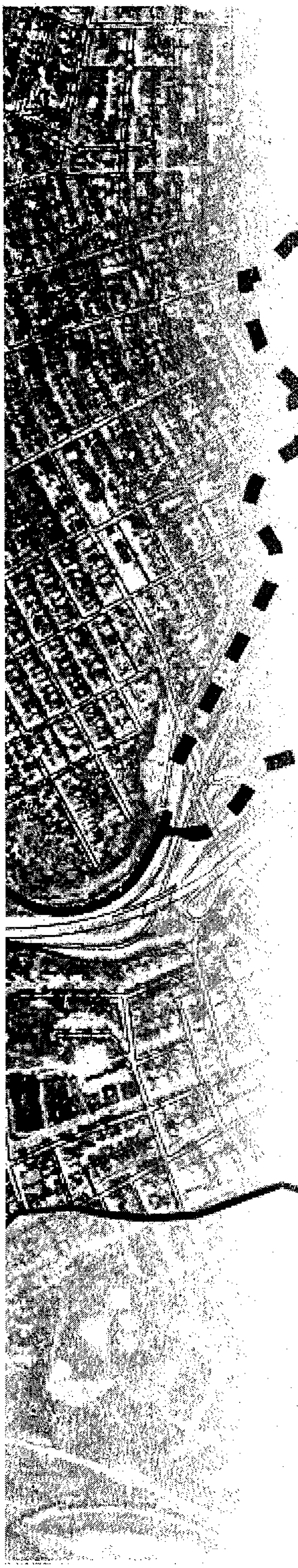


Nine Mile Run Watershed Rivers Conservation Plan

Executive Summary

City of Pittsburgh
Carnegie Mellon University
Carnegie Museum of Natural History
Pennsylvania State University

August 1998

Sponsored by:
Commonwealth of Pennsylvania Department of Conservation and Natural Resources, Rivers Conservation Plan

Principal Authors:
(in Alphabetical order)

Timothy Collins, MFA, Research Fellow,
STUDIO for Creative Inquiry, Carnegie Mellon University

David Dzombak, Ph.D., P.E. Associate Professor,
Department of Civil & Environmental Engineering,
Carnegie Mellon University

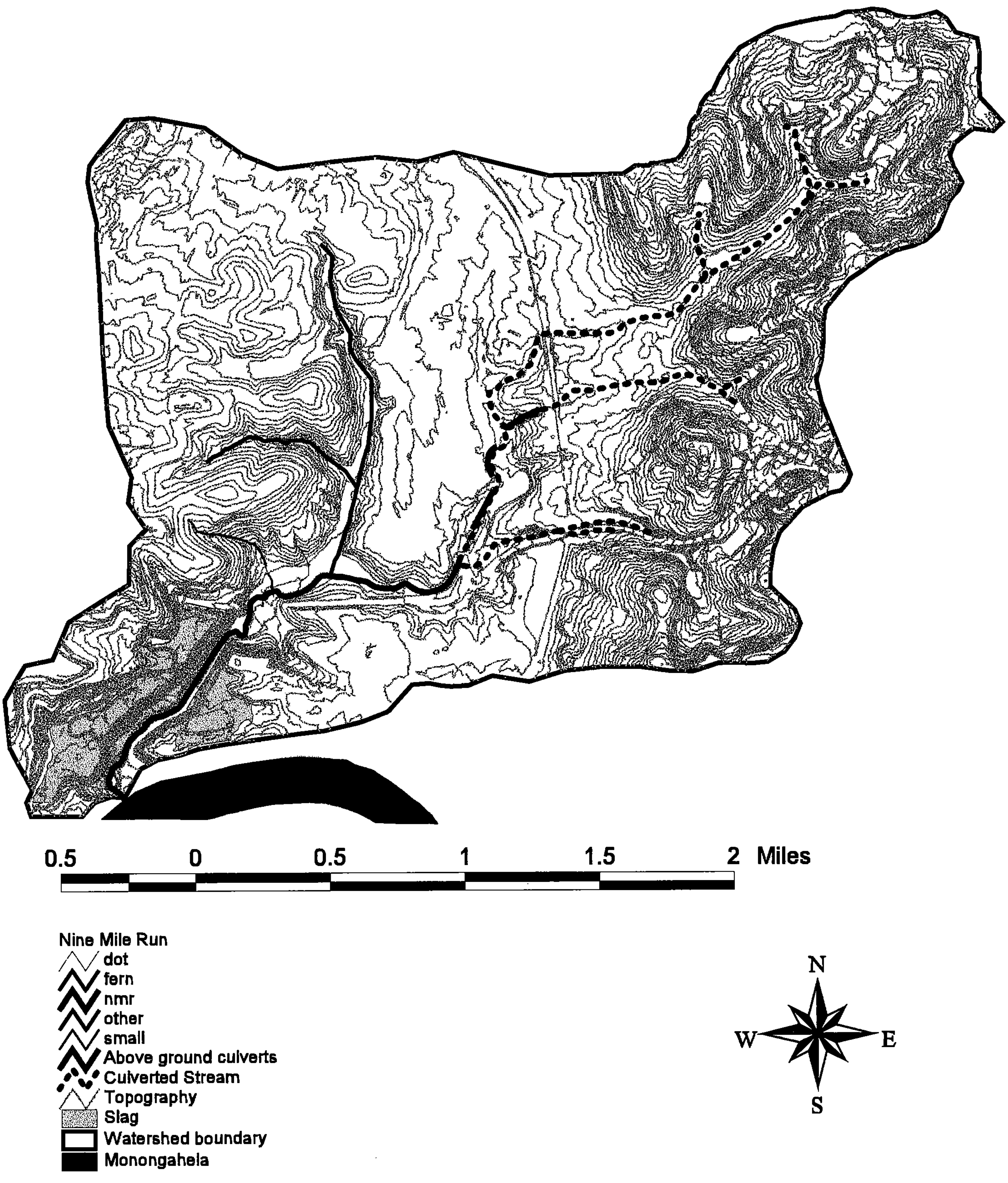
John Rawlins, Ph.D., Associate Curator,
Invertebrate Zoology, Carnegie Museum of Natural History

Ken Tamminga, M.PL., B.LA., Assistant Professor,
Dept. of Landscape Architecture, Pennsylvania State University

Sue Thompson, Ph.D., Assistant Curator,
Botany, Carnegie Museum of Natural History

Nine Mile Run Watershed

Culverted Streams and Tributaries



Nine Mile Run Watershed
Conservation Plan

Sponsored by:
Commonwealth of Pennsylvania
Department of Conservation and Natural Resources

Assessment Team

City of Pittsburgh
Joan S. Blaustein, Manager, Special Projects, Department of City Planning

Carnegie Museum of Natural History
Sue A. Thompson, Ph.D., Assistant Curator, Botany
John Rawlins, Ph.D., Associate Curator, Invertebrate Zoology

Carnegie Mellon University
Bob Bingham, Associate Professor of Art, STUDIO for Creative Inquiry Research Fellow, Project Co-Director
Timothy Collins, Artist, STUDIO for Creative Inquiry Research Fellow, Project Co-Director
David Dzombak, Ph.D., P.E., Associate Professor, Department of Civil & Environmental Engineering
Reiko Goto, Artist, STUDIO for Creative Inquiry Research Fellow, Project Co-Director
Bryan Rogers, Artist, Head of the School of Art, STUDIO for Creative Inquiry Director
John Stephen, Esquire, STUDIO for Creative Inquiry Project Coordinator

Pennsylvania State University
Ken Tamminga, M.PL., B.LA., Assistant Professor, Department of Landscape Architecture

Additional Contributors
Robert Androw,CMNH
Elizabeth Barrow, Mountain Bike Advocate
John Buck, Soil Biologist
Ellen Censky, CMNH
Robert L. Davidson, CMNH
Ted Floyd, Biologist
Mary Kostalos, Biologist
Douglas Lambert, Ph.D. candidate, CMU
Suzanne McLaren, CMNH
Uma Mirani, Biologist
Indira Nair, Ph.D., CMU
Robin Panza, CMNH
Henry Prellwitz, Ph.D. candidate, Univ. of Pgh.
Kirk Savage, Ph.D., Univ. of Pgh.
Jack Solomon, Audubon Representative
Joel Tarr, Ph.D., CMU
Chen Young, CMNH

Assistants-CMU
Petra Keuhl
Georgina King
Choli Lightfoot
Richard Pell
Steve Shaw
Karin Tuxen

Assistants-CMNH
Suvajee Chanthaman
Bonnie Isaac
David Koenig
Michelle Rosenberger
Michael Sally
Timothy Tomon
Walter Zanol

Editors
Jennifer Brodt
Erin Gray
Christine Simony
Kathryn Sitter

Steering Committee

Barbara Balbot	Frick Environmental Center
Dianne Barnett	Rankin Christian Center
Elizabeth Barrow	Western Pennsylvania Wheelman
Eileen Bell	Duck Hollow
A.B. Carl	Wilkinsburg Resident, Turtle Creek Watershed Association
State Senator Jay Costa	(represented by Kenny Steinberg)
US Representative William Coyne	(represented by Ann Gleason)
Sarah Dixon	Glen Hazel Community Development Corporation
Jack Fisher	Regent Square Civic Association
Faith Gallo	Department of Parks and Recreation, City of Pittsburgh
Don Gibbon	Sierra Club, Allegheny Chapter
Jane Harrison	Swissvale Economic Development Company
Jonathan Hill	Edgewood Foundation, Edgewood Council
State Representative Ivan Itkin	(represented by Dan Straughn)
Marc Knezevich	Urban Redevelopment Authority
Charles Martoni	Swissvale Boro Council President
Andrew McElwaine	Howard Heinz Endowments
Jeremy Muller	Steel Industry Heritage Corporation
Bob O'Connor	Pittsburgh City Council
Paul Peffer	Citizens for the Responsible Development of Nine Mile Run
Jeanne Pearlman	Three Rivers Arts Festival
Joseph Plummer	Environmental City Initiative
Maggie Schmidt	Pittsburgh School Board
Mark Schneider	Rubinoff Company, Nine Mile Run Associates
John Schombert	Allegheny County Health Department
John Sheilds	Swisshelm Park Community Council
Jack Solomon	Squirrel Hill resident and birdwatcher
Kenny Steinberg	Squirrel Hill Urban Coalition
Ellen Still	Pittsburgh Cultural Trust
Jeff Wagner	Western Pennsylvania Conservancy

Technical Sub-Committee

Paul Brown	Allegheny County Health Department
David Caligiuri	State Senator Jay Costa's Office
Tim Drier	PA Department of Environmental Protection
David Dzombak	Carnegie Mellon University
Alex Hutchinson	Hutchinson Engineers
Mary Kostalas	Chatham College Department of Biology
Robert Lasky	Chester Engineers
Daniel Lockhard	Pittsburgh Water & Sewer Authority
Jan Oliver	Allegheny County Sanitation Authority
Nancy Racham	Department of Environmental Protection
John Schombert	Allegheny County Health Department
Kathy Stadterman	Allegheny County Sanitation Authority
Don Waldorf	Department of Engineering & Construction, City of Pittsburgh
Mark Young	PennDOT
Robert Zischkau, Jr.	Bankson Engineers

PROJECT AREA CHARACTERISTICS

Nine Mile Run (NRM) is an urban stream that can be found on the USGS Pittsburgh East Quadrangle map of Allegheny County (7.5 minute series, topographic. The watershed includes the areas north of the mouth, through a section of Squirrel Hill, into Homewood, then east to Wilkinsburg, then south to Edgewood and Swissvale. The entire length of the stream is under 1.8 miles from where it first emerges from culvert near Braddock Avenue in Frick Park to its mouth at the Monongahela. The watershed is roughly 6.5 square miles.

The topography consists of low hills and river valleys. Much of the watershed is primarily hard surface, typical of an urban watershed. In the upper section, there is a 476-acre park of primarily wooded uplands with some river valley bottom and remnant wetland areas. The lower section of NMR is dominated by an industrial dump site (or brownfield) where slag, a by-product of the steel industry, was dumped continuously over a 50-year period. The broad floodplain that once existed is irretrievably buried in piles of slag up to 20 stories high. This creates a canyon-like environment with some residual riparian growth.

The NMR watershed is characterized by two river valleys that drain spring-fed first order creeks, themselves feeding into second order tributaries, to the main body of the stream, which is of the third order. The larger of the two second order tributaries has been culverted. It winds through three municipalities to emerge in open channel in Frick Park before meeting the other major tributary. The other second order tributary is a 400-acre remnant of the original watershed in Frick Park. This second order stream is known as Fern Hollow Creek which is in turn fed by spring-fed creeks. Fern Hollow Creek and its first order tributaries are fairly clean.

To adequately describe the Nine Mile Run corridor, we need to consider the upper and lower reaches. The upper reach emerges from a culvert and travels downstream in a westerly direction. The northern banks transition from minimal parkland to significant stretches of parkland. The southern banks border a thin stretch of parkland transitioning into the Parkway East (I-376) and beyond that, the community of Swissvale. The lower reach passes under Commercial Avenue just below the Irish Center of Pittsburgh. It travels in a southwest direction to empty into the Monongahela. The lower reach is defined by a brownfield/slag dump, the community of Squirrel Hill to the northwest, and the community of Swisshelm Park to the southeast.

ISSUES, CONCERNS, AND CONSTRAINTS

Urban Ecosystems

NMR has had its ecosystem disrupted by years of human intervention. Urban infrastructure is intended to resolve problems that occur as we create cities and towns, disrupting the natural landscape and its flora, fauna, and hydrology. The urban ecosystem is stressed by a 'problem solving' mentality that is often oblivious to the cause and effect relationships of the system. By resolving systemic problems as isolated issues, we often create significant problems elsewhere in the system and frequently reduce the economic, aesthetic, and experiential value the system may provide to the community.

As an urban stream, the value of NRM and its attendant ecosystem is lost within the existing conservation paradigm which views ecosystem value as primarily properties beyond the suburban edge, beyond human intervention. While there is a solid constituency which recognizes the value of post-industrial nature, the view of the stream and its surrounding lands as a dump devoid of nature still resonates amongst many of the parties with an interest in the site.

Water Quality

Water quality in NMR is negatively impacted by inputs of domestic sewage from unauthorized sewer discharges to the culverted section of NMR, from sewer leakage or unauthorized sewer discharges to storm water sewers, and from sanitary sewer overflows (SSOs) and combined sewer overflows (CSOs) to NMR along its length. These sewage inputs are contributed by all four watershed communities and have been occurring for many years. The sewage inputs cause high levels of fecal coliform bacteria in the stream during both dry and wet weather conditions, thus serving to make the water unsafe for human contact. This is recognized as a significant human health hazard by the Allegheny County Health Department.

The NRM streambed will soon be surrounded by a contiguous public space from where its first tributary emerges from culvert at Braddock Avenue right to its mouth at the Monongahela. There are three tiers of problems that need to be addressed: (1) the value of NRM is lost to most viewers upon seeing the trash, smelling the SSO/CSO discharge points, and observing the detritus of sewer, highway, and urban neglect which defines the stream and floodplain; (2) fecal counts in excess of DEP/EPA standards for human access and use occur on this stream 365 days a year; (3) stormwater events are extremely dynamic resulting in a torrent minutes after a major rain event. This can present a potential danger to anyone in the stream channel. Storm events are also laden with fecal matter, a problem which is illustrated by chronically discharging manholes.

<u>Water Quality and Ecosystems</u>

The NRM watershed is 34 percent open space. Runoff from adjacent Frick Park and Homewood Cemetery produce three small creeks that exhibit good water quality and a diversity of benthic organisms. Despite this fact, Frick Park and Homewood Cemetery place a significant amount of surface flow into storm sewers to protect trails. A study of the park during construction of the sewers in 1947 indicated a significant drop in the ground water levels and a cause and effect on the plant life (Black, 1947). NMR has lost its floodplain and wetlands to industry, highway construction, and pressing recreational uses. Because of this, NMR digs into its streambed with a powerful erosive force. The effect of this includes a sediment load that is detrimental to life in the stream; it also has an obvious effect on the Monongahela, as illustrated by the sandbar that has developed at the mouth of NMR.

<u>Slag and Toxicity</u>

The lower end of the NMR floodplain is dominated by 20 million tons of steel mill slag. This brownfield site is currently being studied and prepared for development for both a housing and a greenway component. Recent studies commissioned by the site owner, Urban Redevelopment Authority of Pittsburgh (URA), has indicated a number of issues that are relevant to the NMR Rivers Conservation Plan.

The overt effect of slag on the stream is clearly demonstrated by the walls of the stream that are producing a leachate characterized by a 9.6-10.6 pH. This occurs in the lower end of the stream just above the mouth at the Monongahela. The pH change produces an obvious precipitate which coats the bottom of the stream and appears to prevent algae from forming. This is an effect on the ecosystem, which has been observed but not analyzed. Tests for exposure to water and slag (which may contain toxic elements) are under review by the URA. The most recent *Report on Clean-Up Plan for Nine Mile Run Slag Area* by Advanced Systems Technology Systems (June 1997) comments on slag and water. "All target receptors are below the target levels set by the EPA and the PADEP for exposure to the existing constituents of the slag material. Soil cover will be a minimum of 18 inches to allow adequate cover of the slag, eliminating any exposure pathways to future residents". And on water, "No direct contact with groundwater is likely to exist and this exposure pathway would not require further evaluation." An 18-inch cover is unlikely in the lower greenway part of the valley, and access to the stream is a critical part of the greenway. A subsequent report was commissioned by the URA at the request of various community groups. Environmental Resources Management (ERM) completed a review of the environmental investigation conducted at the NMR site. They concluded that no environmental issues that would halt residential development of the site have been identified in the preliminary investigations completed to date. However, ERM believes additional studies are required prior to finalization and implementation of the residential development plans.

Public Access and Use

NMR is most accessible in lower Frick Park where an adjacent ballfield encourages children and families (with dogs) to sometimes recreate in and along the stream banks. The other access point is on the URA property, where children and adults find easy access under I-376 and by various trails leading to the water's edge on the Commercial Avenue end of the property. The steep slag slopes deny access to the stream throughout the rest of the property with exceptions at a dilapidated bridge in the center of the property and two maintenance trails leading to remnant wetlands which are bordered by shale outcroppings on the eastern/Duck Hollow side of the property.

The NMR green corridor contains a number of conflicting use patterns. The primary conflicts occur between slow-moving contemplative users and more active users of the park. The user group with the least effect on landscape and maintenance are naturalists who use the park for walking, birding, and botany study. A significant user group are dog walkers in the park. A preference to let dogs run free is a source of conflict with other users and wildlife in the park. The expanded use of mountain bikes for both transport and recreation has created a situation in which trails, hillsides, and paths are developing erosion problems. The ballfield in lower Frick Park is also the site of significant use, causing attendant traffic, parking, and maintenance demands.

Historic and Future Development

The NMR upper watershed is primarily developed in all four municipalities. Characterized by residential and commercial uses, large scale industrial uses have moved out of the watershed. Remnant open spaces in the upper watershed are either defined as parks, highway right-of-way, or properties which are not conducive to development because of steep grades or other site-specific economic constraints. Properties available for redevelopment are either residential or, as in the case of some properties north of Penn Avenue such as the Rockwell Industrial Park and the Wilkinsburg recycling transfer station, post-industrial brownfield properties.

The lower watershed of NMR is, by contrast, primarily open space, and some of it is available for development. Principally characterized by parks and cemeteries, there is also 240 acres at the mouth of NMR which is currently targeted for the development of 700 homes and a 100-acre greenway. The 100-acre stream corridor and its adjacent development have increased public awareness of the stream's condition. Community members and public officials have galvanized around the issue and are currently championing a number of initiatives to address water problems in NMR. If the stream stays unculverted, there is a road planned which will connect the two plateaus by moving down and through the valley. This will affect the stream corridor in two ways: (1) it will cross in the quietest part of the valley; and (2) it will exit onto Commercial Avenue by crossing through one of the forested areas growing on natural shale soils.

Other issues pertaining to development which are relevant to the Rivers Conservation Plan include: regrading within the valley, sediment and alkaline runoff from the construction, and potential values of the additional stormwater flow if it is properly managed and delivered to the stream. The final development issue involves ongoing planning by the Pennsylvania Turnpike Commission for the Mon-Fayette Expressway which would (as presently planned) cross the mouth of NMR at the Monongahela. This will have a significant effect on the larger Monongahela riparian corridor and its ability to benefit the NMR ecosystem. Sound may be an issue, as well as overall change, in the riverside aesthetic experience.

LAND RESOURCES

Soil Characteristics

The entire lower reach of NMR bordered by Squirrel Hill, Commercial Avenue, Swisshelm Park, and the Monongahela River is complicated by the dumping of steel mill slag. The upper reaches are typically defined as a shale soil.

Geology of the Nine Mile Run Area

The rock and soil materials observed at the NMR slag study area fall into four major categories and formation time periods. The oldest features are the nearly horizontal beds of sedimentary rocks deposited about 300 million years ago, followed by abandoned river channel deposits of sand and gravel with an age of about 100,000 years. After a period of erosion, following the major ice ages (about 10,000 years ago) NMR has been depositing clay, sand, and gravel in its floodplain up to the present time. Starting in 1923, and ending in the 1970s, a large volume of steelmaking slag was dumped in the NRM valley.

The bedrock in the NMR area consists of nearly horizontal beds (or layers) of shale, sandstone, claystone, limestone, and coal. These strata were deposited in an environment that was very different from that of present. Continental drift processes have changed the local climate from tropical, during the Pennsylvanian Period of geological history (300 million years ago), to more temperate at the present time. Pittsburgh is now positioned about 40 degrees north latitude, but was only two to five degrees north latitude during the Pennsylvanian Period. The fossil record in the sedimentary rocks indicate a near-shore river delta environment with a hot, steamy, tropical climate. The resulting plant material from the vast swamps resulted in thick coal beds that contributed to the development of the steel industry in Pittsburgh. The sandstone layers represent meandering river channels, and the shales were once delta and tidal muds. An occasional thin limestone bed, some with abundant marine fossils, was deposited when the sea covered the deltas.

After these sedimentary rocks were deposited and hardened there was a long period of erosion. About 100,000 years ago, when some of the topographic features of the area were starting to form, there was a major glacial ice advance from the north. These ice sheets dammed the northward flowing Monongahela River and the water ponded in the Pittsburgh area, resulting in valley sand and gravel deposits. These flat areas can still be seen at about 920 ft elevation. During the last 10,000 years before the present time, NMR has cut and eroded its valley from 920 ft elevation down to 720 ft, which is the present level of the Monongahela River. During the erosion process, much floodplain material has been deposited, consisting of mud, sand, gravel, and boulders.

Starting in 1923, steelmaking slag was dumped in the NMR valley floodplain. Enough material was dumped to fill the entire lower floodplain area and to alter the course of the stream. According to the (November 1996) Phase II Environmental Site Assessment conducted by Groundwater Technology for the Urban Redevelopment Agency:

1. The test drilling program confirms that the slag area is of relatively uniform composition without significant amounts of extraneous material. There is some construction/ demolition debris and possibly some clearing and grubbing material on the northwest side of the site. There was no evidence of deleterious industrial wastes.
2. The slag contains elevated but non-leachable concentrations of chromium derived from refractory brick. The concentrations are typical of carbon steel slags and do not represent an environmental concern. The slag pH is typically alkaline with pH values in excess of 11. Although the total chromium in the slag exceeds the December 1993 DER Cleanup Standard, it should not represent an environmental limitation of the site. The standard is based on long-term ingestion by a child. It is assumed that the final residential landscaping of the site will require the placement of a soil cover over the slag to allow for the development of vegetation. This will limit any ingestion potential.

Slag as a Growing Medium

The most important feature of slag at NMR (in relation to revegetation) is that it is not toxic to plants (phytotoxic). Slag's utility as a growing medium can be expanded by identifying and ameliorating some of its inherent limitations as a growing medium and some limitations related to the setting of slag. Inherent limitations of slag can be divided into physical, chemical, and biological components. These limitations, as well as slag assets as a growing medium and opportunities for improvement, are discussed below.

Physical limitations of the slag as a growing medium include:

- Coarse texture and associated low water holding capacity.
- Dark colored slag absorbs excessive heat in direct sunlight, dehydrating seedlings before they become established.
- Fused (cemented) slag makes a poor seedbed, is difficult for roots to penetrate, and it is difficult to amend (mix with soil amendments)

Chemical limitations include:

- High pH (typically pH 9-10 before weathering) and associated low nutrient (e.g., phosphorus, iron, manganese, copper, zinc) solubility, and tendency for ammoniacal form of nitrogen to volatilize.
- Lack of plant-available nitrogen (ammonium, nitrate).

Biological limitations include:

- Shortage of seed source (low production except at site fringe and robust pockets of vegetation).
- Shortage of soil enzymes that facilitate nutrient cycling.

Limitations of the site setting include:

- High wind and sun exposure of large expanses of unvegetated surface. Winds dry out and 'sand blast' seedlings.
- Lack of mulch from on-site plant production.

Assets of the slag as a growing medium include:

- High porosity permits excellent air exchange and deep rooting.
- Plants can potentially intercept adequate amounts of water by rooting deeply into slag; this compensates for the poor plant-available water storage of slag.
- Slag weathers to a stable pH between 7 and 8.3.

Critical Areas

The critical land areas in the NMR watershed can be defined as either areas with habitat value, areas with infiltration or detention potential for surface water, and land areas which are broad, flat, and accessible enough to qualify for playing fields.

Lands with habitat value can be found throughout the watershed. There are upper watershed valleys with remnant creeks and relatively diverse urban vegetation, although they are often islands cut off from contact with any larger, more functional ecosystem. The area with the largest habitat value is in the lower watershed. Frick Park has the largest interior forest in the watershed, with a total of 87 acres, plus a supporting 368.5 acres of upland forest, and about 11 acres of wetland/floodplain. The NMR slag site is a 240-acre site of which 158 acres are upland forest and 0.1 acre is interior forest. The habitat value of these contiguous properties are not fully realized, however, until we consider the relative value of connecting these two urban habitats to the greater riparian corridor of the Monongahela River. Industrial development on the north shore of the Monongahela was spotty, with remnant patches of secondary growth beginning to link with dormant brownfield properties, knitting the riparian edge back together again. This provides a significant source of biological diversity in both plant and wildlife. Since the NMR slag site is the link between the Monongahela and Frick Park, it is important to give careful consideration to habitat value and ecosystem function during its assessment and design phases.

One of the challenges of an urban watershed is that so much of the land has been filled, asphalted, and covered with houses, that the water which once soaked slowly into the ground now forms sheets in the streets, disappearing down storm sewers. This develops raging torrents in the stream in the lower watershed. Because of these conditions, it is important to identify and protect open space in the upper watershed. It is also important to reconsider building codes for large parking lots to insure detention and infiltration whenever possible.

It is important to recognize the need for organized sports use of Frick Park, as well as the land forms that are likely to provide the most affordable means to realize this goal. The NMR slag site and its steep slopes and single field may not be ideal for playing fields and their attendant parking needs; the single site worth considering is only three acres without parking.

Landfills

The entire lower reach of the NMR floodplain bordered by Squirrel Hill, Commercial Avenue, Swisshelm Park, and the Monongahela River has been filled by the dumping of steel mill slag. NMR still flows between the piles with typical slopes of 1.5-1. The slag dump covers 238 acres consisting of steel making by-products dumped randomly on either side of the banks of NMR. These dump sites are up to 100 feet in height with less material on the Swisshelm Park side and additional isolated piles on the Squirrel Hill side of 30 feet or more.

WATER RESOURCES

Tributaries

The NMR watershed drains the southeastern part of Pittsburgh and portions of the three neighboring boroughs of Swissvale, Edgewood, and Wilkinsburg. The main branch of NMR is above ground within Pittsburgh, extending from its mouth at the Monongahela River up through the south end of Pittsburgh's Frick Park. Upstream and to the east of Frick Park (east of Braddock Avenue) NMR is completely underground in a concrete culvert, with several culverted tributaries connected underground.

The largest tributary to NMR is Fern Hollow Creek. This brook runs from north to south through Frick Park to meet NMR. Fern Hollow Creek contributes flow most of the year with the exception of some occasions during dry summer weeks. The remaining tributaries in the NMR watershed have been culverted and are no longer in their natural state. However, they are significant because they contribute a majority of the flow to NMR. The main branch of NMR lies in a culvert, often called the Wilkinsburg Culvert, that runs from north to south through Wilkinsburg and Edgewood. There are several culverted branches within Wilkinsburg that contribute flow, presumably from groundwater or natural springs. These culverts also act as storm sewers during wet weather.

Adjacent to the mouth of the Wilkinsburg Culvert are two storm sewers which also contribute flow year round. These storm sewers can be traced on maps in the direction of tributaries that existed before extensive development occurred in this area. One extends up the valley alongside and beneath I-376 in Edgewood, and the other beneath an Edgewood shopping center and into Swissvale. During the 1997 summer months, these 'storm sewers' contributed more flow than the main branch of NMR, likely from the same sources. These influents can safely be labeled as tributaries, although there is no historical name associated with them.

Other Tributaries

Another similar tributary/storm sewer originating from the west end of Swissvale flows into NMR upstream of Frick Park. As a tributary in dry weather, it contributes consistent though very little flow to NMR. Downstream of Frick Park, a concrete pipe originating in the direction of an original

NMR tributary valley has a consistent flow of water to NMR. This pipe is not a storm sewer and is likely groundwater that has been piped directly to the stream. A former tributary that is now covered by slag in the lower reaches of the stream still contributes flow to NMR. This flow enters NMR as seepage along the banks of the stream and is very significant in dry months when flow in the stream is low. A major tributary meets Nine Mile Run just upstream of its mouth at the Monongahela (at Duck Hollow). This tributary has also been culverted, though it contributes significant flow to NMR.

Wetlands

Wetlands are important ecosystems that contribute greatly to their bioregional contexts and serve vital hydrological, biogeochemical, and habitat functions. Large, high-energy riverine and floodplain wetlands were likely to have been found along the Monongahela, Allegheny, and Ohio Rivers prior to the obliterating effects of bank stabilization, flood control works, and industrialization of shorelines and floodplains. Historic aerial photographs and geological mapping show an extensive floodplain in the lower reaches of NMR, now largely covered with slag and landfill. Lowland forest growth would historically have covered much of this area. Because of the relatively steep gradient of NMR as a headwater (first and second order) stream, wetlands would likely have been limited to those areas where groundwater seeps and high water tables were to be found, or where beaver dams may have impounded open water wetlands.

National Wetlands Inventory (NWI) mapping (1986) shows no regulatory wetlands in either Nine Mile Run or the immediately surrounding area. Since the NWI protocol in Pennsylvania employed black and white aerial photography and fairly large minimal mapping units, small, non-open water wetlands were frequently missed. Based on preliminary field reconnaissance during October and November 1997, it appears that two remnant wetlands exist in the study area. Both are palustrine wetland complexes dominated by grasses, sedges, and forbs.

The larger wetland, just upstream from Commercial Street, is set back from the north bank some 20 to 30 m and extends upgradient some 30 to 50 m. It has been tentatively classified as a slope wetland according to the Hydrogeomorphic (HGM) approach. The water source is presumably a mix of surface water and ground water; hydrologically, it appears to be linked with the southerly-facing slope extending up into Frick Park. Its position substantially above the bank of the stream and its noticeable cross-slope suggest that this is a low-energy seep system and, hence, is not reliant on flood events. Soil samples taken in November 1997 within the root zone (to 18 in) showed the soil to be hydric, with a chroma of between 1.5 and 2.0.3 Hydrophytes are present on site.

The smaller site further downstream along NMR presents a more peculiar situation. Roughly 20m by 80m in size and rather well-concealed, it is perched on a sloped terrace located just below a 2 m high linear embankment. This, in turn, is situated some 2 to 2.5 m above the streambed. Several test holes dug in November 1997 show a distinct hard clay/soft shale layer within several inches of the surface. Apparently, this functions as an impermeable lens, limiting root penetration and water infiltration, but also setting up hydrological conditions suitable to wetland formation. Root zones as thin as 5 cm were evident in one area toward the down-gradient end of the site. On-site soil sampling showed a soil matrix chroma of approximately 2.0, as well as some mottling and oxidized root channels characteristic of hydric soils. Plants species are more predominantly herbaceous than the upstream wetland.

Penn State University's Cooperative Wetland Center has recently included these two sites as reference wetlands within its Pennsylvania Wetlands Study (PAWS). Automated test wells have been installed to assess hydrological dynamics through time. Data from these wells will be compiled as hydrographs--essential in confirming whether these sites are functional wetlands in the regulatory sense. Additional biophysical assessments (soils, vegetation, etc.) will be conducted in Summer 1998. At the present time, biological indicators strongly suggest that, regardless of status, these small ecosystems exhibit wetland-like characteristics that may be of considerable value to both NMR and Pittsburgh in general.

Floodplain

The NMR floodplain has been severely affected by culverting in the upstream northeast valley of the watershed, and slag fill in the lower watershed. The management goals of the NMR watershed have been principally to protect property and alleviate flooding by conducting flows to the Monongahela as quickly as possible. This method is even obvious in the feeder creeks in Frick Park, where overflow is conducted into the storm sewer and the floodplains have been turned into grassy lawns or childrens' play equipment areas.

Lakes and Ponds

There is one pond in the watershed. It is in the upper end of Homewood Cemetery near the entrance off Dallas Street. Appearing to be spring-fed, it has some emergent wetland plant growth. Less than a 0.25 acre in size, it has habitat value in its unique form and relatively protected location.

Water Quality : Point Sources

Sewage pollution has been a problem in NMR since the turn of the century. References to sewage problems are documented as early as 1910 and have continued to the present. Data have been collected for fecal coliform and other pollutants by various organizations over the past 10 years. The overall impact of sewage discharges is not only represented by the concentration of pollutant, but also by the amount of flow contributed to the stream by a particular source. No historical flow data are available for NMR. As part of this study, flow measurements were performed at the time of some water quality sampling events in order to relate water quality measurements with flow rate information. Samples were taken both in-stream and at the natural tributary and storm sewer influent points adjacent to the stream.

Sewage discharges to NMR occur via combined sewer overflows (CSOs) and sanitary sewer overflows (SSOs) in wet weather. CSO discharges can occur even during short duration rain events. CSOs commonly are designed to discharge combined stormwater-sewage flows for rainfall events with precipitation greater than 0.1 - 0.3 in/hr (Shamsi, 1997). SSOs behave similarly although their magnitude, frequency, and specific sources are not well understood for NMR. Sanitary sewer overflows are perhaps less in volume compared with the CSO discharges during wet weather, but they are responsible for substantial raw sewage inputs to NMR. During a storm event, infiltration and inflow into the sanitary sewers causes overloading which results in either surcharging manholes, or discharge through constructed diversion chambers. Such diversion chambers help relieve overloaded pipes and prevent manholes from surcharging. Whether sanitary sewage discharges occur from manholes or diversion pipes, the result is the same: raw sewage, diluted by stormwater, enters the stream.

Water Quality: Non-Point Sources

The primary concern with most urban streams is runoff problems during storm events. Every structure, road, and parking lot that is built increases the impact of a rainfall event on the nearest stream. Water that flows into gutters and storm sewers flows into stream channels faster, resulting in greater flows and increased erosion and flood danger. To control these problems and facilitate greater runoff flow rates, urban streams often have been culverted or placed in concrete channels which can lead to runoff problems further downstream.

NMR is a unique urban stream because it is culverted near its source and on the surface further downstream. Due to this configuration, runoff flows in the surface section increase rapidly, making the stream "flashy" in nature. This causes accelerated erosion of banks and uneven deposition of sediments in the stream bed.

Along with erosion during high storm flows, there is also degradation in water quality in NMR due to sewer overflow inputs. Fecal coliform bacteria concentrations in the stream often are sufficiently high to render the water unfit for human contact. Sewage pollution problems are a result of shortcomings in the sewage infrastructure system in the watershed. The problems derive from a number of sources within the culverted region of the watershed. CSOs, SSOs, unauthorized sewer tie-ins, and inappropriate stormwater management are among the issues involved.

There are also water quality impacts to NMR during dry weather. A tributary to NMR that now passes through the slag piles contributes a significant amount of water during dry weather and raises the pH of the stream. Tributaries and storm sewers in the upper half of the watershed sometimes have high levels of fecal coliform bacteria as a result of leaking sewers and unauthorized sanitary sewer tie-ins with storm sewers.

BIOLOGICAL RESOURCES

There are several currents in landscape ecology which are relevant to the planning and design of urban greenways. The most fundamental has to do with the extent to which landscape heterogeneity (mix of habitats and land uses) is encouraged at various scales, and how biological resources are assessed. A landscape ecology model provides a useful way of understanding the issue of multiple-scaled and interactive ecosystems in fragmented, urbanized regions. Landscape ecology has been defined as a study of the interactions and fluxes of energy, mineral nutrients, and species among clustered stands or ecosystems (Forman, 1981). This defines a landscape system with several working scales: alpha (within habitat or vegetation community), beta (between habitat), gamma (bioregional or watershed), and delta (biome) (Noss, 1983; Naveh, 1994).

At NMR an example of an alpha-scale habitat is the mid-successional woodland along older slag slopes. The beta-scale could be considered environments such as open brownfields and dense urban development. The complex of alpha and beta environments combine to form the gamma-scale system--Pittsburgh's bioregion--and the combined watersheds of the Allegheny, Monongahela, and Ohio Rivers might be considered Pittsburgh's delta ecosystem. Beyond this scale, geological regions assume even larger proportions; NMR functions as a tiny part of the Allegheny Plateau, which itself is a sub-component of the Stable Interior region (primarily layered sedimentary rocks) stretching from upstate New York to New Mexico.

For planning purposes, the NMR project area can be organized into an assortment of individual, but overlapped and linked, ecosystems. Each ecosystem in NMR presents a range of ecological attributes that say something of their ecological integrity. Some are isolated, some well-connected; some are small, some large; some are buffered, some unbuffered; some are degraded internally, some are relatively pristine; some are high in biodiversity, some extremely simplified. Coupled to the location and categorization of ecosystems within NMR is the relationship that the stream valley has to its adjacent exterior ecosystems and to the Pittsburgh bioregion in general. Finally, NMR can be assessed for its function (past, present, and future) as an ecological stream corridor corridor for biological resources within an urban environment.

Assessment of the biological resources at NMR focused on two key indicator groups, the vascular plants and insects. Plants and insects typically comprise over 90 percent of the biotic diversity in most ecosystems, and at NMR plants and insects may comprise an even higher percentage, given a depauperate vertebrate fauna. Due to their dominance in most ecosystems, plants and insects are valuable tools for environmental assessment, including water quality and the general health of ecosystems. Plants are often used as biotic indicators because they are immobile and thus are impacted by even subtle changes in abiotic factors. Insects, due to sheer diversity and habitat-specific lifeways, are one of the best groups of animals for use as biological indicators in both terrestrial and aquatic systems.

Although the biodiversity profile of NMR has changed substantially since the turn of the century, preliminary studies, especially studies of vascular plants and selected lineages of arthropods, indicate significant remnant populations of native species still existing in the watershed. Paradoxically, changing conditions at NMR created new habitats which have enabled native species, previously not found in the watershed, to colonize this area. For example, hop tree (Ptelea trifoliata), which has a conservation status of threatened in Pennsylvania, did not grow historically at NMR, but today occurs along the base of slag slopes, areas similar to the more xeric habitats typical of this plant. In addition, a number of grass-associated species of native cutworm moths, unusual in or absent from forest habitats, have become abundant on or near the slag habitats.Given these shifts in the biota of the NMR watershed, both in terms of its historical past and potential future rehabilitation as different habitat types, one of the objectives of this project was to determine what ecological communities are possible within a severely degraded urban watershed and to propose rehabilitation potentials for this degraded urban environment.

Wildlife

Several urban areas across North America have defined their bioregion as a prelude to understanding the setting of site-specific initiatives. Such an exercise has yet to be fully conducted in the Pittsburgh area; however, the Allegheny County greenways map begins to show the network of natural spaces and corridors remaining in the city and surrounding Allegheny County. Other bioregional mapping efforts have taken a multi-layered approach to generating a definable bioregion: geology, hydrogeology, hydrology/watersheds, physiography, wildlife, floristic patterns, soils, and cultural heritage expressed in landscape-level patterns. All of these spatial variables can be synthesized into a single bioregional representation of the greater Pittsburgh area. The process of generating and applying bioregional characterizations often reveals opportunities for a regional-scale system of linked and enhanced remnant natural features and the associated biological resources.

Although a bioregional map of Pittsburgh does not yet exist, it is clear that the biological resources of NMR are linked to other natural areas within the region. While NMR does not contain large areas of habitat suitable for wildlife, the valley does exhibit linear patterns of successional vegetation (see Section V-b). These remnant patches combined with the stream suggest that NMR functions as an ecological corridor between Frick Park and the Monongahela River. For example, the stream serves as a conduit for the down-gradient flow of materials, nutrients, and microorganisms. Small mammals, white-tailed deer, birds, and invertebrates pass up and down the valley. The NMR/Frick Park deer herd moves seasonally as well, using the forest interior of the park as a wintering yard and spreading south into the valley and laterally along the well-wooded north slope of the Monongahela River during the warmer seasons. The Monongahela itself provides a larger ecological corridor for aquatic and avian species. As a major valley flyway, it funnels both nesting and migratory birds near the mouth of NMR. Near the mouth of NMR, the oak-hickory slopes along the north bank of the Monongahela River also serve as a species-conducting linear greenway. Terrestrial and aquatic wildlife are discussed below in the context of NMR as an ecological corridor within the Pittsburgh bioregion.

Terrestrial Wildlife: Vertebrates

A total of 240 species of vertebrates have been observed in the Nine Mile Run stream corridor area, including 189 birds, 22 species of mammals, and 29 species of amphibians and reptiles (see Appendices V-1 to V-3) for species lists). The vertebrate species occurring at NMR are typical for this bioregion and the habitats represented at NMR. Two species of mammals introduced in Pennsylvania, house mouse and Norway rat, which are associated with human-dominated ecosystems, occur in the watershed. Although aesthetically pleasing in terms of wildlife enjoyment, white-tailed deer at NMR may pose a serious threat to vegetation through over-browsing, and the population should be monitored.

Terrestrial Wildlife: Invertebrates

A number of ecologically diverse lineages of insects were comprehensively assessed from the samples taken. In general, the insect fauna was as expected for disturbed secondary forests associated with fields and open areas near a stream. Compared to similar undisturbed habitats elsewhere in the Pittsburgh bioregion, the following summary points on the terrestrial insect fauna may be noted: (1) species richness (= number of species) was reduced in each of the major insect groups studied, (2) numbers of individuals captured for most (but not all) species were reduced, and (3) a number of species considered unusual in the bioregion were present at densities greater than expected, especially introduced taxa and species associated with xeric habitats and grasses. Most notably, aquatic species occur in low numbers in light trap samples.

Aquatic Wildlife

Comparisons between pristine reference streams and degraded streams have resulted in indicators of stream ecology integrity in a manner similar to landscape ecology. Many species, especially some macroinvertebrates and amphibians, are reliable indicators of water quality. Highly oxygenated, cool waters with relatively stable base flows and few pollutants will accommodate sensitive species not found in highly impacted streams. While some of the more resilient macroinvertebrates are still found in the stream, a number of sightings of other riparian creatures, such as the Belted Kingfisher near the creek's mouth, suggest that a semblance of ecological integrity still remains within and alongside NMR, despite decades of chemical, biological, and physical assault.

Vegetation

The NMR stream corridor is presently a severely degraded system, unlikely to be restored to its original condition, but clearly a candidate for rehabilitation and/or remediation to another type of more natural habitat. Prior to degradation, the biodiversity of NMR was typical of similar wooded stream corridors in western Pennsylvania. Two-hundred years ago, NMR's terrestrial environment would have consisted of a mixed oak-hickory association on the plateau and dryer side slopes, with northern hardwoods and hemlock mixed in on the cool northern slopes. Typical riparian areas along such wooded stream valleys might have included floodplain forests dominated by trees such as American elm, sycamore, silver maple, and boxelder. Besides irregular fire events and blowdowns, the original forests of NMR would have largely exhibited interior habitat characteristics: closed-canopied, multi-layered, and accommodating a diversity of habitat-specialist species, free from the "edge effects" typical of fragmented habitats found today throughout the Pittsburgh region. The stream itself would have been pristine compared to current conditions--clear, fresh, well-supplied with oxygen and nutrient-rich organic detritus, and with stable base flows--and would have supported a variety of aquatic animals and plants.

As development in this area progressed, both terrestrial and aquatic ecosystems at NMR were heavily impacted, and the vegetation changed drastically. The dumping of millions of tons of slag, which ended in the 1970s, essentially eliminated the stream valley and associated riparian forests and wetlands, and changed the surrounding slopes from wooded hillsides to giant slag piles. The NMR watershed today contains a mosaic of vegetation types, heavily influenced by the activities of man over many decades, including remnants of native vegetation types to areas heavily invaded by exotic species to slag almost completely devoid of plant growth. Two overall vegetation types occur today in NMR: upland vegetation communities and lowland/riparian vegetation communities. There are seven basic community types of upland vegetation ranging from open slag slope to secondary forest and areas of planted evergreens, and three different types of riparian vegetation. These vegetation communities are not discrete and distinct entities with fixed boundaries, and many areas intermediate between different types occur at NMR. All vegetation communities at NMR contain a mixture of both exotic and native plants, although in different proportions. Many of the plant species at NMR are introduced from Europe and Eurasia, but a substantial proportion are species that are native to this area, including many native "weedy" species. The native weed species play an important role in normal successional growth and include species, such as staghorn sumac and black locust, that colonize open areas. In areas of NMR, these plants compete with introduced successional species, such as the tree-of-heaven, which can even grow through cracks in sidewalks.

Relatively undisturbed secondary forest areas contain native hardwoods. The dynamics of this mixture must be monitored to maintain this vegetation type within NMR. Non-forested upland vegetation communities include meadows and the more open slag slopes. Vegetation on the open slag areas consists primarily of a few species of woody plants and little else. Early meadows occur on the slag plateau and elsewhere at NMR, and contain a sparse mixture of early successional herbs and grasses . As meadows become more established, perennial herbs, become more dominant. Meadows grade into woodlands, especially in some areas on the slag slopes, as early successional tree species start to grow. Wetlands at NMR include both facultative and obligate wetland species.

Invasive Species:

An exotic species of plant or animal is one that was introduced, either intentionally or unintentionally, by human endeavor into a locality where it previously did not occur (SER, 1994). Introduced plant species form an important part of our environment, contributing immensely to agriculture, horticulture, landscaping, and soil stabilization. But among the thousands of plant species introduced to North America, approximately 10 percent display unexpected aggressive growth tendencies, resulting in real threats to native ecosystems (Blossey, 1997). Disturbed sites such as NMR provide a haven for invasive plants. These species have left behind the natural controls (usually insects) that kept them in check in their native habitats in favor of compromised urban environments. Some have over time become integrated into the flora of Pittsburgh's urban watersheds. These can be considered "naturalized" and, although newcomers to an ecosystem with a long natural history, can be tolerated and even appreciated in an urban watershed such as NMR.

Other plant species are of greater concern, for they have proven that they can out-compete and displace indigenous vegetation. None is more evident at NMR than honeysuckle. As with most other species successful in invading disturbed ecosystems, dense thickets of honeysuckle can modify ecosystem structure and functions to their exclusive advantage (Luken et al., 1997). Other invasive species at NMR include tree-of-heaven, garlic mustard, giant knotweed (Polygonum sachalinense) and Japanese knotweed also known as Mexican bamboo (Polygonum cuspidatum), and multiflora rose (Rosa multiflora). Populations of these species at NMR are extensive.

PNDI Species

The Pennsylvania Natural Diversity Inventory (PNDI), established in 1980, is a comprehensive inventory and database of significant natural areas as well as plant and animal species of conservation concern in Pennsylvania. PNDI focuses on elements of special concern due to uniqueness or rareness in Pennsylvania, and monitors plants, animals, geologic landmarks, natural communities, and other natural features. Plant and animal species are assigned rankings based primarily on the number of extant populations within the state. Although these rankings differ slightly among organisms, the basic categories are (1) extirpated (extinct in Pennsylvania); (2) endangered (in danger of becoming extinct in the state); (3) threatened (may become endangered if critical habitat is not maintained); and (4) rare (uncommon due to restricted geographic areas or occurring in low numbers throughout Pennsylvania).

Two PNDI plant species presently are found in the NMR stream corridor, and NMR has historically contained populations of four additional species of conservation concern, including three currently listed in PNDI and one candidate species. An extensive population of hop-tree (Ptelea trifoliata), which is listed as threatened in Pennsylvania, grows at the base and along the lower edge of slag slopes at NMR. Fringe-tree (Chionanthus virginicus), recommended this year for listing as threatened by the Pennsylvania Biological Survey (PABS), is another species which did not occur historically at NMR.

Five PNDI-listed species of birds have been sighted since 1970 in the NMR stream corridor: Bald Eagle (endangered), Common Snipe (threatened), Olive-sided Flycatcher (presently listed as extirpated in Pennsylvania), Osprey (endangered), and Yellow-bellied Flycatcher (threatened). In addition, five "Candidate at Risk" (species particularly vulnerable to exploitation or environmental modification) have been seen in this region: American Coot (historical record only), Blue Grosbeak, Pied-billed Grebe (historical record only), Summer Tanager, and Swainson's Thrush. Three "Candidate Rare" (species which occur in restricted areas or habitats or in low numbers) are also known from NMR: Common Barn Owl (historical record only), Northern Harrier, and Prothonotary Warbler. Another four species, which presently have no legal status but are under study for future listing, are also known from NMR either historically (American Bittern) or from more recent records (Black-crowned Night-heron, Great Blue Heron, and Virginia Rail). Of all these species, only the Summer Tanager is known to have bred in the area (up until 1982), and the Great Blue Heron probably had breeding populations at least in the nearby vicinity.

Knowledge of the presence and abundance of most invertebrates in Pennsylvania is extremely limited. The most diverse lineage of invertebrates are insects, and precise information on the conservation status for most species other than butterflies, dragonflies, damselflies, and a few beetles is not available. As a result, PNDI ratings are conjectural for most terrestrial species and the best information on conservation status depends on the impressions of regional specialists of which there are few. Although a few species of insects thought to be relatively rare or unusual in the Pittsburgh region were documented during this study, no officially-listed PNDI invertebrate species were documented. There are no records or sightings of PNDI-listed mammals, amphibians, reptiles, or fish in the NMR area.

Important Habitats

Site investigations and background studies reveal a number of important habitats, representing almost all areas of the valley and adjacent uplands. Six categories of important habitat have been identified: wetlands, slag plateaus and slopes, remnant secondary forests, aquatic habitats, remnant riparian forests, and rock outcroppings.

CULTURAL RESOURCES

NMR extends for less than 1.8 mi. from the mouth of the culvert in Frick Park to the Monongahela River. Over much of its length, NMR falls within the boundaries of Frick Park. In addition, its major tributary, Fern Hollow, runs north to south through Frick Park. Due to the location of NMR and its major tributary, a majority of the recreation uses in the watershed are confined to the 476 acres of Frick Park. The park is one of four regional parks in Pittsburgh and as such contains many recreational amenities. The recreation uses and facilities in the NMR watershed are broken down into two major categories: (1) physical recreation facilities used for organized sports leagues, and (2) individual/neighborhood recreation and organized nature programming and individual nature activities.

There are a number of historically significant properties in the Nine Mile Run watershed, including National Registry Properties, Pittsburgh Registry Properties, and architecturally significant buildings.

MANAGEMENT OPTIONS

Missions and Goals

The mission of the Nine Mile Run Watershed Conservation Plan is to educate and inspire, and to reveal the opportunity that exists in degraded urban landscapes. The tendency to value pristine environments over the landscapes that we access in our daily lives undermines the urban and suburban environment. If we are to reclaim our cultural uses and relationships to urban rivers, we need to carefully consider their opportunities along with their problems. We must learn to see (and teach) the value of ecosystem function in our neighborhood parks, backyards, vacant lots, and daily lives. From the daily practice of attention and care comes the values that will protect and enable a sustainable balance between the built and natural environments.

The Goal is to protect, restore, and enhance the biotic, abiotic, cultural, and scenic values of a post-industrial urban watershed, and to promote public understanding, appreciation, and enjoyment of this heritage within a sustainable greenway program. To achieve these goals, priority will be given to the regeneration, conservation, and communication of key aquatic, riparian, and upland ecosystems with the intent of nurturing an environment which is experientially rich, aesthetically complex, and economically, ecologically, and culturally sustainable.

Restoration, Healing, and Ecosystem Regeneration

Restoration, regeneration, reclamation, and healing are terms used in a variety of literature that explores the science and art of resolving ecosystem problems of land and water which have been severely affected by urbanization, industry, or natural catastrophe. As we consider the language of systemic change, it is important to note that the challenge at NMR is defined by the goal of restored ecosystem function, rather than the return to its historic (pre-degradation) form and function. While the latter is the ideal and one of the baselines for planning, the former is the realistic goal for this systemically degraded urban watershed.

General Revegetation Principles

There are a number of well-established principles for restoration plantings in riparian areas and along stream banks. Following are some of the more important points that should serve to guide plantings in the near future.

- The greatest limitation of riparian revegetation is that it often does not address the cause of degradation or stress; when it does not, it is likely that the riparian system will continue to be unstable (Briggs et al., 1994). An understanding of water, sediment, and energy fluxes is essential to selecting the appropriate species, designing the soil profile, and determining whether plantings are even the correct solution (Harris and Olson, 1997
- Focus on common pioneer and quick-growing native tree species that are found in the immediate area of NMR or in nearby, reference sites. Trees such as willow, dogwood, poplar, and river birch are tried and true lowland restoration species, and presently grow within the NMR stream corridor.
- Allow enough time for locally-collected cuttings and seeds (local genotypes) to be grown by either volunteers or contract growers; commercially-available stock is often not adapted to the local situation.
- When gathering seeds and propagules, collect from different stock plants to broaden the genetic diversity of the plantings in order to enhance the overall biodiversity of NMR.
- Collect seeds and propagules in such a manner as not to jeopardize natural stands or significantly deplete the plant source (again, collect from several different individuals so as to obtain a representative sampling of genetic material).
- Err on the side of resilient lowland species: sandbar, black and pussy willow; redosier, gray, and silky dogwood; smooth and speckled alder; river birch; silver maple; American and

slippery elms; green and black ash; chokeberry; cottonwood; sycamore; elderberry; basswood; red and silver maple; and viburnums. Where workforce and money are constraints, consider a successional strategy that starts with early colonizers, then underplant with a variety of other slower-growing and somewhat shade-tolerant species.

- Native shrubs can play an important role in diversifying the characteristics of the habitat, protect soil from erosion, and help shelter the edge of tree plantings. Make use of evergreens on the up-gradient sides of larger plantings to establish an interior habitat in a more timely fashion.
- As with stream restoration, riparian revegetation should aspire to natural diversity and structural complexity. Provide variation in topography (see below), species, age, and density to maximize biodiversity.
- Rescue plants from nearby donor sites slated for development.
- Consider the potential benefits of restoration technology: Tubex™ tree shelters and deer and rodent repellents are essential; the new VisPore tree mats are an interesting alternative to standard mulch; polymer soil conditioners and mycorrhizal innoculants are worth investigating.
- Conduct research on locally available biotechnologies in concert with on-going studies of stream morphology for specific application along degraded and threatened reaches of the stream. These technologies are usually to be preferred over static bank stabilization measures such as concrete and gabions, which often fail in grand style and provide little habitat value.
- Incorporate the notion of accessibility and visibility into site selection criteria; those projects that are open to public scrutiny and easy for all to access can play a major role in building an inspired NMR greenway constituency. Denuded stretches along the creek just up- and downstream from the Forward Avenue crossing are excellent spots for revegetation, as are riparian areas near the playing fields and along the more visible stretches of Fern Hollow.
- Likewise, ensure that initial projects are successful. Nothing dampens community and agency enthusiasm like failure.

Opportunities to improve the performance of slag as a growing medium abound. The strategy for successful revegetation of slag consists of the following:

- Improve nutrient availability. Add manure, compost, biosolids, and/or fertilizers. A veneer of organic amendments or soil over slag will perform as well (and sometimes better than) amendments mixed into slag.
- Provide a sheltered seedbed with adequate improved water availability by mulching with compost, straw/hay, and/or manure. These amendments will help sustain seedlings as they germinate and root into the underlying soil, and will provide sources of soil microbes and enzymes.
- Seed/plant fast-growing species that will quickly cover the surface, produce mulch in-situ, and break the wind at ground surface.
- Seed/plant deep-rooting species, including leguminous species: plants in the pea family (Fabaceae or Leguminosae), many of which have the capacity to fix nitrogen.
- Build or plant windbreaks (snow fence, earthen windrows, planted or seeded woody plant hedgerows) to reduce wind stress on downwind plants.

It is important to note that, depending on available resources and the level of landscaping intensity, the above measures can be used to improve the growth of plants on slag with or without the use of imported cover soil. Use of cover soil will generally improve the speed of establishment and diversity of plants established in the long run. Use of soil will also tend to increase surface water runoff and decrease, but not eliminate, percolation of water through slag. Even with thick soil cover, it is reasonable to expect that about one third of annual precipitation will percolate into and through the slag.

Management of Rare and Endangered Species

Native rare species and significant/sensitive habitats have been identified in the background research. PNDI species should be addressed through the standard protocol, as guided by botanists and biologists with the Carnegie Museum of Natural History. In planning the exact location of trails, trailheads, and other facilities and programs, important habitats should be avoided to minimize trampling and wildlife disturbance.

A multi-disciplinary approach (designers and scientists) should be encouraged as a prelude to any specific installation or program application. Access by researchers and educational groups should occur only by permission of the watershed's management authority when it has been established that the watershed values will not be affected. Except for carefully planned and monitored watershed activities, native species should not be disturbed or removed unless under an approved research permit.

Management of Wildlife and Feral Pets

NMR stream corridor contains a fairly significant diversity of animal species. The emphasis of management should be on allowing the stream corridor's native animal populations to develop with as little human intervention as possible. This policy will require the management of people and related land uses.

Management of Human Predation and Destruction

Illegal harvesting of plants, animals, and material has probably been occurring in NMR for decades, although this is not well-documented. The killing of wildlife such as native snakes, the picking of spring wildflowers, harvesting of fiddleheads, mushrooms, and other wild edibles--these and similar actions adversely affect species, natural communities, and the local environment (Dawson, 1991). Appropriate state regulations and watershed policies should be enforced. Stream corridor visitors and surrounding residents should be encouraged to become stewards in monitoring and reporting illegal and damaging activities. A proactive program of public awareness and education should be considered as part of more detailed management strategies.

Management of Invasive Plants

Invasive plants are a highly significant reality in NMR. Invasive patterns of disrupted soil regimes, industrial fill, impoverished growing conditions, and a readily available source of invasive species propagules combine to create an optimum culture for invasive species. However, because a range of natural and cultural values are at stake, it is wise to begin assuming responsibility for management and control of invasive plants in NMR and throughout the watershed.

We consider the application of new ecological knowledge within an adaptive management approach 'where monitoring and responsive-but-cautious interventions are essential to both long-term success and a heightened understanding of ecosystem dynamics' to be the most appropriate approach for NMR. Priorities for control or removal of invasive species should be directed at those that pose the greatest ecological threats, namely those that (SER, 1994):

- replace indigenous key species or rare and endangered (PNDI) species;
- substantially reduce indigenous species diversity, particularly with respect to the species richness and abundance of conservation species;
- significantly alter ecosystem or community structure or functions;
- persist indefinitely as sizeable sexually reproducing or clonally spreading populations;
- are very mobile and/or are expanding locally.

Recovery of Riparian Plant Communities

Vitally important to the long-term ecological health of the NMR stream corridor is the ecological integrity of its riparian slopes and stream banks. This linear zone is, along with the aquatic ecosystem, the lifeline of the stream corridor, providing the primary ecological conduit for materials, energy, and species between the Monongahela River valley, Frick Park, and the upper watershed. Riparian and lowland vegetation provides a conduit for the in- and out-migration of animals and--over longer periods of time--plants. Biotic movement in NMR is not only important for immediate species richness, but to ensure that genetic communication takes place between isolated populations, thereby increasing their viability (Ambrose, 1992). Frick Park and the Monongahela valley therefore are seen as important sinks of natural genetic material.

Riparian vegetation also provides important values for NMR's aquatic environments. Overhanging trees and shrubs provide organic detritus that is invaluable to fish and macroinvertebrates. Shade provided by bankside vegetation helps maintain cooler water temperatures; streambank vegetation also provides a resilient and regenerative means of erosion control. Finally, riparian and lowland vegetation provides widely acknowledged habitat value.

In contrast to the slag slopes, much of NMR's riparian and floodplain ecosystems are fairly well vegetated, although often with non-native species. Rather than the comprehensive program for regeneration called for on the slag, these habitats require a more surgical approach to dealing with the problems of erosion, soil degradation, stretches of riparian-based slag, cultural intrusions such as mown turf and mountain bike trails, and invasive species control.

Regeneration on Slag Slopes

The dysfunctional characteristics of the existing slag slopes are well-documented in this and prior reports. It is clear that the ubiquitous nature of the slag presents a complex challenge. Published research on similar precedents is scarce. Rather than thinking of slag as a 'constraint' to be 'overcome', perhaps it presents an opportunity in creative learning, a potential contributor to the continuing story of the culture-nature continuum so evident in this valley.

By looking at regeneration on NMR's slag lands as experimental, there is an opportunity to watch, measure, tinker, and demonstrate to a wider brownfields constituency. This approach overtly acknowledges that there is (as yet) no one tried-and-true technique that conventional reclamation may, in fact, hinder other, more creative solutions. Pittsburgh's public and stakeholders will surely understand built models better than conceptual ones. Perhaps most importantly, an experimental approach will provide one of the more important scientific bases for ecological management and design of this brownfield site and others like it. It can provide insights that currently do not exist. If the mechanisms that cause vegetative change are understood, then they can be exploited to manipulate vegetation, and the results of these manipulations can be predicted more reliably (van der Valk, 1988).

What is the range of possible approaches to the slag slopes? Short of wholesale relocation of the slag elsewhere, which is indefensible from a sustainability perspective, possibilities range from conventional regrading to standardized gradients (e.g. 2:1 or 3:1), application of imported topsoil and hydroseeding with pedigree turf, to quite unorthodox and ecologically-intriguing solutions incorporating natural successional processes.

Hodge and Harmer (1995) profile five general approaches to woodland creation on difficult urban and post-industrial sites characterized by high levels of environmental stress (drought, pH extremes, etc.). The descending order of approaches illustrates the full range of regenerative approaches to revegetation, moving from the natural selection and competition which occurs in nature to increasingly intensive management. It could be argued that the goal of a sustainable post-industrial vegetation regeneration is an approach which provides the most experiential-aesthetic benefit while achieving an equitable balance between management costs and ecological risk.

Natural colonization
(Approach #1) is clearly evident on the northerly, older slag slopes. This presents the most immediate and relevant reference site for reclamation of more open slag slopes. As noted earlier, however, the mid-successional slopes may embrace subtle differences, attaining a tolerable growing culture not yet evident on open slopes. The relative stability of surface aggregates and the possible presence of mineral soils may both provide just the level of sustenance needed to stimulate vegetative growth. On the other hand, existing vegetated slopes are older than the open areas (Prellwitz, pers. comm.) and have had a longer time to vegetate.
It is forseeable that given time, natural succession may yet prevail on all slopes.

Nurture colonization, natural planting, and nurture planting
(Approaches #2, #3, and #4) are the models that we suggest may prove most fruitful for Nine Mile Run. These accept that some sort of accelerated vegetation, or 'kick-starting', will be necessary to help restore stream corridor ecosystem functions and enhance open space aesthetics in concert with the proposed development on the slag plateaus. Approaches #2 and #3 work with natural processes, but are not adverse to translating contemporary knowledge in restoration ecology and reclamation science. Approach #4 takes into account the challenging conditions of germination, and closely manages the first two years of growth.

Ideal-driven planting and forced ideal planting
(Approaches #5 and #6) represent conventional models that have in the past appealed to managers of high-use urban open space. They tend to be driven by economic or visual criteria, rather than ecological principles. Each entails a visually ideal choice of plant materials which may not be suited to the constraints of the environment and therefore requires increasingly intensive management and an elevated risk of failure.

Stream Restoration

Upstream Testing
Fecal coliform testing should be expanded upstream of the daylighted portion of NMR. Site 3 branches out in three directions on the other side of the I-376/Braddock Avenue interchange. Each branch should be tested to pinpoint the source of constant sewage pollution that is discharged from this influent to NMR. The 16 ft box culvert at Braddock Avenue (Site 1) has several branches that could be tested. Testing three to five strategic locations in Edgewood and Wilkinsburg would be extremely beneficial for narrowing the possible sources of sewage during dry weather and perhaps wet weather. Sites 2 and 6 have daylighted portions that could easily be tested. Should these sites become a greater impact on NMR as the weather changes, testing could be moved upstream. Site 11 could be tested further up, though it must be traced first. This pipe is currently not mapped with the city of Pittsburgh sewers.

Detailed Sewage Infrastructure Mapping and Assessment
A necessary first step toward repair or renovation of the sewage infrastructure in the NMR watershed is mapping and assessment of infrastructure. The Allegheny County Health Department is currently compiling sewer maps from the four municipalities that can be used to evaluate the sewershed as a whole. This sewershed mapping is critical for evaluating and mitigating sewage impacts on NMR. A rigorous field verification must be performed to assure that the digitized maps reflect what is in the field. Discrepancies have been found, for example, between the CADD map of Pittsburgh and the actual locations of manholes and stream crossings. Field surveying of selected manhole locations, invert elevations, and other features is needed to ensure accurate mapping. In conjunction with the mapping effort, inspections of selected sewers and culverts are needed. Visual and television inspections typically are performed in such efforts. An assessment and inventory of all influent pipes would help identify unauthorized tie-ins. Such tie-ins clearly exist and it should be possible to identify a significant number of them rapidly. Inspections will also identify pipe blockages that contribute to SSO problems.

Watershed Stormwater Management Program

A significant part of the sewage contamination problems in NMR is related to current stormwater management practices. Stormwater management should be reevaluated on a watershed-wide basis. A task force focused on the problems of the NMR watershed, with representation from the governments of all four watershed municipalities, should be created to look at the problems as a whole, and a stormwater management plan should be developed. This plan could include enhancement of stormwater infiltration in the watershed, restoration of stormflow in subsurface or surface basins, including wetlands, and other measures (see Appendix VII-g, wetlands are addressed in Section V). With such a plan, local efforts can begin on a variety of aspects in a coordinated manner. Proper separation of stormwater and domestic sewage within the NMR watershed is vital to the long-term mitigation of sewage problems in NMR. Also, the mitigation of other problems, such as high peak flows, will be best addressed through localized but coordinated efforts throughout the watershed.

Pittsburgh NPDES Permit Conditions

A long-term plan to upgrade the sewer system in the east end of Pittsburgh should be among the requirements in the NPDES general permit for Pittsburgh CSOs. A solution to the awkward CSO configuration discussed in this report, namely the CSO discharge to the NMR culvert in Wilkinsburg, should be a condition in the permit.

Modifications to CSO Discharges

The odor impact in dry weather from both CSO and SSO diversion chambers is an important aesthetic issue relevant to NMR. Flap gates on all the CSO discharges would improve the odor problem significantly and could be implemented in the short-term. Flap gates may also help reduce odors from the three SSO discharge pipes at Braddock Avenue by breaking the direct path that exists between the sewage and the open air.

The stagnant pools associated with two CSO discharges (Sites 9 and 12) should also be addressed in the short term. This problem could be fixed relatively easily. The pool at the outfall downstream of Commercial Avenue could be adjusted with some skillful backhoe work. The outfall in Frick Park may take some redesign because the bottom of the chamber is at stream grade.

Stream Odor Survey

Although general observations have been made regarding odor problems around NMR, a separate detailed stream odor survey is highly recommended. Odor problems have been confirmed in the vicinity of CSOs and SSOs specifically. A survey of the entire stream along its length at different times would be beneficial, as no comprehensive inventory has been documented at this point.

Stream Erosion Survey

Several sections of Nine Mile Run show signs of accelerated bank erosion. A detailed study should be carried out to inventory the extent of the damage already done and to identify the most serious problems. Bank stabilization options could then be considered. The 'flashy' nature of the watershed cannot be changed readily. However, some measures could be taken to reduce energy in the flow, perhaps by placing baffles or large stones in the concrete channel. The ideal configuration for such energy dissipation measures will require further study.

Use of Constructed Wetlands for Remediation at NMR

Constructed wetlands may be potentially useful for helping to mitigate both water quality and flow problems in NMR. Constructed wetlands have the potential for reducing fecal coliform bacteria concentrations in the water through the sedimentation and attachment to plants (Gearheart, 1997). A wetland could be designed as a passive system, where streamwater in NMR passes through wetland plants, providing some water quality benefits. A wetland may also be part of a managed treatment system designed for optimal water quality improvement. There are several

Watershed Management, Integrating Infrastructure with Ecology

Urban watersheds have traditionally been managed as infrastructure systems, ignoring the underlying ecosystems which have been often displaced and always affected. The Federal Clean Water Act and the Pennsylvania Clean Streams Law have instigated regulatory agencies (Pennsylvania Department of Environmental Protection and Allegheny County Health Department) to maintain water quality standards at the 'receiving body of water'. This has typically been accomplished through the regulation of point source discharges and related enforcement actions. Typically, such action has resulted in expensive detention projects or watershed authorities who concentrate on an isolated length of trunk sewer line (local examples include Falls Run and Girty's Run). An integrated watershed authority mandated to monitor and protect the stream ecosystem through chemical and biological analysis would provide a more equitable gauge of infrastructure function efficacy than the existing model. Urban ecosystems may prove to require a more vigilant analysis than suburban and rural systems. An integrated watershed authority with the ability to monitor and protect the stream ecosystem and maintain the infrastructure would connect the cause and effect of urban watershed degradation. We will outline a number of options for creating a multi-municipal watershed authority and its potential to integrate ecosystem and infrastructure in its management mission.

The overall goals of a NMR Watershed management structure are:
1. Equitably eliminate existing sewage pollution and slag leachate problem.
2. Explore options to minimize stormwater damage and pollution.
3. Restore and steward the ecosystem functions in the stream corridor.
4. Manage the infrastructure and ecosystem to maximize benefits and minimize costs.
5. See the greenway built and managed as a watershed resource.

In summation, the NMR watershed agencies and communities are infrastructure focused, with little attention paid to the cause and effect of the infrastructure and its dysfunction on the ecosystem which defines the 'receiving stream'. Pittsburgh City Parks and the DEP are the most likely agencies to take an interest in the conditions of urban infrastructure. DEP's interests are statewide and focused on more pristine environments rather than historic urban problems. The Pittsburgh City Parks Department is interested, but not enabled politically or financially to act on the problem.

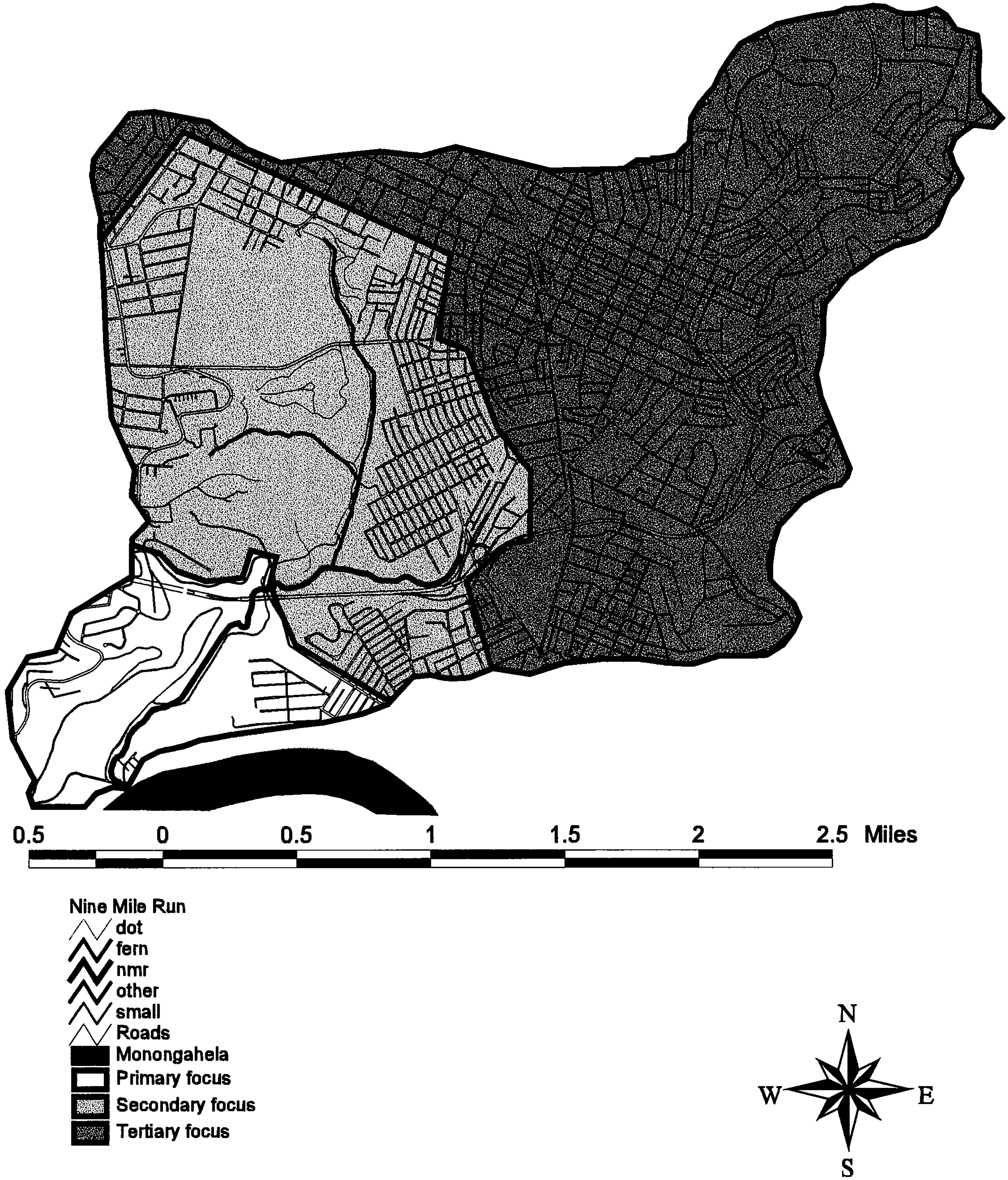
Multi-Municipal Watershed Approaches

Local governments have the legal authority through existing legislation to enter into an agreement, a contract, or an environmental compact. In fact, the Allegheny County Health Department has recently issued new Sewage Disposal Regulations which require 'municipal management and cooperation of sewage management between municipalities'. (Section 1401 of the Allegheny County Health Department Rules and Regulations). The organizational structure is up to the participating municipalities.

Nine Mile Run Watershed Rivers Conservation Plan
Specific Project Recommendations

Project	Estimated Cost	Lead Agency/Partners	Time Schedule
Bio-Blitz of Nine Mile Run	Unknown	Pittsburgh Department of Parks and Recreation/ Carnegie Museum of Natural History	Spring, 1999
'Job corps' style program style program of native species management and training	Unknown	City of Pittsburgh/Western Pennsylvania Conservancy	Unknown
National conference on the issues of brownfield redevelopment	Unknown	Industrial Site Recycling Conference	
Local education initiative for both public and private sectors	Unknown		
Greenhouse program featuring native species propagation, seedbank and nursery program onsite	$50,000	City of Pittsburgh/ Carnegie Mellon University/Carnegie Museum of Natural History/US EPA	Spring 1999
Specific demonstration projects for re vegetation of slag slopes.	$80,000	City of Pittsburgh/ Carnegie Mellon University/Carnegie Museum of Natural History/US EPA	Fall 1998—Spring 2000
Regeneration of prairie grasslands	Unknown		
Riparian corridor regeneration and bank stabilization	$7.7 million *	City of Pittsburgh/ Three Rivers Wet Weather Demonstration Project/ Army Corps of Engineers	2000-2003
Upstream testing of storm sewers	$300,000	Three Rivers Wet Weather Demonstration Project	1999
Sewage infrastructure mapping and assessment	Unknown	Three Rivers Wet Weather Demonstration Project	1999-2000
Watershed Storm Water management program	Unknown	Three Rivers Wet Weather Demonstration Project	1999-2004
A long term plan to upgrade the sewer system	Unknown	Three Rivers Wet Weather Demonstration Project	1999-2004
Modifications of the existing CSO discharges	Unknown	Alcosan/City of Pittsburgh	1999-2000
Stream odor survey	Unknown	Carnegie Mellon University	
Streambed/bank Erosion Survey	$7.7 million *	City of Pittsburgh/ Three Rivers Wet Weather Demonstration Project/ Army Corps of Engineers	2000-2003
The restoration of floodplain	$7.7 million*	City of Pittsburgh/ Three Rivers Wet Weather Demonstration Project/ Army Corps of Engineers	2000-2003
Pilot infiltration projects for upstream communities	$75,000	Carnegie Mellon University/Rocky Mountain Institute	Fall 1998
Engineering feasibility studies on alkaline leachate	Unknown		

Watershed Priority Focus Areas



Introduction: An Ecosystem Perspective

In the past, many river planning efforts have served to enshrine rivers and their watersheds as resource-generators. River conservation plans have often seen the river as a commodity, a watery channel from which benefits could be gained. From this river-as-resource theme typical objectives have emerged: boating, angling, tourist dollars, hydro-electric power, conduits for stormwater and wastewater. But over the past decade or so, rivers have been the focus of much more holistic scrutiny, cutting across an ever- widening spectrum of natural and social sciences. There is an emerging consensus that we need a new, more complex approach to rivers and their environs.

In looking for a replacement paradigm, those interested in river conservation have begun to see riverine environments as only one thread of a vastly complex and larger living land-scape. This stance views the stream, its valley corridor, the region (both naturalistic and humanistic) and beyond as inseparable in concept and fact.[1] Disciplines that address the earth and its organisms are finding it increasingly difficult to "draw the line." Geologists, ecologists, anthropologists, economists, engineers, planners, artists—all are beginning to relate to the notion of *ecosystems*.

An ecosystems planning approach to Nine Mile Run would emphasize the need to balance ecosystem health, quality of life, and economic vitality. It would find a balance between natural and cultural diversity. Policies and development proposals in and around the valley would not be judged solely on their economic merits or other social objectives, but also on whether they add to regenerating and improving a region's ecological health. Collectively, these goals point towards an overall heightened level of ecosystem integrity, and by extension ecosystem sustainability.

The ecosystems approach, then, is antidotal to disjointed and simplistic thinking about environments, communities and relationships. It includes humans as an integral part of the urban region's ecology, but also demands an ethical response to the heritage of environmental degradation that pervades places like Nine Mile Run. It celebrates natural and social history, and searches for links between the biotic and the abiotic. For Nine Mile Run specifically, the ecosystems model provides the most hopeful and integrative outlook from which to plan a sustainable public space in the stream valley with the support and stewardship of the communities that border it.

"We cannot continue to satisfy our own needs at the expense of future generations"
G. H. Brundtland (1987)

---

[1] The ecosystem perspective brings together two key Leopoldian notions. The first is that "everything is connected to everything else" (Leopold 1949). The second is that to appropriately intervene into any natural system, one must delve into the essence of that system. If Leopold were to comment on the NMR project, he might initially suggest that we "think like a stream valley." And upon delving into the study area, he might also come to acknowledge the tremendous role of culture and commerce in shaping what Nine Mile Run has become, perhaps adding "and like a slag pile, too."

I. Project Area Characteristics

I-a. Location (Map I-a)

Nine Mile Run (NMR) is an urban stream that can be found on the USGS Pittsburgh East Quadrangle map of Allegheny County (7.5 minute series, topographic). It can be easily found by looking for the third bend of the Monongahela River, measured from Point State Park. Directly across from Homestead, the **watershed** includes the areas north of the mouth, through a section of Squirrel Hill, into Homewood, then east to Wilkinsburg, then south to Edgewood and Swissvale.

Referencing the 1,000 meter grid:

Longitude	591,000 meters east - 596,000 meters east
Latitude	4,474,000 meters north - 4,479,000 meters north

Community Input

John Seibal mentioned that he is attracted to the site by the fact that it is one of the last remaining examples in the city of a valley stream flowing down to the river.

Peggy Charny suggested we need to look at the slag pile in a more positive way. Assuming it is safe, the slag pile can be used as an education resource. There is already some new vegetative growth near the Parkway and the site can be used for people to gain an appreciation of successional growth. The slag is evolving if you pay close attention.

I-b. Size

The entire length of the stream is under 1.8 miles from where it first emerges from culvert near Braddock Avenue in Frick Park to its mouth at the Monongahela. The watershed is roughly 6.5 square miles.

I-c. Topography

The topography consists of low hills and river valleys. Much of the watershed is primarily hard surface, typical of an urban watershed. In the upper section, there is a 476-acre park of primarily wooded uplands with some river valley bottom and remnant wetland areas. The lower section of NMR is dominated by an industrial dump site (or brownfield) where slag, a by-product of the steel industry, was dumped continuously over a 50-year period. The broad floodplain that once existed is irretrievably buried in piles of slag up to 20 stories high. This creates a canyon-like environment with some residual **riparian growth.**

I-d. Major Tributaries (Map I-d)

The NMR watershed is characterized by two river valleys that drain spring-fed first order creeks, themselves feeding into second order tributaries, to the main body of the stream, which is of the third order. The larger of the two second order tributaries is culverted. It winds through three municipalities to emerge in open channel in Frick Park before meeting the other major tributary. The other second order tributary is a 400-acre remnant of the original watershed in Frick Park. This second order stream is known as Fern Hollow Creek which is in turn fed by spring-fed creeks. Fern Hollow Creek and its first order tributaries are fairly clean.

I-e. Corridor

To adequately describe NMR, we need to consider the upper and lower reaches. The upper reach emerges from a **culvert** and travels downstream in a westerly direction. The northern banks transition from minimal park land to significant stretches of park land. The southern banks border a thin stretch of park land transitioning into the Parkway East (I-376) and beyond that, the community of Swissvale. The lower

watershed: a region or area bounded peripherally by a water parting that drains to a particular body of water

riparian growth: plants living or located on a natural watercourse

culvert: a concrete pipe that encloses a portion of or an entire stream or creek reach passes under Commercial Avenue just below the Irish Centre of Pittsburgh. It travels in a southwest direction to empty into the Monongahela. The lower reach is defined by a brownfield/slag dump and the community of Squirrel Hill to the northwest and the community of Swisshelm Park to the southeast.

Immediately across the Monongahela River from the mouth of NMR is a large, vacant brownfield site and the main streets of downtown Homestead.

I-f. Social Economic Profile

I-f1. Population Centers

Of the seven square miles in the watershed, approximately 35% is undeveloped land. This undeveloped area is generally steep slopes or extensive green areas, including Frick Park and Homewood Cemetery. The balance of the watershed is primarily residential with some commercial and industrial uses. Because of the small scale of the watershed, it is all in the proximate area of the Nine Mile Run stream and the Monongahela River.

The population of the City of Pittsburgh has declined since the collapse of the steel industry in the 1970's, moving from a high of 700,000 in 1950 to 370,000 today. The region also has a large elderly population and a small outmigrating young population. The population of the communities in the watershed are:

Community	Population
Edgewood	3,589
Swissvale	10,637
Wilkinsburg	21,080
Regent Square	1,108
Swisshelm Park	1,522
Squirrel Hill/South	4,573
Point Breeze	3,467
Homewood/South	2,097
Total	**48,073**

Table I-f1

See also:
- **Map 1-f1a** for Unemployment Rate
- **Map 1-f1b** for Median Household Income
- **Map 1-f1c** for Population per square mile

I-f2. Regional and Local Vehicular Access

NMR is strategically positioned with respect to regional transportation systems. It is generally accessible by pedestrians from the surrounding neighborhoods **(Map I-f2)**. As a potential riparian corridor system, however, several transportation modes will become important as the primary means of connecting people with the study site by: car, bus, foot and bicycle. There is also a possibility that access by boat may someday become feasible.

Access for motorized vehicles to Nine Mile Run can be considered at both the regional and local levels. At the regional scale, the four-lane Parkway East (I-376) provides a high-capacity means of accessing the general study area. Since it passes over the heart of the valley, I-376 provides no direct access. Instead, one must negotiate the flanking neighborhoods of Squirrel Hill, Swissvale, or Edgewood. The Squirrel Hill approach is easily accessed from Interchange 8 and through the Monitor-Beechwood-Commercial arterial street combination.

The Swissvale approach from I-376 to the primary Commercial Street through-route is less convenient. From Interchange 9, the most direct link to Commercial Street is via Whipple Street, a narrow local residential street that was not designed to accommodate through traffic. Interchange 9, however, provides very direct access to the upper end of the greenway via Braddock Avenue in the southwest Edgewood area. From Braddock Avenue, a spur lane below what is recognized colloquially as the "Foodland" parking lot, culminates at the main culverted outlet of NMR. This small side street accesses the uppermost reach of the study area and should be further investigated for its potential as a **trailhead** parking area.

Access from Pittsburgh's Southside can be gained via the Homestead High Level Bridge and Brown's Hill Road. From this direction, the lower portion of the site can be accessed via Old Brown's Hill Road, while accessing the central and upper portions of the site would require taking the Beechwood-Commercial Drive route noted previously.

Two roads lead directly into the core of NMR: Old Brown's Hill Road and the Forward Avenue-Commercial Street combination. Both are steep, winding, two-lane asphalt drives with minimal shoulders and gravel verges. The former is lightly traveled, while Forward Avenue is a busy throughway (5,400 vehicles per day) that links neighborhoods on either side of the valley and functions as an unofficial bypass of the Squirrel Hill Tunnel during rush hours. Old Brown's Hill Road culminates in a small parking lot (40-50 space) overlooking the Monongahela River. A short laneway (McFarren Street) doubles back over a narrow bridge spanning NMR to access the 18-residence hamlet of Duck Hollow.

In overall terms, NMR is highly accessible to both regional and locally-based vehicular traffic. The most accessible and least disruptive route for regional visitors coming from I-376 is via the Beechwood Exit (Interchange 8) while a quick, but rather intrusive, route (Interchange 9) is available to visitors originating from the east along I-376. Access to the valley proper is available through either of the two main gateways mentioned above. The Forward Avenue-Commercial Street descent is of primary concern due to its steep grade and winding alignment.

I-f2a. Public Transit

Access to NMR via the PAT (Port Authority of Allegheny County) service is dispersed along the periphery of the site. Along the north border of

Propsed Development Changes

A current development plan calls for a roadway entrance to Commercial Street near the location of the CMU trailer.

"The entranceway should be more toward Nine Mile Run. . . A center, left-turn-only lane for westbound traffic on Commercial Street should be part of the Phase III entranceway construction to facilitate entrance onto the Phase III development without causing traffic to back up on Commercial Street."
Position of the Residents of Swisshelm Park on the Current Proposed Development of the NMR Valley

Citizens at an early workshop discussed how to access the greenway, some of the issues raised:
- Commercial Street is dangerous,
- Traffic near the trailer is dangerous,
- Crossing the road is hazardous.

The citizens discussed options that might make the Commerical Street crossing safer including:
- wildlife underpass,
- pedestrian activated signal.
- traffic calming,
- pedestrian overpass.

---

trailhead: the point where a trail begins the study site in Squirrel Hill, the 64A Highland Park bus route runs along Brown's Hill Road and the 74A route runs along Beechwood Boulevard. Numerous stops give ample opportunity to those seeking to access the valley's brow from the Squirrel Hill side, although trailheads are currently informal and rather infrequent (see Pedestrian Access below). Access to the mouth of the creek via bus transit would currently entail disembarking at the stop at the intersection of Brown's Hill Road and Old Brown's Hill Road and walking a distance of more than 2,300 feet along Old Brown's Hill Road.

Bus lines 61A and 61B also serve the neighborhoods of Swissvale and Edgewood along the east side of the valley. In particular, bus stops along Braddock Avenue near the Braddock Street trailhead (historically called the Swisshelm Entrance) provide a potentially important public transit service to the upper limits of the riparian corridor.

I-f2b. Pedestrian Access and Trailheads (Map I-f2)

NMR is flanked to the east and west by pedestrian-friendly neighborhoods. A network of sidewalks, curb cuts, and traffic control devices generally provide a barrier-free environment for walkers and those with walking disabilities. Many side streets (with and without sidewalks) follow the valley's brow or extend laterally to cul-de-sacs at the edge of the site. Each of the three major neighborhoods encircling NMR have a number of existing and potential trailheads. Only a few have formal accommodations: signage, surface trails and parking.

The primary means of pedestrian entry into NMR from the perimeter neighborhoods is via a series of informal trailheads. For the most part, these entry points do not possess the necessary space, positioning, or ownership status to serve as public portals into the valley. A few exceptions include:

- the Frick Park parklet at the west side of Frick Park;
- the Frick Environmental Center, which serves as a major trailhead to the Falls Ravine Trail and Tranquil Trail, both of which merge with Braddock Trail which descends further down the valley;
- the Hutchinson Entrance (an asphalt lane) at the southeast side of Frick Park, extending to the Braddock Trail and recreational facilities of Fern Hollow in the valley below (includes a large parking lot);
- a small public green space at the intersection of Sanders and Richmond Streets at the southeast side of Frick Park from which a dirt path links with the marked Braddock Trail; and
- possibly one or several of the cul-de-sacs located in the extreme westerly sector of Swisshelm Park. In collaboration with local residents, the termini of Goodman, Love, Uptegraff, and Onandago Streets should be investigated in more detail for their capability to accommodate mini-trailhead facilities: 3-5 car parking, signage,bicycle stands, and formalized trail leads into the valley. (Note: No similar opportunities to upgrade cul-de-sacs exist on the Squirrel Hill side of the valley.)

Within the valley itself there are four functional trailheads. Listed from upper to lower valley, these include:

- a small gravel pull-off (3-4 car) along Forward Avenue at the head of Fire Lane Trail (little more than a widened shoulder);
- the 20-25 car private gravel parking lot serving the Irish Centre and located along Forward Avenue almost immediately beneath the I-376 overpass;
- the clearing associated with the present Carnegie Mellon University trailer, accessible from Commercial Street; current graveled area can accommodate 5-8 cars; and
- the 40-50 car parking lot (gravel and asphalt) at the base of Old Brown's Hill Road along Second Street (an unimproved public right-of-way aligned between the Monongahela River and the CSX railway).

A network of trails and pathways can be found within the valley-and-terrace topography which characterizes NMR. From the I-376 overpass south, the primary means of negotiating the valley is a 3 m wide graveled track known as "the jeep trail." Its main easterly alignment stretches some 1,700 m (5,600 ft) culminating at Old Brown's Hill Road. Along the way, it passes through a variety of environments, crossing the stream via a small timber bridge of questionable stability at approximately the half-way point. Just west of the bridge it forks, allowing walkers and bikers the opportunity to ascend a 1,030 m (3,400 ft) **switchback route** that traverses the slag pile on its way to the top of the plateau near the Squirrel Hill Tunnel entrance. The slag terraces themselves are almost completely open, permitting the walker (or biker, see below) to decide his own course. The jeep trail comprises a route over 2,730 m (1.7 mi) in length, accessing the main internal units of NMR below the overpass, and linking Frick Park with the lower end of the valley. Originally installed to service slag-dumping operations, it has over the years become adapted to new use patterns and now serves as the spine of movement through the valley.

From the Braddock Street culvert trailhead to the I-376 overpass, a series of trails link the community of Swissvale with Frick Park's NMR and Fern Hollow and the lower NMR site. Extending westerly from the Braddock Street culvert are two packed-earth trails on both sides of the stream. At times both trails meander precariously close to the steeply-eroded stream bank; slumped earth and poorly-maintained chain link fencing combine to create a hazardous situation which should be rectified. The trail along the south bank crosses the stream in an informal manner via the semi-buried Swissvale stormwater main which runs diagonally through the creek bed, culminating at the playing fields. Several dirt trails continue to parallel the stream's north bank, terminating at Forward Avenue. About 120 m up-gradient from these streamside trails is the Fire Lane Trail, a gravel-and-asphalt track linking the parking lots in Fern Hollow with the small Forward Avenue trailhead noted previously. When pedestrians confront Forward Avenue, they are met with a challenge: either cross the roadway or turn back. Considering Forward Avenue's hairpin corners and extreme slope, more than a few pedestrians decide against attempting a crossing.

A vast network of even more informal and uncharted paths exist throughout the lower reach of NMR and the lower portion of Frick Park.

switchback route: a zigzag road in a hilly

Community Input

"Nine Mile Run provides a feeder route from the upper watershed into an expanding network of trails that will provide safe, non-motorized routes to popular destinations as urban as downtown Pittsburgh and as rural as Ohiopyle! With increased bicycle traffic we will need to begin to plan management options. Imagine...too many bicyclists in Pittsburgh!"

John Stephen 1998

Without the benefit of ongoing monitoring and on-site agency control, walkers and bikers have been largely free to travel where topography and vegetation have permitted. The creek itself is a favored route for "stream-stomping," particularly during low (and no) flow periods when the various surface textures of pebbles, silt, sand, cobbles, and concrete may best be appreciated. Because of its incised nature and generally thick riparian brush along its steep banks, the stream and parallel path systems are not well-linked, converging at only a few points along the entire valley.

I-f2c. Bicycle Access

A myriad of informal bicycle access points and trails exist along the edge of, as well as within, the NMR valley. In fact, one of the most popular and visible activities in the valley for the past several decades has been off-road trail biking. As discussed above for pedestrian access, most trailheads provide dual service in accommodating bicycle access. The only designated bicycle path near the study area is located along Beechwood Boulevard generally paralleling the westerly boundary of the valley. This asphalt road-based system is well-signed and well-utilized, although along some stretches cyclists are forced to maneuver between the traffic lanes and curb-side parking.

Within the valley proper, there are no formal on-site means to distinguish or separate pedestrians from cyclists. The overlapping, informal networks of old asphalt, graveled, and dirt paths internal to the valley and its terraces currently serve both pedestrian and bicycle movement without discrimination. There have been no (still to be confirmed with police) reports of collisions or conflicts between walkers and cyclists. In considering the potential integration of bicycling as a recreational pursuit and a sustainable means of transportation, one must acknowledge the tradition of relatively unfettered access NMR cyclists have enjoyed over the past several decades. To this significant and largely unorganized group, NMR represents both a challenge and a place of respite away from road traffic.

I-f2d. Boat Access

There is currently no boating activity associated with NMR itself. Shallow low-flow conditions, flashy stormwater regimes, steep longitudinal drop, and a myriad of in-stream structures combine to frustrate any attempts at canoeing or rafting. Boating access to the stream's convergence with the Monongahela River, however, is worth investigating. Fishing and recreational power boating are popular activities in this reach of the Monongahela, and smaller boats and canoes can be seen pulled up along shore. Tugs-and-barges transporting coal from West Virginia ply the Monongahela's deeper channels, and a variety of larger recreational powercraft enjoy the river throughout the year. Some 10 km (6 miles) up-river are the docks of the Gateway Clipper Fleet. Water taxis serve portions of the Allegheny/Ohio pool.

Considering the extent of boating traffic in the Three Rivers area, there appears to be considerable potential for a "**blueway—greenway**" connection at the mouth of NMR. Currently, however, no formal docking

greenway: a network of land designed and managed for multiple purposes including recreational, aesthetic, cultural, and ecological

blueway: a network of water designed in the same way and for the same purposes as a greenway facilities exist near the mouth. A 4 m high corrugated sheet-pile shorewall extends some 120 m down-river from the mouth. While it now serves to retain the gravel parking lot previously noted, it was historically associated with the queuing of barges to unload slag. The convergence of the sediment-laden flow of NMR with the comparatively placid waters of the Monongahela River has resulted in a significant **alluvial fan.** Extending some 20 to 30 m out from the stream's mouth, the deposits not only restrict any up-stream small boat movement, but also raise the specter of periodic dredging to accommodate any future small boat navigation in the immediate vicinity.

Further detailed studies of both the site and the boating market in the region should be conducted to assess the desirability and feasibility of a possible Monongahela/NMR recreational boating hub linked to the proposed greenway.

I-f3. Major Sources of Employment

Since the early 1980s, Pittsburgh's economy has undergone a dramatic shift from heavy industry to a more diversified economic base anchored by service, high technology, health care, and education industries. Currently, approximately 20 percent of the region's employment is in goods producing jobs, including primary and fabricated metals, other manufacturing, and construction and mining. The balance of employment is in service producing jobs, including finance, insurance and real estate, retail trade, and services. The NMR watershed embraces the business districts of Wilkinsburg, Edgewood, and Swissvale.

alluvial fan: loose material, such as sand, gravel or silt, that a stream deposits into a larger body of water over time

A Carnegie Mellon University art student identifies plants along the trail.

Photo courtesy of NMR Project, STUDIO for Creative Inquiry, Carnegie Mellon Univeristy

II. Issues, Concerns, and Constraints

II-a. Urban Ecosystems

NMR has had its ecosystem disrupted by years of human intervention. Urban infrastructure is intended to resolve problems that occur as we create cities and towns, disrupting the natural landscape and its flora, fauna, and hydrology. The urban ecosystem is stressed by a "problem solving" mentality that is often oblivious to the cause and effect relationships of the system. By resolving systemic problems as isolated issues, we often create significant problems elsewhere in the system and frequently reduce the economic, aesthetic, and experiential value the system may provide to the community.

As an urban stream, the value of NMR and its attendant ecosystem is lost within the existing conservation paradigm which views ecosystem value as primarily properties beyond the suburban edge, beyond human intervention. While there is a solid constituency which recognizes the value of post-industrial nature, the view of the stream and its surrounding lands as a dump devoid of nature still resonates amongst many of the parties with an interest in the site.

II-b. Watershed Management

Urban watersheds have traditionally been managed as infrastructure systems, ignoring the underlying ecosystems which have been often displaced and always affected. The Federal Clean Water Act and the Pennsylvania Clean Streams Law have instigated regulatory agencies, namely the Pennsylvania Department of Environmental Protection and the Allegheny County Health Department, to enforce water quality standards on a number of local watersheds. This has typically resulted in expensive detention projects or watershed authorities who concentrate on an isolated length of trunk sewer line. Arguably, the focus of the Clean Water Act and the Clean Streams Law is to maintain and protect the water quality of the receiving stream. An integrated watershed authority with the ability to monitor and protect the stream ecosystem, as well as maintain the infrastructure, would be the most equitable and cost effective way to manage this watershed. This would connect the cause and effect of urban watershed degradation.

II-c. Water Quality

II-c1. Water Quality and Human Use

Water quality in NMR is negatively impacted by inputs of domestic sewage from unauthorized sewer discharges to the culverted section of NMR, from sewer leakage or unauthorized sewer discharges to storm water sewers, and from sanitary sewer overflows (SSOs) and combined sewer overflows (CSOs) to NMR along its length. These sewage inputs are contributed by all four watershed communities and have been occurring for many years. The sewage inputs cause high levels of fecal coliform bacteria in the stream during both dry and wet weather conditions, thus serving to make the water unsafe for human contact. This is recognized as a significant human health hazard by the Allegheny County Health Department.

Community Input

Eileen Bell There needs to be a barrier to dumping. It seems that dumping occurs whenever the jersey barriers are opened. Vehicle access should be prevented to discourage that type of use.

Kenny Steinberg Now that we know many of the sources of the SSO's and broken pipes, what are the regulatory issues? What strategies do we have, given obvious clean-streams law violations?

Jim De Angelis Raising issues and public awareness does NOT affect the stream. The municipalities will not decide to act unless compelled to act. Provide the information to compel action or admit defeat and dissolve this process.

The NMR streambed will soon be surrounded by a contiguous public space from where its first tributary emerges from culvert at Braddock Avenue right to its mouth at the Monongahela. There are three tiers of problems that need to be addressed: (1) the value of NMR is lost to most viewers upon seeing the trash, smelling the SSO/CSO discharge points, and observing the detritus of sewer, highway, and urban neglect which defines the stream and floodplain; (2) fecal counts in excess of DEP/EPA standards for human access and use occur on this stream 365 days a year; (3) stormwater events are extremely dynamic resulting in a torrent minutes after a major rain event. This can present a potential danger to anyone in the stream channel. Storm events are also laden with fecal matter, a problem which is illustrated by chronically discharging manholes.

A NMR **fecal fountain**, or in the language of the the sanitary engineer, a "chronic discharge."

Photo courtesy of NMR Project, STUDIO for Creative Inquiry, Carnegie Mellon Univeristy

II-c2. Water Quality and Ecosystems
The NMR watershed is 34 percent open space. Runoff from adjacent Frick Park and Homewood Cemetery produce three small creeks that exhibit good water quality and a diversity of benthic organisms. Despite this fact, Frick Park and Homewood Cemetery place a significant amount of surface flow into storm sewers to protect trails. A study of the park during construction of the sewers in 1947 indicated a significant drop in the ground water levels and a cause and effect on the plant life (Black, 1947).

NMR has lost its floodplain and wetlands to industry, highway construction, and pressing recreational uses. Because of this, NMR digs into its streambed with a powerful erosive force. The effect of this includes a sediment load that is detrimental to life in the stream; it also has an obvious effect on the Monongahela, as illustrated by the sandbar that has developed at the mouth of NMR.

II-d. Slag and Toxicity

The lower end of the NMR floodplain is dominated by 20 million tons of steel mill slag. This brownfield site is currently being studied and prepared for development for both a housing and a riparian corridor component. Recent studies commissioned by the site owners, the Pittsburgh Urban Redevelopment Authority (URA), have indicated a number of issues that are relevant to the NMR Rivers Conservation Plan.

The overt effect of slag on the stream is clearly demonstrated by the walls of the stream that are producing a leachate characterized by a 9.6-10.6 pH. This occurs in the lower end of the stream just above the mouth at the Monongahela **(see Map II-d)**. The pH change produces an obvious precipitate which coats the bottom of the stream and appears to prevent algae from forming. This effect on the ecosystem has not been analyzed. Tests for exposure to water and slag which may contain toxic elements are under review by the URA. They are working with the community to test, review, and retest as necessary to identify any potential problems. The reports, thus far, have concentrated on the area of housing development and have not addressed the lower riparian corridor and its open space. The most recent *Report on Clean-Up Plan for Nine Mile Run Slag Area* by

Community Input

Eileen Bell asked about stormwater flow, especially from the new development. Are Duck Hollow residents going to need flood insurance?

Elizabeth Barrow asked if the study is looking at wetlands as a filtration mechanism.

Advanced Systems Technology Systems (June 1997) comments on slag exposure: "All target receptors are below the target levels set by the EPA and the PADEP for exposure to the existing constituents of the slag material. Soil cover will be a minimum of 18 inches to allow adequate cover of the slag, eliminating any exposure pathways to future residents." And on water: "No direct contact with groundwater is likely to exist and this exposure pathway would not require further evaluation." An 18-inch cover is unlikely in the lower riparian corridor part of the valley, and access to the stream is a critical part of the riparian corridor. In a recent discussion (April 21, 1998) with a senior representative of the URA, Jerry Dettorre outlined a subsequent toxicity analysis which will address the toxicity pathways as they would apply to the riparian corridor and its users.

II-e. Public Access and Use

NMR is most accessible in lower Frick Park where an adjacent ballfield encourages children and families with dogs to sometimes recreate in and along the stream banks. The other access point is on the URA property, where children and adults find easy access under I-376 and by various trails leading to the water's edge on the Commercial Avenue end of the property. The steep slag slopes deny access to the stream throughout the rest of the property with exceptions at a dilapidated bridge in the center of the property and two maintenance trails leading to remnant wetlands which are bordered by shale outcroppings on the eastern/Duck Hollow side of the property.

The NMR corridor contains a number of conflicting use patterns. The primary conflicts occur between slow-moving contemplative users and more active users of the park. The user group with the least effect on landscape and maintenance are naturalists who use the park for walking, birding, and botany study. A significant user group are dog walkers in the park. A preference to let dogs run free is a source of conflict with other users and wildlife in the park. The expanded use of mountain bikes for both transport and recreation has created a situation in which trails, hillsides, and paths are developing erosion problems. The ballfield in lower Frick Park is also the site of significant use, causing attendant traffic, parking, and maintenance demands.

II-f. Historic and Future Development

The NMR upper watershed is primarily developed in all four municipalities. Characterized by residential and commercial uses, large scale industrial uses have moved out of the watershed. Remnant open spaces in the upper watershed are either defined as parks, highway right-of-way, or properties which are not conducive to development because of steep grades or other site-specific economic constraints. Properties available for redevelopment are either residential or, as in the case of some properties north of Penn Avenue such as the Rockwell Industrial Park and the Wilkinsburg recycling transfer station, post-industrial brownfield properties.

The lower watershed of NMR is, by contrast, primarily open space and some of it is available for development. Principally characterized by

Community Input

Mary Kostalos What are the specific toxicity issues of the slag on water quality?

Marilyn Skolnick the NMR watershed valley is one of the last natural areas. How will the Mon-Fayette Expressway affect this natural connection of stream to river?

Elizabeth Barrow, of the Nine Mile Run Greenway Steering Committee, recommends the International Mountain Biking Association's Rules of the Trail:

1. RIDE ON OPEN TRAILS ONLY. Respect trail and road closures.
2. LEAVE NO TRACE. Be sensitive to the dirt beneath you.
3. CONTROL YOUR BICYCLE! Inattention for even a second can cause problems.
4. ALWAYS YIELD THE TRAIL. Make known your approach well in advance.
5. NEVER SPOOK ANIMALS. All animals are startled by an unannounced approach.
6. PLAN AHEAD. Know your equipment, your ability, and the area in which you are riding.

KEEP TRAILS OPEN by setting a good example of environmentally sound and socially responsible off-road cycling.

For more information about mountain biking in Pittsburgh you can contact Elizabeth Barrow of the Nine Mile Run Cyclists by email at:
ebarrow@telerama.lm.com

parks and cemeteries, there is also 240 acres at the mouth of NMR which is currently targeted for the development of 700 homes and a 100-acre greenway. The 100-acre greenway and its adjacent development have increased public awareness of the stream's condition. Community members and public officials have galvanized around the issue and are currently championing a number of initiatives to address water problems in NMR.

If the stream stays unculverted, there is a road planned which will connect the two plateaus by moving down and through the valley. This will affect the greenway in two ways: (1) the road will cross in the quietest part of the valley **(see map VII-j)**; and (2) it will exit onto Commercial Avenue by crossing through one of the forested areas growing on natural shale soils.

Other issues pertaining to development which are relevant to the Rivers Conservation Plan include: regrading within the valley, sediment and alkaline runoff from the construction, and potential values of the additional stormwater flow if it is properly managed and delivered to the stream.

The final development issue involves ongoing planning by the Pennsylvania Turnpike Commission for the Mon-Fayette Expressway which would (as presently planned) cross the mouth of NMR at the Monongahela. This will have a significant effect on the larger Monongahela riparian corridor and its ability to benefit the NMR ecosystem. Sound may be an issue, as well as overall change, in the riverside aesthetic experience.


Rosemont, a new community built upon the slag

Photo courtesy of NMR Project, STUDIO for Creative Inquiry, Carnegie Mellon Univeristy.


Duck Hollow, an historic community which once had a floodplain in its backyard.

Photo courtesy of NMR Project, STUDIO for Creative Inquiry, Carnegie Mellon University


The current plan for Summerset at Frick Park. The flowing stream was not always part of the plan.

Community Input

Jack Solomon Will the current plans for the housing development/slag grading change the existing conditions? Will the current plans enhance the site?

Bill Kolicius Is the downstream culvert which was proposed by the developer a dead issue? If it is NOT, this is a MAJOR THREAT TO THE STREAM! And everything we are trying to accomplish here.

John Schombert I can give you 20 reasons why culverting is a bad idea.

Examining an unstable stream bank

Photo courtesy of NMR Project, STUDIO for Creative Inquiry, Carnegie Mellon University

III. Land Resources

III-a. Soil Characteristics

The entire lower reach of NMR bordered by Squirrel Hill, Commercial Avenue, Swisshelm Park, and the Monongahela River is complicated by the dumping of steel mill slag. The upper reaches are typically defined as a shale soil.

III-a1. Geology of the Nine Mile Run Area

The rock and soil materials observed at the NMR slag study area fall into four major categories and formation time periods. The oldest features are the nearly horizontal beds of sedimentary rocks deposited about 300 million years ago, followed by abandoned river channel deposits of sand and gravel with an age of about 100,000 years. After a period of erosion, following the major ice ages (about 10,000 years ago) NMR has been depositing clay, sand, and gravel in its floodplain up to the present time. Starting in 1923, and ending in the 1970s, a large volume of steelmaking slag was dumped in the NRM valley.

The bedrock in the NMR area consists of nearly horizontal beds (or layers) of **shale**, sandstone, claystone, limestone, and coal. These strata were deposited in an environment that was very different from that of present. Continental drift processes have changed the local climate from tropical, during the Pennsylvanian Period of geological history (300 million years ago), to more temperate at the present time. Pittsburgh is now positioned about 40 degrees north latitude, but was only two to five degrees north latitude during the Pennsylvanian Period. The fossil record in the sedimentary rocks indicate a near-shore river delta environment with a hot, steamy, tropical climate. The resulting plant material from the vast swamps resulted in thick coal beds that contributed to the development of the steel industry in Pittsburgh. The sandstone layers represent meandering river channels, and the shales were once delta and tidal muds. Occasional thin limestone beds, some with abundant marine fossils, were deposited when the sea covered the deltas.

After these sedimentary rocks were deposited and hardened there was a long period of erosion. About 100,000 years ago, when some of the topographic features of the area were starting to form, there was a major glacial ice advance from the north. These ice sheets dammed the northward flowing Monongahela River and the water ponded in the Pittsburgh area, resulting in valley sand and gravel deposits. These flat areas can still be seen at about 920 ft elevation.

During the last 10,000 years before the present time, NMR has cut and eroded its valley from 920 ft elevation down to 720 ft, which is the present level of the Monongahela River. During the erosion process, much floodplain material has been deposited, consisting of mud, sand, gravel, and boulders.

Starting in 1923, steelmaking slag was dumped in the NMR valley floodplain. Enough material was dumped to fill the entire lower floodplain area and to alter the course of the stream.

shale: rock formed in layers by consolidated clay, mud, or silt that can be easily split apart

Addendum on slag:
According to the (November 1996) *Phase II Environmental Site Assessment conducted by Groundwater Technology for the Urban Redevelopment Agency* (p. 33):

1. The test drilling program confirms that the slag area is of relatively uniform composition without significant amounts of extraneous material. There is some construction/demolition debris and possibly some clearing and **grubbing** material on the northwest side of the site. There was no evidence of deleterious industrial wastes.
2. The slag contains elevated but non-leachable concentrations of chromium derived from refractory brick. The concentrations are typical of carbon steel slags and do not represent an environmental concern. The slag pH is typically alkaline with pH values in excess of 11. Although the total chromium in the slag exceeds the December 1993 DER Cleanup Standard, it should not represent an environmental limitation of the site. The standard is based on long-term ingestion by a child. It is assumed that the final residential landscaping of the site will require the placement of a soil cover over the slag to allow for the development of vegetation. This will limit any potential ingestion.

Note: A subsequent report has been commissioned by the URA at the request of various community groups. Summary of *Environmental Resources Management, Review of the Environmental Investigation Conducted at the Nine Mile Run Site:*

> Environmental Resources Management (ERM) completed a review of the environmental investigation conducted at the NMR site. They concluded that no environmental issues that would halt residential development of the site have been identified in the preliminary investigations completed to date. However, ERM believes additional studies are required prior to finalization and implementation of the residential development plans.

Community Input

Peggy Charny suggested we need to look at the slag pile in a more positive way. Assuming it is safe, the slag pile can be used as an education resource. There is already some new vegetative growth near the Parkway and the site can be used for people to gain an appreciation of successional growth. The slag is evolving if you pay close attention.

III-a2. Discussion of Slag as a Growing Medium

Since our focus is the creation of public space and the health of NMR, we will confine our discussion of slag to the subject of revegetation, but acknowledge the various studies which are available on the viability of slag to support construction.[1] The most important feature of slag at NMR is that it is not toxic to plants (phytotoxic). Slag's utility as a growing medium can be expanded by identifying and ameliorating some of its inherent limitations as a growing medium and some limitations related to the setting of slag. Inherent limitations of slag can be divided into physical, chemical, and biological components. These limitations, as well as slag assets as a growing medium and opportunities for improvement, are discussed below.

Physical limitations of the slag as a growing medium include:
- Coarse texture and associated low water holding capacity.
- Dark colored slag absorbs excessive heat in direct sunlight, dehydrating seedlings before they become established.

grubbing: the digging up or clearing of roots and stumps

[1] Various reports on the development are available in area libraries.
- Phase I Environmental Site Assessment of Ninemile Run Slag Area. Prepared for the Urban Redevelopment Authority of Pittsburgh. (January 1996).
- Phase II Environmental Site Assessment, Ninemile Run Slag Area, Pittsburgh, Pennsylvania. Prepared for the Urban Redevelopment Authority of Pittsburgh. (November 1996).
- Urban Redevelopment Authority of Pittsburgh, Report on Clean-Up Plan for Ninemile Run Slag Area, City of Pittsburgh, Allegheny County, PA (June 1997).
- Environmental Resources Management, Review of the Environmental Investigation Conducted at the Nine Mile Run Site (1998).

Unvegetated slag slope meets a vegetated slag slope. Same exposure, same angle of repose, different grain size. More construction debris on the right slope.

Photo courtesy of NMR Project, STUDIO for Creative Inquiry, Carnegie Mellon University

- Fused (cemented) slag makes a poor seedbed, is difficult for roots to penetrate, and it is difficult to amend (mix with soil amendments)

Chemical limitations include:
- High pH (typically pH 9-10 before weathering) with associated low nutrient solubility,(e.g., phosphorus, iron, manganese, copper, zinc) and tendency for **ammoniacal** form of nitrogen to **volatilize.**
- Lack of plant-available nitrogen (ammonium, nitrate).

Biological limitations include:
- Shortage of seed source (low production except at site fringe and robust pockets of vegetation).
- Shortage of soil enzymes that facilitate nutrient cycling.

Limitations of the site setting include:
- High wind and sun exposure of large expanses of unvegetated surface. Winds dry out and "sand blast" seedlings.
- Lack of mulch from on-site plant production.

Assets of the slag as a growing medium include:
- High porosity permits excellent air exchange and deep rooting.
- Plants can potentially intercept adequate amounts of water by rooting deeply into slag; this compensates for the poor plant-available water storage of slag.
- Slag weathers to a stable pH between 7 and 8.3.

Opportunities to improve the performance of slag as a growing medium abound. The strategy for successful revegetation of slag consists of the following:
- Improve nutrient availability. Add manure, compost, biosolids, and/or fertilizers. A veneer of organic amendments or soil over slag will perform as well (and sometimes better than) amendments mixed into slag.
- Provide a sheltered seedbed with adequate improved water availability by mulching with compost, straw, hay, and/or manure. These amendments will help sustain seedlings as they germinate and root into the underlying soil, and will provide sources of soil microbes and enzymes.
- Seed/plant fast-growing species that will quickly cover the surface, produce mulch *in-situ,* and break the wind at ground surface.
- Seed/plant deep-rooting species, including **leguminous species**.
- Build or plant windbreaks (snow fence, earthen windrows, planted or seeded woody plant hedgerows) to reduce wind stress on downwind plants.

It is important to note that, depending on available resources and the level of landscaping intensity, the above measures can be used to improve the growth of plants on slag with or without the use of imported cover soil. Use of cover soil will generally improve the speed of establishment and diversity of plants established in the long run. Use of soil will also tend to increase surface water runoff and decrease, but not eliminate, percolation of water through slag. Even with thick soil cover, it is reasonable to expect that about one third of annual precipitation will

---

ammoniacal: having properties of ammonia

volatilize: to facilitate the change of a substance into a vapor

leguminous species: plants in the pea family *(Fabaceae or Leguminosae)* many of which have the capacity to fix nitrogen percolate into and through the slag.

III-b. Ownership

The vast majority of the land in this watershed is privately owned, on a parcel by parcel basis. Public ownership ranges from 0 up to 5% of the parcels. However, there are two significant portions of public ownership: Frick Park and the development site for Summerset at Frick Park (currently the Nine Mile Run slag dump) which account for approximately 700 acres or 15% of the land area.

III-c. Critical Areas

The critical land areas in the NMR watershed can be defined as either areas with habitat value, areas with infiltration or detention potential for surface water, and land areas which are broad, flat, and accessible enough to qualify for playing fields.

III-c1. Habitat Value

Lands with habitat value can be found throughout the watershed. There are upper watershed valleys with remnant creeks and relatively diverse urban vegetation, although they are often islands cut off from contact with any larger, more functional ecosystem. The area with the largest habitat value is in the lower watershed. Frick Park has the largest interior forest in the watershed with a total of 87 acres, plus a supporting 368.5 acres of upland forest, and about 11 acres of wetland/floodplain (See section V-d). The NMR slag site is a 240-acre site of which 158 acres are upland forest and 0.1 acre is interior forest. The habitat value of these contiguous properties are not fully realized, however, until we consider the relative value of connecting these two urban habitats to the greater riparian corridor of the Monongahela River. Industrial development on the north shore of the Monongahela was spotty, with remnant patches of secondary growth beginning to link with dormant brownfield properties, knitting the riparian edge back together again. This provides a significant source of biological diversity in both plant and wildlife. Since the NMR slag site is the link between the Monongahela and Frick Park, it is important to give careful consideration to habitat value and ecosystem function during its assessment and design phases.

A view of Nine Mile Run looking Southwest (downstream) from Route 376 overpass.

Photo courtesy of NMR Project, STUDIO for Creative Inquiry, Carnegie Mellon University

Note: The planned Mon-Fayette Expressway for the north shore will have a detrimental affect on this ecosystem connection. This issue was highlighted as a special concern by members of the advisory committee **(see Appendix VIII)**.

III-c2. Land with Infiltration or Surface Detention Potential

One of the challenges of an urban watershed is that so much of the land has been filled, asphalted, and covered with houses that the water which once soaked slowly into the ground now forms sheets in the streets, disappearing down storm sewers. This develops raging torrents in the stream in the lower watershed. Because of these conditions, it is important to identify and protect open space in the upper watershed.
It is also important to reconsider building codes for large parking lots to insure detention and infiltration whenever possible.

Community Input

Bob Hurley suggested that the Conservation Plan should take a harder look at recreational uses. We need to plan for active uses such as bicycles and soccer. (There are not enough fields in Pittsburgh.)

This is important for the strategy of keeping young people in the city.

If the plan identifies a need to take away one field to expand the wetland, the plan should be to replace it (somewhere in the city or region, if not in the valley). He said that the area is a regional park.

Peggy Charny reminded the table that there is a flat spot near the radio towers—on the Swisshelm Park side.

Lois Liberman suggested we look at baseball fields/schools.

Bob Hurley replied that size and demand prevent the schools from having much effect on the issue.

Elizabeth Barrow suggested that the report should include the specific recommendation that any recreational use taken away needs to be replaced somewhere else. The table concurred.

III-c3. Broad Flat Lands for Playing Fields

Section VII outlines the need for organized sports use of Frick Park. It is important to recognize this need, as well as the land forms that are likely to provide the most affordable means to realize this goal. The NMR slag site and its steep slopes and single field may not be ideal for playing fields and their attendant parking needs; the single site worth considering is only three acres without parking.

III-d. Landfills (Map III-d)

The entire lower reach of the NMR floodplain bordered by Squirrel Hill, Commercial Avenue, Swisshelm Park, and the Monongahela River has been filled by the dumping of steel mill slag. NMR still flows between the piles with typical slopes of 1.5-1. The slag dump covers 238 acres consisting of steel making by-products dumped randomly on either side of the banks of NMR. These dump sites are up to 100 feet in height with less material on the Swisshelm Park side and additional isolated piles on the Squirrel Hill side of 30 feet or more.

III-e. Hazard Areas

III-e1. Waste Sites

There are no DEP identified waste sites existing in this region.

III-e2. Abandoned Mines and Quarries

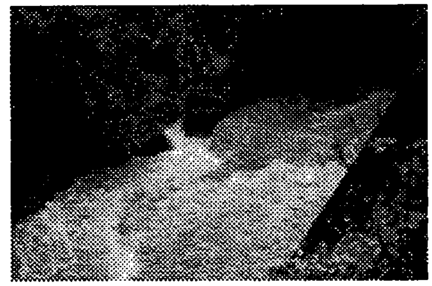
Abandoned mines and quarries are identified on **Map III-e2**

conducted by botanists and entomologists from

IV. Water Resources

IV-a. Tributaries (Map I-d)

The NMR watershed drains the southeastern part of Pittsburgh and portions of the three neighboring boroughs of Swissvale, Edgewood, and Wilkinsburg. The main branch of NMR is above ground within Pittsburgh, extending from its mouth at the Monongahela River up through the south end of Pittsburgh's Frick Park. Upstream and to the east of Frick Park (east of Braddock Avenue) NMR is completely underground in a concrete culvert, with several smaller tributaries connected underground.



Like all urban streams, impervious pavement and culverted tributaries result in destructive flows during wet weather. (See p. 20 for same site in dry weather.)

Photo courtesy of NMR Project, STUDIO for Creative Inquiry, Carnegie Mellon University

The largest open air tributary to NMR is Fern Hollow Creek. This creek runs from north to south through Frick Park to meet NMR. Fern Hollow Creek contributes flow most of the year with the exception of some occasions during dry summer weeks.

The remaining tributaries in the NMR watershed have been culverted and are no longer in their natural state. However, they are significant because they contribute a majority of the flow to NMR. The main branch of NMR lies in a culvert, often called the Wilkinsburg Culvert, that runs from north to south through Wilkinsburg and Edgewood. There are several culverted branches within Wilkinsburg, Pittsburgh and Edgewood that contribute flow, presumably from groundwater or natural springs. These culverts also act as storm sewers during wet weather.

Adjacent to the mouth of the Wilkinsburg Culvert are two storm sewers which also contribute flow year round. These storm sewers can be traced on maps in the direction of tributaries that existed before extensive development occurred in this area. One extends up the valley alongside and beneath I-376 in Edgewood; the other runsbeneath an Edgewood shopping center and into Swissvale. During the 1997 summer months, these "storm sewers" contributed more flow than the main branch of NMR, likely from the same sources. These influents can safely be labeled as tributaries, although we have been unable to discover the historical name associated with them.

IV-a1. Other Tributaries

Another similar tributary/storm sewer originating from the west end of Swissvale flows into NMR upstream of Frick Park. As a tributary in dry weather, it contributes consistent though very little flow to NMR. Downstream of Frick Park, a concrete pipe originating in the direction of an original NMR tributary valley has a consistent flow of water to NMR. This pipe is not a storm sewer and is likely groundwater that has been piped directly to the stream. A former tributary that is now covered by slag in the lower reaches of the stream still contributes flow to NMR. This flow enters NMR as seepage along the banks of the stream and is very significant in dry months when flow in the stream is low.

A major tributary meets Nine Mile Run just upstream of its mouth at the Monongahela (at Duck Hollow). This tributary has also been culverted, though it contributes significant flow to NMR.

Community Input

Bob Hurley mentioned that the mouth of NMR at the Monongahela River makes the site unique. There are few opportunities in the urban region where a stream flows into a larger river in daylight.

IV-b. Wetlands

Wetlands are important ecosystems that contribute greatly to their **bioregional** contexts and serve vital **hydrological, biogeochemical,** and habitat functions. These, in turn, provide important societal values, including flood control, maintenance of biodiversity, enhancement of water quality, and aesthetic, recreational, and educational opportunities (Cole and Tamminga, 1997).

Large, high-energy **riverine** and floodplain wetlands were likely to have been found along the Monongahela, Allegheny, and Ohio Rivers prior to the obliterating effects of bank stabilization, flood control works, and industrialization of shorelines and floodplains. NMR, in its own comparatively diminutive way, has gone through a parallel process of urban industrialization and wetland displacement.[1] Historic aerial photographs and geological mapping show an extensive floodplain in the lower reaches of NMR, now largely covered with slag and landfill. Lowland forest growth would historically have covered much of this area. Because of the relatively steep gradient of NMR as a headwater stream (first and second order), wetlands would likely have been limited to those areas where groundwater seeps and high water tables were to be found, or where beaver dams may have impounded open water wetlands.

National Wetlands Inventory (NWI) mapping (1986) shows no regulatory wetlands in either Nine Mile Run or the immediately surrounding area. In fact, NWI mapping for the entire city of Pittsburgh shows no remaining wetlands other than artificial ponds and reservoirs. This does not mean that wetlands are not present in NMR. Since the NWI protocol in Pennsylvania employed black and white aerial photography and fairly large minimal mapping units, small, non-open water wetlands were frequently missed. Recognizing this, the Army Corps of Engineers has established an on-the-ground protocol for delineating regulatory wetlands. **(Map IV-b1)**

Based on preliminary field reconnaissance during October and November 1997, it appears that two remnant wetlands exist in the study area (**Map IV-b2)**. Both are **palustrine** wetland complexes dominated by grasses, **sedges**, and **forbs**. The larger wetland, just upstream from Commercial Street, is set back from the north bank some 20 to 30 m and extends upgradient some 30 to 50 m. It has been tentatively classified as a *slope* wetland according to the Hydrogeomorphic (HGM) approach.[2] The water source is presumably a mix of surface water and ground water; hydrologically, it appears to be linked with the southerly-facing slope extending up into Frick Park. Its position substantially above the bank of the stream and its noticeable cross-slope suggest that this is a low-energy seep system and, hence, is not reliant on flood events. Soil samples taken in November 1997 within the root zone (to 18 in) showed the soil to be **hydric**, with a **chroma** of between 1.5 and 2.0.[3] Hydrophytes are present on site (see **Section V-b** for a fuller account of site botanical assessment).

The smaller site further downstream along NMR presents a more peculiar situation. Roughly 20 m by 80 m in size and rather

---

bioregional: having to do with the study of "place" and attention to the region as defined by its life forms rather than by political dictates; "a region governed by nature, not legislature" (Sale, 1985)

hydrological: having to do with the study of water and its properties

biogeochemical: having to do with the study of how chemicals in the earth react with plants and animals in the area

riverine: type of land formed by a river or around freshwater with few trees and shrubs

palustrine: non-tidal, freshwater wetlands dominated by trees, shrubs, rooted aquatic plants, moss, and lichens

sedges: plants with solid stems, in the family *Cyperaceae* Many sedges grow in wetlands.

forbs: herbs other than grasses

hydric: saturated to the point that oxygen is diffused very slowly

chroma: color strength or purity (chroma of 2 or less generally indicates hydric)

1 Note that the use of the term "wetland" is not meant to denote a "regulatory wetland" as defined by the Army Corp of Engineers. Detailed wetland delineation efforts are required to confirm the extent and type of wetlands in the study area.

2 The HGM approach categorizes actual wetlands based on idealized characteristics and functions of model reference wetlands. It focuses on wetland position within the basin and hydrological conditions, and also considers soil conditions, energy levels, and vegetation patterns. The HGM approach is becoming increasingly used by wetland ecologists as a functional model, and complements the pattern-oriented U.S. Fish and Wildlife Service classification scheme commonly used over the past several decades.

3 Visually assessed using the Munsell Soil Chart.

well-concealed, it is perched on a sloped terrace located just below a 2 m high linear embankment. This, in turn, is situated some 2 to 2.5 m above the streambed. Several test holes dug in November 1997 show a distinct hard clay/soft shale layer within several inches of the surface. Apparently, this functions as an impermeable lens, limiting root penetration and water infiltration, but also setting up hydrological conditions suitable to wetland formation. Root zones as thin as 5 cm were evident in one area toward the down-gradient end of the site. On-site soil sampling showed a soil matrix chroma of approximately 2.0, as well as some **mottling and oxidized root channels** characteristic of hydric soils. Plants species are more predominantly **herbaceous** than the upstream wetland. **Obligate** and **facultative** wetland species include path rush (*Juncus tenuis*), bullrush (*Scirpus atrovirens*), wool grass (*Scirpus cyperinus*), and several sedges (e.g. *Carex lurida*), as well as herbs such as common boneset (*Eupatorium perfoliatum*) and sensitive fern (*Onoclea sensibilis*).

Penn State University's Cooperative Wetland Center has recently included these two sites as reference wetlands within its Pennsylvania Wetlands Study (PAWS). Automated test wells have been installed to assess hydrological dynamics through time. Data from these wells will be compiled as hydrographs—essential in confirming whether these sites are functional wetlands in the regulatory sense. Additional biophysical assessments (soils, vegetation, etc.) will be conducted in Summer 1998. At the present time, biological indicators strongly suggest that, regardless of status, these small ecosystems exhibit wetland-like characteristics that may be of considerable value to both NMR and Pittsburgh in general.

IV-c. Floodplain (Map IV-c)

The NMR floodplain has been severely affected by culverting in the upstream northeast valley of the watershed, and slag fill in the lower watershed. The management goals of the NMR watershed have been principally to protect property and alleviate flooding by conducting flows to the Monongahela as quickly as possible. This method is even obvious in the feeder creeks in Frick Park, where overflow is conducted into the storm sewer and the floodplains have been turned into grassy lawns or childrens' play equipment areas.

IV-d. Lakes and Ponds

There is one pond in the watershed. It is in the upper end of Homewood Cemetery near the entrance off Dallas Street. Appearing to be spring-fed, it has some emergent wetland plant growth. Less than a 0.25 acre in size, it has habitat value in its unique form and relatively protected location.

IV-e. Water Quality

IV-e1. Point Sources

IV-e1a. Water Quality and Flow in NMR (Map IV-e1a)

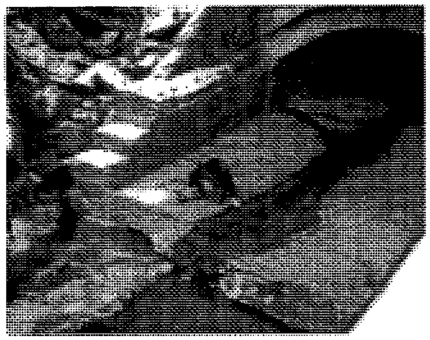
Sewage pollution has been a problem in NMR since the turn of the century. References to sewage problems are documented as early as

mottling and oxidized root channels: root chanels in hydric soils characterized by oxidized iron

herbaceous plants: plants that are leafy and bush like; not woody

obligate: organisms that need the particular environment they are in to survive

facultative: organisms that can survive in conditions other than the one they are found in



Water quality sampling in one of the 3 major culverted tributaries. (See p. 17 for same site in wet weather.)

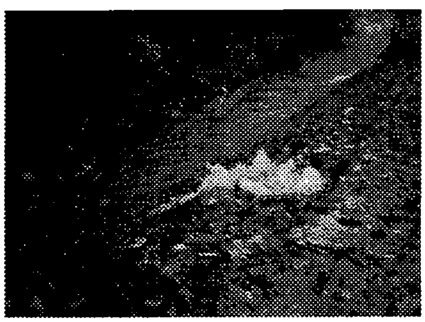
Photo courtesy of NMR Project, STUDIO for Creative Inquiry, Carnegie Mellon University

1910 and have continued to the present. Data have been collected for fecal coliform and other pollutants by various organizations over the past 10 years. Several testing sites studied in 1997 have historical data associated with them. The overall impact of sewage discharges is not only represented by the concentration of pollutant, but also by the amount of flow contributed to the stream by a particular source. No historical flow data are available for NMR. As part of this study, flow measurements were performed at the time of some water quality sampling events in order to relate water quality measurements with flow rate information. Samples were taken both in-stream and at the natural tributary and storm sewer influent points adjacent to the stream.

IV-e1b. Sewage Discharge Problems

Sewage discharges to NMR occur via combined sewer overflows (CSOs) and sanitary sewer overflows (SSOs) in wet weather. CSO discharges can occur even during short duration rain events. CSOs commonly are designed to discharge combined stormwater-sewage flows for rainfall events with precipitation greater than 0.1 - 0.3 in/hr (Shamsi, 1997). SSOs behave similarly although their magnitude, frequency, and specific sources are not well understood for NMR.

There are six documented CSO outfalls that discharge directly into NMR. Five are 24-in pipes that each empty a single diversion chamber **(Map IV-e1b)**. Two of these are located near Duck Hollow **(Sites 17 on Map IV-e1b)** and three downstream of Commercial Avenue **(Sites 12, 14, 15).** The CSO just upstream of Commercial Avenue **(Site 9)** has a different design. This CSO is a box culvert that runs along Fern Hollow in Frick Park. It is fed by several diversion chambers and is completely open at the outfall, discharging at grade with the stream.



Fecal fountain! Chronically discharging manholes on sanitary sewer lines indicate a public health threat and long-term maintenance problem.

Photo courtesy of Mike Lischte, Allegheny County Health Department

The culvert terminus at Braddock Avenue **(Site 1 on Map IV-e1b)**, which can be classified as a NMR tributary or as a Wilkinsburg/Edgewood storm sewer, receives a CSO input from the city of Pittsburgh. The diversion chambers are located approximately 1.5 mi away in the Homewood section of Pittsburgh (Pittsburgh, 1995). CSO discharges from this section of Pittsburgh must travel underground through Wilkinsburg and Edgewood before reaching NMR.

Sanitary sewer overflows are perhaps less in volume compared with the CSO discharges during wet weather, but they are responsible for substantial raw sewage inputs to NMR. During a storm event, infiltration and inflow into the sanitary sewers causes overloading which results in either surcharging manholes, or discharge through constructed diversion chambers. There are three documented SSO diversion structures at the mouth of the Wilkinsburg culvert (Pittsburgh, 1997). These SSOs are pipes originating from sewer manholes and discharge during storm events when the manhole chamber is overloaded. Two are associated with an Edgewood sewer and one with a Swissvale sewer. Such diversion chambers help relieve overloaded pipes and prevent manholes from **surcharging**. Whether sanitary sewage discharges occur from manholes or diversion pipes, the result is the same: raw sewage, diluted by stormwater, enters the stream.

---

surcharge: to fill to excess or overload

IV-e2. Non-Point Sources

IV-e2a. Runoff and Water Quality Problems in NMR

The primary concern with most urban streams is runoff problems during storm events. Every structure, road, and parking lot that is built increases the impact of a rainfall event on the nearest stream. Water that flows into gutters and storm sewers flows into stream channels faster, resulting in greater flows and increased erosion and flood danger. To control these problems and facilitate greater runoff flow rates, urban streams often have been culverted or placed in concrete channels which can lead to runoff problems further downstream.

NMR is a unique urban stream because it is culverted near its source and on the surface further downstream. NMR is culverted from its source in Wilkinsburg to Braddock Avenue in Swissvale **(see Map I-d)**. Due to this configuration, runoff flows in the surface section increase rapidly, making the stream "flashy" in nature. This causes accelerated erosion of banks and uneven deposition of sediments in the stream bed.

This "Fecal fountain" discharges along a trail in Frick Park. The sewage overflows and ponds, visible and oderous, days after a storm.

Photo courtesy of Mike Lischte, Allegheny County Health Department

Along with erosion during high storm flows, there is also degradation in water quality in NMR due to sewer overflow inputs. Fecal coliform bacteria concentrations in the stream often are sufficiently high to render the water unfit for human contact. Sewage pollution problems are a result of shortcomings in the sewage infrastructure system in the watershed. The problems derive from a number of sources within the culverted region of the watershed. CSOs, SSOs, unauthorized sewer tie-ins, and inappropriate stormwater management are among the issues involved.

There are also water quality impacts to NMR during dry weather. A tributary to NMR that now passes through the slag piles contributes a significant amount of water during dry weather and raises the pH of the stream. Tributaries and storm sewers in the upper half of the watershed sometimes have high levels of fecal coliform bacteria as a result of leaking sewers and unauthorized sanitary sewer tie-ins with storm sewers.

Community Input

Marilyn Skolnick stated that the plumbing code must be reviewed and changed to make a visible difference in stormwater management.

Peggy Charny mentioned that the new development should be used to model some of the recommended Best Management Practices that come from this study.

Lois Winslow suggested the use of belgian block or other permeable surface material.

It was agreed that we need code changes, but that that takes time, so we should consider modelling some recommended code changes (perhaps in the new development).

John Shombert (Allegheny County Health Department): Because communities share sewers, they could share responsibility for problems when enforcement occurs.

Alex Hutchinson (Contract engineer for the City of Edgewood): If it is found that sewers need to be replaced, joint systems should be considered.
- Television survey results may induce cooperation, e.g., in the building of a common sewer.
- Penn DOT has some responsibility.

IV-e2b. Sewage Infrastructure in the NMR Watershed

There are three types of sewers within the NMR watershed: sanitary sewers, storm sewers, and combined sewers. Sanitary sewers are typically smaller pipes (e.g., 6 -20 in diameter) and are designed to carry household waste to the treatment facility. Storm sewers channel storm water runoff to the nearest open body of water. Combined sewers carry both sewage and stormwater runoff, and are designed to overflow to natural surface waters in the event of overloading (to prevent backup into homes).

During dry weather, sewage is piped through the combined sewers and emptied into the main sewer lines. Combined sewers pass through diversion chambers which are designed to limit the amount of water that can enter the main line for treatment. Diversion chambers are meant to handle about 3.5 times the normal flow of sewage before they trigger a CSO (Shamsi, 1997). It does not require a very intense storm to create runoff 3.5 times greater than normal sanitary sewage flow. During a rainfall event in a community with combined sewers, stormwater runoff is mixed with sanitary sewage and discharged into a body of water.

Communities with separate sewers should not experience sewage discharge problems because household sewage and storm runoff are routed separately. However, SSOs occur when a sanitary sewer becomes overloaded because of infiltration (e.g., through cracks in the pipe or poorly sealed pipe connections) and inflow (e.g., from unauthorized storm sewer inputs from household gutter connections) during storm events. Furthermore, unauthorized discharges of sanitary sewers directly to culverted streams could be a major source of sewage pollution in communities with separate sewage infrastructure. **Table IV-e2** lists the types of sewage infrastructure in each community in the NMR watershed.

All sewers within the city of Pittsburgh are combined. Wilkinsburg is equipped with separate sanitary and storm sewage infrastructure. Swissvale sewers that enter the trunk sewer are exclusively sanitary according to a map compiled by Bankson Engineers (Swissvale, 1989). Maps from the I-376 construction show separate storm sewers in Swissvale adjacent to the highway. The separate storm sewer infrastructure in the vicinity of NMR was added when I-376 was constructed.

Summary of Sewage Infrastructure in NMR Watershed

Municipality	Type of Sewer
City of Pittsburgh	Combined
Borough of Edgewood	Separate
Borough of Swissvale	Separate
Borough of Wilkinsburg	Separate
Pittsburgh - Homewood	Combined

Table IV-e2.

According to Robert Zischkau, town engineer, Swissvale sewers are separate (Brown, 1997). However, storm sewer infrastructure has not been mapped in detail so it is uncertain exactly how storm water is channeled within Swissvale. Sanitary sewers may be loaded with a significant amount of storm drainage. Edgewood has some separate storm sewer infrastructure. In the Edgewood sewer map, storm sewers run up several streets but not all of them (Edgewood, 1915).

In the NMR sewershed, the main line for the Pittsburgh combined sewers is a trunk sewer that runs along and beneath the daylighted section from Frick Park to the Allegheny County Sanitary Authority interceptor sewer near the Monongahela River. Since 1983, the Pittsburgh trunk sewer has been used by other communities within the NMR sewershed **(see Appendix IV-e)**. The Swissvale and Wilkinsburg sanitary sewers enter the trunk sewer at the east end of Frick Park. A 20-in Edgewood sanitary sewer meets the trunk sewer just west of Commercial Avenue.

Community Input

Alex Hutchinson (Contract engineer for the City of Edgewood)

Commented on Edgewood maps, insisting that they are good.

Commented on potential cooperation between communities: Historically municipalities have worked individually. Wilkinsburg and Swissvale television surveying and mapping of trunk sewer could provide impetus for cooperation; a confederation could work. He believes that roof drains tied directly into sewers are the biggest problem.

Commented on the "why" of no cooperation between municipalities thus far:
- Have been various attempts at cooperation over the years, but momentum dies out;
- Political turnover makes it difficult to keep a sustained effort going;
- No inertia; ACHD needs to push for action
- Mentioned that parts of Braddock Hills and Forests Hills impact watershed.

"Alex commented, I will bring these concerns to politicians in Edgewood, will speak with Swissvale engineer (Bob Zischkau) and discuss possibilities for collaboration."

Lois Winslow suggested we need to explore alternative acceptable low cost means to redo the sewer systems with elected officials.

Elected officials must be involved because they are going to be taking the heat if taxes or rates increase and they have the power to form authorities to float bonds.

Patricia Miller (Pennsylvania State Department of Environmental Protection): DEP is addressing sewage issues and will be taking steps soon. Getting communities together first does not hurt, but it will not affect regulatory proceedings.

IV-e3. Monitoring

IV-e3a. Historical Data

A report prepared by the Pittsburgh Water Department Laboratory confirms that the sewage problem existed in 1990 (City of Pittsburgh, 1990). This survey reports high levels of fecal coliform in the stream between Braddock Avenue and Frick Park from March to August of 1990. Samples from Sites 1, 2, and 3 **(see Appendix IV)** had levels of fecal coliform bacteria consistently higher than $5x10^3$ CFU/100 ml at that time, an indication of active sewage inputs to these sites (Brown, 1997). Samples from Site 13 had values ranging from 1,000 to 96,000 CFU/100ml over a 6-month period. For comparison, raw sewage has fecal coliform bacteria concentrations generally more than $3x10^6$ CFU/100 ml (Viessman and Hammer, 1993).

Instream data from the Allegheny County Health Department (1997) from 1990 to 1996 show fecal coliform in NMR with an average concentration of about 105 CFU/100 ml. This does not include data taken on January 24, 1992, when exceptionally high fecal coliform concentrations ranging from $2.4x10^6$ - $5.9x10^6$ CFU/100ml were found instream. These 1990 to 1996 data exhibit great variability with no particular correlation to season. These fluctuations may be flow dependent, but no corresponding flow data were obtained, so investigation of a correlation is not possible.

Instream data from Chester Environmental (1995) from 1991-1992 were also assembled. On August 26, 1991 the concentration of fecal coliform at sampling points instream decreased progressively downstream. This pattern was seen in recent data as well. Data from Chester Environmental on other occasions exhibit variability, ranging from 730 to 51,000 CFU/100 ml. A collection of these and other data corresponding to the current sampling points can be found **(see Appendix IV** in Dzombak and Lambert, 1998).

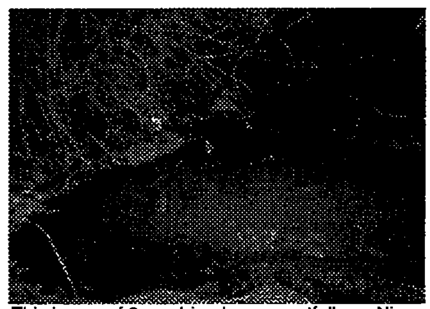
The most recent sampling effort in NMR began in March 1997 by the Department of Engineering and Public Policy (EPP) at Carnegie Mellon University (CMU) in collaboration with the Studio for Creative Inquiry at CMU. Data from this effort are presented in the EPP project report (EPP, 1997). Members of the NMR Watershed Project team continued sampling into Summer 1997. Weekly data for fecal coliform and other pollutant species from the same testing points were obtained.

Samples from NMR were analyzed for several water quality parameters for the EPP project. Along with fecal coliform bacteria counts, samples were analyzed for ammonia, dissolved oxygen, temperature, nitrate, nitrite, pH, and chloride. Although several of these parameters could be indicators of sewage, fecal coliform is the best indicator. Samples were also analyzed for total sulfate. This parameter may be a good indicator of slag runoff inputs and is discussed later in this report.

The average fecal coliform count in CFU/100 ml from April through June 1997 was elevated for each testing site. Samples from Site 1 averaged greater than 104 CFU/100ml during this period. Samples from Sites 2 and 3 were also high, commonly in the 103 range, and up to

There are 11 sewer lines crossing NMR over its length of 1.5 miles.

Photo courtesy of NMR Project, STUDIO for Creative Inquiry, Carnegie Mellon University



This is one of 6 combined sewer outfalls on Nine Mile Run. The ponding is typical.

Photo courtesy of NMR Project, STUDIO for Creative Inquiry, Carnegie Mellon University

Community Input

Melisa Crawford volunteered to present an overview of the water table discussion during the second public meeting. Her summary was as follows:

1. Organizational systems for Watershed Management:
    a. Joint management
    b. Joint authorities
    c. Privatization
2. Limitations of Act 167
3. Historic attempts by municipalities to address issues
4. Need to set priorities for solving problems

Marilyn Skolnick mentioned that the odors are a first priority because it is the most obvious sign of the problem.

Karin Tuxen mentioned that that could mean addressing the pools collecting at the CSO outfalls.

32,000 during a storm event. These results are noteworthy because data taken in August 1997 showed much less impact from Site 1 and very heavy impact from Site 3. The data for 1997 are presented along with the other historical data in Dzombak and Lambert (1998).

IV-e3b. Recent Data

Beginning in Summer 1997, a more systematic and focused testing scheme was initiated. Fecal coliform was considered the indicator of sewage and several testing sites were the same as in previous studies. However, a distinction was made between the instream testing points and the influent points. All influent points were sampled on a single day so that the impact of each influent could be viewed relative to the others. On alternate weeks, points in the stream were sampled at regular increments downstream to provide a "profile" of the contamination along the stream from Braddock Avenue to Duck Hollow.

A map of the water quality sampling points an elaborate description of the upstream sources and a table of the various functions of each influent point is found in **Appendix IV**.

IV-f. Water Supply

IV-f1. Public/Private

All water in the NMR area is public, supplied by the Pittsburgh Water and Sewer Authority or the Wilkinsburg-Penn Joint Water Authority.

IV-f2. Well Head Protection

There are no wells in the Nine Mile Run watershed.

V. Biological Resources

An aerial view of the slag dump/propsed development site. View looking northeast towards I-376.

Photo courtesy of NMR Project, STUDIO for Creative Inquiry, Carnegie Mellon University

Background
There are several currents in landscape ecology which are relevant to the planning and design of urban greenways. The most fundamental has to do with the extent to which landscape heterogeneity (mix of habitats and land uses) is encouraged at various scales, and how biological resources are assessed. A landscape ecology model provides a useful way of understanding the issue of multiple-scaled and interactive ecosystems in fragmented, urbanized regions. Landscape ecology has been defined as a study of the interactions and fluxes of energy, mineral nutrients, and species among clustered stands or ecosystems (Forman, 1981). This defines a landscape system with several working scales: alpha (within habitat or vegetation community), beta (between habitat), gamma (bioregional or watershed), and delta (biome) (Noss, 1983; Naveh, 1994).

At NMR an example of an alpha-scale habitat is the **mid-successional woodland** along older slag slopes **(see Section V-b).** The beta-scale could be considered environments such as open brownfields and dense urban development. The complex of alpha and beta environments combine to form the gamma-scale system—Pittsburgh's bioregion—and the combined watersheds of the Allegheny, Monongahela, and Ohio Rivers might be considered Pittsburgh's delta ecosystem. Beyond this scale, geological regions assume even larger proportions. NMR functions as a tiny part of the Allegheny Plateau, which itself is a sub-component of the Stable Interior region (primarily layered sedimentary rocks) stretching from upstate New York to New Mexico **(see Section III-a1)**.

The usefulness of this landscape ecology model becomes apparent when assessing biological resources at NMR in light of objectives of ecosystems integrity, **biodiversity**, and sustainability. When the pattern and interconnectedness of ecosystems are assessed, one can begin to understand how patchy, poorly-linked habitats show less species diversity, tolerate stresses poorly, and reveal dysfunctional natural processes.

A final important ecological process involves the dispersal and containment of genetic resources. The health of a population of organisms is dependent on the wide exchange of genetic material since it is through the sharing of chromosomes within a species that resiliency is achieved. It is in this realm that NMR presents its greatest degree of isolation and disconnection. One of the important outcomes of this study will be to propose ways in which ecological fragmentation can be reversed in order to facilitate genetic diversity and species resiliency **(see Section VII).**

For planning purposes, the NMR project area can be organized into an assortment of individual, but overlapped and linked, ecosystems. This approach is consistent with trends in ecology over the last few decades

mid-successional woodland: disturbed landscape which is developing from an initial growth of early pioneer species, to a vegetation which may be more typical of the region

biodiversity: the different plants, animals and organisms in a given area

Hop tree (*Ptelea trifoliata*)is an unusual, but welcom find in the slag soils of the lower watershed. The hop treeis a Pennsylvania threatened species.

Photo courtesy of NMR Project, STUDIO for Creative Inquiry, Carnegie Mellon University

that have seen a shift away from the stable-holistic model of static and community-oriented assemblages of organisms to an ecosystems continuum model that stresses an individualistic, competitive, and largely functional ecology displaying a complex continuum of processes as part of often indistinct ecosystems (Barbour, 1995; Tamminga, 1997).

Each ecosystem in NMR presents a range of ecological attributes that say something of their ecological integrity. Some are isolated, some well-connected; some are small, some large; some are buffered, some unbuffered; some are degraded internally, some are relatively pristine; some are high in biodiversity, some extremely simplified. Coupled to the location and categorization of ecosystems within NMR is the relationship that the stream valley has to its adjacent exterior ecosystems and to the Pittsburgh bioregion in general. Finally, NMR can be assessed for its function (past, present, and future) as an ecological riparian corridor for biological resources within an urban environment.

Assessment of the biological resources at NMR focused on two key indicator groups, the **vascular** plants and insects. Plants and insects typically comprise over 90 percent of the biotic diversity in most ecosystems, and at NMR plants and insects may comprise an even higher percentage, given a **depauperate** vertebrate fauna. Due to their dominance in most ecosystems, plants and insects are valuable tools for environmental assessment, including water quality and the general health of ecosystems. Plants are often used as **biotic indicators** because they are immobile and thus are impacted by even subtle changes in **abiotic factors**. Insects, due to sheer diversity and habitat-specific lifeways, are one of the best groups of animals for use as biological indicators in both terrestrial and aquatic systems.

Although the biodiversity profile of NMR has changed substantially since the turn of the century, preliminary studies, especially studies of vascular plants and selected lineages of **arthropods**, indicate significant remnant populations of **native species** still existing in the watershed. Paradoxically, changing conditions at NMR created new habitats which have enabled native species, previously not found in the watershed, to colonize this area. For example, hop tree (*Ptelea trifoliata*), which has a conservation status of threatened in Pennsylvania, did not grow historically at NMR, but today occurs along the base of slag slopes, areas similar to the more **xeric habitats** typical of this plant **(see Section V-c).** In addition, a number of grass-associated species of native cutworm moths, unusual in or absent from forest habitats, have become abundant on or near the slag habitats (including *Agrotis gladaria, Agrotis venerabilis, Euxoa bostoniensis, and Euxoa obelis-coides*).

Given these shifts in the biota of the NMR watershed, both in terms of its historical past and potential future rehabilitation as different habitat types, one of the objectives of this project was to determine what ecological communities are possible within a severely degraded urban watershed and to propose rehabilitation potentials for this degraded urban environment **(see Section VII).**

---

vascular plants: plants with specialized systems for conducting tissue; these are the most common plants in the terrestrial environments

depauperate: falling short of natural development, lower than would be expected

biotic indicators: signs or indicators of life

abiotic factors: non-living factors

arthropods: invertebrate animals like insects, spiders, etc. that have jointed bodies and limbs

native species: plants and animals that are indigenous, originating and growing in a region

xeric habitats: environments which are characterized by small amounts of moisture

General Methods
Studies of the vascular plants and terrestrial insects at NMR were conducted by botanists and entomologists from the Carnegie Museum of Natural History (CMNH) using a rigorous protocol of specimen-based documentation (see below for specific research methods). The collection of vouchers (specimen-based documentation) is an essential component of any responsible biotic inventory. For groups of organisms - including many plants and insect species - that are not easily identified or even described, the preservation of vouchers as part of current studies provides the basis for future biodiversity assessments. Professional and scientifically useful preservation of vouchers is required (1) to render ongoing investigations credible, (2) to provide context for current studies as systematic or biological discoveries are made in the future, and (3) to provide an indication of past diversity as expertise develops to identify groups of organisms which have not yet been studied.

An intensive survey of selected lineages of terrestrial insects and vascular plants was conducted at four study sites within the NMR area. These sites were picked to represent the diversity of habitat types found within the overall conservation area. Three of the sites were located along the valley floor and the wooded areas adjacent to it, and the fourth site was located on the top of the slag heap itself. This provided a comparison of the flora and invertebrate fauna of a range of habitats from relatively less disturbed to totally unnatural conditions. Sites were located in a secondary forest patch, a wetland, on a small floodplain of NMR in a **riparian forest**, and on an open slag slope **(See Table V-1 and Map V-1).**

CMNH Transects and Radius

#	Name	Lat/Long	Alt.	Description	Collections
1	Secondary Forest	40-25-26N 79-54-21W	245 m	Secondary forest near meadows	Light trap, pit-falls, intercept, AVA plants
2	Wetland	40-25-27N 79-54-24W	235 m	Small wetland in disturbed woodland	Light trap, AVA, plants
3	Riparian Forest	40-25-26N 79-54-28W	230 m	Disturbed forest on floodplan near stream	Light trap, pit-falls, intercept, AVA, plants
4	Slag Slope	40-25-30N 79-54-33W	285 m	Extremely disturbed scrub on slag slope	Light trap, AVA, plants
	Transect 1	40-25-19N 79-54-40W	225-290 m	Wooded and open SSE-facing slag slope	Quadrat data for plants only
	Transect 2	40-25-25N 79-54-32W	225-265 m	Wooded NNW-facing shale slope	Quadrat data for plants only

Table V-1

Site 1. The secondary forest site was located southeast of the main gravel walking trail in a secondary forest patch with a semi-shrubby understory. This area is relatively less disturbed with a variety of trees, including American elm (*Ulmus americana*), sassafras (*Sassafras*

riparian forest: plants and trees growing along a body of water *albidum*), sugar maple (*Acer saccharum*), ash (*Fraxinus sp.*), and spicebush (*Lindera benzoin*). Common non-native plants at the site include garlic mustard (*Alliaria petiolata*) and Amur honeysuckle (*Lonicera maackii*). The soil is rich but well-drained, as the site was located on the lower portion of a hillside.

Site 2. The wetland site was located east of the main walking trail and south of a path leading to the creek itself at the small wetlands discussed in Section IV-b **(see Map IV-b1)**. The site was in a low area, which remained slightly damp even during the driest parts of the summer. Vegetation in the area includes both **facultative and obligate wetland species** such as cattails (*Typha angustifolia*), sensitive fern (*Onoclea sensibilis*), and various species of sedges (*Carex spp.* and *Scirpus spp.*). Nearby trees include cottonwood (*Populus deltoides*), sycamore (*Platanus occidentalis*), and staghorn sumac (*Rhus typhina*).

Site 3. The riparian forest site was located in the bottoms on the west bank of NMR at the point at which the creek changes from a southerly to a westerly flow direction. The soil is a rich clay composition in the wooded part of the site, almost mucky in places, and changes to sand and stones along the stream. The site was subject to flooding during high water events, and although traps were set above the projected waterline, they were flooded during several heavy rains. Dominant trees in the floodplain include silver maple (*Acer saccharinum*), American elm, and the introduced Siberian elm (*Ulmus pumila*).

Site 4. Chosen as a comparison site, the slag slope location was just below the top of the slag heap at the edge overlooking the stream, just south of I-376 and the Squirrel Hill Tunnel. The site **substrate** was composed entirely of slag, and the woody plants were primarily a mixture of staghorn sumac and tree-of-heaven (*Ailanthus altissima*).

Precise latitude and longitude coordinates for each site were determined using a hand-held global positioning system (**GPS**) unit (Magellan Trailblazer XL), and altitude was determined using both the GPS unit and a hand-held **barometric altimeter**. Field measurements of latitude, longitude, and altitude were confirmed using the United States Geological Survey (USGS) 7.5 minute, 1:24,000 topographic map for the Pittsburgh East Quadrangle.

In addition to the intensive study of vascular plants and terrestrial insects, data on the biological resources at NMR were gathered from a variety of sources, including a historical work on the ecology of Frick Park (Black, 1947), specimens in the CMNH collections, and more recent observations of the mammals, birds, amphibians, and reptiles in the area.

Deposition and Access to Specimen Data

All plant and insect specimens collected during this project are deposited at CMNH and are the property of CMNH. As appropriate, information on insects and plants are available for transfer to the Pennsylvania Natural Diversity Inventory (PNDI). Future access to all preserved specimens of insects and plants resulting from this survey, and their associated data, is the right of the Pittsburgh Department of City Planning and the Pennsylvania Department of Conservation and Natural Resources with suitable compensation for preparation and identification of specimens requiring extraction from bulk sample residues stored at CMNH and in accordance with CMNH data release policy.

---

facultative wetland species: would indicate plant species which may occur in wetlands but may also survive in more upland enviroments

obligate wetland species: indicate plant materials which are uniquely suited to survive only in wetland conditions

substrate: the layer beneath surface soil

GPS: Global Positioning System, a hand-held tool which communicates with satellites to tell the user his/her position on the earth in longitude and latitude

barometric altimeter: hand-held tool which uses air pressure to analyze the relative height of the user/tool in its position, above sea level

V-a. Wildlife

Background

Several urban areas across North America have defined their bioregion as a prelude to understanding the setting of site-specific initiatives. Such an exercise has yet to be fully conducted in the Pittsburgh area; however, the Allegheny County greenways map (ACPD, 1995, p.3) begins to show the network of natural spaces and corridors remaining in the city and surrounding Allegheny County. Other bioregional mapping efforts have taken a multi-layered approach to generating a definable bioregion: **geology, hydrogeology, hydrology**/watersheds, **physiography**, wildlife, **floristic patterns**, soils, and cultural heritage expressed in landscape-level patterns. All of these spatial variables can be synthesized into a single bioregional representation of the greater Pittsburgh area. The process of generating and applying bioregional characterizations often reveals opportunities for a regional-scale system of linked and enhanced remnant natural features and the associated biological resources.

Nine Mile Run, a post-industrial stream valley

Photo courtesy of NMR Project, STUDIO for Creative Inquiry, Carnegie Mellon University

Although a bioregional map of Pittsburgh does not yet exist, it is clear that the biological resources of NMR are linked to other natural areas within the region. While NMR does not contain large areas of habitat suitable for wildlife, the valley does exhibit linear patterns of **successional vegetation (see Section V-b).** These remnant patches combined with the stream suggest that NMR functions as an ecological corridor between Frick Park and the Monongahela River. For example, the stream serves as a conduit for the down-gradient flow of materials, nutrients, and microorganisms. Small mammals, white-tailed deer, birds, and invertebrates pass up and down the valley. The NMR/Frick Park deer herd moves seasonally as well, using the forest interior of the park as a wintering yard and spreading south into the valley and laterally along the well-wooded north slope of the Monongahela River during the warmer seasons. The Monongahela itself provides a larger ecological corridor for aquatic and avian species. As a major valley flyway, it funnels both nesting and migratory birds near the mouth of NMR. Near the mouth of NMR, the oak-hickory slopes along the north bank of the Monongahela River also serve as a species-conducting linear riparian corridor. Terrestrial and aquatic wildlife are discussed below in the context of NMR as an ecological corridor within the Pittsburgh bioregion.

Frick Park Stream Valley

Photo courtesy of NMR Project, STUDIO for Creative Inquiry, Carnegie Mellon University

V-a1. Terrestrial Wildlife

V-a1a. Terrestrial Wildlife: Vertebrates

Methods

Information on vertebrate species at NMR is from three sources: (1) historical records, primarily Black (1947) and specimens deposited in the CMNH vertebrate collections; (2) Frick Park records; and (3) sight records by project participants and others who use this area for recreational wildlife-viewing.

Discussion

A total of **240** species of vertebrates have been observed in the Nine Mile Run watershed area, including **189** birds, **22** species of mammals, and **29** species of amphibians and reptiles **(see Appendices V-1 to V-3)** for species lists). The vertebrate species occurring at NMR are typical

geology: the science of rocks and soils

hydrogeology: the science of interaction between soils and moisture

hydrology: the movement of water across a landscape

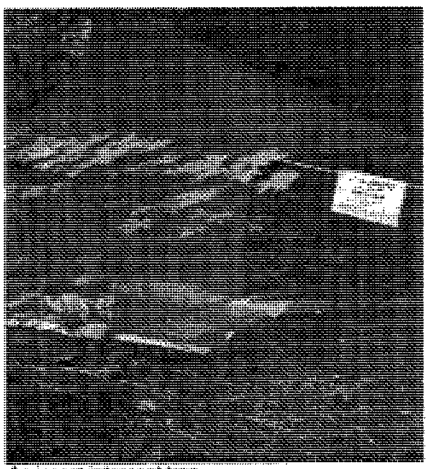
physiography: the science of land forms

floristic patterns: the patterns of growth and interrelationships between plant communities

successional vegetation: the natural replacement of plant species in an orderly sequence of development

Deer and wild turkey are regularly sighted at NMR, this one was photographed on the slag plateau.

Photo courtesy of NMR Project, STUDIO for Creative Inquiry, Carnegie Mellon University



An insect intercept trap

Photo courtesy of NMR Project, STUDIO for Creative Inquiry, Carnegie Mellon University

for this bioregion and the habitats represented at NMR. Two species of mammals introduced in Pennsylvania, house mouse and Norway rat, which are associated with human-dominated ecosystems, occur in the watershed. Although aesthetically pleasing in terms of wildlife enjoyment, white-tailed deer at NMR may pose a serious threat to vegetation through over-browsing and the population should be monitored.

V-a1b. Terrestrial Wildlife: Invertebrates

Methods

Field Sampling: At each of the four study sites, a specific light trap location was selected. Each light trap consisted of a 15-watt blacklight positioned above a metal funnel on top of a standard 5-gallon plastic bucket with power provided by a 12-volt battery. On days when rain was a potential problem, a plastic tarp was installed above the light trap location to protect the trap from precipitation. These traps were used to collect nocturnal flying insects, especially Lepidoptera (e.g., moths). Hand-collection of various insects using aerial nets, beating sheets, and collecting jars occurred at all study sites during each collecting episode.

In addition to light traps and hand-collecting, a tent-intercept trap and a series of 10 pitfall traps were installed at two sites (woodland and floodplain sites) for the duration of the study. An intercept trap consists of a mesh fabric, 2-m high, tent-shaped structure positioned above a pool of saturated salt water (NaCl) held in a plastic liner directly under the tent. The peak of each tent was sprayed weekly with a dilute pyrethrum solution. Insects entering the tent and naturally moving upward toward the peak were subsequently affected by the **pyrethrum** compound and dropped into the pool where they were preserved until collected during weekly site visits. These traps were used to continuously capture the **diurnal flying insect** fauna. Pitfall traps were positioned and maintained throughout the season to sample surface-crawling insects. Each pitfall trap consists of two cups, a connecting baffle, and rain covers.

Nineteen trips were made to the sites on a weekly basis, beginning on 30 June 1997 and continuing through the first frosts on 6 November 1997. CMNH staff entomologists (principal field worker, Robert Androw; assisted by Walter Zanol, Timothy Tomon, David Koenig, and Robert Davidson) conducted the survey. Each visit consisted of a blacklight setup trip in the afternoon of the first day and a retrieval trip in the morning of the second day. Coupled with retrieval of the light traps was the collection of samples from intercept and pitfall traps and a period of hand collection of insects in the field. Environmental data and other information about each trap site and trapping event were recorded on a standard field form. This data included collector, date, time, weather conditions, and notes on equipment problems. Light trap samples were carefully moved from the trap bucket to plastic bags and were stored frozen at CMNH prior to sorting and preparation. Intercept and pitfall samples were strained, rinsed, and preserved in 80 percent ethanol. Hand-collected specimens were stored in glassine envelopes or preserved in 80 percent ethanol as appropriate for the taxon in question.

---

pyrethrum: an insecticide consisting of the chemicals from the dried heads of several Old World chrysanthemums

diurnal insects: insects that are active during the daytime

Sample Processing and Specimen Identification: Light trap samples were retained in freezers at CMNH until sorting took place. Samples were thawed to room temperature, then carefully sorted by Dr. John E. Rawlins, a CMNH entomologist who is an expert on world Lepidoptera. He followed a strategy to optimize diversity information. Every Lepidoptera specimen in all samples was examined individually and retained according to a sorting protocol which (1) assures documentation of occurrence for every species in every sample, (2) strongly registers the difference between one specimen and two or more, and (3) less rigorously reflects total abundance by the presence of three or more vouchers. In general, this protocol produces a set of vouchers that reflects abundance of species in a sample. It is precise at low levels of occurrence and becomes less so as abundance increases. This method is both practical and essential, as many thousands of specimens were captured and examined such that the size and diversity of samples would overwhelm the sorter if precise counting was attempted. The many variables influencing effectiveness of light trap catches are unpredictable and thus precise sample counting is not only expensive in terms of time, but is not likely to yield information of much utility, either for within-species comparisons, and especially for between-species comparisons.

Samples taken by other collecting methods (intercept traps, pitfall traps, hand-collecting) were also selectively sorted following the same general protocol in order to remove all specimens of several targeted lineages of insects for this study and for potential future comparative value for understanding disturbed ecosystems. In particular, beetles (Coleoptera) in the families Carabidae, Silphidae, and Cerambycidae were comprehensively extracted from samples, as were flies in the families Sarcophagidae, Tabanidae, and Tipulidae. A number of other species were documented in other families of Coleoptera and Diptera, but no attempt was made to voucher every species in every sample as was done for the Macrolepidoptera and the non-lepidopterous families listed above. Material not prepared for this study is retained in 80 percent ethanol in the CMNH Invertebrate Residue Collection. CMNH staff entomologists and preparators processed the samples collected according to strict standards of pinning, point-mounting, and labeling to ensure specimen conservation.

Authoritative identifications of insect specimens was provided by staff and associates of the Section of Invertebrate Zoology, CMNH, as follows: John E. Rawlins (Lepidoptera: all families plus other miscellaneous insect families); Robert L. Davidson (Coleoptera: primarily Carabidae); Chen W. Young (Diptera: Tipulidae); and Robert A. Androw (Coleoptera: Cerambycidae and Silphidae).

Discussion

A number of ecologically diverse lineages of insects were comprehensively assessed from the samples taken. All species observed in those lineages are listed in **Appendix V-4.** It is important to emphasize that this survey focused on adults specimens, and that only half of the season was sampled with collecting beginning in late June. Many species with adults occurring in spring and early summer species are **univoltine** and their presence or absence at NMR cannot be determined based on this study. With this sampling restriction in mind, it is possible to summarize the terrestrial fauna based on adult occurrence records from mid-summer through fall.

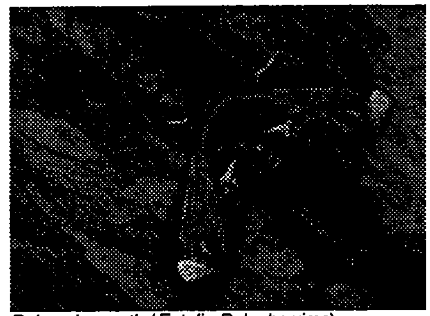
In general, the insect fauna was as expected for disturbed secondary forests associated with fields and open areas near a stream. Compared to similar undisturbed habitats elsewhere in the Pittsburgh bioregion, the following summary points on the terrestrial insect fauna may be noted: (1) species richness (number of species) was reduced in each of the major insect groups studied, (2) numbers of individuals captured for most (but not all) species were reduced, and (3) a number of species considered unusual in the bioregion were present at densities greater than expected, especially introduced taxa and species associated with xeric habitats and grasses. Most notably, aquatic species occur in low numbers in light trap samples, with groups such as Trichoptera (caddisflies), Plecoptera (stoneflies), Dytiscidae (diving beetles), and Hydrophilidae (water scavenger beetles) particularly being low in number. Attempts to hand collect aquatic insects were generally unproductive. Familiar insects such as water striders (Gerridae in the order Heteroptera) were rarely observed, and no indication of a thriving insect fauna in the stream was observed. Despite this, the number of Trichoptera species documented as adults exceeded the number recorded as larvae in the stream by Mirani (1997) **(see Appendix V-5)**.

The following comments on representative insect lineages will illustrate and sustain the faunistic generalizations above. While the majority of beetles collected at NMR were common, widespread species, the diversity in some families was higher than expected considering the disturbed nature of NMR habitats. Most of the Cerambycidae (long-horned beetles) have wood-boring larvae with generalist diets including many families and genera of woody plants. A few, such as *Megacyllene robiniae* in black locust (*Robinia pseudoacacia*) and *Tetraopes tetrophthalmus* in common milkweed (*Asclepias* spp.), are obligate borers of their hosts. Less common species, such as *Clytoleptus albofasciatus* in grape (*Vitis* spp.) and *Astylidius parvus* were collected several times. In contrast, the family Silphidae (carrion beetles) was poorly represented in all trap samples. The only two species collected were *Nicrophorus orbicollis* and *Nicrophorus tomentosus*, both abundant throughout Pennsylvania.

An interesting species of Scarabaeidae, *Onthophagus taurus*, was collected in the intercept at the riparian forest site (Site 3). The species was introduced into the United States in the late 1980s from Africa and was only recently recorded from Pennsylvania.

The group of beetles most frequently used as ecological indicator species are ground beetles (Carabidae); therefore the carabids were exhaustively studied. This ecologically diverse family is represented at NMR by a relatively depauperate fauna. The number of individual carabid specimens collected was much lower than expected, as was the total number of species. However, eight species were new records for Pennsylvania, and three of these were not previously known

univoltine: one developmental cycle per year north of South Carolina or Washington D.C. Most species documented were characteristic of fields, open areas and disturbed habitats. There were no species restricted in association to forested or woodland systems. The fauna is dominated by *Cyclotrachelus convivus, Platynus hypolithos*, and *Trichotichnus vulpeculus*, all generalists of open areas. Large series of *Bembidion affine* (from wet places) and *Lebia viridis* (on vegetation) were taken, the latter in association with a metallic green flea beetle (Chrysomelidae: Alticinae), undoubtedly its host.



Poison ivy moth (*Eutelia Pulcuherrima*)

Photo courtesy of NMR Project, STUDIO for Creative Inquiry, Carnegie Mellon University

Crane flies (Tipulidae) represent a large family of flies with very diverse habitat associations. The larvae are ecologically important as decomposers of stream debris, fallen leaves, rotting logs, and other organic detritus. The crane fly fauna of NMR represents a mixture of species expected for a dry woodland with a small stream, although overall species richness is lower than expected and only a few species were abundant. The occurrence of *Epiphragma solatrix* indicates moist decaying wood available for the larval stages. Other common dry woodland species are *Tipula* (*Lunatipula*) *duplex, Nephrotoma ferruginea* and the late fall species, *Cladura flavoferruginea. Pedicia* (*Tricyphona*) *inconstans* is an aquatic carnivorous species and the larvae require clean cold streams or saturated springy hillsides above a watercourse. Its presence at NMR is notable in terms of water quality.

All families of larger nocturnal Lepidoptera (nocturnal Macrolepidoptera or "larger moths") were assessed exhaustively, and when compared to other systems studied intensively in western Pennsylvania, these moth lineages show reduced species richness and reduced population density for most species. Faunal composition is also shifted toward taxa unexpected for woodland or riparian habitats, especially introduced species and those associated with open, xerophytic, or "barrens-like" natural communities.

Rosy maple moth (*Dryocampa rubicunda*)

Photo courtesy of NMR Project, STUDIO for Creative Inquiry, Carnegie Mellon University

The presence of many species of Lepidoptera with larvae (caterpillars) restricted to feeding on a single genus, or even a single species, of host plant, provides rather thorough indication of the vegetation as confirmed by botanical studies. A few of the many moth examples with such restricted diets include *Zale horrida* on arrow-wood (*Viburnum* spp.), *Mellilla xanthometata* on honey-locust (*Gleditsia triacanthos*), *Paectes oculatrix* on poison ivy (*Toxicodendron radicans*), *Schinia trifascia* on eupatorium (*Eupatorium* spp.), *Achatodes zeae* on elderberry (*Sambucus*), *Spragueia leo* on morning glory (Convolvulaceae), *Eumorpha pandorus* and the primarily diurnal *Harrisina americana* on grapes, *Epiglaea decliva* on cherry (*Prunus* spp.), *Ellida caniplaga* on basswood (*Tilia americana*), *Scoliopteryx libatrix* on willows (*Salix* spp.), and *Basilodes pepita* on flowers and nascent infructescences of wingstem (*Verbesina alternifolia*) to name only a few. Of greater interest is the presence of herbivorous species known to be restricted to a single larval food plant, but for which that **hostplant** was not documented by botanical efforts. For example, the presence of *Semiothisa quadrinotaria* is certain indication of buckeye (*Aesculus* spp.) at NMR despite that host plant genus remaining unrecorded by the present botanical survey. It is therefore predicted that one or more buckeye trees will eventually be found growing at NMR or in adjacent habitats.

hostplant: a plant/food source which an insect has adapted to

In contrast to the above, several species of Lepidoptera were absent, despite having their hostplants represented by established populations in the sampling area. For example, large stands of hops (*Humulus*) were not associated with notable populations of the host-restricted moth *Hypena humuli.* Bristly locust (*Robinia hispida*) growing at the site may support a population of the rare and monophagous inchworm, *Heliomata infulata,* but adults of this attractive moth are active before the sampling period of this study and additional fieldwork is required to document its presence.

The invasive plant species at NMR are associated with monophagous herbivores that have established invasive populations of their own. Some are exotic species feeding on exotic host plants, such as the European moth *Calophasia lunula*, which was introduced from Mediterranean regions into Canada and New England to control populations of the European weed, butter-and-eggs (*Linaria biennis*). In some cases, an invasive exotic plant species is sustaining populations of native moth species that have caterpillars feeding on the same genus or family of plants. This is the case with our attractive native moth *Nerice bidentata* that is feeding on both introduced and native species of elms at NMR. More obvious is the colorful orange moth, *Atteva punctella* (*Ailanthus* webworm), a native species feeding at NMR exclusively on invasive tree-of-heaven. Before introduction of tree-of-heaven, the species fed on other New World Simaroubaceae farther south and were not found in Pennsylvania.

The small wetland at Site 2 contained a number of moth species characteristic of wetlands and wet soil habitats. These include *Amolita fessa* associated with soft-leaved wetlands grasses, and various species of owlet moths (Noctuidae) with larvae boring in large stemmed herbaceous species: *Luperina passer* in dock (*Rumex spp.*), *Papaipema impecuniosa* boring in stems of composites (*Aster* and *Helenium*), and *Papaipema baptisiae* boring in stems of a wide variety of large-stemmed herbs, including wetlands plants as well as dry habitat species such as dogbane (*Apocynum*).

The xeric, well-drained habitats on the slag slope are not historically represented at NMR, nor do they occur extensively in the Pittsburgh bioregion. It is significant to note the presence of abundant populations of several moth species associated with such systems. These species are rare or missing in the other habitat types at NMR, and in general are unusual in the Pittsburgh bioregion. The most conspicuous of these taxa are several cutworm moths with larvae feeding on various grasses and associated with open dry to xeric habitats. They include *Agrotis gladiaria*, *Euxoa (Euxoa) bostoniensis*, and *Euxoa (Euxoa) obeliscoides*. Less restricted but still unusual in the NMR region are other cutworms, *Euxoa (Longivesica) messoria*, *Agrotis venerabilis*, and *Feltia jaculifera* on grasses. A number of specimens of *Abagrotis cupida* were taken, although the highly similar *Abagrotis brunneipennis* and *Abagrotis anchocelioides* were not recorded. A rare undescribed species of *Abagrotis* with earlier adult flight periods is possible in the Pittsburgh area, but will require sampling in June to confirm.

Several species of moths documented at NMR in this study are unexpected or have unusual habits and, therefore, deserve special comment. These include the stiriine noctuid moth *Plagiomimicus pityochromus* that feeds only on the seeds of ragweed (*Ambrosia*), and is known in western Pennsylvania from very few specimens. It occurs at the secondary forest site (Site 1). *Dysodia oculatana,* a member of the strange moth family Thyrididae, was seen in surprising numbers at all sites on NMR and especially on the slag slope. Known from only a few specimens from this region, the species reportedly feeds as a caterpillar on beans and other herbaceous legumes, but the actual host at NMR remains unknown. Finally, the unusual parasitic moth *Fulgoraecia exigua* was found as both adults and larvae in the secondary forest site. The species is the only North American member of the family Epipyropidae and is the only true Lepidoptera in North America to be parasitic on other insects, feeding on the abdominal secretions of fulgoroid planthoppers. Two larvae were found attached to abdomens of a planthopper taken in light traps.

Diversity indices and similarity values between sites were calculated. Despite overall insect diversity being low at each site (alpha diversity within a given habitat), between-site diversity was relatively high (beta diversity or between habitat diversity) for sampling stations only separated by a few hundred feet. Many species were recorded from only one or two sites. At all sites both species diversity and the number of individuals were low compared to undisturbed habitats elsewhere in the Pittsburgh bioregion. However, considering the disturbance history of NMR, a comparatively diverse reservoir of species is present, and with beta diversity levels high, populations of many species could grow rapidly through reproduction of existing individuals as opposed to waiting for more serendipitous recolonization of such species by dispersing individuals from outside the system. As a result, populations of many species, including ones with relatively narrow or restricted ecological requirements (stenotopic species), are likely to expand rapidly should habitat changes favor them in the future.

Each of the four insect trapping stations had a characteristic fauna:

Site 1, the secondary forest, was the most productive site in number and diversity of moth species. However, the intercept and pitfall traps at this site produced relatively few specimens of ground beetles, carrion beetles, and other non-Lepidoptera.

Site 2, the wetland, produced an intermediate number of specimens and species from light trap samples and was the site most affected by weather conditions, especially low evening temperatures.

Site 3, the riparian forest, yielded diverse light trap catches, but not at the level of Site 1. In contrast, intercept and pitfall trap samples at this site were larger and more diverse than those in the secondary forest. Ground beetles were quite numerous and relatively diverse.

The light trap at Site 4, the slag slope, documented fewer total specimens of nocturnal Lepidoptera than the upland forest or riparian

Common Snaping Turtle from NMR

Photo courtesy of NMR Project, STUDIO for Creative Inquiry, Carnegie Mellon University

forest sites, but catch size was more stable than at the other sites. Being elevated above the stream, this site was consistently warmer later into the evening, providing longer periods of insect activity and therefore increased probability of capture in the light trap. Site 4 was also the first to be warmed in the morning and insect activity was greater much earlier than at the other sites. Species diversity here also seemed more consistent, although lower than at the other sites.

V-a.2. Aquatic Wildlife

Comparisons between **pristine reference streams** and degraded streams have resulted in indicators of stream ecology integrity in a manner similar to landscape ecology. Many species, especially some **macroinvertebrates** and amphibians, are reliable indicators of water quality. Highly oxygenated, cool waters with relatively stable base flows and few pollutants will accommodate sensitive species not found in highly impacted streams. Some of the more resilient macroinvertebrates are still found in the stream **(see Section V-a.2b).** A number of sightings of other riparian creatures, such as the Belted Kingfisher near the creek's mouth, suggest that a semblance of ecological integrity still remains within and alongside NMR, despite decades of chemical, biological, and physical assault.

V-a2a. Aquatic Wildlife: Vertebrates

In addition to the Belted Kingfisher mentioned above, several other species of birds associated with riparian habitats have been observed in the vicinity of NMR: Osprey, American Coot (historical record only), great Blue Heron.

Several species of amphibians and reptiles associated with aquatic habitats have been found historically in the NMR watershed, primarily in Fern Hollow. These include five species of frogs (Green Frog, Mountain Chorus Frog, Northern Leopard Frog, Pickerel Frog, and Wood Frog); five species of salamanders (Longtail Salamander, Northern Dusky Salamander, Northern Spring Salamander, Northern Two-lined Salamander, and Spotted Salamander); three species of snakes (Northern Water Snake, Eastern Ribbon Snake, and Queen Snake); and the Common Snapping Turtle. Several individuals of an unidentified species of fish were sighted in the stream below Commercial Avenue during 1997. The aquatic mammals observed within the watershed include an immature beaver seen in the stream in 1997 and regular sightings of muskrats.

V-a2b. Aquatic Wildlife: Invertebrates

Benthic Studies (excerpted from Mirani, 1997)

Recent studies of **benthic macroinvertebrates** in NMR and Fern Hollow show similar results to previous studies of these streams. Both streams support a variety of organisms, but in low numbers. Downstream of Fern Hollow, the water quality of NMR seems to exhibit some improvement, possibly due to the confluence with Fern Hollow. Relative conditions of the two streams do not seem to have changed drastically in the past 10 years or more. While NMR is inhabited by pollution-tolerant organisms, Fern Hollow is dominated by clean-water scuds (*Gammarus minus*) and

pristine reference stream: a stream in a watershed which is relatively untouched by development or agriculture. Stream conditions in a pristine environment would include: clear, fresh water, well-supplied with oxygen and nutrient-rich organic detritus, and stable base flows supporting a variety of aquatic animals and plants

macroinvertebrates: insects which are visible with the human eye; in this context it refers to creatures which live during some part of their life cycle amongst the mud and detritus in streams

benthic study: an analysis of bottom dwelling insects

benthic macroinvertebrates: organisms with no spinal column that live at the bottom of a body of water supports a limited colony of caddisflies (*Neophylax* sp., *Rhyacophila* sp.). **(See also Appendix V-5)**

Adult Aquatic Invertebrates
Incidental to the detailed study of terrestrial arthropods in NMR, adults of various aquatic insect groups were collected. Of interest is the documentation of several genera of Trichoptera in addition to those noted as larvae by Mirani (1997) in **Appendix V-5**. This suggests a more diverse and biologically variable aquatic fauna than previously thought in NMR. This impression is supported by the collection of *Pedicia (Tricyphona) inconstans*, an aquatic carnivorous crane fly with larvae requiring clean cold streams or saturated springy hillsides above a water course.

V-b. Vegetation

Methods

Field Sampling: The vegetation surrounding the light trap station at all four study sites was quantified using Adjacent Vegetation Analysis (AVA), a protocol developed at CMNH and used in comparable surveys. All woody plants equal to, or greater than, 1 cm diameter at breast height (dbh) and located within a 25 m radius of each light trap were identified and their dbh measured and distance from the light trap recorded. Notes were made on the **herbaceous vegetation** also occurring within this radius throughout the growing season. Two transects **(see Table V-1, Map V-1)** were installed to allow comparison of vegetation growth on the slag slopes versus a natural shale slope. Transect 1 (T1) started on the slag plateau and descended the SSE-facing slag slopes, including areas with regrowth and open slag, and ended at the streambed. Transect 2 (T2) started in an oak-maple woods on the opposite side of NMR and descended a NNW-facing shale slope, also ending at the streambed. Both transects consisted of a series of 10 m quadrats in which all woody plants equal to, or greater than, 1 cm dbh were identified and recorded for the quadrat along with their dbh. Notes were also made on the herbaceous vegetation occurring within each quadrat.

In addition to AVA and transects, general collections were made of vascular plants throughout the area of NMR below Commercial Avenue. During 1997. CMNH botanists made a total of 16 visits to NMR for fieldwork from 19 June to 29 October. All major habitats within the area below Commercial Avenue were surveyed and all plant species encountered were documented with voucher specimens (291 vouchers total). Specimens were collected and processed using standard botanical techniques of field pressing, with subsequent drying of specimens occurring at CMNH.

Mapping of the vegetation was done by Ken Tamminga, Assistant Professor of Landscape Architecture, through exhaustive on-site survey of the watershed area as well as use of aerial photographs.

Sample Processing and Specimen Identification: All plant specimens collected at NMR were labelled and prepared by CMNH staff in

herbaceous vegetation: vegetation which has little or no woody tissue and persists for a single growing season accordance with strict **herbarium** standards using archival paper and labels. Authoritative identifications of plant specimens were done primarily by Dr. Sue Thompson, Assistant Curator of Botany, CMNH. Confirmation of some identifications will be sought from external experts in specific taxonomic groups, if necessary.

Discussion

General Vegetation: The NMR watershed is presently a severely degraded system, unlikely to be restored to its original condition, but clearly a candidate for rehabilitation and/or remediation to another type of more natural habitat. Prior to degradation, the biodiversity of NMR was typical of similar wooded watersheds in western Pennsylvania. Two-hundred years ago, NMR's terrestrial environment would have consisted of a mixed oak-hickory (*Quercus-Carya*) association on the plateau and dryer side slopes, with northern hardwoods and hemlock (*Tsuga canadensis*) mixed in on the cool northern slopes. Typical riparian areas along such wooded stream valleys might have included floodplain forests dominated by trees such as American elm, sycamore, silver maple, and boxelder (*Acer negundo*). Specimens in the CMNH herbarium indicate that NMR historically contained populations of three plant species presently considered to be of conservation concern in Pennsylvania and one additional species presently a candidate for listing **(see Section V-c)**.

Besides irregular fire events and blowdowns, the original forests of NMR would have largely exhibited interior habitat characteristics: closed-canopied, multi-layered, and accommodating a diversity of habitat-specialist species, free from the "edge effects" typical of fragmented habitats found today throughout the Pittsburgh region. It has been estimated that the eastern **deciduous forest** had 80 percent continuous forest cover by mature and old-growth (over 100 years old) trees and a 20 percent cover of successional vegetation or unforested lands (Riley and Mohr, 1994). The stream itself would have been pristine—clear, fresh, well-supplied with oxygen and nutrient-rich organic detritus, and with stable base flows—compared to current conditions and would have supported a variety of aquatic animals and plants.

As development in this area progressed, both terrestrial and aquatic ecosystems at NMR were heavily impacted, and the vegetation was changed drastically. The dumping of millions of tons of slag, which ended in the 1970s, essentially eliminated the stream valley and associated riparian forests and wetlands. It changed the surrounding slopes from wooded hillsides to giant slag piles. The NMR watershed today contains a mosaic of vegetation types, heavily influenced by the activities of man over many decades, including remnants of native vegetation types to areas heavily invaded by exotic species to slag almost completely devoid of plant growth.

Two overall vegetation types occur today in NMR: upland vegetation communities and lowland/riparian vegetation communities **(Table V-2, Map V-2, vegetation map and key to vegetation map).** There are seven basic community types of upland vegetation, ranging from open slag slope to secondary forest and areas of planted evergreens, and

---

herbarium: a collection of dried plant specimens usually mounted and systematically arranged for reference
deciduous forest: forests of trees with leaves that fall off at the end of the growing season

three different types of riparian vegetation. These vegetation communities are not discrete and distinct entities with fixed boundaries, and many areas intermediate between different types occur at NMR. All vegetation communities at NMR contain a mixture of both exotic and native plants, although in different proportions. Many of the plant species at NMR are introduced from Europe and Eurasia, but a substantial proportion are species that are native to this area, including many native "weedy" species. The native weed species play an important role in normal **successional growth** and include species, such as staghorn sumac and black locust (*Robinia pseudoacacia*) that colonize open areas. In areas of NMR, these plants compete with introduced successional species, such as the tree-of-heaven which can even grow through cracks in sidewalks! (See also section on Invasive Species).

Vegetation Communities at Nine Mile Run

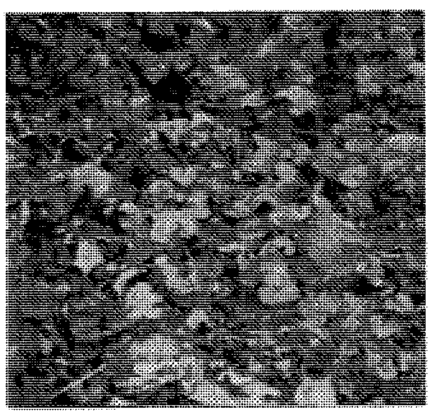
Type	Description
Upland Vegetation Communities	
Open Slag (U.1)	Slag with a few scattered early pioneer species.
Meadow — Early (U.2)	Sparse or early successional species of herbs and grasses (includes areas on the slag plateau).
Meadow — Early (U.3)	Established herbes and grasses without significant woody vegetation.
Meadow/Early Successional Woodland Complex (U.4)	Mixture of early successional woody species (poplars, sumac) and meadow vegetation.
Woodland — Mid-Successional (U.5)	Short-stature woody plants with open canopy (includes parts of slag slope with soil debris and regrowth).
Secondary Forest (U.6)	Areas of trees with a distinctive understory and forest floor component, includeing both relatively undisturbed (U.6) and disturbed (U.6-D) forests.
Evergreen (E)	Planted evergreen trees.
Lowland/Riparian Vegetation Communities	
Wet Meadow/Wetland (L.1)	Areas with more or less permanent water characterized by obligate wetland species.
Riparian Woodland — Mid-Successional (L.2)	Short-stature riparian trees with open canopy.
Riparian Forest (L.3)	Forest along the stream and in the stream valley characterized by trees such as sycamore and elms.

Table V-2

Relatively undisturbed secondary forest areas contain native hardwoods, including tulip-tree (*Liriodendron tulipifera*), basswood (*Tilia americana*), various species of oaks, American elm, sassafras, sugar maple, and ash as well as a mixture of introduced (e.g., garlic mustard and Amur honeysuckle) and native species (e.g., mayapple (*Podophyllum peltatum*) and spicebush) in the understory and forest floor.
The dynamics of this mixture must be monitored to maintain this vegetation type within NMR. Non-forested upland vegetation communities include meadows and the more open slag slopes. Vegetation on the open slag areas consists primarily of a few species of woody plants (staghorn sumac and tree-of-heaven) and little else. Early

Tree-of-heaven (*Ailanthus altissima*)

Photo courtesy of NMR Project, STUDIO for Creative Inquiry, Carnegie Mellon University



Garlic mustard (*Alliaria officinalis*)

Photo courtesy of NMR Project, STUDIO for Creative Inquiry, Carnegie Mellon University

meadows occur on the slag plateau and elsewhere at NMR, and contain a sparse mixture of early successional herbs (e.g., sweet-clover (*Melilotus alba* and *M. officinalis*)) and grasses (e.g., foxtail barley (*Hordeum jubatum*)). As meadows become more established, perennial herbs, including asters (*Aster* spp.), goldenrods (*Solidago* spp.), and sweetpea (*Lathyrus latifolius*), become more dominant. Meadows grade into woodlands, especially in some areas on the slag slopes, as early successional tree species, such as poplars and staghorn sumac, start to grow.

Wetlands at NMR include both facultative and obligate wetland species such as cattails, sensitive fern, and various species of sedges (*Carex* spp. and *Scirpus* spp.). Trees fringing these wetlands include cottonwood, sycamore, staghorn sumac as well as introduced shrubs, such as Amur honeysuckle. Dominant trees in the floodplain riparian forest include silver maple, American elm, and the introduced Siberian elm.

Invasive Species: An exotic species of plant or animal is one that was introduced, either intentionally or unintentionally, by human endeavor into a locality where it previously did not occur (SER, 1994). Introduced plant species form an important part of our environment, contributing immensely to agriculture, horticulture, landscaping, and soil stabilization. But among the thousands of plant species introduced to North America, approximately 10 percent display unexpected aggressive growth tendencies, resulting in real threats to native ecosystems (Blossey, 1997). These invasive plants typically exhibit (1) highly successful seed dispersal, germination, and colonization; (2) rapid growth and maturity; (3) prolific seed production; (4) rampant spread; (5) ability to outcompete native species; and (6) high cost to remove and control (Miller, 1994).

Disturbed sites such as NMR provide a haven for invasive plants. These species have left behind the natural controls (usually insects) that kept them in check in their native habitats in favor of compromised urban environments. Some, such as the common dandelion (*Taraxacum officinale*) or ox-eye daisy (*Chrysanthemum leucanthemum*), have over time become integrated into the flora of Pittsburgh's urban watersheds. These can be considered "naturalized" and, although newcomers to an ecosystem with a long natural history, can be tolerated and even appreciated in an urban watershed such as NMR.

Other plant species are of greater concern, for they have proven that they can out-compete and displace indigenous vegetation. None is more evident at NMR than honeysuckle. As with most other species successful in invading disturbed ecosystems, dense thickets of honeysuckle can modify ecosystem structure and functions to their exclusive advantage (Luken et al., 1997). Other invasive species at NMR include tree-of-heaven, garlic mustard, giant knotweed (*Polygonum sachalinense*) and Japanese knotweed also known as Mexican bamboo (*Polygonum cuspidatum*), and multiflora rose (*Rosa multiflora*). Populations of these species at NMR are extensive and control of these plants is addressed in Section VII. Following is an overview of existing and potential invasive species of primary concern.

Several species of honeysuckle were introduced to the eastern U.S. in the late 1890s as horticultural shrubs and vines and for wildlife habitat improvement. Plants are present throughout the study area and are clearly associated with areas of disturbed soil and fill situations. The species of primary concern are Japanese honeysuckle (*L. japonica*), a vine form, and Amur honeysuckle, an upright shrub. Species of honeysuckle can freely hybridize (Williams, 1995), and some **hybridization** may have occurred with closely related species such as Tartarian honeysuckle (*L. tatarica*) and Morrow's honeysuckle (*L. morrowii*), both of which are present throughout the NMR watershed as common ornamental shrubs. Morrow's honeysuckle is of special concern because it is able to invade wetter riparian areas.

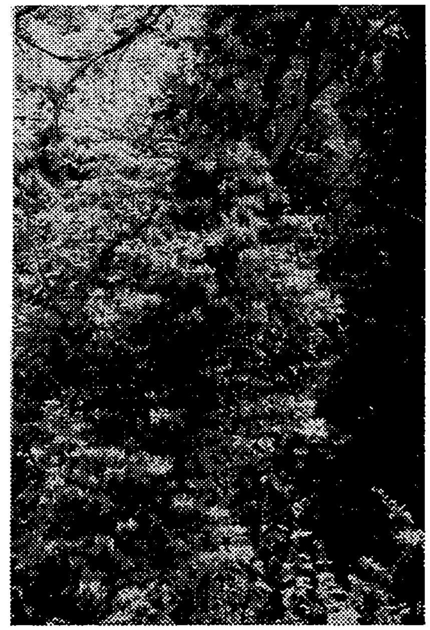

Honeysuckle (*Lonicera* spp.)

Photo courtesy of NMR Project, STUDIO for Creative Inquiry, Carnegie Mellon University

Honeysuckle often out-competes native plants due to earlier leaf expansion and later fall leaf retention. Large thickets of honeysuckle interfere with the life cycles of many native woody and herbaceous plants. These stands can alter habitats by decreasing light availability and depleting soil moisture and nutrients. Some honeysuckle species are likely allelopathic, releasing chemicals into the soil that inhibit the growth of other plant species (Converse, 1995). Fruits are consumed and passed by many birds, which makes effective control difficult (Williams, 1995).

Tree-of-heaven is a fast growing tree of Chinese origin and is ubiquitous in urban areas, including Pittsburgh. It is a prolific seed producer, a persistent stump and root sprouter, and an aggressive competitor with respect to surrounding vegetation. Tree-of-heaven occurs primarily in disturbed areas, but can also invade undisturbed habitats. It is found throughout NMR, from the most isolated slag slope locations to shady riparian environments. A high degree of shade tolerance gives tree-of-heaven a competitive edge over other plant species. The production of toxic chemicals may also explain the success of this plant, helping to limit natural succession in tree-of-heaven stands (Hoshovsky, 1995). Tree-of-heaven presents an interesting dilemma in disturbed areas such as NMR—a tree that grows where little else can, thus sometimes providing just the foothold needed for other species to colonize vs. a tree that can outcompete many other early successional native species.

Garlic mustard, a biennial herb of European origin, is unusual among invasive species in that it is also shade tolerant and spreads readily under forest canopy, especially in moist sites such as riparian woodlands. It is found at NMR especially in wooded areas, but occurs in scattered patches throughout the site. A prime local example is the woodland study area, where garlic mustard is found both in the understory and in full light settings near the trail. This resilient species is very aggressive in disturbed soil, forming a dense monoculture and displacing native herbs. Spring seedlings can attain densities of 20,000 seedlings/m^2 (Blossey, 1997). The mode of dispersal is unknown, but believed to be influenced by white-tailed deer populations, where trampling exposes soil and allows seeds to germinate. Human trampling and alteration of light conditions achieve the same affect.

hybridization: a reproductive process where different species of plants combine to produce a third species which is a genetic mixture of the first two.

Japanese knotweed and giant knotweed are two related and often confused species of Asian perennial herbs, which both occur at NMR. While little is known about the geographic distribution of giant knotweed in North America, Japanese knotweed has spread throughout the eastern U.S. and Great Lakes area. In some areas of Pennsylvania, it forms large **monospecific stands** along forested floodplains. Small stands of both species are established throughout NMR, including on the slag slopes as well as in riparian habitats. A vigorous patch is located just downgradient from the CMU trailer in an area of disturbed soil. Although plants produce viable seeds, they are dispersed mostly through the spread of **rhizome** fragments (Seiger, 1995).

Multiflora rose is an adaptable, thorny shrub attaining a height between 10- 23 m. This Asian rose has arching stems that form impenetrable clumps up to 6 m in width, choking out native plants. Long planted for wildlife food and erosion control, it has become a major pest in fallow field and bottomland clearings throughout the United States, and is officially listed as a noxious weed in Pennsylvania. Although decidedly less ubiquitous at NMR than honeysuckle, multiflora rose is found scattered throughout the more open riparian slopes of NMR, especially in the old field area downstream of the soccer fields. It can spread clonally outward from established clumps, but seems to be dispersed largely through consumption and subsequent deposition of seeds by songbirds.

Other invasive species grow at NMR, but have not yet become major problems. Crown vetch (*Coronilla varia*), introduced into the area during I-376 reconstruction, is present near the trailer on Commercial Avenue and has become somewhat aggressive. Kudzu (*Pueraria lobata*), which is listed as a noxious weed in Pennsylvania, is a hugely invasive vine, especially in the south, smothering large trees as it clambers for light; a small patch occurs above the Squirrel Hill Tunnel. Canada thistle (*Cirsium arvense*), another Pennsylvania noxious weed, has also been spotted at NMR, but does not appear to be spreading at present. Dame's rocket (*Hesperis matronalis*) is considered to be a potentially troublesome species elsewhere in Pennsylvania (Tamminga, 1997), and frequently occurs along stream margins. Several grasses may also be potential threats, including smooth brome (*Bromus inermis*) and Kentucky bluegrass (*Poa pratensis*). Additional fieldwork is required to determine the extent and impact of invasive forbs and grasses at NMR.

A discussion of aggressive invasive plants would not be complete without mention of several native species. Boxelder and wild grapes as well as other native species possess the ability to form fairly exclusive monocultures that thrive in disturbed environments.

V-c. PNDI Species

The Pennsylvania Natural Diversity Inventory (PNDI), established in 1980, is a comprehensive inventory and database of significant natural areas as well as plant and animal species of conservation concern in Pennsylvania. PNDI focuses on elements of special concern due to uniqueness or rareness in Pennsylvania, and monitors plants, animals, geologic landmarks, natural communities, and other natural features.

---

monospecific stand: a single plant species which out-competes and crowds out all others

rhizome: underground stems which produce shoots aboveground and roots below

Plant and animal species are assigned rankings based primarily on the number of extant populations within the state. Although these rankings differ slightly among organisms, the basic categories are (1) extirpated (extinct in Pennsylvania); (2) endangered (in danger of becoming extinct in the state); (3) threatened (may become endangered if critical habitat is not maintained); and (4) rare (uncommon due to restricted geographic areas or occurring in low numbers throughout Pennsylvania).

Plants

Two PNDI species presently are found in the NMR watershed, and NMR has historically contained populations of four additional species of conservation concern, including three currently listed in PNDI and one candidate species.

An extensive population of hop-tree (*Ptelea trifoliata*), which is listed as threatened in Pennsylvania, grows at the base and along the lower edge of slag slopes at NMR. Hop-trees did not grow historically at NMR and were first documented in this area in 1991. Although hop-trees are found throughout most of North America, populations are localized, resulting in listing as a species of conservation concern in many areas. Hop-tree is an excellent colonizer and is often found in open areas, such as sand dunes along the Great Lakes. Trees are extremely shade intolerant, and individuals in partial shade show a marked reduction, or absence, of flowering and fruiting (Ambrose et al., 1985). At NMR, hop-trees grow along the base of slag slopes, especially along Old Browns Hill Road, in areas similar to the drier natural habitats typical of this species, as well as on the shale slopes near the mouth of the run. Trees at NMR exhibited abundant flowering and fruiting, and seedlings and saplings were present. The success of hop-trees at NMR is likely due to the porous nature of the slag substrate and the open habitat in those areas. Standard PNDI Site Survey and Special Plant forms were completed for this population and have been submitted to PNDI.

Fringe-tree (*Chionanthus virginicus*), recommended this year for listing as threatened by the Pennsylvania Biological Survey (PABS), is another species which did not occur historically at NMR. One individual was documented growing on a bluff along the Monongahela River near the mouth of NMR in 1991. The general range of fringe-tree is to the east and south, but other sites are known from Allegheny County. Plants are found mainly in moist open woods and along edges. The species is also cultivated for its fragrant flowers (Cooperrider, 1995), and the tree along the Monongahela River may represent a plant naturalized from cultivation. Appropriate habitat at NMR needs to be searched for additional plants, and a natural status at NMR verified.

Historical records exist in the CMNH herbarium for populations at NMR for four additional PNDI-listed or candidate species: (1) passion-flower (*Passiflora lutea*), endangered; (2) American gromwell (*Lithospermum latifolium*), endangered; (3) blue false-indigo (*Baptisia australis*), recommended this year as a potential endangered species; and (4) white trout-lily (*Erythronium albidum*), recommended this year as a candidate for listing as rare.

Passion-flower and blue false-indigo were collected near the mouth of NMR in 1909; American gromwell was found in the area in the 1890s, and white trout-lily was last collected at NMR in 1908—all dates prior to slag dumping in the valley. Passion-flower is at the edge of its range in Pennsylvania, and in other areas is often found along roadside woods and hedgerows (Clancy, 1993). American gromwell occurs in dry woods and thickets and on limestone slopes; its range in Pennsylvania is limited to the southwestern corner (Rhoads and Klein, 1993).

Blue false-indigo prefers clay soil (Kosnik et al., 1996) and has been observed in open woods, river banks, and sandy floodplains in Pennsylvania (Rhoads and Klein, 1993). It grows mainly in the eastern United States, but has been found as far southwest as Texas. In Pennsylvania, the species is native to western counties and has been introduced to some of the eastern counties (Rhoads and Klein, 1993).

White trout-lily is a herbaceous perennial spring plant in many deciduous forests. The flowers and fruit mature in the spring and plants wither by early summer, and thus are visible only for a short period each year (Kaul, 1989). Plants are found in wooded areas, low moist ground, and also along streams and floodplains. White trout-lily is among the widest ranging of the eastern North American trout-lilies, occurring as far south as Texas and as far west as Nebraska. The species can withstand stress, and is often the first to return to previously overgrown woods after burning or mechanical clearing of underbrush (Swink and Wilhelm, 1994).

Despite previous searches in the area for passion-flower and American gromwell by staff of the Western Pennsylvania Conservancy and the extensive botanical fieldwork during this project, no populations of these two species have been found recently at NMR. No specific searches have been conducted for white trout-lily and blue false-indigo, but neither species was found during the botanical fieldwork for this project. Since fieldwork for this project did not start until late June, which is after white trout-lily has completed its seasonal cycle, additional fieldwork is needed.

Vertebrates

Five PNDI-listed species of birds have been sighted since 1970 in the NMR watershed: Bald Eagle (endangered), Common Snipe (threatened), Olive-sided Flycatcher (presently listed as extirpated in Pennsylvania), Osprey (endangered), and Yellow-bellied Flycatcher (threatened). In addition, five "Candidate at Risk" (species particularly vulnerable to exploitation or environmental modification) have been seen in this region: American Coot (historical record only), Blue Grosbeak, Pied-billed Grebe (historical record only), Summer Tanager, and Swainson's Thrush. Three "Candidate Rare" (species which occur in restricted areas or habitats or in low numbers) are also known from NMR: Common Barn Owl (historical record only), Northern Harrier, and Prothonotary Warbler. Another four species, which presently have no legal status but are under study for future listing, are also known from NMR either historically (American Bittern) or from more recent records (Black-crowned Night-heron, Great Blue Heron, and Virginia Rail). Of all

Community Input

A letter to DCNR steering committee member Jack Solomon

Dear Jack,

I am writing to you about the ornithological value of Frick Park. In short, I consider Frick Park to be the premier spring migrant "trap" in all of Pennsylvania. I say this as one who has birded extensively and intensively in every corner of the Commonwealth.

The major attraction for birders is the spring warbler flight through Frick Park. There are 36 species of warblers that occur regularly in Pennsylvania, and every single one of them has been seen in Frick Park. All but two of them (Prothonotary Warbler and Connecticut Warbler) occur annually in the park. On a good day in May, it is possible to see nearly 30 species of warblers. Some of the more common species (Yellow-rumped Warbler, Black-throated Green Warbler, Blackburnian Warbler, Chestnut-sided Warbler, and Black-and-white Warbler) routinely number in the high double digits. On exceptional days, it is possible to see well over a thousand individual warblers in the park.

In recent years, Frick Park has become increasingly popular with birders. On a typical morning in May, one will encounter a dozen or more birders—including visitors from the suburbs and beyond. A visit to Frick Park is a must for anyone seriously contemplating a May "Big Day" in southwestern Pennsylvania. That's because, quite simply, there is no better place in Pennsylvania for finding large numbers of nearly all the warbler species. It is not surprising that Frick Park is a popular site for outings sponsored by the Audubon Society of

(continue to next page)

these species, only the Summer Tanager is known to have bred in the area (up until 1982), and the Great Blue Heron probably had breeding populations at least in the nearby vicinity. There are no records or sightings of PNDI-listed mammals,amphibians, reptiles, or fish in the NMR area.

Invertebrates
Knowledge of the presence and abundance of most invertebrates in Pennsylvania is extremely limited. The most diverse lineage of invertebrates are insects, and precise information on the conservation status for most species other than butterflies, dragonflies, damselflies, and a few beetles is not available. As a result, PNDI ratings are conjectural for most terrestrial species and the best information on conservation staus depends on the impressions of regional specialists of which there are few. Although a few species of insects thought to be relatively rare or unusual in the Pittsburgh region were documented during this study, no officially-listed PNDI invertebrate species were collected.

V-d. Important Habitats

Site investigations and background studies reveal a number of important habitats, representing almost all areas of the valley and adjacent uplands. While additional work to acquire baseline data is needed to identify the extent of some of these resources, there is sufficient data to suggest that the following areas be noted as important habitats and be managed accordingly. Six categories of important habitat have been identified and are discussed below.

Wetlands
Two wetland areas have been preliminarily identified **(see Section IV-b)** within NMR. Their importance stems from a number of interrelated issues and characteristics:

- they are apparently unique to the NMR watershed, which is in a larger urban area that has no mapped wetlands according to the National Wetlands Inventory;
- they serve vital hydrological, biogeochemical, and habitat functions that are in extremely short supply in the valley;
- they provide a repository for plant and animal species that occur nowhere else in the study area, for example, hydrophytes such as sedges and other obligate wetland species;
- they are small and only tenuously connected to the landscape context; they are surrounded by fairly degraded landscapes and human activities (paths, ballfields, etc.) rendering them prone to further stress; and
- they can provide richly contrasting educational and experiential opportunities if carefully managed and accessed.

Additional research is required to assess hydrological and biological parameters of these sites, to delineate their boundaries in a more accurate manner, and to ensure their protection in terms of hydrological supply and biological and soil resources. With the upstream wetland, in particular, there is ample opportunity for remedial work and control of invasive species.

Pennsylvania. In fact, when the American Ornithologists' Union met in Pittsburgh in 1988, Frick Park was chosen as the location for the morning field trips. Dozens of the best ornithologists on the planet visited the park, and they were well pleased with the park's offerings of everything from Yellow-throated Warblers to Olive-sided Flycatchers.

When I first started birding in Frick Park, as a teenager, I was mesmermized by the great abundance and diversity of warblers that would stream through the park every spring. But I also assumed that similar spectacles were staged in every comparable forest fragment throughout the region. I have since learned that, to the contrary, Frick Park is exceptional, and nearly unique, in comparison with similar forest tracts in the region. I believe I am appropriately credentialled to offer this assessment, having served for years as the Allegheny County.

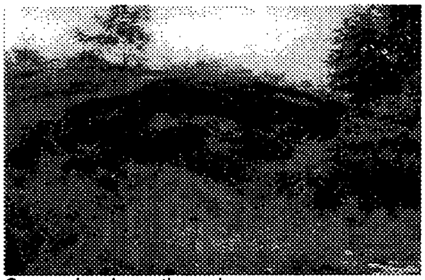
Editor for the journal, *Pennsylvania Birds*, and more recently as the Philadelphia County Editor of that journal. I am also the state coordinator for the North American Migration Count, and I am always impressed by Allegheny County's haul—much of which comes right out of Frick Park.

Sincerely yours,

Ted Floyd

There is a small slope wetland on the slag property.

Photo courtesy of NMR Project, STUDIO for Creative Inquiry, Carnegie Mellon University



Successional growth on slag.

Photo courtesy of NMR Project, STUDIO for Creative Inquiry, Carnegie Mellon University

Slag Plateaus and Slopes.

Slag may seem a rather unlikely candidate for important habitat, but is discussed here for several reasons. Biotic colonization of the almost impossibly severe surfaces of the slag slopes and plateaus presents an important brownfield research opportunity. Life forms from warmseason grasses to nonindigenous vegetation to macroinvertebrates to microorganisms to birds, herptiles, and small mammals all contribute to a surprisingly complex web of life. The slag represents a superb lesson for the public in urban ecology; themes include survival, succession, nutrient cycling, and the human role among others that are sometimes only subtly apparent. For example, the fact that hop-trees, a threatened species in other areas of Pennsylvania, grows at NMR because of the slag presents a useful teaching tool about the complicated interrelationships among organisms and the effects of substrate on biodiversity. Early successional species that make up much of the slag's most important constituents can provide a ready source of seeds and propagules to promote managed succession **(see Section VII, Restoration)**. While much of the plateau and slag slope area is slated for development and accelerated succession, respectively, some examples should be retained for research and educational purposes.

Remnant Secondary Forests

These areas **(see Map V-2)** are relatively scarce within the riparian corridor proper, but are more abundant in Frick Park and along the Monongahela River. Secondary forests provide many values, particularly forest interior habitat, the production of organic material which feeds ecosystems, **downgradient hydrological buffering**, and microclimate amelioration. These **mesic stands** may provide a ready source of seeds and **propagules** of local origin—an important consideration in revegetation strategies. These secondary forests are some indication of what existed prior to clearance, and they hold great interpretive potential as offspring of denser, grander old growth forests in inspiring the challenge of ecological regeneration throughout the valley. All remnant upland forests not slated for residential development should be protected and managed for enhanced ecological integrity. Invasive species, clearing, and dumping are current threats.

One of the most important roles of these secondary forest patches is in providing **interior habitat**, which is critical in maintaining populations of many organisms, especially birds. Although the present study at NMR focused on plants and insects, another widely-used indicator of the integrity of forest interior habitat correlates habitat patch size and shape with bird species that require minimum areas for successful breeding. As the patch size and corresponding interior increase, habitat specialists are more likely to be found. These are usually species that are declining due to habitat fragmentation resulting from urbanization or land clearing and include indicator species such as **neotropical migrants** (e.g. warblers), neotemperate migrants (e.g., Red-shouldered Hawk), and resident species (e.g., Pileated Woodpecker).

This approach is so well-developed as to be quite reliably predictive. Under certain threshold sizes, area-sensitive interior species are not

downgradient hydrological buffering: protection of downhill slopes due to uphill forest cover

mesic stands: stands of trees which are characterized by a moderate amount of soil moisture and good drainage

propagules: a plant which will produce roots and grow without seed

interior habitat: natural habitat of woods which are surrounded on all sides by significant stands of timber

neo-tropical migrants: bird species which migrate from tropical climates to temperate climates likely to breed successfully. As the size of forested interior area decreases, edge habitat and developed landscape increase. Instead of warblers, one is more likely to find species associated with successional and scrubby vegetation, such as House Sparrow, Catbird, Brown Thrashers, and the parasitic Cow Bird—all species that, relative to pre-contact conditions, are superabundant in settled landscapes.

Table V-3 shows key habitat threshold sizes, determined in previous studies by avian biologists, with possible associated bird species (Riley and Mohr, 1994; Moorhead, 1995) and corresponding habitats in and adjacent to NMR. This type of spatial overview analysis is useful since it suggests that a strategic approach to revegetation could bolster interior habitats (and associated species) which are increasingly rare in the Pittsburgh area. As importantly, it would also undoubtedly reverse the decades-old trend toward diminished biodiversity at NMR.

Habitat Thresholds for Breeding Birds

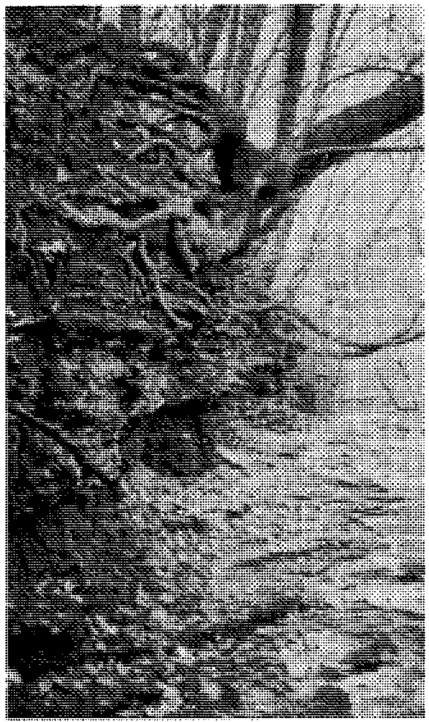
Patch Type / Size	Possible Breeding Bird Species	Representative Areas in NMR (see Map V-d)
Meta-Woodland (100-400 ha or 250-1000 ac)	highly area-sensitive species (e.g. Pileated Woodpecker, Northern Waterthrush, Canada Warbler	Frick Park main woodland (107 ha), marginally meta-scale due to convoluted shape and frequent gaps.
Meso-Woodlands (30-100 ha or 75-250 ac)	area-sensitive species (e.g. Veery, Wood Thrush, Scarlet Tanager, many warblers)	Frick Park main woodland
Micro-Woodlands (4-30 ha or 10-75 ac)	generalist and moderately area-sensitive species (e.g. Yellow-bellied Sapsucker, Gray Catbird, Red-eyed Vireo, some warblers, possibly Scarlet Tanager)	several in Fern Hollow/Frick Park; 4 or 5 stands in NMR south of Hwy. 376.
Wooded Patches under (4 ha or 10 ac)	generalist "field-and-edge species", permanent residents, short distance migrants (e.g. Gray Catbird, Cowbird, Robin, Gold Finch)	a number of scattered examples in NMR south of Hwy. 376.
Early-Successional Patches (loosely scattered trees, shrubs and forbs)	generalist and edge species (e.g. White-throated and House Sparrow, Brown Thrasher, Cowbird, Mockingbird, Blue Jay, Cardinal, Robin, Gold Finch)	many scattered examples in NMR south of Hwy. 376.

Table V-3

Frick Park could be expected to act as a local refugia for interior bird species; it is also likely to contain breeding populations of interior-nesting neotropical migrants. Frick Park also serves a similar function for small mammals and herptofauna. The mapping of forest interior habitat **(Map V-d, Interior and Upland Forest)** clearly shows that while total upland forest cover in Frick Park is almost 370 acres (150 **ha**), the actual interior habitat in the single meta-woodland is approximately 87 acres (35 ha), less than 25 percent the total coverage.

NMR south of I-376 contains virtually no forest interior habitat. In fact, of the approximately 158 acres (64 ha) of upland forest vegetation in total, only a tiny 0.1 acre core has been identified as having any potential as interior habitat. However, a number of small patches do attain the

ha: hectare, 2.47 acres



Shale outcropping with Basswood trees. There are four shale outcrops along NMR, two in Frick Park, and two along the slag-dump property.

Photo courtesy of NMR Project, STUDIO for Creative Inquiry, Carnegie Mellon University

micro-woodland scale in which moderately area-sensitive bird species may be expected to nest. All the other patches of early successional woody vegetation and old field habitat support habitat generalist bird species that are ubiquitous throughout the greater Pittsburgh area.

Many researchers point out the importance of context in determining minimum woodland size requirements. For example, the number of area-sensitive species within woodlands and the rate of increase of forest interior birds in larger woodlands were highest in an area that had the most overall forest cover on the landscape, about 30 percent (Freemark and Collins, 1992). Related to this is the importance of proximity. NMR has excellent proximity not only to the significant secondary forests of Frick Park, but also the flanking slopes of the Monongahela River and several large forest patches extant across Browns Hill Road in Calvary Cemetery and along Rivermouth Drive **(See Map V-d).**

Thus, although NMR exhibits extreme patchiness, it is nested within an urban region that is decidedly more wooded than most other North American cities. This would suggest that revegetation efforts in NMR and Frick Park are likely to result in an increased number of vertebrate species because of the ability to "borrow" biodiversity from adjacent wooded patches.

Aquatic Habitats

NMR has been the focus of previous research on the effects of urbanization on small urban streams. Benthic organism and water quality studies provide valuable clues to trends, ecological tolerances, and critical thresholds of biodiversity. Two contrasting types of habitats can be identified, highly degraded and relatively pristine. The former is worthy of much attention, with attendant short- and long-term goals for rehabilitation and restoration. The latter exist in short stream reaches on site, natural substrates, shale ledges, several well-developed meanders, a few deeper pools, and some very interesting sandbars showing natural selection.

Remnant Riparian Forests (See Map IV-b)

While in very short supply, there are several sites both up and down stream of Forward Avenue which accommodate fairly important remnant riparian forests. These are small floodplain flats spared of slag dumping. Disturbed soil regimes, stormflow litter, and invasives species, however, contribute to their current state of serious degradation. Nevertheless, forested floodplains—once a ubiquitous part of the Nine Mile Run system—must be considered important vestiges of the past, and valuable as *in situ* reference sites for wider restoration efforts. Their role in stormwater uptake, habitat, erosion control, nutrient cycling, and educational opportunities should be recognized and strengthened. Some of the more unusual terrestrial species of insects at NMR are associated with these riparian habitats, such as the large long-horned beetle (*Prionus laticollis*), which has larvae boring in the roots of mature trees associated with undisturbed bottomland forest.

Rock Outcroppings

There are a number of interesting geological features along NMR that should be included as important habitats. Natural and man-made shale cuts exist in good supply along the upper reaches of the stream, as well as several large exposures along the midreaches of the stream and along the jeep trail. They are a source of high-profile educational opportunities, harkening to past eons that formed the foundation for current ecosystem functions and cultural utilization of the local area. While more work is required on the specific ecologies at work on these very sensitive features, there are some intriguing species of native plants, including wild hydrangea (*Hydrangea arborescens*) and rattlesnake root (*Prenanthes altissima*), associated with these rock outcrops. The presence of adults of the crane fly (*Limonia (Geranomyia) communis*) also indicates habitats with hygopetric association such as rocky margins of streams with vertical cliffs where the surface is continually wet and covered with algal growth.

Community Input

Dynamo Soccer said that Pittsburgh has a shortage of fields for active recreation. The city needs more soccer fields. Have we analyzed the available flat lands for recreational fields?

Question from the Second Public Meeting:

Sports league attendance is listed at 410,000 per yaer. That is 1100 people, 365 days a year. Iis that realistic?

VI. Cultural Resources

VI-a. Recreation Use

NMR extends for less than 1.8 mi from the mouth of the culvert in Frick Park to the Monongahela River. Over much of its length, NMR falls within the boundaries of Frick Park. In addition, its major tributary, Fern Hollow, runs north to south through Frick Park. Due to the location of NMR and its major tributary, a majority of the recreation uses in the watershed are confined to the 476 acres of Frick Park. The park is one of four regional parks in Pittsburgh and as such contains many recreational amenities. The recreation uses and facilities in the NMR watershed are broken down into two major categories: (1) physical recreation facilities used for organized sports leagues, and (2) individual/neighborhood recreation and organized nature programming and individual nature activities.

VI-a1. Recreation

The recreation facilities in the NMR watershed are extensively used for organized sports programming and individual nature activities **(Table VI-a)**. CitiParks, the City of Pittsburgh Department of Parks and Recreation, sponsors a tennis league for youth at the Braddock Avenue tennis courts. Similarly, little league football, soccer, and baseball leagues use other facilities located within Frick Park. In addition, adult recreation leagues utilize facilities such as the Braddock Avenue tennis courts, the softball fields, and the lawn bowling center.

Apart from the organized recreation activities occurring in the NMR watershed, the area's physical recreation facilities also support recreation uses that are not part of organized leagues. Parents and children extensively use the two playgrounds in Frick Park and neighborhood residents take advantage of the fields and tennis courts for casual recreation.

Frick Park Facilities Usage

Facility/Activity	1997 Attendance
KinderCamp	425
Great Race	15,000
Picnic Shelters	9,500
Run Around the Square 5k/10k	1,260
Space Camp	770
Sports Leagues	410,300
Tennis Courts	31,500

Source: City of Pittsburgh Department of Parks and Recreation

Table VI -a

VI-a2. Nature Programming and Nature Activities

The NMR watershed and Frick Park are also home to a substantial amount of environmental programming run through the Frick Environmental Center (FEC), which organizes education, outreach, and training programs. Some of the education programs offered during 1997 were: Winter Bridge, a school program for kindergarten and first grade classes; Maple Festival, a two-day community festival focusing on the historical growth of maple sugaring and nature education; Nature School, a hands-on program teaching preschoolers and kindergartners about the environment; and Kids NatureCamp, a three-week-long day camp to teach children an appreciation of the natural world.

In addition to education programming, the FEC also organizes outreach programs. One such program, Nature in Your Neighborhood, is a hands-on investigation of nature in 10 Pittsburgh communities. The program is organized for children in grades 1 through 6. During 1997 the program had 110 participants who attended twice a week for a 20-week period. Finally, the FEC organized several training programs. One program, the Green Team, trained six individuals in landscaping and gardening. Another training program, the Junior Naturalist Program, trains students in grades 9 through 12 to assist and implement family, youth, and community programming throughout the year.

Along with the organized programming, the NMR watershed in Frick Park is extensively used by individuals for nature walks, bird watching, mountain biking, and jogging. The Frick Park Nature Reserve (150 acres in the northwest corner of the park) had 12,000 users from May through August 1997. The FEC estimates the number of visitors at approximately 6,000 for the remaining eight months of the year.

Frick Park Nature Center Usage

Program	1997 Participation
Community Festivals	3,500
Community Meetings	450
Environmental Education	15,000
Evening Programs and Lectures	485
Harvest Fair	3,150
Nature In Your Neighborghood	2,100
Nature Reserve (walkers, joggers, bird watching, etc.)	(May-August) 12,000
	(September-April) 6,000

Source: City of Pittsburgh Department of Parks and Recreation

Table VI-b.

VI-b. Recreation Facilities

The Department of Parks and Recreation manages six clay tennis courts, two softball fields, one little league field, one football field, one soccer field, one basketball court, one lawn bowling green, and two playgrounds. The Frick Park Lawn Bowling Club oversees the lawn bowling center. In addition to these facilities, Frick Park contains miles of hiking trails, numerous picnic shelters, and passive recreation areas.

Community Input

Jack Solomon: My two cents worth about Frick Park is that of all the city parks I've seen, in Pittsburgh and elsewhere in comparably sized urban areas, Frick comes the closest to providing a sense of "wildness." I don't mean wilderness: that's a word more appropriate to describe something like Yellowstone, and Frick is not that, and could not be. Still, there are sections of the (approximately) 450 acre park containing a few hundred acres of woodland, unbroken by highways or large clearings, where native plants and animals abound.

My current prime interest is in birds. Sixty-seven species of birds were seen in Frick yesterday, and the spring migration hasn't even peaked yet. This number compares nicely with what birders find this time of year at suburban and rural locations around here.

My interest as a boy, when the mile or two walk to Frick bothered me not at all, was reptiles and amphibians. The park had garter and brown snakes, and also milk, smooth green and black rat snakes, as well as a number of frog, toad, and salamander species.

Frick has grown over 50 years older in my memory, and some of the old oaks, sycamores, and other trees have grown so big that pileated woodpeckers are seen there frequently. The pileated is a big woodpecker the size of a crow and is an indicator of a somewhat mature forest. The beauty of the big trees and other flora in the park compares favorably with parks several times its size.

The miracle of Frick is that even the valley along the slag heaps just outside and south of the park's boundary (and soon, I hope to be added to it) are a haven for wild life, because they are next to Frick. I've seen more mockingbirds in the stream valley next to the slag than anywhere else in this end of the state. It was wonderful for this city boy to be able to play and wander in Frick. This aging city man still enjoys it.

VI-c. Archaelogical/Historical

Historically Significant Properties in the Nine Mile Run Watershed

Neighborhood	Property/ Structure Name	Location	Architect	Date	Historic Designation
Edgewood	Western Pennsylvania School for the Deaf—Administration Building	Swissvale Ave. & Walnut St.	Alden & Harlow	1903	Architectural Significance
Edgewood	House	326 Maple Ave.	unknown	1890	Architectural Significance
Edgewood	C.C. Mellor Library and Edgewood Club	Pennwood & W. Swissvale Ave.	Edward B. Lee	1914	Architectural Significance
Edgewood	Gardner-Bailey House	124 W. Swissvale Ave.	unknown	1864	National Register, Historic Landmark Plaque
Edgewood	Railroad Underpass	Race St.	unknown	1915	Architectural Significance
Edgewood	Pennsylvania Rail Road Station	Edgewood St.	Furness, Evan & Co.	1903	Architectural Significance
Edgewood	Houses	115-212, 129 LaCrosse St. and 143 Gordon St.	Fredrick Scheibler	1909-1910	Architectural Significance
Homewood Cemetery	Administration Building, Gatehouse, Chapel	Homewood Cemetery	MacClure & Spahr	1923	Historic Landmark Plaque
Homewood Cemetery	Worthington	Homewood Cemetery, monument	Louis S. Stevens	1919	Architectural Significance
Homewood Cemetery	Heinz	Homewood Cemetery, monument	Vrydaugh & Woldf	1897	Architectural Significance
Homewood Cemetery	Walker	Homewood Cemetery, monument	Max Bachmann, sculptor	1913	Architectural Significance
Homewood Cemetery	Brown Pyramid & Section 14	Homewood Cemetery, monument	Alden & Harlow	1907	Architectural Significance
Homewood Cemetery	Schoon maker	Homewood Cemetery, monument	unknown	1910	Architectural Significance
Park Place	The Whitehall	East End Ave. & Tuscarora St.	Fredrick Scheibler	1906	Historic Landmark Plaque
Park Place	Park Place School	427 S. Braddock Ave.	Ellsworth Dean	1902	National Register, Pittsburgh Register Property
Park Place	Old Heidelberg	S. Braddock & Waverly St.	Fredrick Scheibler	1905	National Register, Historic Landmark Plaque, City Historic Plaque, Pittsburgh Register Property
Park Place	Rockledge	579 Briarcliff Rd.	Fredrick Scheibler	1910	Pittsburgh Register Proprerty
Park Place	Abbott-Edgerton	Abbott St., Edgerton Ave., and Cromwell St.	various	various	Eligible Historic District
Regent Square	Linn Apartments	816 S. Braddock Ave.	unknown	1870s	Pittsburgh Register Proprerty
Regent Square	Double House	728-730 East End Ave.	Fredrick Scheibler	1920s	Pittsburgh Register Proprerty
Regent Square	House	1103 Macon	unknown	1910s	Pittsburgh Register Proprerty
Squirree Hill	Frank & Eva B. Harter House	2557 Beechwood Blvd.	Fredrick Scheibler	1923	Architectural Significance
Wilkinsburg	Pennsylvania Rail Road Station	Hay St. at Ross Ave.	Walter H. Cookson	1916	National Register, Historic Landmark Plaque
Wilkinsburg	Wetherall Apartment House	501 Hill St.	Fredrick Scheibler	1911	Architectural Significance
Wilkinsburg	Singer House	1318 Singer Place	unknown	1869	National Register
Wilkinsburg	Houses	1328-66 Singer Place	Fredrick Scheibler	1909, 1914	Architectural Significance
Wilkinsburg	Sheltering Arms Home for Aged Protestants	441 Swissvale	unknown	1869	Architectural Significance

Table VI-c

VII. Management Options

VII-a. Missions and Goals for Watershed Management

The mission of the Nine Mile Run Watershed Rivers Conservation Plan is to educate, inspire, and reveal the opportunity that exists in degraded urban landscapes. The tendency to value pristine environments over the landscapes that we access in our daily lives undermines the urban and suburban environment. If we are to reclaim our cultural uses and relationships to urban rivers, we need to carefully consider their opportunities along with their problems. We must learn to see (and teach) the value of ecosystem function in our neighborhood parks, backyards, vacant lots, and daily lives. From the daily practice of attention and care comes the values that will protect and enable a sustainable balance between the built and natural environments.

The following goals envision the Nine Mile Run Corridor as a sanctuary for nature and post-industrial culture in an urban context. They set the framework for management that will help ensure a perpetually flourishing, resilient, and complex ecosystem; one that the people of Pittsburgh will come to cherish and steward as a place of discovery, respite, and inspiration. Because the watershed's vitality depends to a great extent on human influences beyond its boundaries, these goals are proactive in calling for watershed stewardship and open space conservation measures throughout the Three Rivers Bioregion.

A view of the NMR classroom/public access trailer with a tent set up for an onsite public meeting.

Photo courtesy of NMR Project, STUDIO for Creative Inquiry, Carnegie Mellon University

Overall Goal

To protect, restore, and enhance the biotic, abiotic, cultural, and scenic values of a post-industrial urban watershed, and to promote public understanding, appreciation, and enjoyment of this heritage within a sustainable watershed program. To achieve these goals, priority will be given to the regeneration, conservation, and communication of key aquatic, riparian, and upland ecosystems. The intent is to nurture an environment which is experientially rich, aesthetically complex, and economically, ecologically, and culturally sustainable.

Natural History Goal

To ensure the health and integrity of the corridor's natural aquatic and upland ecosystems by protecting, restoring, and enhancing ecological and hydrological functions in a manner that results in a more sustainable and cohesive watershed ecosystem.

Cultural Heritage Goal

To reveal, maintain, and celebrate the cultural features of the Nine Mile Run watershed and surrounding area for their inherent value. Cultural elements and systems will be considered for their capacity to illustrate the shifting values evident in the cycles of human use, abuse, appreciation, and regeneration of the natural environment and urban rivers.

Community Input

Catherine Wunk Isn't it important to preserve the site as it is? Does it need to be cultivated?

Peggy Charny mentioned how Brown's Hill Road acts as a barrier. Education should be used to get communities not directly tied to the site involved. We need to get the community of Glen Hazel Heights involved. Perhaps this means making the link with jobs. We also need to get schools farther afield from Nine Mile Run involved.

Community Input

Don Gibbon commented on how important it is that the project addresses values and community education; education of politicians, homeowners, and children.

It was agreed that a task force should be devised to address this.

A representative of Dynamo Soccer suggested that any loss of playing fields be met by a two-for-one replacement.

Education and Interpretation Goal

To provide opportunities for students of all ages to explore and learn about urban ecosystems, public space, and river corridors as links between the built environment and nature. Interpretation can be experiential and participatory, promoting a relationship to the urban environment based on principles of sustainable use and stewardship.

Recreation Goal

To enable sustainable recreational opportunities, public safety, and access to diverse user groups throughout the watershed in a manner that is consistent with the above goals: to suffer no net loss of playing fields.

VII-b. Restoration, Healing, and Ecosystem Regeneration

Restoration, regeneration, reclamation, and healing are terms used in a variety of literature that explores the science and art of resolving ecosystem problems of land and water which have been severely affected by urbanization, industry, or natural catastrophe. The concepts implicit in these terms are important to anyone with a serious interest in urban ecosystems. In light of this, we clarify the language and intent below. As we consider the language of systemic change, it is important to note that the challenge at NMR is defined by the goal of restored ecosystem function, rather than the return to its historic (pre-degradation) form and function. While the latter is the ideal and one of the baselines for planning, the former is the realistic goal for this systematically degraded urban watershed.

Typically, **restoration** is a term reserved for interventions that aspire toward restoring the form and function of original habitats or ecosystems. As William Jordan (1997, p. 115) explains: "Restoration, when successful, results in the creation of an ecosystem that resembles the model, historic ecosystem in crucial (and ideally all) respects." There seems little merit in this notion as an overall approach to NMR, since the implausibility of restoration in the pure sense for all but some isolated, minimally degraded spots is easily apparent—slag mounds, urban development, and culverted stormwater are a present reality that will continue as primary ecological determinants into the foreseeable future.

More recently, the notion of **regeneration** has been applied to long-degraded urban ecosystems, emphasizing the revival of ecosystem functions without the intent to replicate the form of pre-degradation ecological patterns and native habitats. Regeneration places the emphasis on natural processes that may generate a newly sustainable, albeit altered, urban ecology. This new urban ecology can complement urban infrastructure, and in the case of urban stormwater, provide the potential for dual aesthetic and functional improvement. The regenerative approach tolerates the environmental scars that are almost impossible to erase in urban ecosystems. The functional vitality of the watershed valley's ecology may be recovered, but pre-industrial indigenous biodiversity, landform, hydrological patterns, and vegetation structure will never be fully re-created.

Another possible approach is found in **reclamation**—a term usually reserved for treatment of exhausted quarries and mine lands. The goal is to achieve a more sustainable landcover with fewer environmental impacts while providing enhanced habitat value and improved visual characteristics. This approach has obvious value when we consider the nature of the slag mountain which dominates the river mouth floodplain **(see Section VII-e).**

The notion of **healing** offers another model, one that operates at the end of the environmental management continuum opposite from restoration. The latter looks back to a rather idealistic and, in the case of the NMR watershed, a largely unachievable past. The healing approach is concerned primarily with the future, "emphasizing the goal of independence, of getting the 'patient' ecosystem back on its feet, making it [more] self-sufficient, whatever its history might be" (Jordon, p. 115).[1] Both the looking back and the looking forward are important for different reasons. We see merit in the concept of both healing and restoration, embraced by the overarching concept of regeneration within the NMR riparian corridor and larger watershed. We need healing to create ecosystems needed to sustain life, and we need restoration to "conserve the classic ecosystems, communities, and species that are the heritage of the past" (Jordon, p. 115). Moreover, while aspirations for literal restoration in post-industrial urban settings such as NMR are questionable, its utility as a metaphor could "resonate in the minds and hearts of individuals and communities, eliciting meanings and values that are already there" (Whitney, 1997, p. 15). Part of the cultural implication of restoring ecosystem function to urban watersheds would include a healing of the senses. In communities that have had their relationship to nature defined by the extraction and manipulation of resources, this healing can be advanced through the experiences, values, and wonders of a functioning urban ecosystem.

Finally, the ecosystem planning perspective. and its attendant focus on sustainability, should be seen as having a major role in reconciling human use and abuse of NMR. The valley and other remnant open spaces and waterways in Pittsburgh should be viewed as an interacting mosaic of ecosystems, connected by flows of energy and materials. This perspective strives towards a more intentional and harmonious co-existence between members of NMR's biotic community, one that includes humans, native species, and benign naturalized species. Such a conception is both inclusive and realistic, avoiding the pitfalls of anthropo- and bio-centric philosophies of urban nature. **(See Appendix VII-B Sustainable Ecosystems Management)**

VII-c General Revegetation Principles

There are a number of well-established principles for restoration plantings in riparian areas and along stream banks. Following are some of the more important points that should serve to guide plantings in the near future.

- The greatest limitation of riparian revegetation is that it often does not address the cause of degradation or stress; when it does not, it is likely that the riparian system will continue to be unstable (Briggs et

[1] Over the past 30 years or so, the ascendent paradigm of ecology as contingent and stochastic (rather than stable) suggests that there is no such thing as a completely self-sufficient ecosystem at the bioregional scale and smaller. Ecological principles of 'balance' and 'order' have been replaced by the principle of 'ecological gradation' (Soulé, 1995) encompassing a continuum of human and natural disturbances, with degrees of stability or diversity depending on spatio-temporal perspectives. In this discussion, biodiversity is a primary concept. The eminent biologist E. O. Wilson (1992) affirms that biodiversity is the key to global health worldwide. Others note that biodiversity is a key measure of sustainability at the bioregional and watershed scale (*UNCED*, 1992; Riley and

From *The Ecology of a City Park, Frick Park, Pittsburgh, PA,* by William L. Black (1947).

Protecting the native and introduced animal life produces interesting and paradoxical situations. Protected hawks, owls, and crows prey on nesting and migratory birds. Raccoons, skunks, and opossums often destroy the nests of rabbits and pheasants. The urine of dogs kills evergreens, but the feces and urine- soaked grass provide a habitat for certain types of flies. Dogs and cats kill rabbits, squirrels, chipmunks, mice, moles, and shrews. These smaller mammals often damage or kill introduced plants. Quail have been eliminated from the creek areas for years, possibly by Cooper's Hawks, cats, and hunting dogs. The anti-pollution laws have not prevented the elimination of amphibians, reptiles, fish, and water insects in Nine Mile Run, nor have the laws, publicity, or education forced the responsible communities to contain this sewage.

al., 1994). An understanding of water, sediment, and energy fluxes is essential to selecting the appropriate species, designing the soil profile, and determining whether plantings are even the correct solution (Harris and Olson, 1997). In particular, episodic flooding common to NMR can render new plantings vulnerable (Hawkins et al., 1997). The involvement of a stream hydrologist and fluvial geomorphologist is essential to ensure successful long-term restoration.

- Focus on common pioneer and quick-growing native tree species that are found in the immediate area of NMR or in nearby, reference sites. Trees such as willow, dogwood, poplar, and river birch are tried and true lowland restoration species, and presently grow within the NMR watershed.
- Allow enough time for locally-collected cuttings and seeds (local genotypes) to be grown by either volunteers or contract growers; commercially-available stock is often not adapted to the local situation.
- When gathering seeds and propagules, collect from different stock plants to broaden the genetic diversity of the plantings in order to enhance the overall biodiversity of NMR.
- Collect seeds and propagules in such a manner as not to jeopardize natural stands or significantly deplete the plant source (again, collect from several different individuals so as to obtain a representative sampling of genetic material).
- Err on the side of resilient lowland species: sandbar, black and pussy willow; redosier, gray, and silky dogwood; smooth and speckled alder; river birch; silver maple; American and slippery elms; green and black ash; chokeberry; cottonwood; sycamore; elderberry; basswood; red and silver maple; and viburnums. Where workforce and money are constraints, consider a successional strategy that starts with early colonizers, then underplant with a variety of other slower-growing and somewhat shade-tolerant species.
- Native shrubs can play an important role in diversifying the characteristics of the habitat, protect soil from erosion, and help shelter the edge of tree plantings. Make use of evergreens on the up-gradient sides of larger plantings to establish an interior habitat in a more timely fashion.
- As with stream restoration **(see Section VII-g)**, riparian revegetation should aspire to natural diversity and structural complexity. Provide variation in topography (see below), species, age, and density to maximize biodiversity.
- Rescue plants from nearby donor sites slated for development. For instance, the LTV site has a supply of willow and poplar that would be suitable for cutting and bare-root stock.
- Consider the potential benefits of restoration technology: Tubex® tree shelters and deer and rodent repellents are essential; the new VisPore tree mats are an interesting alternative to standard mulch; polymer soil conditioners and mycorrhizal innoculants are worth investigating.
- Conduct research on locally available biotechnologies in concert with on-going studies of stream morphology for specific application along degraded and threatened reaches of the stream. These technologies are usually to be preferred over static bank stabilization measures

such as concrete and gabions, which often fail in grand style and provide little habitat value.
- Incorporate the notion of accessibility and visibility into site selection criteria; those projects that are open to public scrutiny and easy for all to access can play a major role in building an inspired NMR greenway constituency. Denuded stretches along the creek just up- and downstream from the Forward Avenue crossing are excellent spots for revegetation, as are riparian areas near the playing fields and along the more visible stretches of Fern Hollow.
- Likewise, ensure that initial projects are successful. Nothing dampens community and agency enthusiasm like failure.

VII-d. Management Issues

VII-d1. Management of Rare and Endangered Species

Native rare species and significant/sensitive habitats have been identified in the background research. PNDI species should be addressed through the standard protocol, as guided by botanists and biologists with the Carnegie Museum of Natural History. In planning the exact location of trails, trailheads, and other facilities and programs, important habitats should be avoided to minimize trampling and wildlife disturbance.

A multi-disciplinary approach (designers and scientists) should be encouraged as a prelude to any specific installation or program application. Access by researchers and educational groups should occur only by permission of the watershed's management authority when it has been established that the watershed values will not be affected. Except for carefully planned and monitored corridor activities, native species should not be disturbed or removed unless under an approved research permit.

VII-d2. Management of Wildlife and Feral Pets

As documented in previous sections, NMR watershed contains a fairly significant diversity of animal species. The emphasis of management should be on allowing the watershed's native animal populations to develop with as little human intervention as possible. This policy will require the management of people and related land uses.

Deer management is a potential challenging issue, although the extent of the problem is not clear. Other urban and near-urban greenspace systems have grappled with the problem of excessive browsing of native vegetation for some time (Robertson, 1994). With an absence of natural predator-prey relationships, deer have often achieved unsustainable densities of up to 60 deer per square mile. Natural background levels for rural and near-urban landscapes have been variously quoted at between 10 and 20 deer per square mile.

Deer seem to be especially attracted to new plantings. Robertson and Robertson (1995) have seen some success with the application of Anipel (also known as Bitrex), a bitter-tasting systemic deer and rodent repellent. Treeshelters have become almost a necessity in revegetation projects. Many other techniques can and should be considered by watershed managers; sustainability principles discussed above should be adhered to.

Maintenance of appropriate population levels should be a priority. Preservation and reinforcement of natural linkages both within the watershed and between the greenway and Frick Park and the flanking slopes of the Monongahela River should be supported. This would permit the migration of deer and other species, thus easing the potential pressures of browsing and other effects of overpopulation due to habitat isolation. The advice of the Pennsylvania Game Commission should be sought, as should the opinion of those urban open space managers with more experience, such as Pennypack Wilderness Preserve and Valley Forge National Historic Park.

Other wildlife has the potential to become a nuisance. This tends to occur where watershed maintenance is lax (e.g. raccoon feeding at waste receptacles) and hand feeding takes place. Canada geese graze on turf, and may cause significant water quality and aesthetic problems. Watershed managers should watch for such problems as the watershed returns to a state of enhanced ecological integrity; county extension professionals and biologists are readily available for consultation. To the greatest extent possible, wildlife should be managed through appropriate ecosystems-based strategies. For example, areas of low-growing, high-nitrogen turf would be replaced with native, taller-growing meadow species to discourage geese grazing.

Loose-running domestic pets and feral ("wild") domestic species, largely cats and dogs, have known impacts on native fauna, particularly ground-nesting birds, low and mid-canopy songbirds, and small mammals. Wildlife management in NMR should incorporate a baseline study and monitoring protocol of actual impacts as well as establish specific mechanisms for control. One key aspect of prevention should be the initiation of education programs to heighten awareness of this problem. Pets should be under the owner's control in the watershed, and should be prohibited from running free in the stream. A "stoop-and-scoop" policy should be enforced.

Community Input

Sarah Dixon There are large numbers of deer and raccoons in Hazelwood, do they move around?

Barbara Balbot Deer cross Forbes Avenue into neighborhoods and eat in peoples' yards, thus, many people do not appreciate them.

Blair Jones Could there be a target study for animal diversity, coyote for example, to control deer population?

Ken Tamminga Could work with the fish and game commission to keep a sustainable herd.

Blair Jones What is a sustainable herd?

Ken Tamminga 10 to 20 —larger usually cause regional vegetation problems. The herd can be controlled through sterilization, sleep drug, bow hunting, etc.

Peggy Charny Frick Park off Beechwood is overun with unleashed dogs to the point of being dangerous at times.

VII-d3. Management of Human Predation and Destruction

Illegal harvesting of plants, animals, and material has probably been occurring in NMR for decades, although this is not well-documented. The killing of wildlife such as native snakes, the picking of spring wildflowers, harvesting of fiddleheads, mushrooms, and other wild edibles—these and similar actions adversely affect species, natural communities, and the local environment (Dawson, 1991). Appropriate state regulations and greenway policies should be enforced. Greenway visitors and surrounding residents should be encouraged to become stewards in monitoring and reporting illegal and damaging activities. A proactive program of public awareness and education should be considered as part of more detailed management strategies.

VII-d4. Management of Invasive Plants

Invasive plants are a highly significant reality in NMR. As discussed in Section V-b, invasive patterns of disrupted soil regimes, industrial fill, impoverished growing conditions, and a readily available source of invasive species propagules combine to create an optimum culture for invasive species. However, because a range of natural and cultural values are at stake, it is wise to begin assuming responsibility for management and control of invasive plants in NMR and throughout the watershed. Three approaches can be identified. For comparative purposes, several of the species of primary concern in NMR will be addressed in each.

Community Input

Questions from the Second Public meeting:

Is NMR different from other natural areas in terms of plants and insect population and diversity?

What invasive plants exist on site?

What is the best way to deal with the invasive plants?

Where are the invasive plants?

1) Direct management primarily involves application of physical, chemical, and biological interventions to the stand of invasive plants. Seedlings of tree-of-heaven, for instance, are easily pulled by hand before the development of the tap root. Applying this same approach to honeysuckle is a recipe for disaster since any disturbance simply provides opportunity for honeysuckle and other invasive species seeds (particularly garlic mustard) in the soil to sprout. Simply cutting honeysuckle and many other invasive shrubs and smaller trees is also frequently a waste of time since it results in resprouting and even more aggressive growth habits. Increasingly, natural area managers have advocated direct management through chemical means; the application of a non-persistent systemic herbicide such as Roundup® to cut stems and stumps to effect a complete kill with minimal soil disturbance. Biological interventions—usually the introduction of a herbivorous insect originating from the same source as the invasive host plant—is often considered where physical and chemical approaches have shown to be ineffective. A well-debated body of literature promotes integrated pest management (IPM, a technique adapted from greenhouse management) to discern the best direct management approach through time. It selects from, or combines the best of mechanical, biological, and chemical means of control of pest species.

Directing ecological succession is a common secondary management effort, often entailing the inter- or under-planting of robust, early successional native woody and herbaceous species. The objective is to out-compete invasive species. For example, after an initial round of honeysuckle eradication, riparian slope species common to NMR such as ash, slippery elm, willow, or redosier and gray dogwood (*Cornus* spp.) can be interplanted to facilitate canopy closure and root competition in an effort to reduce honeysuckle re-sprouting.

2) Indirect ecological management is gaining momentum as a more 'holistic' approach to dealing with aggressive non-indigenous plants. It stresses the importance of early plant detection, modification of human activity, and manipulation of system attributes as components of an ecological approach to modifying plant invasion (Hobbs and Humphries, 1995).

Some scientists feel that the most effective approach to long-term control of exotic pest plants is removal of the conditions that give these species a competitive advantage (Whiteaker, 1993). In NMR this may be more unrealistic than in most open space units; there will always be in external influences and a built-in disturbance regime (e.g. slag piles, flashy hydrology, and damaged soils) resulting in internal stresses which will require on-going and direct management.

Community Input

Peggy Charny mentioned that the city has a hard enough time maintaining the parks as it is, let alone adding anything new.

Bob Hurley mentioned that the Pittsburgh Parks Conservancy is addressing this issue.

For example, there is little precedent for successful indirect management of honeysuckle where extensive thickets are already well-established. A literal interpretation of the indirect approach would see the wholesale removal of slag fill and the reestablishment of pre-disturbance landform, soil, and hydrological regimes—"restoration" in its pure sense, as discussed above.

Once control and native revegetation tactics prove successful, indirect ecological management becomes more feasible. For example, management of hiker, mountain bike, and deer movements would reduce trampling and exposure of the seed bank, thus limiting the potential for invasives such as garlic mustard to become re-established.

3) The do-nothing option is a time-honored management option that is gaining renewed interest, albeit with ecological overtones lately. Eastman (1995) argues that there is no definitive solution to the challenge of invasive species and that therefore we should tolerate them as best we can. He cites community self-regulating mechanisms (herbivory, diseases, etc.) for their ability to moderate invasive dominance over the long term. The invasive plant is eventually integrated into a stable but changed ecosystem.

That NMR is a disturbed ecosystem within a fully urban watershed might work in favor of the third approach. However, this stance can be seen as fatalistic because it side-steps the real progress made in restoration ecology and reclamation science over the last decade. And it bespeaks an inherent pessimism: that any human intervention is, in the long run, bound to fail. Many precedents contradict this stance. NMR has been actively degraded for many decades. It will take several decades of active ecological management and restoration to recover a semblance of ecosystem function. Finally, the do-nothing option under-emphasizes the extensive damage invasive plants have inflicted on stressed urban ecosystems across the continent. NMR's ecological function and stability have been heavily degraded; the more clearly this is documented, the more we are obligated to rectify the situation in favor of native and benign naturalized life forms.

We consider the application of new ecological knowledge within an adaptive management approach—where monitoring and responsive-but-cautious interventions are essential to both long-term success and a heightened understanding of ecosystem dynamics—to be the most appropriate approach for NMR. Priorities for control or removal of invasive species should be directed at those that pose the greatest ecological threats, namely those that (SER, 1994):

- replace indigenous key species or rare and endangered (PNDI) species;
- substantially reduce indigenous species diversity, particularly with respect to the species richness and abundance of conservation species;
- significantly alter ecosystem or community structure or functions;
- persist indefinitely as sizeable sexually reproducing or clonally spreading populations;
- are very mobile and/or are expanding locally.

When considering vegetation management approaches in such a deceptively "green" corridor as exists along the lower elevations of NMR, it is important to make the distinction between "invasive"/"pest" plants, and those that may be non-indigenous. The latter may be benignly naturalized in their ecosystem context and may contribute some values such as habitat and seasonal beauty. The essential point is not whether a plant is "native" or "non-native," but whether it serves the larger interests of ecosystem health and integrity. In perpetually stressed environments such as NMR, some tolerance is certainly in order for both pragmatic and didactic reasons.

Community Input

Catherine Wunk: Would it help to publish a list of invasive species? Do wildflowers help enhance insect population diversity?

Jack Solomon: Is it possible to introduce more wildflowers to the site...even if invasive?

Further research is required to understand specific threats that may be present from NMR's invasive plant populations. Several species pose a rather philosophical challenge. For example, one response to the stoic tree-of-heaven might be admiration and the "better-this-tree-than-no-tree-at-all" observation. Hough (1995) stresses the validity of some introduced species in stressed urban environments. Their natural history (they frequently originate from long-disturbed European ecosystems) often matches perfectly with the disrupted conditions on site—a clear urban ecology lesson.

Others have pointed out the fallacy in this as a long-term management response. Robertson (1995, p. 65) notes that "in the long run, proliferation of highly invasive and competitive alien trees often leads to reduced diversity. The exotics are also invasive in a subtler, psychological sense. The lush, green landscape they create can produce the illusion of an intact ecosystem where, in fact, many species have been lost and complex relationships disrupted." While the tree-of-heaven on the more open slag slopes and plateaus appears to be growing synergistically with other smaller pioneering species, its role on more advanced successional slopes and in riparian areas can be questioned.

Some species represent, however, a much higher order of impact. **Appendix VII-d-4** contains a list of plant species that preliminary site investigations have suggested should be high priority considerations for control. While control techniques have been profiled above, each species should be the subject of a custom-tailored control and monitoring protocol. We strongly suggest that botanists with the Carnegie Museum of Natural History be involved in this on-going endeavor.

VII-e. Recovery of Riparian Plant Communities

Vitally important to the long-term ecological health of the NMR watershed is the ecological integrity of its riparian slopes and stream banks. This linear zone is, along with the aquatic ecosystem, the lifeline of the watershed, providing the primary ecological conduit for materials, energy, and species between the Monongahela River valley, Frick Park, and the upper watershed. Riparian and lowland vegetation provides a conduit for the in- and out-migration of animals and—over longer periods of time—plants. Biotic movement in NMR is not only important for immediate species richness, but to ensure that genetic communication takes place between isolated populations, thereby

A Slope eroded by the force of the storm flow

Photo courtesy of NMR Project, STUDIO for Creative Inquiry, Carnegie Mellon University

increasing their viability (Ambrose, 1992). Frick Park and the Monongahela valley therefore are seen as important sinks of natural genetic material.

Riparian vegetation also provides important values for NMR's aquatic environments. Overhanging trees and shrubs provide organic detritus that is invaluable to fish and macroinvertebrates. Shade provided by bankside vegetation helps maintain cooler water temperatures; streambank vegetation also provides a resilient and regenerative means of erosion control. Finally, riparian and lowland vegetation provides widely acknowledged habitat value.

In contrast to the slag slopes, much of NMR's riparian and floodplain ecosystems are fairly well vegetated, although often with non-native species. Rather than the comprehensive program for regeneration called for on the slag, these habitats require a more surgical approach to dealing with the problems of erosion, soil degradation, stretches of riparian-based slag, cultural intrusions such as mown turf and mountain bike trails, and invasive species control.

Since there are so many opportunities for small restoration initiatives on riparian slopes and along the stream bank, specific designated sites will not be identified herein. Rather, some general approaches are discussed below which should guide restoration plantings in the near future. Also, further studies must be conducted regarding **hydrogeomorphic** conditions, **stream morphology**, sediment transport, soil characteristics, and wetland delineation prior to establishing any significant restoration initiatives. Obviously, plantings in areas likely to be subject to stream remediation or wetland creation work would be premature. Lastly, several issues discussed previously (such as the use of plants of local origin, biotechnology, etc.) apply equally well to riparian ecosystems and should be referenced.

VII-e1. Microtopography Duplication

There are several low-lying and poorly developed areas along NMR that present an opportunity to restore mound-and-pool **microtopography**. This phenomenon has recently been the focus of restoration ecology research. Initial findings suggest that the hummocks and hollows created through wind-throw and root wad tip-ups provide an ideal growing environment for a wide diversity of both wetland and somewhat more mesic plants. The utility of this technique for the restoration of depressional wetlands—such as identified just downstream from the playing fields—is discussed in Barry, et al. (1996). He notes that with this approach the margin of tolerance is increased and that both wetland obligate and facultative species may be accommodated in low and high spots, respectively. This technique should also be explored for some of the more denuded and invasive-species infested areas of the lowland forest.

VII-e2. Monitoring

Monitoring is a necessary part of any riparian and aquatic restoration program (Kershner, 1997). Increasingly, resource management agencies are lengthening the period of monitoring, as it becomes clear

---

hydrogeomorphic: the study of changes which occur in the land due to its relationship with flowing water

stream morphology: the changes in the stream bed due to the erosive and depositional (creation of sand bars) nature of streams

microtopography: the smallest scale of topographic analysis that ecosystems dynamics take some time to appear. Short-term monitoring protocols have often spurred "instant" solutions which fail soon after observations ended and may not have been beneficial to the ecosystem in the first place. For wetland restoration, Barry, et al. (1996) cites the appropriateness of the Army Corps 404 permitting schedule, which calls for a 10-year monitoring plan and monitoring reports at the first, second, third, fifth, and tenth years following installations, as well as identifying any remedial actions. Even for very small or simple plantings, procedures should be documented and results tabulated for application to future projects in the valley and around the Three Rivers Bioregion. Also, it should be ensured that a record of stock source is obtained and deposited in a secure source, such as the Carnegie Museum of Natural History herbarium.


Volunteer growth on a slag slope

Photo courtesy of NMR Project, STUDIO for Creative Inquiry, Carnegie Mellon University

VII-f. Regeneration on Slag Slopes

The dysfunctional characteristics of the existing slag slopes are well-documented in this and prior reports. It is clear that the ubiquitous nature of the slag presents a complex challenge. Published research on similar precedents is scarce. Rather than thinking of slag as a "constraint" to be "overcome," perhaps it presents an opportunity in creative learning, a potential contributor to the continuing story of the culture-nature continuum so evident in this valley.

Saunders suggests that experimental ecological projects can "induce learning, encourage innovative thinking, and provide flexible opportunities to test new ideas" (1997, p.119). Smith, et al. (1997) have noted that both naturally occurring catastrophic events and human-induced mega-disturbances such as large slag dumps provide unique opportunities for studying forest development, primary succession, and ecosystem recovery.

By looking at regeneration on NMR's slag lands as experimental, there is an opportunity to watch, measure, tinker, and demonstrate to a wider brownfields constituency. This approach overtly acknowledges that there is (as yet) no one tried-and-true technique that conventional reclamation may, in fact, hinder other, more creative solutions. Pittsburgh's public and stakeholders will surely understand built models better than conceptual ones. Perhaps most importantly, an experimental approach will provide one of the more important scientific bases for ecological management and design of this brownfield site and others like it. It can provide insights that currently do not exist. If the mechanisms that cause vegetative change are understood, then they can be exploited to manipulate vegetation, and the results of these manipulations can be predicted more reliably (van der Valk, 1988).

What is the range of possible approaches to the slag slopes? Short of wholescale relocation of the slag elsewhere, which is indefensible from a sustainability perspective, possibilities range from conventional regrading to standardized gradients (e.g. 2:1 or 3:1), application of imported topsoil and hydroseeding with pedigree turf, to quite unorthodox and ecologically-intriguing solutions incorporating natural successional processes.

Hodge and Harmer (1995) profile five general approaches **(see Table VII-f)** to woodland creation on difficult urban and post-industrial sites characterized by high levels of environmental stress (drought, pH extremes, etc.). We have reconfigured the profile somewhat in the table on the next page, and added a sixth approach to clarify the continuum. The descending order of approaches illustrates the full range of regenerative approaches to revegetation, moving from the natural selection and competition which occurs in nature to increasingly intensive management. It could be argued that the goal of a sustainable post-industrial vegetation regeneration is an approach which provides the most experiential-aesthetic benefit while achieving an equitable balance between management costs and ecological risk.

Hodge and Harmer's (1995) profile of five general approaches

Method	Management	Planting	Failure Rate/ Time to Establish
1. Natural colonization	No management	Natural selection	Low/Decades
2. Nurture colonization	Low-intensity management	Natural selection	Low/3-10 years
3. Natural planting	Low-intensity management	Site-informed selection	Medium/1-5 years
4. Nurture planting	Mid-intensity management	Site-informed selection	Medium/1-3 years
5. Ideal-driven planting	Mid-intensity management	Idealized plant selection	Medium-High/Instant-1 year
6. Forced-ideal planting	High-intensity management	Idealized plant selection	High/Instant- 1 year

Table VII-f

<u>Natural colonization</u> (Approach #1) is clearly evident on the northerly, older slag slopes. This presents the most immediate and relevant reference site for reclamation of more open slag slopes. As noted earlier, however, the mid-successional slopes may embrace subtle differences, attaining a tolerable growing culture not yet evident on open slopes. The relative stability of surface aggregates and the possible presence of mineral soils may both provide just the level of sustenance needed to stimulate vegetative growth. On the other hand, existing vegetated slopes are older than the open areas (Prellwitz, pers. comm.) and have had a longer time to vegetate.

It is foreseeable that given time, natural succession may yet prevail on all slopes. The most analogous study available, on an old iron slag site in North Canaan, Connecticut, investigates a 75-year old, moderately high pH slag dump (Smith et al., 1997). It found that the accumulation of nutrient capital, largely organic matter from nearby forests and production of organics *in-situ,* was sufficient to establish appropriate mesic soil conditions on both plateau and moderately steep side slopes. Floristic patterns and size of white pine (*Pinus strobus*), oak, red maple (*Acer rubrum*), grey birch (*Betula populifolia*), white ash, and eastern hemlock were similar to nearby second and third growth woodlots (Smith et al., 1997).

<u>Nurture colonization, natural planting, and nurture planting</u> (Approaches #2, #3, and #4) are the models that we suggest may prove most fruitful for Nine Mile Run. These accept that some sort of accelerated vegetation, or 'kick-starting,' will be necessary to help restore watershed ecosystem functions and enhance open space aesthetics in concert with the proposed development on the slag plateaus. Approaches #2 and #3 work with natural processes, but are not adverse to translating contemporary knowledge in restoration ecology and reclamation science. Approach #4 takes into account the challenging conditions of germination, and closely manages the first two years of growth. A number of variations within these general approaches are included in **Appendix VII-c**.

Ideal-driven planting and forced ideal planting (Approaches #5 and #6) represent conventional models that have in the past appealed to managers of high-use urban open space. They tend to be driven by economic or visual criteria, rather than ecological principles. Each entails a visually ideal choice of plant materials which may not be suited to the constraints of the environment and therefore requires increasingly intensive management and an elevated risk of failure.

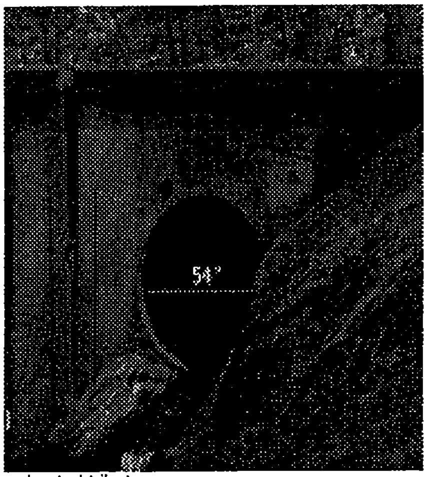
These approaches present an expensive, and perhaps, even imprudent scenario, given the challenges of the site. Whole-scale planting of non-adapted woody species on stressed brownfields sites such as NMR is risky, and far from sustainable. Rather than work with natural processes through time, these approaches invariably rely on frequent and heavy dosages of fertilizer, pesticides, and soil admixtures, as well as a high level of human effort. Furthermore, such approaches usually utilize non-native species with low habitat value. Clearly, an intensive "pedigree" approach to slag slopes is inconsistent with ecosystem design and sustainability principles.

Any number of experimental and adaptive management techniques which emulate ecological processes could be explored within the general #2-#4 model. The establishment of baseline conditions is essential. For instance, a thorough lab analysis should be conducted of soils from all areas identified for test plots and subsequent managed colonization and low-intensity plantings. Samples should be taken in each plot and tested for available nutrients, metals, pathogens, seed banks, pH, phenolic compounds, and other standard reclamation indicators (Majcher, 1997). Results should be analyzed by an experienced soil scientist or reclamation ecologist, and made relevant to the design of experimental/control plots.

VII-g. Stream Restoration

VII-g1. Upstream Testing

Fecal coliform testing should be expanded upstream of the daylighted portion of NMR. Site 3 branches out in three directions on the other side of the I-376/Braddock Avenue interchange. Each branch should be tested to pinpoint the source of constant sewage pollution that is discharged from this influent to NMR. The 16 ft box culvert at Braddock Avenue **(Site 1 on Map IV-e1a)** has several branches that could be tested. Testing three to five strategic locations in Edgewood and Wilkinsburg would be extremely beneficial for narrowing the possible sources of sewage during dry weather and perhaps wet weather. Sites 2 and 6 have daylighted portions that could easily be tested. Should

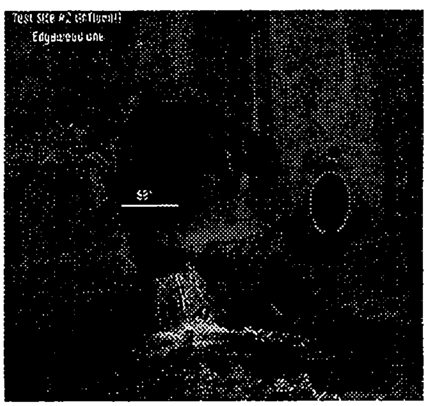


culverted tributary

Photo courtesy of NMR Project, STUDIO for Creative Inquiry, Carnegie Mellon University

these sites become a greater impact on NMR as the weather changes, testing could be moved upstream. Site 11 could be tested further up, though it must be traced first. This pipe is currently not mapped with the city of Pittsburgh sewers.

VII-g2. Detailed Sewage Infrastructure Mapping and Assessment
A necessary first step toward repair or renovation of the sewage infrastructure in the NMR watershed is mapping and assessment of infrastructure. The Allegheny County Health Department is currently compiling sewer maps from the four municipalities that can be used to evaluate the sewershed as a whole. This sewershed mapping is critical for evaluating and mitigating sewage impacts on NMR. A rigorous field verification must be performed to assure that the digitized maps reflect what is in the field. Discrepancies have been found, for example, between the CADD map of Pittsburgh and the actual locations of manholes and stream crossings. Field surveying of selected manhole locations, invert elevations, and other features is needed to ensure accurate mapping. In conjunction with the mapping effort, inspections of selected sewers and culverts are needed. Visual and television inspections typically are performed in such efforts. An assessment and inventory of all influent pipes would help identify unauthorized tie-ins. Such tie-ins clearly exist and it should be possible to identify a significant number of them rapidly. Inspections will also identify pipe blockages that contribute to SSO problems.



culverted tributary

Photo courtesy of NMR Project, STUDIO for Creative Inquiry, Carnegie Mellon University

Up-to-date sewershed mapping combined with inspection data should make it possible to determine areas where stormwater is likely to be entering the sanitary sewers. Possible sources include roof gutters piped directly into sanitary sewers or sanitary sewer manholes on the streets acting as storm drains. Also, the non-existence of actual storm sewers in some areas may be an important problem.

The possibility exists that the current sanitary sewers in Swissvale, Wilkinsburg, and Edgewood are under capacity for the volume they handle during peak hours. Up-to-date sewer mapping will facilitate investigation of this possibility which should be evaluated. A detailed sewer mapping and inspection program will identify readily fixable problems (e.g., pipe blockages, unauthorized sanitary sewer tie-ins to storm sewers) that could be the source of a significant fraction of the water quality problems in NMR. The maps and data obtained would also serve as the basis for long-term planning regarding sewage infrastructure.

Community Input

Patricia Miller (DEP) DEP is addressing sewage issues and will be taking steps soon.

John Smith The DCNR is a sister organization to the DEP. The NMR problem is a Health Department/DEP issue.
When will action be taken? It has been requested by various members of the citizenry for over 8 years!

VII-g3. Watershed Stormwater Management Program
A significant part of the sewage contamination problems in NMR is related to current stormwater management practices. Stormwater management should be reevaluated on a watershed-wide basis. A task force focused on the problems of the NMR watershed, with representation from the governments of all four watershed municipalities, should be created to look at the problems as a whole, and a stormwater management plan should be developed. This plan could include enhancement of stormwater infiltration in the watershed, restoration of stormflow in subsurface or surface basins, including

wetlands, and other measures **(see Appendix VII-g,** wetlands are addressed in **Section V)**. With such a plan, local efforts can begin on a variety of aspects in a coordinated manner. Proper separation of stormwater and domestic sewage within the NMR watershed is vital to the long-term mitigation of sewage problems in NMR. Also, the mitigation of other problems, such as high peak flows, will be best addressed through localized but coordinated efforts throughout the watershed.

VII-g4. Pittsburgh NPDES Permit Conditions

A long-term plan to upgrade the sewer system in the east end of Pittsburgh should be among the requirements in the NPDES general permit for Pittsburgh CSOs. A solution to the awkward CSO configuration discussed in this report, namely the CSO discharge to the NMR culvert in Wilkinsburg, should be a condition in the permit.

VII-g5. Modifications to CSO Discharges

The odor impact in dry weather from both CSO and SSO diversion chambers is an important aesthetic issue relevant to NMR. Flap gates on all the CSO discharges would improve the odor problem significantly and could be implemented in the short-term. Flap gates may also help reduce odors from the three SSO discharge pipes at Braddock Avenue by breaking the direct path that exists between the sewage and the open air.

The stagnant pools associated with two CSO discharges (Sites 9 and 12 on **Map IV-e1a**) should also be addressed in the short term. This problem could be fixed relatively easily. The pool at the outfall downstream of Commercial Avenue could be adjusted with some skillful backhoe work. The outfall in Frick Park may take some redesign because the bottom of the chamber is at stream grade.

VII-g6. Stream Odor Survey

Although general observations have been made regarding odor problems around NMR, a separate detailed stream odor survey is highly recommended. Odor problems have been confirmed in the vicinity of CSOs and SSOs specifically. A survey of the entire stream along its length at different times would be beneficial, as no comprehensive inventory has been documented at this point.

VII-g7. Stream Erosion Survey

Several sections of Nine Mile Run show signs of accelerated bank erosion. A detailed study should be carried out to inventory the extent of the damage already done and to identify the most serious problems. Bank stabilization options could then be considered. The "flashy" nature of the watershed cannot be changed readily. However, some measures could be taken to reduce energy in the flow, perhaps by placing baffles or large stones in the concrete channel. The ideal configuration for such energy dissipation measures will require further study.

Holes have been identified within 100 yds of the Braddock Avenue culvert (a culverted tributary). This significantly affects stream flow and may be adding to SSO and chronic discharge loading of sanitary sewers.

Other problems encountered in this initial inspection tour included toilet paper and fecal deposits on the culvert floor beneath lines which are tapped directly into the culvert.

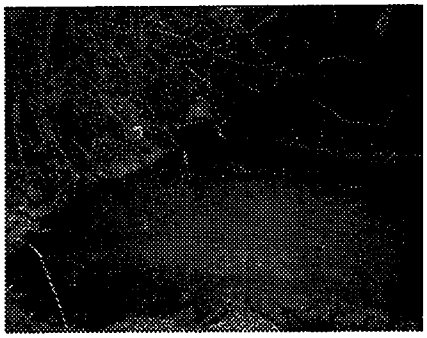
Photo courtesy of NMR Project, STUDIO for Creative Inquiry, Carnegie Mellon University

Community Input

Bob Zischkau Will the study describe the actual physical problems?

Jim De Angelis Volunteerism is great, although there is some evidence of cooperation at Nine Mile Run, compliance comes from the outside. Will the Nine Mile Run report be specific enough, airtight, and able to force the four municipalities to comply with the law?

What evidence will you bring to bear that will force the municipalities to act on this issue? Otherwise you're wasting the state's money and the citizens' time.



A Pittsburgh Sewer and Water CSO with a standing oviferous pool, just downstream from Commercial Avenue.

Photo courtesy of NMR Project, STUDIO for Creative Inquiry, Carnegie Mellon University

VII-g8. Use of Constructed Wetlands for Remediation at NMR
Constructed wetlands may be potentially useful for helping to mitigate both water quality and flow problems in NMR. Constructed wetlands have the potential for reducing fecal coliform bacteria concentrations in the water through the sedimentation and attachment to plants (Gearheart, 1997). A wetland could be designed as a passive system, where streamwater in NMR passes through wetland plants, providing some water quality benefits. A wetland may also be part of a managed treatment system designed for optimal water quality improvement. There are several constraints in NMR that appear to limit potential water quality benefits of wetlands. The DEP requirement of less than 200 CFU/100 ml of fecal coliform bacteria for human contact could not be guaranteed on a consistent basis for an unmanaged wetland. Creating a managed wastewater facility, using wetlands as part of the treatment process in a city park to help resolve sewage infrastructure problems in other municipalities, may be viewed by many as an inappropriate use of public space. Furthermore, wetland treatment efficacy is directly related to detention time, which is determined by wetland depth and area, so high flows and minimal available land in the floodplain complicate the use of wetland solutions. Finally, in NMR there are major constraints related to consistency of flow in the stream. Flows in the summer can range from nearly stagnant to high storm flows, and the latter would need to be diverted from the wetland via an engineered diversion structure in the stream.

University of Pittsburgh Ph.D. candidate in geology, Henry Prellwitz, surveys a bank erosion problem with a member of the project team.

Photo courtesy of NMR Project, STUDIO for Creative Inquiry, Carnegie Mellon University

VII-g8a. Wetland at Low Flow
A wetland that is bypassed by high storm water flows could benefit low-flow water quality in NMR, but is unlikely to provide a complete solution to the water quality problems during dry weather. Significant reduction of fecal coliform bacteria has been achieved in wetlands (Hammer, 1989), in some cases up to several orders of magnitude reduction (Kadlec, 1996). However, constructed wetlands which have provided high removal efficiencies are managed facilities, such as the Arcata Marsh and Wildlife Sanctuary in California (EPA, 1993). Although some removal of fecal coliform bacteria could be expected in a wetland in NMR, additional disinfection treatment will most likely be required to reduce bacteria to the PADEP standard for human contact (200 CFU/100 ml) on a consistent basis. Meeting a discharge standard below 500 CFU/100 ml may be difficult because of natural levels found in wetlands having significant wildlife activity (Kadlec, 1996).

The potential benefits of wetlands in NMR is highly dependent on the goals of water quality improvement in NMR. The PADEP standard for human contact of 200 CFU/100 ml may be not be a realistic goal in an urban stream such as NMR, even during dry weather with no active sewage discharges. (For example, coliform levels in Frick Park's Fern Hollow, which does not receive direct sewage inputs, ranged from 200 to 800 CFU/100 ml during Summer 1997). If the goal is merely to achieve some water quality improvement downstream, passive treatment through a constructed wetland is likely to provide some positive benefit. However, such an approach to water quality improvement in NMR would amount to treatment of symptoms. Investigation and development of a mitigation plan for unauthorized dry-weather sewage impacts should be undertaken prior to deciding upon the role, if any, for wetlands as treatment units.

VII-g8b. Wetlands in the Treatment of Storm Flows

A wetland could only be effective for treatment of wet weather pollution if all the stormwater for storms of a chosen magnitude could be captured and slowly released into the wetland over time. This would necessitate a storage reservoir in addition to the space for a wetland. The design storm for capture and release/treatment in NMR is a variable limited by the space available. The potential area for this is in the southern end of Frick Park. Due to the high input concentrations of fecal coliform bacteria associated with storm flows, a wetland would not render the water fit for human contact under DEP regulations. Also, as long as there are authorized CSOs directly downstream of the potential wetland area, the overall benefits to water quality would be limited. Therefore, a wetland to treat captured storm flows in NMR should not be considered before an SSO/CSO mitigation plan is developed.

VII-h. Site-Based Infiltration in the Upper Watershed (Map VII-h)

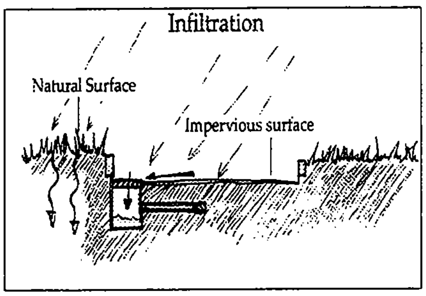
Traditionally, American cities have employed a "send it away" approach to stormwater management. Any precipitation not needed to water lawns and plants was considered a nuisance, something to be poured off roofs, parking lots, and streets, funneled into pipes and concrete channels, and carried off and dumped someplace—usually a stream or river few paid much attention to—where it would not interfere with daily life. City planners and engineers built enormous networks of storm sewers and combined sewers to send away the water running off the many impervious surfaces in the cityscape. The Nine Mile Run watershed is typical of many urban watersheds in these respects.

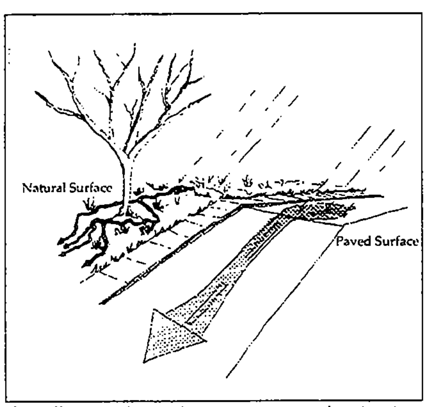
Today, around the country, water experts and city residents alike are beginning to outline a better approach for managing the water falling on our cities. This alternative paradigm has several components. First, we are recognizing the impacts of stormwater on the receiving waters. Large pulses of runoff scour and degrade stream channels, and oil, dirt, dog feces, and other contaminants carried by urban runoff degrade water quality downstream. Second, we are coming to see rainwater and melting snow as a resource that can be put to use to increase the beauty and functionality of our cities; for instance, these sources can be used to water new trees that help clean the air and shade our streets and buildings. Third, we are discovering many ways to handle precipitation more naturally. One way is to absorb it where it falls and then release it slowly, as nature does. Landscape architect Bruce Ferguson says it best: "Water belongs in the soil."

<u>The guiding principle</u> of this new approach is to start the use and management of each drop of precipitation as close to where it falls as is technically possible and economically feasible. This means examining the options available at the scale of individual buildings, yards, parks, streets, and neighborhoods. Some of the measures that have worked in other communities and could be considered here include:

Community Input

John Smith All this discussion is concentrating on sanitary sewer issues. How about stormwater? Roofs and streets rush water into that stream—we are forgetting that what has been used as an open storm sewer is a living thing.





Runoff is accelerated on non-porous city streets

- Tree plantings. Studies have shown that tree foliage can hold and absorb or evaporate up to 35 percent of the rain falling annually on the diameter of the tree canopy.
- Turf management. Aeration and other techniques can increase the infiltration rate of lawns. Certain grass species, by virtue of denser, deeper roots, can further improve infiltration.
- Roof leader disconnects. Removing rain leaders from sewers seems an obvious step to cut stormwater volumes in combined or separated lines, but what then happens to the roof runoff? Appropriate redirection of the leaders, re-grading of the landscape around a building, use of dry wells (constructed infiltration chambers), and other techniques can infiltrate roof runoff without flooding basements.
- Cisterns. Some roof runoff can be captured in rain barrels or other cisterns and either used for yard and garden watering, or released to dry wells or other infiltration systems once the storm passes.
- Surface infiltration basins. In some yards and many commercial landscapes, ponds, temporal "water gardens," and other basins can be designed to gather site runoff and hold/infiltrate it over varying periods of time.
- Driveway "cuts." Modifying driveways to increase pervious area can be done in many ways.
- Street narrowing. Common now in new developments, narrow streets calm traffic, increase green space, improve property values, and reduce impervious area. Some American communities are narrowing existing streets for the multiple benefits created. Portland, Oregon calls its effort the "Skinny Streets" program.
- Parking lot redesign. Creative layout can incorporate "infiltration islands," filter strips, and other stormwater management features with no or little impact on the number of parking spaces.
- Porous pavements. The techniques are well-developed and the performance well-tested. As streets and parking areas are re-paved in coming decades, porous paving options should be given strong consideration.
- Subsurface detention/infiltration chambers. Made of gravel or manufactured components, varying depths and capacities of chambers can be installed under lawns and parking lots to hold large volumes of site runoff during a storm and infiltrate that water to the subsoil in the following hours or days.
- Eco-roofs. A modern variant on the sod roof, with lower weight and easier handling and maintenance, has been created and installed widely in Europe. Eco-roofs absorb water and evaporate it back to the air or grow incorporated plants, greening and cooling the cityscape.

<u>Benefits of this Approach</u>

The possible benefits, economic, aesthetic, and environmental, of small-scale infiltration/detention approach are many. Naturally they depend on the measures used, local hydrology, problems addressed, and costs and nature of alternative approaches. Here are some ways residents, businesses, and governments in the NMR watershed might benefit from implementing these sorts of measures:

- Reducing stormwater volumes in combined sewer lines. This approach could save money by freeing up capacity in existing lines, perhaps avoiding costly separation of sewer and stormwater flows in some parts of the watershed.
- Similarly, reduced stormwater volumes could allow for *in-situ* lining of sewer lines, or downsizing of pipes where new lines must be installed or old ones replaced.
- PA is likely to ratchet-up regulations on the water quality impacts of stormwater runoff in the future. Many of these measures provide treatment benefits (soils, their micro-organisms, and plants absorb, break-down, take-up or otherwise neutralize many pollutants) and will help local communities address water quality.
- This approach can help reduce high flows, and provide recharge to augment low flows in NMR. Moving towards a more natural stream flow regime will improve the chances of success of the stream restoration efforts envisioned by many local residents for Frick Park.
- Many of these measures will improve the landscaping of area homes and businesses, increasing property values.
- By literally "greening" local landscapes, yard-by-yard and neighborhood-by-neighborhood, these measures can produce tangible benefits such as reducing the energy load created by unshaded pavement and buildings. And they will produce the less tangible psychological benefits of a greener cityscape.

VII-i. Watershed Management, Integrating Infrastructure with Ecology

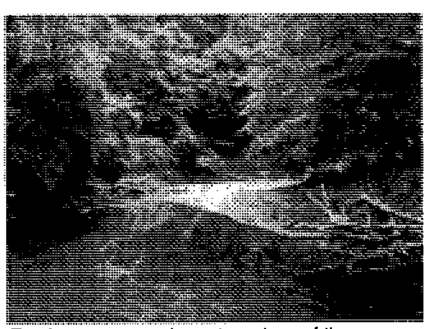
Urban watersheds have traditionally been managed as infrastructure systems, ignoring the underlying ecosystems which have been often displaced and always affected. The Federal Clean Water Act and the Pennsylvania Clean Streams Law have instigated regulatory agencies (Pennsylvania Department of Environmental Protection and Allegheny County Health Department) to maintain water quality standards at the "receiving body of water". This has typically been accomplished through the regulation of point source discharges and related enforcement actions. Typically, such action has resulted in expensive detention projects or watershed authorities who concentrate on an isolated length of trunk sewer line (local examples include Falls Run and Girty's Run). An integrated watershed authority mandated to monitor and protect the stream ecosystem through chemical and biological analysis would provide a more equitable gauge of infrastructure function efficacy than the existing model. Urban ecosystems may prove to require a more vigilant analysis than suburban and rural systems. An integrated watershed authority with the ability to monitor and protect the stream ecosystem and maintain the infrastructure would connect the cause and effect of urban watershed degradation. We will outline a number of options for creating a multi-municipal watershed authority and its potential to integrate ecosystem and infrastructure in its management mission.

Community Input

Alex Hutchinson (Edgewood Borough Engineer) If found that sewers need to be replaced, joint systems should be considered. Television survey results may induce cooperation, e.g., in the building of a common sewer.

A midair sewer line crossing in Frick Park. It is straddled by a large tree washed down in a storm

Photo courtesy of NMR project, STUDIO for Creative Inquiry, Carnegie Mellon University



Erosion occurs on the outer edges of the streambanks and deposition on the inner

Photo courtesy of NMR project, STUDIO for Creative Inquiry, Carnegie Mellon University

The goals of a NMR Watershed management structure are:

1. Eliminate sewage pollution and slag leachate.
2. Minimize stormwater damage and pollution.
3. Restore and steward the ecosystem functions in the watershed.
4. Manage the infrastructure and ecosystem to maximize benefits and minimize costs.
5. Rebuild the watershed so it becomes a resource.

In 1997, Don Berman outlined the reasons why governments should cooperate. First, ecological and infrastructure systems are not confined to municipal boundaries in either form or function. Multi-municipal agreements which enable a geographical (watershed) approach ensure that the problem is integrated in definition and integrated in solution. Second, economies of scale become evident in cooperative management programs. Multi-municipal initiatives can increase purchasing power and reduce costs through bulk purchasing. Personnel costs can be leveraged in terms of mitigated inspection overlap, consistent integrated problem solutions, and employee job pride. Larger projects can bring a multi-municipal personnel approach with shared costs and access to more equipment. Third, many grants and low-interest loan programs now give priority points to multi-municipal projects.

While the cooperative management of a watershed would seem to be a logical solution to stormwater and sanitary waste transport problems, a report on stormwater management for Allegheny County clearly states: "Coordinated stormwater management will be difficult to achieve if left to voluntary municipal cooperation" (Coopers & Lybrand, 1988).

Looking to ecosystems for indication of water quality and pollutants is an accepted monitoring practice. Benthic organisms in particular have been used since the 1900s as indicators of water quality/water pollution (Mirani). Protocol for benthic water quality analysis is recognized by the EPA and the State Department of Environmental Protection. The water quality study by Dzombak and Lambert (Appendix VII-E) for this report identifies specific discharge points as well as changes in water quality over the length of the stream. An understanding of the physical infrastructure coupled with an evolving ecosystem analysis of biotic and abiotic components of NMR will provide a good baseline from which to identify indicator species and physical components of the ecosystem for monitoring.

The rationale for monitoring an ecosystem to manage sewage and wastewater infrastructure is both good science and good public relations. Biological monitoring is easily communicated to the population that will be actively using NMR. Populations of insects, plants or fish are either there or not there—healthy or not healthy—taking some of the guesswork out of maintaining water quality in an urban stream. If a watershed authority is required to regularly monitor ecosystem function and water quality in receiving waters (with a strict protocol) then regulatory agencies can test the veracity of the management program with spot checks and comparisons. A site-specific public program of biological monitoring **(see Section VII-J Enhancement)** can provide the public with some general observational tools which will allow them to develop a deeper understanding of water quality and ecosystem relationships.

The multiplicity of municipal and regulatory interests in NMR complicate the resolution of problems because of a lack of understanding of who is responsible for what and the problem of regulating a system which has artificial boundaries upstream from the effects of the problems. For instance, the upstream municipalities have responsibility for the collection and transport of sanitary waste and stormwater from their municipal boundaries to the general region of Frick Park, where stormwater emerges into the stream, and sanitary waste is merged in a trunk sewer which is under the control of Pittsburgh Sewer and Water.

Stormwater emerging from the culverts and stormwater pipes serving the following upstream municipalities has been rigorously documented as pathogen impacted, although the exact source(s) of the problem have not been identified. It is suspected that illegal tie-ins of sanitary lines to the storm sewer, leaking adjacent sanitary lines, and other problems are affecting NMR water quality. **(See Section IV-E Water Quality, see Appendix IV-E for the full report.)** The following municipalities maintain their sewer systems through their individual departments of public works. Management of the systems and major maintenance is handled through contracts with private engineering firms. Wilkinsburg and Swissvale share the same engineer.

- Wilkinsburg - Public Works Department — Maintenance of Wilkinsburg's separated storm and sanitary sewers until they reach Nine Mile Run and the trunk sewer, respectively.
- Swissvale - Public Works Department — Maintenance of Swissvale's separated storm and sanitary sewers until they reach Nine Mile Run and the trunk sewer, respectively.
- Edgewood - Public Works Department — Maintenance of Edgewood's separated storm and sanitary sewers until they reach Nine Mile Run and the trunk sewer, respectively.
- The Pittsburgh Water and Sewer Authority — Maintenance of the city's combined sewer system and the trunk sewer extending through the valley to the Allegheny County Sanitary Authority interceptor near the Monongahela River. Pittsburgh has one CSO which discharges into the upper watershed culvert. Pittsburgh is primarily responsible for both Frick Park and the NMR development site as well as the trunk sewer used by Wilkinsburg, Swissvale, and Edgewood to transport sanitary waste to the Allegheny County Sanitary Authority (ALCOSAN) Interceptor at the mouth of NMR, near Duck Hollow. The city of Pittsburgh has four CSO outfalls on NMR. A recent performance audit indicates that Swissvale is the only municipality signed to a maintenance agreement on the NMR Trunk Sewer (Flaherty, 1998). A maintenance study by Chester Environmental indicated serious problems in the trunk sewer, allowing sanitary waste to discharge into the NMR water table, and consequently into the stream itself.
- City of Pittsburgh - Public Works Department — The City Public Works Department is responsible for maintaining Frick Park. The

Community Input

Kathy Stadterman: Are there any options for developing a watershed wide authority?

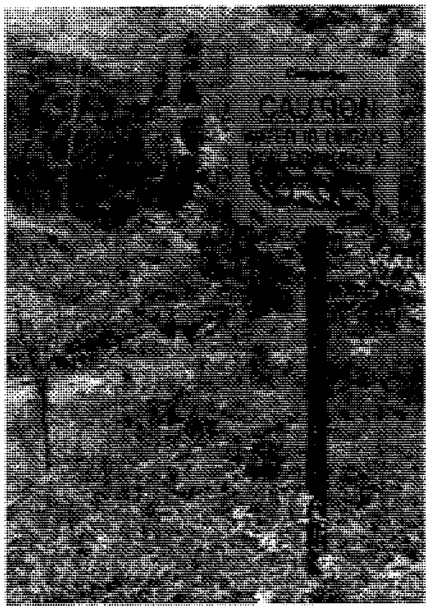
AB Carl Several types of watershed authorities and associations have been formed in the region. The Turtle Creek Watershed Association has a volunteer citizens organization that focuses on the use of the stream for fishing.

John Schombert Girty's Run in the North Hills is an example. They are an authority with the option to go take out loans to solve problems.

Ken Johnson Do authorities work with volunteers or appointed personnel?

The culvert at Braddock Avenue during a stormflow.

Photo courtesy of NMR project, STUDIO for Creative Inquiry, Carnegie Mellon University



The current "best solution" to NMR water quality problems.

Photo courtesy of NMR project, STUDIO for Creative Inquiry, Carnegie Mellon University

Public Works Department's Construction Division is responsible for new construction.

- City of Pittsburgh - Department of Parks and Recreation — Programming and planning for Frick Park. The Department of Parks and Recreation has been unable to affect the 90-year history of sanitary effluent/public health hazards, infrastructure failure, and a compromised riparian ecosystem.
- The Department of City Planning — Is responsible for new planning for city parks. It has taken an avid interest in water quality and ecosystem improvement in NMR.
- Urban Redevelopment Authority — Landowner of 235 acres in the lower watershed, through which Nine Mile Run flows.

The following agencies have responsibilities that transcend municipal boundaries. They are designed to resolve regional problems and protect public health and environmental quality.

- Allegheny County Sanitary Authority(ALCOSAN) Maintenance of the interceptor sewer near the Monongahela River. ALCOSAN's official responsibilities go no further than their collection point in Duck Hollow. Despite this, they have taken an active interest in NMR, working with the municipalities and providing support for onsite analysis of the problem. ALCOSAN has also helped initiate and coordinate with the Health Department on the Three Rivers Wet Weather Demonstration Program, which will help municipalities to address sewer overflows.
- Allegheny County Health Department — Regulatory agency with authority to enforce Pennsylvania's Clean Streams Law and the Federal Clean Water Act. The Health Department and ALCOSAN initiated and are coordinating the federally funded Wet Weather Demonstration Project to help municipalities address sewer overflows.
- Department of Environmental Protection — A State regulatory agency with authority to enforce Pennsylvania's Clean Streams Law and the Federal Clean Water Act.

In summation, the NMR watershed agencies and communities are infrastructure focused, with little attention paid to the cause and effect of the infrastructure and its dysfunction on the ecosystem which defines the "receiving stream." Pittsburgh City Parks and the DEP are the most likely agencies to take an interest in the conditions of urban infrastructure. DEP's interests are statewide and focused on more pristine environments rather than historic urban problems. The Pittsburgh City Parks Department is interested, but not enabled politically or financially to act on the problem.

Multi-Municipal Watershed Approaches

Local governments have the legal authority through existing legislation to enter into an agreement, a contract, or an environmental compact. In fact, the Allegheny County Health Department has recently issued new Sewage Disposal Regulations which require "municipal management and cooperation of sewage management between municipalities" (Section 1401 of the Allegheny County Health Department Rules and Regulations). The organizational structure is up to the participating municipalities.

Community Input

Jim De Angelis Has the State or County told the municipalities that they will be needing to resolve the dry weather problems?

In 1988, the Allegheny County Planning Department and Coopers & Lybrand completed a stormwater management study which addressed a watershed approach to management. The study reviewed eight institutional alternatives legally available in the Commonwealth of Pennsylvania. The institutional alternatives relevant to Nine Mile Run are:

Joint Municipal Authority — Two or more municipalities agree to operate jointly an authority with the capacity to own, construct, and operate facilities, sell revenue bonds, set fees, and perform other related services under contract to the municipalities. The legal authorization for such an alternative is the Municipality Authorities Act of 1945, 53 Pa. C.S. Sec. 301, et seq.

Allegheny County Sanitary Authority — Expand the management powers of ALCOSAN, a joint municipal authority incorporated under the Municipal Authorities Act described above, to include stormwater management and the municipal sewer lines. The ALCOSAN Board would have to agree to expand its responsibilities and each municipality would have to pass an ordinance to join for that purpose.

Environmental Improvement Compact — An environmental improvement compact, authorized by the Pennsylvania Environmental Compact Act, is formed when two or more municipalities join together and enter into an agreement to allocate municipal functions to a new political body, governed by elected officials and having jurisdiction over all participating municipalities. The citizens of each municipality must authorize such participation through initiative and referendum.

Stormwater District — A stormwater district would require enabling state legislation, but it would have the power to tax, charge fees, and sell bonds.

Contract with a Private Entity — Municipalities contract individually or jointly with a private entity capable of performing some watershed functions. Responsibility for implementation and the powers of enforcement continue to reside with the municipalities.

Management Committee — Municipalities agree to share in the costs and responsibilities of upgrading and maintaining a shared resource. Each municipality must enact legislation authorizing the agreement. This is an informal approach not considered by the Coopers & Lybrand study.

Criteria for rating management options for Nine Mile Run should include:

(1) the ease with which the organization could be implemented by the municipalities within the watershed;
(2) the degree to which the organization will be able to enforce compliance with applicable standards and criteria;
(3) the extent to which the organization promotes democratic participation and the representation of the constituent municipalities and local citizens;

Community Input

Uzair Shamsi (Chester Engineering, author of the Trunk Sewer Study) Privatization of CSO treatment should be considered.

- Perhaps a company from Pittsburgh is interested in operating a treatment plant.

- Cited case studies in Atlanta and a 20-yr contract for managing CSOs near Boston.

Jim De Angelis Raising issues and public awareness does NOT effect the stream. The municipalities will not decide to act unless compelled to act. Provide the information to compel action or admit defeat and dissolve this process.

(4) the ease with which it will be able to finance the activities necessary to achieve the goals for the watershed, either through user fees, bonds, or taxes;
(5) the extent to which the organization links infrastructure improvement and ecosystem function; and
(6) the authority it has to bind the municipalities.

When management fails. Citizens can respond to a lack of management and regulatory inertia. Citizens who live along a stream and feel that they are being negatively affected by upstream water problems have various opportunities to pursue legal action. After years of discussion and unfulfilled calls for mapping, assessment, and management planning, a group of individuals in Regent Square are currently exploring their legal options as citizens to force the issue and encourage the municipalities and the regulatory agencies to take action on the chronic sewage which affects NMR. **(See the Appendix VII-i for Case Studies in Multi-Municipal Watershed Approaches.)**

VII-j. Enhancement (Map VII-j)

One year ago, enhancing Nine Mile Run included the option of culverting it. Culverting urban streams has been the preferred practice in American cities for over 100 years. Culverting as a historic solution to water problems can be described as an application of science and technology in such a way that it would eliminate waste (undevelopable land), manage urban problems (stormwater problems exacerbated by paving and poorly maintained sanitary sewers), and enable production (development). Turning vacant valleys and wetlands into attractive parcels for urban development was part of the ideal of a value system which was based in human production. The relative value of the environment as context for the meaning of "quality of life" was rarely considered. Quality of life, at that time, was defined by cultural constructs—the product of human labor enabled by the raw material of nature. Quality of life has shifted away from cultural constructs and toward environmental interests since the days of industrial dominance of Pittsburgh's waterfronts.

Today, culverting has fallen out of favor with regulators and communities alike. Here in Allegheny County, John Shombert, Chief of the Water and Waste Division of County Health, has said publicly, "I can give you 20 reasons why culverting is a bad idea." In private conversations he has described culverting as the "out of sight, out of mind approach," whereby municipalities often ignore their water problems and regulatory agencies must make incredible efforts to pinpoint problems to bring any enforcement action. Communities from Cleveland, Ohio and Montgomery County, Maryland to Berkeley, California have taken their urban streams to heart, recognizing the quality of life enhancements which an urban stream can bring to an urban experience. There are a number of national organizations that have taken urban streams as their focus including the Center for Restoration of Urban Watersheds (CRUW). American Rivers has its own urban streams program and the Izaak Walton League has created numerous texts to enable citizens to not only monitor their streams but begin to plan for their recovery.

With this document, we begin a process of public involvement to enhance Nine Mile Run—to celebrate it, its place and its community of people, their attendant homes, the wildlife that populate its open spaces, and the habitat they depend upon. In the preceding pages, the team has worked to outline an approach to a river corridor which will shift a 90-year paradigm of tragic abuse. The remnant ecosystem has been carefully analyzed in sections on land and biological resources; the infrastructure has been analyzed in the section on water resources. Previously in this section, the team has outlined approaches to revegetation, restoration, and sustainable practices on an urban watershed. After conducting a case study of existing watershed models, the relationships between the natural ecology and the ecology of the infrastructure have been integrated and a proposal made for a watershed authority which transcends existing models. The community has offered input on these concepts, methods, and approaches, expressing dismay and anger at the history of problems, defended existing amenities (the lower Frick Park ballfield), and rallied around the opportunities for change.

Samuel Hayes has said, ***"One of the major political tasks of the present day is to lay bare the value implications of planning so that the public can understand the choices that are being suggested and make intelligent decisions about them."***

There is an emerging interest in the environment as the context for quality life experiences. Planning for the future is a value-based exercise which can be informed by history and the knowledge of experts, but must ultimately be integrated with community interests and active citizens to have any effect. Over the last 100 years, Pittsburgh's environmental values have shifted radically, from the use of the environment as source, context, and sink (Tarr, 1984) for industrial production to the environment as context for living. Defining the environmental values (and by extension the enhancement options) of post-industrial cities will be an ongoing process. This watershed dominated at its mouth by a brownfield site is a new context for a model of river conservation planning, a new way to think about places which have been abandoned. NMR has been stripped of its natural characteristics then allowed to lie fallow, recovering on its own, with humans and wildlife reentering, rediscovering the use-value of this property. This River Conservation Plan is essentially a tool to define the relative values of urban watershed restoration (quality of life goals) and how they should apply to the changes which will occur in and around the NMR watershed. There are many difficult and exciting choices ahead and this plan is only the beginning.

If we are going to enhance an urban watershed, quality of life must be a priority goal. That quality of life has to be achieved in the context of economic equity and long-term sustainability. This goal is not going to be easy to achieve.

The first approach to the challenge of enhancement is found in knowing the place again. Recent trips to the top of the watershed by the NMR-DCNR River Conservation Team found unculverted sections and a spring-fed creek, with benthic organisms only present in clean streams.

Samuel P. Hayes, a Professor Emeritus at the University of Pittsburgh, outlines the evolution of environmental thinking in his book *Explorations in Environmental History*:

1) Environmental conservation as best use with an interest in efficient production. This is typified locally by the Army Corps of Engineers early work on the rivers. Dams, locks, and controlled release of water enables the efficient use of the Monongahela, Allegheny, and the Ohio for transportation, drinking water intake, and flood control.

2) Environmental preservation, the protection of lands from commercial development or production in order to enjoy them for their natural beauty. This approach is best illustrated on the state and federal level by national and state parks and on the local level by the Western Pennsylvania Conservancy.

3) Environment as the context for quality life experiences. This is an emerging set of values which are qualitative. A search for a better standard of living which focuses on surroundings which can be perceived as either more pleasant or more degraded.

> Seven percent of the land in America is classified as urban, but this is where 74% of the population lives, works, and plays. Urban streams are amongst the most degraded streams in the country.
>
> Bruce K. Ferguson
> in *Introduction to Stormwater*

The ongoing analysis of the lower watershed indicates a remarkably resilient urban ecosystem with potent pockets of biodiversity. Even the NMR slag dump has illustrated a remarkable potential for regeneration; we must experience the watershed and its component places to understand the opportunities as well as the problems. So, the first method of enhancement will be defined as familiarity with our watershed.

NMR is an urban stream which flows from an urban valley where it is joined by the remnants of a spring-fed creek in an urban park. It then flows into a post-industrial slag dump and empties into a larger river, which is still defined for its use as an industrial waterway by the Port of Pittsburgh. The Monongahela is one of the defining bodies of the Three Rivers region and a definitive focus of future economic growth and quality of life planning. At the same time, this river is being targeted as the location of a major new highway and its banks being touted for industrial, commercial, and residential housing. Clearly, the future of Pittsburgh's urban streams and rivers will be conflicted by interests which range from the historic/industrial to the economic and environmental point of view. The answers to these conflicting interests will be found in the process of democratic discourse. It is clear that if we are to achieve the goals of this plan - regenerating ecosystem functions and establishing the value of natural experience and ongoing education at NMR - it will be essential to marshall creative resources. Let us consider this the second method of enhancement, creativity.

Since the decision to leave Nine Mile Run unculverted has been made, it means that enhancement has taken on a new and more serious public meaning. No longer is it an issue to be dealt with by a private developer. Instead it has become a point of convergence for communities and citizens to rally around with the goal of seeking resolution for a problem which has persisted for well over a century. The sustainable creation, development, and maintenance of a urban public stream corridor at NMR will take many individuals with an "invested interest" in the creation of such an amenity. In many ways this community of stewards who will restore the public function and value of the NMR watershed will need to mirror the "invested interests" of the private industries that created a dump at NMR. The third method of enhancement, is stewardship.

In the following paragraphs we will expand upon the methods of urban stream enhancement: (1) familiarity, (2) creativity, and (3) stewardship. Then we finish the section with some specific recommendations which came out of the community planning process.

VII-j1. Watershed Familiarity and Urban Stream Appreciation

How do we share the concepts, experiences, and ideas of watershed appreciation? Urban areas are full of problems and issues which often overwhelm the most nimble urban minds. The question that we must address is how do we link emotions and experience of the opportunity with the intellectual/cognitive analysis of problems? If we are going to motivate an emerging appreciation for urban streams, we must rely on pleasurable experiences, personal memories, and a shared history to build the motivation to change.

How do we link the experience of trash at the mouth of NMR with the economics of street cleaning in the upper watershed? How do we link the effect of 500 roof drains on the erosion occurring along the ballpark in lower Frick Park? How do we connect a history of cheap sewer rates with a degraded urban stream? How do we connect the needs of the steel industry in 1924 with the aesthetic and ecological challenge of 1998? If we are to enhance the NMR watershed and its streams, we must understand its current condition. Citizens, students, teachers, politicians, and municipal officials need to be introduced to the place, its wonders as well as its problems. It needs to become a subject of conversation amongst diverse communities, in the schools and in the homes. We need to create opportunities to be along the stream, then forums for discussion, then the political will to understand the problems and address them. Throughout this process we need to welcome all users to the table as we discuss the ways to improve, maintain, and sustain this urban resource.

Without both experience of the opportunity and an understanding of the issues, no change can occur.

VII-j1a. Access

Access is a key issue. If we can't approach a place, it is hard to appreciate it.

- Nine Mile Run is an accessible urban stream - by the simple fact that a significant part of it is not underground in culvert! (All of the other urban streams in Pittsburgh between the Monongahela River and the Allegheny River have been culverted.) Furthermore, the spring-fed creeks in Frick Park are still flowing, and the valley will soon become a continuous public greenway with public access to NMR corridor from source to mouth.
- The streambed, however, is not that accessible. Erosive downcutting of the banks provides a physical barrier to anyone who actually wants to "touch" the water. This is further complicated by water quality which is so bad that the Allegheny County Health Authority considers it a health hazard.
- The riparian corridor, the floodplain, and banks along the river are accessible from the sources in Frick Park to the mouth at the Monongahela and at numerous points through the watershed communities. (The trail system being discussed along the busway in Edgewood and into Wilkinsburg would be an important link into the valley.) Access in and through the valley is relatively good and has been illustrated and confirmed as an important benefit at a number of community meetings. It is important to recognize the valley as not only a destination but as an alternative transport corridor, linking hikers and bikers from the interior watershed to the Steel Heritage trails upstream and the Three Rivers Heritage Trail downstream.
- Access from the Monongahela River would be a unique and educational experience. Docking facilities could be constructed at either the site of the old Homestead Bridge or between Duck

Community Input

Ted Floyd When I first started birding in Frick Park, as a teenager, I was mesmerized by the great abundance and diversity of warblers that would stream through the park every spring. But I also assumed that similar spectacles were staged in every comparable forest fragment throughout the region. I have since learned that, to the contrary, Frick Park is exceptional, and nearly unique, in comparison with comparable forest tracts in the region.

"I know of no safe depository of the ultimate powers of society but the people themselves; and if we think them not enlightened enough to exercise their control with a wholesome discretion, the remedy is not to take it from them, but to inform their discretion by education."
Thomas Jefferson

Hollow and Greenwood where Duquesne Slag once offloaded its barges. Organizations like the Pittsburgh Voyager could be encouraged to explore the urban stream and its relationship to the river.

NOTE: The nomination of the Monongahela as a modified recreational river, to be placed on the Pennsylvania Scenic Rivers Inventory, is an important goal. This would be a likely point of interface with the Steel Heritage Foundation which sponsored the Monongahela River Conservation Plan and is a likely sponsor for the nomination.

VII-j1b. Education

Education can occur at many levels and across many communities. Specific grade-school models already exist in various communities of the watershed. The Regent Square School has developed an innovative environmental program with the Frick Environmental Center which integrates adjacent Frick Park and its ecosystems directly into a grade school curriculum. The STUDIO for Creative Inquiry began a program of adult "dialogues" about various aspects and issues of the development of post-industrial (brownfield) open space along the NMR corridor. This program focused on four issues: (1) history and public policy, (2) stream remediation, (3) community and ecology, (4) sustainable open space. These issues are replicated in a children's' education program which takes an integrated inquiry-based method of art and science, to explore ecological and social ecosystems. This program was initially developed in the Homewood Montesorri School and has been/will be presented in other schools throughout the watershed. The Carnegie Museum of Natural History has begun a "Bioblitz" program whereby a team of scientists quantify biological diversity in a 24-hour period in the city parks. This program builds a coalition of environmental and educational organizations with the express intent of teaching the value of biodiversity through a mix of onsite experience and accessible scientific analysis. The data collection and web site which emerge from this event provide an evolving reference and eventual standard for ecosystem function in urban and post-industrial environments. While the Carnegie Museum of Natural History has the collection and expertise to eventually produce a definitive book on natural systems and urban change, other cities are far ahead of us. New York City has a book on natural systems and urban context originally published in 1959!

VII-j1c. Maps

Maps are wonderful tools to help us understand our relationships to places. Census maps can illustrate the economic and social mix of a community; topographical maps tell us about landforms; habitat maps can tell us about plant and soil relationships; road maps get us where we are going. Many different kinds of maps are being created as part of expanding computerized mapping capabilities (GIS, or Geographical Information Systems). There are existing movements to interrelate some of these maps for a variety of public uses. Road maps which express green features (**green maps**) and neighborhood maps which clearly express trail connections, diverse habitat, and sites for a variety of "**wild-in-the-city**" types of experiences can be (and are being) easily

Green Map: An idea currently being explored by a consortium of environmental interests in Pittsburgh. The "Green Map" committee consists of representatives from The National Aviary in Pittsburgh, Friends of the Riverfront, The Environmental City Network, Rachel Carson Homestead, Earth Day Network, The Group Against Smog and Pollution.

Wild In the City: This is a concept that has been used in a number of the larger cities. San Francisco has a "wild in the city" map created over ten years ago.

constructed. The County Health Department has constructed rigorous engineering maps of the watershed and its sewer infrastructure, making these data sets available to municipal government and maintenance crews in the watershed. Variations on this type of information could be provided to the general public to help them "see" the complexity of the system and the interconnections which make municipal management/regulation and enforcement such a challenge.

With the opportunities for electronic publishing, these map options are low-cost variations of the traditional data sets which municipal managers, park and recreation managers, and roadway crews must produce anyway. GIS data/maps can be distributed either through the World Wide Web (and printed out with Adobe PDF files) or with an Internet extension to the commonly used Arc-Info GIS mapping software. Translating management tools into public information tools is increasingly cost-effective and helpful in building a knowledgeable constituency of watershed residents.

VII-j2. Creativity

Creativity is often misunderstood as the sole purview of the arts and humanities. If we are to achieve change and resolution of problems at NMR we will need to look towards innovative and creative ideas in a number of disciplines which address land, water, infrastructure, and policy. We also need creative action from the people who live in the surrounding watershed and its component communities.

Because the NMR watershed has a "reversed" environmental equity issue (i.e., the community at the highest point in the watershed is the most economically challenged while the communities which will extract the most direct benefit—by being adjacent to the stream valley—are economically stable), the "solution" to NMR urban water problems and environmental equity may be found in an analysis of capacities and assets of the upstream municipalities. This asset analysis approach is presented by social theorist, John McKnight, who also cautions that in the resolution of public problems, agencies and regulators should be guided to "do no harm" to communities. This analysis technique has complimentary models in landscape architecture where Ian McHarg has outlined an approach to design which is based in the analysis of ecosystem assets and constraints as the context for landscape design and planning, and in the arts where Robert Irwin has outlined an analysis of experiential phenomena as a foundation of site determined art, or phenomenological art, where the viewer is cast in the same role of aesthetic discovery as the artist. Each of these diverse yet similar models have the potential to cast the community and its citizens in an active rather than passive role. These approaches can enable discussion and promote a perception of capability, responsibility, and creative action.

VII-j2a. Interpreting the Nature/Culture Heritage

Interpreting the nature/culture heritage means examining this urban stream valley as a unique landscape composed of natural and cultural components. Nine Mile Run is a floodplain buried under 15 stories of steel mill slag. There are two potential approaches to this unique

Creativity is a synthesis of matter, space, and time. Creation is not a reproduction of observed fact. The encompassing creative mind knows no boundaries.

a paraphrase of ideas on creativity by Hans Hoffman

problem: (1) make every effort to grade, vegetate, and mask the viewer from the foundation of slag which this park will be built upon, or (2) accept the slag as part of the cultural heritage of the industrial era and develop specific sites to reveal its properties. Part of the creative challenge of NMR is to rethink the meaning, form, and function of ecosystems within the post-industrial context of political/economic needs, realistic chemical and biological constraints, and the evolution of the surrounding community's aesthetic for restoration.

The experience of NMR is complicated by a mix of natural and cultural phenomena. Part of the dissonance (and energy) of the site can be found in the conflicting thresholds of experience that you move through as you walk the site. Simply put, as you wander along this urban stream you will encounter different materials and components of experience. The Nine Mile Run river corridor has a complexity of overlaying natural and cultural experiences (trees, leaves, grassland, trail, wetland, stream bed, sewer line, concrete channel, trash, freeway, slag mountain). Nine Mile Run also has a complexity of overlaying phenomenological experience, a concept outlined below **(Table VII-ja** adapted from Arnold Berleant, *Aesthetic Perception in Environmental Design***)**.

Phenomenological Experience of Landscape

	Panoramic Experience	**Immersive/Participatory Experience**
Definition	A view of the landscape, often without an opportunity to enter (example: scenic overviews, looking at the forest).	An experience of the landscape, where the viewer and the landscape share the same space (example: being "in" the forest).
Intellectual analysis	Space and landscape as an abstract image, intellectual and visual separation between the viewer and the "object" of contemplation.	Space and landscape in relationship to the viewer. Intellectual and sensual immersion in the fabric of the experience.
Experiential analysis	Intellectual/visual response to monumentality, symmetry, geometric balance, and visual harmony (formal considerations).	Physical/sensual response to mass, texture, spatial changes, movement and time in relationship to the viewer (systemic considerations).

Table VII-j2a

At this juncture in time the NMR riparian corridor is defined by the conflicting effects of urban infrastructure upon a remnant/emergent nature. We will never alter the components of this relationship, so the challenge is how to "tune" the experience of this place in such a way that these experiences are clarified and the boundaries of conflicting experiences are revealed. In **Map VII-j2a** we identify specific sites which should be considered as part of the design process.

Examples: Nine Mile Run is always going to have a trunk sewer line running along and in the stream bed. How can the reconstruction that will occur on some of these lines be leveraged to enable access along the stream? Can the cast concrete trunk line be utilized as a support for a pedestrian walkway? (This is an approach used in the Golden Gate Recreational Area's Headlands Park in San Francisco.) Can we replicate the wide deck (no handrail) stream bridge platforms used in downtown Denver on the Platte River trails to subsume the visual effect of sewer line crossings and provide access to both sides of the stream in the process? (This design allows for relatively unimpeded storm flow.)

> All science should be scholarly, but not all scholarship can be rigorously scientific. The terrae incognita of the periphery contain fertile ground awaiting cultivation with the tools and in the spirit of the humanities.
>
> John Kirtland Wright

VII-j2b. Public Art

"Public Art is expressing in a creative act the relationship between people and the place where they live. Public art can be an avenue for promoting and expressing commonalities as well as differences. Public art is a social art. It requires the enthusiasm, cooperation, and creative contributions of many people. The public artist is, by definition, a social interpreter, aesthetically sophisticated, skilled in articulating and responding to the relationship between things, people, and places. The process of making public art invites participants to think critically and creatively. It asks people to respond to a particular place and set of circumstances in ways they may not have done before. It provides an opportunity for people to recover the history of the place where they live, to influence the appearance of their neighborhoods and city. It enables people to participate in the public and political sphere. And in doing so, it promotes civic virtue and deepens the liveliness and sophistication of social discourse. Public art seeks to infuse the social landscape with opportunities for aesthetic involvement, and to increase the community's feeling of ownership and investment in the public domain."

Public Art can stimulate dialogue, not just between the artist and the public, but a dialogue in the broadest sense: between the public and city government, between people who live and work in the area, between the recreational users and the businessmen who invest in nearby properties and businesses. This discussion can be extended conceptually to include the relationship between the individual and the water in the stream, the surrounding wildlife, and the diverse experiences of urban streams.

For the sake of this document it is probably important to state that public art is not constrained to large steel sculpture or works in bronze, stone or other "permanent" materials. The arts and humanities have taken an active role in the restoration of water, land, and societal values affected by industrial processes. This statement assumes restoration to be an integrated process of restoring physical function and societal value to properties long abandoned, ignored, or avoided due to real or perceived problems. The arts and humanities have created important tools, providing the imagery and stories which motivate people to reconsider the value of the damaged landscapes. Ecologist Michael Soule has said, *"The hypothesis is that if our pedagogy is purely cognitive, our chances of motivating a change in values and behavior are nil. We can't succeed in teaching people biophilia (the love of life), with economic arguments and ecological reasoning alone."*

There is a rich literature addressing damaged landscapes. Ann Spurin has written on urban ecology (*The Granite Garden*). Urban historian Andrew Hurley has recently edited a text on cultural diversity and the

Various books on a social approach to public art:

Joseph Bueys was a seminal practitioner of a form of art he called "social sculpture".

Energy Plan for the Western Man: Joseph Beuys in America
(Writings and interviews with the artist)
Compiled by Carin Kuoni, Published by Four Walls Eight Windows NY, NY (1990)

These books provide a good theoretical overview of the issues and artists:

But is it ART?: The Spirit of Art as Activism.
Edited by Nina Felshin.
Published by Bay Press, Seattle (1995)

Mapping the Terrain: New Genre Public Art. Edited by Suzanne Lacy.
Published by Bay Press, Seattle (1995)

The Reenchantment of Art
By Suzi Gablik. Published by Thames and Hudson Ltd., London, England (1991)

Culture in Action (Exhibition Catalog)
Essays by M.J. Jacob, M.Brenson and Eva M. Olson. Published by Bay Press, Seattle (1995)

Two books which provide an overview of artists who work with environmental issues:

Sculpting with the Environment.
(features artists writing on their work)
Edited by Bylai Oakes, Published by Van Nostran Reinhold, NY, NY (1990)

Fragile Ecologies. Contemporary Artists Interpretations and Solutions.
(Exhibition Catalog) By Barbara Matilsky. Published by Rizzoli International Publications, NY, NY. (1992)

Books on the issues of public art:

Art Space and the City: Public Art and Urban Futures, By Malcom Miles
Published by Routledge, London, NY (1997)

Spirit Poles and Flying Pigs. Public Art and Cultural Democracy in American Communities, By Erika Doss.
Published by Smithsonian Institution Press, Washington D.C. (1995)

urban environment (*Common Fields : An Environmental History of St. Louis*). Various urban projects around the country have pointed to the importance of the arts and humanities as tools to motivate change. Interestingly enough, the arts and humanities councils in various states have been amongst the first to respond to the interest in damaged environments supporting artists, historians, and writers to do work which raised peoples' awareness and understanding of the potential of their damaged environment.

There is a history to the shifting of values related to damaged environments which is not popularly known. In the visual arts, cities like Kent, Washington brought in teams of artists in the late 1970s to consider a variety of post-industrial waste sites. The Kent Arts Commission developed two celebrated projects, one a stormwater management/summertime amphitheater project by Herbert Bayer, and a desolate commemorative landscape by Robert Morris. Other artists have taken a more systems-based approach to disturbed landscapes from Allan Sonfist who developed a native forest in downtown Manhattan in the early '70s to Helen and Newton Harrison who did a decades work on lagoons and estuaries. They have more recently been involved in a project which explored the issues on the northwest rainforest/old-growth forest, where they intervened in the logging/no-logging dialectic by outlining the acres lost, then making a work of art which used images and text to present an argument for a restoration/ regeneration approach to the old-growth forest. They are currently working on a river in Eastern Europe. Mel Chin has developed a project with Rufus Chaney, a USDA soil scientist, to explore phytoremediation, or the use of plants to extract contaminants from soils. Chen and Chaney replicated their experiment on three sites in the U.S. and one in Europe. This experimental collaboration in art and science has become a powerful tool to communicate the value of phytoremediation to a broad segment of the population.

Artists shift values. During the last 100 years the focus has been on specific artist's materials, media, and processes. During the last 30 years artists, like other professionals, have started to peer over the borders of their discipline for new ways to think about the relationship of art to materials, place, and people. Artists are a powerful force for change and for new ways of thinking. The value is not in the solution of problems, but in the expansion of context and the potential to reflect/ affect values that may be otherwise forgotten or missing from a program of utilitarian resolution. Helen and Newton Harrison's analysis of the old-growth forest is a wonderful example; the "problem" was defined by logging interests needing to log, and the environmental interests needing to protect. The solution could be found outside the problem statement in a need for a commitment to "investing" in planting to create the future "old-growth" forests of the northwest.

VII-j3. Stewardship

In "Regenerative Design for Sustainable Development," Richard Lyle references Daniel Bell's prediction that conflicts between participatory and hierarchical decision-making processes would characterize the early decades of the post-industrial era. Lyle states: "There are reasons to believe that we are making a transition in both public and private organizational structures from rigid vertical hierarchies to more flexible network-like structures that can facilitate flows of information in all directions."

The NMR Rivers Conservation Plan and various supporting programs (The Heinz Endowments support of Ample Opportunity, the Army Corps of Engineers consideration of an ecosystem restoration, and the new Three Rivers Wet Weather Demonstration Project) are part of an investment in post-industrial change that is supported by local, state, and private foundation interests. The diverse nature of the interest (and funding) in the post-industrial public realm at NMR has supported an atmosphere of consensus-based planning amongst the local citizens and members of the watershed. The goal of this final section of the report is to outline a specific program of continued citizen access to planning, management, and long-term stewardship of the ecological, utilitarian, and recreational infrastructure of the Nine Mile Run riparian corridor.

VII-j3a. Keepers Cottage/Ecosystem Monitoring Center

In Section VII-i, we have outlined an approach to the Nine Mile Run watershed which would integrate the cause of upstream infrastructure to downstream ecosystem effects on the ecosystem. The argument is simple and straightforward: if the goal of infrastructure design and maintenance is minimal impact on the receiving waters, then the management of the infrastructure must be integrated with the monitoring of those waters. The method of integration would be a watershed authority that went beyond the regulatory mandate with the long-term intent of managing the watershed to its best possible effect rather than the lowest possible regulatory mandate. While the short-term change in actual water quality may track the regulatory mandate, the long-term benefits of this approach would be found in a watershed management team that has the tools to understand the systemic fluctuations and relationships between weather phenomenon, human/user effect, and infrastructure management. This complex understanding has enormous potential to result in policy, design, construction, and maintenance changes that provide maximum benefit for the least capital investment.

As mentioned earlier, to teach a community to care for the environment and ecosystem is a challenge which must be met by intellectual understanding as well as emotional engagement. Yi-Fu Tuan, speaks of topophilia: *". . .the bond between people and place or setting. Diffuse as a concept, vivid and concrete as personal experience."* Urban infrastructure and its professional class of engineers and managers have created a social phenomenon where the common man on the street has no idea where his sustaining fluids come from or where they go when he's done with them. If we are going to create a facility which integrates infrastructure with ecosystem we must also find a way to engage the emotions and physical senses, to tell the histories of change, the experience of individuals right alongside the data and analysis of the professional and the manager. We need to find creative ways to complicate the topophilia of industrial culture with the diverse and emergent topophilia of today.

To meet the goal of integrated management and post-industrial topophilia, we propose a greenway keepers' cottage and ecosystem monitoring center. The concept is based in the idea of creating a public-access node for ecosystem and infrastructure. From a systems point of view, this would be an architectonic structure which integrates the diverse social needs of an urban greenway and its typical receiving waters with the infrastructure management of an urban watershed. The social goal is to create a site of public understanding, public education, public expression, and public access.

An outline for a program for this facility:
(1) create a node of monitoring and communication about the lower watershed and its cause and effect relationship with the upper watershed;
(2) create a method of analyzing and documenting the effects of an ongoing watershed maintenance program;
(3) devise a chemical and bio-monitoring program which will provide an early warning system for maintenance problems in the infrastructure (canary in the coal mine);
(4) integrate professional knowledge with community education through programs which complicate the perception and understanding of the urban ecosystem and its biological indicators; and
(5) make the integrated urban ecosystem available for study amongst local schools and universities.

The design of the facility which would include the following elements:
(1) a state-of-the-art, sustainable design integrating utility with regionally relevant creative form;
2) a downstairs laboratory with state-of-the-art lab equipment coupled with an open architectural floor plan for community meetings and discussions; and
3) an upstairs residence, providing a consistent and passive element of security, access, and responsibility for the greenway.

VII-j3b. Inter-Species Nodes and Systems of Reintroductions

As surely as industrial culture and its physical by-products have transformed the Pittsburgh landscape, post-industrial culture has the potential to do the same. As we restore, reclaim, regenerate, revegetate, and heal the watershed ecosystem, we have the potential to reintroduce species. The reintroduction of species has both scientific and cultural validity; it complicates and restores natural diversity while providing imagery and stories which redefine post-industrial nature and culture. Any introduction of animals and plants into the watershed should take place within the context of the restoration approaches discussed in the sections above. Reintroduction of animal species or their specific habitats should be modeled on extant, local communities under controlled conditions. A number of possibilities have been raised to date: osprey platforms near the mouth of the stream; habitat installations for reptiles; nesting structures for songbirds and other migrants. Guidelines for such initiatives should be developed in consultation with groups such as the Carnegie Museum of Natural

History, Chatham College, University of Pittsburgh, Penn State University, the Department of Conservation and Natural Resources, and the Federal Fish and Wildlife Service. The involvement of the local community and school groups is essential to building a constituency for such projects, as well as cultivating a pool of local volunteer stewards for monitoring and education programs.

If we are to create a community of stewardship, empowerment is only part of the equation. The other part is education, stories, and ritual. The local public must play an important and visible role in the planning, installation, and monitoring of regeneration and ecosystem management. Woods (1994) remarked on the high level of community anticipation and involvement in prescribed burns at the University of Wisconsin Arboretum's Curtis Prairie. In what has become an annual event, volunteers shape their restored savanna ecosystem in festive style; the number of participants grows each year, contributing to what has become a new urban ritual in the Madison area. This "ritualized" aspect of urban ecosystem management has been characterized by several researchers (Holland, 1994; Hartig, et al. 1994; Freehafer, 1995), who see it as a response to individual and collective societal needs to reconcile with the earth and nurture the local natural places around them.

Pittsburgh has begun one such ritual in the "Bioblitz" initiated by the Carnegie Museum of Natural History (explained in the section on education above). Biodiversity refers to all the different kinds of plants, birds, mammals, insects, amphibians, reptiles, fish, and other organisms in an area. It can be measured in many ways, including species richness (number of different species); abundance (number of individuals of each species); adaptations (variation among individuals of each species); and habitats (different kinds of places). The biological components of an area (the plants, animals, and other life forms, such as bacteria and other single-celled organisms) and their interrelationships with the soil, water, and other non-living factors make up ecosystems. Although people usually associate biodiversity with rainforests and other wilderness areas, these concepts are important in Pittsburgh and other cities for the following reasons

Why is Biodiversity Important:

1. **Biodiversity translates into city parks that are rich in natural experiences. City parks that have healthy and diverse habitats can offer complex experiences, including the sights and sounds of wildlife as well as the experience of natural environments, which are both immersive and intense (forests, wetlands) and at times expansive and contemplative (fields, ridge views).**

2. **Biodiversity and ecosystem functions contribute to improved water quality, land and soil regeneration, and pest control. Ecosystems that are out of balance and diminished in diversity require greater care, including fertilization, soil stabilization, and insect control.**

An excerpt from **"The bear who came to town"** Published as an editorial in the *Pittsburgh Post-Gazette*, on Saturday, Jan 11, 1997.

By Brian Connelly

Walking along NMR in Frick Park looking for deer on the last Saturday in December, I noticed the trash bags hanging like prayer flags from the low branches of the trees over the stream. The bags are deposited in the branches when the stream floods after a rain, and the water flows 4 feet over its normal level.

I was looking for that small herd of deer that ekes out an existence between the polluted stream and the parkway, but there was not much chance of seeing the deer, because two young boys were riding bicycles through the muddy track along the stream and making noise. As they both pulled alongside me one asked, "is there bears in Pittsburgh?"

Although the bear was seen heading for Westmoreland County before Christmas, after trekking across the East End from Garfield to Duck Hollow where NMR meets the Monongahela, and then swimming the Mon, he may still be around. In the last few weeks I have overheard a few people telling their kids to watch out for the bear. Maybe the bear will become eternal as an urban legend. I like his presence in whatever form.

The bear's choice of a route through Pittsburgh was interesting. A group called the Nine Mile Run Project are working to create a greenway connecting the Monongahela to the NMR river valley. This is pretty much the bear's route down to the Monongahela.

Already in the East End of Pittsburgh and the near suburbs, more and more deer, hawks and turkeys show up in places where they haven't been common in a hundred years.

Without greenways to link the open spaces, wildlife is trapped in small areas, and this leads to inbred populations surviving on marginal food resources. So now deer regularly eat my Dad's rose bushes in Mt. Lebanon and communities like Bethel Park and Fox Chapel organize hunts to take out the deer that survive in their backyards and show up bewildered on their streets.

The bear followed the nascent greenway to the river because it was there. He probably had an idea where he wanted to go, and green valley bottoms lead to a river. And he could get to the river without crossing any major highways. If he had found himself in Monroeville or along Route 19 in the South Hills, he might not have made it to the river alive.

BioBlitz '98 was a hit. We had a good public turnout with estimates of 1,200-1,500 people participating in some aspect on Saturday. About 300 kids participated in the Junior BioBlitz and over 150 people were at the Twilight Picnic.

The final species count at 3 pm on Saturday was 1,471 (compared with 1,164 for last year's BioBlitz at Riverview Park).

The breakdown by group is:
- Insects - 974 species
- Plants (including mosses) - 344
- Birds - 83
- Amphibians & Reptiles - 15
- Mammals - 15
- Fish - 2
- Other - 38

Interesting finds this year include:

Mile-a-minute weed—A horrible, thorny vine that is listed as a noxious weed in PA. Already a problem in southeastern PA and elsewhere in the east, it wasn't really known from western PA. Steve Grund from the Western PA Conservancy found one population (8-10 sq. m) in zone 3 and is checking out precisely where (he says it's at the edge of a field in that area).
I'm contacting Citiparks about a weed pull—perhaps we can nip it in the bud!

Ravine Salamander—Species restricted to southwestern PA and not found in Frick since the 1950s. It's still alive and well and presently getting its little picture taken.

Surf Scoter—A sea bird not previously noted from the Frick vicinity. Maybe from the air the slag looks like dunes??

New herps for Frick Park—American Toad, Northern Ringneck Snake, and Bullfrog. Sorry, still no Copperhead. Botanists added over 60 plant species that had not previously been reported for Frick/NMR.

Mammals—Lots of traps set, but only one little mouse caught. All other records were from sightings, tracks, other sign. Beaver seems to be their most exciting find. Mammalogists attribute the low trapping activity to the hot weather.

Bugs—Lots and lots and lots of species still being counted.

3. **Plant communities with a diversity of species require less maintenance and teach us to work with nature and to recognize natural cycles and systems.**

4. **Understanding biodiversity and its effects can help us understand ecosystems value and management in urban settings. If we can teach the value of diversity and ecosystem interrelationships in populated city environments, the protection and value of wilderness systems will be easier to sustain in the future.**

Information on the Pittsburgh Bioblitz can be found at:
http://slaggarden.cfa.cmu.edu/bioblitz

VII-j4. Conclusion:

NMR is an ecosystem that has been damaged by decades of industrial dumping, residential sewage, and urban runoff. To heal that ecosystem—and make it a vital part of the region's quality of life—we need concerted civic action on the part of various municipal governments, regulatory agencies, and citizens groups.

But this is only one part of the story we have been telling here. NMR presents not only problems to be solved but opportunities to be appreciated, right now and in the future--opportunities on both the individual and community levels for education, research, experience, and even inspiration. Every "problem," in fact, can be redefined as an opportunity: to learn more about how urban ecosystems function, to renew our appreciation for our natural and cultural heritages, to change our whole way of thinking about the role of ecology in our daily lives. What we are proposing in this document, therefore, is not simply a list of technical "solutions" but a more fundamental change in our attitude toward urban ecosystems. First and foremost we need to foster an attitude of appreciation and wonder for NMR as a place (and a system) of unique value in our region. From this attitude comes inspiration and motivation; from inspiration and motivation comes the creative action and stewardship necessary to regenerate the ecosystem and maximize its opportunities.

With the importance of this attitude always in mind, we can summarize our specific recommendations:

- Create a watershed management authority to implement a plan to reduce sewage flow and urban runoff into the stream;
- Build a keeper's cottage/educational facility on site;
- Institute pilot projects to restore specific habitats;
- Control invasive plants, revegetate slag, and reintroduce particular species;
- Enhance the two existing wetland sites;
- Expand educational programming;
- Create stewardship rituals.

VII-k. Project Recommendations
The Nine Mile Run Rivers Conservation Plan

General Objectives:
The mission of the Nine Mile Run Rivers Conservation Plan is to educate and inspire, to reveal the opportunity that exists in degraded urban landscapes. The tendency to value pristine environments over the landscapes that we access in our daily lives undermines the urban and suburban environment. If we are to reclaim our cultural uses and relationships to urban rivers we need to carefully consider their opportunities along with their problems. We must learn to see (and teach) the value of ecosystem function in our neighborhood parks, backyards, vacant lots and daily lives. From the daily practice of attention and care comes the values that will protect and enable a sustainable balance between the built and natural environments.

Stewardship

* Annual Event Modeled on CMNH's Bio-Blitz: Nine Mile Run will be the first post-industrial property to be re-generated or healed into a functioning urban ecosystem. Conducting a regular public survey of the expansion of the bio-diversity and ecosystem functions on the property would be a wonderful way to chart the process.
* A "job corps" style program of native species management and training and application of biological techniques for stream bank restoration and tall grass prairie restoration.
* National conference on the issues of brownfield redevelopment and urban streams.
* Local education initiative for both public and private sectors.

Regeneration of vegetation

* A Greenhouse program featuring native species propagation, seedbank and nursery program onsite. Part of the initiative would consider the propagation and growth of Pennsylvania threatened plants (like the hop tree) and others that survive on barrens, or seem to take to the specific soil types at the slag site. This program would include a research initiative on alkaline-tolerant species.
* Specific demonstration projects for revegetation of slag slopes. The focus would be: 1) soil mix, 2) plants, 3) applications.
* Regeneration of prairie grasslands. The field off Commercial Avenue could be the site of a prairie grass restoration.
* Riparian corridor regeneration and bank stabilization. There are numerous stream sections along NMR that need attention.

Addressing water problems

* Upstream testing needs to occur to take the next logical step to identify the sources in the three storm sewers which have been identified as the primary sources of pathogens to the stream.
* Sewage infrastructure mapping and assessment need to occur. This will provide a complete overview of the system and its general conditions, manhole by manhole.

Specific Project Recommendations

Project	Estimated Cost	Lead Agency/Partners	Time Frame
Investigate development stormwater issues	Unknown	City of Pittsburgh/Urban Redevelopment Authority/Three Rivers Wet Weather Demonstration Project	1-2 years
Engineering feasibility studies on access sites	Unknown		2-5 years
Repair of the existing pedestrian bridge	Unknown	City of Pittsburgh/Boy Scouts	2-5 years
Feasibility study on constructing a pedestrian walkway	Unknown		2000
Architectural feasibltity study/conept design on a "greenway keeper's" cottage	Unknown		2-5 years
Greenway access to Glen Hazel	Unknown		5-10 years

*Part of the Army Corps of Engineers "Aquatic Habitat Restorarion" project

Appendices

Appendix I. Maps

1-a	USGS Pittsburgh Quadrant
I-d	Culverted Streams and Major Tributaries
I-f1a	Watershed Unemployment
I-f1b	Watershed Income
I-f1c	Watershed Population
I-f2b	Pedestrian Access
II-d	Watershed Priority Focus Areas
III-c1	Area of Conflicting Value and Use
III-d	Eroded Soil, Deposited Slag
III-e2	Abandoned Mines and Gas Wells
IV-b1	Existing Wetlands and Potential Wetland Areas
IV-b2	Areas of Potential Wetland Regeneration
IV-c	The Flood Plain
IV-e1a	Water Quality Testing Points
IV-e1b	Combined Sewer Outfalls
V-1	Botany Study Areas
V-2	Vegetation Communities
V-d	Interior and Upland Forest
VII-h	Stormwater Management: Potential Areas for Infiltration and Detention
VII-j	Sound/Silence
VII-j2	Experiential Nature/Culture

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

PITTSBURGH EAST QUADRANGLE
PENNSYLVANIA–ALLEGHENY CO.
7.5 MINUTE SERIES (TOPOGRAPHIC)

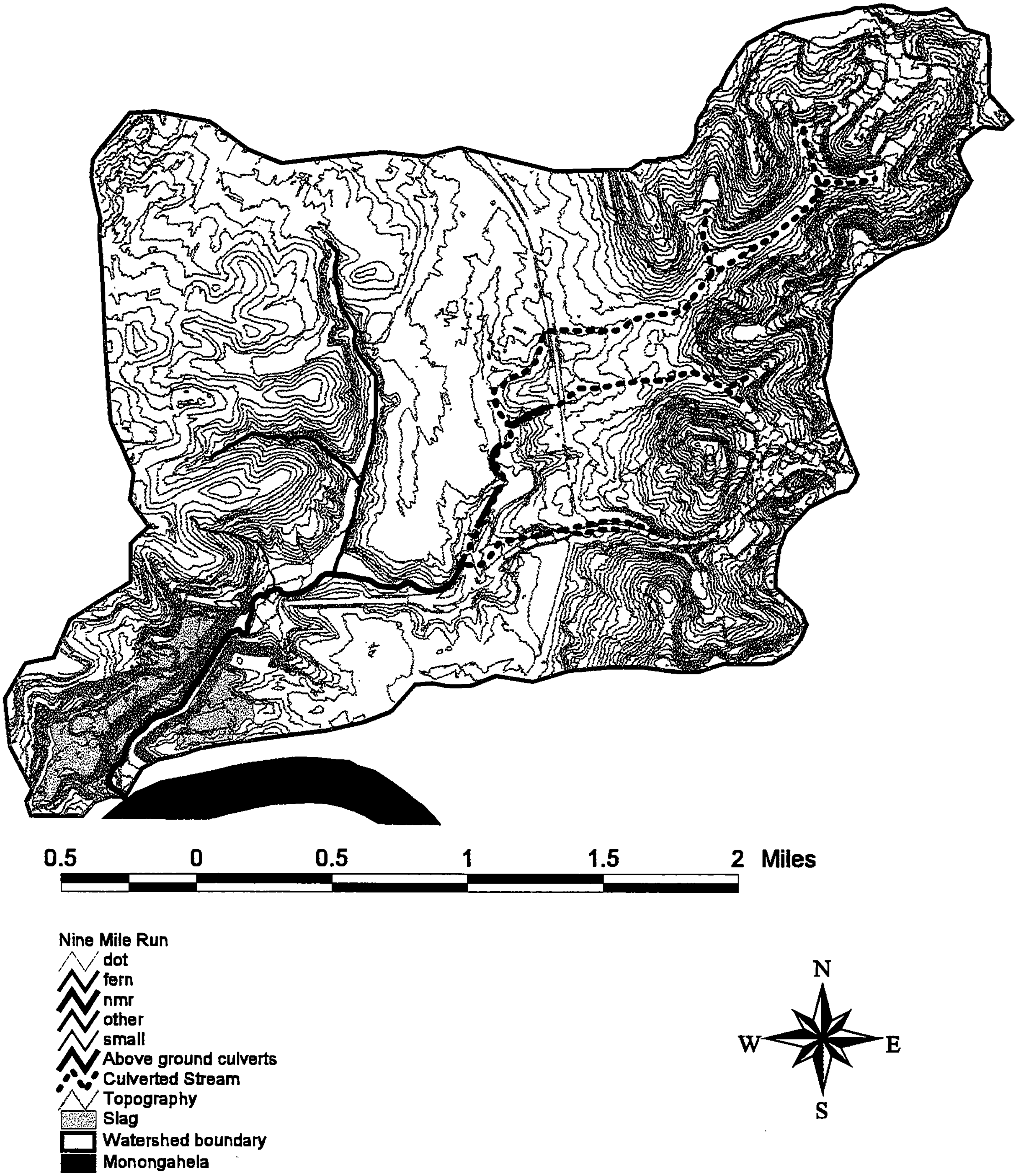
SCALE 1:24 000

KILOMETERS
METERS
MILES
FEET

CONTOUR INTERVAL 20 FEET

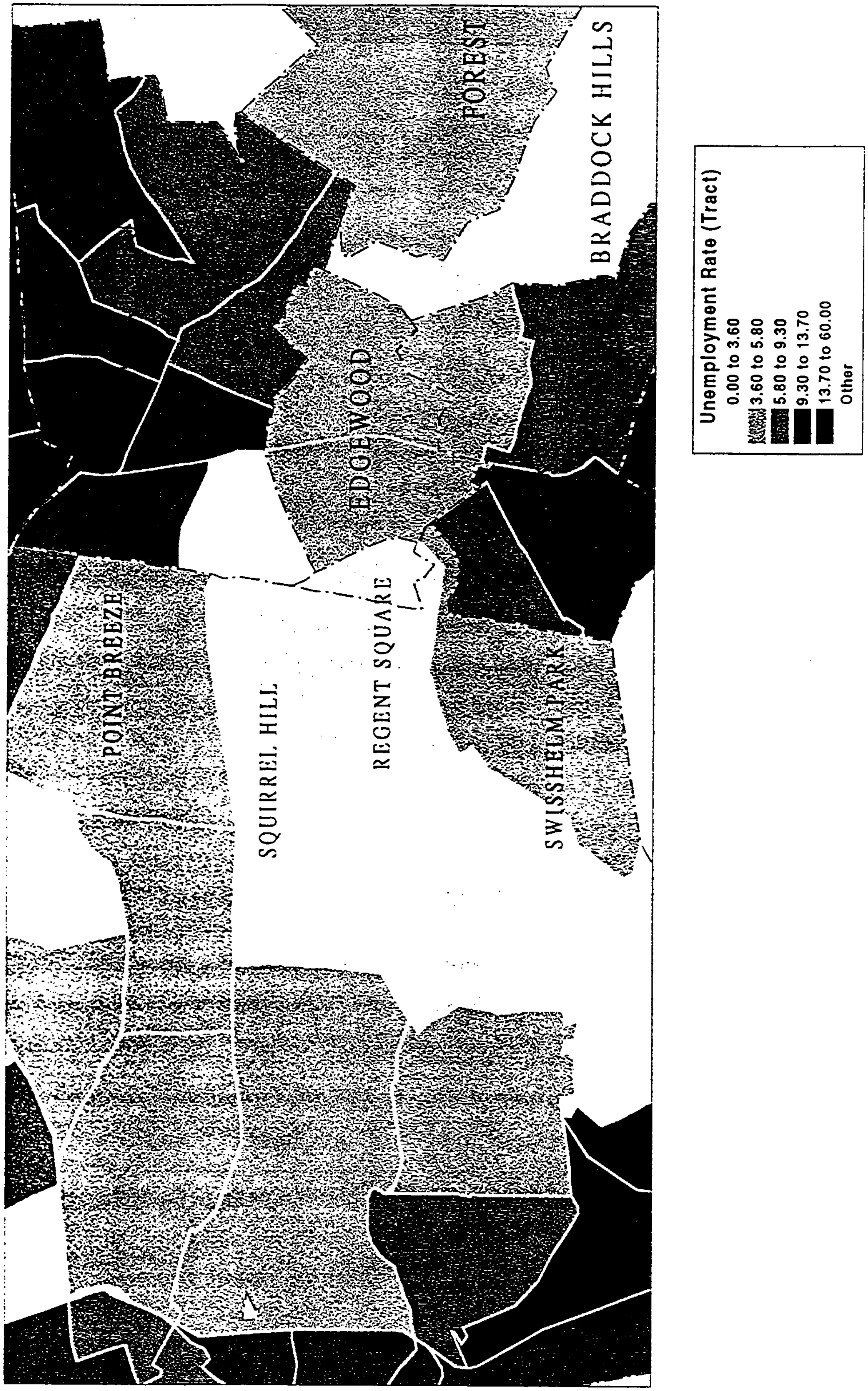
PITTSBURGH EAST, PA.
40079-D8-TF-024
1993
DMA 5064 IV NW-SERIES V831

Map I-d Culverted Streams and Major Tributaries

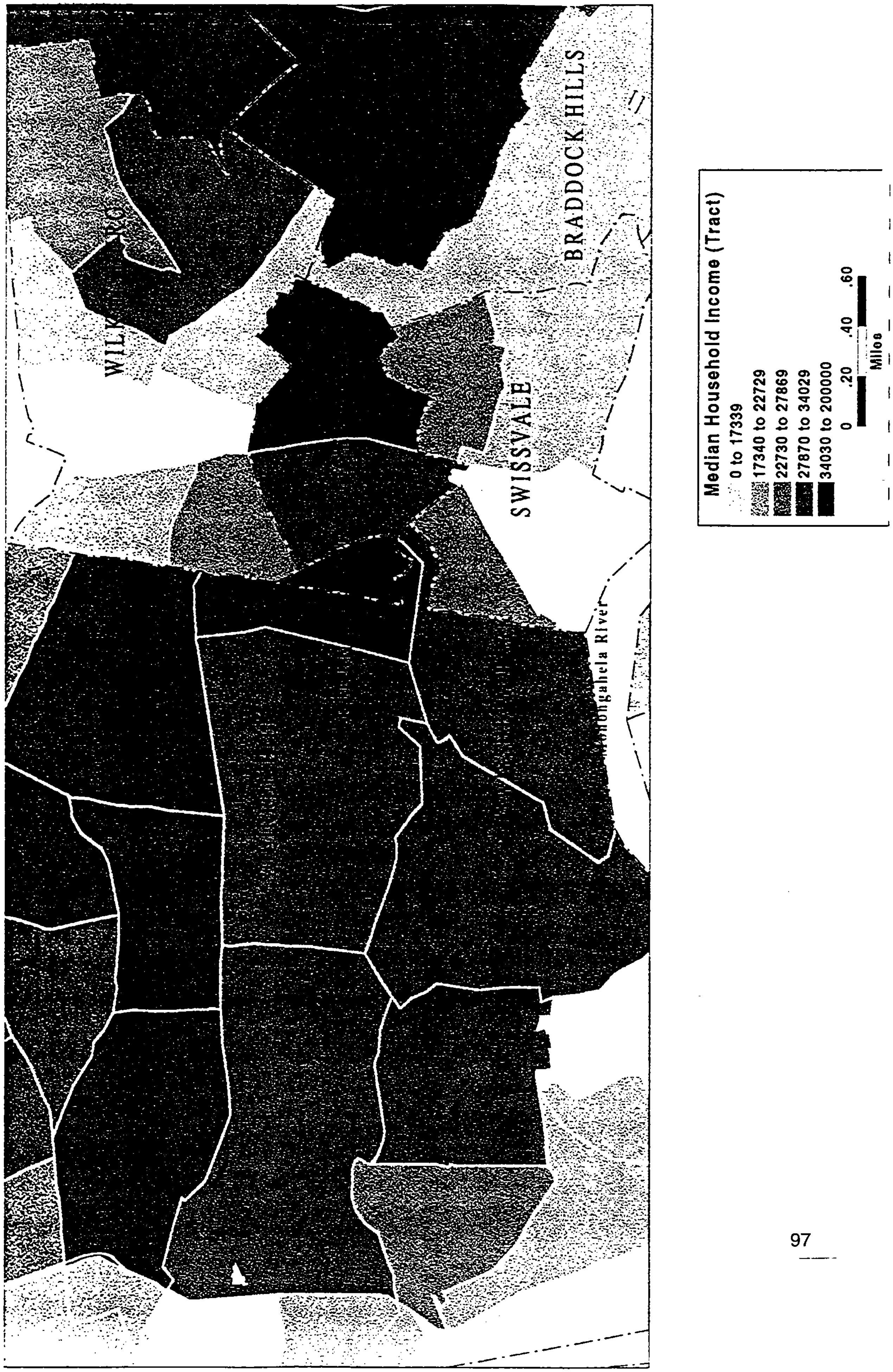


I-f1a **Watershed Unemployment**

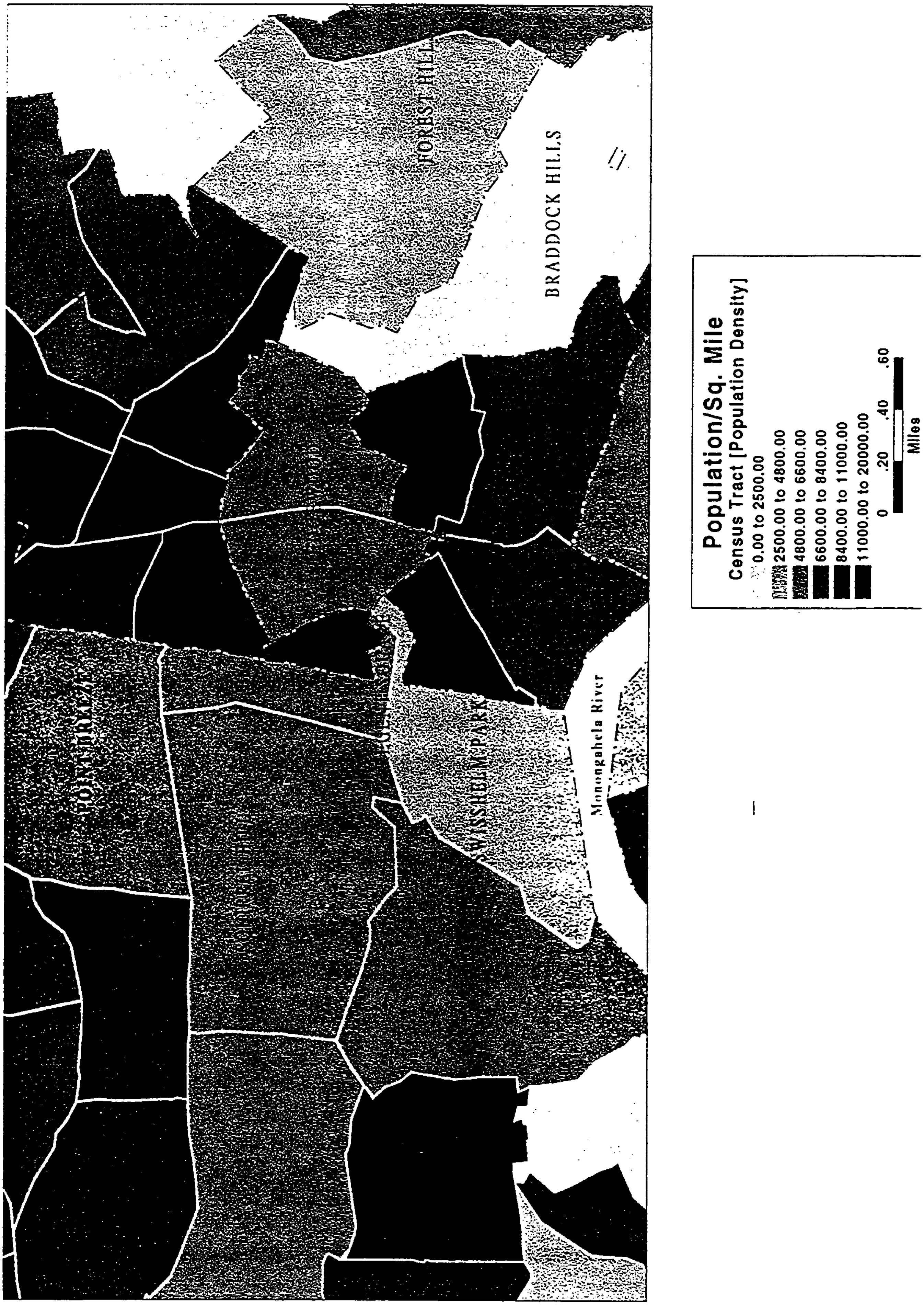
Nine Mile Run Watershed -- Unemployment



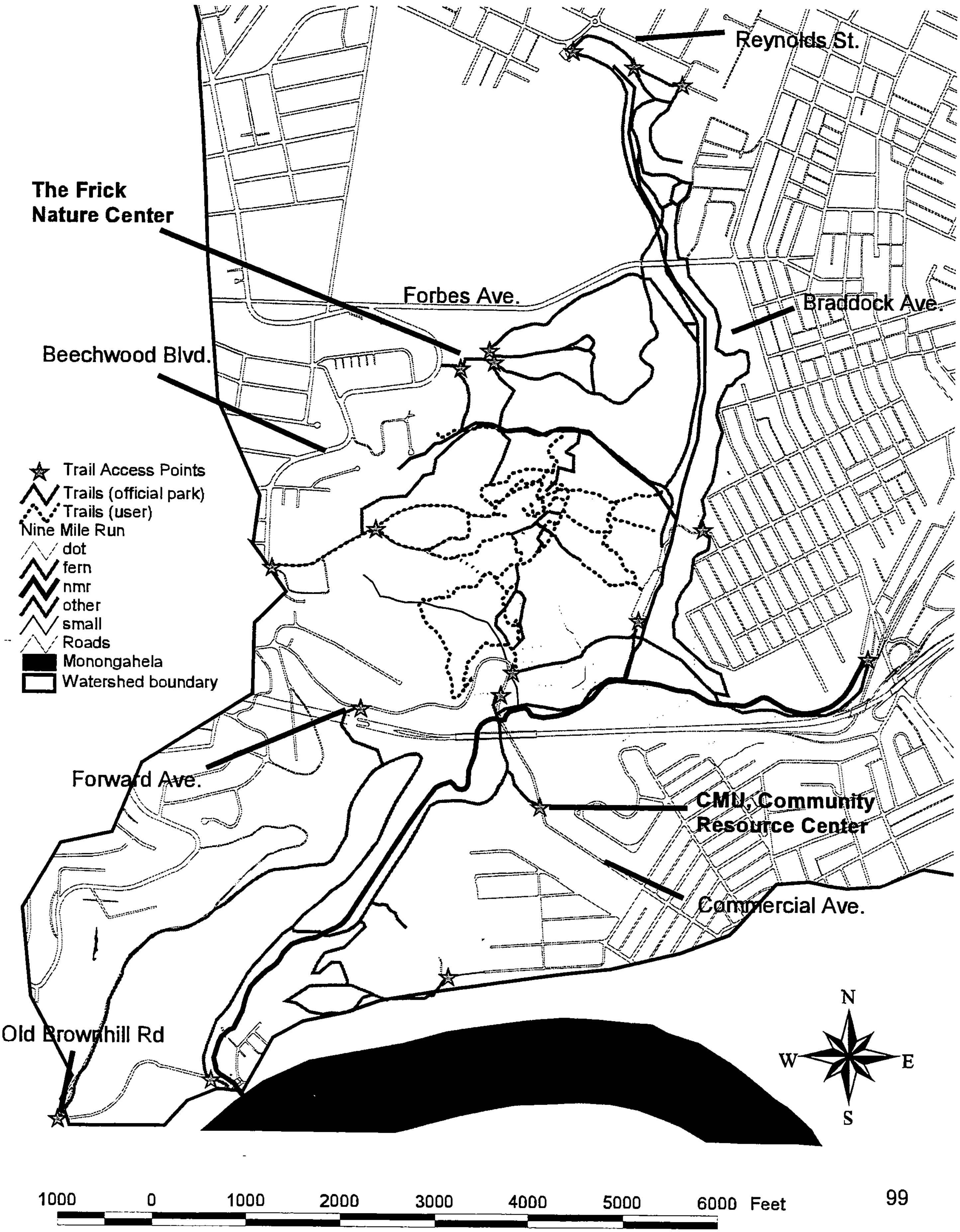
Nine Mile Run Watershed -- Income



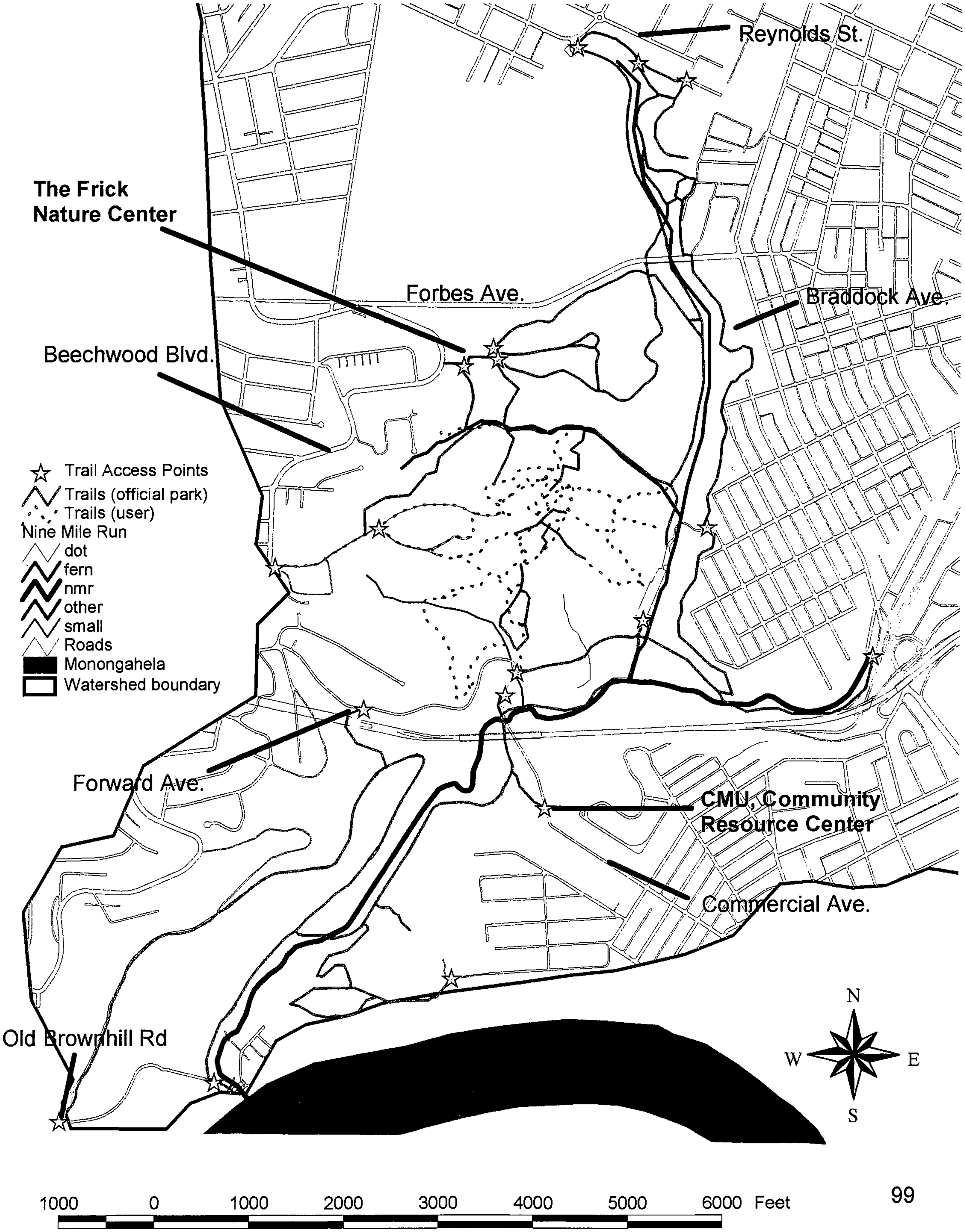
Nine Mile Run Watershed Population



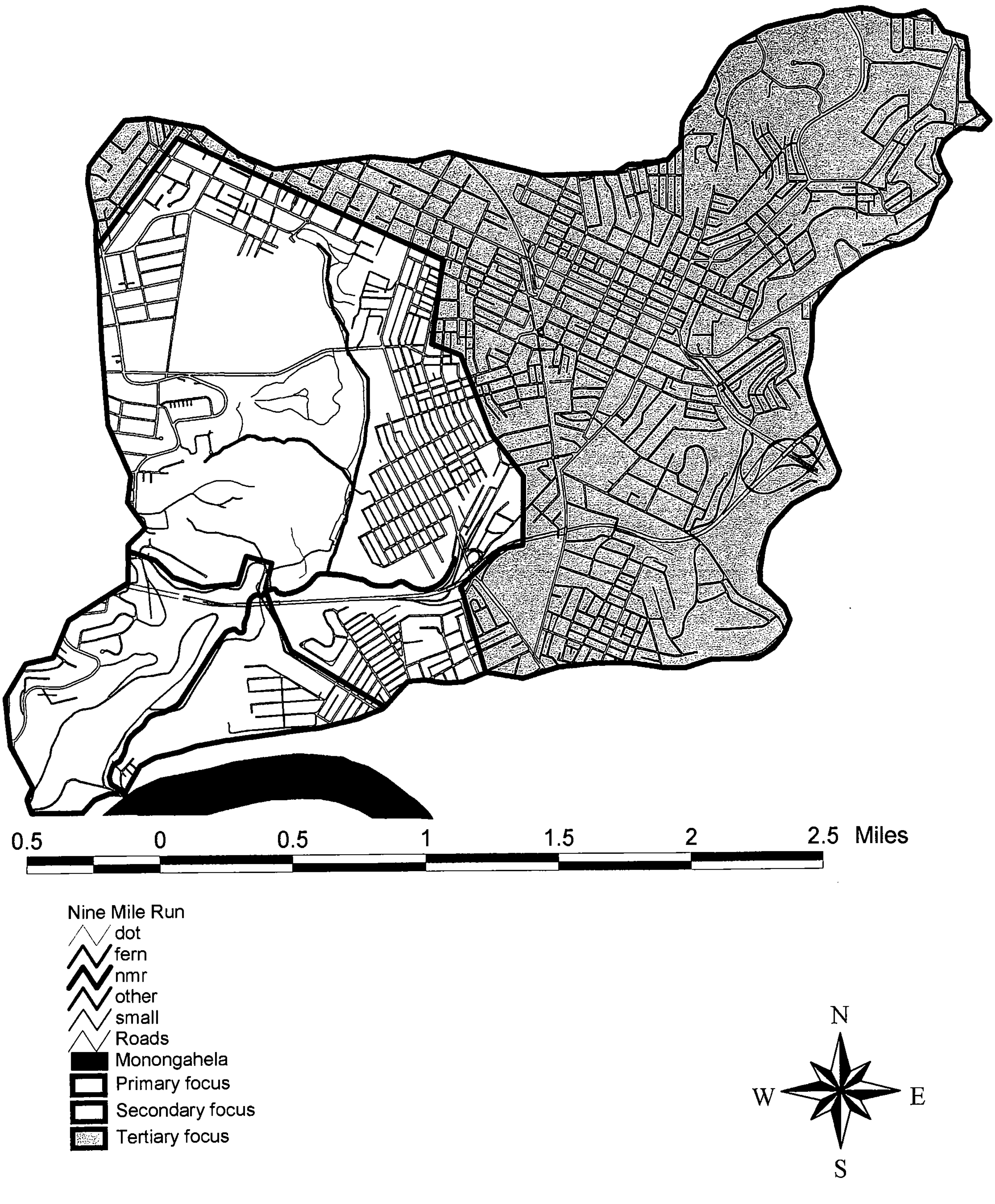
Map I-f2b Pedestrian Access



Map I-f2b Pedestrian Access

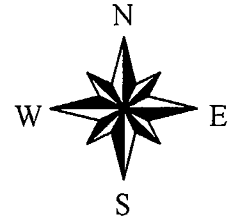


Map II-d Watershed Priority Focus Areas

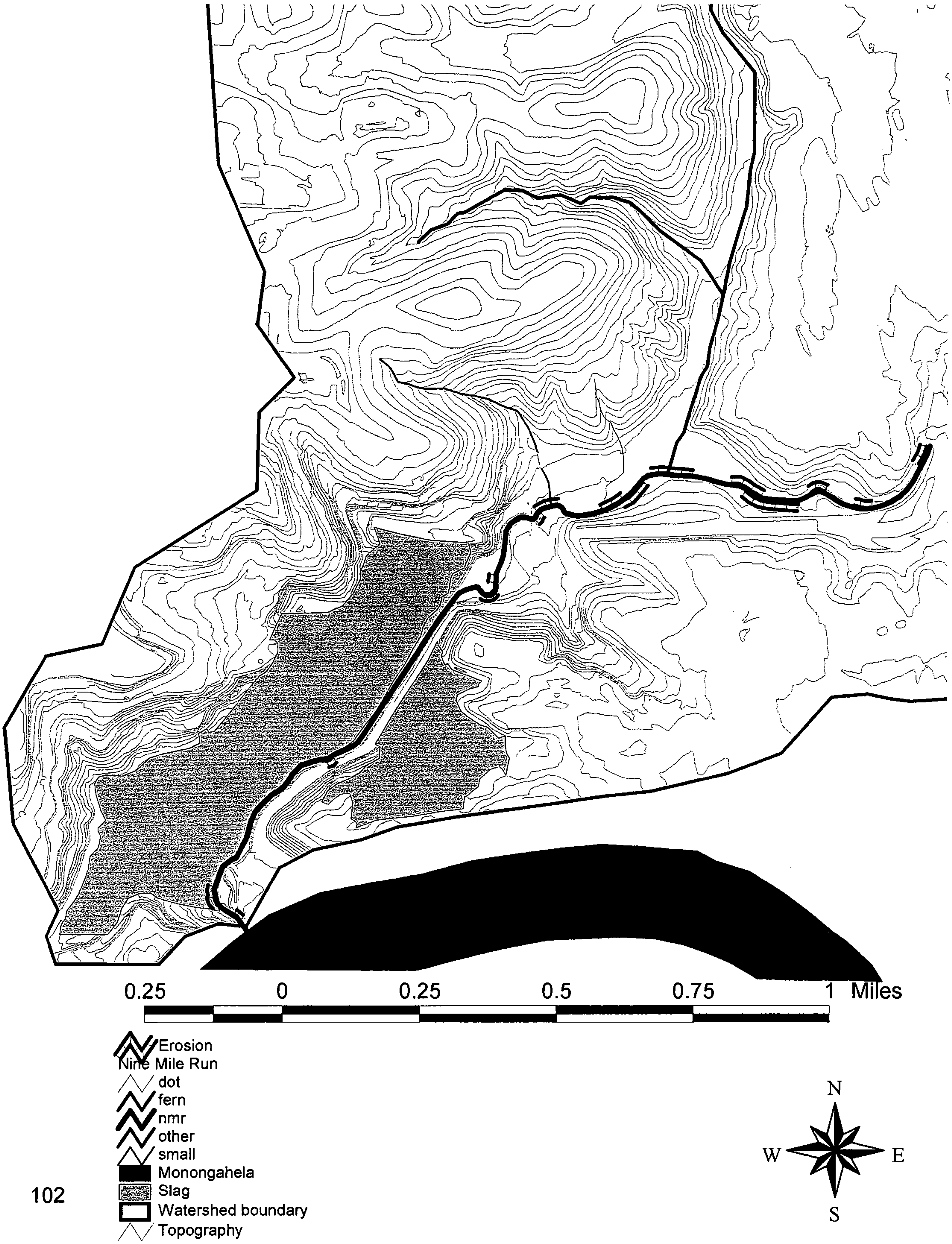


Map III-c1 Area of Conflicting Use/Conflicting Value

The circled area above, has specific habitat value, as an interior forest breeding area for migratory warblers. It also has specific recreational value for hikers and bikers that enjoy a steep slope wooded incline experience. Bikers, birders and park maintenance personell, will need to work together to resolve these conflicts.

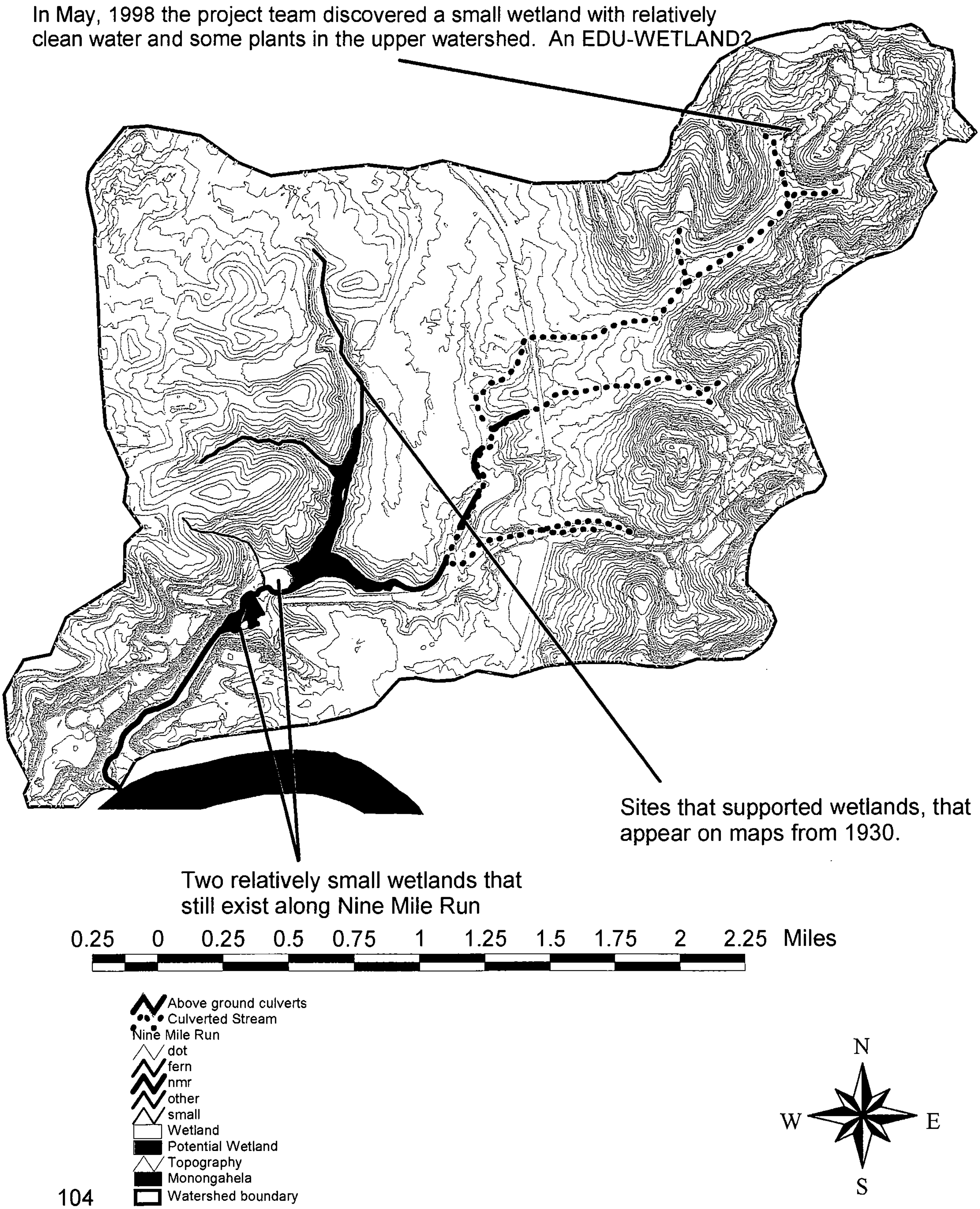


Map III-d Eroded Soil Deposited Slag

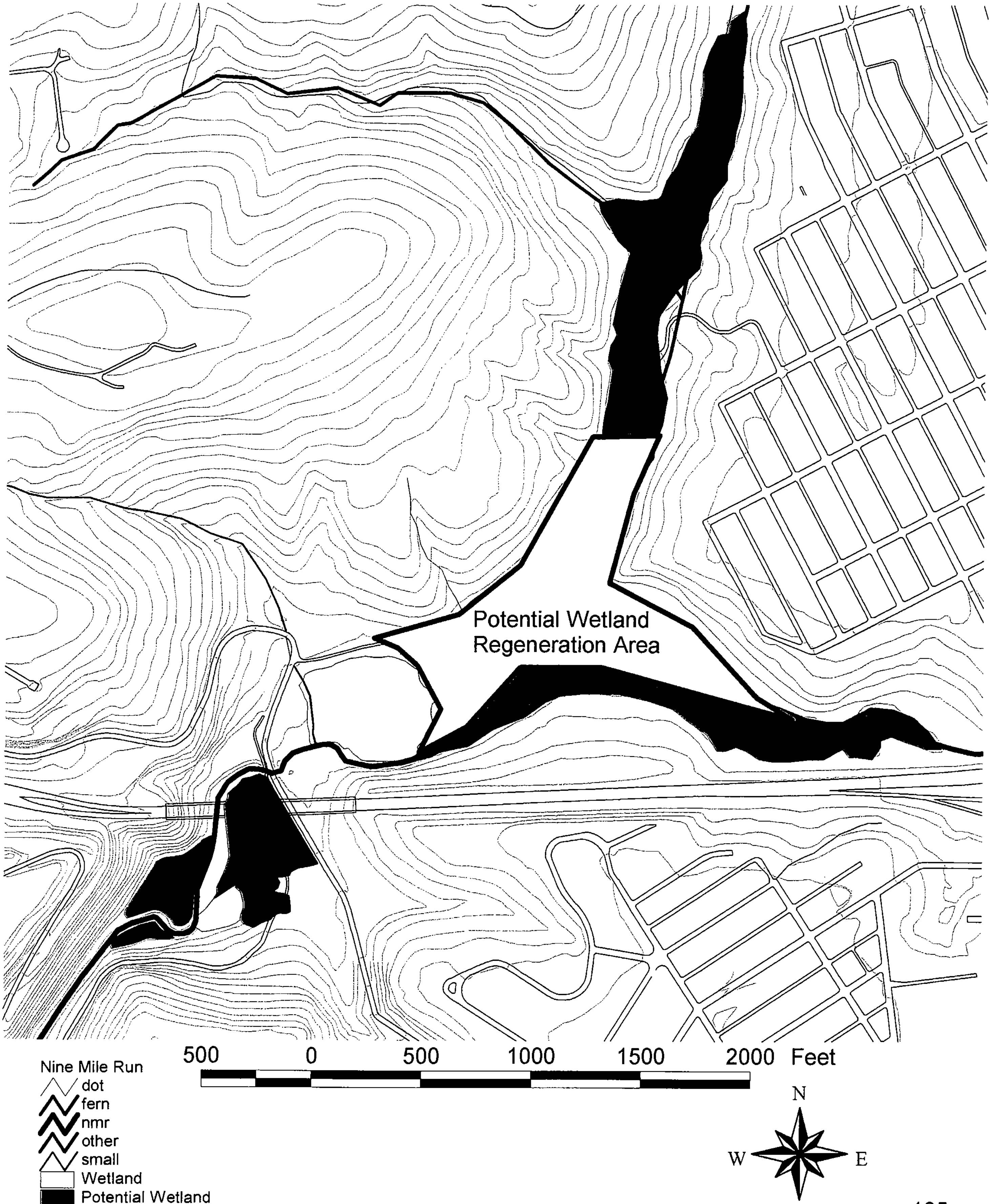


Map III-e2 Abandoned Mines and Gas Wells

Map IV-b1 Existing Wetlands and Potential Wetland Areas

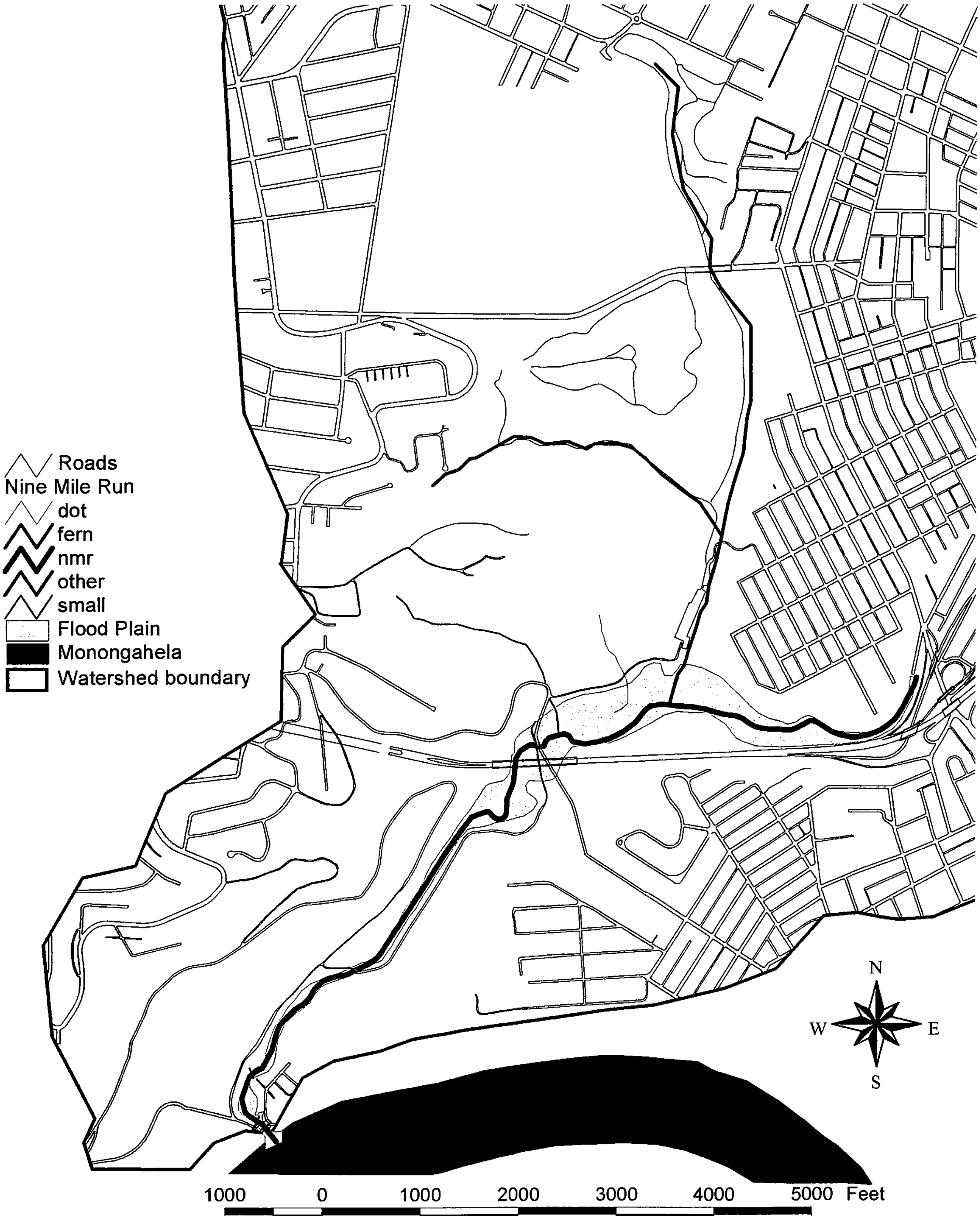


Map IV-b2 Areas of Potential Wetland Regeneration

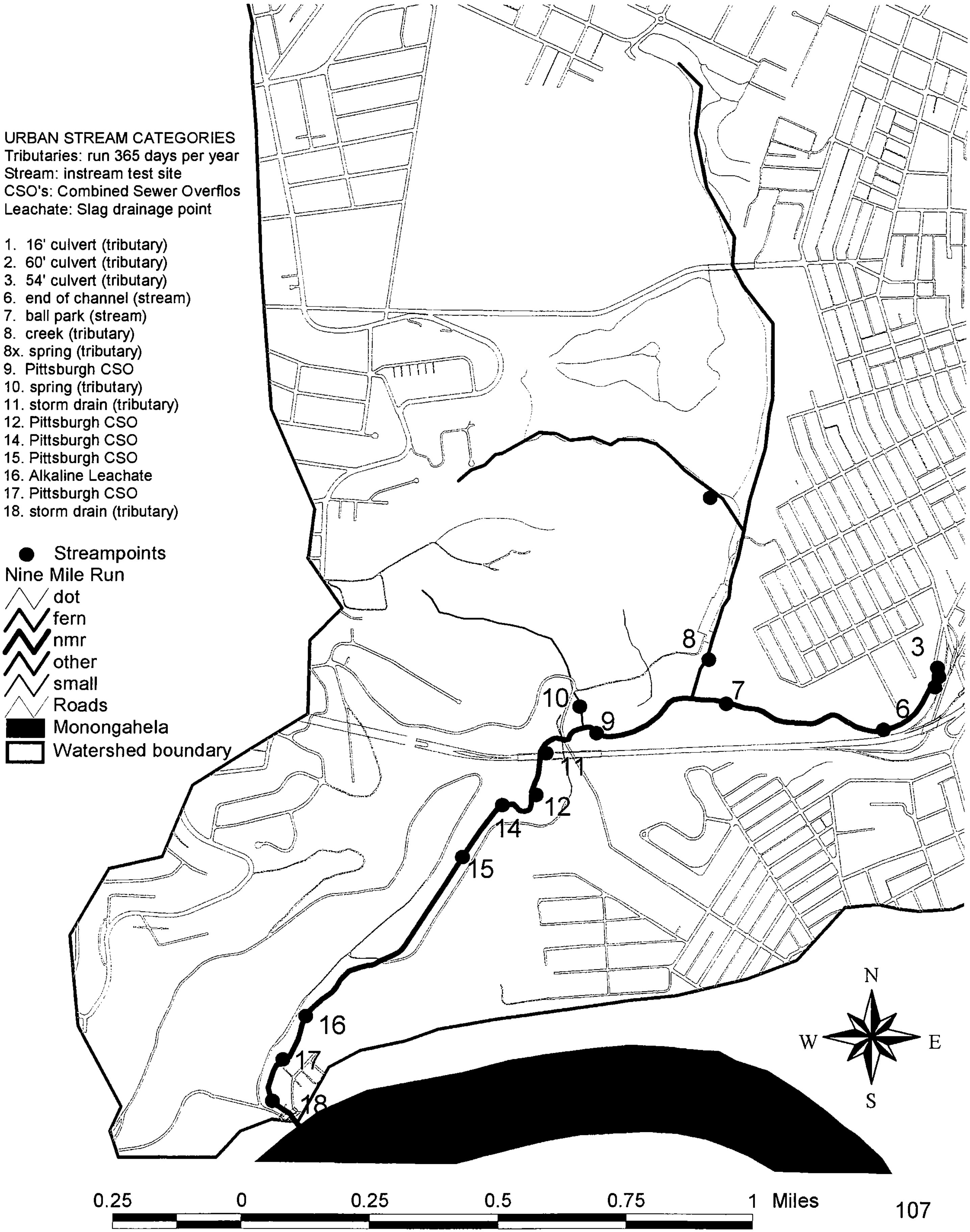


Nine Mile Run
dot
fern
nmr
other
small
Wetland
Potential Wetland
Roads
Topography
Monongahela

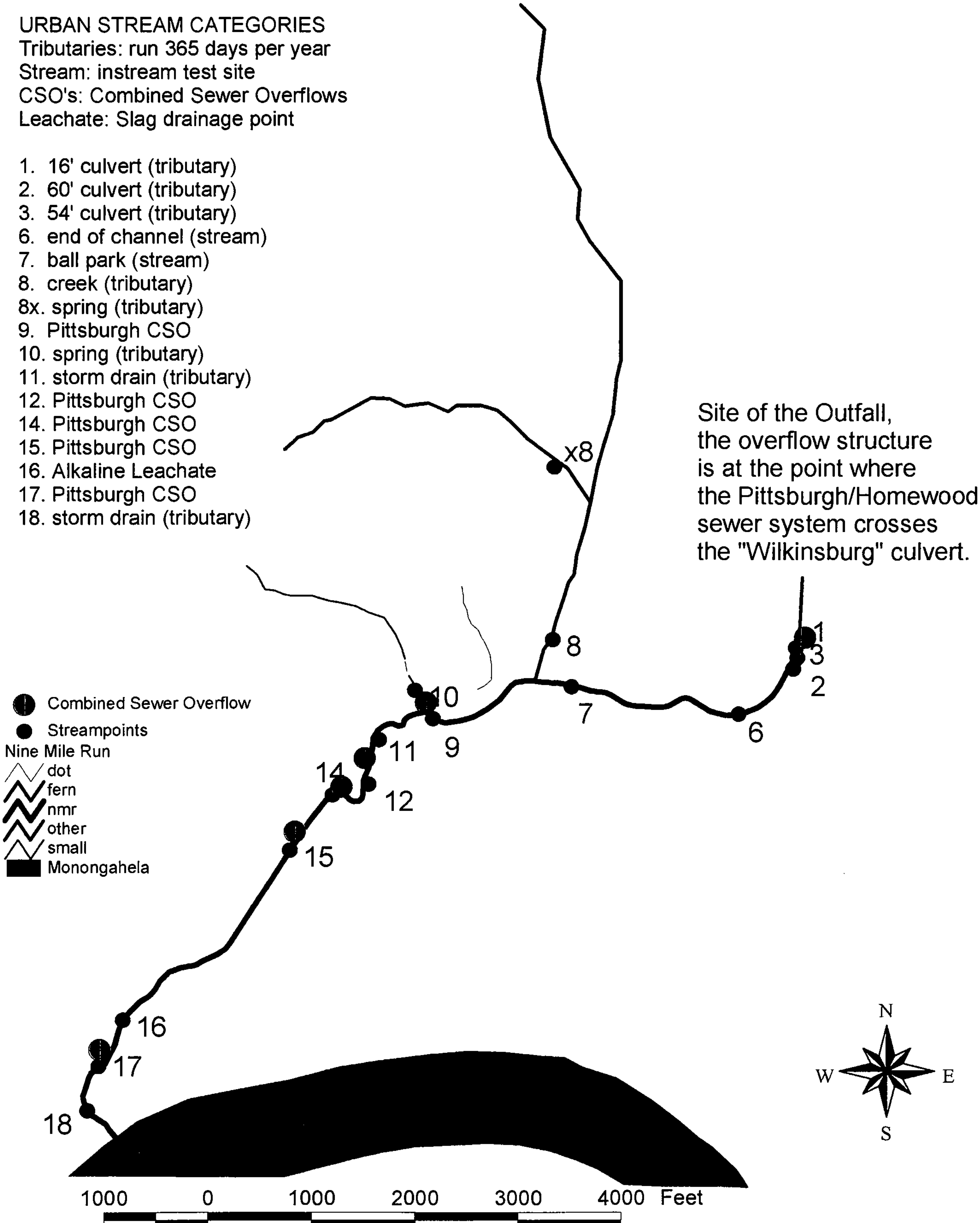
Map IV-c The Flood Plain



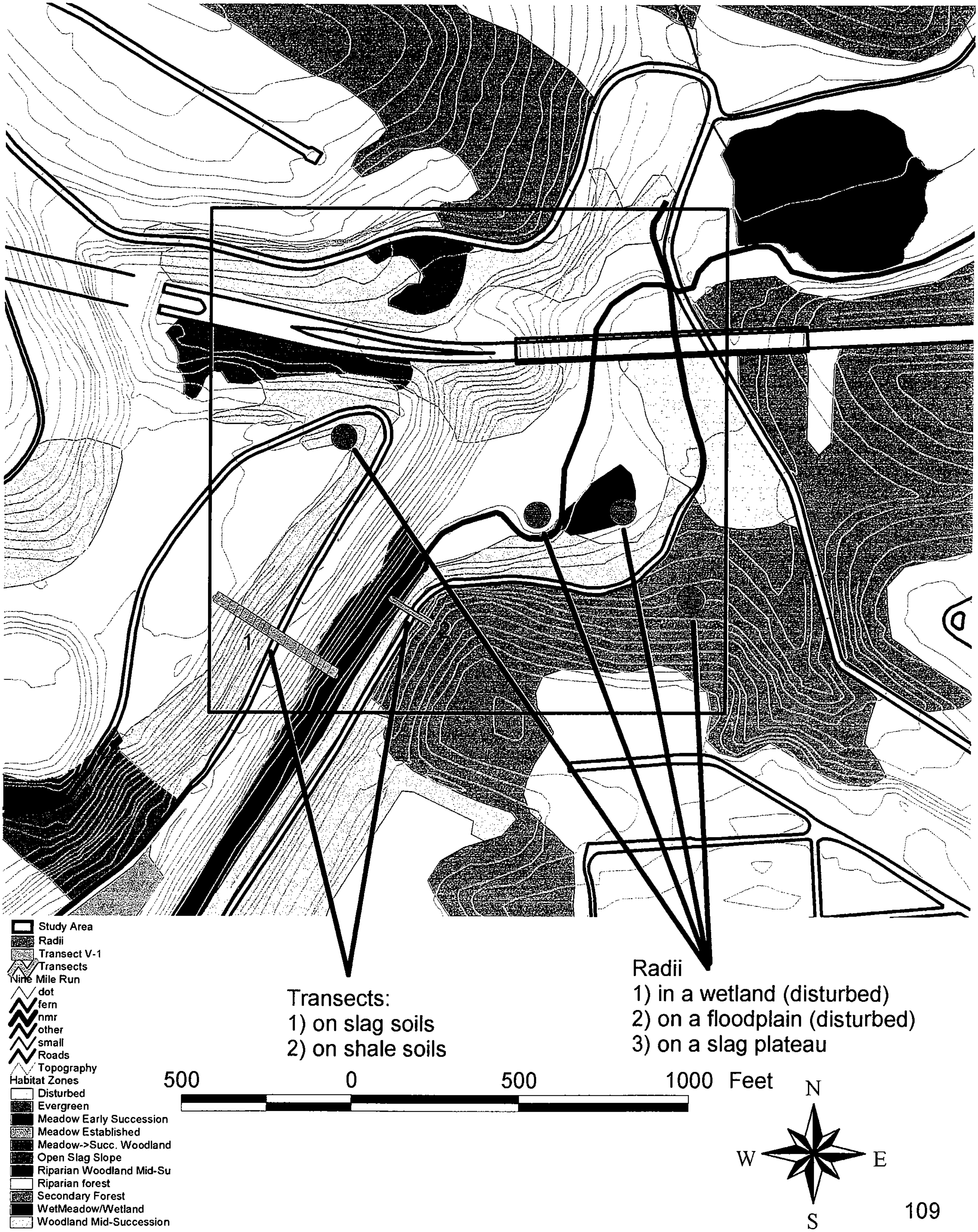
Map IV-e1a Water Quality Testing Points



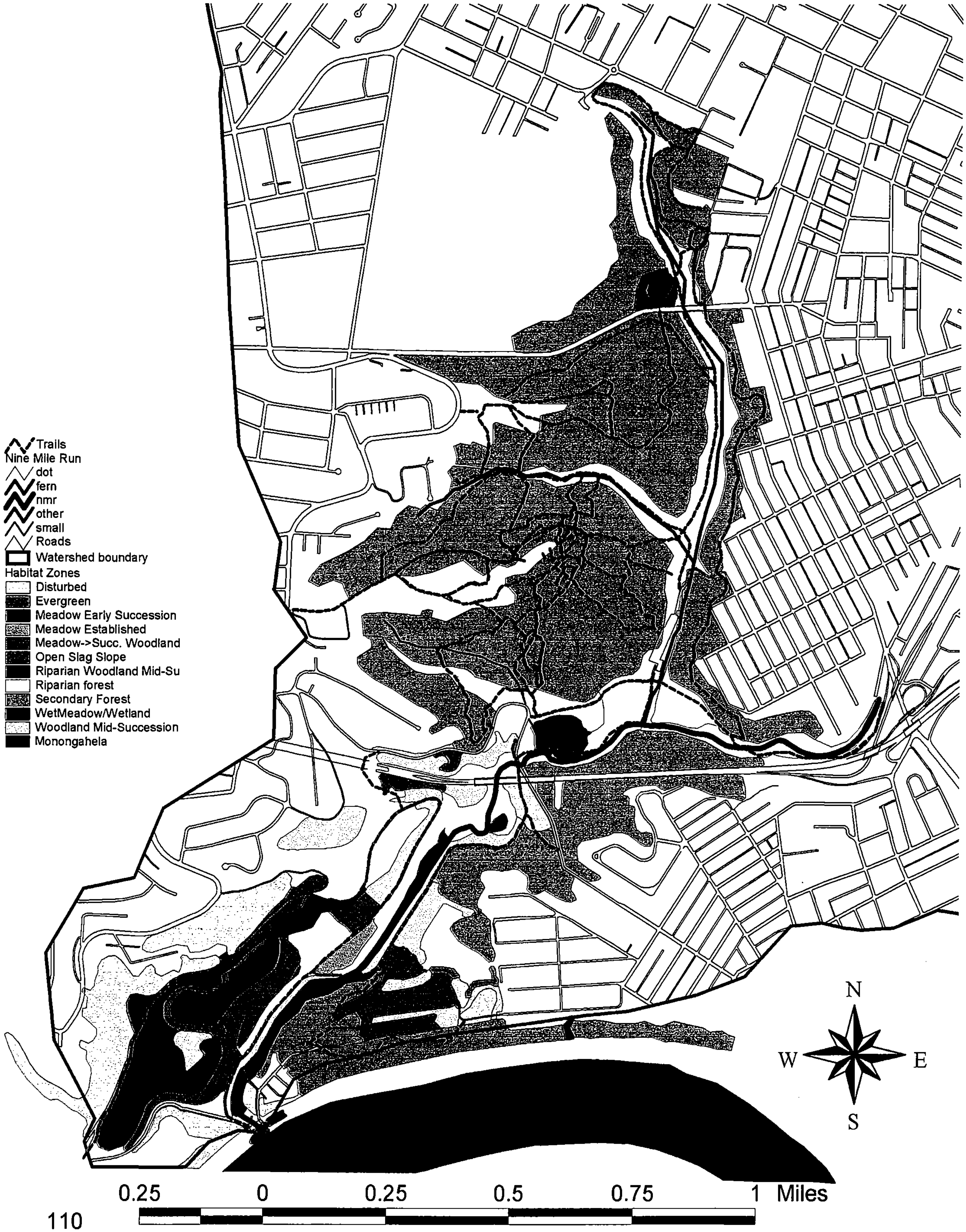
Map IV-e1b Combined Sewer Outfalls



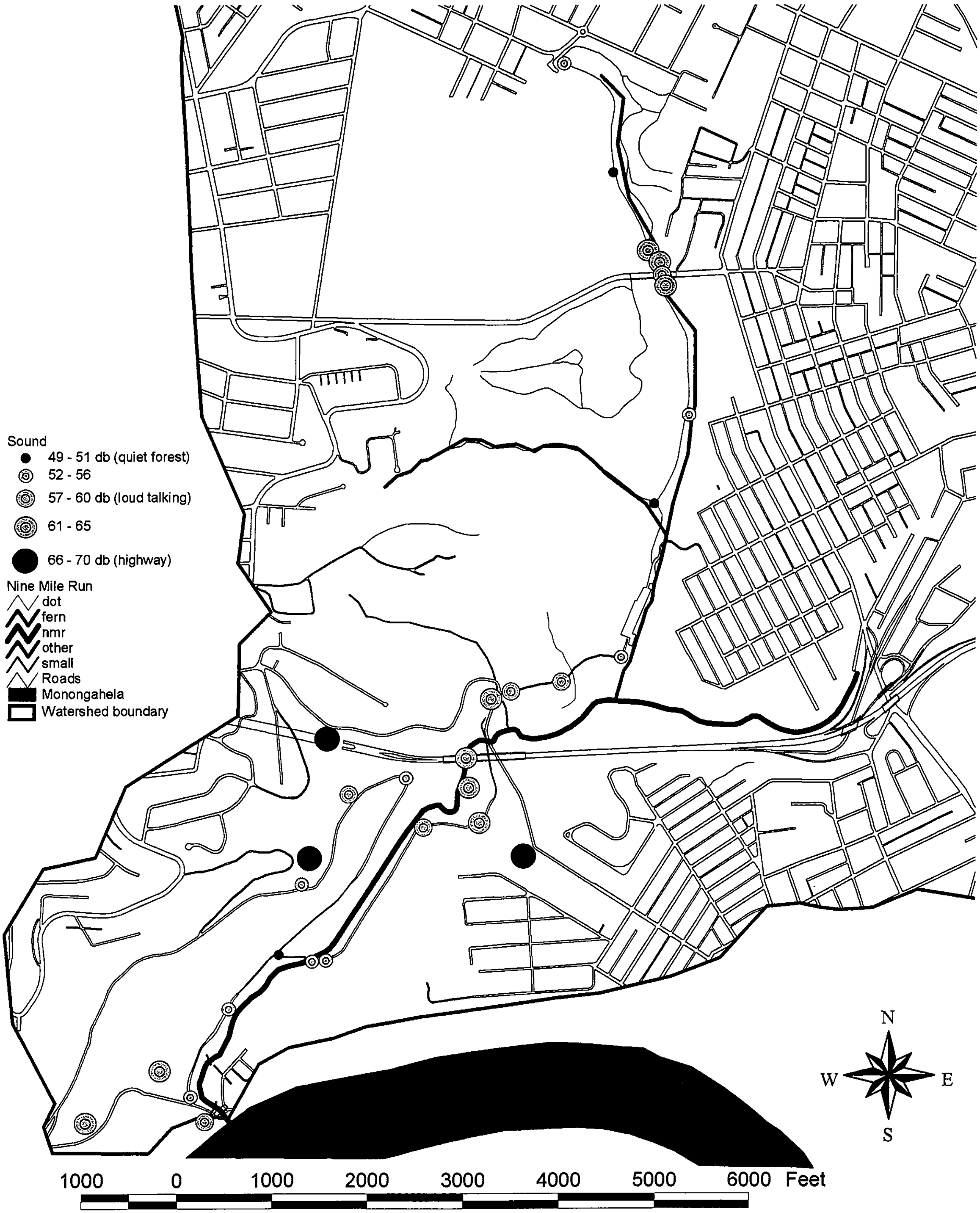
Map V-1 Botanical Study Sites V-1



Map V-2 Vegetation Communities

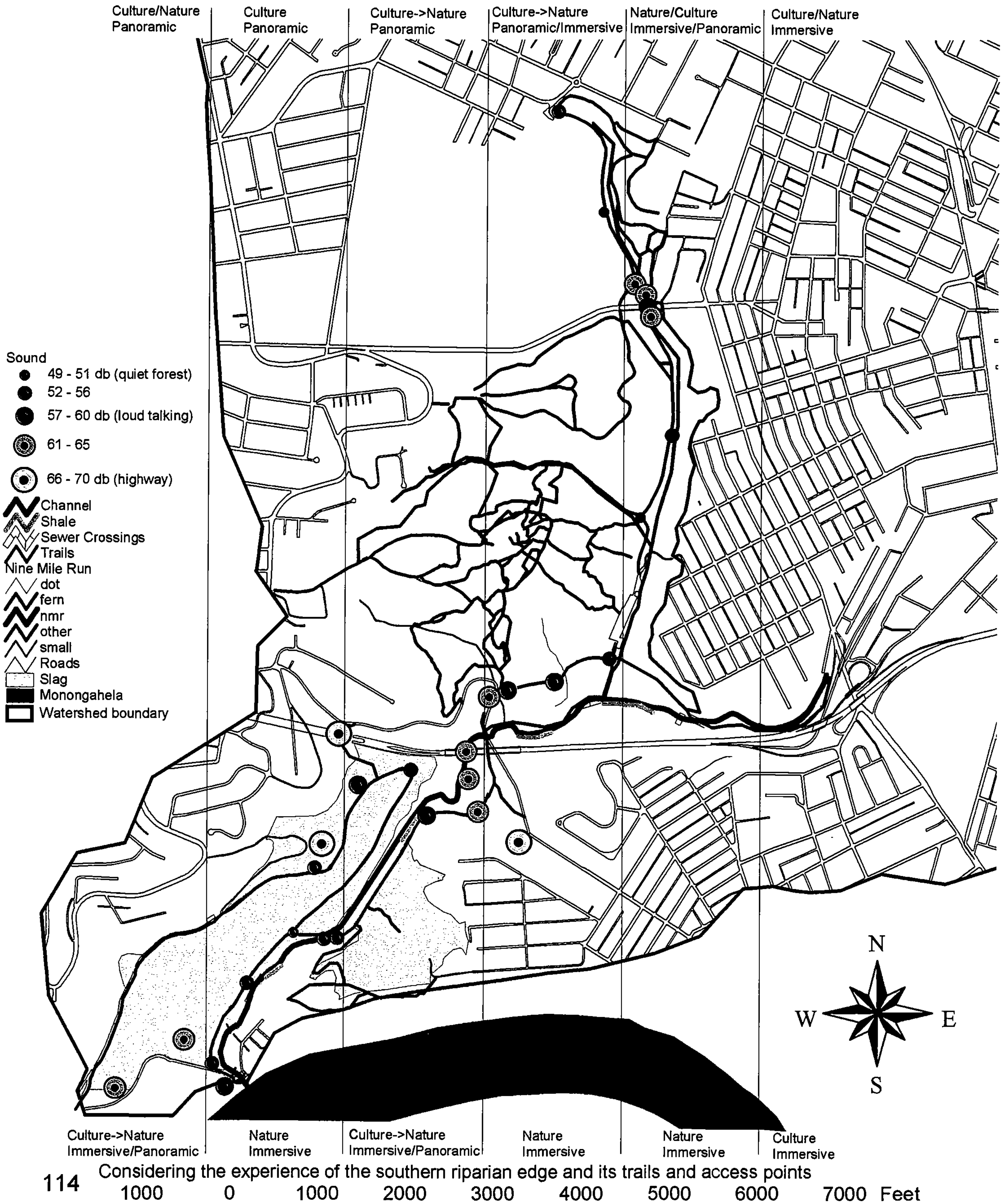


Map VII-j   Sound/Silence



Map VII-j2 Experiential Nature/Culture

Considering the experience of the northern riparian edge and its trails and access points.



Appendix IV

Water Quality Issues in the Nine Mile Run Watershed

Appendix IV

WATER QUALITY ISSUES IN THE NINE MILE RUN WATERSHED

Douglas Lambert
David A. Dzombak

Carnegie Mellon University
Department of Civil and Environmental Engineering
Pittsburgh, PA 15213

Report prepared as part of the
Nine Mile Run Watershed Rivers Conservation Plan

for

Pennsylvania Department of Conservation and Natural Resources

January 13, 1998

Acknowledgments

The authors of this report would like to thank several people for their time, effort, and patience, which were vital to our current understanding of Nine Mile Run.

Thanks to members of the Allegheny County Health Department who assisted with the water quality sampling, including Edward Dermot, John Schombert, Mary Balzina, Norma Ruffing. Special thanks to Paul Brown for providing maps, answering questions and preparing bottles for sampling. Thanks also to the following members of the Department of Civil and Environmental Engineering at Carnegie Mellon for help in the water sampling and flow testing efforts: Michael Paschka, Catherine Bingham, Larry Cartwright, and Brian Blashich.

A thorough understanding of the current status of combined sewer overflows in Pittsburgh would not have been possible without help from the following people:

Uzair Shamsi, Chester Engineers.
Don Waldorf, Department of City Engineering and Construction
Timothy Dreier, Pennsylvania Department of Environmental Protection
Anthony Setto, Pennsylvania Department of Environmental Protection

Thanks to Terry Pallas and the Pennsylvania Department of Environmental Protection for the use of a flow meter.

Finally, we are grateful to the NMR greenway team members in the Carnegie Mellon Studio for Creative Inquiry, especially Choli Lightfoot and Sean Lyons, for providing assistance with acquisition of existing data and maps for Nine Mile Run; and Timothy Collins, for the stream tours and substantial valuable advice.