STREAM REMEDIATION

Ample Opportunity: A Community Dialogue 2

Saturday, July 19, 1997

Introduction: The second workshop was designed to provide greater on-site experience for participants. On Saturday morning, stream tours were led by workshop advisors. A heavy summer storm the previous day resulted in combined sewer overflows and sewer failures, providing topics for the roundtable discussions. The afternoon session started with each of the advisors providing a ten minute report introducing the problem from their perspective. The keynote speaker presented a national overview of the issues. After the keynote speaker, three roundtable discussions followed on the subjects of Regulation and Reality, Stream Ecology and the Urban Aesthetic, and Stream Banks and Floodplains.

Review: The tours helped provide context and a lead-in to group discussion. The presentation times were approximately of equal length leading to requests for more discussion time at the end of the event. The relatively poor attendance at this event was noted, some community members requested less technical language on our announcements. Changes were made in the planning for the next event.
Attendance: 50

Advisors:
David Dzombak, *Associate Professor, Department of Civil and Environmental Engineering, Carnegie Mellon University*
Dr. Dzombak's area of research interests include fate and transport of chemicals in water, water and wastewater treatment, and hazardous waste site remediation.

Mary Kostalos, *Ecologist, Chatham College, co-founder of the Rachel Carson Institute*.
Dr. Kostalos first tested the waters of Nine Mile Run for her doctoral thesis in the late '60s and has returned to the site with her students in the intervening years.

Nancy Racham, *Water Pollution Biologist, Southwestern Region, Department of Environmental Protection*
Ms. Racham, a graduate of Slippery Rock University, manages environmental impacts associated with water obstructions and encroachments to streams and wetlands.

John Schombert, *Chief, Public Drinking Water and Waste Management, Allegheny County Health Department*
The Health Department has regulatory authority over community sewage disposal systems in Allegheny County.

Kathy Stadterman, *Environmental Scientist, Allegheny County Sanitary Authority*
Ms. Stadterman monitors ALCOSAN's compliance with pertinent regulations and completes public research associated with combined sewer overflows and cryptosporidium and giardia in urban streams. She is also producer of the environmental news show, *Allegheny Frontier.*

Mark Young, *Environmental Scientist and Project Manager*, *Pennsylvania Department of Transportation*

The stream is unfit for human contact because of high concentrations of Fecal Coliform bacteria, an indicator of the presence of disease-causing microorganisms. The waters of the stream are often far above the standard set by the Environmental Protection Agency for human contact. Contact with the stream provides the potential for infection by viruses including hepatitis, bacteriological illnesses, and parasites such as Cryptosporidium and Giardia. It is important to minimize the exposure to young children, the elderly, and individuals with compromised immune systems.

—Allegheny County Health Department

The People have a right to clean air, pure water, and to the preservation of the natural scenic, historic and aesthetic values of the environment. Pennsylvania's public natural resources are the common property of all the people, including generations yet to come. As trustee of these resources, the Commonwealth shall conserve and maintain them for the benefit of all the people.

—Article I, Section 27
Pennsylvania Constitution

A *fecal fountain*, a chronic sanitary sewer discharge, draining into Nine Mile Run. 1997

The Wilkinsburg culvert

The Wilkinsburg culvert after rainfall

Introduction

Nine Mile Run is in many ways a typical urban stream. It is polluted with excessive amounts of sewage and goes from a trickle to a torrent with rain events. At the same time, Nine Mile Run is unique because it is about to be surrounded by a continuous public space. This offers opportunity for development of a greenway with Nine Mile Run as the central feature for aesthetic enjoyment and recreation. However, the reclamation of an urban stream is a difficult and challenging process. The following document is intended to provide a background for the discussion at the July 19th Ample Opportunity: A Community Dialogue workshop on urban stream water issues. We will begin with a summary of Nine Mile Run, then move into the history of water and sewers, and finish with an overview of the options for remediation.

Two immature beavers were recently sighted on Nine Mile Run!

I. Water: the aesthetic element that defines and defiles Nine Mile Run

Is there anything special about Nine Mile Run?

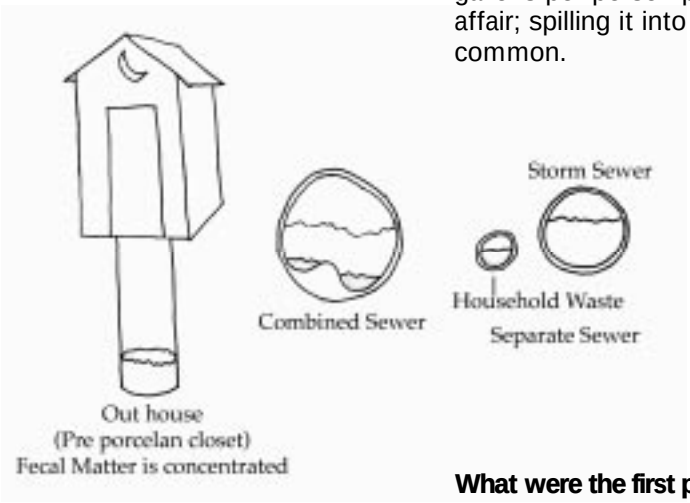
The Nine Mile Run stream originates in the hills and slopes of Pittsburgh, Edgewood, Swissvale and Wilkinsburg. It flows through Frick Park, is squeezed between the slag piles then flows into the Monongahela at Duck Hollow. Nine Mile Run is the last relatively large, free-flowing stream within the original borders of the city of Pittsburgh. The area has a wide variety of habitats, including the stream, the **riparian** area along the stream, wetland areas, a variety of open and wooded areas, and the slag dump slopes as well. Nine Mile Run is not the normal pristine environment that we are trained to value, but with its proximity to bus lines and hiking and biking trails it provides a rich environment for human experience.

Riparian: Living on, relating to, or located along the banks of a stream, river, lake or tidewater.

The area contains a surprisingly wide variety of plant and animal life including rare and threatened species such as the hop plant (Ptelea trifoliata). The valley forms a corridor which presently allows wildlife to move between Frick Park and the river. Numerous birds, deer, turkeys, butterflies, and other fauna are found in this area. The stream, cleaned of pollution and managed to prevent large flows, will have the potential to become a fishable urban stream, if we care enough to insist that this be so.

II. The history of water and sewers on the East End of Pittsburgh

What was it like in the "good old days"?
The first water systems in Pittsburgh consisted of a network of household wells. The capacity of these wells was soon surpassed and in 1824 a city waterworks was established on the Allegheny River. The initial system was fraught with technical difficulties but by 1853 the system was supplying the city's inhabitants with approximately 60 gallons per person per day. Disposal of water continued to be a casual affair; spilling it into the yard, street gutter, cesspool or alley was common.



What were the first priorities?
Piping in pure drinking water was a priority for most major cities across the county in the early 1800s. In contrast it was widely believed that a constructed sewer system was both unnecessary and costly. However with increased urban development, the traditional spilling of waste water into yards, gutters, and cesspools created standing pools of fetid water. These practices and events began to take a toll on the citizens of Pittsburgh. There were signs of a disturbing deterioration in health and aesthetic standards. Pittsburgh was the site of a number of devastating typhoid and cholera epidemics right through the first decade of the 20th century.

What was the effect of the modern toilet?
A complicating factor in all this was the increasing popularity of the water closet (the modern toilet) patented in the U.S. in 1833. The cesspools and vaults designed to hold human waste were seriously overburdened by the increase in volume of water mixed with fecal matter. The means to collect and dispose of this domestic waste was still dominated by individuals and municipally-licensed scavengers who hand collected the liquid and solid matter in barrels on horse drawn carts to be transported to the outskirts of the city.

When did problems first show up on Nine Mile Run?
The problems of increased water mixed with fecal matter became so bad in the East End of Pittsburgh (where Nine Mile Run is located) that local residents were forced to lay private sewers and dig open ditches to carry off stormwater.[1] "In warm weather," reported city councils in 1882, "many parts of the East End are absolutely unfit for habitation owing to the polluted atmosphere arising from open runs of filth of every description."

1 Tarr, J. and McClelland, J.H. "Dangers to Health in Suburban Districts," Fifth Annual Report of the State Board of Health (Harrisburg, Pa. 1891), p. 41.

What are the ideas behind combined and separate sanitary sewers?
In the late 1800s there was a national discussion about the merits of combining storm/street **runoff** with sanitary (household waste) sewers versus the virtues of separate systems. In Pittsburgh, the Board of Health supported the separate systems for economic, maintenance, and health reasons. They argued that the separate, smaller scaled system for sanitary removal provided "limited quantity and uniformity of sewage, making its ultimate disposal easy and reliable." They intended to rely on surface gutters for stormwater management.

The public works officials and members of the engineering community came to different conclusions. Engineers felt that the increased size and heavy flows of stormwater events would provide a self cleaning capacity to the city sewer systems. They argued that the construction of a single combined system diminished the complications in engineering and plumbing which could occur when building separate systems although the per mile costs of sanitary sewers were cheaper. In cities like Pittsburgh, where stormwater needed to be eliminated along with human waste, it was more economical to adopt the combined system.

Runoff: Rain or melted snow which passes over the surface of land and enters a stream. Runoff from a city street is different than runoff from a forested hillside. Street runoff is usually filled with litter and moving at a higher rate of speed than water falling over a more irregular surface.

Watershed: A land formation that drains into a singular stream, river or lake. The Nine Mile Run watershed includes portions of the communities of Pittsburgh, Edgewood, Swissvale, and Wilkinsburg.

What instigated the construction of the first sewers?
Climactic conditions subject the city of Pittsburgh to short but intensive cloudbursts. Because of the steep hillsides, early drainage channels and stream beds were often backed up and overflowing. The paving of streets and the change from cobblestones to smooth asphalt surfaces increased the runoff flow and concentration of water into stream channels and storm conduits. These conditions of climate and landscape made it easier for the engineers' argument for combined sewers to take precedence. (Combined sewers will be reconsidered in our discussion of the contemporary issues facing the Nine Mile Run watershed.) Construction of combined sewers began in Pittsburgh in the mid- to late 1880s. By 1909 there were 542 miles of combined sewers in Pittsburgh. Like municipalities across the nation, these combined sewers were designed to discharge directly (untreated raw flow) into the Monongahela or Allegheny, usually following old stream beds in the ravines.
Note: Initial service to the Nine Mile Run watershed communities would not be established until the period between 1911 and 1915.

What happened once the sewage went directly into the rivers?
Pittsburgh built a sewer system that took untreated household wastes to the rivers by the shortest route, as did each municipality upstream and downstream. Unfortunately each municipality also took their drinking water from these same rivers. In Pittsburgh, once the municipal sewer system was underway the next link in the water system was protecting the water supply. There were two choices: filter the wastewater providing a clean product for the next city down river and hope the upstream communities would do the same, or filter the drinking water. Cities across the United States and in Europe primarily practiced **"downstream management"** of sewage, discharging untreated sewage directly into the rivers and in turn filtering drinking water (drawn from upstream sources) from these same rivers.

Downstream management: Moving water problems downstream so they don't effect the source community (a common practice).

Pittsburgh held the dubious record of having the highest rate of water borne typhoid mortality of any city in the United States in epidemics that raged between 1873-1912.[2] In the first years of the

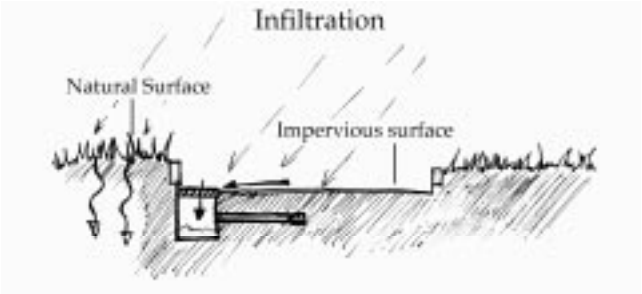
[2] Yosie, T. *Retrospective Analysis of Water Supply and Wastewater Policies in Pittsburgh, 1800-1959,* p.120.

20th century, sanitary engineers took the position, expressed editorially by the *Engineering Record*, "It is often more equitable to all concerned for an upper riparian city to discharge its sewage into a stream and a lower riparian city to filter the water of the same stream for a domestic drinking water supply, than for the former city to be forced to put in sewage treatment works."[3] Nationally respected engineers like Allen Hazen argued that "the discharge of crude sewage from the majority of cities is not locally objectionable in any way to justify the cost of sewage purification."[4] In light of this, Pittsburgh, like every major city in the nation, began to filter and chemically purify the drinking water supply in 1907.

When did we start treating sewage in Pittsburgh?

In 1905, the Purity Water Act was passed by State Legislature to address abatement of untreated sewage discharge throughout Pennsylvania. A subsequent report in 1912 indicated that the economic burden prevented enforcement of the laws only in instances where a downstream water intake was directly jeopardized.[5] (These same arguments are still in use throughout Allegheny County, and have stalled clean up of Nine Mile Run for over 90 years!) In 1937, the Clean Streams Act was passed in Pennsylvania. It wasn't until 1946 that its goals would start to affect Pittsburgh.

In 1946, the State Sanitary Board ordered 102 municipalities and 90 industries in Allegheny County to quit discharging untreated sewage into area waterways. On March 13, 1946, the Allegheny County



Sanitary Authority was formed through incorporation under the 1945 Pennsylvania Municipality Authorities Act. Widely know today as ALCOSAN, the authority was created to provide sewage collection and treatment on a county-wide basis to meet the requirements of the Pure Streams Act of 1937 which dictated pollution abatement of streams and rivers. On October 1, 1959 ALCOSAN went into operation after six years of preparatory work, four years of design, and three years of construction.

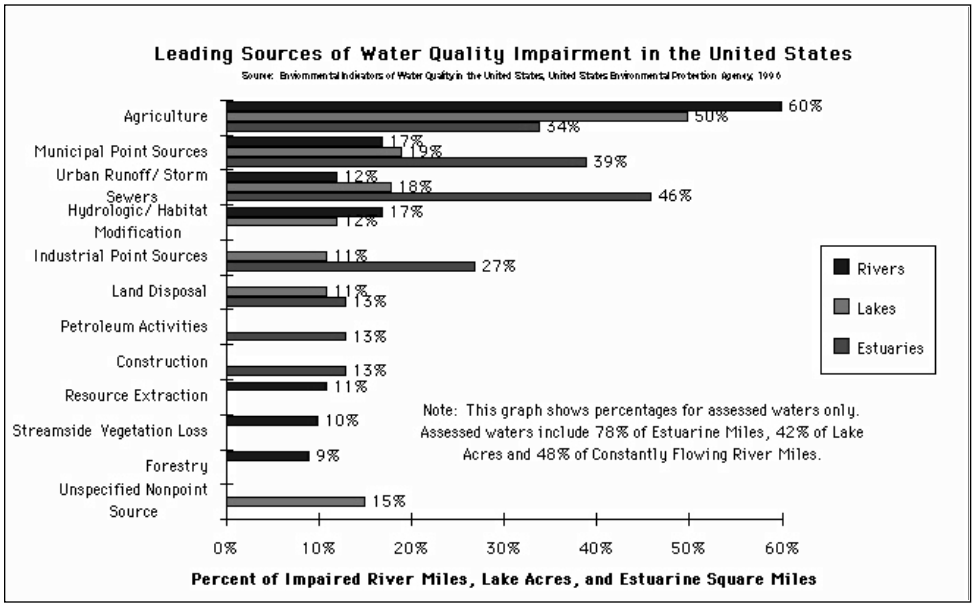
Is Nine Mile Run getting better?

Residential and commercial development in the Nine Mile Run watershed has had a number of significant effects on the flow characteristics and water quality of Nine Mile Run. Urban streams across America are affected by the same problems we find on Nine Mile Run; excess sewage and powerful flow events during storms. We have to consider the historic buildup of the East End watershed and its effect on the water moving through Nine Mile Run. Development of the communities in the watershed led to the paving over of a significant fraction of the watershed area, thus reducing infiltration and increasing runoff to the stream. The result is a stream that has low flows during dry weather but which rises very rapidly and substantially in response

[3] Tarr, J., McCurley, J., Mc Michael, F., Yosie, T. "Water and Wastes: A Retrospective Assessment of Wastewater Technology in the United States, 1800-1932.," in *Technology and Culture,* vol. 25, no. 2, April 1984, p. 243.
[4] Hazen, A. "Clean Water and How to Get It," 1907.
[5] Yosie, T., p. 307.

to rainfall events. Nine Mile Run undoubtedly was subject to flash floods in its natural state, but this problem has been made much worse by development. (This is not to suggest that development is bad, simply that the historic development on the watershed has ignored the effect on the stream.) High flows increase stream bank erosion, which has been significant in NMR during this century, and have substantial impacts on stream biology. Suspended particles of dirt and sand scour the insects, algae and other organisms that support higher life forms in the stream.

Culvert: A pipe used to encase a stream or river usually placed underground.
Floodplain: Land that is periodically submerged as a river or stream rises and expands beyond its normal channel.



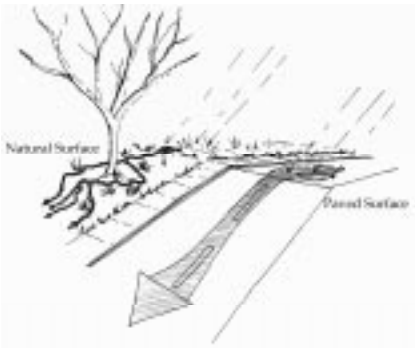
Up until the 1920s, Nine Mile Run ran open to the air in two major valleys: the Frick Park valley, as well as the valley leading up into Edgewood and Wilkinsburg. The culverting of Nine Mile Run through Wilkinsburg and Edgewood prevented any retention/control of water in that floodplain. Another development related factor contributing to the rapid rise in Nine Mile Run during storm events is the loss of access to floodplain in the area beneath the slag piles. The slag dumping has consumed floodplain and created a narrow stream channel in that portion of the watershed. With less floodplain and increased paving, flow events in Nine Mile Run are no doubt worse than they were 100 years ago. See the historic watershed map on page 296.

Why is there still sewage in Nine Mile Run?

Four municipalities: Pittsburgh, Swissvale, Edgewood, and Wilkinsburg have independent sewer lines along Nine Mile Run. Because of the history of poor maintenance and sewer line mismanagement, the city of Pittsburgh provides a sewer through Frick Park that the communities tie into. You can imagine the political challenge the upstream communities face when they consider raising user fees to alleviate pollution problems in Pittsburgh! Until recently, sewage in Nine Mile Run has been neglected by everyone from the municipalities and community members to the regulatory agencies.

Within the Nine Mile Run watershed, two types of sewer systems are present: combined and separate. Separate sewers have one smaller

pipe for sanitary sewage and a larger, separate pipe for storm water. There are three storm sewers draining into Nine Mile Run, contributing to the extreme high flows described above during rain events. One of these storm sewers which holds the remnants of the upper Nine Mile Run watershed flow from Wilkinsburg is 16 feet across! These three sewers also have extremely high levels of sewage in dry weather flow which they shouldn't have.



Combined sewer systems, as discussed above, convey both sanitary sewage and stormwater in the same pipe. They are designed to discharge this combined sewage and stormwater into Nine Mile Run when the lines run at capacity during a rainstorm, known as a CSO event, or a Combined Sewer Overflow. All existing sanitary sewer lines and combined sewers are connected to a city of Pittsburgh trunk sewer at Commercial Avenue which then connects to an ALCOSAN interceptor at Duck Hollow. (CSOs are currently not against the law.)

Problems in Nine Mile Run exist because the combined and separate sewer systems have not been well maintained and as a result have deteriorated. Cracked sewer pipes, illicit tie-ins from home sewer lines to storm sewers, and culverted streams deep underground make leakage of sewage matter into the stream difficult to find and resolve.

In the past, even separate sanitary systems were designed to discharge into the stream when flows exceeded the capacity of the sewer lines. All discharges of sewage from separate sanitary sewers into streams and rivers are called SSOs or Sanitary Sewer Overflows. They are illegal.

According to the EPA, municipal point-source pollution is the number two source of pollution in rivers, lakes, and estuaries.

Are there any other problems on Nine Mile Run?

The proximity of the slag on two sides of Nine Mile Run also presents some problems. Slag is a porous, highly alkaline material. (Alkaline material is dissolved in water creating a base, or a pH higher than 7.) Pittsburgh drinking water is around 8.0-8.2; the water below the slag piles is as high as 10.7! Plants and other living organisms have a hard time sustaining life at pH values greater than 9.0.

What grows in Nine Mile Run under these conditions?

Surprisingly the flora and fauna of Nine Mile Run has proven fairly resilient. Recently a few fish, crayfish, and a variety of benthic (bottom dwelling) organisms have been found in the stream. The stream has enough dissolved oxygen to support most fish populations. The stream has a variety of naturally occurring algae which feed off the nutrient matter in the stream. (Human waste, like cow and horse manure, is a very good plant nutrient!)

How can this be so?

During much of the year the physical and chemical parameters in the stream are quite compatible with a diverse assemblage of aquatic organisms. However, periodic discharges of high volumes of water greatly reduce the numbers and diversity of organisms that are able to establish populations in the stream. (So much water, silt and stone comes down the stream that they just can't hang on!) Many of the insects and crustacean groups (animals which have an exo-skeleton like crayfish) which are typical of streams the size and character of Nine Mile Run are not present in this stream.

III. Possible Solutions

Slowing down the water rushing through the stream during storms.
As described above, water resource and stream bank degradation in NMR is related to flash flooding. Some alleviation of the flash flooding problem could be accomplished by increasing the floodplain area (e.g., removing some of the slag) or by increasing the water retention capacity of the existing floodplain (e.g., by increasing wetland areas throughout the watershed). Another possibility is that some fraction of high flows could be captured in a retention tank or basin, but such a retention unit would have to be very large.

The other major problem to resolve is the sewage running into the stream from leaking and overflowing sewers. Improvement of the water quality would require:

1. Reduction or elimination of sewage discharges.
This approach addresses the problem at its source and would involve repair or replacement of part of the sewer infrastructure in the watershed by each of the communities involved. The combined sewers in the watershed communities could be replaced with separate sewers, or repaired such that overflow would be less frequent and less substantial. Restoration and upgrade of the sewer infrastructure would be costly. The most important step in addressing the sewage discharges is obtaining the cooperation of all municipalities involved to begin to document and determine the condition of their sewer systems, and begin rehabilitation.[6] Illicit connections need to be identified and removed, cracked and collapsed lines need to be repaired, and Sanitary Sewer Overflows need to be eliminated.

2. Treatment of the sewage upon discharge (end of pipe).
The sanitary and combined sewer overflows could be captured and directed to a device for partial treatment at the point of discharge. Point of discharge sewage treatment usually involves removal of large particles and floatables (street trash) via swirl/vortex separators, and/or disinfection. Such technologies are relatively inexpensive (compared to sewer infrastructure restoration and replacement), but provide only partial treatment.

3. In-stream treatment of the sewage-contaminated stream water.
NMR is affected both by leaking sewers and by overflow discharges from sewers located along the stream. If partial treatment of the major overflow points is not sufficient to improve water quality to the desired degree, then another option would be to divert NMR or a significant fraction of it into a treatment facility. This would most likely be done at the end of the culverted stream section, just downstream of the Braddock Avenue culvert termination. The treatment facility would require disinfection capability at a minimum, as pathogenic bacteria are the most significant NMR water quality concern from the standpoint of human health. A wetland could be used in conjunction with a conventional treatment facility, e.g., for removal of particles by sedimentation. Active or passive treatment facilities would be moderately expensive to construct, maintain, and operate. Design of an effective treatment facility for NMR would be complicated by the wide range of stream flows experienced.

[6] With a grant from the Pennsylvania River Conservation Program, the Nine Mile Run Greenway team has begun a program to accomplish this. The most recent meeting was June 27th. [Representatives from] Pittsburgh, Swissvale, Wilkinsburg, Edgewood, The County Health Department and ALCOSAN all came to Nine Mile Run to attempt to identify the stream problems.

Wetlands: Wetlands are often referred to as marshes, bogs, swamps, wet meadows and shallow ponds. Wetlands are those areas that are flooded or saturated by surface or ground water often enough to support vegetation typically adapted for life in saturated conditions.

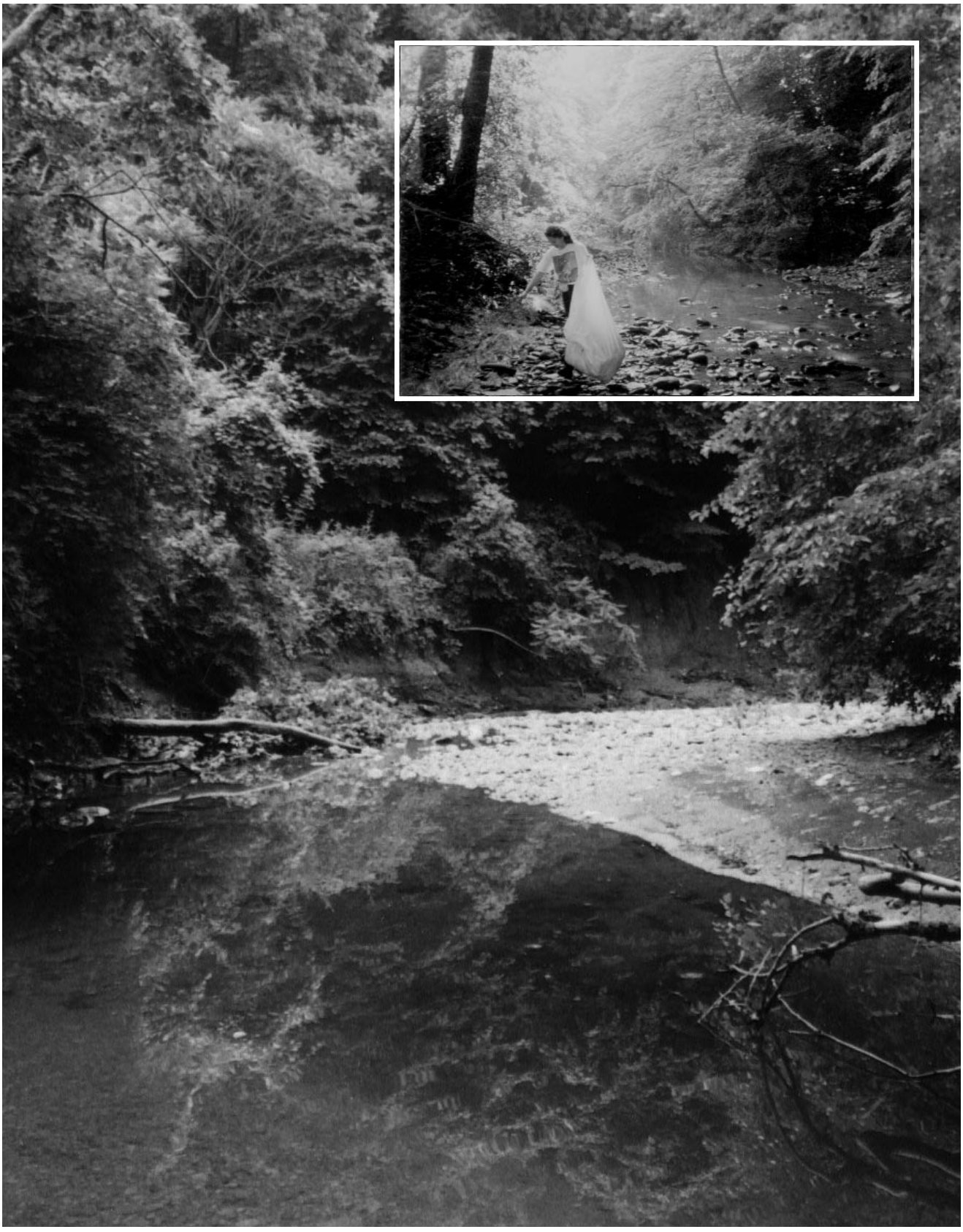
3a. Wetlands as an approach to both flow and water quality.
There are a variety of benefits that can be derived from **wetlands** including the following: wildlife habitat, water quality improvement, nutrient absorption, flood control, sediment retention, and ground water recharge. As a source of sewage treatment, wetlands can provide some nutrient retention, filter solids and remove contaminants and pathogens. Along Nine Mile Run, wetlands could be used in conjunction with other remedies (e.g., reduce/eliminate CSOs and SSOs, fix leaking sewer pipes, eliminate illegal discharges) to reduce the sewage load in the stream and improve the water quality of the stream.

4. Culvert the entire stream to its point of discharge into the Monongahela.
This is the historical approach as indicated by the culverting of Nine Mile Run through Wilkinsburg and Edgewood. Within the culvert, a number of "out of sight" illicit tie-ins and maintenance problems have occurred and the resultant water quality problems are then transferred to downstream municipalities. Each of the participating agencies at the July 19th workshop will explain why this approach is no longer deemed satisfactory.

5. Implementation of one or all of options 1-3 would involve use of the Environmental Protection Agency approach to CSO problems.
In 1989, the U.S. EPA created its Nine Minimum Controls policy to address CSOs (Combined Sewer Overflows). These "best" management practices include controls that can be implemented without major capital expenses:
1. Proper operation and maintenance of sewer systems;
2. Maximum use of the collection system for stormwater storage;
3. Review of industrial and commercial sites in the watershed area for effects;
4. Removal of debris from sewers to provide maximum conveyance to the treatment plant;
5. Prohibition of CSO discharges during dry weather;
6. Control of solids and floatables (litter) from entering the sewers (street cleaning);
7. Pollution prevention in households and on the roads;
8. Public notification of CSO events and impacts; and
9. Monitoring to understand the impact of the CSO and its eventual control mechanism.

The Pennsylvania Department of Environmental Protection is now requiring communities to apply for discharge permits (NPDES or National Pollutant Discharge Elimination System) for their CSO structures and to begin to implement the Nine Minimum Controls.

6. A final issue to address is the alkaline leachate from the slag.
The alkalinity is drawn out of the slag as runoff passes through the porous material. There are two approaches to resolve this:
1. Cap or cover the slag with a soil and plant growth that will reduce infiltration (flow through) into the slag.
2. A more aggressive approach would include the placement of interceptor trenches lined with an acidic substance to neutralize the alkalinity. The approach to the alkalinity problem will require some tests.



Urban stream wonders require stewardship.