, 1996-98

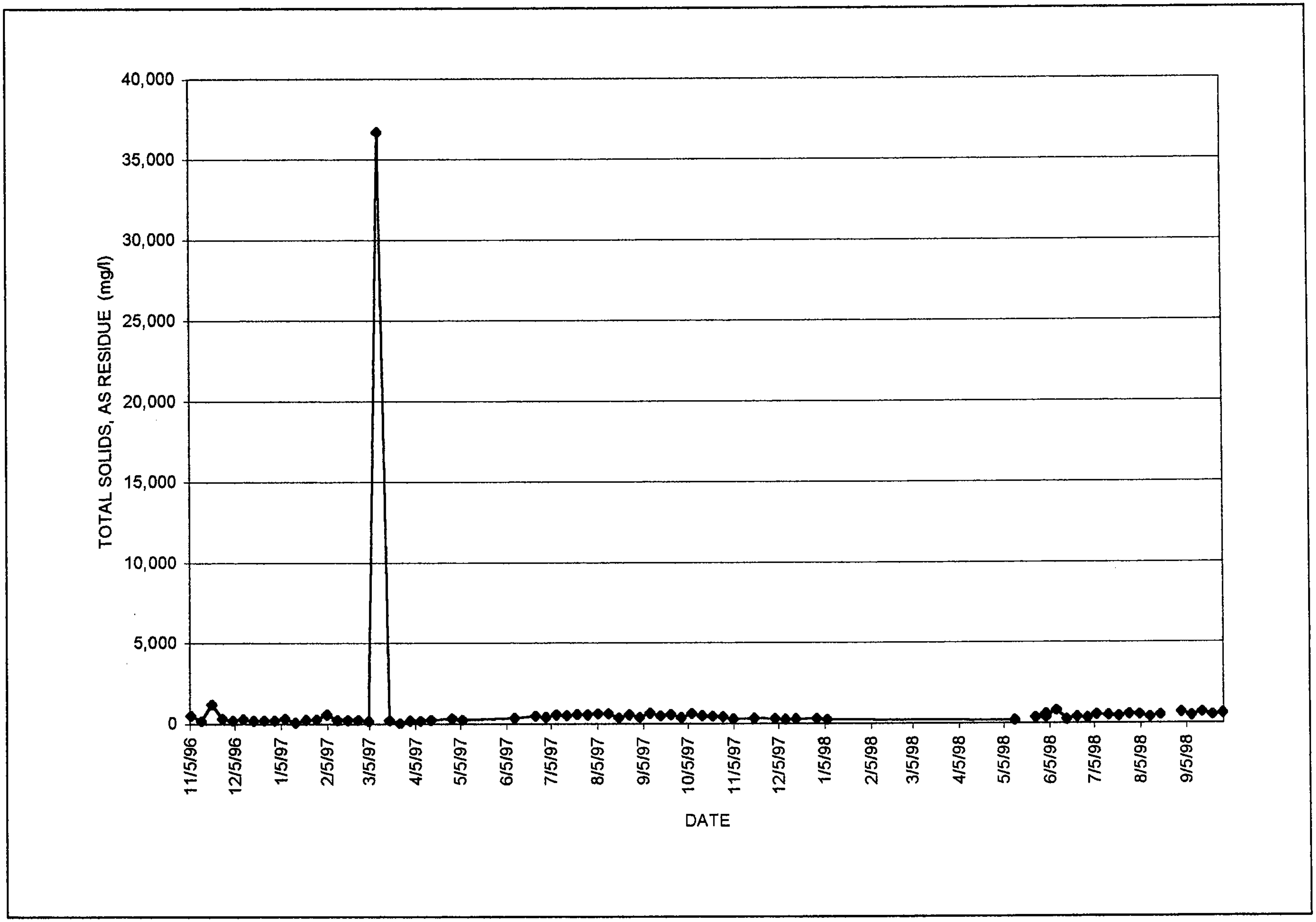

Figure E4. Nescopeck Creek Total Solids, as Residue, 1996-98

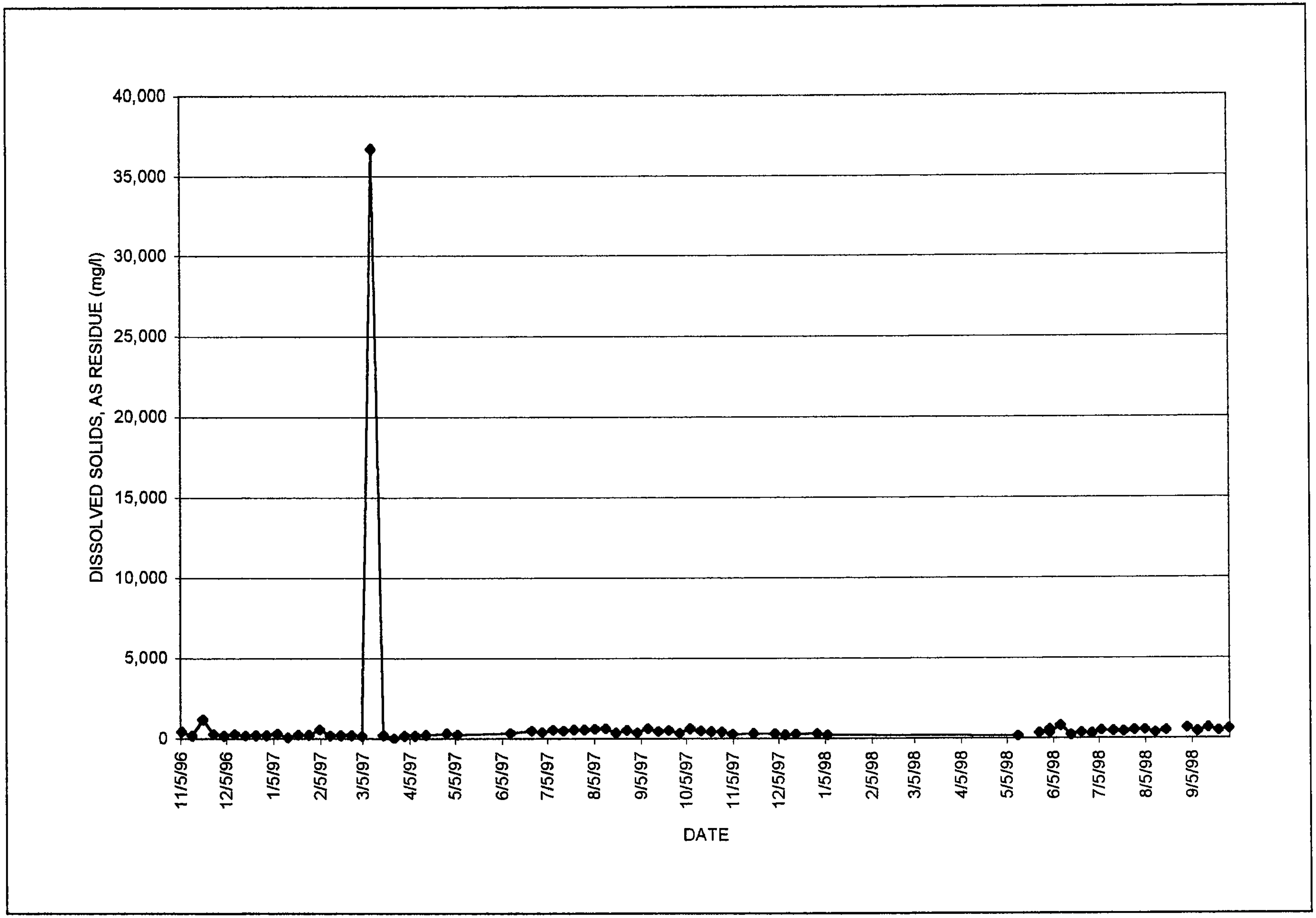

Figure E5. *Nescopeck Creek Dissolved Solids, as Residue, 1996-98*

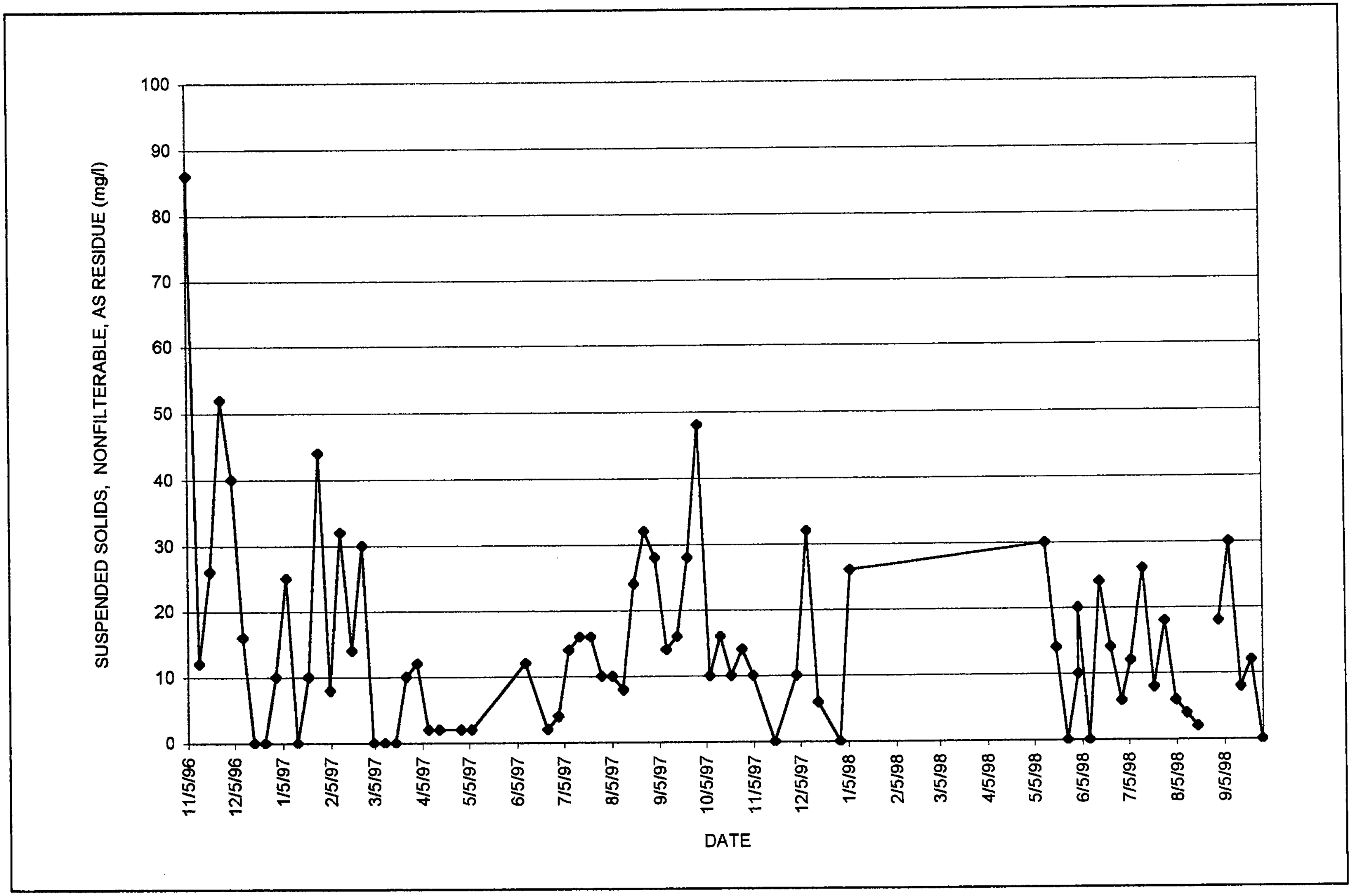

Figure E6. Nescopeck Creek Suspended Solids, Nonfilterable, as Residue, 1996-98

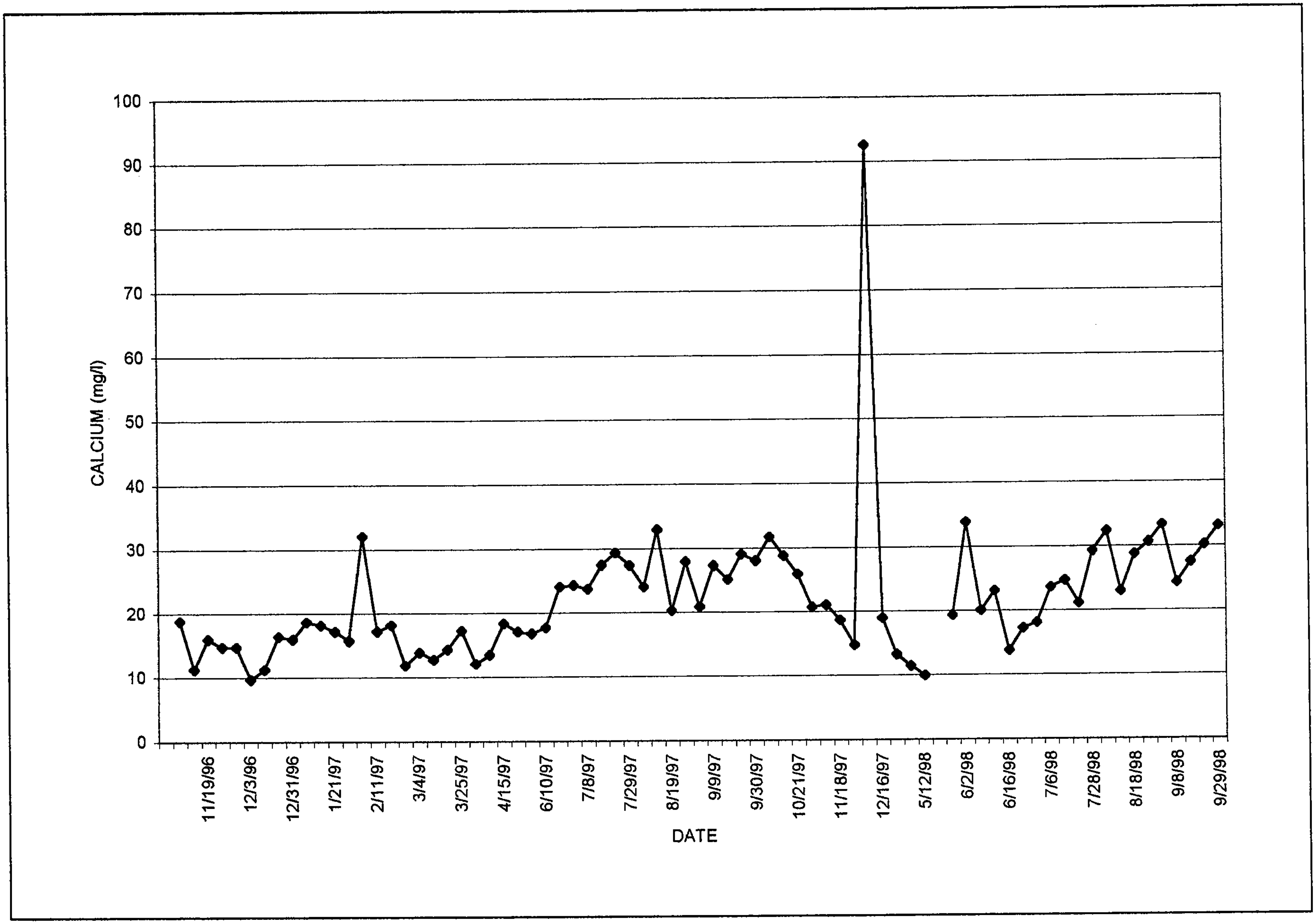

Figure E7. *Nescopeck Creek Calcium Concentrations, 1996-98*

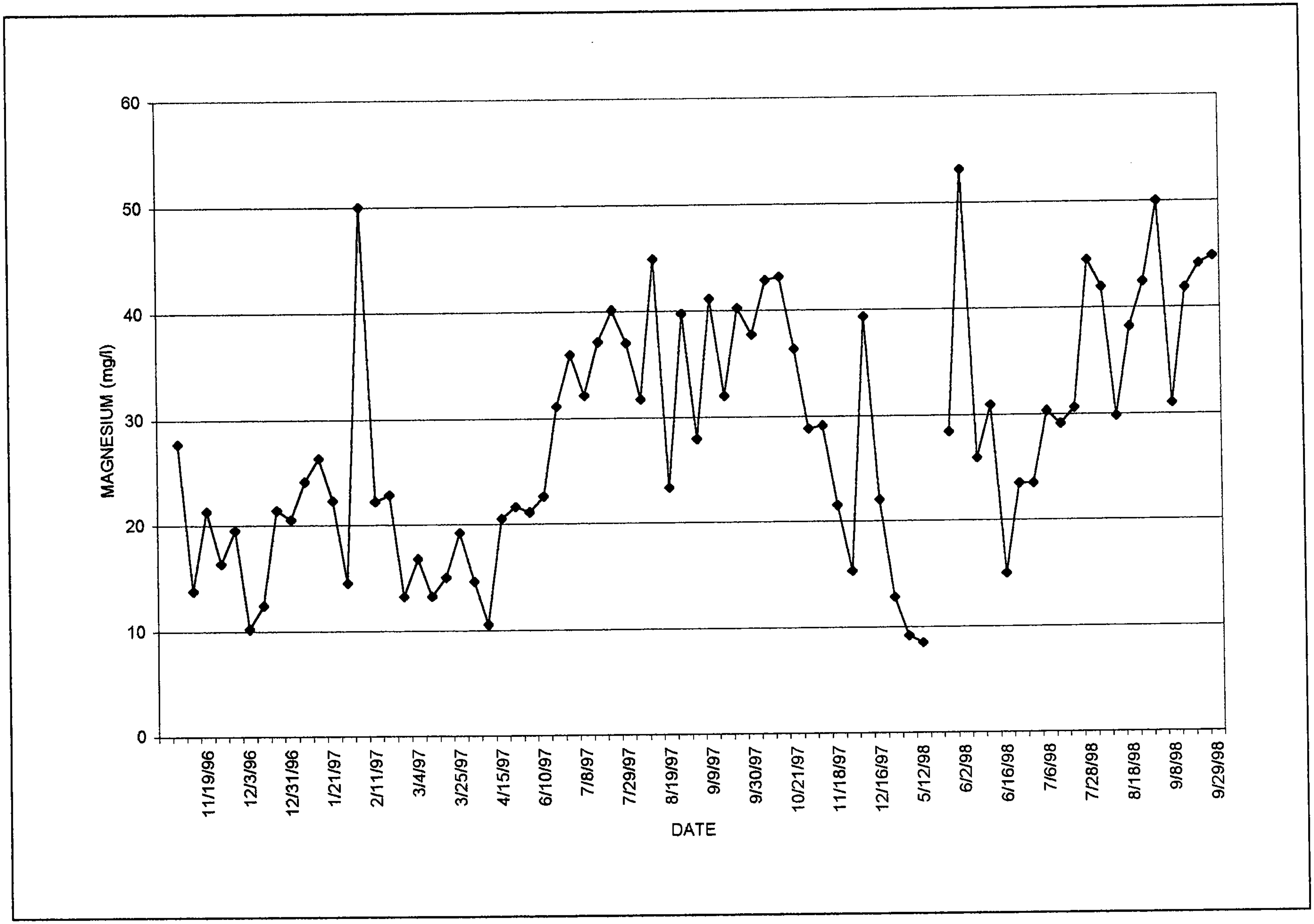

Figure E8. *Nescopeck Creek Magnesium Concentrations, 1996-98*

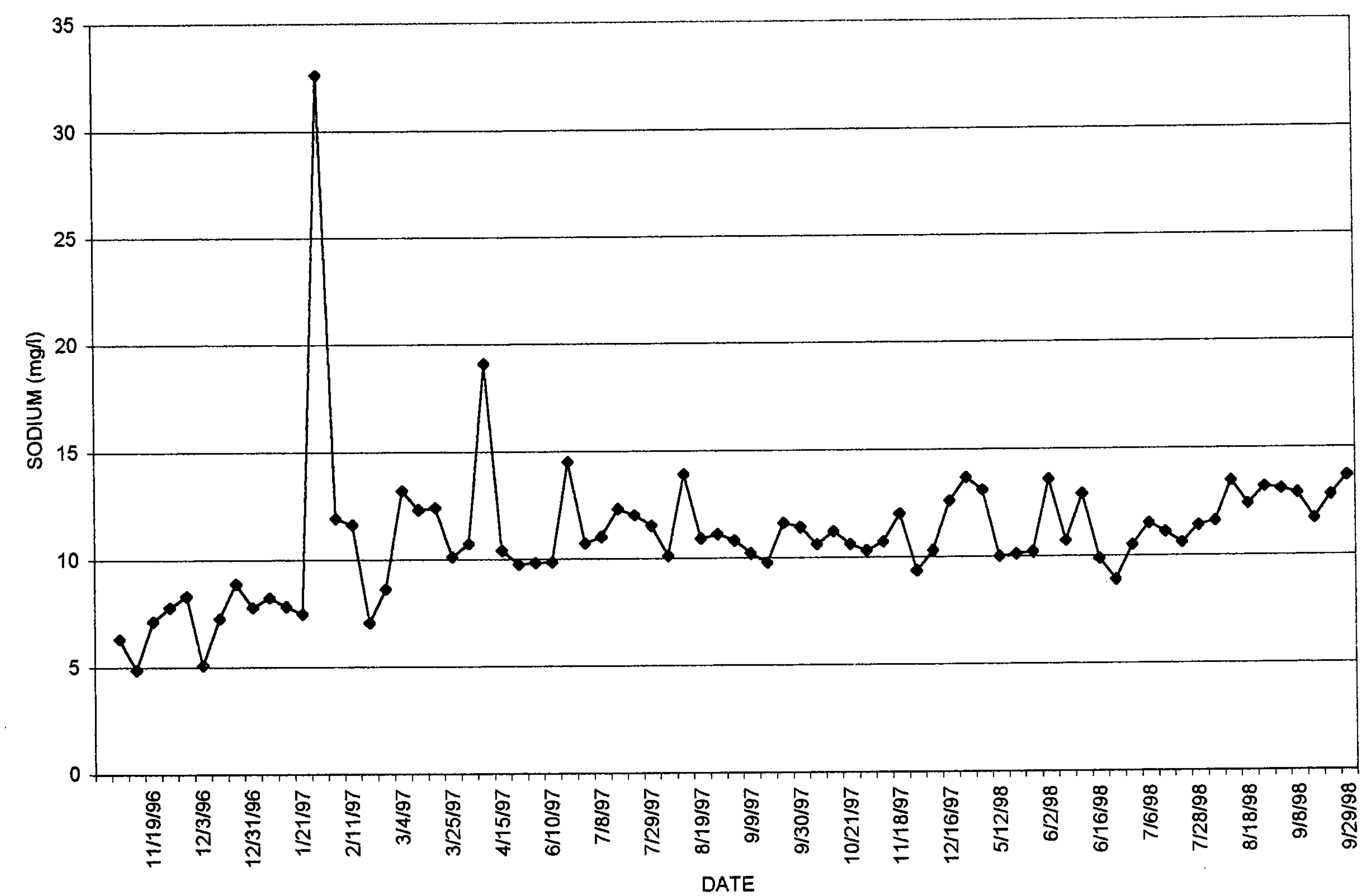

Figure E9. *Nescopeck Creek Sodium Concentrations, 1996-98*

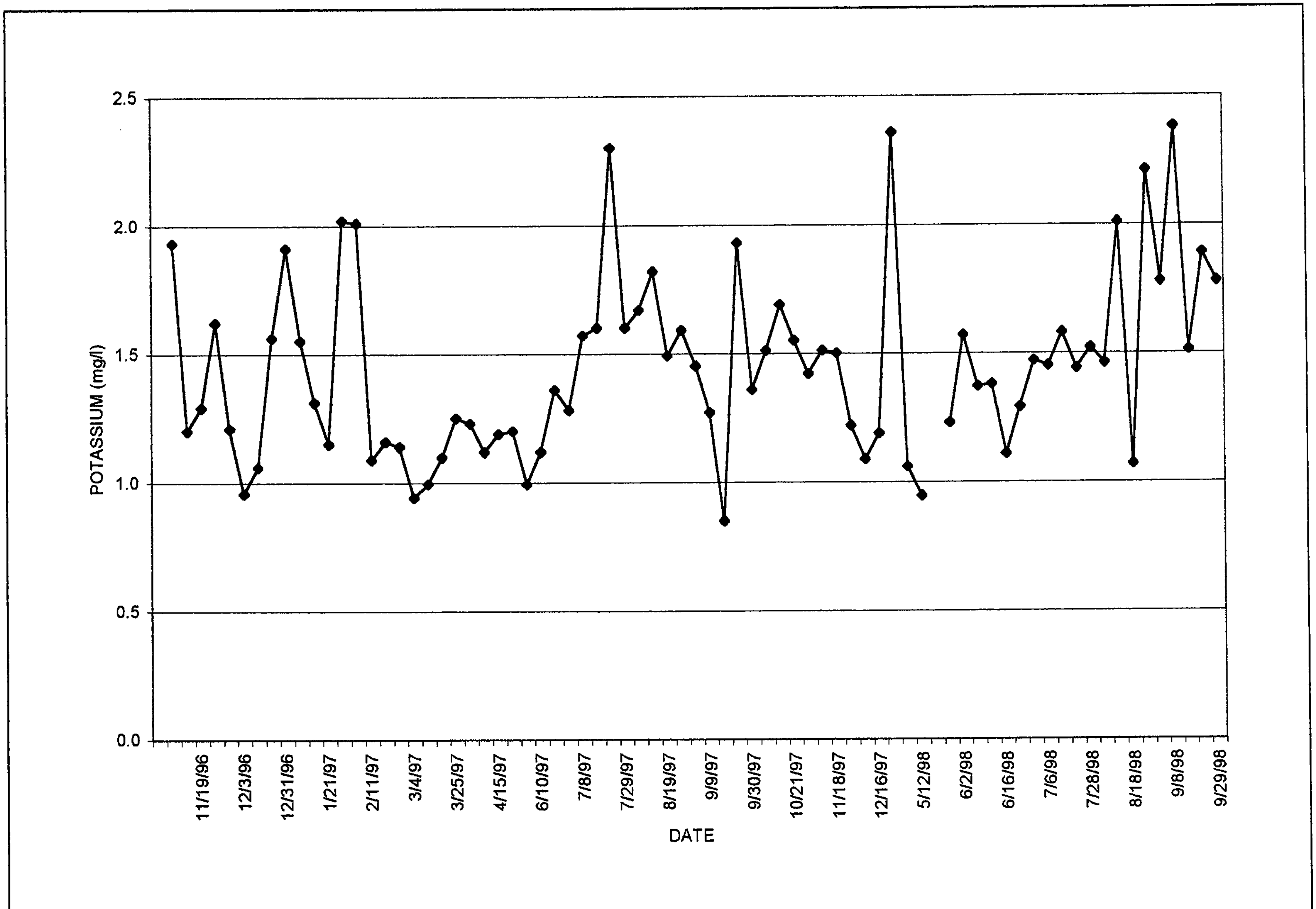

Figure E10. Nescopeck Creek Potassium Concentrations, 1996-98

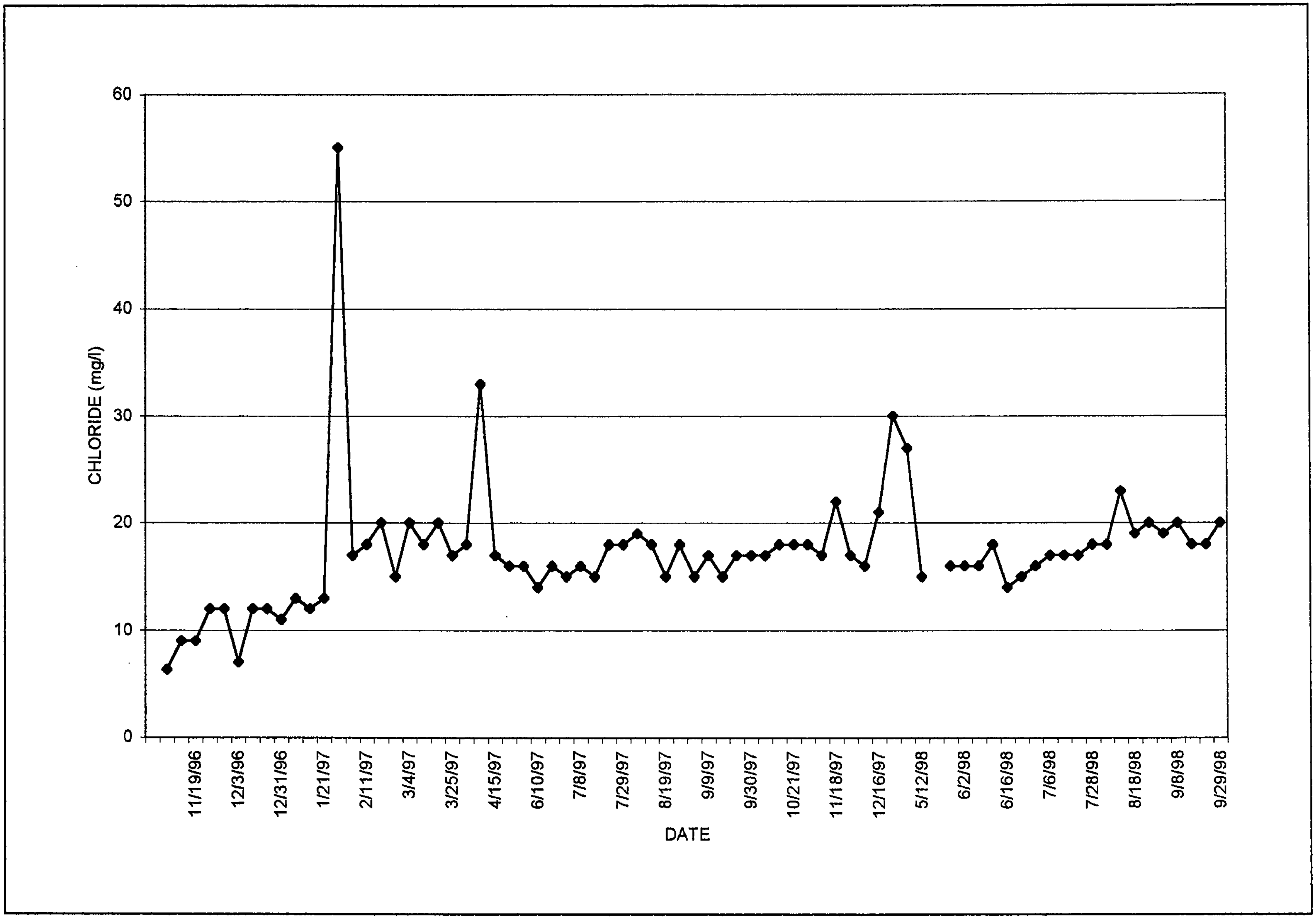

Figure E11. ***Nescopeck Creek Chloride Concentrations, 1996-98***

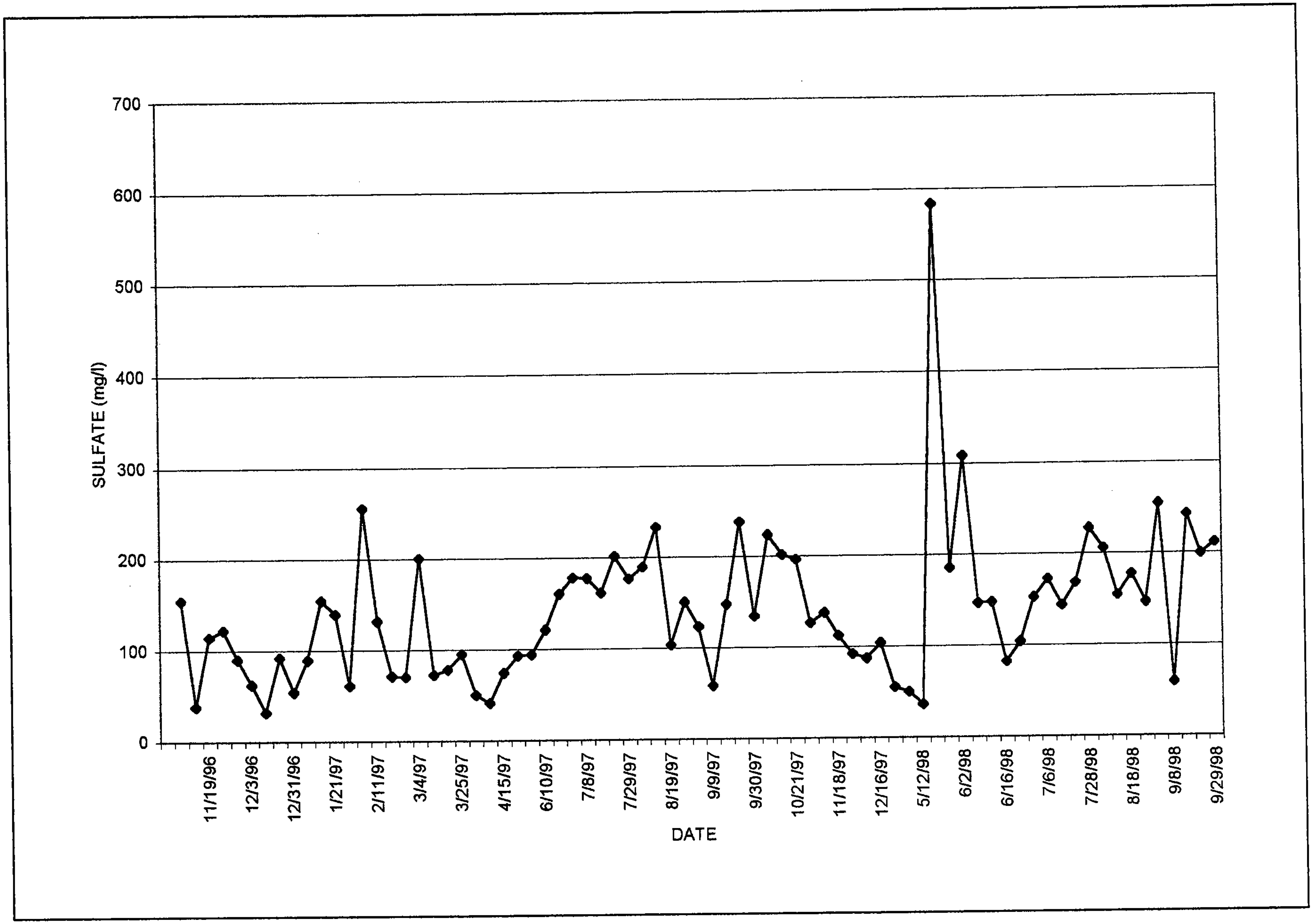

Figure E12. ***Nescopeck Creek Sulfate Concentrations, 1996-98***

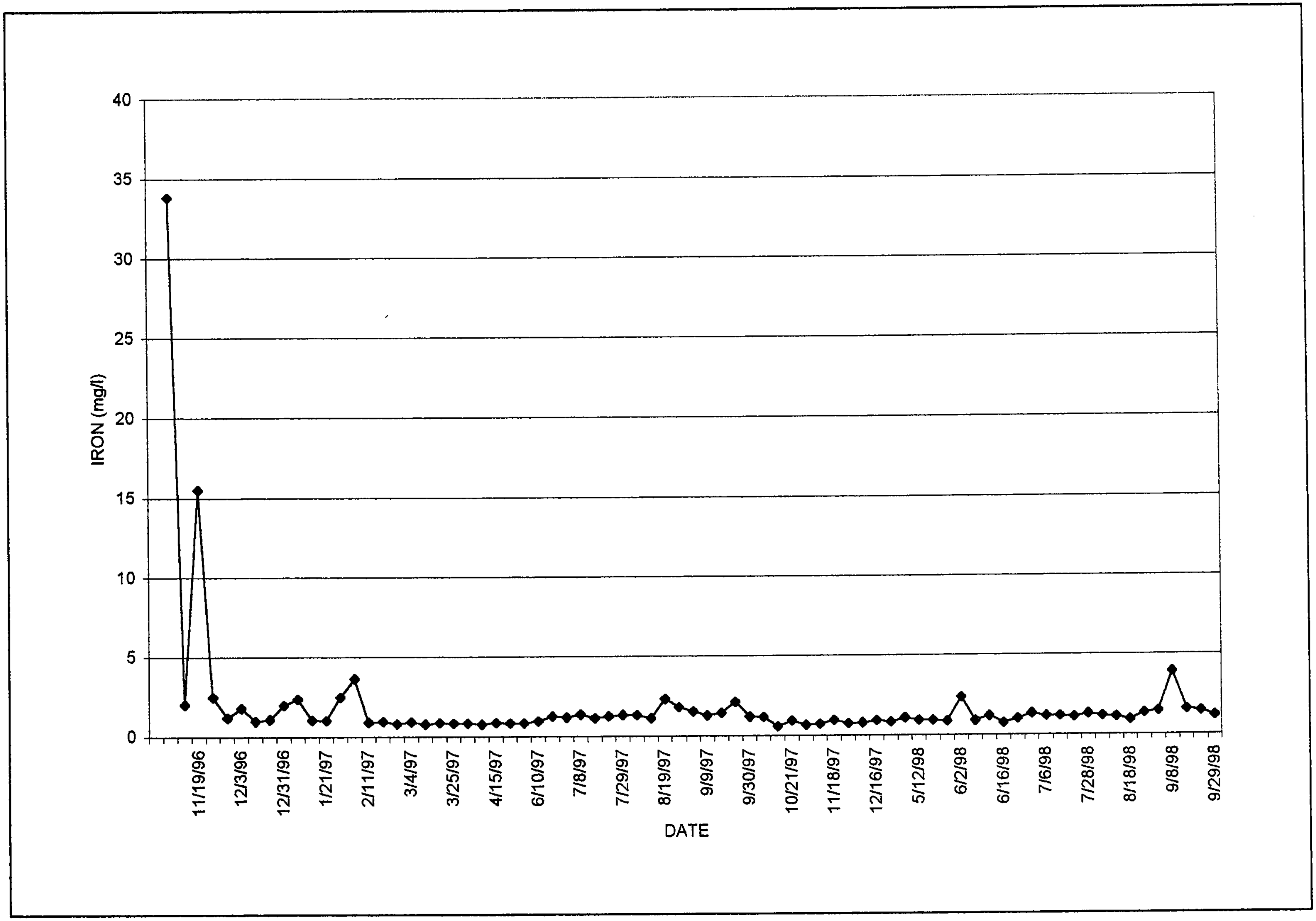

Figure E13. ***Nescopeck Creek Iron Concentrations, 1996-98***

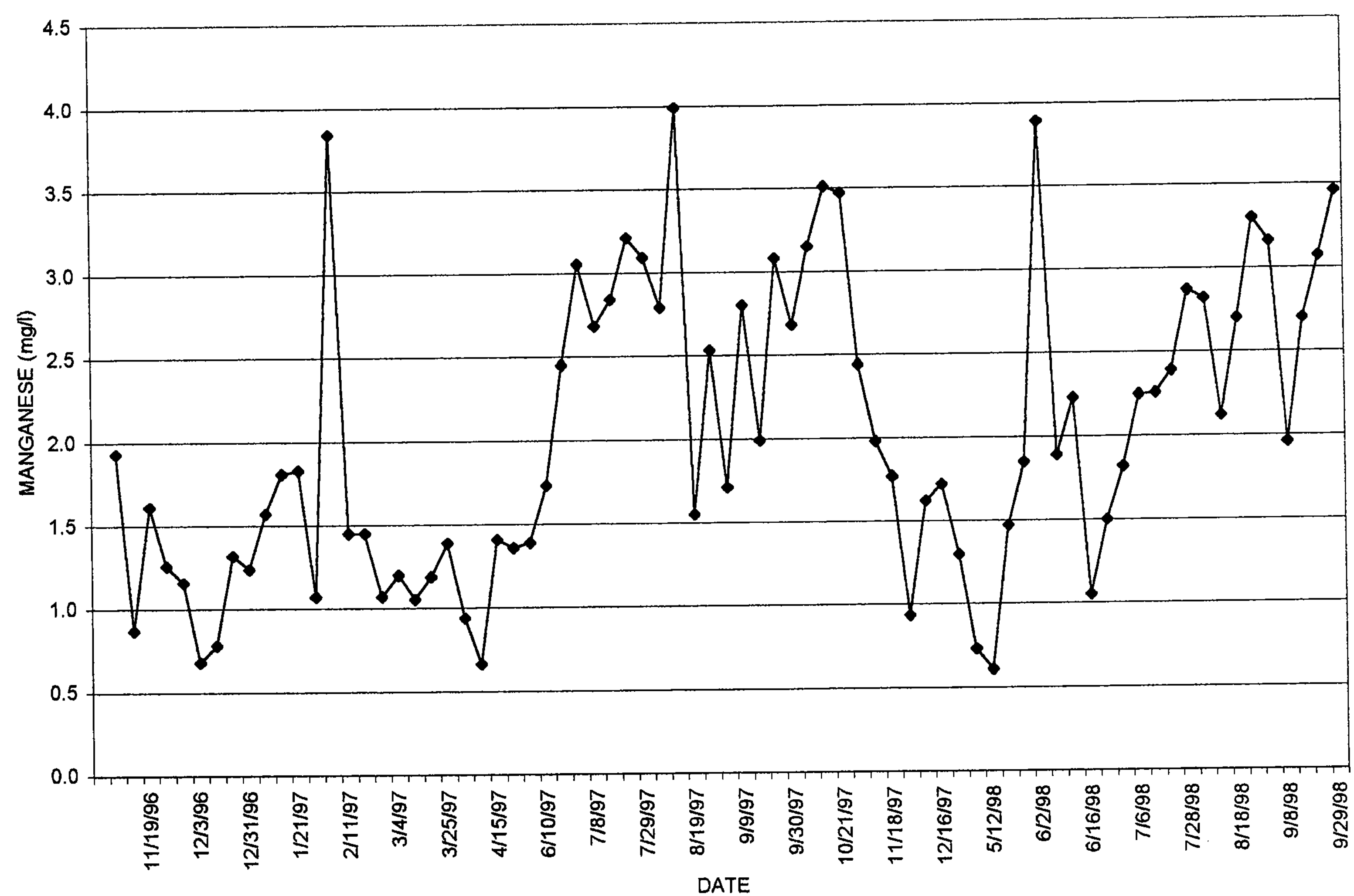

Figure E14. Nescopeck Creek Manganese Concentrations, 1996-98

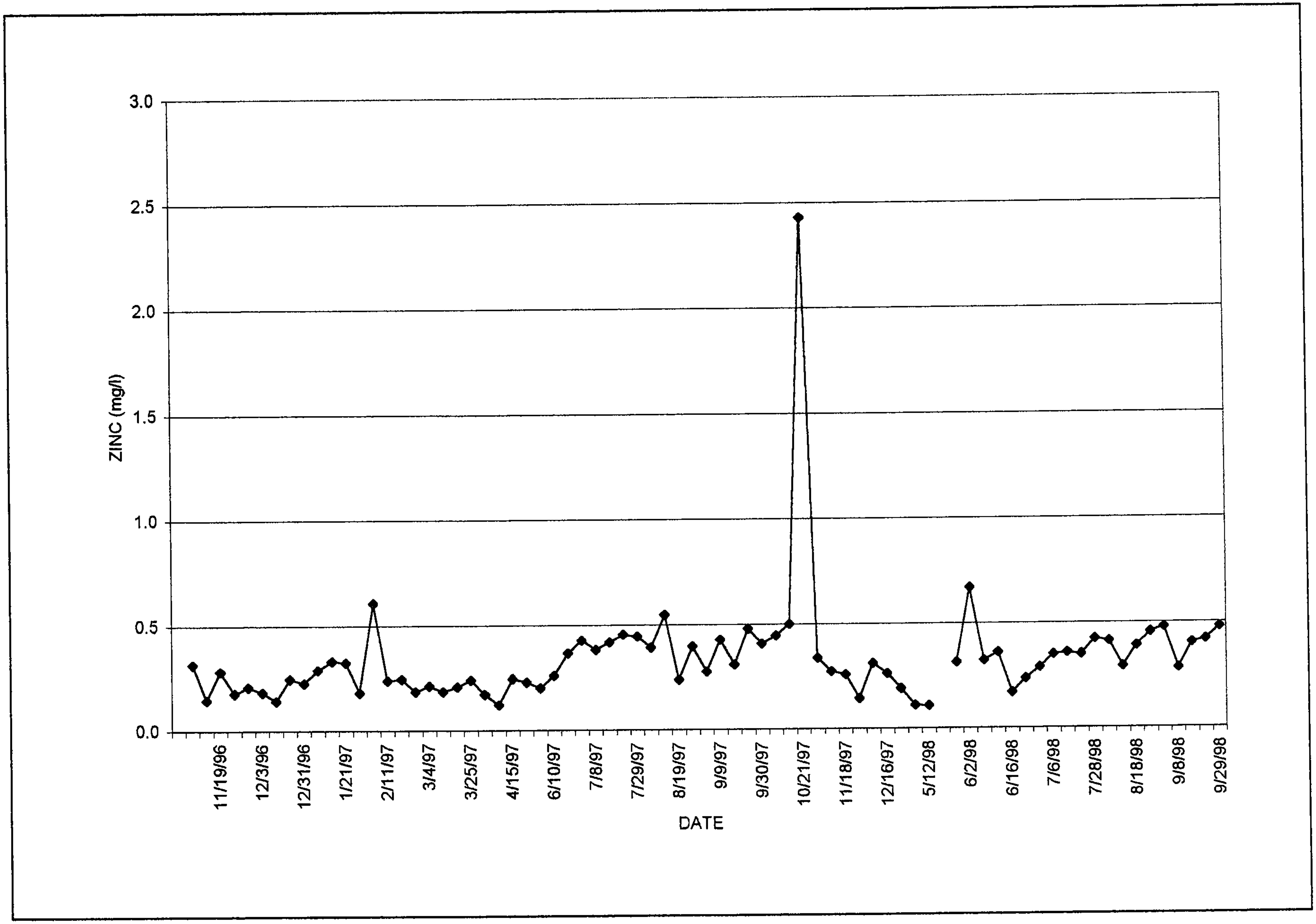

Figure E15. *Nescopeck Creek Zinc Concentrations, 1996-98*

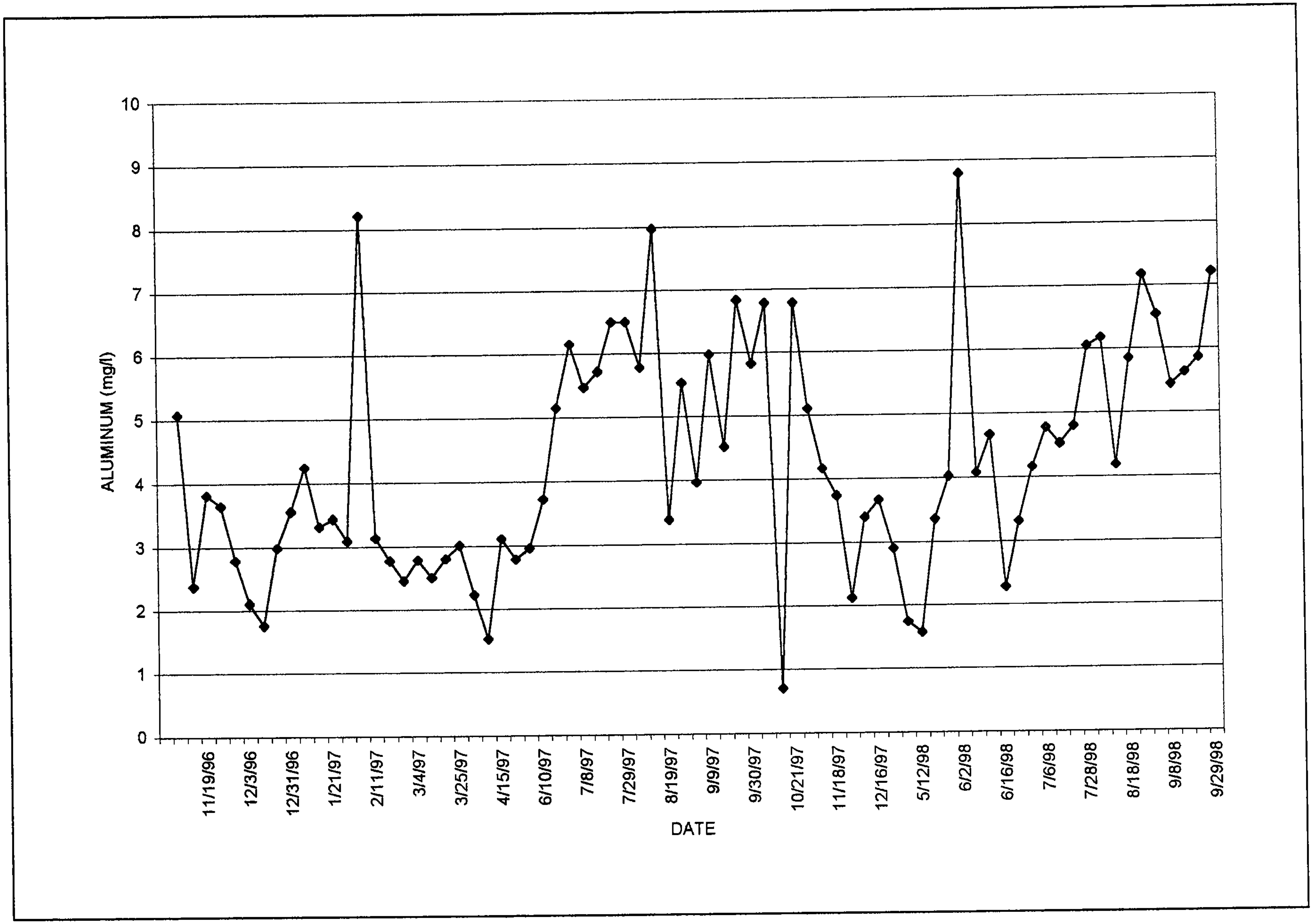

Figure E16. *Nescopeck Creek Aluminum Concentrations, 1996-98*

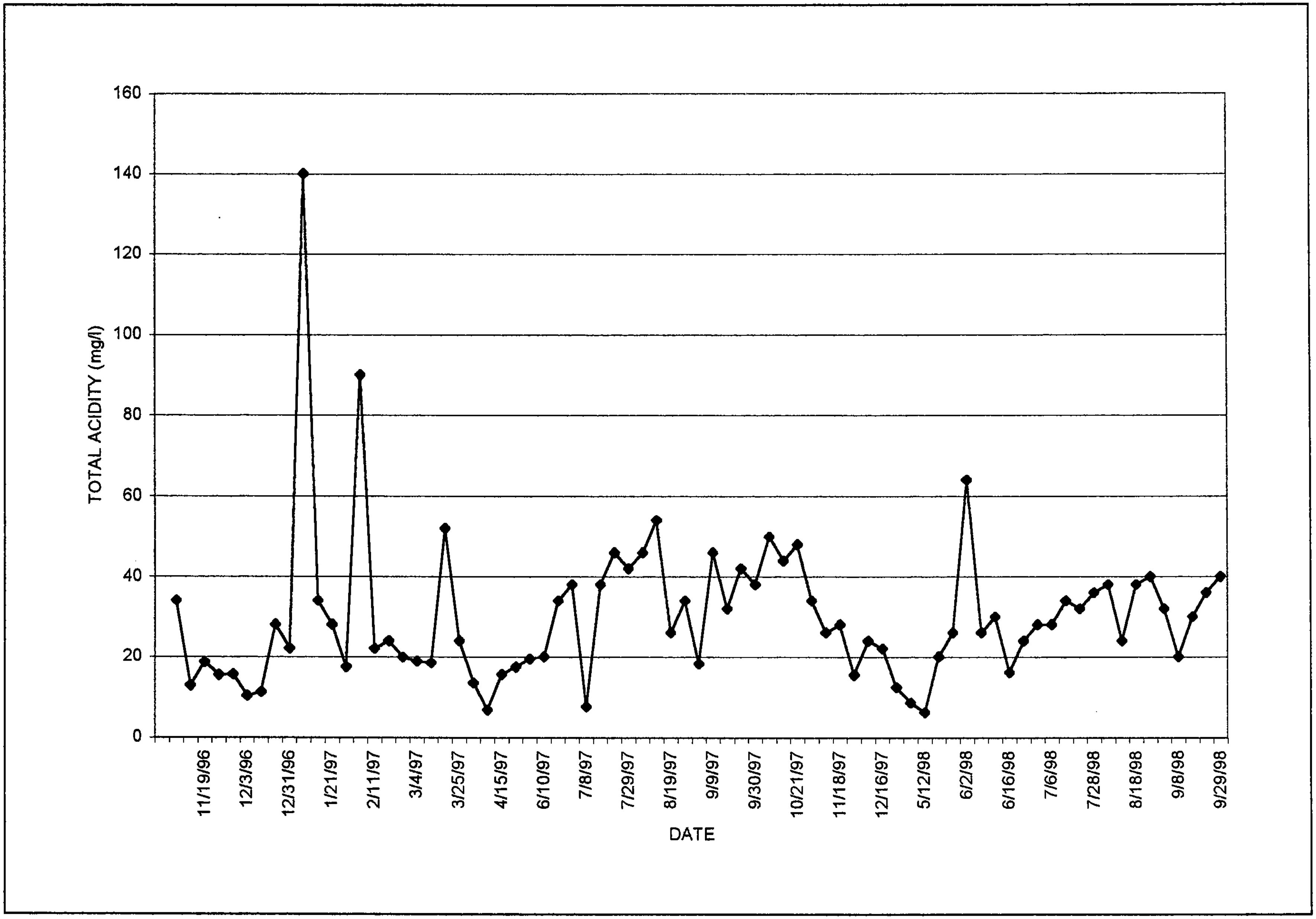

Figure E17. Nescopeck Creek Total Acid Concentrations, 1996-98

APPENDIX F

JEDDO TUNNEL WATER QUALITY DATA

Table F1. Jeddo Tunnel Outfall Water Quality Data, 1995-98 *(sample collected by Friends of Nescopeck, analyzed by Pa. DEP)*

Sample Date	Specific Conductance	pH	Alkalinity	Total Solids, as Residue	Dissolved Solids, As Residue	Suspended Solids, Nonfilterable, as Residue	Calcium	Magnesium
	µohms/cm		mg/l					
04/04/95	730	4.3	7.8	996	794	202	35	47.7
04/04/95		4.2	5.8			20		
04/11/95	747	4.3	7	882	796	86	36.2	48.1
04/18/95	699	4.4	9.6	848	604	244	28.7	40.5
04/25/95	693	4.3	6.8	952	688	264	29.1	42.3
05/02/95		4.4	8.8			8		
05/09/95		4.2	6.2			82		
05/15/95		4.2	6.4			308		
05/23/95		4.2	6.2					
05/30/95	760	4.1	4	692	620	72	34.8	42
06/06/95	729	4.2	6	1,260	876	388	36	48.9
06/13/95	724	4.2	4.8	1,038	800	238	34.6	46.1
06/20/95	673	4.2	5.8	8.32	716	116	34.6	40.9
06/28/95	711	4.1	4.4	886	766	120	34.3	43.1
07/11/95	719	4	2.8	1,610	789	812	34.6	50.9
07/18/95	742	4.4	7.8	866	826	40	39.9	59
07/25/95	813	4.1	5.4	1,708	1,202	506	37.1	49.6
08/03/95	824	3.9		1,890	1,302	588	38.2	52
08/08/95	792	4.1	4.2	1,094	918	176	35.6	47.9
08/15/95	847	4	3.4	3,212	2,796	416	35.9	47
08/22/95	859	4	2.8	1,084	1,038	46	41.3	54.2
08/29/95	875	3.9		1,732	1,120	612	42.2	54.1
09/26/95	882	3.8		2,436	1,036	1,400	41.5	52.2
09/05/95	862	3.9		256	4,282	48	39.9	53.9
09/12/95	902	3.9		1,124	1,010	114	45.5	60.8
09/19/95	874	3.8		1,566	864	592	36.9	49.4
10/03/95	901	3.8		1,188	1,086	102	42.1	63.9
10/10/95	897	4	4.6	1,089	1,034	64	40.2	56.1
10/19/95	876	4.1	4.2	1,168	700	468	47.7	65.7
10/24/95	799	4.3	6	712	690	22	38.3	53.7

Table F1. ***Jeddo Tunnel Outfall Water Quality Data, 1995-98*** *(sample collected by Friends of Nescopeck, analyzed by Pa. DEP)—Continued*

Sample Date	Specific Conductance	pH	Alkalinity	Total Solids, as Residue	Dissolved Solids, as Residue	Suspended Solids, Nonfilterable, as Residue	Calcium	Magnesium
	µohms/cm		mg/l					
11/07/95	800	4.2	7.8	888	798	90	39.4	60.8
11/14/95	705	4.5	9.2	576	564	12	32.2	42.4
11/21/95	737	4.5	7.6	626	606	20	32.6	45.4
11/28/95	770	4.3	7.4	688	642	46	37.9	57.1
12/05/95	721	4.4	9	642	600	42	36.6	49.9
12/12/95	735	4.3	7.2	646	634	12	32.4	52
12/19/95	747	4.2	5.4	608	594	16	34.9	50.1
12/26/95	780	4.4	10.6	604	606	10	37	46.3
01/02/96	776	4.2	7.6	610	610	2	39.8	54.2
01/17/96	786	4.1	3.4	806	806	2	37.7	50.5
01/23/96	792	4.5	9	938	686	252	37.5	52.7
02/13/96	780	4.6	10.4	702	702	2	39.1	74.8
02/20/96	761	4.4	9	718	550	6	40.8	55
02/27/96	642	4.4	7.6	536	536	8	34.7	51.8
03/05/96	660	4.4	7.4	578	578	2	34.5	49.3
03/12/96	685	4.4	6.6	620	608	12	36	53
03/26/96		3.6						
04/03/96	626	4.5	9.6	550	548	2	34.9	50.6
04/09/96	646	4.5	8	538	524	14	34	51.1
04/16/96	578	4.4	7.6	500	492	8	29.2	42.2
04/23/96	640	4.6	10.4	568	20	48	29.9	41
04/30/96	660	4.6	9.8	682	682	2	35.7	53.6
05/08/96	616	4.5	8.6	668	626	42	31.2	47.9
05/14/96	593	4.6	9.4	730	8	722	29.9	46
05/21/96	650	4.6	10	640	762	62	28.6	39.8
06/04/96	737	4.3	8	1,470	1,140	330	36.7	54.4
06/11/96	734	4.2	4.6	792	680	112	38.7	58.4
06/18/96	737	4.4	8.6	1,076	948	128	41.7	66.5
06/25/96	649	4.2	5.2	1,034	936	98	41.5	60.3
07/02/96	706	4.2	6.4	727	742	110	38.4	55.6

Table F1. ***Jeddo Tunnel Outfall Water Quality Data, 1995-98*** *(sample collected by Friends of Nescopeck, analyzed by Pa. DEP)—Continued*

Sample Date	Specific Conductance	pH	Alkalinity	Total Solids, as Residue	Dissolved Solids, as Residue	Suspended Solids, Nonfilterable, as Residue	Calcium	Magnesium
	µohms/cm		mg/l					
07/16/96	678	4.4	7.8	834	750	84	32	52.1
07/23/96	700	4.3	6.6	516	468	48	34.6	45.7
07/30/96	700	4.3	7.6	844	774	70	37	51.1
08/06/96	733	4.3	6.2	914	842	72	34	50.7
08/13/96	706	4.1	4	1,242	786	456	33.8	50.5
08/20/96	759	4.2	5.6	1,034	882	152	33.9	48.9
08/27/96	756	4.1	5.6	936	844	92	42.2	68.8
09/03/96	765	4	3.2	1,202	1,010	192	43.5	69.1
09/10/96	800	4	4	1,200	818	382	39.5	62.3
09/17/96	740	4	3.4	1,030	700	330	37.6	56.8
09/24/96	765	4.2	6.8	4,352	2,982	1,370	41.1	60.5
10/08/96	828	4.2	6.2	982	776	206	41	65
10/29/96	723	4.4	8.8	800	562	238	39.7	66.4
10/22/96	713	4.6	9.8	960	752	208	32	51.1
10/15/96	820	4.2	6.4	1,652	1,646	406	42.5	61.9
11/19/96	696	4.5	9.8	1,180	514	566	33.7	52.1
11/12/96	663	4.7	10.2	556	510	26	30.2	50.1
11/05/96	727	4.3	7	3,404	2,508	896	34.4	58.4
11/26/96	678	4.8	14.8	1050	622	428	33.7	55.2
12/04/96	570	4.6	9.8	556	490	66	30.8	49.3
12/11/96	650	4.7	11.8	604	580	24	32.5	55.4
12/17/96	586	4.7	11	600	490	110	33.3	53.4
12/24/96	615	4.6	12.8	464	464	<2	34.3	57.4
12/31/96	614	4.7	11.8	474	452	22	35.5	59.3
01/07/97	633	4.7	11	622	542	80	37.4	62.7
01/14/97	676	4.6	11.6	520	520	<2	32	52.7
01/22/97	700	4.6	12.2	540	526	14	30.8	50.4
01/28/97	700	4.6	12.4	532	524	8	35.9	57.9
02/06/97	334	5	12.8	264	160	104	15.7	18
02/11/97	702	4.6	10.8	554	530	24	34.7	56.3

Table F1. ***Jeddo Tunnel Outfall Water Quality Data, 1995-98*** *(sample collected by Friends of Nescopeck, analyzed by Pa. DEP)—Continued*

Sample Date	Specific Conductance	pH	Alkalinity	Total Solids, as Residue	Dissolved Solids, as Residue	Suspended Solids, Nonfilterable, as Residue	Calcium	Magnesium
	µohms/cm		mg/l					
02/25/97	636	4.3	7.2	6,812	6,770	42	26.5	38.7
03/04/97	620	4.4	9.2	440	412	28	33.9	47.1
03/11/97	597	4.4	7.6			82	30	43.4
03/18/97	601	4.5	10.4	436	432	4	28.5	41.5
03/25/97	621	4.4	7.8	506	498	8	23.1	38
04/01/97	589	4.5	9	474	474	<2	33.8	52
04/08/97	563	4.5	8.2	448	442	6	27.4	44.2
04/15/97	624	4.6	11.2	528	522	6	30.6	47.3
04/29/97	668	4.6	10.6	712	712	2	37.4	63.3
05/06/97	675	4.5	11	566	564	2	34.3	52.2
06/10/97	633	4.3	6.4	614	602	12	29.6	45.8
06/17/97	671	4.3	6.4	646	610	36	35.1	54.3
06/24/97	673	4.3	5.8	740	740	2	35	53.9
07/01/97	708	4.3	7	608	564	44	36.1	57.1
07/07/97	706	4.2	4.4	780	780	2	33.1	51.2
07/15/97	722	4.3	6.8	838	760	78	39.6	60.7
07/22/97	721	4.3	6.6	854	840	14	38	60.2
07/29/97	722	4.2	5.8	810	764	46	35.7	55.8
08/05/97	758	4.2	5.8	882	804	78	37.7	65.3
08/12/97	775	4.2	5.2	856	774	82	43.8	70.5
08/19/97	750	4.4	8.4	264	244	20	41	68.1
09/02/97	780	4.7	11.8	900	872	28	40.2	74.8
09/09/97	802	4.5	8.8	942	932	10	36.6	63.6
09/16/97	755	4.4	7.8	804	796	8	33.7	58.5
09/23/97	756	4.4	8.2	754	726	28	41	69.4
09/30/97	760	4.4	10	682	644	38	40.6	63.1
10/07/97	802	4.2	5.8	786	782	4	43	63
10/14/97	805	4.2	5.4	756	748	8	39.3	74.6
10/21/97	814	4.2	6.2	482	456	26	38.2	61.7
10/28/97	820	4.2	5.8	800	790	10	37.3	74.8

Table F1. ***Jeddo Tunnel Outfall Water Quality Data, 1995-98*** *(sample collected by Friends of Nescopeck, analyzed by Pa. DEP)—Continued*

Sample Date	Specific Conductance	pH	Alkalinity	Total Solids, as Residue	Dissolved Solids, as Residue	Suspended Solids, Nonfilterable, as Residue	Calcium	Magnesium
	µohms/cm		mg/l					
11/04/97	799	4.3	7.8	682	674	8	38.5	63.2
11/18/97	756	4.4	10.4	650	558	92	31.5	47.2
12/02/97	703	4.2	6	660	652	8	35.4	58.8
12/09/97	703	4.1	4.4	602	570	32	29	48.4
12/16/97	724	4.2	6.6	360	360	<2	34.1	54.1
12/30/97	698	4.1	5.6	604	590	14	29.1	45.2
01/06/98	694	4.2	6.2	670	262	8	27.8	40.5
05/12/98	567	4.7	10.6	504	484	20	26.3	40.9
05/19/98		4.5	8.6			10		
05/26/98	644	4.6	10	566	564	2	31.1	50.8
06/02/98	660	4.7	11.8	572	562	10	33.80	53.10
06/09/98	695	4.6	11.4	496	488	8	34	54.1
06/16/98	675	4.5	8.8	764	748	16	34.3	53.8
06/23/98	723	4.6	9.6	796	772	24	33.6	53.5
06/30/98	729	4.5	9.4	580	562	18	30.9	49.9
07/06/98	745	4.5	10	842	832	10	36.5	55.4
07/14/98	747	4.5	8.4	796	784	12	34.4	53.5
07/21/98	781	4.4	7.6	734	730	4	33.5	61
07/28/98	786	4.2	6.4	826	818	8	41.3	71.2
08/04/98	810	4.3	6.8	735	731	4	44.2	67
08/11/98	800	4.4	8	800	794	6	37.1	58.8
08/18/98	807	4.3	7.8	894	850	44	39.7	64.5
08/24/98	820	4.3	7	934	926	8	39.4	56.1
09/09/98	827	4.3	8	950	938	12	43.8	61.1
09/08/98	798	4.4	7.4	340	340	2	42.1	79.3
09/15/98	815	4.3	7	834	826	8	37.2	73
09/22/98	844	4.4	7.4	764	728	36	39.9	66.1
09/29/98	853	4.3	7	656	656	10	43.3	66.9

Table F1. ***Jeddo Tunnel Outfall Water Quality Data, 1995-98*** *(sample collected by Friends of Nescopeck, analyzed by Pa. DEP)—Continued*

Sample Date	Sodium	Potassium	Chloride	Sulfate	Iron	Manganese	Zinc	Aluminum	Total Acidity, Hot
					mg/l				
04/04/95	9.87	3.62	11	293	21.2	4.86	0.75	22.7	4
04/04/95	10			324	15.5	4.67		18.2	78
04/11/95	10	2.94	11	271	11	4.72	0.744	14.6	74
04/18/95	8.48	3.19	28	474	15.3	3.64	0.614	15.3	64
04/25/95	8.68	3.99	11	276	15.1	4.06	0.666	17.2	86
05/02/95	9.39			344	11.4	4		14.9	76
05/09/95	9.39			323	4.94	4.56		10.5	66
05/15/95				283					78
05/23/95	9.56				9.13	5.26		13.1	96
05/30/95	10.5	1.87	11	285	4.42	4.79	0.731	9.72	84
06/06/95	9.68	3.5	9	287	11.7	4.44	0.698	15.7	74
06/13/95	13.2	2.65	12	288	14.6	4.4	0.646	14.5	60
06/20/95	8.98	2.22	10	282	5.98	4.08	0.6	10.3	86
06/28/95	12.9	2.19	14	230	5.98	4.24	0.678	11.1	70
07/11/95	9.88	3.32	9	303	37.6	4.58	0.77	24.7	78
07/18/95	10.8	1.85	10	362	4.43	5.24	0.772	12.2	72
07/25/95	10	3.17	11	389	32.6	4.83	0.809	26.7	86
08/03/95	8.94	7.37	11	343	68	5.09	0.775	44.4	98
08/08/95	8.61	2.54	11	317	9.51	4.72	0.705	13.8	8.6
08/15/95	8.18	6.91	11	319	39.6	4.59	0.81	31.5	126
08/22/95	9.04	2.03	11	368	4.88	5.84	0.843	11.7	86
08/29/95	9.54	2.44	12	512	34.9	6.28	0.814	25.7	102
09/26/95	10.5	6.33	13	373	46	6.22	0.858	30.4	128
09/05/95	9.39	1.69	12	345	4.91	5.82	0.663	12	100
09/12/95	11.9	2.18	13	360	10.5	6.75	0.9604	16.7	98
09/19/95	9.67	3.47	16	345	12.6	5.63	0.742	16.5	114
10/03/95	10.3	1.97	11	461	9.17	6.34	0.802	15.1	104
10/10/95	10.3	2.55	11	381	5.89	5.93	0.819	13.2	100
10/19/95	11.2	3.83	12	372	11.4	6.74	0.997	13.5	104
10/24/95	9.09	2.18	9	346	7.23	4.49	0.772	11.1	106
10/31/95	8.26	1.77	9	391	4.12	5.14	0.783	12.22	88
110/7/95	7.98	2.61	11	354	12.7	4.9	0.829	14.4	88

Table F1. Jeddo Tunnel Outfall Water Quality Data, 1995-98 *(sample collected by Friends of Nescopeck, analyzed by Pa. DEP)—Continued*

Sample Date	Sodium	Potassium	Chloride	Sulfate	Iron	Manganese	Zinc	Aluminum	Total Acidity, Hot
	mg/l								
11/21/95	8.26	1.34	13	298	4.02	3.92	0.655	9.05	76
11/28/95	8.64	1.8	10	299	3.84	5.14	0.905	12	94
12/05/95	8.67	1.96	10	250	4.55	4.78	0.844	11.3	78
12/12/95	9.34	1.71	10	290	3.48	4.76	0.819	10.9	72
12/19/95	9.87	1.53	11	307	3.21	4.97	0.799	10.9	80
12/26/95	9.36	1.78	11	320	3.14	4.83	0.777	10.1	84
01/02/96	9.15	1.61	11	365	3.53	5.1	0.797	12.2	90
01/17/96	10.9	1.59	13	313	4.2	5.49	0.821	11.6	88
01/23/96	12.6	2.72	16	297	49.7	4.8	0.746	18.6	68
02/13/96	9.02	1.83	11	427	2.89	3.89	0.842	10	74
02/20/96	8.16	1.76	11	303	2.43	3.58	0.776	8.57	70
02/27/96	12.2	1.9	14	317	3.61	3.72	0.74	9.45	62
03/05/96	9.21	1.8	11	344	2.84	3.63	0.685	9.06	72
03/12/96	11.1	1.71	13	293	3.3	4.91	0.075	10.3	84
03/26/96				90	3.6	4.39		3.64	54
04/03/96	10.5	1.71	16	286	6.36	3.62	0.662	9.23	84
04/09/96	12	1.53	14	281	3.1	3.94	0.709	9.32	60
04/16/96	15.1	2.05	15.4	226	8.68	3.18	0.583	10.2	48
04/23/96	7.57	1.71	12	282	3.75	3.47	0.587	8.01	58
04/30/96	11.6	1.75	14	269.3	4.31	4.03	0.715	9.53	54
05/08/96	10.2	1.64	12	284	3.65	3.57	0.664	8.59	72
05/14/96	10	1.73	10	51	2.63	3.37	0.603	8.01	60
05/21/96	8.69	2.88	12	277	7.27	3.54	0.64	10.9	68
06/04/96	10.1	3.75	12	295	9.42	4.56	0.844	13.5	82
06/11/96	12.5	2.15	15	311	6.7	4.69	0.752	13.6	22
06/18/96	10.7	2.02	13	316	6.38	4.36	0.736	11.6	66
06/25/96	11.2	2.21	13		8.48	4.89	0.755	13.3	88
07/02/96	17.6	2.42	12	307	6.16	4.58	0.727	11.3	70
07/09/96	11.4	2.37	12	306	7.46	5	0.79	12.8	70
07/16/96	11.4	2.23	12	293	6.81	4.23	0.761	11.7	70
07/23/96	8.65		11		4.56	4.04	0.752	10.3	80
07/30/96	9.15	1.89	13	279	3.63	3.63	0.65	9.45	78

Table F1. ***Jeddo Tunnel Outfall Water Quality Data, 1995-98*** *(sample collected by Friends of Nescopeck, analyzed by Pa. DEP)—Continued*

Sample Date	Sodium	Potassium	Chloride	Sulfate	Iron	Manganese	Zinc	Aluminum	Total Acidity, Hot
					mg/l				
08/13/96	8.81	3.44	13	277	19.4	4.93	0.804	14.4	92
08/20/96	8.9	2.53	13	337	7.96	4.3	0.693	11.3	92
08/27/96	11.6	2.21	12	336	7.19	5.5	0.842	14.5	86
09/03/96	10.1	3.26	13	314	25	5.11	0.747	21	104
09/10/96	11.4	3.05	13	299	20.8	5.47	0.833	18.7	100
09/17/96	7.26	3.47	12	344	19.6	4.35	0.6889	15.7	90
09/24/96	10.5	5.9	13	355	90.5	4.64	0.809	37.4	100
10/08/96	11	2.73	13	360	14.4	5.25	0.773	16.9	94
10/29/96	9.11	2.95	10	345	15.1	4.34	0.746	23	76
10/22/96	8.25	2.9	11	327	16.8	3.61	0.578	14.8	72
10/15/96	11.6	3.96	13	375	48.2	5.5	0.819	30	94
11/19/96	8.94	4.36	9	296	29.5	4.34	0.778	22	70
11/12/96	6.66	1.9	10	253	4.01	2.95	0.498	6.7	50
11/05/96	8.25	6.07	10	154	50.8	4.21		25	90
11/26/96	9.5	3.72	15	305	28.2	4.14	0.662	18.1	70
12/04/96	7.39	2.02	8	240	6.92	2.75	0.555	8.32	50
12/11/96	8.56	1.63	9	211	2.88	3.7	0.652	8.42	58
12/17/96	9.83	2.3	12	202	8.3	2.96	0.534	10.5	48
12/24/96	9.85	2.26	9	240	2.54	3.53	0.643	7.84	64
12/31/96	9.69	2.43	9	249	2.93	3.62	0.654	8.32	64
01/07/97	9.82	2.82	11	251	3.84	3.83	0.715	9.46	50
01/14/97	8.95	2.03	10	311	2.36	3.96	0.74	9.54	66
01/22/97	7.92	1.67	11	315	2.83	4.21	0.761	9.21	72
01/28/97	13.2	1.91	19	263	3.12	4.31	0.722	9.3	76
02/06/97	10.5	1.31	21	95	1.13	1.33	0.21	3	38
02/11/97	15.7	1.59	20	249	2.61	3.95	0.654	8.71	66
02/18/97	8.58	1.94	17	256	3.01	4.14	0.685	8.14	70
02/25/97	12.4	2.15	18	210	2.5	3.33	0.573	7.87	58
03/04/97	12.1	1.53	16	213	2.98	3.71	0.652	8.77	62
03/11/97	14.7	1.44	17	227	2.83	3.84	0.667	9.21	64
03/18/97	14.4	1.7	19	213	2.65	3.63	0.633	8.42	62
03/25/97	11.2	1.55	16	245	2.32	3.64	0.626	7.98	68

Table F1. Jeddo Tunnel Outfall Water Quality Data, 1995-98 *(sample collected by Friends of Nescopeck, analyzed by Pa. DEP)—Continued*

Sample Date	Sodium	Potassium	Chloride	Sulfate	Iron	Manganese	Zinc	Aluminum	Total Acidity, Hot
	mg/l								
04/08/97	15.4	1.61	18	138	2.3	3.15	0.529	7.13	52
04/15/97	13.6	1.61	17	205	2.4	3.77	0.626	8.32	54
04/29/97	13.3	1.73	16	258	2.44	3.88	0.653	8.32	60
05/06/97	15.3	1.64	18	258	2.49	4.12	0.593	8.53	76
06/10/97	11.4	1.57	14	251	2.72	3.69	0.576	8.04	62
06/17/97	13.5	1.81	16	232	4.18	4.15	0.644	9.73	74
06/24/97	15.4	1.76	15	277	2.8	4.35	0.656	9.33	70
07/01/97	11.1	1.93	15	260	5.95	5.05	0.721	12.4	76
07/07/97	12.2	1.75	15	84	2.9	4.65	0.678	9.77	64
07/15/97	13.2	2.14	15	265	5.54	5.08	0.709	13	78
07/22/97	11.2	2.49	15	329	6.05	4.87	0.689	10.7	74
07/29/97	11.9	1.94	16	284	4.6	4.52	0.707	10.4	72
08/05/97	12.4	2.26	17	178	7.3	5.3	0.723	12.2	86
08/12/97	14.1	2.35	15	335	8.44	5.64	0.808	14.1	86
08/19/97	12.3	1.92	15	297	6.54	4.7	0.74	10.7	90
09/02/97	11.1	1.95	12	311	3.93	4.76	0.79	11.1	66
09/09/97	10.1	1.89	13	161	2.67	4.53	0.741	10.5	82
09/16/97	10.4	1.27	13	145	3	4.07	0.651	8.99	82
09/23/97	11.4	2.02	13	282	3.26	4.96	0.824	11.5	82
09/30/97	11.8	1.69	14	256	2.85	4.73	0.789	11	80
10/07/97	11	1.45	15	239	3.09	5.05	0.718	11.3	96
10/14/97	11.8	1.71	16	311	3.72	5.51	0.796	11.6	86
10/21/97	12.3	1.68	16	320	3.94	5.51	<.01	11.6	92
10/28/97	13.1	1.67	18	287	4.17	5.68	0.774	11.3	104
11/04/97	13.4	1.81	17	325	4.52	4.94	0.686	10.8	80
11/18/97	11.9	1.77	17	394	3.19	4.15	0.638	9.04	76
12/02/97	12.4	1.92	16	227	3.49	4.06	0.614	9.02	74
12/09/97	11.2	1.63	16	256	3.36	4.39	0.735	9.54	72
12/16/97	13.2	1.61	15	267	3.27	4.57	0.691	9.87	70
12/30/97	12.2	1.91	19	192	3.78	4.99	0.728	11.6	66
01/06/98	13.9	1.84	22	218	3.22	3.67	0.558	8.4	72
05/12/98	12.8	1.5	17	226	2.24	2.9	0.521	6.62	48

Table F1. ***Jeddo Tunnel Outfall Water Quality Data, 1995-98*** *(sample collected by Friends of Nescopeck, analyzed by Pa. DEP)—Continued*

Sample Date	Sodium	Potassium	Chloride	Sulfate	Iron	Manganese	Zinc	Aluminum	Total Acidity,Hot
	mg/l								
05/26/98	10.2	1.65	15	310	2.09	3.6	0.609	8.02	56
06/02/98	13.60	1.57	16.0	308	2.340	3.890	0.665	8.79	64
06/09/98	14.2	1.77	16	249	2.46	3.97	0.675	8.79	60
06/16/98	14.9	1.77	18	220	2.3	3.88	0.643	8.72	56
06/23/98	13.3	1.7	18	239	2.52	4	0.626	8.86	68
06/30/98	14.1	1.72	18	298	2.56	3.87	0.616	8.79	66
07/06/98	13.2	1.71	17	266	2.71	4.09	0.636	8.92	70
07/14/98	12.2	1.69	16	235	2.68	3.93	0.617	8.73	66
07/21/98	12.1	1.7	17	289	4.86	4.73	0.703	10.2	74
07/28/98	13.1	1.75	17	293	2.9	4.56	0.678	10	70
08/04/98	12.8	1.79	17	269	3.16	4.5	0.665	11	68
08/11/98	14.3	1.73	20	345	4.15	4.48	0.63	9.8	72
08/18/98	13.9	1.37	19	280	3.35	4.5	0.65	9.92	72
08/24/98	14.7	2.03	18	308	4.39	5.06	0.72	11.1	72
09/09/98	14.5	1.93	18	352	3.87	4.8	0.799	10.9	64
09/08/98	15.5	1.84	20	344	7.8	4.34	0.595	9.32	
09/15/98	13	1.66	17	369	3.21	4.45	0.64	10	62
09/22/98	14.1	1.9	17	305	3.46	5.04	0.66	10.2	74
09/29/98	16.5	1.93	19	375	3.73	5.34	0.746	11.9	74

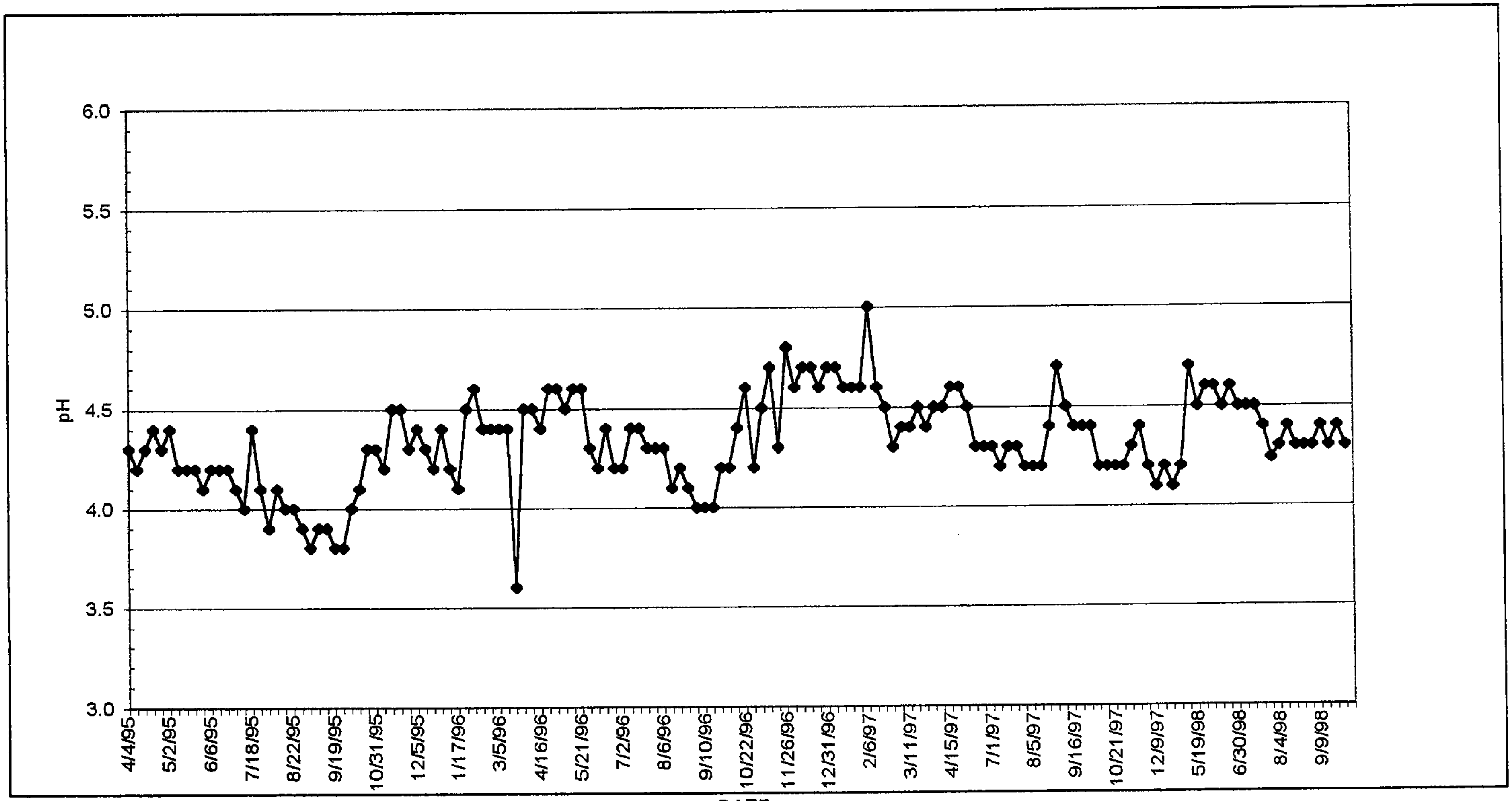

Figure F1. Jeddo Tunnel pH, 1995-98

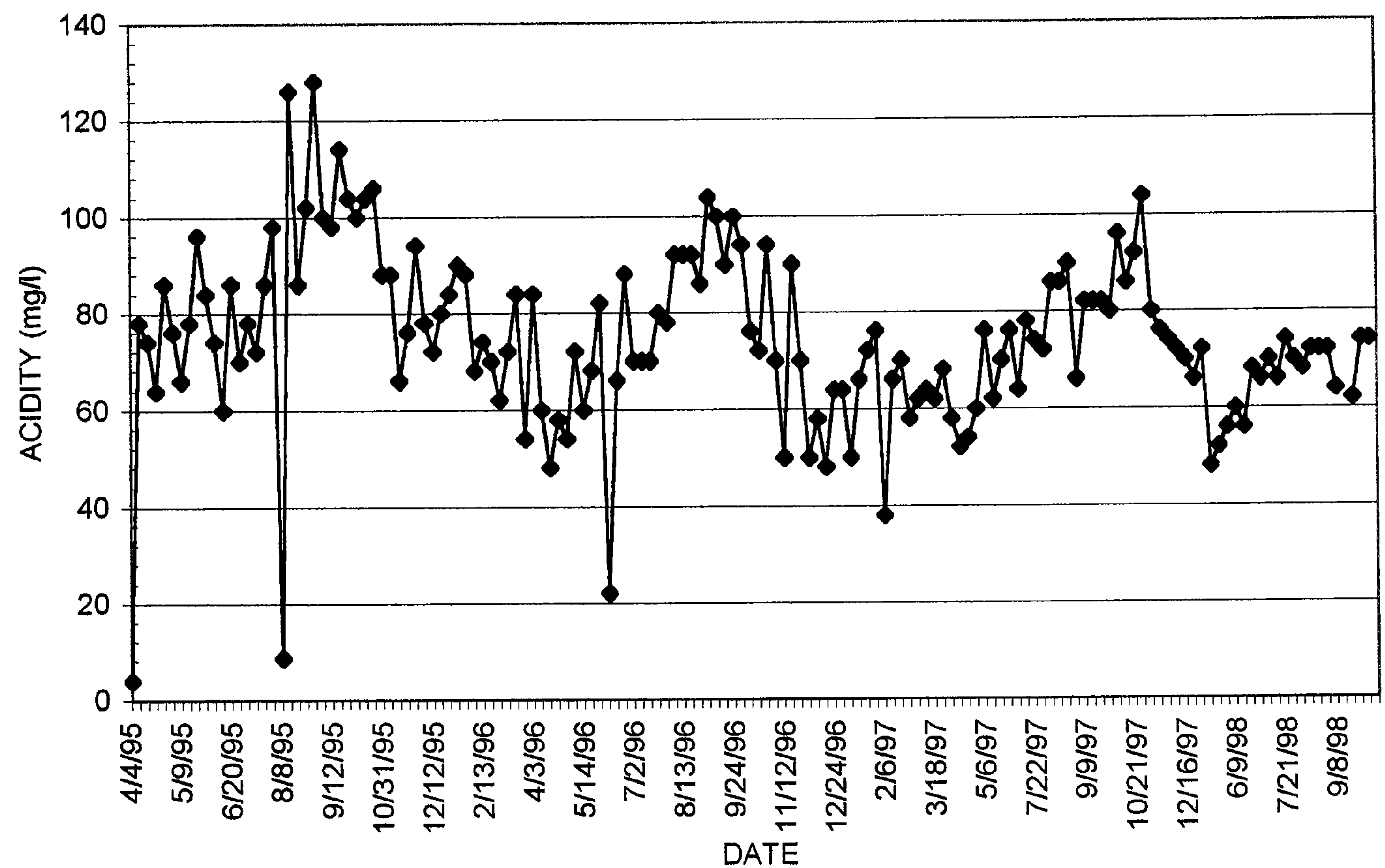

Figure F2. Jeddo Tunnel Acid Concentrations, 1995-98

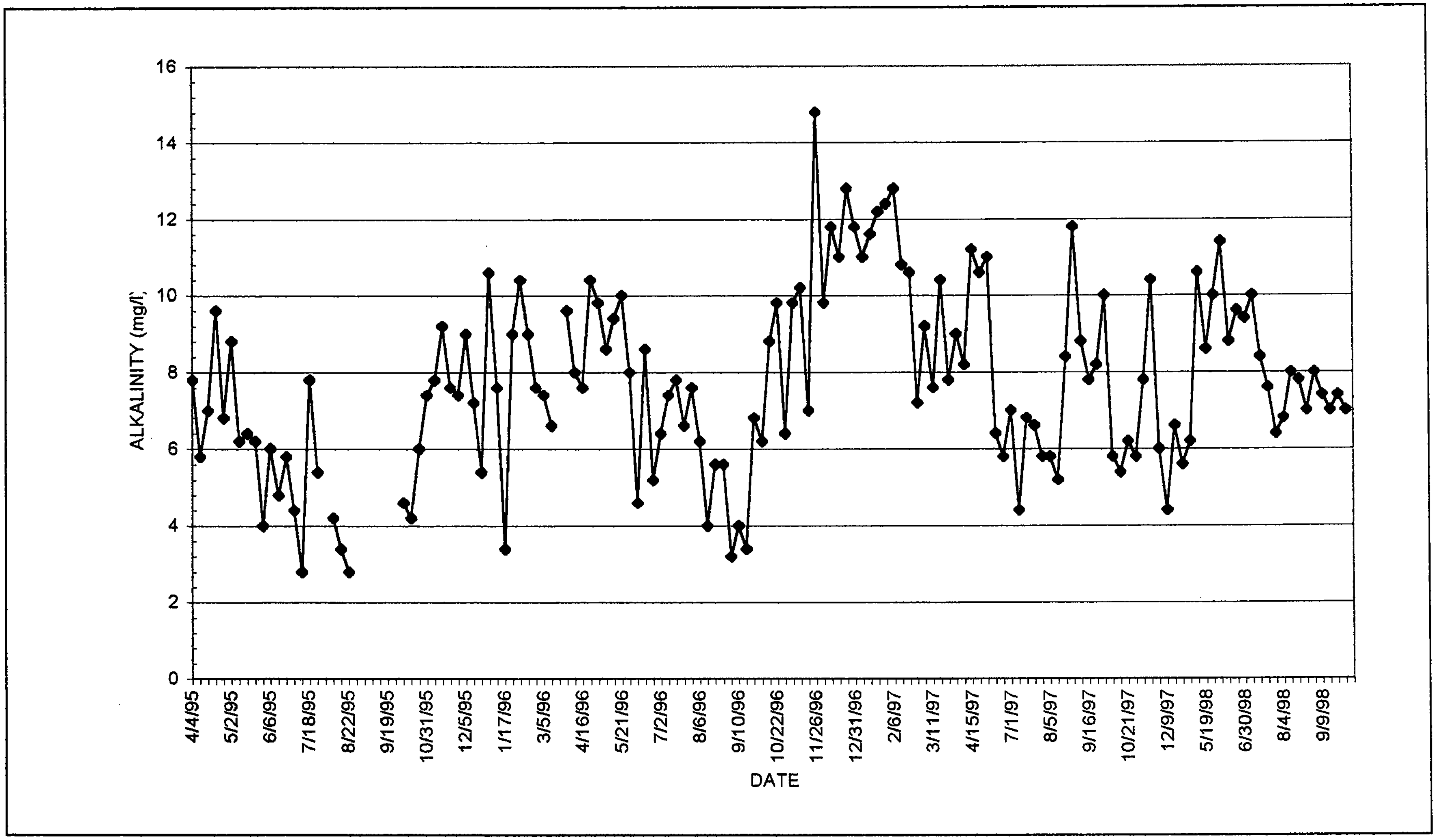

Figure F3. Jeddo Tunnel Alkaline Concentrations, 1995-98

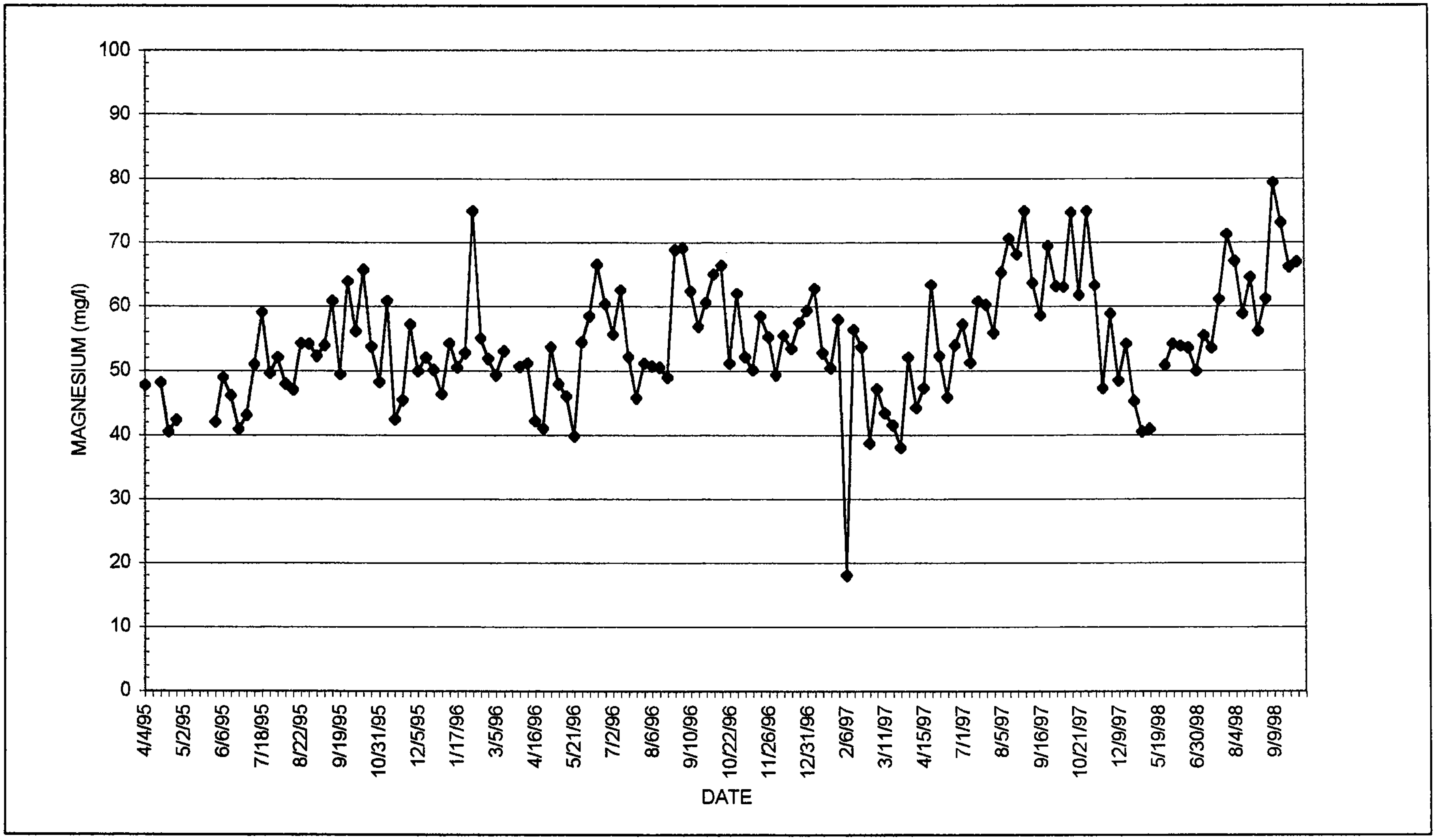

Figure F4. Jeddo Tunnel Magnesium Concentrations, 1995-98

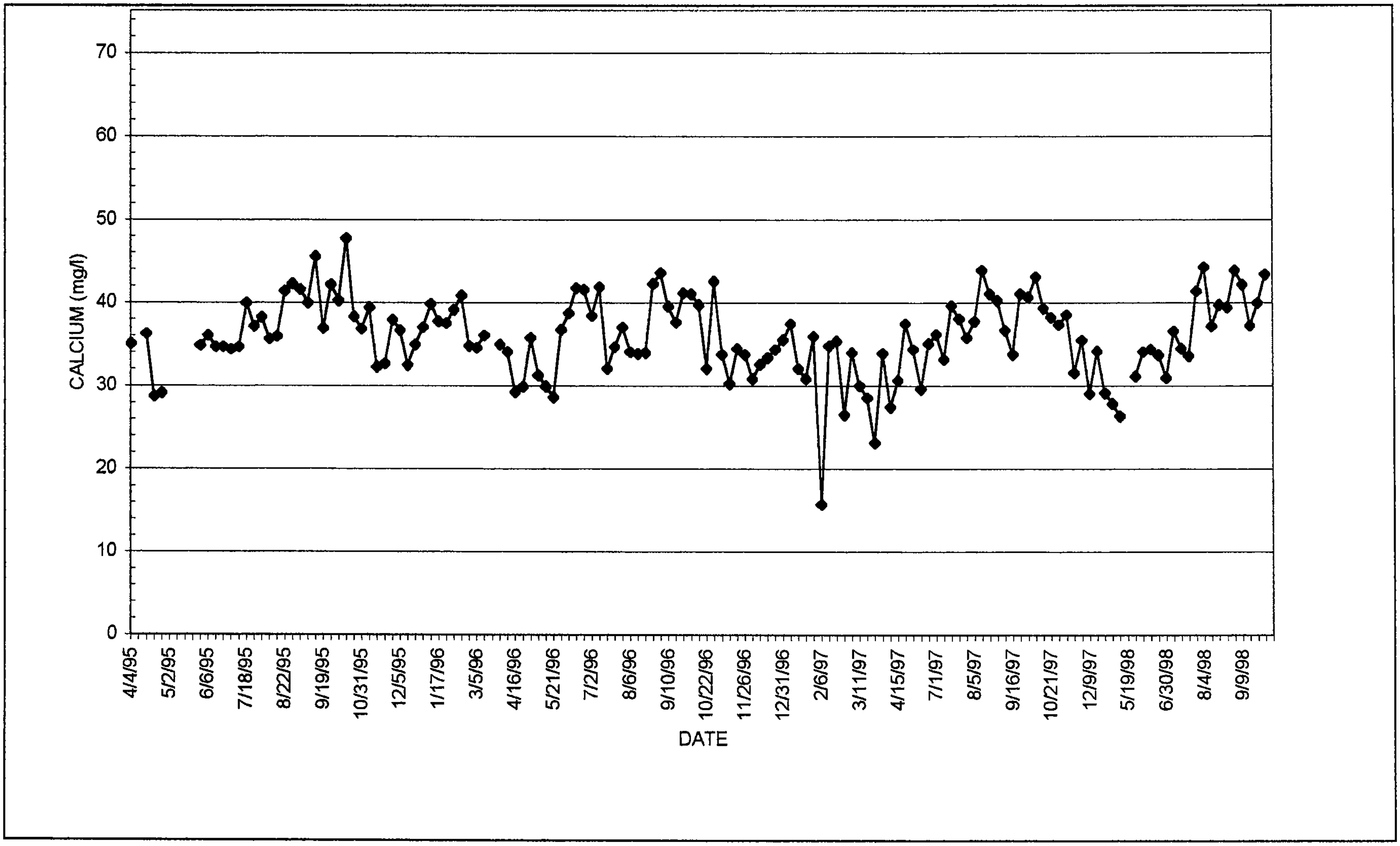

Figure F5. Jeddo Tunnel Calcium Concentrations, 1995-98

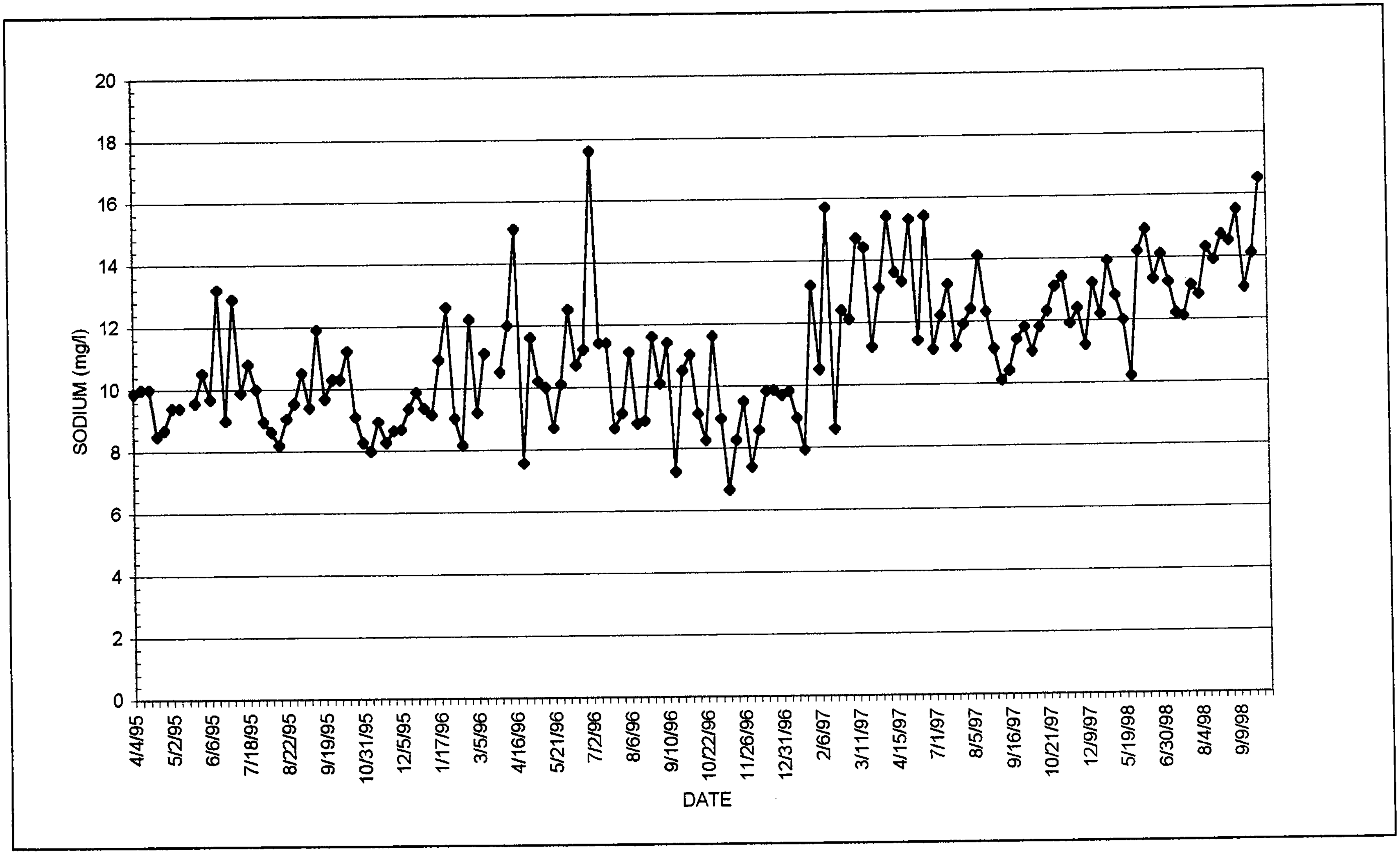

Figure F6. Jeddo Tunnel Sodium Concentrations, 1995-98

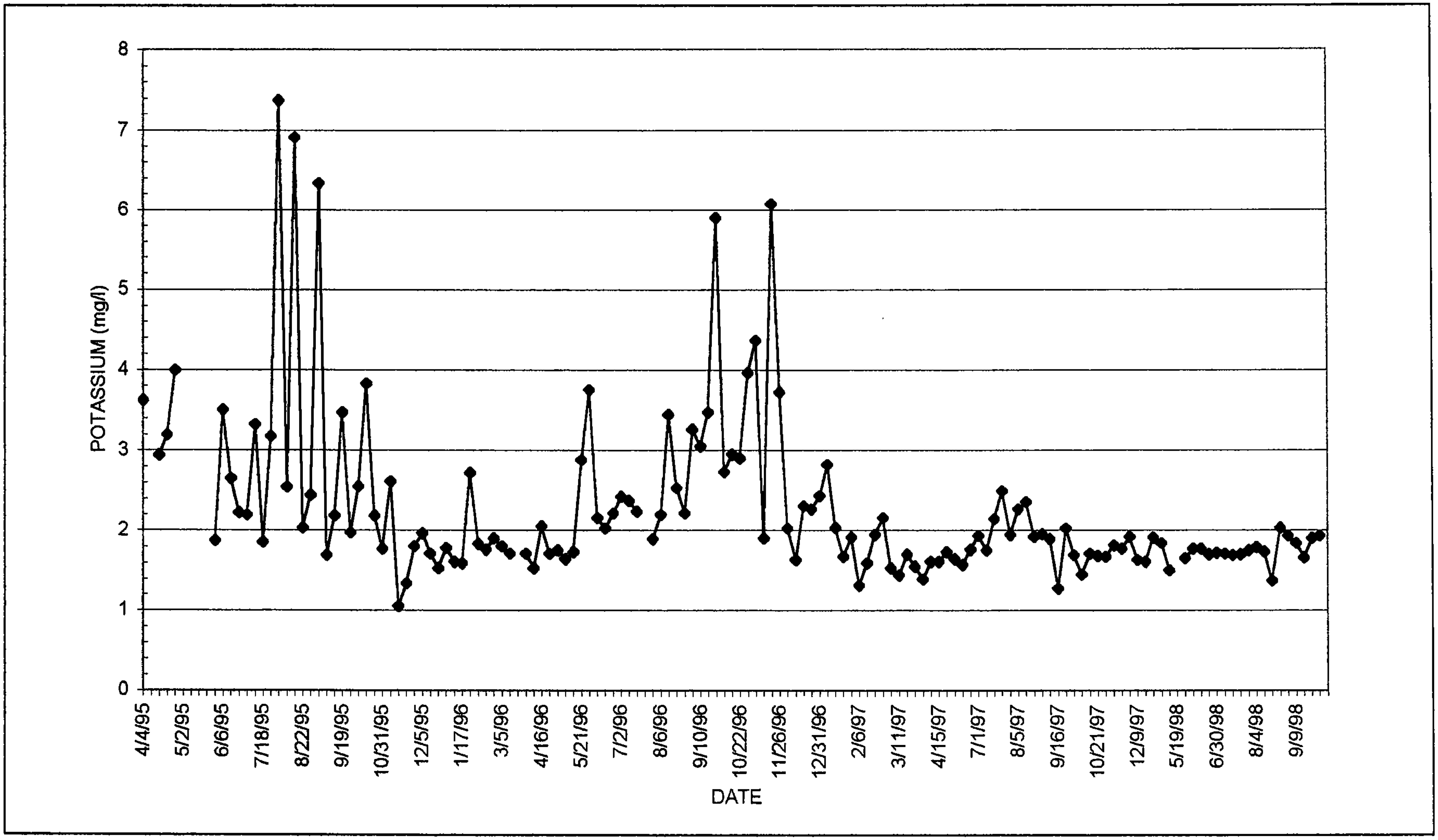

Figure F7. Jeddo Tunnel Potassium Concentrations, 1995-98

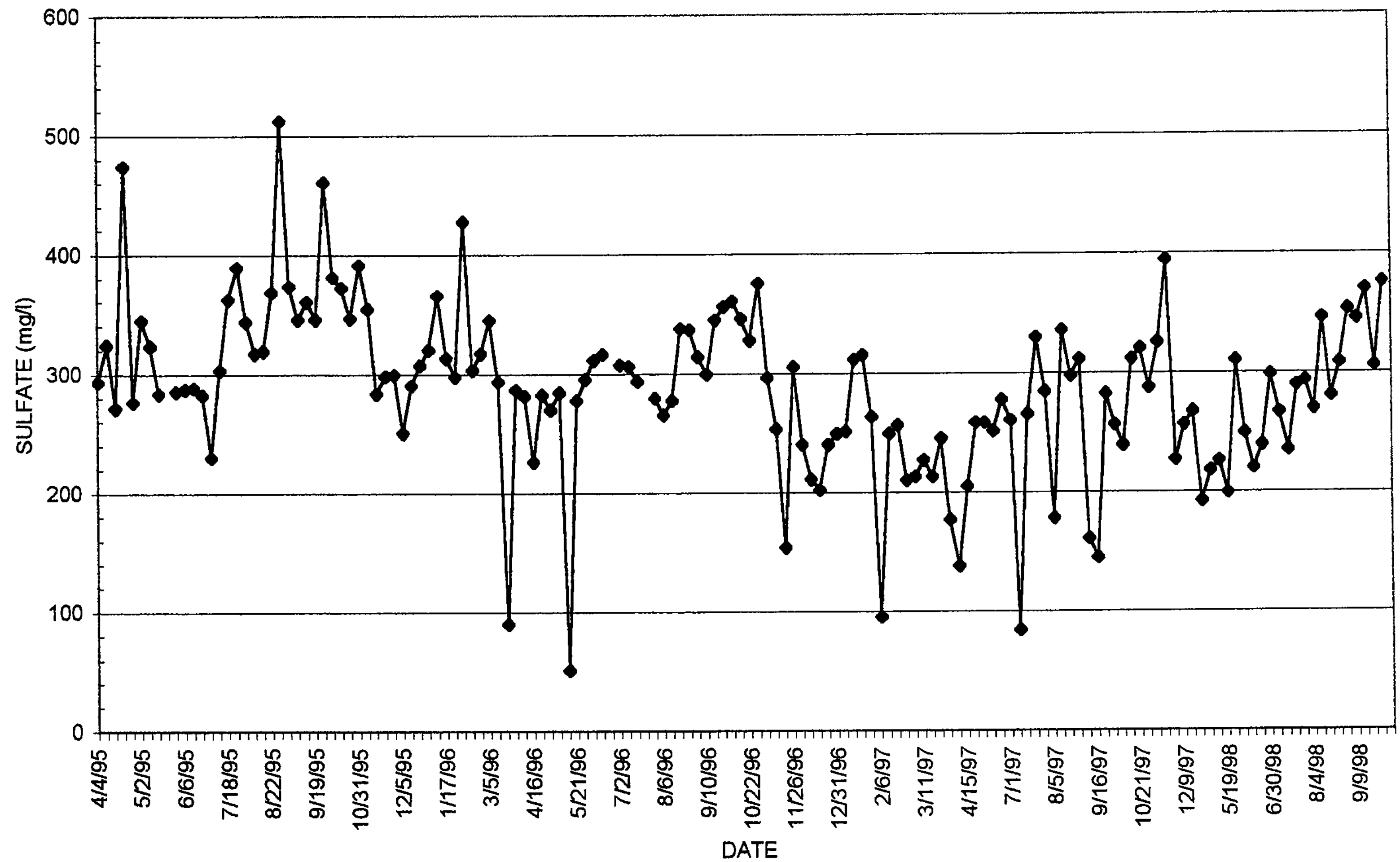

Figure F8. Jeddo Tunnel Sulfate Concentrations, 1995-98

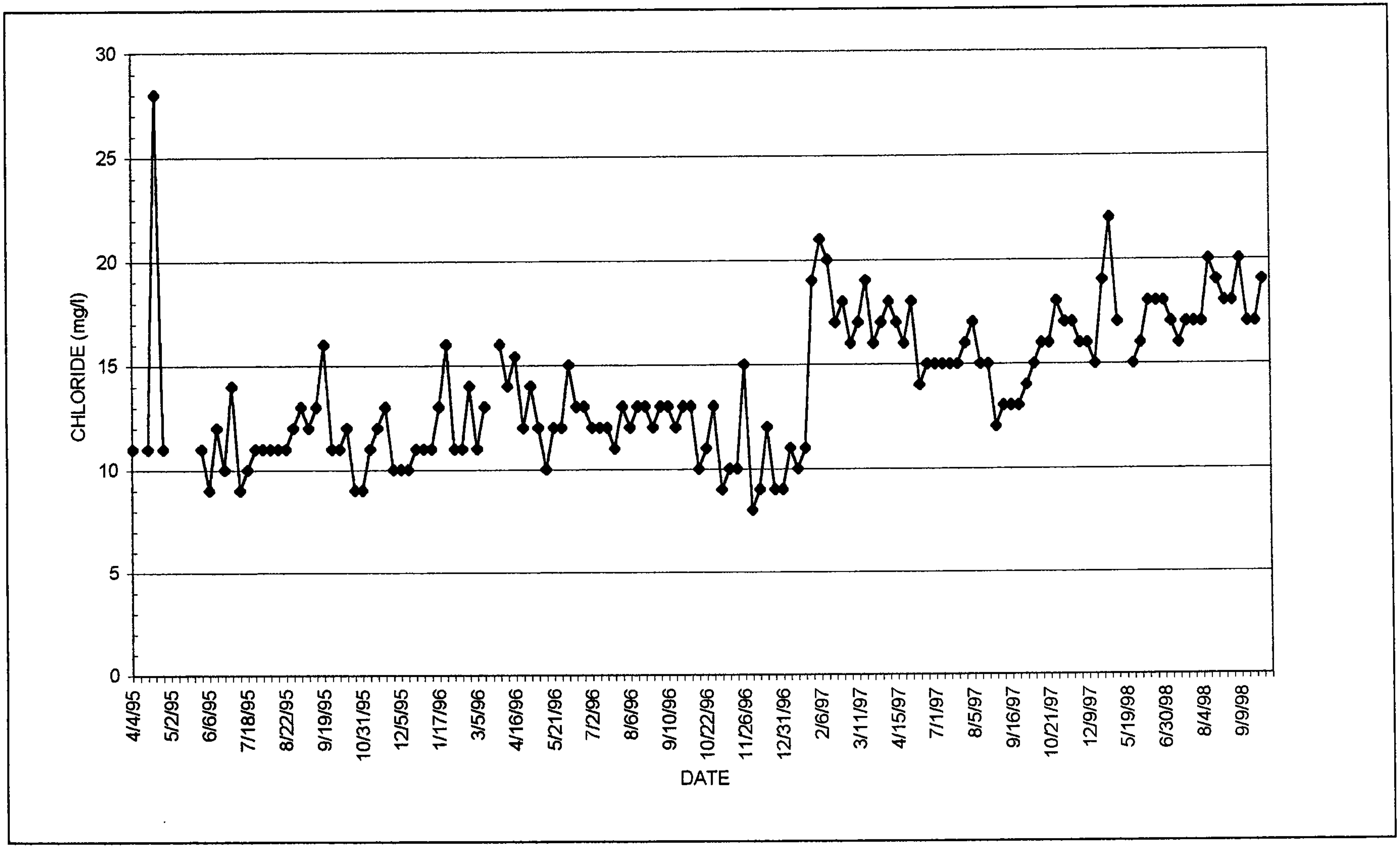

Figure F9. Jeddo Tunnel Chloride Concentrations, 1995-98

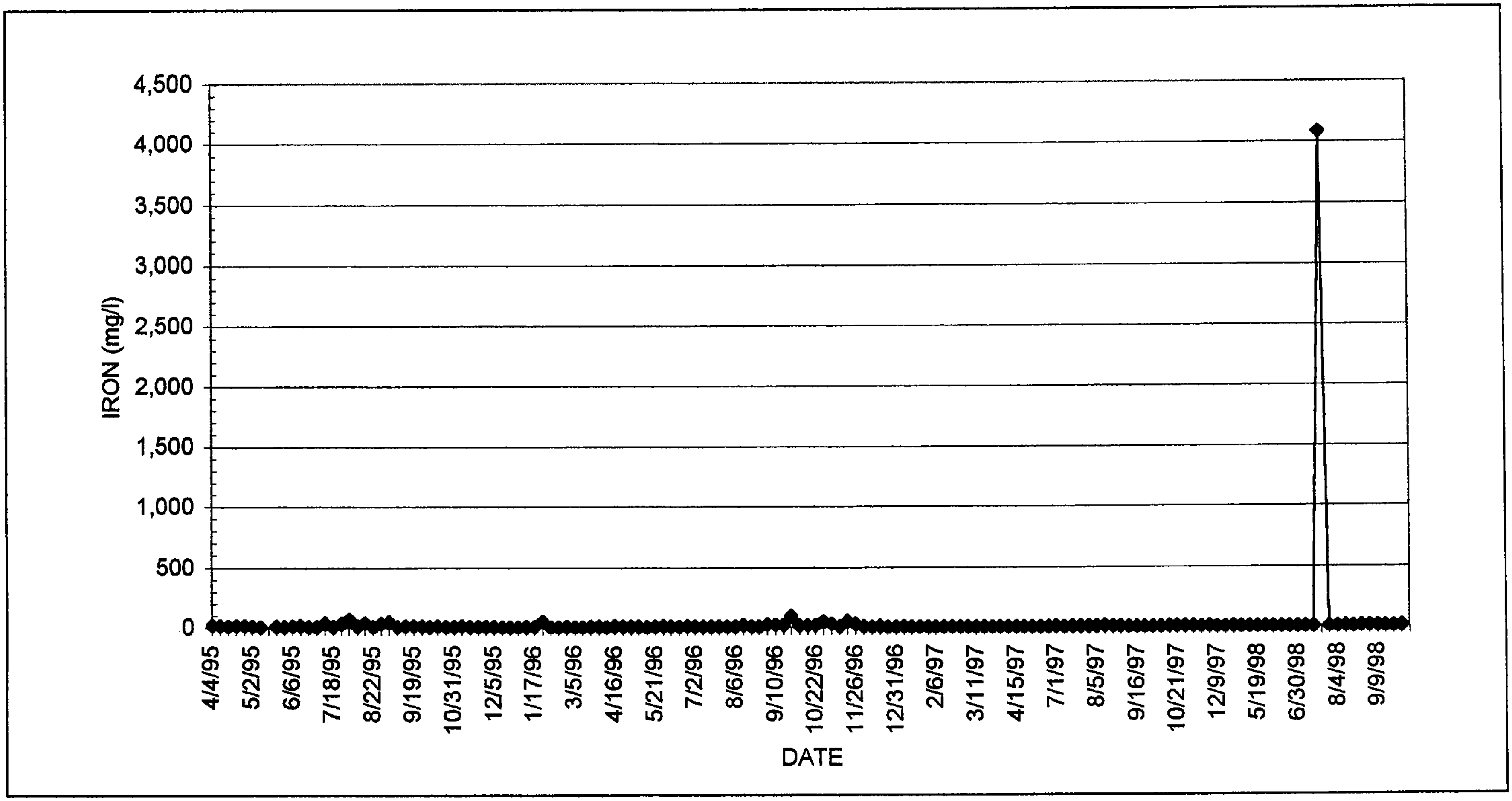

Figure F10. *Jeddo Tunnel Iron Concentrations, 1995-98*

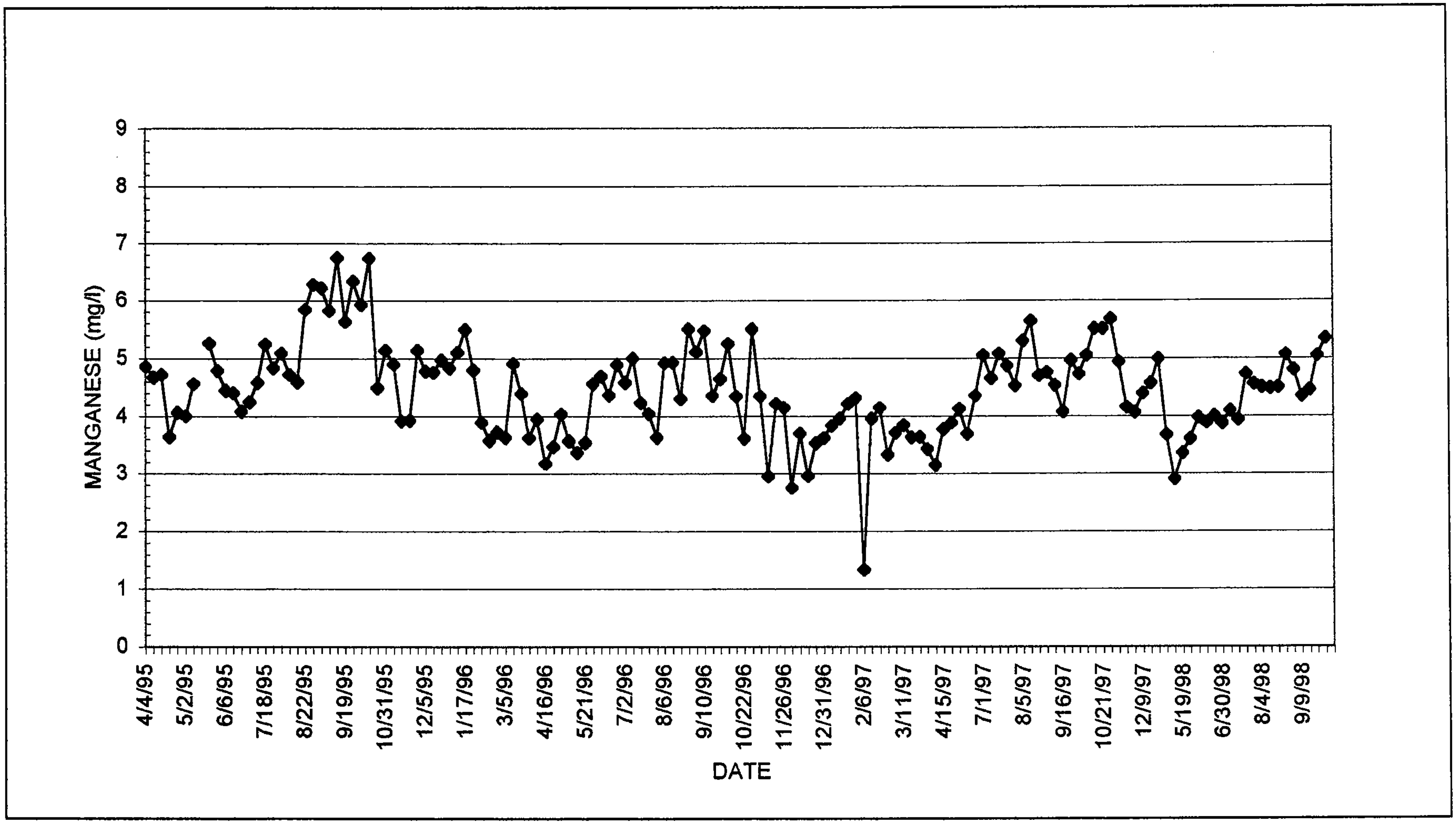

Figure F11. Jeddo Tunnel Manganese Concentrations, 1995-98

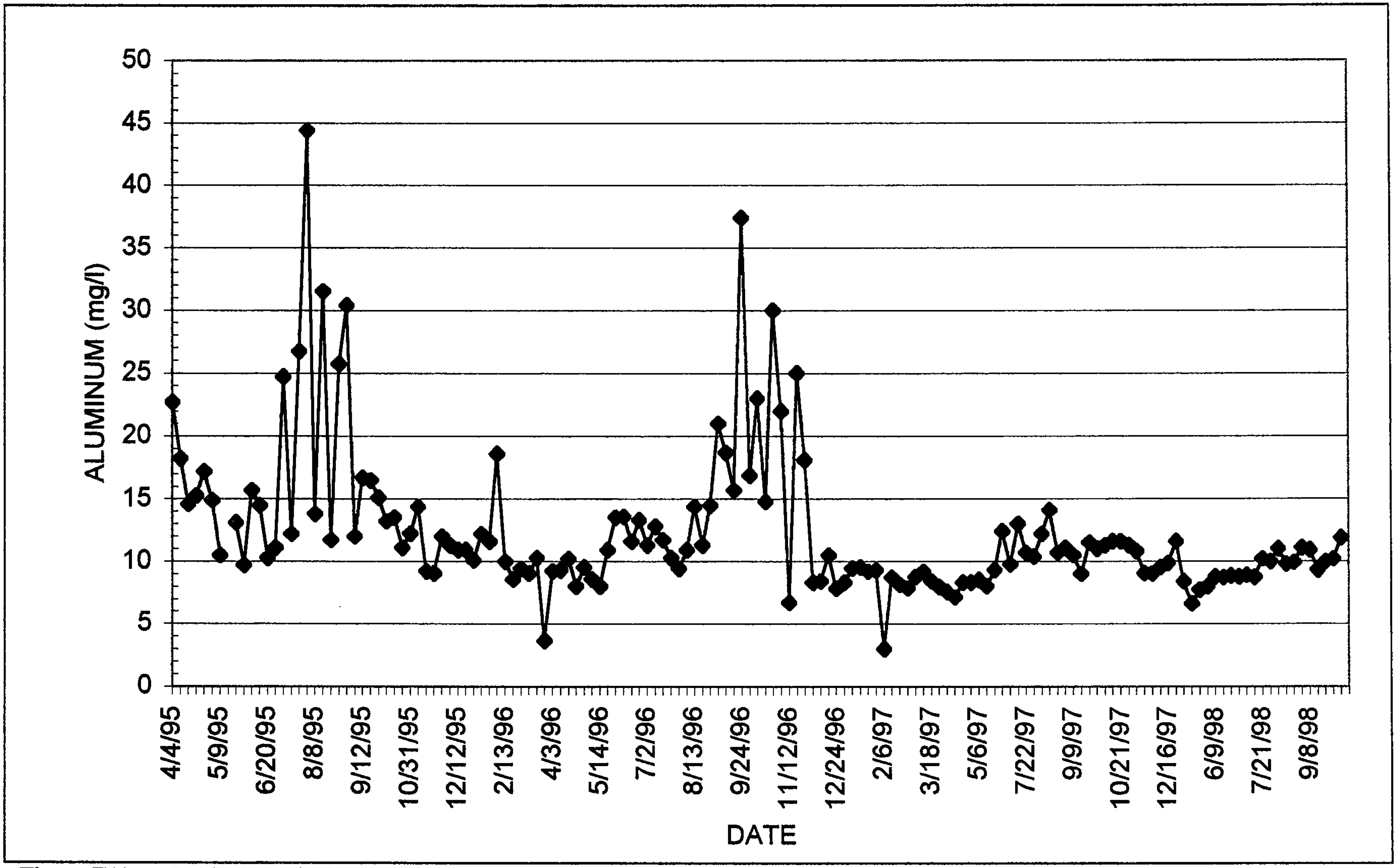

Figure F12. Jeddo Tunnel Aluminum Concentrations, 1995-98

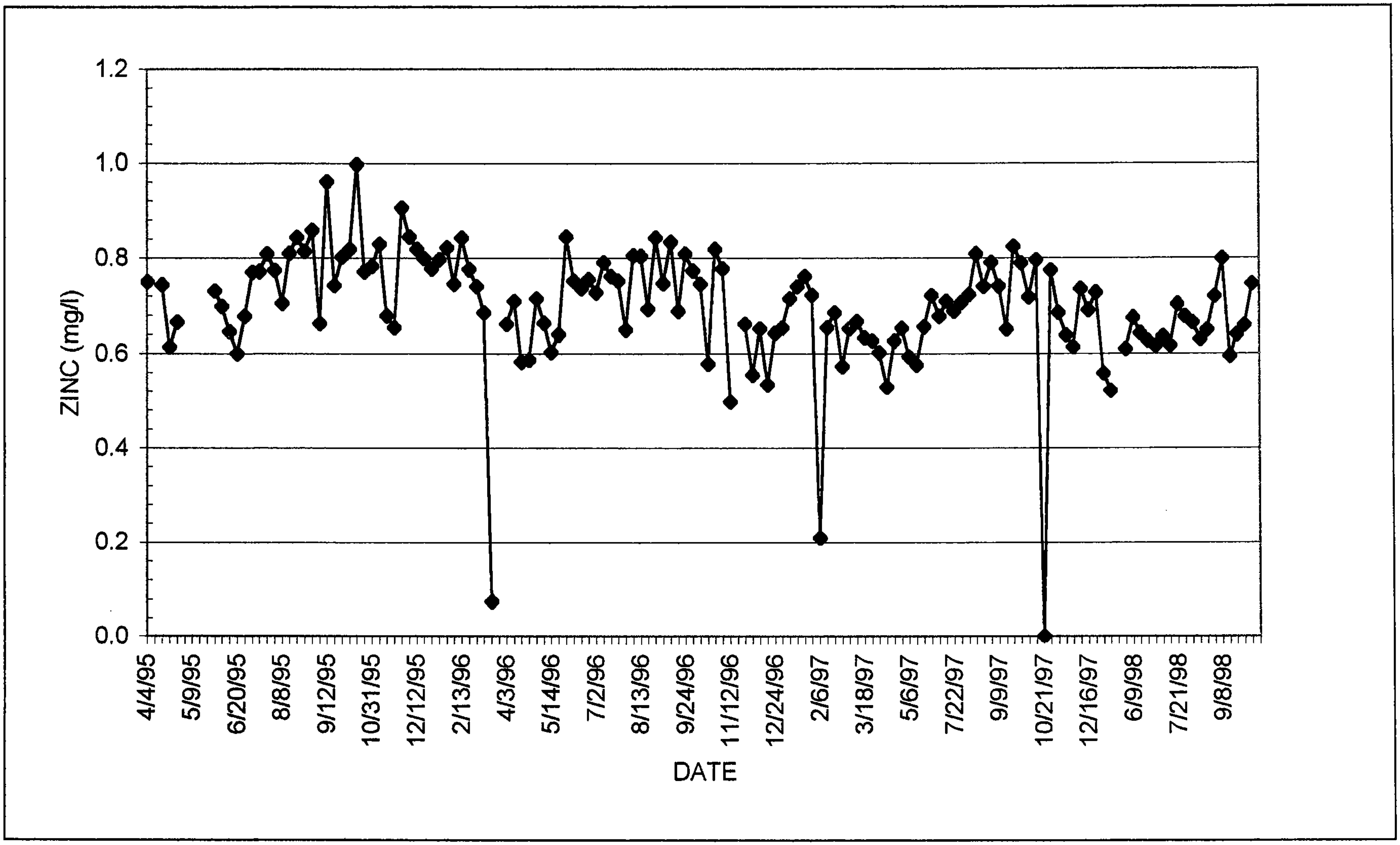

Figure F13. Jeddo Tunnel Zinc Concentrations, 1995-98

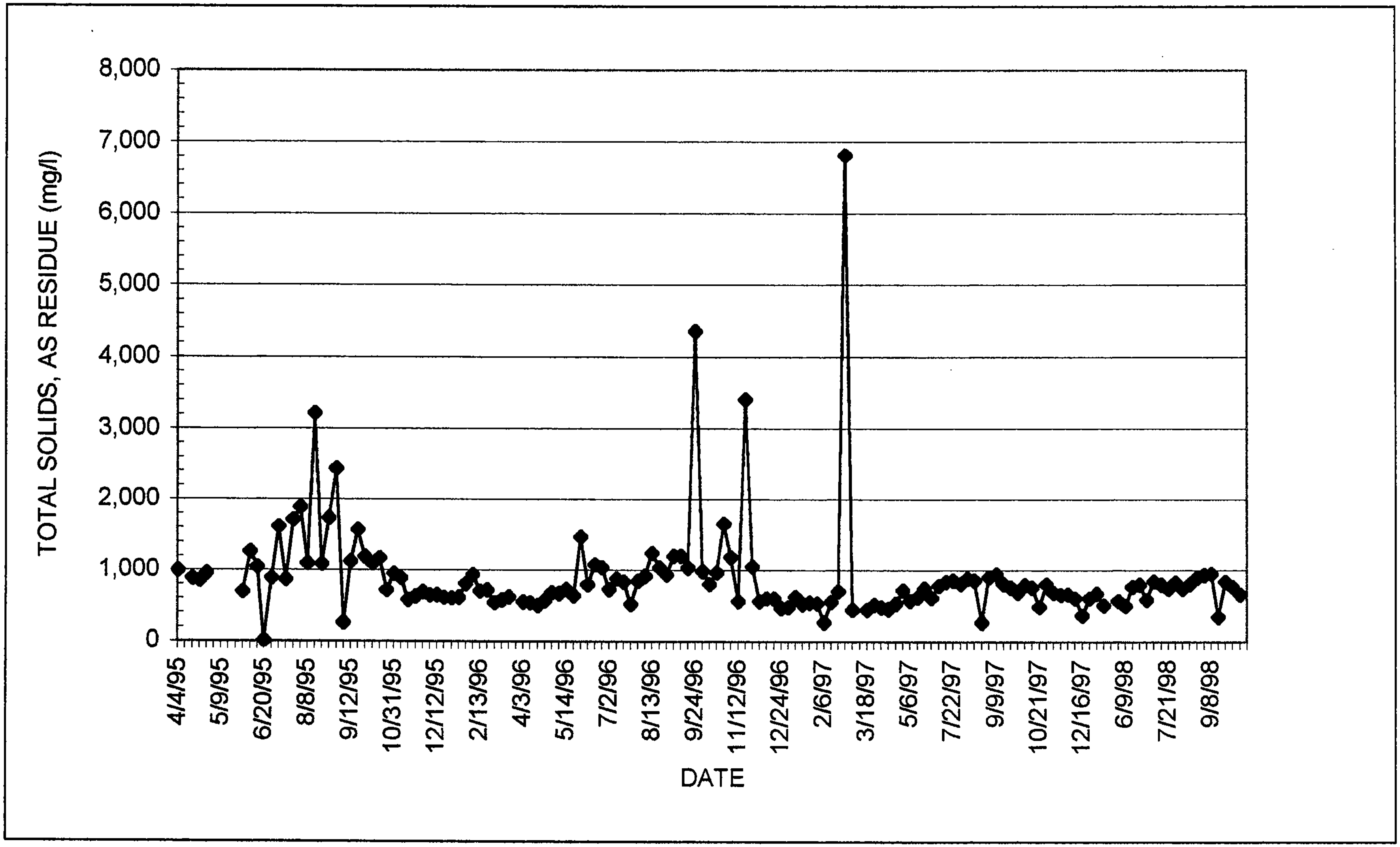

Figure F14. Jeddo Tunnel Total Solids, as Residue, 1995-98

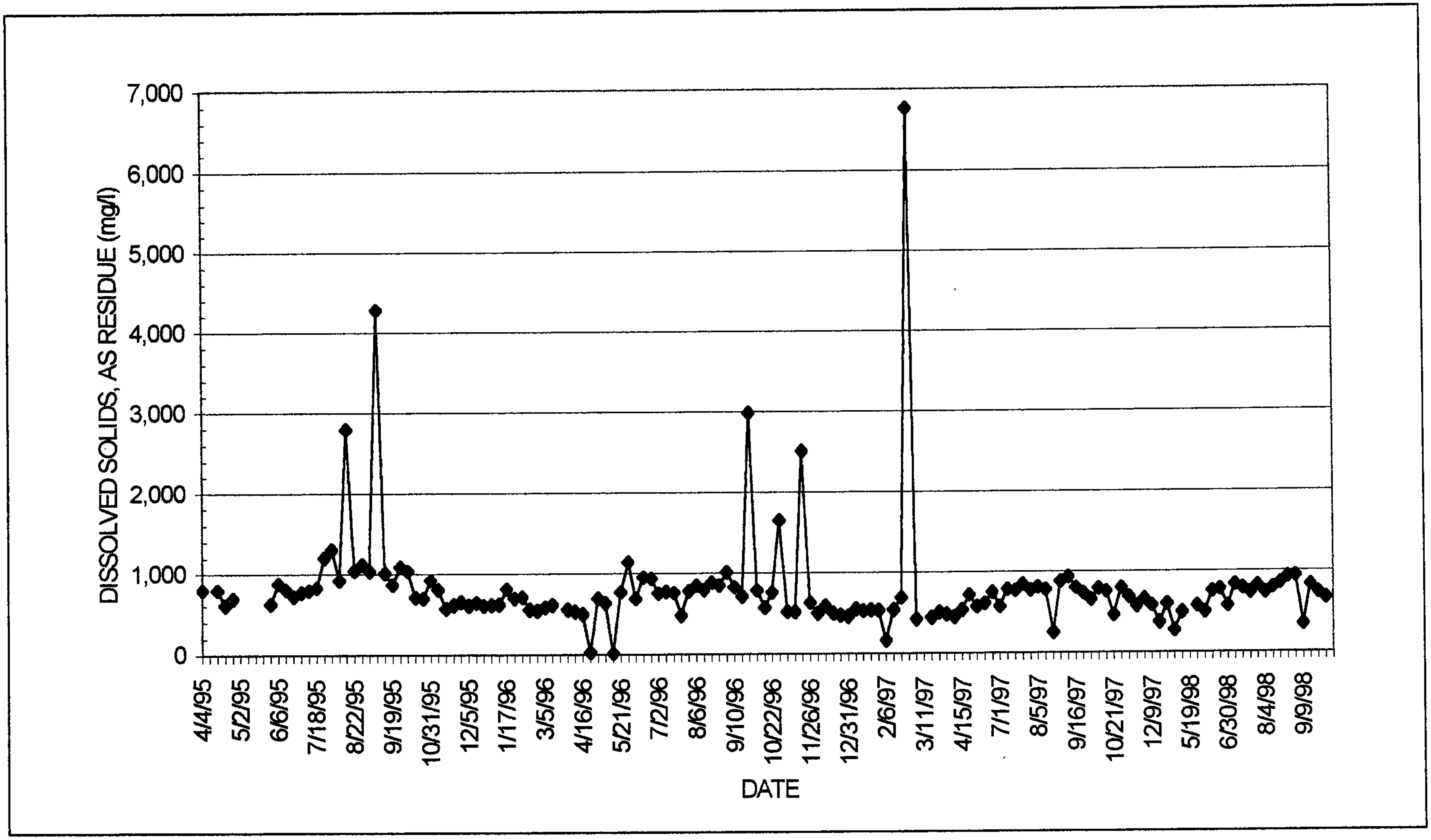

Figure F14.1. Jeddo Tunnel Dissolved Solids, as Residue, 1995-98

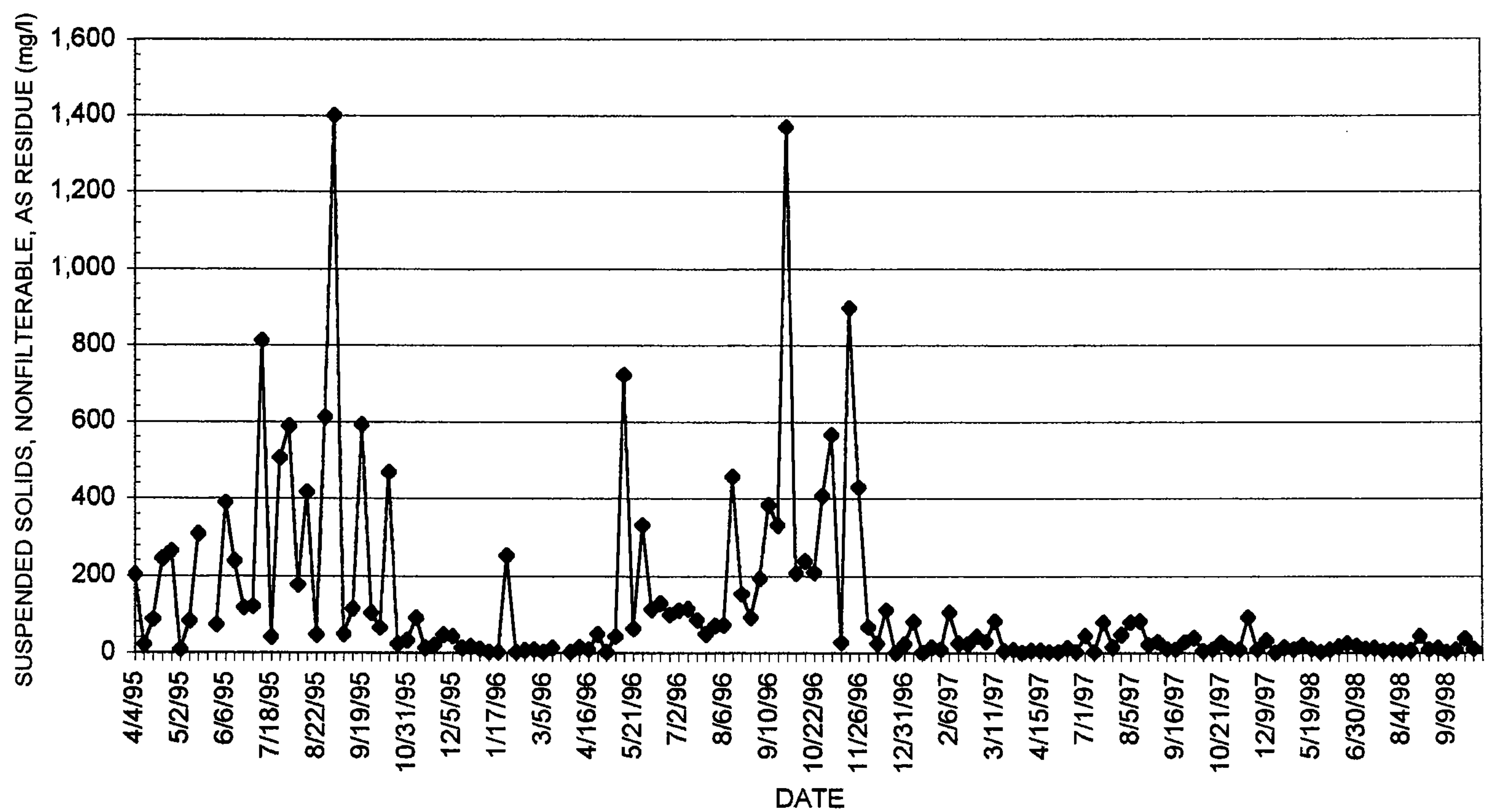

Figure F14.2. Jeddo Tunnel Suspended Solids, Nonfilterable, as Residue, 1995-98

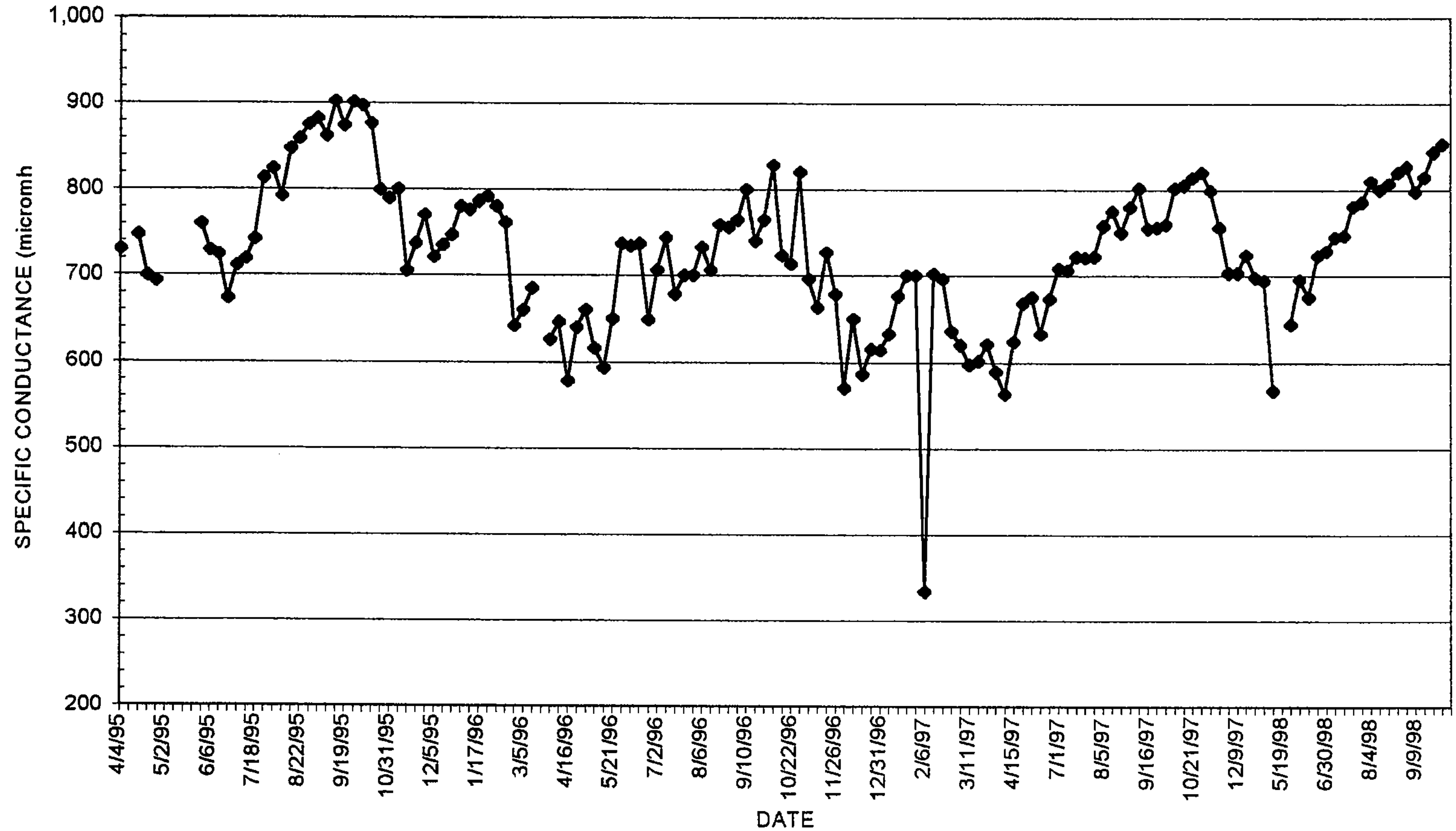

Figure F15. Jeddo Tunnel Specific Conductance, 1995-98

APPENDIX G

JEDDO TUNNEL LOADS, FLOW, DISCHARGE, TURBIDITY AND PRECIPITATION

Average Annual Concentrations and Associated Loads
at the Jeddo Tunnel From 1995-1997 Water Years
(Source: Wildlands Conservancy)

		average annual concentration mg/L	average annual load lbs/day
1995-96	Acidity	71.83	34481.85
	Alkalinity	7.78	3734.77
	Iron	12.60	6048.60
	Sulfate	268.70	128988.90
	Manganese	4.13	1983.56
	Aluminum	12.89	6187.82
	Magnesium	53.67	25764.18
	Zinc	0.67	322.11
1996-97	Acidity	74.86	34532.17
	Alkalinity	8.25	3805.64
	Iron	3.56	1642.19
	Sulfate	248.00	114399.92
	Manganese	4.33	1998.77
	Aluminum	9.74	4492.96
	Magnesium	55.44	25573.92
	Zinc	0.66	305.84
1997-98	Acidity	59.75	22726.51
	Alkalinity	9.33	3548.76
	Iron	2.48	943.29
	Sulfate	244.90	93150.16
	Manganese	3.66	1390.60
	Aluminum	8.24	3134.17
	Magnesium	49.07	18664.27
	Zinc	0.61	230.88

Table G1. Jeddo Concnetration and Load, 1995-1998

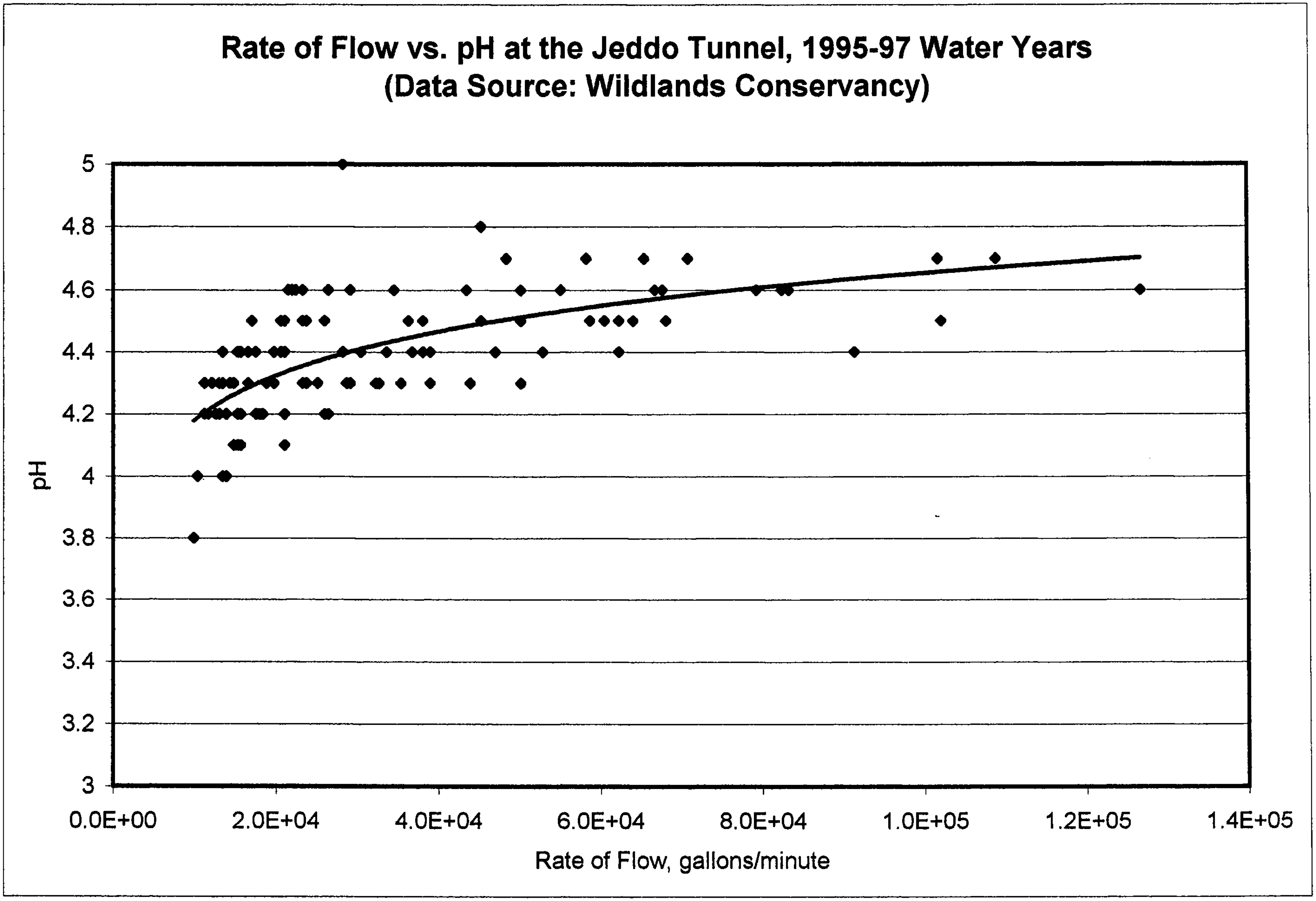

Figure G1. Wildlands pH vs. Flow, 1995-97

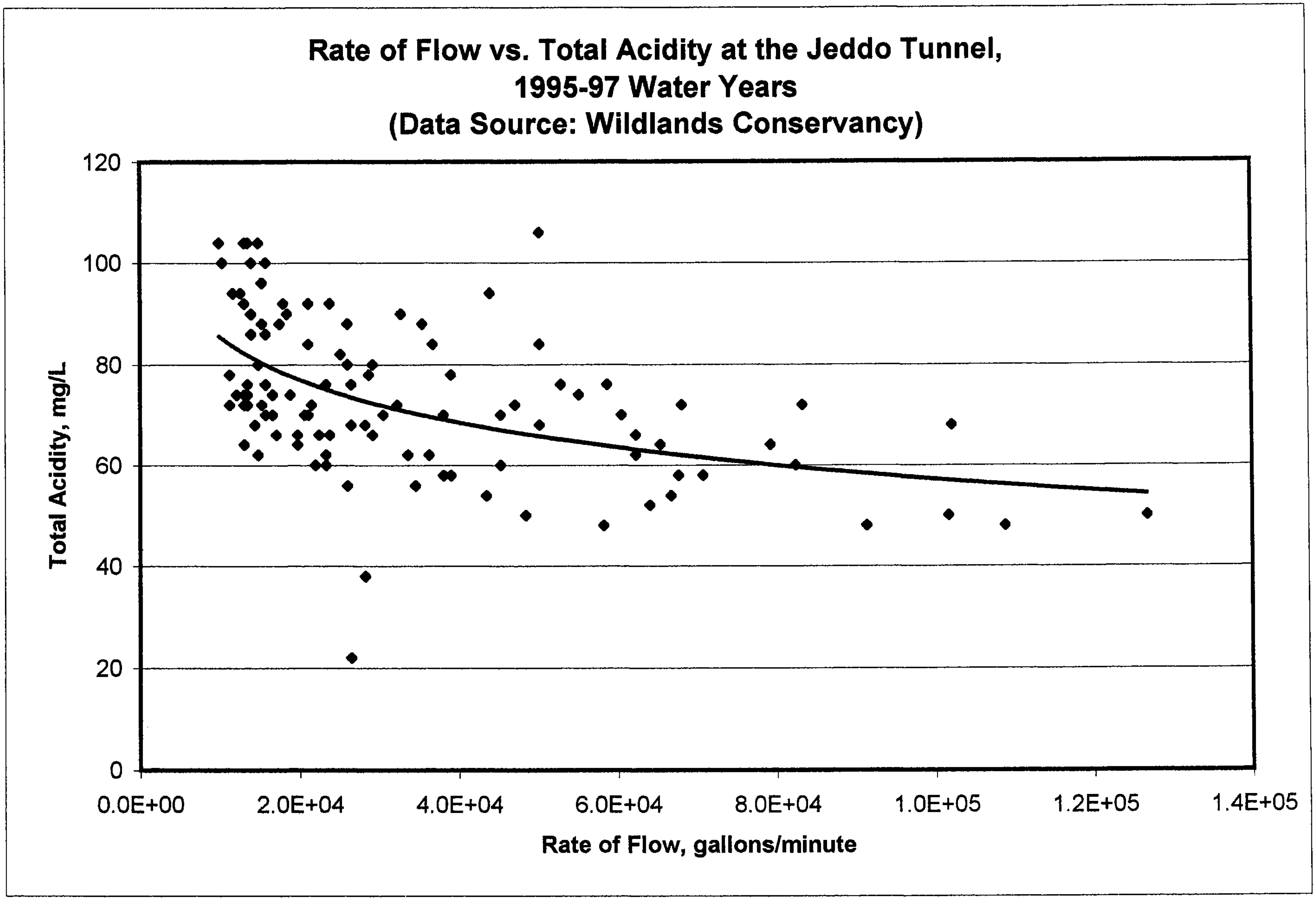

Figure G2. Wildlands Acidity vs. Flow, 1995-97

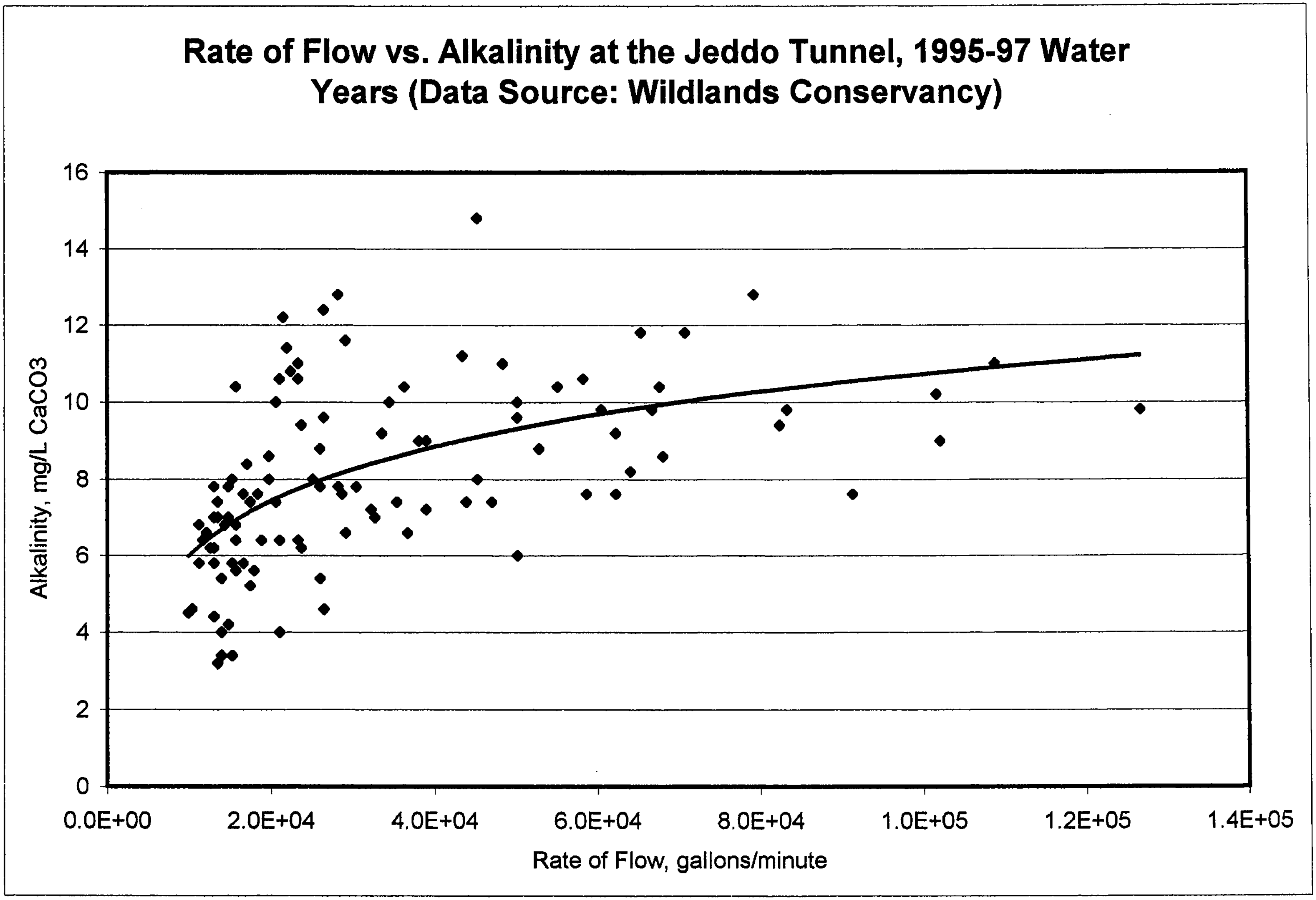

Figure G3. Wildlands Alkalinity vs. Flow, 1995-97

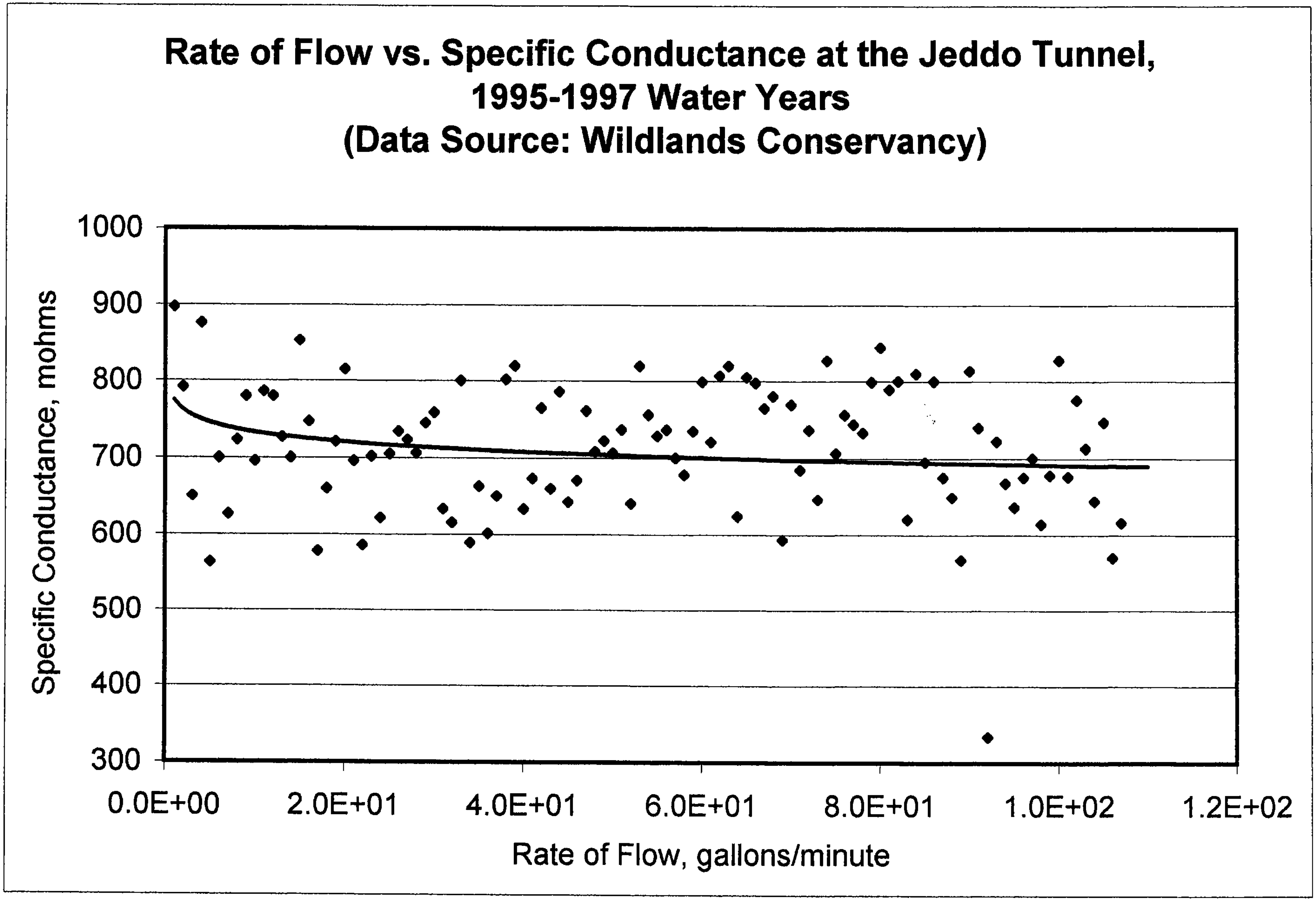

Figure G4. Wildlands Specific Conductance vs. Flow, 1995-97

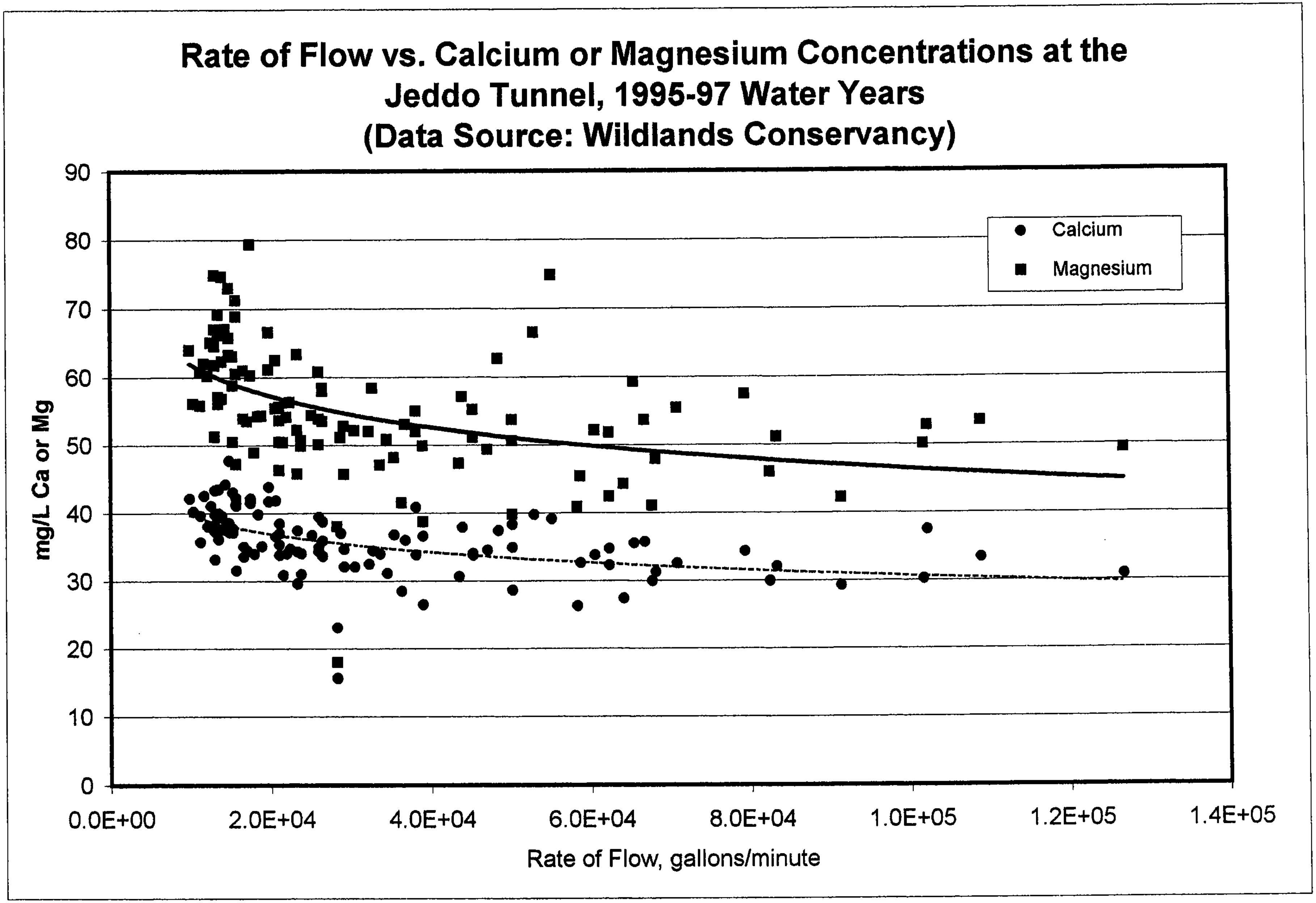

Figure G5. Wildlands Calcium and magnesium vs. Flow, 1995-97

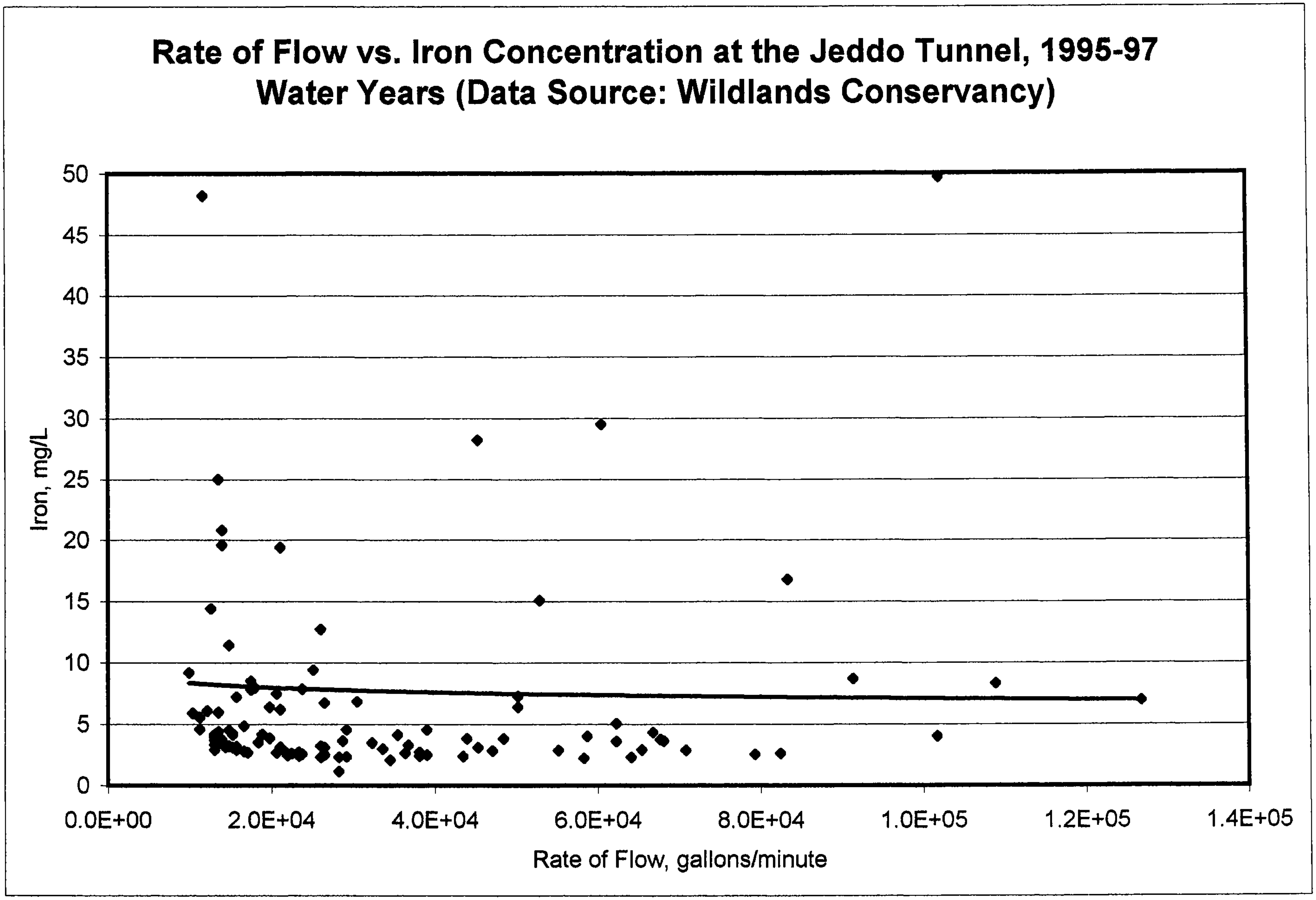

Figure G6. Wildlands Iron vs. Flow, 1995-97

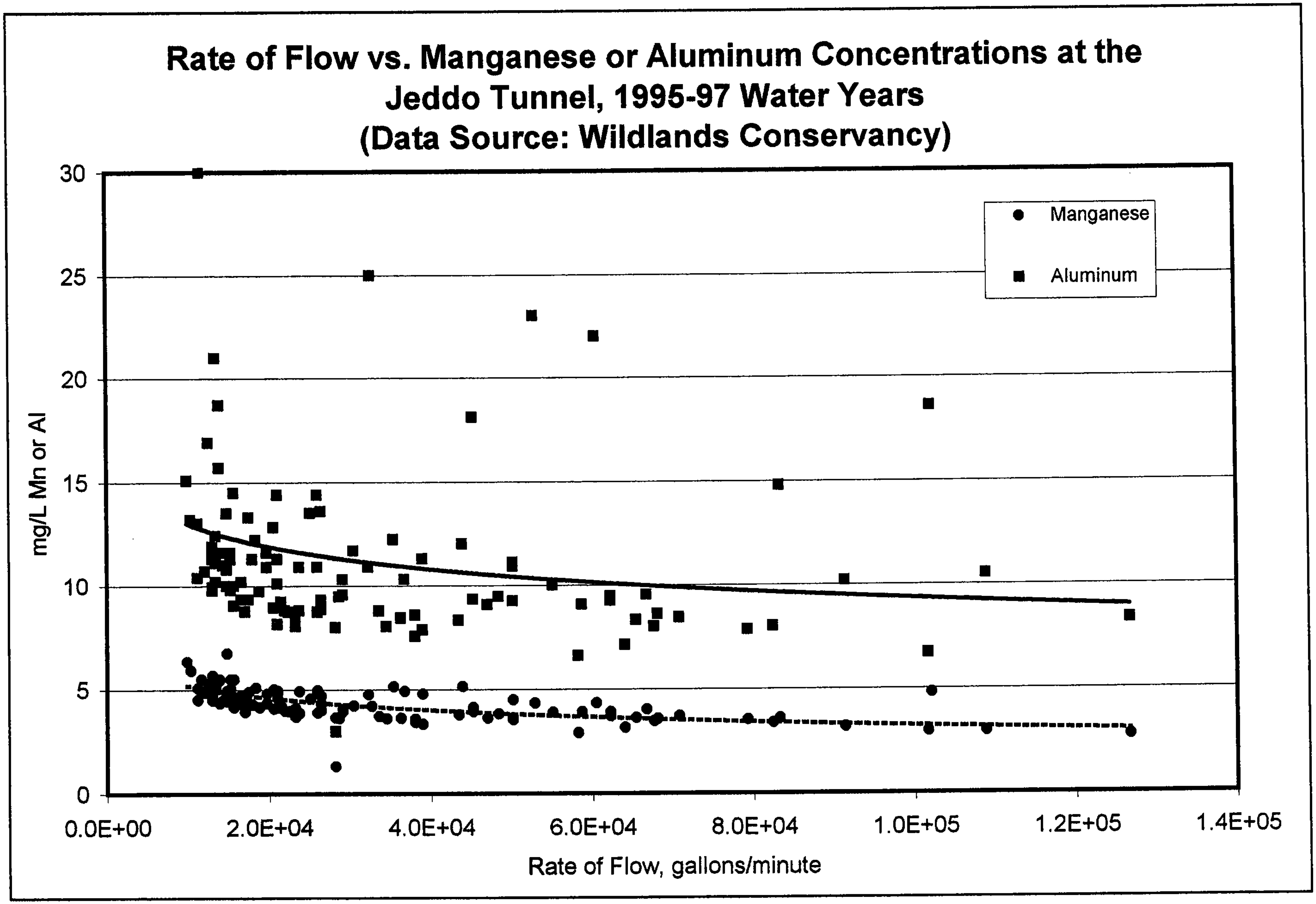

Figure G 7. Wildlands Manganese and Aluminum vs. Flow, 1995-97

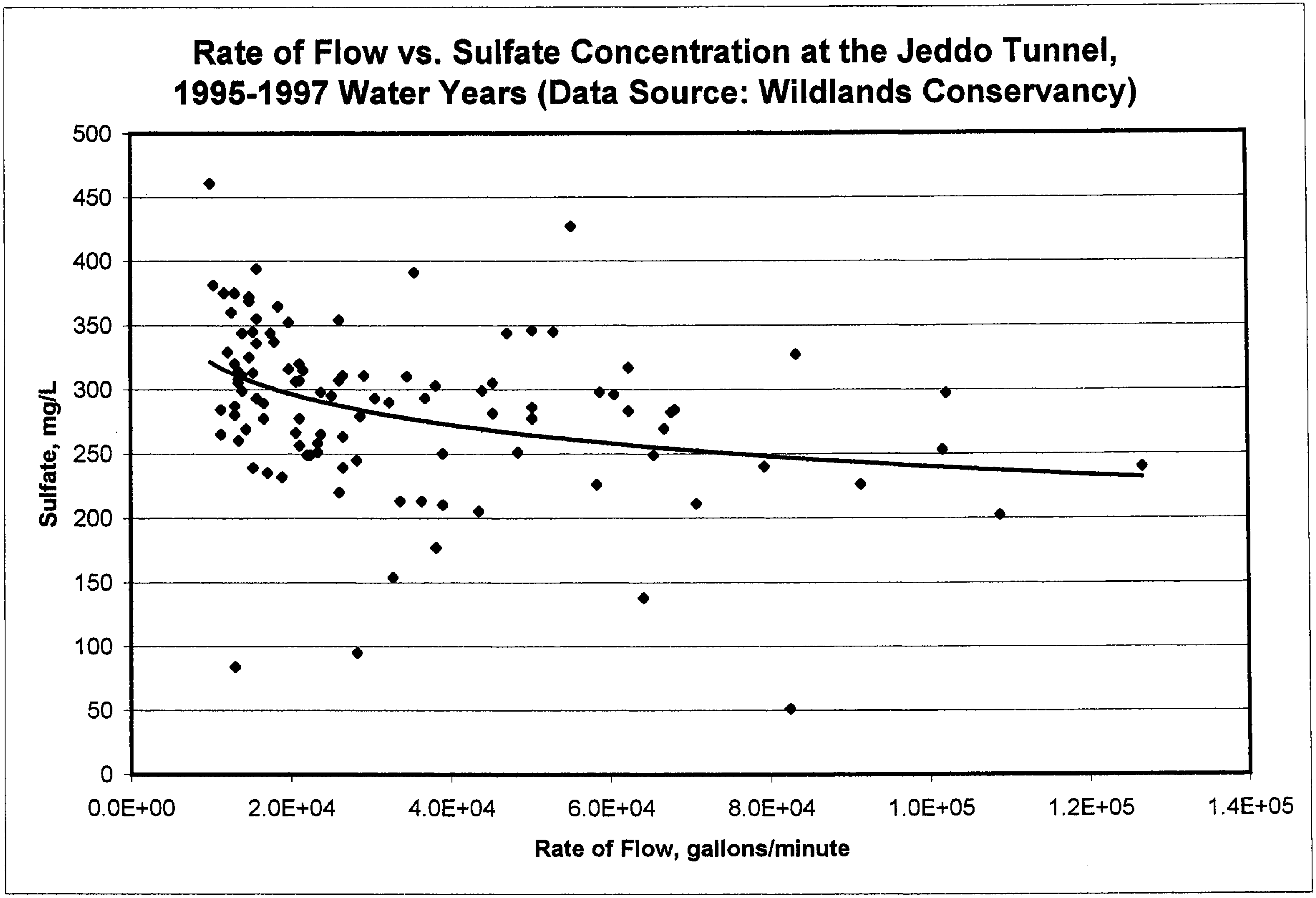

Figure G8. Wildlands Sulfate vs. Flow, 1995-97

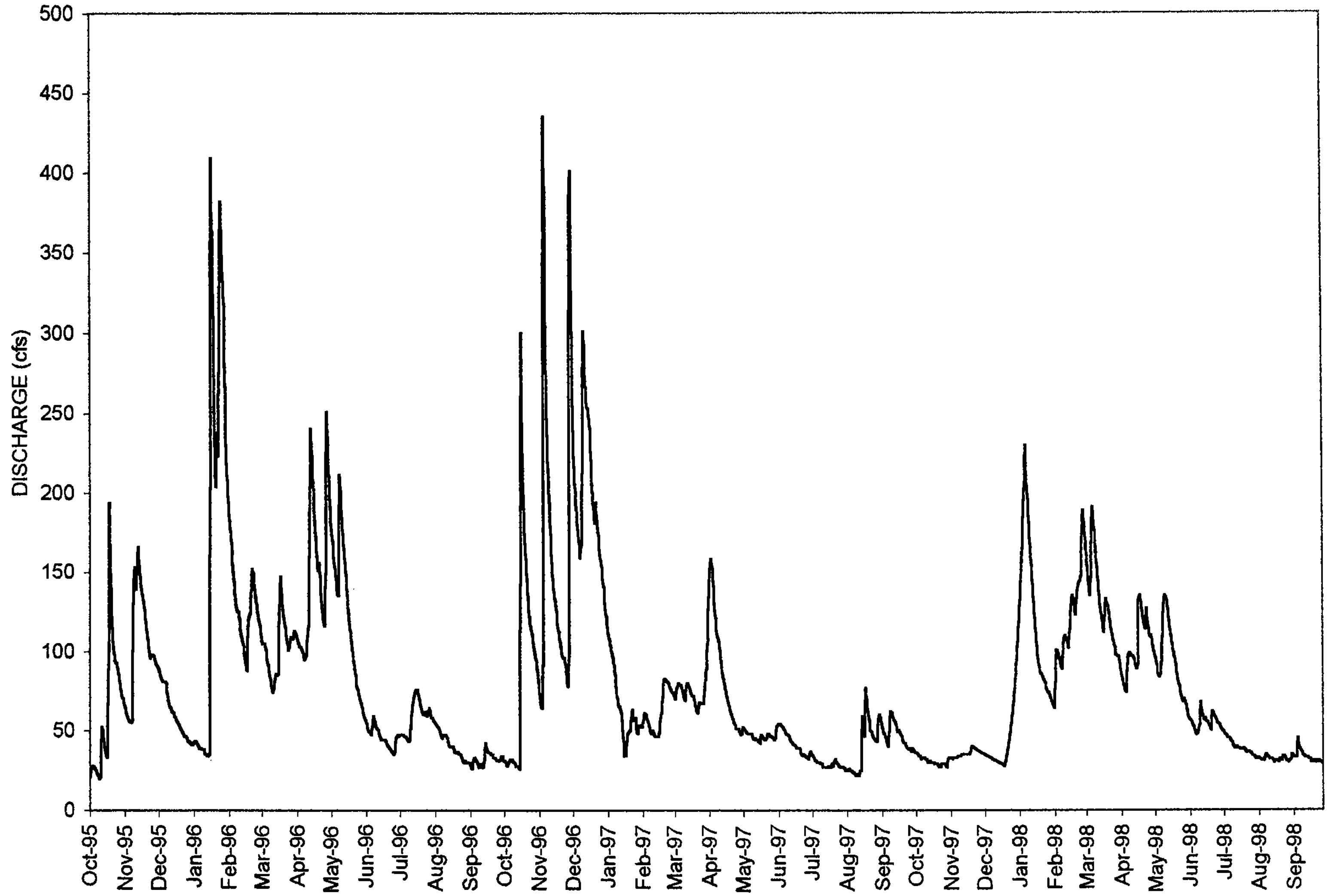

Figure G9. Discharge From Jeddo Tunnel, Water Years 1996-98

Table G3. Jeddo Tunnel Turbidity Readings, 1995-97

Day	Date	Time	Turbidity Reading (NTU)	Weather	Comments
Wednesday	11/29/95	10:45	11.4		
Friday	12/01/95	11:00	8.03		
Sunday	12/03/95	9:15	11.6		
Monday	12/04/95	13:30	18.1		
Tuesday	12/05/95	11:30	14.7		
Wednesday	12/06/95	10:45	13		
Friday	12/08/95	10:15	12.7		
Sunday	12/10/95	9:30	6.14		
Tuesday	12/12/95	8:30	5.76		
Wednesday	12/13/95	11:30	5.27		
Friday	12/15/95	9:00	6.36		
Saturday	12/16/95	9:30	7.51		
Sunday	12/17/95	9:30	5.55		
Tuesday	12/19/95	9:30	6.39		
Thursday	12/21/95	10:15	6.57		
Friday	12/22/95	10:00	5.09		
Saturday	12/23/95	8:30	7.38		
Sunday	12/24/95	9:00	6.36		
Tuesday	12/26/95	10:30	4.45		
Wednesday	12/27/95	10:15	7.33		
Thursday	12/28/95	10:00	8.64		
Saturday	12/30/95	12:30	6.73		
Monday	01/01/96	10:30	7.5		
Tuesday	01/02/96	10:30	5.64		
Thursday	01/04/96	10:30	6.48		
Friday	01/05/96	10:30	7.3		
Wednesday	01/10/96	16:30	5.65	snow, frozen	
Thursday	01/11/96	10:30	6.18		
Friday	01/12/96	10:30	7.32		
Saturday	01/13/96	10:00	7.58		
Sunday	01/14/96	11:00	5.63		
Tuesday	01/16/96	9:30	7.46		
Wednesday	01/17/96	9:00	5.77		
Thursday	01/18/96	8:00	7.67		
Friday	01/19/96	7:30	231		main creek 311 (thawing and flooding)
Saturday	01/20/96	8:30	32.2		brown(thawing and flooding)
Sunday	01/21/96	8:30	14		brown(thawing and flooding)
Monday	01/22/96	7:30	20.4		
Tuesday	01/23/96	8:30	368		
Thursday	01/25/96	9:30	17.8		
Friday	01/26/96	9:00	17.6		
Saturday	01/27/96	10:30	63.3		Brown Creek, Grey Tunnel (rain and flooding)
Sunday	01/28/96	10:00	52.5		
Monday	01/29/96	7:30	13.2		
Tuesday	01/30/96	10:00	13.5		
Thursday	02/01/96	17:00	20.8		
Friday	02/02/96	8:30	15.4		
Saturday	02/03/96	9:30	14.1	extreme cold	

Table G3. Jeddo Tunnel Turbidity Readings, 1995-97—Continued

Day	Date	Time	Turbidity Reading (NTU)	Weather	Comments
Sunday	02/04/96	10:00	15.5	extreme cold	
Tuesday	02/06/96	9:30	11.5	extreme cold	
Wednesday	02/07/96	10:00	10.9		
Friday	02/09/96	9:00	11.5		greenish yellow
Saturday	02/10/96	9:00	11.6		greenish yellow
Sunday	02/11/96	8:00	11.6		greenish yellow
Monday	02/12/96	8:30	9.13		greenish yellow
Tuesday	02/13/96	9:30	9.9	extreme cold	
Wednesday	02/14/96	9:00	7.66		
Thursday	02/15/96	9:30	12.9		yellow
Saturday	02/17/96	9:00	7.21		yellow
Sunday	02/18/96	9:30	6.08		low water
Monday	02/19/96	9:00	6.23		low water
Tuesday	02/20/96	9:30	7.51	rain	low water
Wednesday	02/21/96	9:00	28.2		gray foamy high water
Friday	02/23/96	8:00	12.6		gray, high water
Saturday	02/24/96	9:00	82.6		gray foamy high water
Sunday	02/25/96	9:30	10.5		gray, high water
Monday	02/26/96	9:00	10.2		gray, going down
Tuesday	02/27/96	9:30	12.6		gray, going down
Thursday	02/29/96	9:30	28.6		gray, lower
Friday	03/01/96	9:30	17.7		gray, lower
Saturday	03/02/96	9:30	19.9		gray, lower
Sunday	03/03/96	10:00	14.6		gray, lower
Tuesday	03/05/96	9:00	6.06	rain	low water
Wednesday	03/06/96	9:30	8.39		rising
Thursday	03/07/96	9:45	6.87	snow	rising
Saturday	03/09/96	9:45	6.68	cold snow	
Sunday	03/10/96	10:00	5.8	cold	
Monday	03/11/96	10:00	7.53	cold	
Tuesday	03/12/96	9:30	5.42	cold	
Thursday	03/14/96	9:30	6.92	thawing	clear
Friday	03/15/96	9:00	7.24	warm	clear
Saturday	03/15/96	10:00	20.8	warm	gray visible fines
Monday	03/18/96	9:30	7.74	warm	greenish
Tuesday	03/19/96	9:00	7.95	warm	greenish
Wednesday	03/20/96	9:00	25	rain storm	gray silt
Thursday	03/21/96	8:30	14.2	rain	high water, gray/green
Saturday	03/23/96	9:00	9.38		green
Sunday	03/24/96	9:30	7.14		greenish
Tuesday	03/26/96	9:00	6.32		
Thursday	03/28/96	9:30	8.85		gray, green
Friday	03/29/96	9:00	7.09		green
Saturday	03/30/96	9:30	5.49		green
Monday	04/01/96		10		green
Tuesday	04/02/96		48.7		black
Wednesday	04/03/96	14:30	107		black
Wednesday	04/03/96	15:15	347		very black
Thursday	04/04/96	12:30	52.1		black

Table G3. Jeddo Tunnel Turbidity Readings, 1995-97—Continued

Day	Date	Time	Turbidity Reading (NTU)	Weather	Comments
Friday	04/05/96	10:30	66.1	light snow	black
Saturday	04/06/96	8:00	37.5		black
Monday	04/08/96	15:15	5.66	clear	grayish
Tuesday	04/09/96	9:00	9.67	snow	grayish
Wednesday	04/10/96	9:00	4.74		greenish
Friday	04/12/96	11:30	73.3	medium water	black
Saturday	04/13/96	9:00	56.2	medium water	black
Sunday	04/14/96	10:00	8.74	light rain	greenish
Tuesday	04/16/96	9:00	45.3	heavy rain	high water, gray/black
Wednesday	04/17/96	9:30	25.4		high water, brownish gray
Thursday	04/18/96	9:00	9.14		high water, brownish gray
Saturday	04/20/96	12:30	16.9		high water, gray
Sunday	04/21/96	10:00	5.69	clear	high green
Tuesday	04/23/96	9:30	19.7		med water gray
Wednesday	04/24/96	10:00	24.7	rain night before	gray
Thursday	04/25/96	9:15	10.7		high green-gray
Friday	04/26/96	12:00	26.1		high gray
Sunday	04/28/96	10:00	9.95		med water greenish
Monday	04/30/96	9:30	11.5	heavy rain	greenish
Tuesday	04/31/96	9:00	13.8	rain	high water green/gray
Wednesday	05/01/96	10:00	22.5		very high water gray
Friday	05/03/96	10:00	26.1		high water, gray
Sunday	05/05/96	9:00	9.46		high gray
Monday	05/06/96	10:00	5.48	rain	high greenish
Tuesday	05/07/96	7:30	17.5		high water greenish
Thursday	05/09/96	10:00	18.9	rain	high greenish
Friday	05/10/96	9:00	45.1	rain	high gray/black
Saturday	05/11/96	11:00	66.4	rain	black high
Sunday	05/12/96	8:30	18.6		gray raging
Tuesday	05/14/96	9:30	11.1		high gray
Wednesday	05/15/96	8:30	17.7		high gray
Wednesday	05/15/96	20:30	44.5		Mill hill bridge
Friday	05/17/96	11:00	94.4		high water black
Saturday	05/18/96	9:00	10.6		high water gray
Monday	05/20/96	7:00	9.22		medium-high, gray-green
Tuesday	05/21/96	9:30	91.8		medium-high, black
Wednesday	05/22/96	10:00	19.6		medium-high, greenish gray
Thursday	05/23/96	8:00	47.6		Mill hill bridge
Friday	05/24/96	10:00	87.2		medium-high, black
Saturday	05/25/96	9:15	14.4		medium, greenish-gray
Monday	05/27/96	10:00	14.9		medium-low, greenish
Tuesday	05/28/96	7:00	8.82		medium, greenish
Wednesday	05/29/96	11:30	1,000		medium-low, black
Thursday	05/30/96	13:00	40.8		medium-low, gray-black
Saturday	06/01/96	11:00	252		medium-low, black
Sunday	06/02/96	10:30	15.7		low, greenish
Monday	06/03/96	14:00	1,000		low, black
Tuesday	06/04/96	10:30	1,000		low, black
Thursday	06/06/96	13:30	1,000		low, sludge

Table G3. Jeddo Tunnel Turbidity Readings, 1995-97—Continued

Day	Date	Time	Turbidity Reading (NTU)	Weather	Comments
Saturday	06/08/96	7:45	54.7	rain night before	low, gray
Sunday	06/09/96	10:15	22.7		low, greenish
Monday	06/10/96	9:00	70.9	rain	rising, gray
Tuesday	06/11/96	8:30	37.2		rising, gray
Wednesday	06/12/96	9:45	30.6		medium-low, greenish
Thursday	06/13/96	13:00	1,000		medium-low, black, diamond discharging
Friday	06/14/96	9:00	52.6		medium-low, gray, diamond not discharging
Saturday	06/15/96	9:30	56.2		medium-low, gray
Monday	06/17/96	14:30	1,000		medium-low, black, diamond coal discharging
Tuesday	06/18/96	9:15	34.1	a.m. rain	med., blackish-gray. 9:30am diamond not discharging.
Tuesday	06/18/96	10:30	83.6	a.m. rain	med., blackish-gray.10:15 a.m. diamond discharging.
Tuesday	06/18/96	11:30	1,000	a.m. rain	low, black, diamond coal discharging
Wednesday	06/19/96	8:30	38.3		medium-low, gray. 8:45 diamond coal discharging.
Thursday	06/20/96	9:30	73.8		low, gray. 9:45 AM diamond coal not discharging.
Friday	06/21/96	10:30	65.1		low, gray. 10:35 diamond coal not discharging.
Monday	06/24/96	9:30	12.6		low, greenish. 9:35 a.m. diamond coal discharging.
Monday	06/24/96	13:15	1,000		low, black. 1:10 p.m. diamond coal discharging.
Tuesday	06/25/96	9:00	70.2		low, gray. 9:15 diamond coal discharging.
Tuesday	06/25/96	13:20	1,000		black, diamond discharging
Wednesday	06/26/96	10:45	1,000		black, diamond discharging
Wednesday	06/26/96	20:00	1,000		diamond discharging
Thursday	06/27/96	12:05	1,000		low, black, diamond coal discharging
Monday	07/01/96	9:45	24.1	weekend rain	rising, greenish. 9:55 a.m. diamond coal not discharging.
Tuesday	07/02/96	9:30	39.8		medium, gray. 9:45 a.m. diamond coal discharging.
Tuesday	07/02/96	13:00	1,000		diamond discharging
Wednesday	07/03/96	8:45	52.8		diamond discharging
Friday	07/05/96	15:15	1,000		diamond discharging
Monday	07/08/96	9:00	23.2		No discharge
Tuesday	07/09/96	8:30	37.8		No discharge
Wednesday	07/10/96	14:00	951		diamond discharging
Thursday	07/11/96	9:30	98.4		diamond discharging
Sunday	07/14/96	10:00	33.5		Heavy rain, High water
Monday	07/15/96	10:45	14.2		Heavy rain, High water
Tuesday	07/16/96	8:30	26.8		diamond discharging
Thursday	07/18/96	9:15	32.9		diamond discharging
Friday	07/19/96	12:30	290		diamond discharging
Monday	07/22/96	10:30	8.31		diamond discharging
Monday	07/22/96	14:00	65		diamond discharging

Table G3. Jeddo Tunnel Turbidity Readings, 1995-97—Continued

Day	Date	Time	Turbidity Reading (NTU)	Weather	Comments
Tuesday	07/24/96	9:00	25.9		diamond discharging
Thursday	07/26/96	9:15	32.2		diamond discharging
Friday	07/28/96	11:30	1,000		diamond discharging
Tuesday	08/01/96	9:30	21.3		Discharge low
Friday	08/04/96	9:00	53.18		Working on silt pond
Monday	08/07/96	9:15	11.3		diamond discharging
Tuesday	08/08/96	9:30	16.2		diamond discharging
Thursday	08/10/96	9:00	28.1		diamond discharging
Monday	08/14/96	13:30	1,000		diamond discharging
Tuesday	08/15/96	10:00	566		diamond discharging
Thursday	08/17/96	12:00	1,000		diamond discharging
Friday	08/16/96	16:35	1,000		3152 actual reading after dilution
Monday	08/19/96	16:25	1,000		
Tuesday	08/20/96	7:30	49.9		Low water 7:45 Diamond Coal discharging starts (light)
Tuesday	08/20/96	8:00	43.2		Diamond discharging heavy 8:15 a.m.
Tuesday	08/20/96	8:30	41.6		
Tuesday	08/20/96	9:00	34.6		
Tuesday	08/20/96	9:30	43		
Tuesday	08/20/96	10:15	30.8		
Tuesday	08/20/96	10:45	1,470		
Tuesday	08/20/96	11:15	2,000		
Tuesday	08/20/96	11:45	2,520		
Tuesday	08/20/96	12:15	2,000		
Tuesday	08/20/96	12:45	2,560		
Tuesday	08/20/96	13:15	2,768		
Thursday	08/22/96	16:00	1,134		
Thursday	08/22/96	16:30	1,000		
Thursday	08/22/96	17:00	1,710		
Thursday	08/22/96	17:30	1,464		
Thursday	08/22/96	18:00	2,000		
Thursday	08/22/96	18:30	1,640		
Thursday	08/22/96	19:00	1,440		
Friday	08/23/96	0:15	4,000		
Saturday	08/24/96	0:15	8,000		
Tuesday	08/27/96	8:30	49.3		8:45 Diamond discharging (clear water)
Tuesday	08/27/96	9:00	49		
Tuesday	08/27/96	9:30	46.6		9:45 no discharge at Diamond
Tuesday	08/27/96	10:00	36.8		
Tuesday	08/27/96	10:30	29.8		
Tuesday	08/27/96	11:00	32.6		10:45 or 11:15 no discharge at Diamond
Thursday	08/29/96	12:30	8,000		
Friday	08/30/96	10:00	53		
Monday	09/02/96	9:30	16.1		
Tuesday	09/03/96	9:30	9.81		
		10:00	9.46		
		10:30	10.6		

Table G3. Jeddo Tunnel Turbidity Readings, 1995-97—Continued

Day	Date	Time	Turbidity Reading (NTU)	Weather	Comments
Tuesday	09/03/96	11:30	392		Diamond discharge appears clear
		12:00	2,148		
		1:00	4,000		
		1:30	3,944		
		2:00	4,216		
		8:30 p.m.	6,352		2:15 Diamond discharging black
		9:00	84.9		
Wednesday	09/04/96	9:15			
		9:30	77		Diamond discharging black
		10:00	63.8		
		10:30	903		
		11:00	3,128		
		11:30	4,000		
		12:30	5,344		
		8:30	8,000		
		9:30	53.8		
Thursday	09/05/96	10:00	47.7		9:45 a.m. Diamond not discharging
		10:30	50.3		
		11:00	43.7		10:45 No Discharge
		11:30	37.5		
		12:00	39		11:45 No Discharge
		2:05	42.7		
		4:35	41.9		2:15 No Discharge
		12:30	6,272		4:45 Diamond Coal discharging black
Friday	09/06/96	9:30	44.5		
Monday	09/08/96	10:00	45.5		9:45 Diamond Coal discharging
		10:30	47.6		
		11:00	38.2		
		11:15	127		
		11:20	1,000		
		11:25	2,000		
		11:30	2,908		
		11:45	3,604		
		12:00	4,000		
		10:15	50		
Tuesday	09/10/96	10:45	53.6		10:30 a.m. Diamond discharging
		11:00	51.4		
		11:10	314		
		11:15	874		
		11:20	1,506		
		11:25	1,878		
		11:30	1,454		
		11:45	374		very sudden drop at tunnel mouth
Friday	09/13/96	10:30	106		10:45 Diamond Coal discharging
		11:00	771		
		11:30	1,680		
		12:00	2,000		

Table G3. Jeddo Tunnel Turbidity Readings, 1995-97—Continued

Day	Date	Time	Turbidity Reading (NTU)	Weather	Comments
Saturday	09/14/96	10:00	99.9		10:15 Diamond not discharging
		10:30	98.4		Clear weather creek higher
		11:00	116		
		11:30	97.5		
		12:00	108		
Monday	9/16/96	12:00	20.7		12:15 Diamond discharging black
Tuesday	9/17/96	10:30	60.8		10:45 Diamond discharge black
		11:00	46.2	rain	water rising slightly very foamy
		11:30	43.1		
		12:00	38.2		
		12:30	250		
		1:00	1,000		
		1:30	1,000		
		2:00	1,664		
Thursday	09/19/96	11:00	31.1		11:10 Diamond Coal discharging
		11:30	31.8		
		12:00	36		
		12:30	31.7		
		1:00	28.7		
		1:30	696		
		2:00	1,258		
Monday	09/23/96	11:00	1,000		11:15 diamond coal discharge is black
Tuesday	09/24/96	10:15	68.2		10:30 no discharge
		10:45	859		11:00 no discharge
		11:15	2,000		11:30 no discharge
Wednesday	09/25/96	9:00	83.3		
		4:00	1,000		
Monday	09/30/96	10:25	10.5		
		10:45	15.8		
		11:00	516		
		11:15	1,194		
Tuesday	10/01/96	10:15	84.5		10:30 Diamond discharging
		10:45	1,000		
		11:00	553		battery low
		11:15	584		battery low
		11:30	1,250		
Thurday	10/03/96	10:15	56.6		
		10:45	74.2		Diamond Coal discharging
		11:15	1,476		
Friday	10/04/96	10:30	745		Diamond discharging
		4:00	648		
Sunday	10/05/96	10:30	39		no discharge
Tuesday	10/08/96	8:15	278		discharging
Wednesday	10/09/96	10:15	139		10:30 Diamond not discharging
		10:45	1,000		11:00 not discharging
		11:15	1,312		11:30 Diamond discharge black
Friday	10/11/96	10:15	43.6		10:30 Diamond discharging
		10:45	1,438		
		11:15	1,000		

Table G3. Jeddo Tunnel Turbidity Readings, 1995-97—Continued

Day	Date	Time	Turbidity Reading (NTU)	Weather	Comments
Monday	10/14/96	10:00	20.7		10:15 no discharge
		10:30	20.3		
		•11:00	21.6		11:15 no discharge
Tuesday	10/15/96	10:15	359		10:30 Diamond discharging
		10:45	1,262		
		11:00	1,352		
Friday	10/18/96	9:45	949		10:00 Diamond discharge black
Saturday	10/19/96	9:30	957	heavy rain	raging water, large particles, black and foamy
Sunday	10/20/96	9:45	69.1	rain stopped	water raging, brown foamy level higher than Saturday
Monday	10/21/96	10:45	15.8		water greenish brown 11:00 no discharge
		11:15	16.3		
		11:45	15.1		
Tuesday	10/22/96	6:30	31.9		8:45 Diamond starts discharging
		10:45	109		
		11:15	247		
		11:45	394		
		12:15	520		
Friday	10/22/96	1:00	1,000		
Monday	10/28/96	11:30	577		
Tuesday	10/29/96	10:15	190		2.35
Thursday	10/31/96	11:30	1,000		2.25-2.3
Monday	11/04/96	2:45	1,000		
Thursday	11/07/96	11:30	54.4		2.2 - 2.5
Saturday	11/09/96	8:15	75.8		2.9-3.0
Monday	11/11/96	3:00	443		3.3+
Tuesday	11/12/96	10:00	10.6		2.9-3.0
Thursday	11/14/96	8:30	9.97		2.7-2.8
Friday	11/15/96	10:30	44.8		2.7
Tuesday	11/19/96	1:40	1,000		2.45-2.5
Friday	11/22/96	8:30	69.4		2.4
Tuesday	11/26/96	1:00	724		2.25
Tuesday	12/03/96	1:35	48.6		3.2-3.3
Tuesday	12/10/96	11:25	9.33		2.65-2.7
Wednesday	12/11/96	4:30	901		
Friday	12/13/96	19:30	76.4		
Saturday	12/14/96	9:10	16.4		3-3.2
Monday	12/16/96	19:30	48		
Tuesday	12/17/96	8:10	8.64		
Tuesday	12/17/96	12:45	79.5		2.9-3
Tuesday	12/24/96	9:00	7.97		2.7-2.8
Friday	01/03/97	5:00	1,000		
Tuesday	01/07/97	9:10	14.3		
Tuesday	01/14/97	?	7.37		2.09+
Tuesday	01/21/97	1:20	7.94		
Tuesday	01/28/97	12:45	8.8		
Tuesday	02/04/97	11:30	13.4		

Table G3. Jeddo Tunnel Turbidity Readings, 1995-97—Continued

Day	Date	Time	Turbidity Reading (NTU)	Weather	Comments
Tuesday	02/11/97	11:30	6.52		
Tuesday	02/18/97	12:00	15		
Tuesday	02/18/97	8:00	89.2		
Tuesday	02/25/97	10:15	12.5		
Tuesday	03/04/97	11:00	15.6		
Tuesday	03/11/97	11:00	10.8		
Tuesday	03/18/97	10:30	7.54		
Tuesday	03/25/97	11:30	5.11		no discharge
Tuesday	04/01/97	10:30	7.03		no discharge
Thursday	04/03/97	14:30	8.93		
Tuesday	04/08/97	11:15	4.41		no discharge
Tuesday	04/15/97	11:45	4.49		
Tuesday	04/22/97	10:25	5.4		
Tuesday	04/29/97	10:30	6.73		
Tuesday	05/06/97	9:30	5.15		
Tuesday	05/13/97	11:00	5.55		
Tuesday	05/20/97	10:45	6.82		
Tuesday	05/27/97	9:30	4.81		
Tuesday	06/03/97		8.42		
Tuesday	06/10/97	10:45	7.21		
Tuesday	06/17/97	9:30	6.23		
Thursday	06/19/97	9:30	21.6	rain last night	
Friday	06/20/97	10:30	9.34		
Tuesday	06/24/97	10:30	7.08		
Friday	06/27/97		5.84		water greenish gray, bottom visible yellow rocks
Tuesday	07/01/97	10:15	39.4		gray silty water
Wednesday	07/02/97	9:30	49.1	heavy rain	
Monday	07/07/97		5.1		
Tuesday	07/08/97	10:15	5.2		water greenish yellow
Tuesday	07/15/97	10:15	46.8		water black fine sediment on bottom
Friday	07/18/97	21:30	85.1	Rain storm	
Saturday	07/19/97	9:00	64.9		
Tuesday	07/22/97	11:45	33.4		gray visible sediment
Tuesday	07/29/97	11:15	32.3		gray silty
Tuesday	08/05/97	11:45	41.6		moderate rain night before
Thursday	08/07/97				
Monday	08/11/97	12:00	33		
Tuesday	08/12/97	10:30	50.9		Tunnel water silty
Thursday	08/14/97				
Sunday	08/17/97	12:30	23.3		showers previous evening
Monday	08/18/97	11:30	158		3 inches of rain previous evening
Tuesday	08/19/97	9:30	22.1		brownish gray water
Thursday	08/21/97				
Monday	08/24/97	12:40	13		
Tuesday	08/26/97	10:45	9.54		
Thursday	08/28/97				
Tuesday	09/02/97	10:00	10.3		grayish water
Thursday	09/04/97				

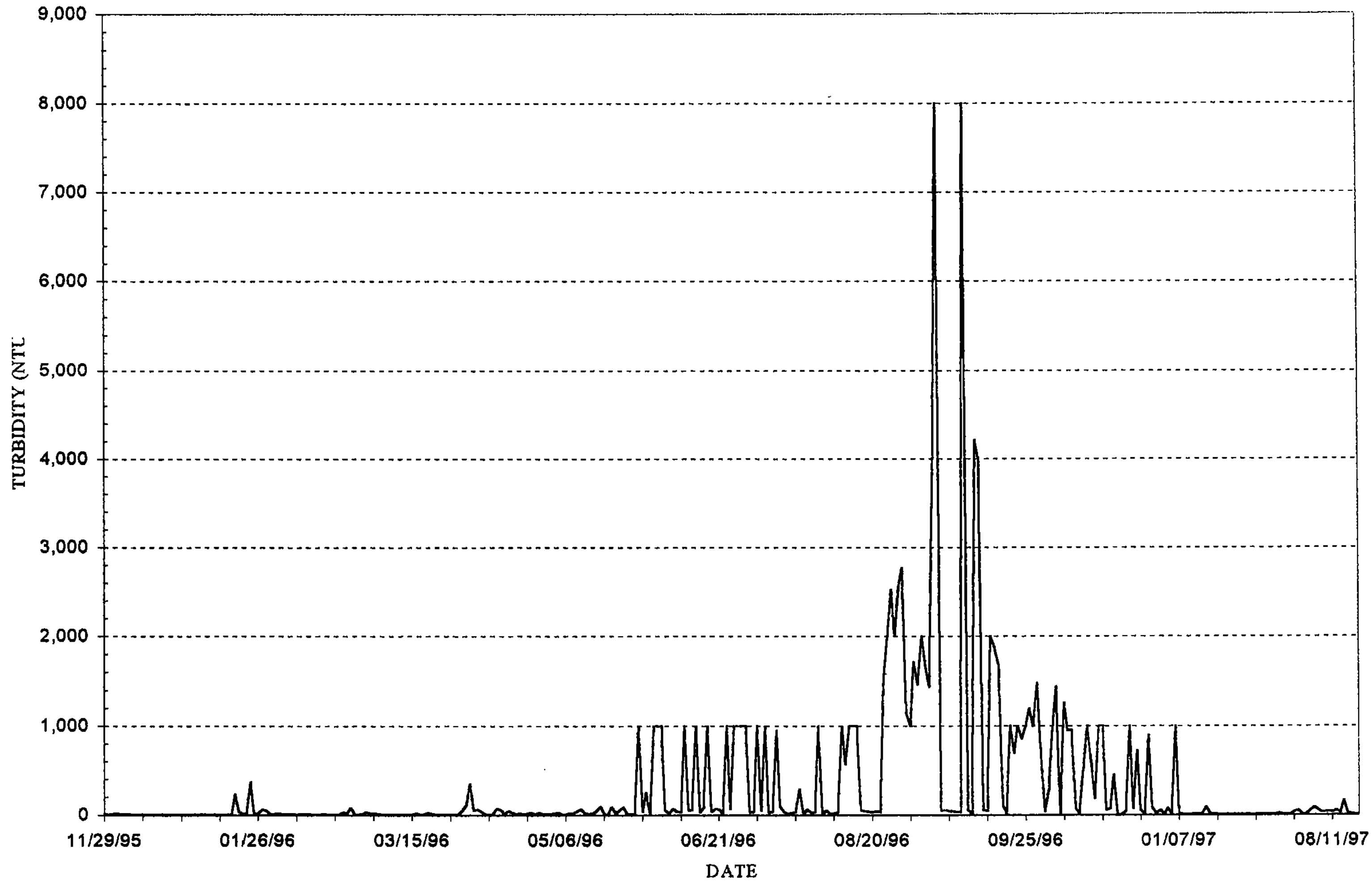

Figure G10. Jeddo Tunnel Turbidity, November 1995 to September 1997

Table G4. Freeland Precipitation for Period of Record, 1931-89 *(in inches)*

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Total
1931	1.79	2.28	4.10	3.92	6.31	2.64	5.92	2.20	3.39	1.76	1.16	2.66	38.13
1932	4.55	2.25	4.84	2.20	3.74	5.29	2.41	2.47	1.80	8.99	6.56	1.88	46.98
1933	2.00	3.30	4.87	5.00	4.06	2.89	6.31	11.30	6.51	3.80	1.69	2.60	54.33
1934	3.41	1.80	2.96	5.38	4.38	3.73	7.24	2.96	7.43	1.69	5.25	4.34	50.57
1935	2.92	2.73	2.97	3.77	2.15	5.52	8.32	3.53	3.29	1.19	6.35	2.24	44.98
1936	4.25	2.09	7.78	2.74	3.14	3.62	2.04	3.10	1.48	3.19	3.10	4.75	41.28
1937	5.52	3.52	2.31	4.81	3.77	3.58	3.68	6.60	1.70	9.50	3.74	1.80	50.53
1938	3.68	2.40	2.58	4.76	4.78	5.91	6.28	3.29	6.79	2.93	5.62	5.49	54.51
1939	3.51	4.31	4.12	4.45	1.79	2.74	1.42	4.14	1.94	3.72	1.39	2.98	36.51
1940	1.68	3.44	8.46	5.46	3.83	4.64	3.60	3.84	5.83	2.57	4.91	2.29	50.55
1941	2.19	0.91	2.55	2.02	1.69	5.47	6.26	4.48	1.15	2.19	3.76	4.46	37.13
1942	1.59	2.60	3.06	1.69	9.44	4.68	6.53	2.61	5.58	4.49	2.86	6.43	51.56
1943	2.70	2.55	3.14	2.27	5.84	3.41	3.14	2.74	0.36	9.84	5.41	0.87	42.27
1944	1.67	1.72	4.61	4.29	3.28	8.20	1.48	3.27	4.57	2.72	2.92	3.21	41.94
1945	3.36	2.29	2.37	4.09	4.48	3.82	10.14	3.50	5.62	2.46	5.94	4.26	52.33
1946	1.71	1.73	4.91	0.88	10.19	5.71	5.27	4.18	3.59	4.12	1.11	1.98	45.38
1947	3.74	1.64	3.12	4.67	11.84	3.91	15.32	2.77	2.14	1.23	3.13	2.53	56.04
1948	3.45	1.54	3.40	5.27	6.90	3.70	7.72	2.14	0.74	3.04	7.09	5.33	50.32
1949	3.47		1.59	4.76	5.66	1.85	4.01	4.38	3.93	1.41	1.43	4.69	37.18
1950	4.26	4.08	5.97	4.49		4.04			3.76	3.23	7.10	6.29	43.22
1951	4.58	3.76	4.15	1.61	3.31	2.61		1.71	2.22		8.34	6.25	38.54
1952	3.85	2.20	4.07	9.39	6.36	3.54	12.83		5.68	1.25	7.01	6.98	63.16
1953	6.87	2.88	5.35	4.92	6.49	2.23		1.40	5.81	3.50	3.45	4.66	47.56
1954	1.40	2.85	3.11	6.09	4.88	3.20	1.81	5.93	3.84	3.53	4.71	2.45	43.80
1955	1.25	3.25	3.13	2.27	2.29	5.47	0.86						18.52
1955								17.91	3.43		3.36	0.90	25.60
1956			2.90	2.73	4.02	3.91	5.61	3.79	6.59	4.42		6.07	40.04
1957	1.98				3.32	8.17	1.17	2.48	4.64	3.05	3.35	7.90	36.06
1958			3.68	4.30	3.24	3.33		2.70		3.54			20.79
1959				4.40	2.30	3.56			3.60	7.25		4.06	25.17
1960	2.40				7.78	4.68		7.77	7.53			1.84	32.00
1961		2.09		3.31		4.91		5.36	1.03				16.70
1962	1.27					1.86	3.30	7.84	4.09	5.88	1.58	1.26	27.08
1963			2.34							0.13			2.47
1964		3.67	1.39					2.88		1.81		3.62	13.37

Table G4. Freeland Precipitation for Period of Record, 1931-89 *(in inches)—Continued*

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Total
1965	3.37	1.83	2.42	1.79	2.40	2.51	1.29	6.40	4.47	4.32	2.51	1.22	34.53
1966	2.94	2.66	1.58	3.17		0.52	2.02	3.48	3.91		5.39	2.79	28.46
1967	1.61				6.24	1.84	4.44	6.04	3.33	3.83		2.62	29.95
1968		0.23		2.72	5.64	4.87	1.75	2.78	6.29	1.84	4.06	3.00	33.18
1969	1.31	0.99	2.27	4.71	2.75	6.25	9.02	3.92	2.12	1.60	3.90	7.96	46.80
1970	0.40	3.30	3.46	4.77	2.81	3.82	4.87	3.69	2.71	5.72	7.62	2.48	45.65
1971	2.02	6.17	2.63	0.98	4.29	1.58	4.66	5.49	5.10	3.56	5.82	2.23	44.53
1972	2.58	4.18	3.60	3.30	7.52	9.37	2.43	2.26	1.21	3.15	9.31	4.31	53.22
1973	3.97	1.77	3.67	6.47	6.80	8.74	2.57	8.04	5.68	4.13	2.32	7.90	62.06
1974	2.73	3.04	3.89	1.89	3.02	5.98	4.77	5.29	8.19	1.18	2.59	3.80	46.37
1975	2.70	3.41	4.07	2.63	3.71	9.56	8.49	4.05	6.36	3.79	3.66	1.89	54.32
1976	4.34	2.79	3.16	2.78	4.69		5.40	5.63	5.35	9.67		2.38	46.19
1977	1.89		5.95	4.55		2.48	4.15	2.76	7.49	6.54	3.51		39.32
1978		1.33											1.33
1979							2.20	5.09	8.06	4.81	4.08		24.24
1980	0.64	1.07		4.50	3.42	3.47	2.91	2.54	1.69	2.51	3.15	0.71	26.61
1981	1.15	7.28	1.24	3.85	4.42	6.86	3.62	2.12	3.62	3.98	2.32	2.58	43.04
1982	2.40	2.66	1.19	6.78	3.12	6.08	3.50	5.12	3.01	2.46	3.27	2.36	41.95
1983	1.96	3.88	4.12	12.35	6.09	7.24	1.37	3.57	2.60	4.33	6.85	8.02	62.38
1984	1.56	4.35		6.94	8.22	5.38	5.15	3.51	0.77	2.83	3.97	2.56	45.24
1985		2.28	1.72	1.59	4.90	6.11	4.50	5.77	6.82	2.48	7.18	2.51	45.86
1986	4.38	3.62	3.57	5.12	2.95	5.85	4.35	5.66	2.63	2.74	4.79	3.67	49.33
1987	3.94	0.70	1.68	6.00	1.47	2.06	5.99	7.75	10.43	3.02	5.29	2.11	50.44
1988	2.97		2.52		6.83	1.74	13.32	3.76	3.21	3.01	4.27		41.63
1989	0.31				7.96	7.85	2.75	2.68					21.55
LTM AVERAGE	**2.74**	**2.73**	**3.46**	**4.14**	**4.81**	**4.50**	**4.86**	**4.46**	**4.17**	**3.65**	**4.34**	**3.61**	**39.91**

Blank cells are insufficient or no data.

Table G5. Tamaqua Precipitation for Period of Record, 1932-98 *(in inches)*

Water Year	October	November	December	January	February	March	April	May	June	July	August	September	Total
1932	1.53	0.90	2.33	4.78	2.25	6.23	0.97	3.46	5.35	1.88	3.21	1.17	34.06
1933	8.33	6.67	1.83	2.00	2.79	6.18	6.52	5.75	3.65	5.96	14.93	10.46	75.07
1934	3.58	1.07	1.89	3.18	1.04	2.79	4.96	3.54	4.90	2.46	4.02	8.21	41.64
1935	1.81	6.09	3.52	2.35	1.99	2.58	3.77	1.36	7.53	10.55	2.77	3.16	47.48
1936	2.60	5.63	1.94	4.92	2.62	8.27	3.90	1.81	5.32	1.85	6.31	1.78	46.95
1937	3.17	2.53	5.63	6.00	3.50	1.96	6.32	2.09	3.47	4.51	7.70	1.45	48.33
1938	8.77	3.26	2.07	5.08	3.51	2.48	3.30	5.86	6.61	6.15	3.02	6.75	56.86
1939	2.49	4.26	5.36	4.03	4.73	3.98	4.53	1.20	3.60	1.83	4.24	3.79	44.04
1940	5.27	0.77	3.07	1.66	2.36	7.60	4.84	3.65	3.95	2.23	7.80	3.64	46.84
1941	2.79	4.74	2.63	2.97	1.57	1.94	2.04	1.37	3.54	4.03	5.05	0.99	33.66
1942	2.53	3.27	4.35	2.94	2.75	4.19	1.41	11.73	4.70	6.66	5.05	7.79	57.37
1943	4.89	3.24	6.03	2.04	2.17	2.60	2.82	7.47	4.57	3.32	3.75	0.39	43.29
1944	9.78	5.60	0.98	2.13	1.94	4.55	3.76	2.88	5.39	1.73	1.62	6.57	46.93
1945	1.87	3.52	3.51	3.33	1.95	2.53	4.76	5.75	4.13	10.64	3.90	6.53	52.42
1946	2.76	6.72	3.47	2.05	2.66	3.95	1.00	10.96	4.22	5.66	3.44	4.88	51.77
1947	3.94	1.00	2.32	3.62	1.48	3.74	4.31	8.98	4.73	14.82	3.58	3.34	55.86
1948	3.25	6.15	1.45	2.85	2.03	3.75	6.38	7.29	3.74	4.27	2.84	0.93	44.93
1949	2.79	6.95	6.12	3.47	3.02	1.66	5.46	4.40	2.11	4.01	5.07	4.47	49.53
1950	2.21	2.09	4.06	4.13	3.98	6.37	2.38	4.06	3.06	5.20	2.79	3.48	43.81
1951	3.99	7.10	7.00	5.70	5.75	5.91	3.53	2.18	3.83	8.35	4.30	4.74	62.38
1952	4.14	7.81	7.69	3.95	2.24	5.86	10.15	7.11	1.47	9.61	6.91	5.39	72.33
1953	1.03	9.23	5.55	5.88	3.24	5.42	5.99	7.87	2.57	2.95	1.12	4.22	55.07
1954	2.95	3.04	4.79	1.67	3.36	5.28	4.39	4.22	1.46	1.53	6.38	2.97	42.04
1955	3.74	4.15	3.55	0.79	3.20	4.40	2.70	3.02	2.99	0.62	18.22		47.38
1956	4.42		6.07	3.49		2.69		4.09	3.21	7.88	3.83	5.50	41.18
1957	3.10	2.18	4.52		2.65	1.70	6.87	2.24	5.89	1.24	2.14	2.46	34.99
1958	3.56	3.25		4.05	4.16	4.04	4.79	3.72	4.47	4.09	3.38	4.19	43.70
1959	3.74	3.58	0.90	3.00				1.59	5.29	4.18	3.16	3.15	28.59
1960	6.14	5.69	4.06	3.24	5.35	4.75	3.46	7.60	5.58	7.90	4.26	8.12	66.15
1961	1.90	2.09	1.50	2.87	3.62		3.31	3.86	7.61	5.46	5.36	1.46	39.04
1962	0.85	6.10	2.41	1.27		2.24	3.60	2.31	3.39	2.59	5.00	4.30	34.06
1963	4.36	3.40	3.95	2.40	2.38	3.20	1.10	3.63	1.88	3.00	1.83	2.58	33.71
1964	0.19	5.92	2.15	6.08	2.89	3.69	5.73	1.38	4.71	2.23	1.13	3.36	39.46
1965	1.17	2.98	4.14	2.08	4.00	2.61	2.72	1.57	0.60	2.66	5.77	3.49	33.79

Table G5. Tamaqua Precipitation for Period of Record, 1932-98** (in inches)**—Continued

Water Year	October	November	December	January	February	March	April	May	June	July	August	September	Total
1966	4.31	2.37	1.75	3.50	3.07	2.79	3.41	2.83	1.09	2.64	2.33	4.84	34.93
1967	2.93	4.27	3.03	1.98	1.48	5.58	3.36	5.67	2.96	5.28	4.07	2.89	43.50
1968	3.34	3.78	3.98	3.02	0.29	3.15	2.63	6.56	5.38	1.51	2.25	7.65	43.54
1969	2.62	3.48	3.05	1.72	1.39	2.55	4.20	3.39	2.98	8.77	4.78	2.32	41.25
1970	2.24	5.02	4.75	0.45	3.85	3.18	4.56	3.49	3.39	8.57	2.08	2.73	44.31
1971	5.59	7.14	1.24	2.05	6.08	3.20	0.94	4.47	2.71	7.12	6.73	5.05	52.32
1972	2.69	5.65	2.69	3.14	3.45	3.94	3.35	6.83	14.15	2.19	3.78	1.29	53.15
1973	2.57	9.63	6.59	4.41	3.07	4.25	5.53	5.22	6.88	2.32	6.56	7.34	64.37
1974	4.30	2.13	8.77	4.06	2.99	5.68	3.19	4.45	4.70	4.76	5.28	6.44	56.75
1975	1.14	2.94	5.69	5.51	3.81	4.89	2.86	4.32	7.13	9.24	3.89	8.14	59.56
1976	4.88	4.60	3.31	5.91	2.96	2.67	3.27	4.59	5.81	5.48	4.55	6.74	54.77
1977	9.41		1.75	1.16	2.58	8.45	4.91	2.79	3.83	3.15	3.39	6.65	48.07
1978	6.59	6.15	6.05	9.22	1.08	5.07	2.17	8.36	4.02	2.98	5.74	2.58	60.01
1979	4.50	2.84	4.03	11.42	3.87	3.48	4.93	6.51	2.64	3.92	4.71	8.79	61.64
1980	6.29	4.90	3.25	1.54	1.22	7.07	5.99	3.48	3.16	3.27	2.11	2.08	44.36
1981	2.89	3.15	1.40	1.21	10.59	1.41	4.06	5.90	7.53	4.72	2.33	4.35	49.54
1982	4.29	2.40	3.37	4.11	3.57	3.36	5.44	4.64	8.68	3.85	6.52	3.01	53.24
1983	2.18	3.29	3.30	2.69	4.28	4.80	13.33	5.70	8.33	2.67	1.69	2.25	54.51
1984	4.47	7.57	9.04	1.87	5.03	4.48	5.76	8.58	7.04	7.20	2.40	0.82	64.26
1985	2.65	4.32	3.25	1.13	2.40	2.31	1.75	4.28	4.39	4.15	4.86	4.96	40.45
1986	2.80	6.61	2.27	4.53	3.81	3.88	4.53	2.37	4.62	4.34	3.23	3.12	46.11
1987	2.69	5.73	4.61	3.52	0.79	2.58	5.95	2.04	5.12	5.71	4.99	11.55	55.28
1988	3.25	3.95	1.79	2.43	3.85	2.98	2.90	6.96	1.73	13.32	4.25	3.58	50.99
1989	2.77	4.27	1.17	2.44	2.39	3.00	1.38	11.80	7.11	4.65	1.91	4.26	47.15
1990	5.47	5.00	1.11	5.79	3.00	2.34	3.62	9.28	2.52	3.00	8.00	4.58	53.71
1991	7.64	3.66	9.29	2.64	1.48	5.36	3.34	3.38	2.00	3.60	4.78	2.54	49.71
1992	3.22	4.14	3.45	2.42	2.56	5.30	3.66	6.70	3.66	6.58		6.08	47.77
1993	3.86	7.04	3.24		2.12	6.08	10.71	1.96	4.02	3.82	5.72	6.50	55.07
1994	3.83	6.65	5.22	6.26	2.76	5.66	5.12	4.46	8.48	4.25	7.64	4.16	64.49
1995	0.84	6.72	2.48	4.30	1.79	1.82	2.36	3.55	6.18	5.18	1.50	2.61	39.33
1996	8.76	5.54	2.62	8.56	2.86		5.96	4.88	9.48	7.63	1.84	5.14	63.27
1997	7.34	4.54	8.58	3.72	1.99	4.20	2.30	3.70	3.16	4.64	6.22	4.76	55.15
1998	2.18	3.92	3.22	4.50	5.06	4.00	5.50	4.08	5.80	2.16	3.50	3.39	47.31
LTM Average	**3.79**	**4.53**	**3.79**	**3.56**	**3.01**	**4.04**	**4.23**	**4.73**	**4.63**	**4.85**	**4.51**	**4.38**	**49.17**

Table G6. Precipitation Data From Hazleton, Pa., Water Year 1996 (in inches)

Day	October	November	December	January	February	March	April	May	June	July	August	September
1	0	0	0	0	0	0	0.35	0	0	0	0	0
2	0	0.3	0	0.4	0	0	0	0	0	0	0	0
3	0	0	0	0.4	0	0	0	0	0	0.1	0	0
4	0.68	0	0	0	0	0	0	0	0.32	0	0	0.02
5	1.41	0	0.2	0	0	0.25	0	0	0	0	0	0.05
6	0.2	0	0	0	0	0.25	0	0.18	0	0	0	0.2
7	0	0.2	0	0.55	0	0.65	0.55	0.02	0	0	0	0.86
8	0	0	0	0.18	0	0.12	0	0.07	0	0.53	0	0
9	0	0	0	0	0	0	0.12	0.1	0	0	0.07	0
10	0	0	0	0.25	0	0.11	0	0.1	1.18	0	0	0
11	0	2.32	0	0	0	0	0	1.93	0.05	0	0	0
12	0	0.37	0	0.15	0	0	0	0.03	0	0.01	0	0
13	0	0	0	0.65	0	0	0.37	0	0	2.71	0.38	0.41
14	1.85	1.8	0.25	0	0	0	0.07	0	0	0.03	0	0
15	0.05	0.42	0.13	0	0	0	0.71	0	0	0.17	0	0
16	0	0	0	0	0	0	0.87	0	0	0	0	0.18
17	0	0	0	0.38	0	0	0	0	0	0.41	0	1.32
18	0	0	0	0	0	0	0	0	0.03	0	0	0.06
19	0	0	0.75	2.56	0	1.09	0	0	0.15	0.23	0	0
20	0.6	0	0.21	0	0.55	0.21	0	0	0	0	0	0
21	3.05	0	0.1	0	0.48	0.05	0	0.1	0	0	0.22	0
22	0	0	0	0	0.1	0	0	0	0	0	0	0
23	0	0	0	0	0	0	0.6	0	0	0	0	0
24	0	0	0	1.32	0.17	0	0	0	0.14	0	0.13	0
25	0	0	0	0	0	0.03	0	0	0	0	0	0
26	0	0	0	0.28	0	0.02	0.08	0	0	0.33	0	0
27	0.25	0	0	2.95	0	0	0	0.12	0	0	0	0
28	0.38	0	0	0.53	0.15	0.19	0	0	0	0	0	0.66
29	0.14	0.47	0	0.58	0	0.57	0.65	0	0.02	0.6	0	0.02
30	0.03	0	0	0	---	0	1.63	0	1.59	0.03	0	0
31	0.06	---	0	0	---	0	---	0	---	0	0	---
TOTAL	**8.7**	**5.88**	**1.64**	**11.18**	**1.45**	**3.54**	**6**	**2.65**	**3.48**	**5.15**	**0.8**	**3.78**
MAX	**3.05**	**2.32**	**0.75**	**2.95**	**0.55**	**1.09**	**1.63**	**1.93**	**1.59**	**2.71**	**0.38**	**1.32**

Table G6. Precipitation Data From Hazleton, Pa., Water Year 1997 (in inches)

Day	October	Novembe r	Decembe r	January	February	March	April	May	June	July	August	Septemb er
1	0	0	2.76	0	0.02	0	0.17	0	0.03	0	0	1.83
2	0	0	0.34	0.07	0	0.15	0	0	0.83	1.05	0	0
3	0	0	0	0.1	0.03	0.23	0	0.6	0.2	0	0.03	0
4	0	0	0	0	0.15	0	0	0	0.02	0	0.17	0
5	0	0	0	0.1	0.35	0.2	0	0	0	0	0.61	0
6	0	0	0.73	0	0	0.1	0	0.05	0	0	0	0
7	0	0	0.1	0	0	0	0	0	0	0	0.02	0
8	0.6	3.8	0.05	0	0	0	0	0.13	0	0	0	0
9	0.01	0.09	0.07	0.12	0	0	0	0.25	0	0.2	0	0
10	0.14	0.14	0	0.06	0	0	0	0	0	0	0	0.1
11	0	0	0.46	0	0	0	0	0	0	0	0	1.81
12	0	0	0.3	0	0.02	0	0.25	0	0	0	0	0
13	0	0	1.14	0	0	0	0	0.05	0.31	0	0.2	0
14	0	0	0.47	0	0.28	0.87	0	0	0	0	0	0
15	0	0	0	0	0.05	0	0	0.05	0	0	0.86	0
16	0	0	0	0.5	0.01	0	0	0	0	0	0.15	0
17	0	0	0	0	0.02	0	0.03	0	0	2.69	0.4	0
18	0.07	0.11	0	0	0	0	0.05	0.05	0.2	0.95	2.47	0.05
19	4.75	0.07	0.27	0	0.05	0	0	0.63	0	0	0	0
20	0.07	0	0	0	0	0	0	0.07	0	0	1.48	0.1
21	0.1	0	0	0	0.05	0	0	0	0	0.05	0	0
22	0.03	0.03	0	0.11	0	0.1	0	0	0.22	0.05	0	0
23	0.28	0	0	0	0	0	0	0	0	0.11	0	0
24	0	0	0.58	0.5	0	0	0	0	0	0.7	0	0
25	0	0	0	0.15	0	0.02	0	0.73	0	0	0	0
26	0	0.75	0	0	0.07	0.78	0	0	0	0	0	0
27	0	0	0	0.09	0	0	0.05	0.03	0	0	0	0
28	0	0	0	0.19	0	0	0.25	0	0	0	0.4	0.25
29	0	0	0.35	0	---	0	0	0	0	0	0.31	0.28
30	0	0.25	0	0	---	0.11	0	0.02	0	0	0	0.08
31	0	---	0	0	---	1.31	---	0	---	0	0	---
TOTAL	**6.05**	**5.24**	**7.62**	**1.99**	**1.1**	**3.87**	**0.8**	**2.66**	**1.81**	**5.8**	**7.1**	**4.5**
MAX	**4.75**	**3.8**	**2.76**	**0.5**	**0.35**	**1.31**	**0.25**	**0.73**	**0.83**	**2.69**	**2.47**	**1.83**

Table G6. Precipitation Data From Hazleton, Pa., Water Year 1998 (in inches)

Day	October	November	December	January	February	March	April	May	June	July	August	September
1	0.05	0.77	0	0	0	0	0.58	0.02	0.15	0	0	0
2	0	0.3	0	0	0	0	0.02	0.08	0	0	0	1.16
3	0	0.03	0	0	0	0.2	0	0.02	0	0	0	0
4	0	0	0.03	0	0.75	0.05	0.03	0.13	0	0.1	0	0
5	0	0	0.07	0	0.63	0	0	0.17	0	0.05	0	0
6	0	0	0	0.17	0	0	0	0.03	0	0	0	0
7	0	0.17	0.03	0.45	0	0	0	0.02	0.05	0	0	1.26
8	0	0.4	0	0.95	0	0.21	0.17	0.37	0	0.47	0	0.02
9	0	0.15	0	0.45	0	1.3	1.28	0.33	0	0	0	0
10	0.05	0	0.45	0	0	0.05	0.25	0.79	0.12	0	0.96	0
11	0	0	0.07	0	0.32	0	0	0.59	0.03	0	0	0
12	0	0	0.03	0.03	0.18	0	0	0.07	0.62	0	0	0
13	0	0	0	0.02	0	0	0	0	2.14	0	0	0
14	0.07	0.03	0.05	0	0.02	0.02	0.05	0	0.15	0	0	0
15	0.25	0	0	0.43	0	0	0.15	0	0.15	0	0.08	0
16	0.1	0	0	0.37	0	0	0.05	0	0.12	0.07	0	0
17	0	0	0	0	0.58	0	0.08	0	0.15	0.03	0.39	0.05
18	0	0.47	0	0.08	0.37	0.33	0	0	0	0	0.05	0.03
19	0	0.28	0	0.02	0.1	0.13	1.67	0	0	0	0	0
20	0	0	0	0.08	0	0.15	0.1	0	0	0.12	0	0
21	0	0.07	0.02	0	0	1	0	0	0	0.49	0	0
22	0	0.45	0.05	0.02	0	0.1	0	0	0	0	0.92	0.59
23	0	0	0.13	0.65	0.93	0.02	0	0	1.48	0	0	0
24	0.03	0.03	0.07	0.25	1.25	0	0	0	0	0.03	0	0
25	0.47	0	0.3	0.05	0	0	0	0.1	0	0	0.5	0.1
26	0.28	0.08	0	0	0	0	0.91	0	0.05	0	0.09	0
27	0.1	0	0.08	0	0	0	0.03	0	0	0	0	0.16
28	0	0.05	0.02	0	0.25	0	0	0	0	0	0	0.02
29	0	0.02	0.3	0	---	0	0	0.57	0.05	0.05	0	0
30	0	0.55	0.43	0	---	0	0	0.02	0.25	0.07	0	0
31	0	---	0	0	---	0	---	0.05	---	0.27	0	---
TOTAL	**1.4**	**3.85**	**2.13**	**4.02**	**5.38**	**3.56**	**5.37**	**3.36**	**5.51**	**1.75**	**2.99**	**3.39**
MAX	**0.47**	**0.77**	**0.45**	**0.95**	**1.25**	**1.3**	**1.67**	**0.79**	**2.14**	**0.49**	**0.96**	**1.26**

APPENDIX H

PREVIOUS WATER QUALITY DATA

TableH1. Jeddo Tunnel Outfall Water Quality Data (Monthly, 1978-90, 1995-98)

Sample Date	pH	Sulfate	Iron, Total	Iron, Ferrous	Manganese, Total	Aluminum, Total	Acidity, Total HOT
		mg/l					
May-78	3.6	311	5.7	2.2			190
Jun-78	3.61	203	2.4	1.1			189
Jul-78	3.55	467	6.2	6			176
Aug-78	3.45	474	8.2	8			187
Sep-78	3.28	536	5.9	1.6			388
Oct-78	3.6	440	6.7	3.6			241
Nov-78	3.43	479	2.8	2.2			229
Dec-78	3.66	371	6	5.8			182
Jan-79	3.81	406	8.2	8			154
Feb-79	3.74	296	6.6	4.4			98
Mar-79	3.73	345	3.4	1.5			115
Apr-79	3.71	334	4.2	4.2			113
May-79	3.65	374	4.5	3.4			182
Jun-79	3.69	404	5.6	4.6			307
Jul-79	3.42	330	5	3.9			331
Aug-79	3.52		8.9	4.4			191
Sep-79	3.65	476	4.8	3.1			136
Oct-79	3.71	427	4.6	4.5			197
Nov-79	3.69	373	3.9	2.1			222
Dec-79	3.69	378	4.7	1.3			113
Jan-80	3.72	414	4.9	4.2			120
Feb-80	3.09	441	6	2.9			139
Mar-80	3.63	454	6.7	2.2			149
Apr-80	4.3		1.5				
May-80	3.9		2				
Jul-80	3.9		0.4				
Oct-80	3.8		8.2	5.4			
Nov-80	3.9		4	2.4			
Jan-81	3.42	615	7.2	1.9			269
Feb-81	3.72	372	5.9	3.9			122
Mar-81	3.7	401	4.9	2.4			169
Apr-81	3.65	362	6.8	1.8			150
May-81	3.77	360	4	1.1			105
Jun-81	4.2		3	2.5			142
Jul-81	3.67	484	0.6	0.4			230
Aug-81	3.64	387	7.1	2.7			273
Sep-81	3.6		4	3.2			220
Oct-81	3.4	514	9	5.5			309
Nov-81	3.49	472	5.1	5.1			182
Dec-81	3.61	424	0.9	0.5			139

Table H1. Jeddo Tunnel Outfall Water Quality Data (Monthly, 1978-90, 1995-98)—Continued

Sample Date	pH	Sulfate	Iron, Total	Iron, Ferrous	Manganese, Total	Aluminum, Total	Acidity, Total HOT
		mg/l					
Jan-82	3.52	250	0.8	0.7			261
Feb-82	3.72	400	2	0.8			159
Mar-83	3.69	331	5.4	2.6			108
Apr-82	3.69	322	4.6	2.1			103
May-82	3.67	422	6.5	1.8			219
Jun-82	3.86	409	4	1.1			103
Jul-82	3.53	466	6.5	1.2			166
Aug-82	3.59	509	10.2	1.6			137
Sep-82	3.74	508	8.1	2.6			122
Oct-82	3.48	505	8.2	3			185
Nov-82	3.53	451	7.5	2.2			135
Dec-82	3.64		8.9	3.9			118
Jan-83	3.59	366	5.9	1.4			130
Feb-83	3.65	431	4.1	0.8			124
Mar-83	3.78	350	3	1.2			92
Apr-83	3.98	290	4.4	2			81
May-83	3.68	357	2.7	0.7			103
Jun-83	3.66	607	3.7	1.5			128
Dec-83	4.16	500	2.7	2.2			148
Jan-84	3.85	466	4.2	2.1			108
Feb-84	4.12	326	2.4	1			66
Mar-84	4	323	2.5	1			79
Apr-84	4.05	321	0.3				71
May-84	3.92		4	1.2			102
Jun-84	3.87	354	3.9	1.7			101
Jul-84	3.85	398	3.5	1.1			106
Aug-84	3.82	453	3.7	1.2			114
Sep-84	3.63	391	4.2	1.2			123
Oct-84	3.41	447	6.1	1.2			218
Nov-84	3.6	762	5.3	1.5			160
Dec-84	3.69	322	4.4	2.2			128
Jan-85	3.62	396	4.3	1.4			138
Feb-85	3.83	242	4.6	1.3			96
Mar-85	3.72	339	3.6	1.2			108
Apr-85	3.61	359	3.9	1.8			109
May-85	3.75	373	3.5	1			113
Jun-85	3.89	353	2.6	1			98
Jul-85	3.66	384	4.4	1.3			122
Aug-85	3.75	376	4.8	1.7			109

Table H1. Jeddo Tunnel Outfall Water Quality Data (Monthly, 1978-90, 1995-98)—Continued

Sample Date	pH	Sulfate	Iron, Total	Iron, Ferrous	Manganese, Total	Aluminum, Total	Acidity, Total HOT
		mg/l					
Oct-85	3.68	472	4.2	0.7			104
Nov-85	3.93	312	3.4	1.2			94
Dec-85	3.94	422	3.9	1.3			108
Jan-86	4.07	314	3.4	1.2			93
Feb-86	3.89		1.7	1.4			136
Mar-86	3.95	406	2.6	1			113
Apr-86	4.1	282	2.35	0.86	3.64	9.9	66
May-86	4	307	5.02	1.2	4.44	12.1	80
Jun-86		457	19.51	1	6.31	20.08	106
Jul-86	3.8	600	22.89	1.86	7.12	24.01	124
Aug-86	3.8	553	13.78	2.3	0.14	21.08	148
Sep-86	3.6	592	13.2	2.7	7.85	20.82	122
Oct-86	3.7	476	18.28	2.7	7.44	22.25	140
Nov-86	3.8	402	6.94	1.8	6.4	15.47	134
Dec-86	3.9	300	5.09	2.6	5.46	11.5	110
Jan-87	3.6		2.5	0.4			160
Feb-87	3.7	415	1.75	0.44	4.85	26.48	120
Mar-87	3.9	385	3.34	1.2	5.42	12.46	104
Apr-87	4	339	7.66	0.79	4.92	15.06	88
May-87	3.7	403	6.88	1.5	5.58	15.2	102
Jun-87	3.7	485	28.6	1.5	6.91	24.79	116
Jul-87	3.8	529	5.94	1.8	7.87	17.47	128
Aug-87	3.7	441	11.61	2.9	7.17	20.04	126
Sep-87	4	465	6.32	1.7	6.17	21.65	122
Oct-87	3.8	487	4.67	1.8	7.3	17.71	124
Nov-87	4	386	4.45	0.85	5	12.75	94
Dec-87	4.1	393	3.17	0.87	5.48	13.8	128
Jan-88	3.9	427	38.2	2	5.65	23.41	104
Feb-88	4	369	3.78	1.2	5.27	12.72	88
Mar-88	3.9	375	17.05	0.11	5.29	19.4	126
Apr-88	3.9	355	13.78	1.1	5.15	17.28	110
May-88	4.21		1.4	0.7			156
Jun-88	4	424	4.26	1.2	6.34	14.78	104
Jul-88	4.3	428	4.27	1.5	4.91	11.96	82
Aug-88	4	520	4.22	1.6	7.11	15.85	114
Sep-88	4	535	4.54	2.3	7.21	16.28	110
Oct-88	3.9	484	4.92	1.7	7.13	14.77	102
Nov-88	3.9	362	4.54	3	5.1	11.42	94
Dec-88	3.9	250	4.67	1.5	6.8	15.49	96

Table H1. Jeddo Tunnel Outfall Water Quality Data (Monthly, 1978-90, 1995-98)—Continued

Sample Date	pH	Sulfate	Iron, Total	Iron, Ferrous	Manganese, Total	Aluminum, Total	Acidity, Total HOT
		mg/l					
Jan-89	4	363	6.75	2.2	5.67	14.44	104
Feb-89	4	362	4.44	1.8	5.25	12.96	94
Mar-89	4.1	286	5.94	1.4	4.19	11.75	70
Apr-89	3.77		1.7	1.4			166
May-89	4.2	364	4.26	1.7	4.83	12.9	80
Jun-89	4.4	343	3.93	2.4	4.3	10.5	78
Jul-89	4.3	380	3.13	0.72	6.36	14.5	94
Aug-89	4	572	4.38	1.4	7.32	17.3	122
Sep-89	4	510	5.56	5.5	7.21	17.7	112
Oct-89	4	436	18.1	2	6.01	22.1	116
Nov-89	3.9	354	4.35	1	5.61	15.9	96
Dec-89	4	439	3.61	0.74	6.2	16.6	96
Jan-90	4.3	271	9.66	1	3.5	10	70
Feb-90	4	359	18.3	0.77	4.53	22.9	98
Mar-90	4.2	344	35.6	0.85	4.28	16.9	70
Apr-90	4.1	378	7.71	0.67	5.26	13.7	86
May-90	4.3	369	4.93	1.3	4.96	14	82
Jun-90	4	362	4.77	0.55	5.84	16.1	78
Jul-90	4.1	445	9.34	0.65	5.35	14	100
Aug-90	4.1	421	23	2.1	4.84	18.9	100
Sep-90	4	417	79.4	2	6.95	33.5	106
Oct-90	4.3	337	4.92	1.9	4.91	11.06	70
Nov-90	4.2	314	15	1	5.49	14.4	86
Dec-90	4.5	299	2.64	1.3	3.68	8.35	72
Apr-95	4.3	293	21.2		4.86	22.7	78
May-95	4.4	344	11.4		4	14.9	76
Jun-95	4.2	287	11.7		4.44	15.7	74
Jul-95	4	303	37.6		4.58	24.7	78
Aug-95	3.9	343	68		5.09	44.4	98
Sep-95	3.9	345	4.91		5.82	12	100
Oct-95	3.8	461	9.17		6.34	15.1	104
Nov-95	4.2	354	12.7		4.9	14.4	88
Dec-95	4.4	250	4.55		4.78	11.3	78
Jan-96	4.2	365	3.53		5.1	12.2	90
Feb-96	4.6	427	2.89		3.89	10	74
Mar-96	4.4	344	2.84		3.63	9.06	72
Apr-96	4.5	286	6.36		3.62	9.23	84
May-96	4.5	284	3.65		3.57	8.59	72
Jun-96	4.3	295	9.42		4.56	13.5	82

Table H1. Jeddo Tunnel Outfall Water Quality Data (Monthly, 1978-90, 1995-98)—Continued

Sample Date	pH	Sulfate	Iron, Total	Iron, Ferrous	Manganese, Total	Aluminum, Total	Acidity, Total HOT
		mg/l					
Aug-96	4.3	265	7.83		4.92	10.9	92
Sep-96	4	314	25		5.11	21	104
Oct-96	4.2	360	14.4		5.25	16.9	94
Nov-96	4.5	296	29.5		4.34	22	70
Dec-96	4.6	240	6.92		2.75	8.32	50
Jan-97	4.7	251	3.84		3.83	9.46	50
Feb-97	5	95	1.13		1.33	3	38
Mar-97	4.4	213	2.98		3.71	8.77	62
Apr-97	4.5	177	2.74		3.43	7.56	58
May-97	4.5	258	2.49		4.12	8.53	76
Jun-97	4.3	251	2.72		3.69	8.04	62
Jul-97	4.3	260	5.95		5.05	12.4	76
Aug-97	4.2	178	7.3		5.3	12.2	86
Sep-97	4.7	311	3.93		4.76	11.1	66
Oct-97	4.2	239	3.09		5.05	11.3	96
Nov-97	4.3	325	4.52		4.94	10.8	80
Dec-97	4.2	227	3.49		4.06	9.02	74
Jan-98	4.2	218	3.22		3.67	8.4	72
May-98	4.7	226	2.24		2.9	6.62	48
Jun-98	4.7	308	2.340		3.890	8.79	64
Jul-98	4.5	266	2.71		4.09	8.92	70
Aug-98	4.3	269	3.16		4.5	11	68
Sep-98	4.4	344	7.8		4.34	9.32	

Data Source 05/78-12/90 provided by Pa. DEP BAMR
04/95-09/98 collected by Friends of Nescopeck, analyzed by Pa. DEP BMR

Table H2. Jeddo Tunnel Water Quality, Annual Average Concentrations, 1978-98

Calender Year	Specific Conductance	pH	Alkalinity	Total Solids, as Residue	Dissolved Solids, as Residue	Suspended Solids, Nonfilterable, as Residue	Calcium	Magnesium	Sodium
	µmhos/cm		mg/l						
1978	--	3.52	--	--	--	--	--	--	--
1979	--	3.67	--	--	--	--	--	--	--
1980	--	3.78	--	--	--	--	--	--	--
1981	--	3.66	--	--	--	--	--	--	--
1982	--	3.64	--	--	--	--	--	--	--
1983	--	3.79	--	--	--	--	--	--	--
1984	--	3.82	--	--	--	--	--	--	--
1985	--	3.78	--	--	--	--	--	--	--
1986	--	3.55	--	--	--	--	--	--	--
1987	--	3.83	--	--	--	--	--	--	--
1988	--	3.99	--	--	--	--	--	--	--
1989	--	4.06	--	--	--	--	--	--	--
1990	--	4.18	--	--	--	--	--	--	--
1995	785.71	4.16	6.33	1,074.27	854.23	221.95	37.06	50.65	9.67
1996	699.63	4.37	7.95	951.07	764.61	185.26	35.98	54.84	10.20
1997	697.14	4.39	8.25	789.37	764.10	26.76	34.39	55.44	12.21
1998	721.90	4.04	7.54	658.23	628.77	11.74	33.20	53.52	12.40

Calender Year	Potassium	Chloride	Sulfate	Iron	Manganese	Zinc	Aluminum	Total Acidity, Hot
	mg/l							
1978	--	--	410.13	5.49	--	--	--	222.75
1979	--	--	376.64	5.37	--	--	--	179.92
1980	--	--	436.33	4.21	--	--	--	136
1981	--	--	439.1	4.88	--	--	--	192.5
1982	--	--	415.73	6.06	--	--	--	151.33
1983	--	--	414.43	3.79	--	--	--	115.14
1984	--	--	414.82	3.71	--	--	--	114.67
1985		--	371.5	4.12	--	--	--	112
1986	--	--	426.27	9.56	5.42	--	17.47	114.33
1987	--	--	429.82	7.24	6.06	--	17.95	117.67
1988	--	--	411.73	8.8	6	--	15.76	107.17
1989	--	--	400.82	5.51	5.72	--	15.15	102.33
1990	--	--	359.67	17.94	4.97	--	16.15	84.83
1995	2.81	11.68	324.31	13.94	4.98	0.77	15.98	82.89
1996	2.54	12.12	286.58	12.86	4.22	0.70	13.16	73.36
1997	1.80	15.79	248.02	3.56	4.33	0.66	9.74	71.86
1998	1.59	16.18	260.39	3.05	3.87	0.59	8.61	59.82

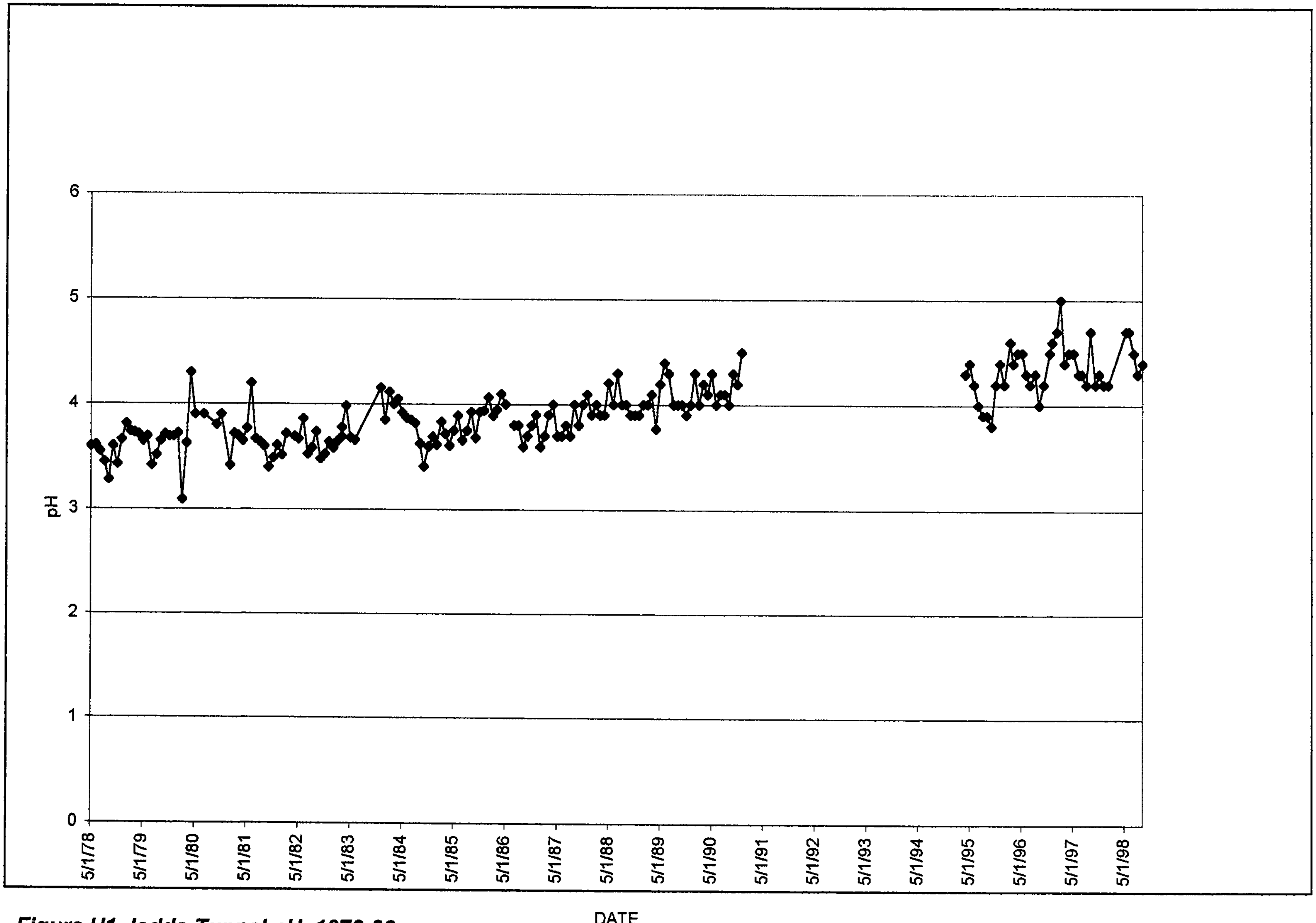

Figure H1. Jeddo Tunnel pH, 1978-98

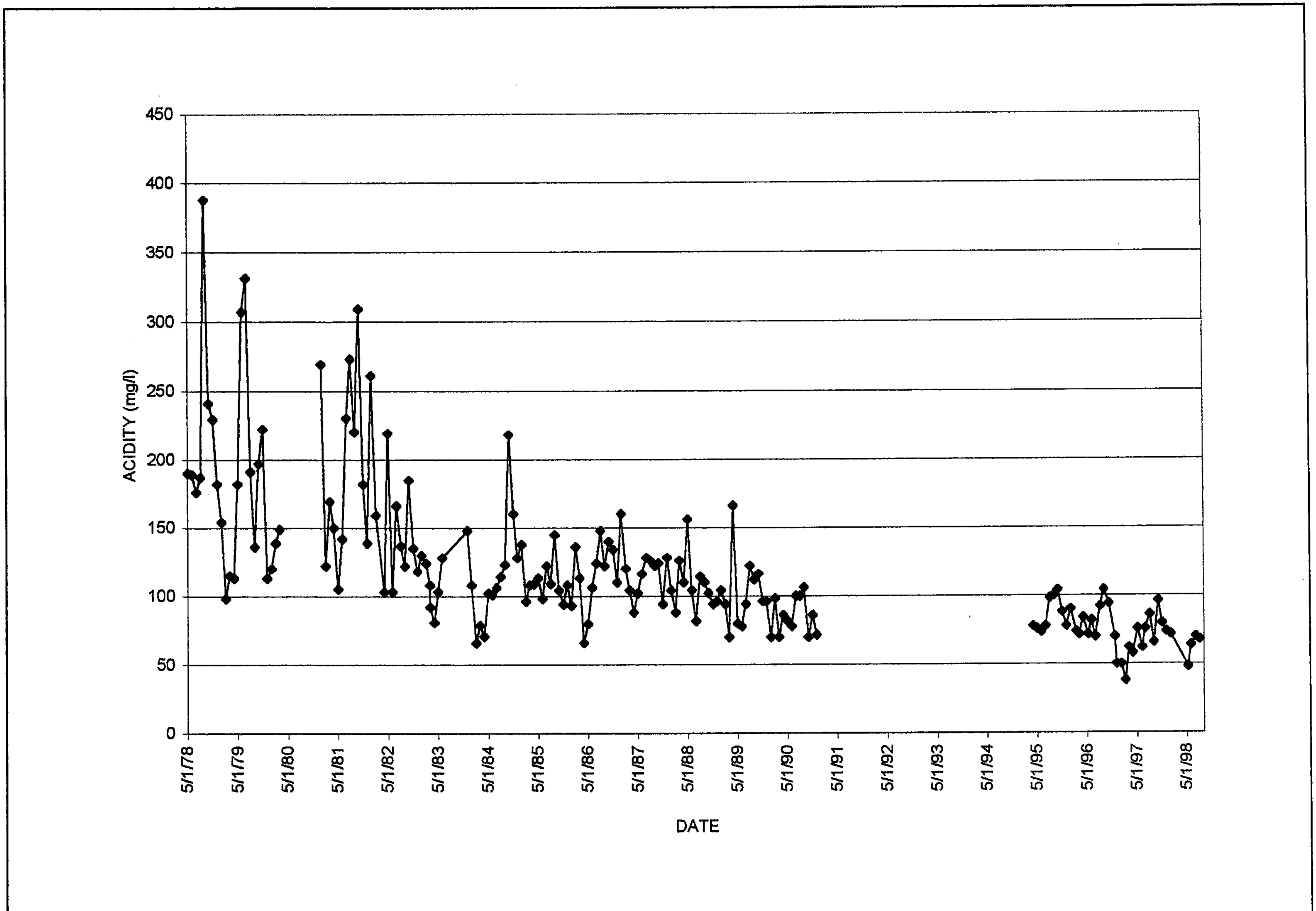

Figure H2. Jeddo Tunnel Acid Concentrations, 1978-98

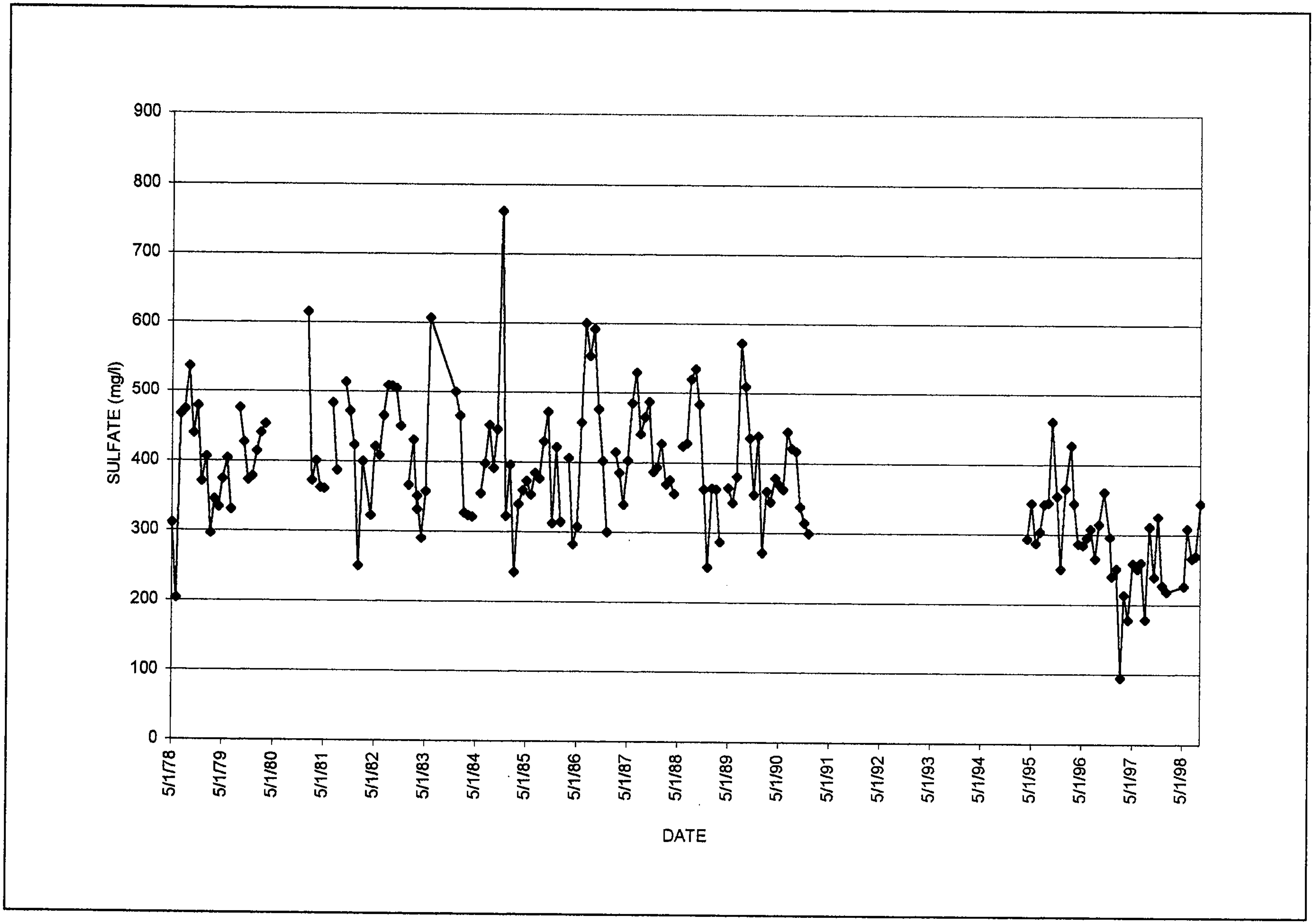

Figure H3. Jeddo Tunnel Sulfate Concentrations, 1978-98

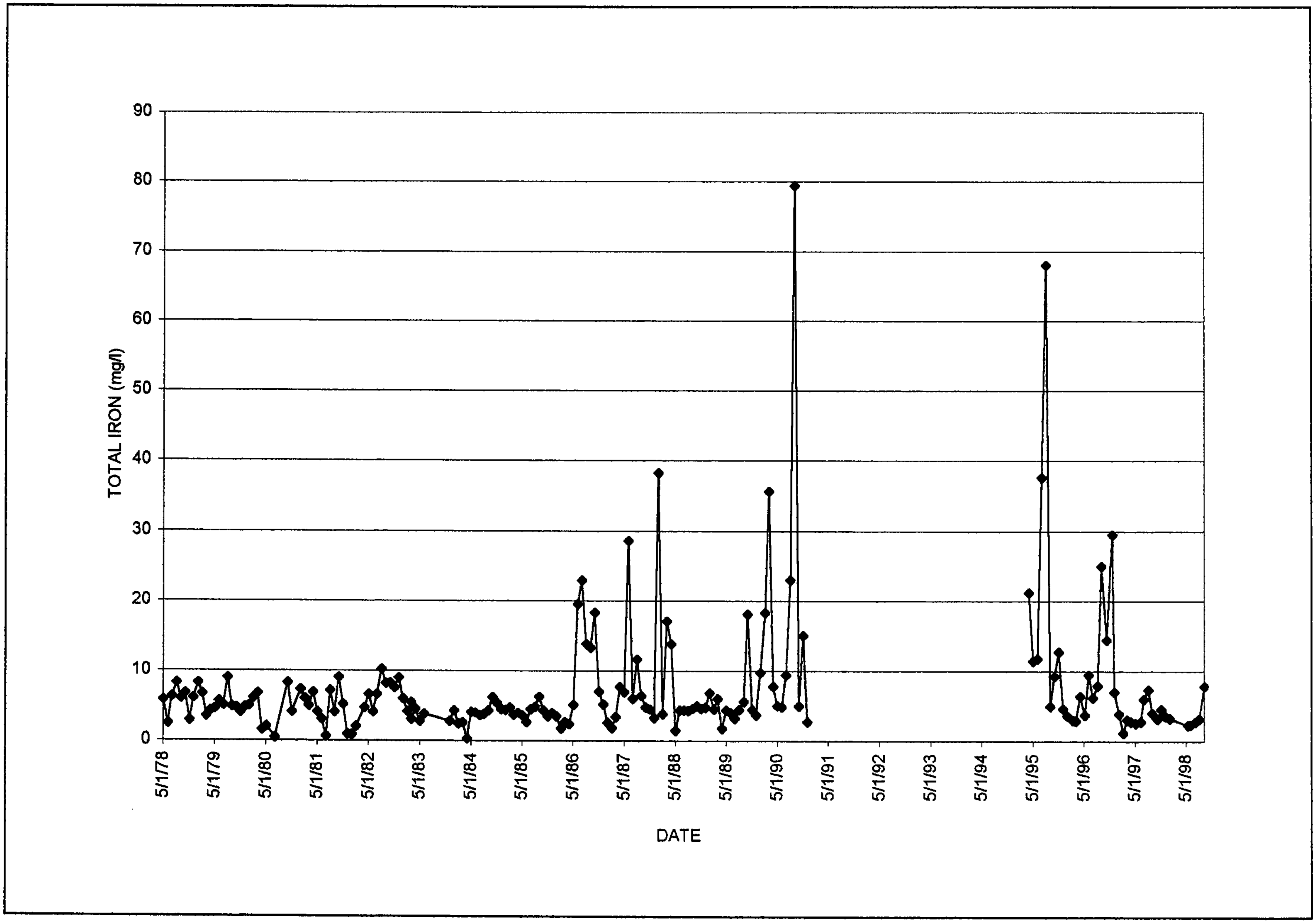

Figure H4. Jeddo Tunnel Total Iron Concentrations, 1978-98

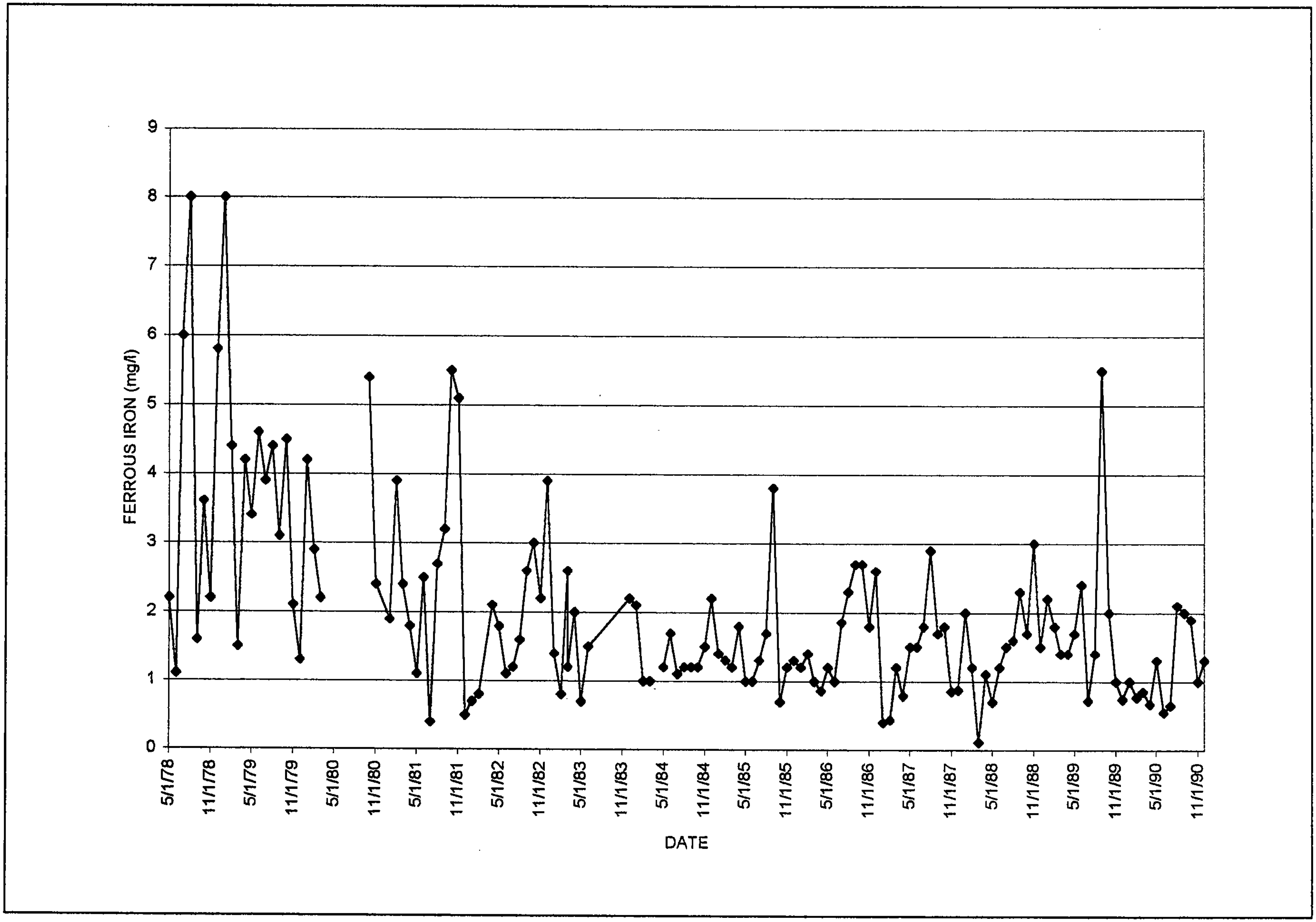

Figure H5. Jeddo Tunnel Ferrous Iron Concentrations, 1978-90

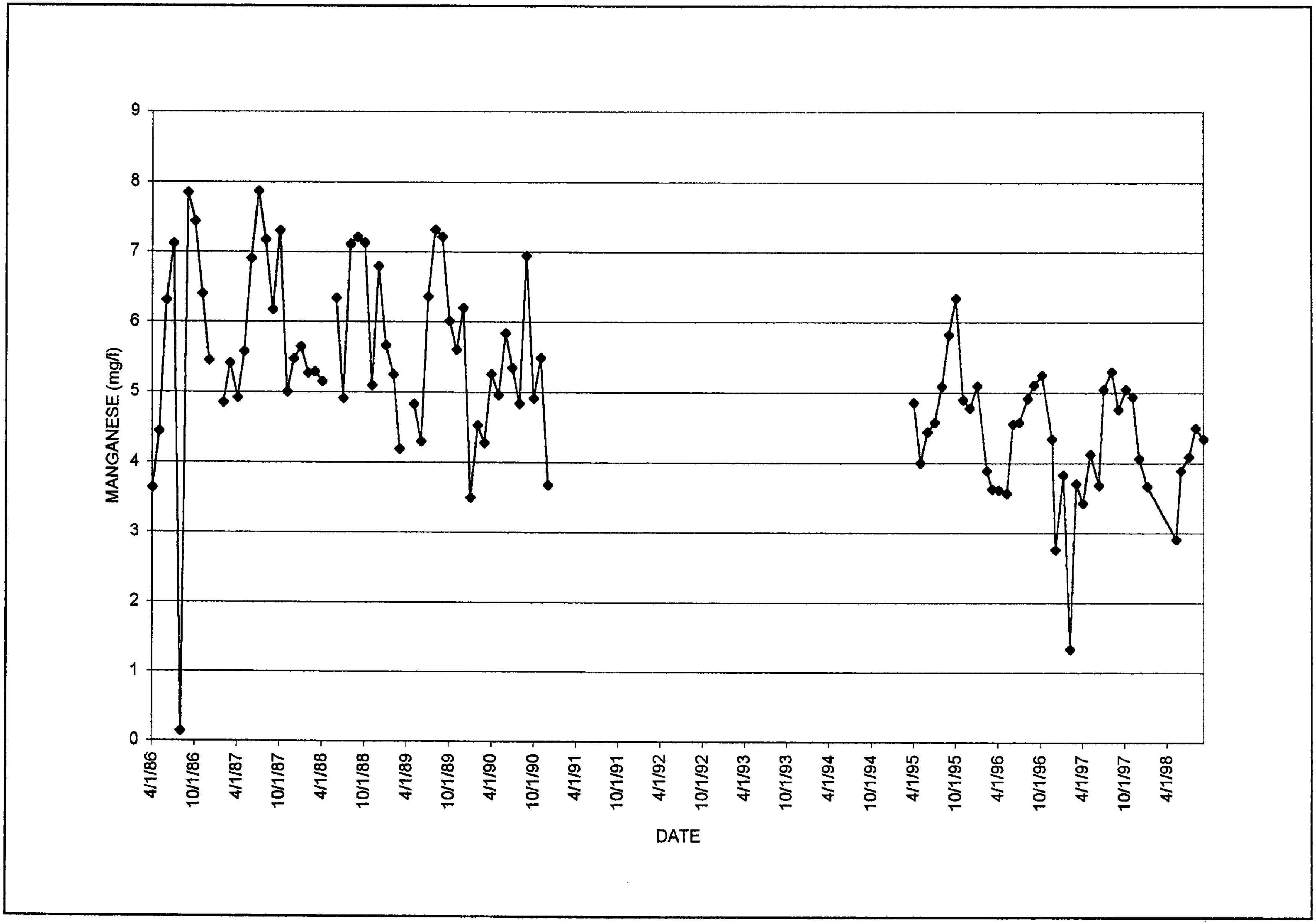

Figure H6. Jeddo Tunnel Manganese Concentrations, 1986-98

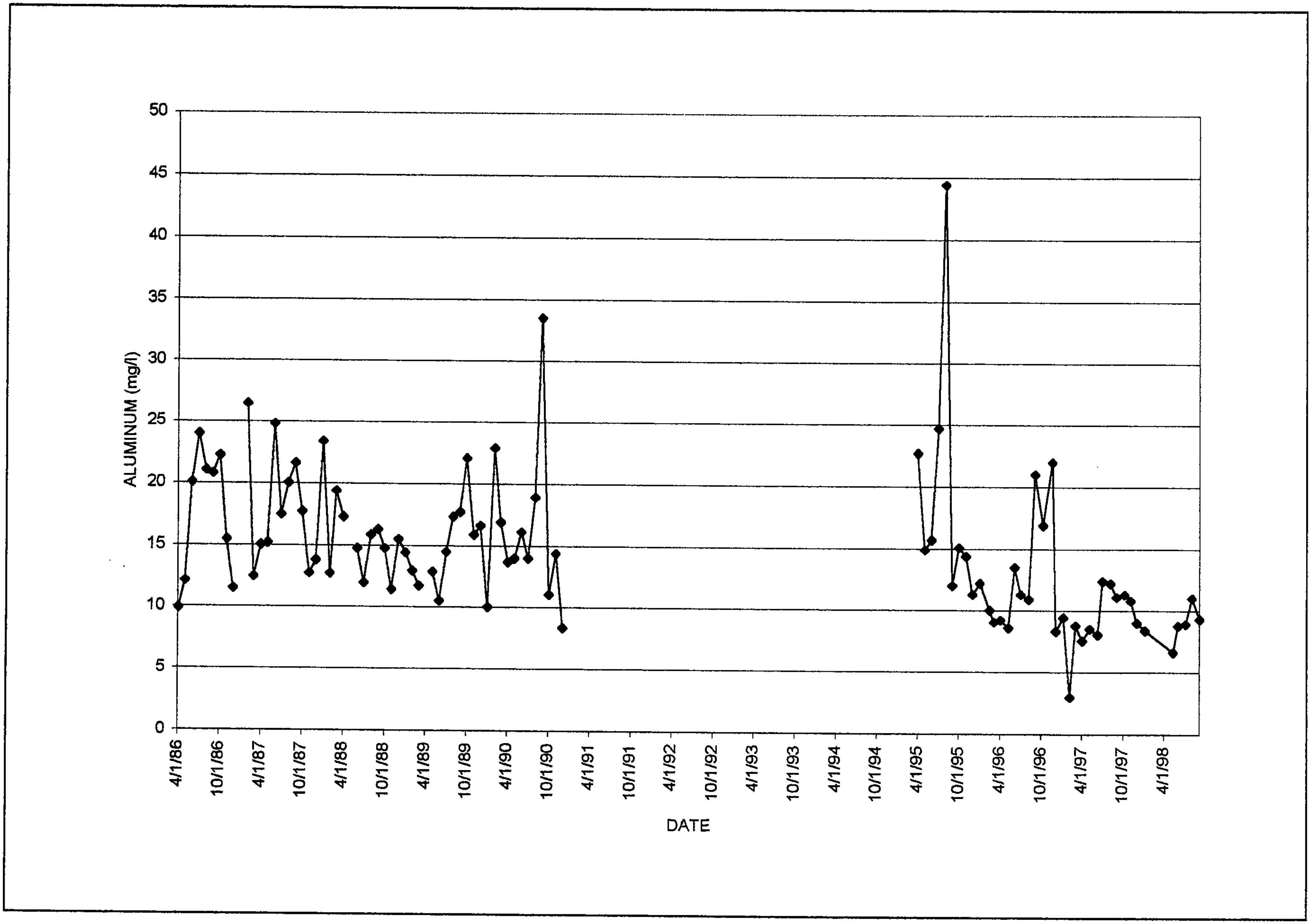

Figure H7. Jeddo Tunnel Aluminum Concentrations, 1986-98

APPENDIX I

ENVIRONMENTAL AGENCIES, PROGRAMS AND CONTACT INFORMATION

UNITED STATES DEPARTMENT OF AGRICULTURE (USDA) CONSERVATION PROGRAMS

While there are a variety of USDA programs available to assist people with their conservation needs, the following primary financial assistance programs are the principal programs available. Citizens and groups are encouraged to contact the State Offices of the appropriate agency for more specific information about each program.

Luzerne County NRCS
911 West Main Street
Plymouth, Pa. 18651-2799
570-779-0645, extension 3

Conservation Technical Assistance (CTA)

Contact: USDA, Natural Resources Conservation Service

The purpose of the program is to assist land-users, communities, units of state and local government, and other federal agencies in planning and implementing conservation systems. The purpose of the conservation systems are to reduce erosion, improve soil and water quality, improve and conserve wetlands, enhance fish and wildlife habitat, improve air quality, improve pasture and range condition, reduce upstream flooding, and improve woodlands.

Objectives of the program are to:

- Assist individual land users, communities, conservation districts, and other units of State and local government and Federal agencies to meet their goals for resource stewardship and assist individuals to comply with State and local requirements. NRCS assistance to individuals is provided through conservation districts in accordance with the memorandum of understanding signed by the Secretary of Agriculture, the governor of the state, and the conservation district. Assistance is provided to land users voluntarily applying conservation and to those who must comply with local or State laws and regulations.
- Assist agricultural producers to comply with the highly erodible land (HEL) and wetland (Swampbuster) provisions of the 1985 Food Security Act as amended by the Food, Agriculture, Conservation and Trade Act of 1990 (16 U.S.C. 3801 et. seq.) and the Federal Agriculture Improvement and Reform Act of 1996 and wetlands requirements of Section 404 of the Clean Water Act. NRCS makes HEL and wetland determinations and helps land users develop and implement conservation plans to comply with the law.

- Provide technical assistance to participants in USDA cost-share and conservation incentive programs. (Assistance is funded on a reimbursable basis from the CCC.)
- Collect, analyze, interpret, display, and disseminate information about the condition and trends of the Nation's soil and other natural resources so that people can make good decisions about resource use and about public policies for resource conservation.
- Develop effective science-based technologies for natural resource assessment, management, and conservation.

Conservation Farm Option (CFO)

Contact: USDA, Farm Service Agency or Natural Resources Conservation Service

The Conservation Farm Option is a pilot program for producers of wheat, feed grains, cotton, and rice. The program's purposes include conservation of soil, water, and related resources, water quality protection and improvement, wetland restoration, protection and creation, wildlife habitat development and protection, or other similar conservation purposes. Eligibility is limited to owners and producers who have contract acreage enrolled in the Agricultural Market Transition Act program, i.e. production flexibility contracts. The CFO is a voluntary program. Participants are required to develop and implement a conservation farm plan. The plan becomes part of the CFO contract which covers a ten year period. CFO is not restricted as to what measures may be included in the conservation plan, so long as they provide environmental benefits. During the contract period the owner or producer (1.) receives annual payments for implementing the CFO contract and (2.) agrees to forgo payments under the Conservation Reserve Program, the Wetlands Reserve Program, and the Environmental Quality Incentives Program in exchange for one consolidated payment.

Conservation of Private Grazing Land Initiative (CPGL)

Contact: USDA, Natural Resources Conservation Service

The Conservation of Private Grazing Land initiative will ensure that technical, educational, and related assistance is provided to those who own private grazing lands. It is not a cost share program. This technical assistance will offer opportunities for: better grazing land management; protecting soil from erosive wind and water; using more energy-efficient ways to produce food and fiber; conserving water; providing habitat for wildlife; sustaining forage and grazing plants; using plants to sequester greenhouse gases and increase soil organic matter; and using grazing lands as a source of biomass energy and raw materials for industrial products.

Conservation Plant Material Centers

Contact: USDA, Natural Resources Conservation Service

The purpose of the program is to provide native plants that can help solve natural resource problems. Beneficial uses for which plant material may be developed include biomass production, carbon sequestration, erosion reduction, wetland restoration, water quality improvement, streambank and riparian area protection, coastal dune stabilization, and other special conservation treatment needs. Scientists at the Plant Materials Centers seek out plants that show promise for meeting an identified conservation need and test their performance. After species are proven, they are released to the private sector for commercial production. The work at the 26 centers is carried out cooperatively with state and Federal agencies, commercial businesses, and seed and nursery associations.

Conservation Reserve Program (CRP)

Contact: USDA, Farm Service Agency

The Conservation Reserve Program reduces soil erosion, protects the Nation's ability to produce food and fiber, reduces sedimentation in streams and lakes, improves water quality, establishes wildlife habitat, and enhances forest and wetland resources. It encourages farmers to convert highly erodible cropland or other environmentally sensitive acreage to vegetative cover, such as tame or native grasses, wildlife plantings, trees, filterstrips, or riparian buffers. Farmers receive an annual rental payment for the term of the multi-year contract. Cost sharing is provided to establish the vegetative cover practices.

Environmental Quality Incentives Program (EQIP)

Contact: USDA, Natural Resources Conservation Service

The Environmental Quality Incentives Program provides technical, educational, and financial assistance to eligible farmers and ranchers to address soil, water, and related natural resource concerns on their lands in an environmentally beneficial and cost-effective manner. The program provides assistance to farmers and ranchers in complying with Federal, State, and tribal environmental laws, and encourages environmental enhancement. The program is funded through the Commodity Credit Corporation. The purposes of the program are achieved through the implementation of a conservation plan that includes structural, vegetative, and land management practices on eligible land. Five- to ten-year contracts are made with eligible producers. Cost-share payments may be made to implement one or more eligible structural or vegetative practices, such as animal waste management facilities, terraces, filter strips, tree planting, and permanent wildlife habitat. Incentive payments can be made to implement one or more land management practices, such as nutrient management, pest management, and grazing land management.

Fifty percent of the funding available for the program will be targeted at natural resource concerns relating to livestock production. The program is carried-out primarily in priority areas that may be watersheds, regions, or multi-state areas, and for significant statewide natural resource concerns that are outside of geographic priority areas.

Soil Survey Programs

Contact: USDA, Natural Resources Conservation Service

The National Cooperative Soil Survey Program (NCSS) is a partnership led by NRCS of Federal land management agencies, state agricultural experiment stations and state and local units of government that provide soil survey information necessary for understanding, managing, conserving and sustaining the nation's limited soil resources.

Soil surveys provide an orderly, on-the-ground, scientific inventory of soil resources that includes maps showing the locations and extent of soils, data about the physical and chemical properties of those soils, and information derived from that data about potentialities and problems of use on each kind of soil in sufficient detail to meet all reasonable needs for farmers, agricultural technicians, community planners, engineers, and scientists in planning and transferring the findings of research and experience to specific land areas. Soil surveys provide the basic information needed to manage soil sustainably. They also provide information needed to protect water quality, wetlands, and wildlife habitat. Soil surveys are the basis for predicting the behavior of a soil under alternative uses, its potential erosion hazard, potential for ground water contamination, suitability and productivity for cultivated crops, trees, and grasses. Soil surveys are important to planners, engineers, zoning commissions, tax commissioners, homeowners, developers, as well as agricultural producers. Soil surveys also provide a basis to help predict the effect of global climate change on worldwide agricultural production and other land-dependent processes. The NRCS Soil Survey Division through its World Soil Resources Staff helps gather and interpret soil information for global use.

NRCS provides the soil surveys for the privately owned lands of the nation and, through its National Soil Survey Center, provides scientific expertise to enable the NCSS to develop and maintain a uniform system for mapping and assessing soil resources so that soil information from different locations can be shared, regardless of which agency collects it. NRCS provides most of the training in soil survey to Federal agencies and assists other Federal agencies with their soil inventories on a reimbursable basis. NRCS is also responsible for developing the standards and mechanisms for providing digital soil information for the national spatial data infrastructure required by Executive Order 12906.

Farmland Protection Program (FPP)

Contact: USDA, Natural Resources Conservation Service

The Farmland Protection Program provides funds to help purchase development rights to keep productive farmland in agricultural uses. Working through existing programs, USDA joins with State, tribal, or local governments to acquire conservation easements or other interests from landowners. USDA provides up to 50 percent of the fair market easement value. To qualify, farmland must: be part of a pending offer from a State, tribe, or local farmland protection program; be privately owned; have a conservation plan; be large enough to sustain agricultural production; be accessible to markets for what the land produces; have adequate infrastructure and agricultural support services; and have surrounding parcels of land that can support long-term agricultural production. Depending on funding availability, proposals must be submitted by the government entities to the appropriate NRCS State Office during the application window.

Emergency Watershed Protection (EWP)

Contact: USDA, Natural Resources Conservation Service

The purpose of the Emergency Watershed Protection program is to undertake emergency measures, including the purchase of flood plain easements, for runoff retardation and soil erosion prevention to safeguard lives and property from floods, drought, and the products of erosion on any watershed whenever fire, flood or any other natural occurrence is causing or has caused a sudden impairment of the watershed.

It is not necessary for a national emergency to be declared for an area to be eligible for assistance. Program objective is to assist sponsors and individuals in implementing emergency measures to relieve imminent hazards to life and property created by a natural disaster. Activities include providing financial and technical assistance to remove debris from streams, protect destabilized streambanks, establish cover on critically eroding lands, repairing conservation practices, and the purchase of flood plain easements. The program is designed for installation of recovery measures.

Flood Risk Reduction Program (FRR)

Contact: USDA, Farm Service Agency

The Flood Risk Reduction Program was established to allow farmers who voluntarily enter into contracts to receive payments on lands with high flood potential. In return, participants agree to forego certain USDA program benefits. These contract payments provide incentives to move farming operations from frequently flooded land.

Forestry Incentives Program (FIP)

Contact: USDA, Natural Resources Conservation Service

The Forestry Incentives Program (FIP) supports good forest management practices on privately owned, non-industrial forestlands nationwide. FIP is designed to benefit the environment while meeting future demands for wood products. Eligible practices are tree planting, timber stand improvement, site preparation for natural regeneration, and other related activities. FIP is available in counties designated by a Forest Service survey of eligible private timber acreage.

Watershed Surveys and Planning

Contact: USDA, Natural Resources Conservation Service

The Watershed and Flood Prevention Act, P.L. 83-566, August 4, 1954, (16 U.S.C. 1001-1008) authorized this program. Prior to fiscal year 1996, small watershed planning activities and the cooperative river basin surveys and investigations authorized by Section 6 of the Act were operated as separate programs. The 1996 appropriations act combined the activities into a single program entitled the Watershed Surveys and Planning program. Activities under both programs are continuing under this authority.

The purpose of the program is to assist Federal, State, and local agencies and tribal governments to protect watersheds from damage caused by erosion, floodwater, and sediment and to conserve and develop water and land resources. Resource concerns addressed by the program include water quality, opportunities for water conservation, wetland and water storage capacity, agricultural drought problems, rural development, municipal and industrial water needs, upstream flood damages, and water needs for fish, wildlife, and forest-based industries.

Types of surveys and plans include watershed plans, river basin surveys and studies, flood hazard analyses, and flood plain management assistance. The focus of these plans is to identify solutions that use land treatment and nonstructural measures to solve resource problems.

Resource Conservation & Development Program (RC&D)

Contact: USDA, Natural Resources Conservation Service

The purpose of the Resource Conservation and Development (RC&D) program is to accelerate the conservation, development and utilization of natural resources, improve the general level of economic activity, and to enhance the environment and standard of living in authorized RC&D areas. It improves the capability of State, tribal and local units of government and local nonprofit organizations in rural areas to plan, develop and carry out programs for resource conservation and development. The program also establishes or improves coordination systems in rural areas. Current program objectives focus on improvement of quality of life achieved through natural resources conservation and community development which leads to sustainable communities, prudent use (development), and the management and conservation of natural resources. Authorized RC&D areas are locally sponsored areas designated by the Secretary of Agriculture for RC&D technical and financial assistance program funds. NRCS can provide grants for land conservation, water management, community development, and environmental needs in authorized RC&D areas.

Stewardship Incentives Program (SIP)

Contact: USDA, Forest Service

The Stewardship Incentive Program provides technical and financial assistance to encourage non-industrial private forest landowners to keep their lands and natural resources productive and healthy. Qualifying land includes rural lands with existing tree cover or land suitable for growing trees and which is owned by a private individual, group, association, corporation, Indian tribe, or other legal private entity. Eligible landowners must have an approved Forest Stewardship Plan and own 1,000 or fewer acres of qualifying land. Authorizations may be obtained for exceptions of up to 5,000 acres.

Watersheds Operations --Small Watershed Program and Flood Prevention Program (WF 08 or FP 03)

Contact: USDA, Natural Resources Conservation Service

The Small Watershed Program works through local government sponsors and helps participants solve natural resource and related economic problems on a watershed basis. Projects include watershed protection, flood prevention, erosion and sediment control, water supply, water quality, fish and wildlife habitat enhancement, wetlands creation and restoration, and public recreation in watersheds of 250,000 or fewer acres. Both technical and financial assistance are available.

Wetlands Reserve Program (WRP)

Contact: USDA, Natural Resources Conservation Service

The Wetlands Reserve Program is a voluntary program to restore wetlands. Participating landowners can establish conservation easements of either permanent or 30-year duration, or can enter into restoration cost-share agreements where no easement is involved. In exchange for establishing a permanent easement, the landowner receives payment up to the agricultural value of the land and 100 percent of the restoration costs for restoring the wetlands The 30-year easement payment is 75 percent of what would be provided for a permanent easement on the same site and 75 percent of the restoration cost. The voluntary agreements are for a minimum 10-year duration and provide for 75 percent of the cost of restoring the involved wetlands. Easements and restoration cost-share agreements establish wetland protection and restoration as the primary land use for the duration of the easement or agreement. In all instances, landowners continue to control access to their land.

Wildlife Habitat Incentives Program (WHIP)

Contact: USDA, Natural Resources Conservation Service

The Wildlife Habitat Incentives Program provides financial incentives to develop habitat for fish and wildlife on private lands. Participants agree to implement a wildlife habitat development plan and USDA agrees to provide cost-share assistance for the initial implementation of wildlife habitat development practices. USDA and program participants enter into a cost-share agreement for wildlife habitat development. This agreement generally lasts a minimum of 10 years from the date that the contract is signed.

Note: More information about these programs are available from staff at the State Office of NRCS and FSA as appropriate.

STREAMBANK FENCING

3 PROGRAMS MAKE FENCING EASIER AND MORE AFFORDABLE

U.S. Fish and Wildlife Streambank Fencing Project

- U. S. Fish and Wildlife will provide wooden fence posts and two strands of wire
- Farmer must install fencing
- Streambank corridor must include a 15-foot buffer on each side of the stream

Ducks Unlimited

- Ducks Unlimited will hire a fencing company to install fencing
- Farmer does not need to do any work with the installation
- Fencing includes wooden fence posts and up to two strands of wire
- Streambank corridor must include a 15-foot buffer on each side of the stream
- Farmer can earn credits toward other BMPs for giving more than a 30-foot buffer
- Ducks Unlimited will provide trees and shrubs for the buffer, if so desired
- Completely private funding

Conservation Reserve Program

- CRP will provide 50% cost-share and 40% incentive payment for the installation of streambank fencing
- Fencing must be double-strand electric
- Streambank corridor must include a 35-foot buffer on each side of the stream
- Farmer will receive annual payment for loss of pasture and an annual maintenance payment
- Cost-share can include crossings and/or alternative water source for animals
- Cost-share for installation of trees and shrubs

⇒ *These programs can partner with each other to provide optimum incentive for streambank fencing.*

⇒ *For more information, contact the Luzerne County Natural Resources Conservation Service at(570) 779-0645, extension 3.*

PA NUTRIENT MANAGEMENT PROGRAM

FUNDING AVAILABLE TO PRODUCERS FOR NUTRIENT MANAGEMENT

Plan Development Incentive Program

- Provides 75% cost-share for the development of a Nutrient Management Plan
- Cost-share available for plans written by farmers or commercial specialists

Nutrient Management Plan Implementation Grant Program

- Provides grants that will cost-share up to 80% or $75,000 towards the installation of any Best Management Practices (BMPs) listed in an approved Nutrient Management Plan
- Some BMPs include rain spouting, barnyard heavy-use protection, diversions, waterways, barnyard curbing and manure storage (contact the NRCS for a more detailed list)
- Applicant must show a financial distress in order to be eligible for a grant
- Applicant must be an agricultural operation in existence on or before October 1, 1997
- Can be partnered with other programs

AgiLink

- Provides low-interest loans to implement BMPs that are part of an approved Nutrient Management Plan
- Can be partnered with other programs

⇒ *These programs can partner with each other to provide maximum financial assistance.*

⇒ *For more information, contact Luzerne County Natural Resources Conservation Service at (570)779-0645, extension 3.*

SOURCES OF INFORMATION PERTAINING TO FARMLAND AND OPEN SPACE PRESERVATION

Wildlands Conservancy
Land Preservation Program
3701 Orchid Place
Emmaus, Pa. 18049-1637
610-965-4397

Bureau of Farmland Protection
Room 404
Agriculture Building
2301 North Cameron Street
Harrisburg, Pa. 17110-9408
717-783-3167

Land Trust Alliance
1319 F Street NW, Suite 501
Washington, DC 20004-1106
202-638-4725

PENNSYLVANIA ENVIRONMENTAL FUNDING INFORMATION

Pennsylvania Department of Environmental Protection
Growing Greener Grants Center
9th Floor, Rachel Carson State Office Building
400 Market Street
P.O. Box 2063
Harrisburg, Pa. 17105-2063
717-705-5400 or 1-877-PAGREEN
Email: GrowingGreener@dep.state.pa.us

Department of Environmental Protection
Bureau of Water Quality Protection, Waterways, Wetlands and Erosion Control
P.O. Box 8554
Harrisburg, Pa. 17105-8554
717-787-2666

Department of Environmental Protection
Chief, Nonpoint Source Management Section
Bureau of Watershed Conservation
10th Floor, RCSOB
P.O. Box 8555
Harrisburg, Pa. 17105-8555
717-772-5629

Department of Conservation and Natural Resources
Bureau of Recreation and Conservation
Rachel Carson State Office Building
P.O. Box 8475
Harrisburg, Pennsylvania 17105-8475
(717) 783-4734

Rails-to-Trails Contact: (717) 772-3704
Rivers Conservation Grant Contact: (717) 787-2316
Land Trust Grants Contact: (717) 783-2663

Pennsylvania Recreational Trails Program
P.O. Box 8475
Harrisburg, Pa. 17105-8475
(717) 783-2654

Luzerne County Conservation District
Smith Pond Road
P.O. Box 250
Lehman, Pa. 18627-0250
717-674-7991

Luzerne County Natural Resources Conservation Service
991 West Main Street
Plymouth, Pa. 18651-2799
570-779-0645

SOURCES OF INFORMATION PERTAINING TO HISTORIC PRESERVATION

Pennsylvania Historic and Museum Commission
Pennsylvania Historical and Museum Commission
P.O. Box 1026
Harrisburg, PA 17108-1026
717-787-3362
Grants Information: 787-4363
Historical Markers: 787-3034
Historic Preservation: 783-8946
Historic Sites and Museums: 787-2723
National Register of Historic Places: 783-8946

Preservation Pennsylvania
257 North Street
Harrisburg, Pa. 17101
717-234-2310
Email: preservationpa.org

Wyoming Historical and Geological Society
49 South Franklin Street
Wilkes-Barre, Pa. 18701
570-823-6244

ABANDONED MINE DRAINAGE PROGRAMS

The following are brief descriptions of some of the programs involved in Abandoned Mine Drainage abatement and restoration. More information can be obtained through the Pennsylvania Department of Environmental Protection, BMAR and BMR.

REGIONAL WATERSHED SUPPORT INITIATIVE

PURPOSE: **To support the development of watershed groups whose primary focus is acid mine drainage abatement and abandoned mine land reclamation**

Summary: The Regional Watershed Support Initiative provides financial support for the formation and activities of watershed groups whose primary focus is acid mine drainage abatement and abandoned mine reclamation. These activities will be accomplished by awarding $50,000 each to the Eastern and Western Pennsylvania Coalitions for Abandoned Mine Reclamation, who will select and subcontract with volunteer watershed groups.

Volunteer groups will be able to use the funds for:
- Legal fees associated with incorporating the watershed group
- Public meetings and associated facility rental costs
- Development and distribution of promotional and public information, such as newsletters and fact sheets
- Support equipment, such as office supplies and computers
- Collection of baseline data on the impacted streams and abandoned mine features within the designated watershed; and
- Implementation of reclamation and acid mine drainage abatement projects.

Stakeholders: All individuals or watershed groups involved with acid mine drainage abatement and abandoned mine reclamation.

Benefit: Increased local and volunteer involvement with mine drainage pollution abatement and reclamation activities.

Cost: The Eastern and Western Pennsylvania Coalitions for Abandoned Mine Reclamation were awarded $50,000 each in fiscal year 1998-1999 from General Fund appropriations. Both groups were issued another $50,000 in fiscal year 1999-2000.

Status: The Eastern and Western Coalitions are actively recruiting watershed groups and expanding funds for existing groups with the money from the General Fund. Summary reports from both groups identifying accomplishments were received in October 1999. The passage of Growing Greener provides a mechanism for the continued funding of this initiative.

Contact: Lou DiLissio
Bureau of Mining and Reclamation
717-787-7007

SENIOR ENVIRONMENTAL CORPS

PURPOSE: **To utilize Pennsylvania's senior citizens' environmental ethic, expertise and commitment to help achieve reclamation goals**

Summary: The Pennsylvania Senior Environment Corps (PaSEC), sponsored by the national non-profit Environmental Alliance for Senior Involvement (EASI), DEP and the Pennsylvania Department of Aging, offers opportunities to the Commonwealth's senior and retired population to participate in real environmental improvements in their own communities. Individual PaSEC sites are sponsored by area agencies on aging, senior centers, local Retired Senior Volunteer Program (RSVP) chapters or other senior service providers. The PaSEC forms an umbrella providing a valuable resource to augment the Commonwealth's abandoned mine reclamation and well plugging efforts.

The Abandoned Mine Reclamation Project of the PaSEC established a partnership with the Eastern and Western Pennsylvania Coalitions for Abandoned Mine Reclamation and DEP's Office of Mineral Resources Management to assist in water monitoring, outreach, education and other reclamation support efforts. DEP's Mineral Resources Management staff will support, facilitate and participate in this partnership.

Stakeholders: PaSEC, the Eastern and Western Coalitions for Abandoned Mine Reclamation, DEP Office of Mineral Resources Management, watershed and environmental groups

Benefit: Increased data collection and analysis, information transfer, public education and outreach, as well as reclamation, well plugging and water pollution abatement.

Cost: Staff resources to facilitate program establishment and financial support (initially $40,000) for equipment, volunteer training and computer and printing costs.

Status: Initial planning meetings between PaSEC, EASI, DEP and the Eastern and Western Coalitions for Abandoned Mine Reclamation were held to generate agreement on the scope of the program, the roles of interested parties and the funding arrangements. The initial contract was executed on Feb. 1, 1999, with a projected completion date of June 30, 2000.

Contact: Christopher Allen
DEP Public Participation Coordinator
717-783-7404

WATERSHED RESTORATION AND PARTNERSHIP ACT

PURPOSE: **To establish a mechanism for DEP to provide funding to volunteer groups for acid mine drainage remediation**

Summary: This legislation, House Bill 867, establishes a program whereby DEP can provide funding to volunteer organizations for acid mine drainage cleanup efforts.

The bill allows funding for six types of activities:

- Watershed group start-up costs
- Watershed surveys
- Development of watershed restoration plans
- Implementation of part or all of watershed restoration plan through projects
- Acid mine drainage demonstration projects using green technologies
- Matching federal, state or local funding sources

The bill also establishes a seven-member review committee to review funding proposals and make recommendations to DEP regarding proposal funding and prioritization.

Stakeholders: All volunteer organizations involved with acid mine drainage remediation efforts

Benefit: Increased involvement by volunteer organizations in acid mine drainage remediation, expanded partnering opportunities and the establishment of a multi-interest project review committee.

Cost: No new funding is provided with the legislation. Minimal staff resources are needed to further develop and implement the program.

Status: Original draft legislation (House Bill 2611) introduced May 11, 1998, but no action was taken during that legislative session. Present draft legislation (House Bill 867) was reintroduced on March 10, 1999, and no action was taken during that legislative session.

Contact:
Hobart (Bud) Baker
Bureau of Mining and Reclamation
717-783-9579

NEW FUNDING SOURCES

PURPOSE: **To develop new sources to fund reclamation and well plugging projects**

Summary: Pennsylvania's total abandoned mineral extraction legacy is estimated at $15 billion. The Commonwealth's high priority abandoned mine features in OSM's inventory encompass approximately 1,600 problem areas and carry a current total unfunded reclamation cost of nearly $1 billion. DEP's intent is to evaluate new sources of funding that are not tax-based to support the reclamation programs and accelerate reclamation activities.

New or expanded state and federal funding sources:

- Growing Greener
- Extension of OSM abandoned mine land fee collections beyond Sept. 30, 2004
- Federal Land and Water Conservation Fund
- Annual General Fund appropriation similar to the Operation Restore Program for bond forfeiture sites
- Mine Stabilization Insurance Fund
- Fly ash for beneficial use

Stakeholders: OSM, Congress, Pennsylvania state legislature, governor's office, general public, sportsmen's groups, coal industry, Pennsylvania Coal Association and other industry groups and property owners

Benefit: The benefits are varied, based on individual proposals. Approximately 100 to 200 acres of additional reclamation could be achieved for each $1 million made available through new funding.

Cost: The costs are varied, based on individual proposal. Minimal to moderate staff resources are needed to further develop the individual proposals.

Status: The passage of Growing Greener has provided an unprecedented boost to reclamation efforts in Pennsylvania. Funding for abandoned mine reclamation and abandoned well plugging projects are included in the nearly $650 million over five years made possible through Growing Greener. Other funding sources have been investigated to determine their actual worth and feasibility, and fiscal review of the proposals is underway.

Contact: Toni Malach
Bureau of Abandoned Mine Reclamation
717-783-5881

ACCESS TO ABANDONED MINE RECLAMATION TRUST FUND

PURPOSE:	**To secure increased funding from the federal Abandoned Mine Reclamation (AMR) Trust Fund**
Summary:	The federal AMR Trust Fund currently has an unappropriated balance of more than $1.4 billion. This money should be made available to the states for abandoned mine reclamation, as provided in the federal Surface Mining Control and Reclamation Act. The management plan prepared by the National Association of Abandoned Mine Land Programs (NAAMLP) and the Interstate Mining Compact Commission (IMCC) is an appropriate mechanism for Congress to adopt to effectively utilize the AMR Trust Fund. Pennsylvania, as well as the other states and Indian tribes, must obtain broad support for the management plan to convince Congress to adopt it.
Stakeholders:	OSM, IMCC, states and tribes with abandoned mine programs, Congress, Pennsylvania Governor's Office
Benefit:	Increased funds to states and tribes with abandoned mine programs, using the more than $1.4 billion balance
Cost:	None, other than minimal staff resources to continue efforts to pursue access to the AMR Trust Fund.
Status:	The NAAMLP discussed the AMR Trust Fund management plan with federal House and Senate staffers in May 1997, and a congressional hearing on the abandoned mine program was suggested. West Virginia Governor Cecil Underwood sent letters in September 1997 to the governors of the other coal-producing state encouraging their involvement and suggesting that they write to their individual representatives in Congress. In 1998, a number of letters, resolutions and endorsements in support of greater access to the AMR Trust Fund were sent to Congress and the president. The 2000 federal budget includes a $10.5 million increase for state abandoned mine land program grants. There are no quick and easy implementation mechanisms for this initiative, and Pennsylvania cannot make it happen alone. The Commonwealth must continue to build coalitions at the national level with support from state groups.
Contact:	Bud Friedrich Bureau of Abandoned Mine Reclamation 717-783-0378

PENNSYLVANIA'S COMPREHENSIVE PLAN FOR ABANDONED MINE RECLAMATION

PURPOSE:	**To confront abandoned mine lands on a watershed basis**
Summary:	Necessary actions to implement and expand Pennsylvania's Comprehensive Plan for Abandoned Mine Reclamation (CPAMR) are being identified and developed. This planning tool will help DEP and other program agencies maximize the positive effects of reclamation activities by evaluating the impacts on an areal basis. The emphasis is placed on identifying all of the pollution sources and reclamation needs in a watershed and planning the work so that the most beneficial projects are implemented first. Comprehensive planning on a watershed basis should involve all agencies and interest groups from the onset to facilitate coordination and cooperation. DEP efforts are being concentrated in conveying the existence of the plan, developing partnerships to maximize the impacts and developing a watershed rehabilitation plan format that is universally accepted.
Stakeholders:	Eastern and Western Pennsylvania Coalitions for Abandoned Mine Reclamation, watershed and environmental groups, Natural Resources Conservation Service, OSM, EPA, the Army Corps of Engineers, Pennsylvania Department of Conservation and Natural Resources, U.S. Geologic Survey and various DEP bureaus
Benefit:	A comprehensive approach to mineral extraction reclamation that will maximize beneficial projects
Cost:	Annual funding (amount to be determined) is needed for the Eastern and Western Pennsylvania Coalitions for Abandoned Mine Reclamation. Significant staff resources are needed to implement and build support.
Status:	The CPAMR was designed and adopted by DEP in June 1997 and updated in June 1998. DEP must continue discussions with other government agencies to solicit their support for managing reclamation on an areal basis and also encourage DEP personnel to support local groups in developing Comprehensive Reclamation Plans that consider all pollution sources in the chosen watershed. DEP staff has met with watershed groups to explain the fundamentals of the CPAMR. Efforts to redirect EPA 104(b)(3) watershed grants toward the development of rehabilitation plans have been successful.
Contact:	Bud Friedrich Bureau of Abandoned Mine Reclamation 717-783-0378

BEST MANAGEMENT PRACTICE PERMITS

PURPOSE: **To develop a watershed approach to water quality improvement through remining**

Summary: This initiative involves operator liability for pre-existing discharges encountered during remining operations. Current Subchapters F and G regulations of the Commonwealth's coal mining regulations require establishing numerical baselines for pre-existing discharge quality and extensive monitoring to determine any changes during and after mining. Operators assume perpetual liability for treatment of any pollution increase in the discharge related to quality or quantity during remining. This potential liability has inhibited the willingness of operators to remine sites with pre-existing discharges, even though the coal industry has a strong track record of remining without negative discharge impacts.

This proposal will provide an option to the Subchapters F and G discharge numerical baseline and operator monitoring requirements with a series of Best Management Practices (BMP) that must be incorporated into remining operations with pre-existing discharges.

Stakeholders: EPA, OSM, coal industry, Pennsylvania Coal Association and other industry groups, watershed and environmental groups

Benefit: Additional remining and acid mine drainage remediation on areas previously affected by mining

Cost: None, other than moderate staff resources to further develop and implement the program

Status: DEP briefed the Mining and Reclamation Advisory Board on this proposal on May 20, 1998, and received preliminary approval from EPA to implement the proposal on a trial basis for a maximum of eight remining sites. DEP's Bureau of District Mining Operations has selected eight sites to implement this initiative on a trial basis through Consent Orders and Agreements.

In January 2000, EPA Region III accepted a BMP Pilot Project into its Project XL development phase, which was created to encourage innovative environmental strategies and to foster excellence in environmental protection. The project will be applied at eight remining operations throughout Pennsylvania. DEP is working with EPA and other stakeholders to develop a Final Project Agreement.

Contact: Donald Barnes
Bureau of District Mining Operations
814-472-1900

Wildlands Conservancy

3701 Orchid Place, Emmaus, PA 18049-1637
610-965-4397
Fax: 610-965-7223
www.wildlandspa.org