THREE RIVERS PARK
LANDSCAPE MANAGEMENT GUIDELINES

DECEMBER 2006

prepared by ANDROPOGON ASSOCIATES LTD.
with CIVIL AND ENVIRONMENTAL CONSULTANTS, INC.
for RIVERLIFE TASK FORCE

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Andropogon Associates, Ltd. with Civil & Environmental Consultants, Inc.

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ACKNOWLEDGMENTS

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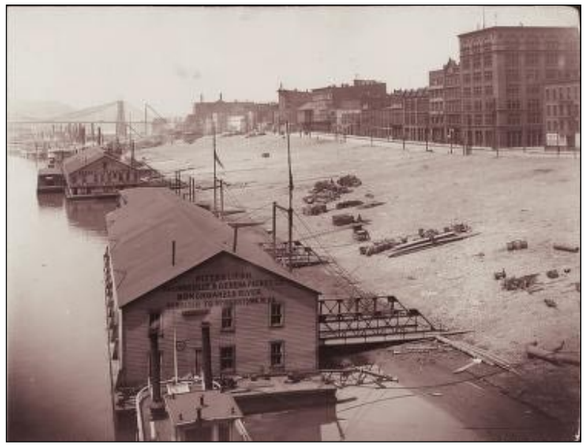
INTRODUCTION



Photographs, left to right and top to bottom:

1896 "Point Bridge." ©Allegheny Conference on Community Development, Historical Society of Western Pennsylvania (HSWP)
1900 "Monongahela Wharf." ©Carnegie Museum of Art Collection of Photographs (CMA)
1910 "Monongahela River" ©Pittsburgh Railways Company
1949 "Steamboat Race" Pittsburgh and Lake Erie Railroad Company, Archives Service Center, University of Pittsburgh
1958 "River: View of the Point from a Hillside on the Ohio River" ©Carnegie Museum of Art

In a moment of both challenge and opportunity, Pittsburgh is transforming its riverfronts. The Riverlife Task Force has successfully marshaled the efforts of City and County agencies, non-profit organizations, community groups and hundreds of ordinary citizens to create an inspiring vision for riverfront development. Major public works – stadiums, a convention center, imaginative public parks – have reoriented people to the rivers and refocused civic attention on the vast natural resources that are truly the lifeblood of this city.

The Allegheny, Monongahela and Ohio riverbanks are a crucial interface for river hydrology, riparian support systems and waterfront activities. These functions are at the core purpose of sustainable design and planning – addressing the web of environmental, economic, social and health systems that sustain our current and future quality of life.

As we start to think about strategies for reconnecting people to the rivers, we are reminded that the river edges are repositories of the city's industrial past, the result of decades of steel milling, slag dumping, barge hauling, coal and gravel mining and rail transport. The evidence, although sometimes muted, is present in the extent of concrete seawalls, old barge mooring posts, poured slag edges and extensive railroad embankments. Landscape management must somehow take these industrial relics into account, as well as the substantial contemporary use of the river edges for highway overpasses, rail corridors, bridges, institutions, sports arenas, businesses and recreation.

Significant studies, reports and plans addressing these interconnected uses, systems and needs have been completed in the past decade and have provided a foundation of material and planning strategy for the Guidelines. Sources consulted are noted in the Reference section; some of the recent significant studies include:

- An Ecological and Physical Investigation of Pittsburgh's Hillsides. 2005. Perkins Eastman, CMU & University of Pittsburgh.
- Three Rivers Second Nature Project Reports Phases I-IV. 2001-2004. Studio for Creative Inquiry, Carnegie Mellon University.
- Three Rivers Conservation Plan. 2004. Pennsylvania Environmental Council.
- A Vision Plan for Pittsburgh's Riverfront (2000) and Three Rivers Park Design Handbook. 2002. Riverlife Task Force.

As a next step, the Riverlife Task Force has identified the need to develop these Landscape Management Guidelines to help focus and provide direction to the many independent initiatives that are taking place or anticipated for the river edge landscape. The Report is one part of a comprehensive set of Design Guidelines for Three Rivers Park, addressing riverfront access, new facilities, lighting, public art and civic identity.

This handbook addresses the use, restoration and management of these riverbanks within a context of public and private stewardship. The Guidelines are based on sustainable design strategies such as introducing and restoring native plants, conserving water and managing storm water. Managing for sustainable human use is an equally vital component of this project, and certainly those who navigate, recreate and work on the rivers share a sense of belonging and knowledge crucial to the crafting of appropriate tools for riverbank landscape management.

STUDY AREA

Three Rivers Park – the area of urban riverfront that links the Allegheny, Monongahela and Ohio riverfronts within Downtown Pittsburgh – is at the heart of these guidelines. Three Rivers Park, including the rivers, is highlighted on the project study map. The focus of the Guidelines is generally a fifty foot corridor along the north and south riverbanks, extending along the Ohio riverfront downstream to Chartiers Creek (three miles), upstream along the Allegheny River to the dam at Highland Park (six miles), and up the Monongahela River to Nine Mile Run (eight miles). Within the City of Pittsburgh a number of smaller neighborhoods, boroughs and municipalities border this stretch of riverbank – nearly thirty in all.

This area encompasses three islands (Brunot Island, Herrs Island and Six Mile Island) and the mouths of several creeks – some of which are culverted at their confluence with one of the three rivers. Tributaries that lie partly within the project include Chartiers Creek, Sawmill Run, Becks Run, Streets Run, Nine Mile Run, Girtys Run, Pine Creek and Guyasuta Creek.

Three Rivers Park

Three Rivers Trail
(including proposed sections)

FIGURE 1. Watersheds Map
Map based on Allegheny County GIS data

Photographs, left to right and top to bottom:
Monongahela River Technology Center above old slag banks and seawall
Industrial Lawrenceville, Allegheny River
John Buck captured by Japanese knotweed on Brunot's Island,

Rail corridor below Route 28 along Allegheny River
Pine Creek CSO, Allegheny River
River access adjacent to Hometead Works, Monongahela River

All photographs by project team, taken 2005.

ISSUES

The diversity of Pittsburgh's riverfronts exhibit a variety of owners and uses, including municipal parks, large industrial sites, rail corridors, a prison, entertainment complexes shopping districts, residential development and several marinas. A range of riverbank conditions are represented, from hard edged conditions (seawalls, slag piles, bridge abutments, riprap) to soft edges (shallow banks with floodplain vegetation, steep banks with planted vegetation, mown and trampled earth banks with invasive vegetation).

These sections of the Ohio, Monongahela and Allegheny Rivers make up the Pittsburgh Pool, a waterway that is maintained at an elevation of 710' by the Emsworth Dams. Numerous dams upstream – Braddock and Aspinwall being closest to the study area – decrease the transfer of sediment and capture small floods that would otherwise contribute new material to the riparian edges. The exception to the normal pool elevation is the result of heavy precipitation that causes the rivers to spill over the dams, with a consequent flood event of sometimes twenty feet or more. Damage wrought by a history of severe floods has led to armoring most of the urban riverbanks. The flooding and consequent hardening of the river edges is a large part of the impetus for the Guidelines.

The presence of dams makes the Three Rivers resemble a long linear lake – stairstepped chains of lakes if the entire system is considered. The channelized river edges disrupt the natural fluctuations of water that support a riparian plant environment. Instead, commercial barge and recreational boat traffic contribute wave action against the shoreline, making it more difficult for young vegetation to establish at the immediate river edge. Wintertime ice scour can further disturb the river banks, regardless of their construction. While ice scour is a natural occurrence in northeastern rivers and streams, ice formation is increased with the slower velocities created by the presence of dams.

The immediate watershed of the Pittsburgh Pool is densely developed with a high percentage of impervious surfaces. Runoff from the urbanized watershed enters the river systems via pipes and culverts rather than natural stream channels. Urban development impacts the hydrologic curve of the tributaries and the river as a whole, decreasing base flows and causing storm peaks to rise drastically. Stormwater carries pollutants off of these impervious surfaces and into the rivers. The presence of combined sanitary and stormwater systems means pathogens consistently impair water quality. The combination of piped runoff and slow velocities in the river channel itself disrupts natural sediment transfer and makes stabilizing the river banks in a natural way even more of a challenge.

Invasive vegetation is a relatively recent problem for the rivers. The Three Rivers Second Nature (3R2N) study highlights this disturbing trend – Japanese knotweed, Tree of heaven and other opportunistic plant species are multiplying on the river edges at a significantly greater rate than native floodplain species. This trend echoes a larger phenomenon that is transforming plant communities throughout the world, resulting in decreased species richness, decreased biodiversity and less resilient ecosystems. The Guidelines offer practical techniques for dealing with invasive species; however, given the widespread nature of this issue, we suggest that management efforts along the rivers focus equally – if not more – on informational partnerships and monitoring.

An unintended consequence of people living, working and playing closer to the rivers is the removal of riverbank vegetation. People naturally want to see the water – with the result that trees are often cut down to give better views of the rivers – resulting in unintentional degradation of the valued resource. This is happening along the Monongahela at the Homestead Works and along other sections of both Ohio and Allegheny Rivers. Addressing these very basic human tendencies is an important component of the public message for the Guidelines.

KEY RECOMMENDATIONS

OVERALL

Strengthen the landscape requirements for the current Riverfront Zoning Overlay District

The Landscape Management Guidelines propose strengthening the planting requirements of the Pittsburgh Code of Ordinances (as amended 2004), specifically the landscape requirements for 906.03 Riverfront Setback and the Riverfront Zoning Overlay District. In municipalities without landscape ordinances or riverfront overlay districts, adding these tools to an existing zoning ordinance would be a logical next step. Adding more specific landscape guidelines – such as the use of native plants – to the Zoning Overlay District could help ensure the ecological vitality of the river edges and improve the continuous landscape effect.

Build on the identity and visibility of Three Rivers Park

Three Rivers Park will be a signature element in a connected trail system within the Pittsburgh Pool. Signage for the Park, in concert with the graphic system for the Heritage Trail – will establish a coherent, recognizable system of places along the Ohio, Allegheny and Monongahela Rivers throughout the County. Landscape management will emerge as a critical component of trail development and longevity as will issues like safety, aesthetics and comfort.

Private property owners can support the Three Rivers Heritage Trail and provide a more complete experience for trail users simply by managing their riverfront properties in accordance with the Guidelines. Proximity to the river trail will be a significant amenity for a private building, as it will provide tenants with easy access to an extensive recreation system and potentially an alternative means of commuting.

Utilize Three Rivers Second Nature GIS studies to prioritize and track management activities

The 2000-2004 3R2N GIS database of river edge conditions is very comprehensive and has been designed to serve as the baseline for ongoing information collecting and monitoring. We recommend that this inventory database be web based so that it can be kept current and shared by everyone who conducts management and restoration activities along the rivers. GIS data can also be combined with other data fields, such as expenses and timekeeping, that are needed for facilities management, budgeting and grant writing.

Train landscape managers in the art and science of working with living systems

Landscape management skills have been misdirected in the arena of public infrastructure, where primary activities are connected more with machines than horticultural knowledge. It is important that training rely on accurate field observation and data collecting. Training should also be more comprehensive, incorporating horticulture and ecology. A feedback or evaluation process that tracks the effectiveness of staff training and identifies specific strategies for needed improvement is possibly the most important – yet most frequently overlooked – element of the program.

Ensure that river edge management is adequately budgeted

Maintenance budgets need to incorporate all new and existing capital projects throughout Three Rivers Park and its planned extensions. Riverfront projects are susceptible to damage from flooding and commercial activities – as well as more typical wear and tear from public use – and are likely to require revenues beyond the usual park budget allotments. The Riverfronts could be considered a special District funded by sources earmarked for management, such as public bond issues, maintenance assessments, or percent-based programs such as the state-based One Percent for Art programs.

PRACTICES

Maintain canopy trees along the entire riverbank to the fullest extent possible

Plants along the riverfront have the potential to enhance the human experience both on land and on water. Landowners along the river will generally be interested in an open view over the water, but each property shares the responsibility of creating and maintaining a pleasing environment along the river. Views from a building and the surrounding site need not be 180 degrees of open landscape to provide a benefit to a building's occupants – a veil of vegetation kept between a structure and the river respects views from the river as well as the opposite bank. If all buildings insist upon no vegetation along their river frontage, Pittsburgh will be left with a hardened riverfront that has reverted to its industrial past – without the industry. Real estate values and recreational uses on the river are too great to allow this to happen.

Plant native or non-invasive species throughout the river corridors

Native species are preferred for the river edge landscapes because of their adaptation to the local environment, response to flood conditions and biodiversity enhancement. Other species may be good candidates if they have been evaluated in a similar environment, and for their invasive potential. Native plant species can extend the ecological web from the countryside into urban areas. Animals that cross into urban areas need to encounter native species when they search for what few plants remain in the city. Except for the most common wildlife, animals, birds and insects are not adapted to non-native plants and cannot use their fruits and stems as readily as plant parts of native species. The need for native species is made all the more critical at the intersection of terrestrial and aquatic habitats on riverside properties.

Replace paved surfaces and lawn with plants and porous materials

With a large percentage of the urban environment paved with impervious surfaces, plants can play a significant role in decreasing stormwater runoff and improving water quality. Tree canopies intercept precipitation as it falls and decrease the amount of runoff leaving a site, even when the understory is paved beneath the drip line of a tree. Where the ground is pervious, plantings help maintain less compact soil with the growth and death of roots. Soil that is less compact will absorb more precipitation and therefore create less runoff. Replacing lawns with native meadow, shrub and tree plantings will decrease the amount of both runoff and pesticides. Plants along a riverbank not only reduce the velocity of surface runoff but also purify the groundwater before it reaches the river by absorbing nutrients.

PRACTICES continued

Develop a diverse hierarchy of landscape cover types

The goal of every planting restoration design should be to restore as much forest as is feasible to each riverfront site. Historically, 99% of the lands east of the Mississippi River were forested because the climate supported a forest environment and natural disturbances were not significantly large. Forests are the preferred restoration target because they have the most biomass and therefore the greatest capacity to restore the urban environment. A diverse mix of forest, woodland, shrubland and meadow will give significant benefits – maximum shade, oxygen production, carbon sequestration, biodiversity habitat and pollution and stormwater mitigation – to the urban environment.

1. Forest (>50% canopy cover): Plant wherever possible; provides shade, recreation, riparian habitat, stormwater and erosion control, flood mitigation and water quality treatment.
2. Woodland (<50% canopy cover): Plant wherever views are desired through trees; provides most benefits of forest and may be more acceptable in developed areas.
3. Shrubland: Plant to protect steep slopes and as natural fences for pedestrian/bicycle traffic control
4. Meadow: Plant as a means of managing large open areas; provides riparian buffers & habitat for small mammals, insects and birds.
5. Lawn: Plant on relatively flat slopes only and active recreation zones; separate lawns from river edges with riparian buffer.

LANDSCAPE COVER TYPES

forest: continuous canopy with layers

plant wherever possible; provides shade, recreation, riparian habitat, stormwater and erosion control, flood mitigation and water quality treatment

balled and burlapped
containers
bare root

woodland: open canopy with tall grasses

plant wherever views are desired through trees; provides most benefits of forest and may be more acceptable in developed areas

balled and burlapped
containers
bare root

shrub buffer: mixed species of varying heights

plant in masses or as a hedgrow to protect steep slopes and as natural fences for pedestrian/bicycle traffic control

containers
brush layers
live stakes

meadow: warm season grasses and wildflowers

plant as a means of managing large open areas; provides riparian buffers & habitat for small mammals, insects and birds

containers
plugs
seeds

KEY RECOMMENDATIONS | THREE RIVERS PARK

Plant and maintain a signature vocabulary of trees to reinforce a landscape identity for Three Rivers Park

The Three Rivers Second Nature studies noted that certain trees and plant communities flourish at the edges of the rivers. Specifically, Silver maples (*Acer saccharinum*), Sycamores (*Platanus occidentalis*), Box-elder (*Acer negundo*) and Willows (*Salix spp.*) are common to the Allegheny and Monongahela, with Cottonwoods (*Populus deltoides*) and Black locust (*Robinia pseudoacacia*) less frequent. Of all these, sycamores are probably the most recognizable for their striking bark, and could create an immediate impact if planted in significant numbers along the waters edge.

Where more open sites are desirable, gold flowering perennials can continue the themed planting developed for Heinz Field and reinforce the connection between the rivers and the culture of the City. Appropriate yellow and gold flowering species include Black-eyed Susans, Tall sunflowers, Ox-eye sunflowers, Goldenrods and Coreopsis. Planting lists are provided under the River Zone pages of these Guidelines.

Develop two or three demonstration projects to illustrate the potential for reinforcing ecology in the urban setting.

Demonstration sites ought to be chosen carefully for potential to succeed and to attract a ready constituency of users. Municipal buildings – such as the Convention Center – can be managed restoratively and to promote civic identity. Bank edges adjacent to condominium developments and trails are ideal, as demonstrated by Seagate. Commercial properties are also good candidates because they have budgets for maintenance and are interested in promoting civic goodwill.

Educate users about the need for consistent and coordinated management for Three Rivers Park

Through the development of a significant public realm plan and through the education and dissemination program, Riverlife will work to not only integrate the guidelines into the public realm of riverfront districts, but also to educate potential users about the Guidelines. Organizations already involved in this work – besides Riverlife – include the City of Pittsburgh Departments of Planning and Economic Development, Allegheny County through the Allegheny Places Program, Pittsburgh Parks Conservancy, Pennsylvania Environmental Council, Friends of the Riverfront, Pittsburgh Wet Weather and Three Rivers Second Nature.

FIGURE 2. Convention Center example illustrates river edge planting of canopy trees and gold flowering perennials
FIGURE 3. Duquesne Incline example illustrates sycamore planting at river edge
Photographs and digital enhancements, Andropogon.

TARGET SITES FOR MANAGEMENT

The Guidelines focus river edge recommendations in three ways: planting and edge stabilization for specific sites, management priorities keyed to a GIS based typology of the river edge conditions, and a vocabulary of stabilization and management techniques appropriate for various conditions.

The target sites were chosen because of their proximity to a maintained park or trail system and to address a range of edge conditions: a near-vertical hard edged bank on the Ohio River at Western State Penitentiary; a moderately steep, vegetated bank on the Allegheny River at the Heinz Plant and Millvale; and a relatively shallow bank with Japanese knotweed infestation on the Monongahela River at Southside Park. The sites were selected from an extensive GIS database, developed by the CMU Studio for Creative Inquiry, Three Rivers Second Nature (3R2N). Condensed versions of the 3R2N maps, describing restoration potential, bank access, substrate conditions, forest continuity and invasive species presence are located in the Appendix of this report.

RULES OF THUMB

Unquestionably, the river edges present challenges for management and restoration. The hardened edges are highly scoured and erosion resistant structures composed of massive rock or cast block. Some of these slopes, particularly the lower edges, can be interplanted with live poles or live stakes. The most durable method of bank restoration, however, involves wholesale removal and reconstruction in lifts – such as geogrid wrapped lifts with brush layering – a technique incompatible with the roots of nearby trees. In addition, most tree roots are not tolerant of burial by added soil.

There are a few general rules of thumb to keep in mind as we attempt to address these target sites. The essential principles are sustainability and impermanence – recognizing that river environments need to remain dynamic by nature, evolving and reshaping to new forms.

- Adjacent upland conditions – such as dumps, combined sewers (CSOs) or impervious paving – should be addressed before committing to a full scale planting effort along the banks. Sites already under some degree of management or ownership have the greatest chance of success.
- Address structural conditions, such as collapsing banks, before planting. Where possible, use green reinforced surface treatments, rather than non-living materials.
- Use lightweight, root-breathable bioengineered walls planted with seed, live stakes, and turf reinforcement mats (TRM) to increase erosion resistance and encourage sediment deposition on banks.
- Accept the possibility of occasional damage by ice and flooding. Incorporate break-away and tie-in points to manage potential losses.

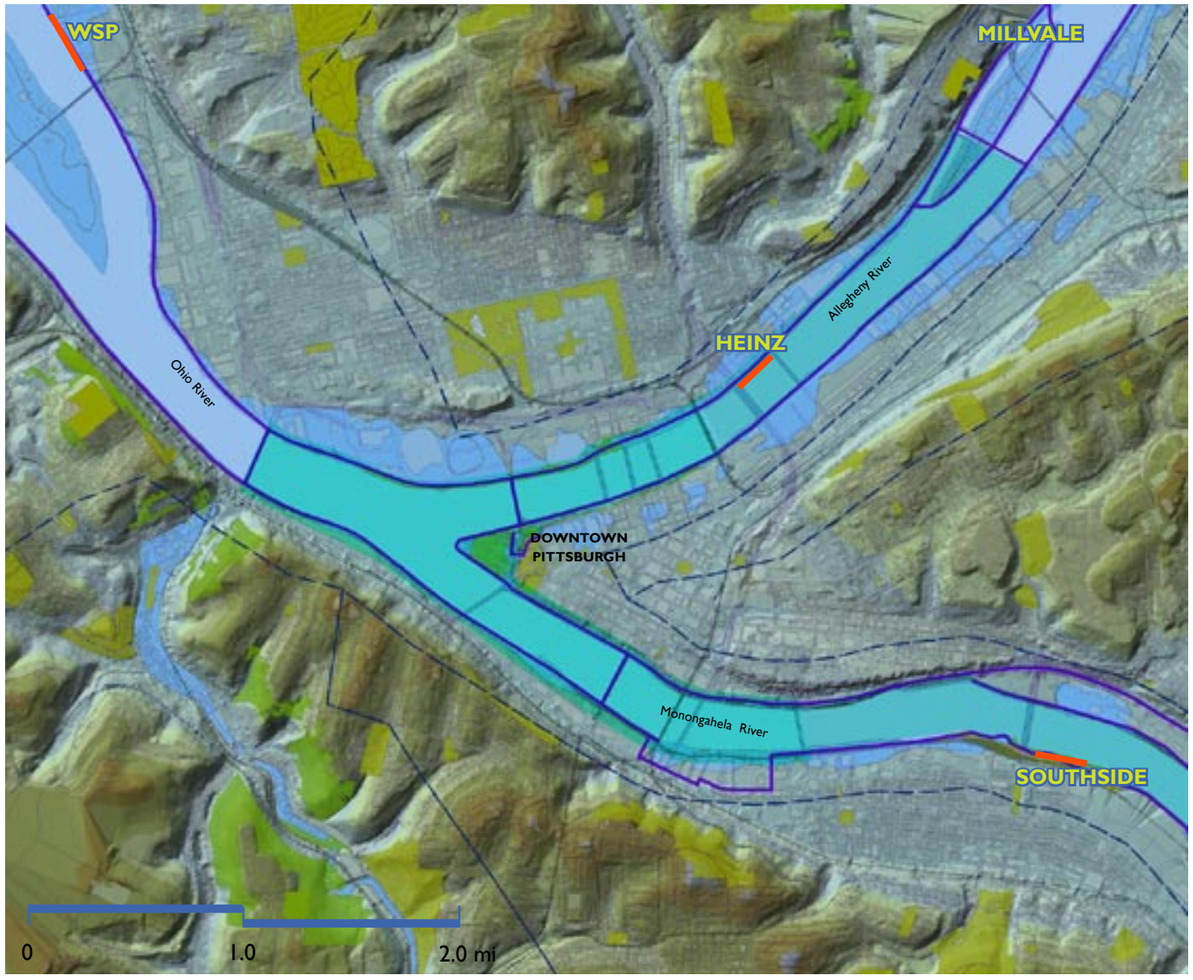


FIGURE 4. Proposed Target Sites for Management
These selected management sites include Western State Penitentiary (WSP) along Ohio River, Heinz Lofts (HEINZ) and Millvale Park (MILLVALE) along Allegheny River; Southside Park (SOUTHSIDE) along Monongahela River.

OHIO RIVER | WESTERN PENITENTIARY

This section of Ohio River edge is formed of mostly slag, resulting in a near vertical face of compressed material that – due to its manufactured nature – is subject to crumbling and erosion. Part of the edge has been reinforced with gabions – stones enclosed with wire mesh. The lower tiers of gabions have begun to fail – reconstruction of this edge is unavoidable. There are several alternative methods for restoring the edge – all involve significant earth moving and construction of a vegetated, reinforced edge.

ALTERNATIVE 1: Fill Against Steep Slag Slopes and Into Ohio River
- Don't need to move North Shore Trail
- Flattens slope to more accessible, safe condition
- Engineered fill is stable and can be green
- Slope encroaches ~25 feet into Ohio River, presenting a permitting challenge

ALTERNATIVE 2: Cut to Flatten Steep Slag Slopes to 4:1
- No encroachment into Ohio River
- Flattens slope to more accessible, safe condition
- Engineered fill is stable and can be revegetated
- North Shore Trail would have to shift and prison fence move toward jail

ALTERNATIVE 3: Cut to Flatten Steep Slag Slopes to 2:1
- No encroachment into Ohio River, minimal encroachment onto Trail
- Flattens slope to constructible, manageable condition
- Engineered fill is stable and can be revegetated
- Slope is still artificially steep and would require some shift in Trail

Recommended: Alternative 2, which would involve terracing with large boulders to create floodplain terraces. The Trail alignment shifts fifteen to twenty feet toward the Penitentiary, and the parking area would lose one bay of parking. The gabion removal will need to be performed in consultation with professional structural engineers.
The proposed cover type for this area is primarily shrubs to stabilize the bank, outcompete invasives and discourage clambering down from the Trail. The upper bank is proposed as woodland.

Landscape Management Tasks

- Following boulder placement, fill terraces with soil containment geogrid
- Plant lower terraces with woody shrubs/brush layering
- Plant upper terraces with riparian grasses and trees
- Plant additional canopy trees in upland areas and along North Shore Trail

Opinion of Costs for 1000LF of bank, 30LF from toe to top of bank

Mobilization, gabion removal and temporary stabilization	30,000sf @ $ 4/sf
Toe and slope stabilization with rock and geogrid	15,000sf @ $ 75/sf
Shrub planting and/or brush layering	20,000sf @ $ 15/sf
Meadow plugging	5000sf @ $ 5/sf
Woodland planting	5000sf @ $ 10/sf

Installation costs for 1000 lf (avg. $58.75/sf)	$ 1,445,000
Engineering design @ 12% of budget	$ 173,000
Maintenance incl. initial irrigation @ 10% of budget	$ 144,500

Opinion of Probable Cost for a 30ft high riverbank $1,760/LF

Photos of existing conditions at Western Penitentiary show deteriorated gabion wall

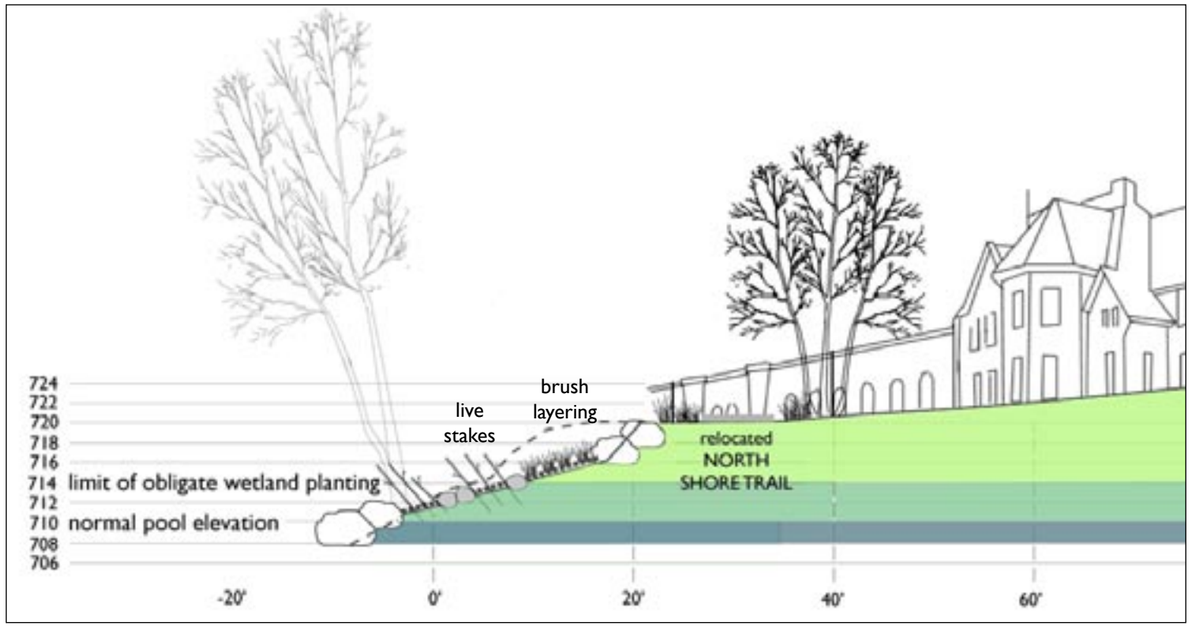


FIGURE 5. Typical Hard Edge Stabilization Section illustrates types of planting and bank stabilization techniques that can replace gabion edges with living materials

OHIO RIVER | WESTERN PENITENTIARY

SHRUB is proposed cover type
TERRACING SLOPE achieves stable area for planting
NORTH SHORE TRAIL relocated between prison and edge
ACCESS to river with rock steps at intervals

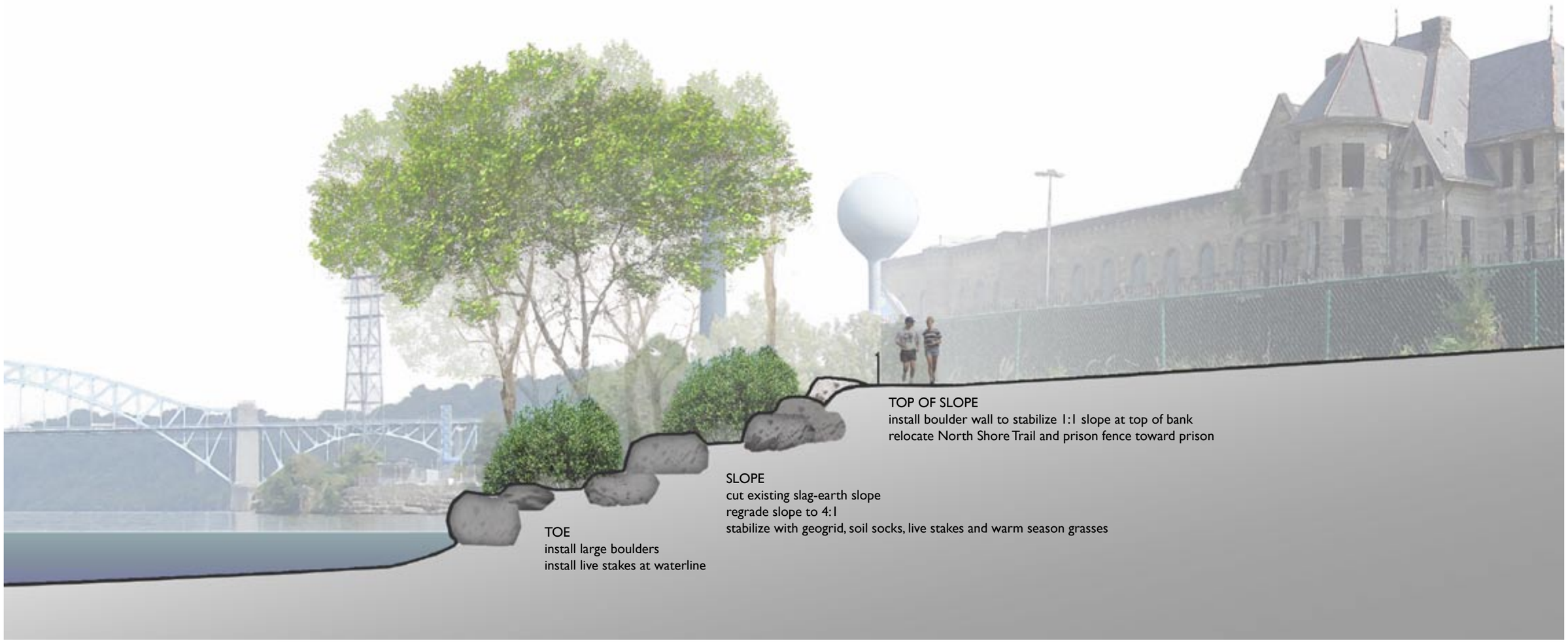


FIGURE 6. Illustrative Section at Western Penitentiary Site

ALLEGHENY RIVER | HEINZ LOFTS

The North Shore of the Allegheny above the Sixteenth Street Bridge possesses a fairly continuous forest canopy and a stable, relatively steep bank with large amounts of placed boulders. It represents an excellent opportunity for management because of the single large owner and the heavily used recreational North Shore Trail that runs throughout this section. At Millvale Park, a number of trees have been cleared along the bank but some canopy remains.

The proposed cover type for this area is woodland, to allow for views of both Downtown Pittsburgh and the river. Stable trails or rock steps are suggested to provide access to the riverbank for fishing. Adversely, access to undesirable areas could be limited simply by planting shrubs.

One assumption made is that all areas here will be planted by hand, which increases costs.

Landscape Management Tasks

- Inventory site conditions, noting locations of large boulders as well as existing canopy
- Record conditions on plan and in database
- Remove invasive plants along Heinz Lofts edge, working with small areas first
- Interplant existing large rocks with live stakes
- Plant additional canopy trees in upland areas and along North Shore Trail

Estimated Costs for 1000LF of Bank, based on 45LF from toe to top of bank

Mobilization, debris removal and invasives control	45000sf @ $0.75/sf
Toe and slope stabilization with rock and geogrid	3000sf @ $50/sf
Live staking and brush layering	15000sf @ $ 8/sf
Meadow plugging	25000sf @ $ 5/sf
Woodland planting	10000sf @ $10/sf
Installation costs (avg. $16/sf)	$503,750
Design and planning @ 12% of budget	$ 60,000
Maintenance incl. initial irrigation @ 30% of budget	$150,000

Opinion of Probable Cost for a 45ft high riverbank $715/LF

Photos show existing conditions at Heinz Lofts - near continuous layer of canopy trees

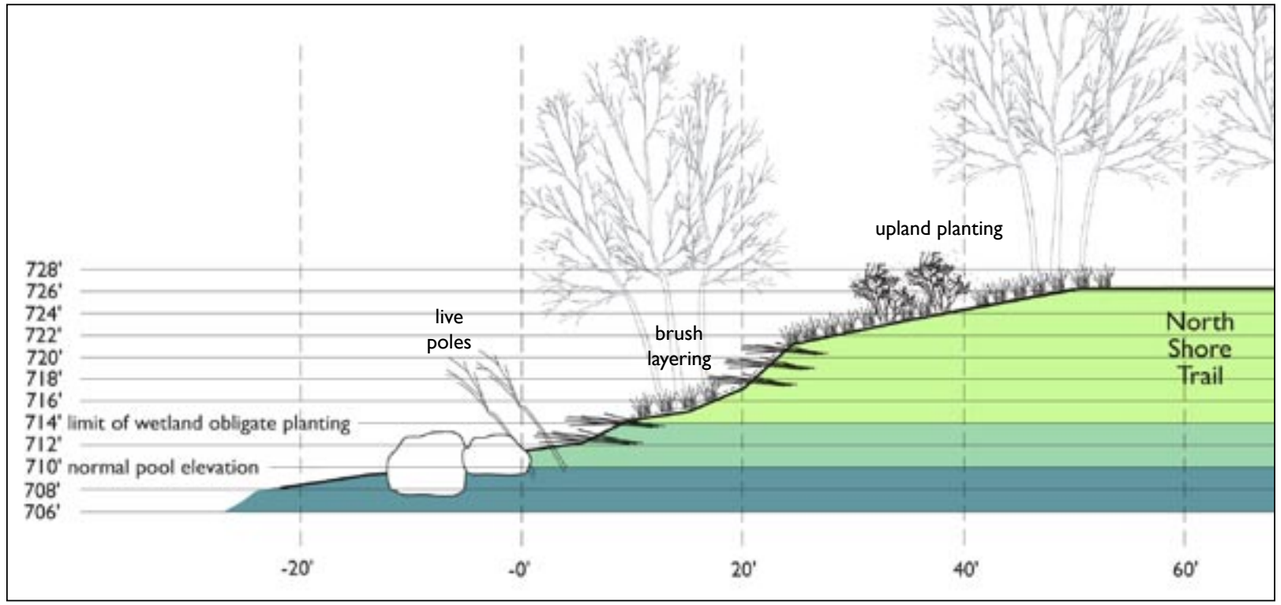


FIGURE 7. Typical Section showing Steep Bank Stabilization underneath fairly continuous layer of canopy trees

ALLEGHENY RIVER | HEINZ LOFTS

WOODLAND is proposed cover type
VIEWS to downtown and river maintained by using meadow areasa within desired view corridors
NORTH SHORE TRAIL planted with an open canopy woodland to reinforce safety and visibility
FISHING accommodated with stabilized rock at toe of bank or platforms at top of bank

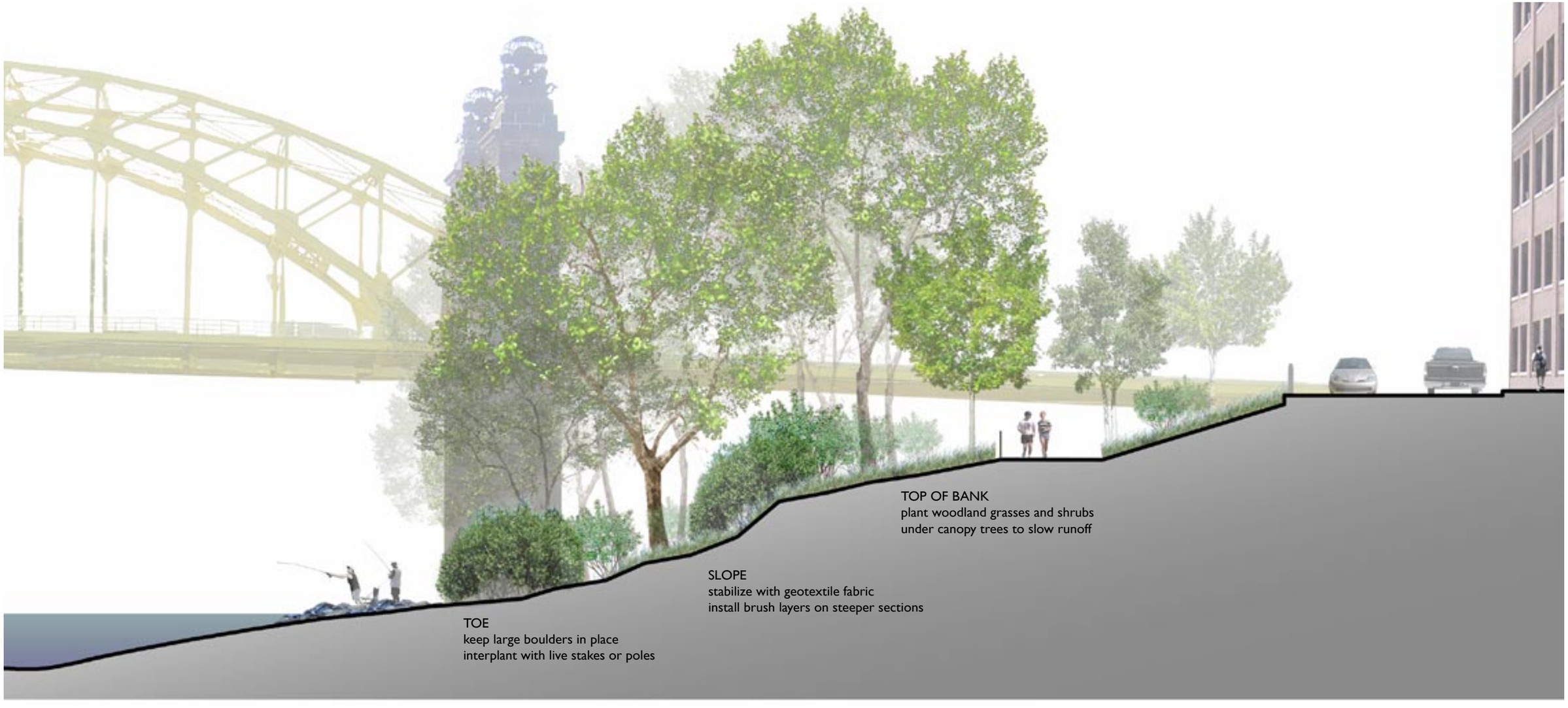


FIGURE 8. Illustrative Section at Heinz Lofts site

ALLEGHENY RIVER | MILLVALE PARK

Above the City boundary, the riverfront is parceled with multiple owners. Millvale Park is a fairly extensive section of the north Allegheny bank that is managed by Millvale Borough as a town park and popular non-motorized boating area. A number of trees have been cleared along the bank to improve views and perhaps to simplify maintenance.

The proposed cover type for this area is woodland, to allow for desired views to the river. Overlooks are desirable in selected areas. Some sections of bank could be stabilized with shrubs where views are less scenic.

Mechanical means – hydroseeding the meadow on the slopes – may be cost effective in this area, once the larger debris is removed and bare areas stabilized with geotextile.

Landscape Management Tasks

- Inventory site conditions, noting locations of canopy trees
- Record conditions on plan and in database
- Remove invasive plants, working with small areas first
- Stabilize toe of slope at Millvale Park with fascines, rock and live stakes (the latter where fishing access is not desired)
- Seed slope with woodland grasses and install geotextile where needed for protection
- Plant upland areas with canopy trees

Estimated Costs for 1000LF of Bank, based on 50LF from toe to top of bank

Mobilization, debris removal and invasives control	50,000sf @ $0.75/sf
Toe and slope stabilization with rock and geogrid	3,000sf @ $50/sf
Live staking and brush layering	15,000sf @ $ 8/sf
Meadow seeding	25,000sf @ $ 5/sf
Woodland planting	10,000sf @ $10/sf
Installation costs (avg. $15/sf)	$532,000
Design and planning @ 12% of budget	$ 64,000
Maintenance incl. initial irrigation @ 30% of budget	$160,000
Opinion of Probable Cost for a 50ft high bank	$750/LF

Photos show Millvale Park bank edge – some trees were cleared several years ago, opening up a window for spread of invasive vegetation

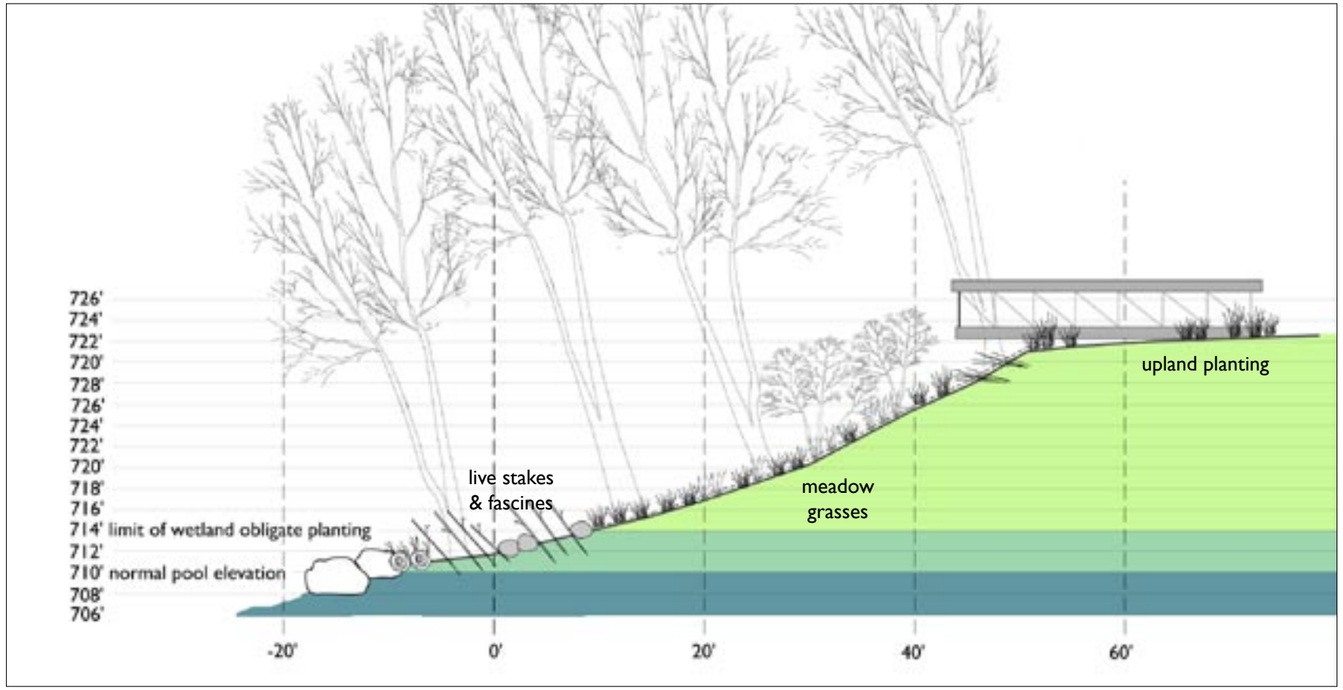


FIGURE 9. Typical Steep Bank Stabilization with sparse canopy trees

ALLEGHENY RIVER | MILLVALE PARK

WOODLAND is proposed cover type
VIEWS to river maintained by use of grasses on slope
OVERLOOKS in places that may be threatened by trampaling
TRAIL at midslopeprovides access to river for boating

FIGURE 10. Illustrative Section at Allegheny River / Millvale Park

MONONGAHELA RIVER | SOUTH SIDE PARK AND HOMESTEAD WORKS

This section of the Monongahela possesses a shallow river edge, with a slight-to-moderately graded slope, a gravel toe and trampled earthen banks. It represents perhaps the best immediate opportunity to conduct successful restoration and management because access is easy, visibility is high and public interest is present. The Three Rivers Heritage Trail is maintained through the park and the adjacent boat ramp is extremely popular, which creates possible volunteer constituencies for management.

The proposed cover type for this area is woody shrub, which will need to be planted as dense protection for the bank to prevent the return of Japanese knotweed. Planting density and maintenance costs will be the budget determiners in this section of river. Projected costs here are higher than some sections of river because of the absence of continuous canopy in many places.

Landscape Management Tasks

- Inventory site conditions, paying particular attention to extent of invasive species and noting native plants that are thriving, as well as their locations above waterline
- Record conditions in database
- Choose initial areas for management based on extent of canopy from canopy trees
- Install boulders and live stakes at toe of slope
- Remove invasive plants, working with small areas and gradually extending these efforts
- Install soil socks, brush layering and plants in areas of bare soil
- Plant additional canopy trees in upland areas and along Heritage Trail, according to plant schedule
- Record management activities in database

Opinion of Costs for 1000LF of Bank based on 30LF from toe to top of bank

Mobilization, debris removal and invasives control	30000sf @ $0.75/sf
Toe and slope stabilization with rock and geogrid	5000sf @ $ 50/sf
Live staking and brush layering	10000sf @ $ 8/sf
Meadow plugging	10000sf @ $ 5/sf
Woodland planting	10000sf @ $10/sf
Installation costs (avg. $23.75/sf)	$502,000
Design and planning @ 12% of budget	$ 60,000
Maintenance – invasives removal @ 30% of budget	$151,000

Opinion of Probable Cost for a 30ft high riverbank $715/LF

Southside Park and Homestead Works are indicative of shallow banks with good river access. Shallower banks tend to be trampled.

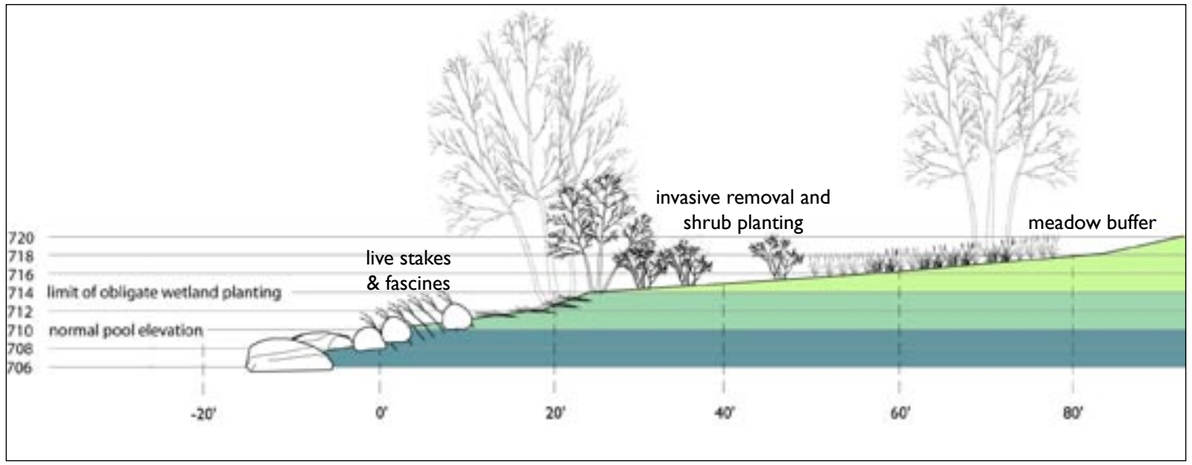


FIGURE 11. Typical Shallow Bank Stabilization with invasive management – South Side Park

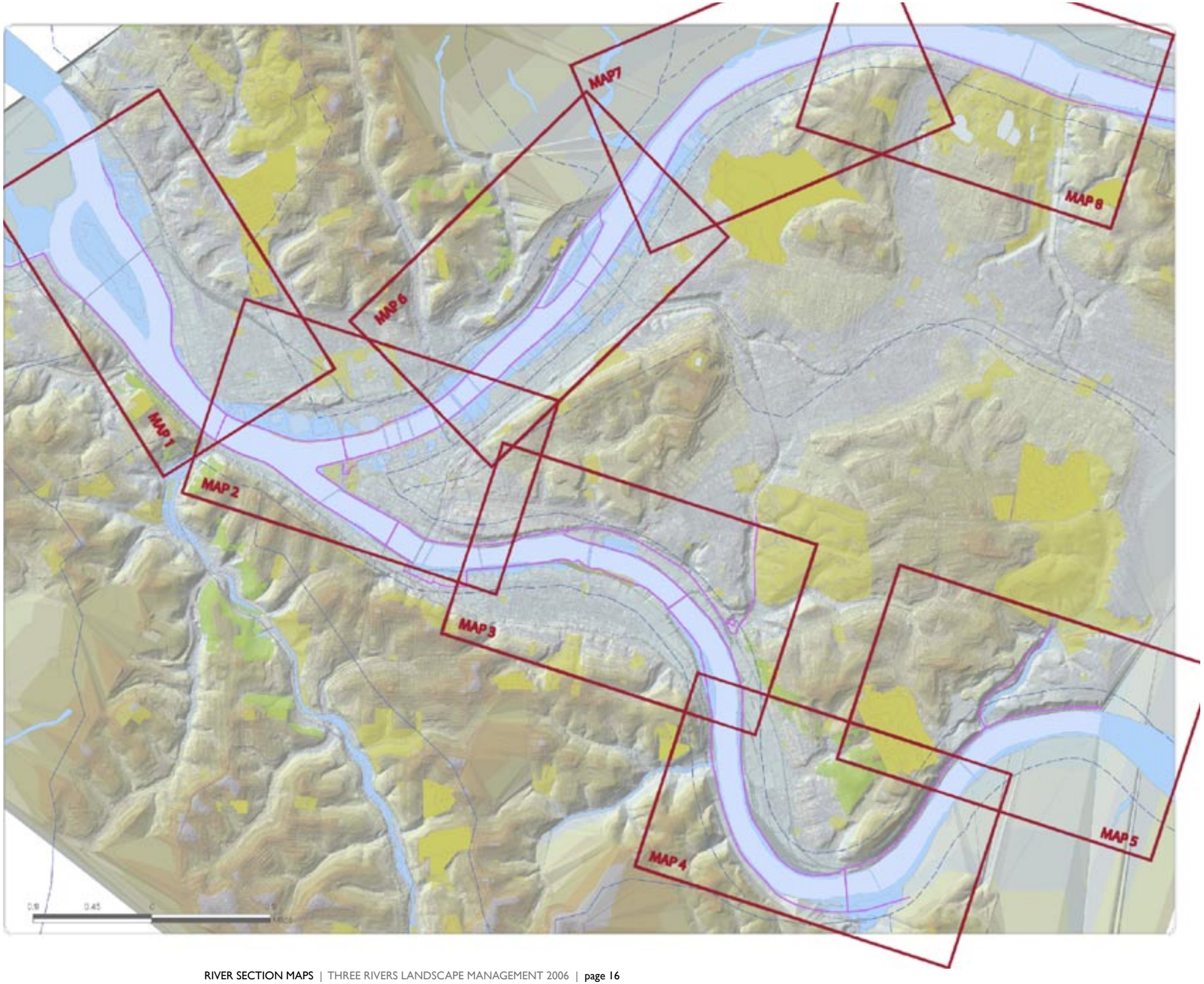
MONONGAHELA RIVER | SOUTHSIDE PARK AND HOMESTEAD WORKS

SHRUB is proposed cover type, interspersed with MEADOW where views are desired
DENSE plantings are crucial to maintaining areas free of knotweed
ACCESS for fishing and river viewing is important - accommodate with rock steps or boardwalks

FIGURE 12. Illustrative Section for Monongahela River edge at Homestead Works / Sandcastle

RIVER SECTION MAPS

1. Ohio River – West End
2. The Confluence
3. Monongahela River – Southside
4. Monongahela River – Hazelwood
5. Monongahela River – Homestead
6. Allegheny River – Strip District
7. Allegheny River – Lawrenceville
8. Allegheny River – Highland Park



RIVER SECTION MAPS

The river edges were assessed for management opportunities, using 2001-2004 GIS mapping developed by Three Rivers Second Nature. The mapping was reviewed visually by the project team in the summer of 2005 and maps were annotated in the field where changes – such as increase in Japanese knotweed or removed canopy vegetation – could be assessed. Following the visual inspection, the annotated maps were correlated with aerial perspective photographs (flown by helicopter during 2004) to obtain an accurate representation of existing conditions. These General Conditions Maps depict sections of river where landscape management is appropriate, or where additional stabilization measures may be needed.

Significant constraints are operating in terms of river edge landscape management. Key riparian functions have been lost due to dams, culverts and armoring of the river banks. The river edges are severed from their uplands by highways and railroad corridors. Much of the river edge is perceived as belonging to no one in particular, or alternately, everyone in general. Ownership questions, accessibility, and loss of riparian functions all represent challenges for even a basic level of landscape management. Within those constraints, however, there are still opportunities to develop management strategies that will reinforce the river as an ecological corridor, providing potential biodiversity and a large scale connection at the landscape level.

HOW TO READ THE MAPS

Green shading along the bank represents river edges that have respectable connectivity and plant community integrity as demonstrated by tree canopy continuity and presence of floodplain species. The existing canopy shades the groundlayer and helps prevent invasive species from spreading, making these areas strong candidates for successful landscape management.

- live staking at river edge between existing boulders
- groundlayer planting, such as native grasses
- understory planting at woodland edges

Yellow shading represents river edge segments that have open canopy – the most significant action here is to plant trees to shade the bank, which will eventually assist in controlling invasive species. Depending on the extent of invasives already established, some of these areas will be easier to replant and manage than others.

- canopy tree planting to provide continuous cover
- invasive management and replanting with brush layering or massed shrubs
- conversion to meadow where areas are currently being mown

Red shading indicates areas that require structural interventions to control erosion and protect the banks. These areas will require professional engineering design to ensure stability of the banks. These areas do have interesting potential for overlooks and other architectural structures that require a hardened edge.

- bank regrading and boulder placement for slope stabilization
- fascines, live stakes and boulders to anchor toe
- bank terracing for trail stabilization and erosion control

MAP 1 OHIO RIVER | WEST END

LAND USE | Condition

Both north and south banks of the Ohio have substantial industrial / commercial uses. An active CSX rail corridor runs along the south bank of the river for the length of this section. Large landowners include Allegheny County Sanitary Authority (ALCOSAN) and the Western Penitentiary on the north bank and an inactive industrial site on the south bank near the mouth of Chartiers Creek. Brunot Island is occupied by an electrical power generating station (Orion Power). A boat club occupies the north shore of the island towards the downstream end.

BANK | Vegetation Character

Ohio River north banks are steep and over twenty feet in elevation. Canopy ranges from intermittent around the Penitentiary to continuous near the Ohio Connecting Railroad Bridge. Ohio River south banks in this section are steep and seawalls protect large sections of the railroad corridor. Slopes are less steep on Brunot Island and average around fifteen – twenty feet in height. The north side of the island lacks mature canopy and has a continuous cover of Japanese knotweed. The south side of the island is more diversely vegetated, with occasional canopy of black willow and sycamore. Knotweed dominates the understory.

PUBLIC ACCESS | River Use

River access from the Ohio north bank is extensive with several marinas and a barge docking facility. The City has plans to extend the riverfront trail through this area; integrating the marinas with the trail should enhance public use of the river. The CSX rail corridor is continuous along the south bank, preventing access. The only other access point at present is the south side of Brunot Island. River use is both industrial and recreational throughout this section.

MANAGEMENT ASSESSMENT

North Bank

1.1 North edge of Ohio below Western Penitentiary has near vertical slopes of slag substrate. Restoration on this steep slope will require regrading and a structural confinement system to hold soil, native grasses and wildflowers. The regraded slope will position the North Shore Trail fifteen feet further toward the prison.

1.2 North edge of Brunot Island has little continuous canopy due to flooding damage and development. Japanese knotweed is rampant. Restoration direction is replacement of knotweed with canopy trees, but disturbance frequency makes this a challenging site.

1.3 This section is representative of other steep banks along Ohio River that possess significant native canopy vegetation. These can be planted using live stakes and soil containment systems on banks.

South Bank

1.4 South bank of Brunot Island possesses native riparian edge in several places, with canopy of sycamore and willow. Restoration direction is to reinforce forest with native understory trees and shrubs.

1.5 Sections of Ohio River banks below rail corridor have no access for management at present.

1.6 Sawmill Run outfall below West End Bridge is an example of a very large CSO – combined sewer outfall – that carries nutrient loaded water to the rivers in wet weather events. CSOs are a long term problem now being addressed by Three Rivers Wet Weather, among others. (www.3riverswetweather.org/)

1.1

1.2

1.3

1.4

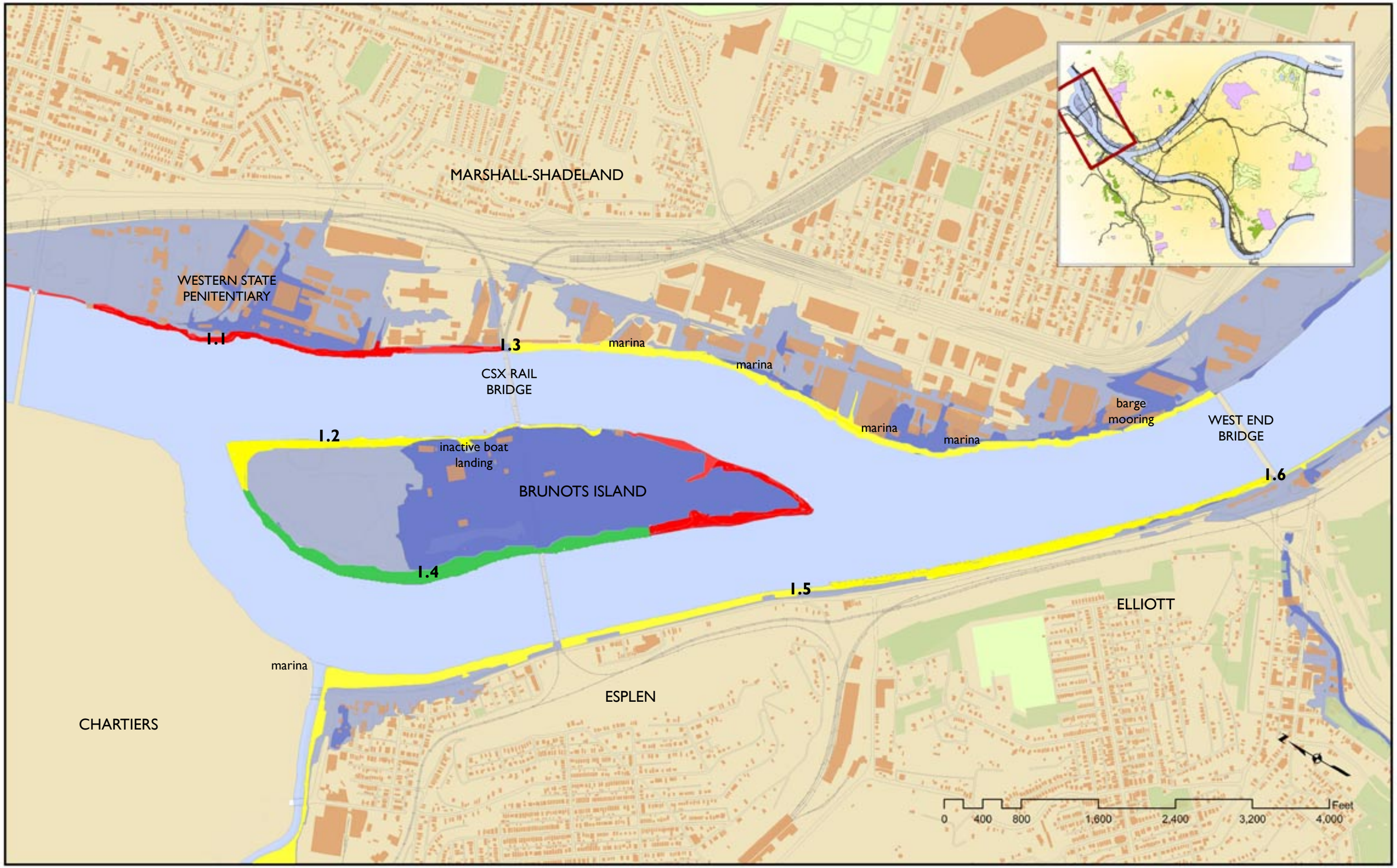
1.5

1.6

MAP LEGEND

- continuous canopy riparian vegetation potential for access
- intermittent canopy exotic vegetation potential for access
- varied canopy hardened edges problems for access
- 2004 Hurricane Ivan 31 ft flood crest
- 41 ft flood crest
- parks greenway trails
- cemetery

MAP 1 (opposite page). Ohio River West End


MARSHALL-SHADELAND
WESTERN STATE PENITENTIARY
1.1
1.3
marina
marina
CSX RAIL BRIDGE
barge mooring
WEST END BRIDGE
marina
marina
1.2
inactive boat landing
BRUNOTS ISLAND
1.6
1.4
1.5
ELLIOTT
marina
ESPLEN
CHARTIERS
0
400
800
1,600
2,400
3,200
4,000
Feet

MAP 2 CONFLUENCE | THREE RIVERS PARK

LAND USE | Condition

Located along the banks at the confluence, Three Rivers Park extends from the West End Bridge to the Thirty-First Street Bridge on the Allegheny and the Hot Metal Bridge on the Monongahela. The land use varies dramatically. The Allegheny River north bank is managed primarily by the Sports and Exhibition Authority as a public park and recreational setting for two major professional sports arenas, Heinz Field (Pittsburgh Steelers) and PNC Park (Pittsburgh Pirates). The south bank is rimmed by Point State Park and the elevated 10th Street bypass. Part of this area has been reclaimed as the Allegheny Riverfront Park. The Monongahela (the Mon) is likewise bordered by the elevated Parkway East (30/376) and the Mon Wharf, currently a parking lot. The south bank of the Mon remains in use as an active rail corridor. The industrial buildings have been reclaimed as a commercial district and Station Square, a shopping and entertainment destination.

BANK | Vegetation Character

This section of river edge surrounds Downtown and – not surprisingly – generally has less natural vegetation than any other stretch of river. A section along the Ohio north bank between the West End Bridge and the Carnegie Science Center, which has canopy vegetation – sycamores, box elders and black locust. The natural vegetation ends at the Science Center. North Shore Riverfront Park along the Allegheny north shore is entirely landscaped with turf, groundcovers, perennials and other ornamental plants. Point State Park is entirely hard edge with lawn above. Allegheny Riverfront Park was planted with red maples and river birch – otherwise, there are few trees in this stretch of river. The Monongahela – excepting the Park and Mon Wharf – has sections of native canopy vegetation, surprising in such urban surrounds.

PUBLIC ACCESS | River Use

A new pedestrian connection is planned for the West End Bridge, which will feature ramp access to the riverbanks. Public access is good throughout the North Shore Riverfront Park and consists mostly of walking along hard promenades, river viewing from overlooks, and recreational boat docking for sports events. Point State Park is accessible for walking and viewing the rivers. Amphibious tour boats launch opposite the Point at a public landing near the Science Center. CSX Transportation controls access within its right-of-way along the south bank of the Ohio and the Monongahela until one reaches Station Square, which has a new marina and pedestrian access over the Smithfield Street Bridge.

MANAGEMENT ASSESSMENT

Allegheny River North and South Banks

2.1 A new pedestrian ramp will complete this section of Three Rivers Park; canopy trees will be needed throughout to reinforce the banks and the park identity.

2.2 Carnegie Science Center is completing its trail section; a complete restoration is not possible, but many native riparian species could be planted and managed by the Center.

2.3 The park is very popular as a lawn, and no management action is contemplated at this point. Additional canopy trees may be desired to shade the riverfront trail – cottonwoods and silver maples would make a signature edge.

2.4 Private developments should follow the lead of Three Rivers Park and plant a border of canopy trees across the bank edge.

2.5 Existing parks and planted areas accessible to the public require constant management attention to defray vandalism and replace damaged trees.

2.6 This private development has set an excellent precedent by planting and maintaining the trail through its property.

Monongahela River North and South Banks

2.7 Mon Wharf will be retrofitted with a planted promenade, with regularly scheduled maintenance to ensure the continual aesthetic quality of the Park.

2.8 This area below the Smithfield Street Bridge is – amazingly – completely vegetated with sycamore trees and could serve as a model for landscape management where banks are relatively well protected.

2.9 Lack of public access continues to protect this stretch of bank.

2.10 Assuming the railroad remains active, the only area for planting is the extreme toe of the slope. Access is via river only.

2.11 Live staking interplanted with the boulders may establish additional edge vegetation at the slope toe.

2.12 These banks could be regraded and terraced with boulders and vegetation, such as masses of willow, alder or elderberry shrubs.


2.1


2.2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2.7


2.8

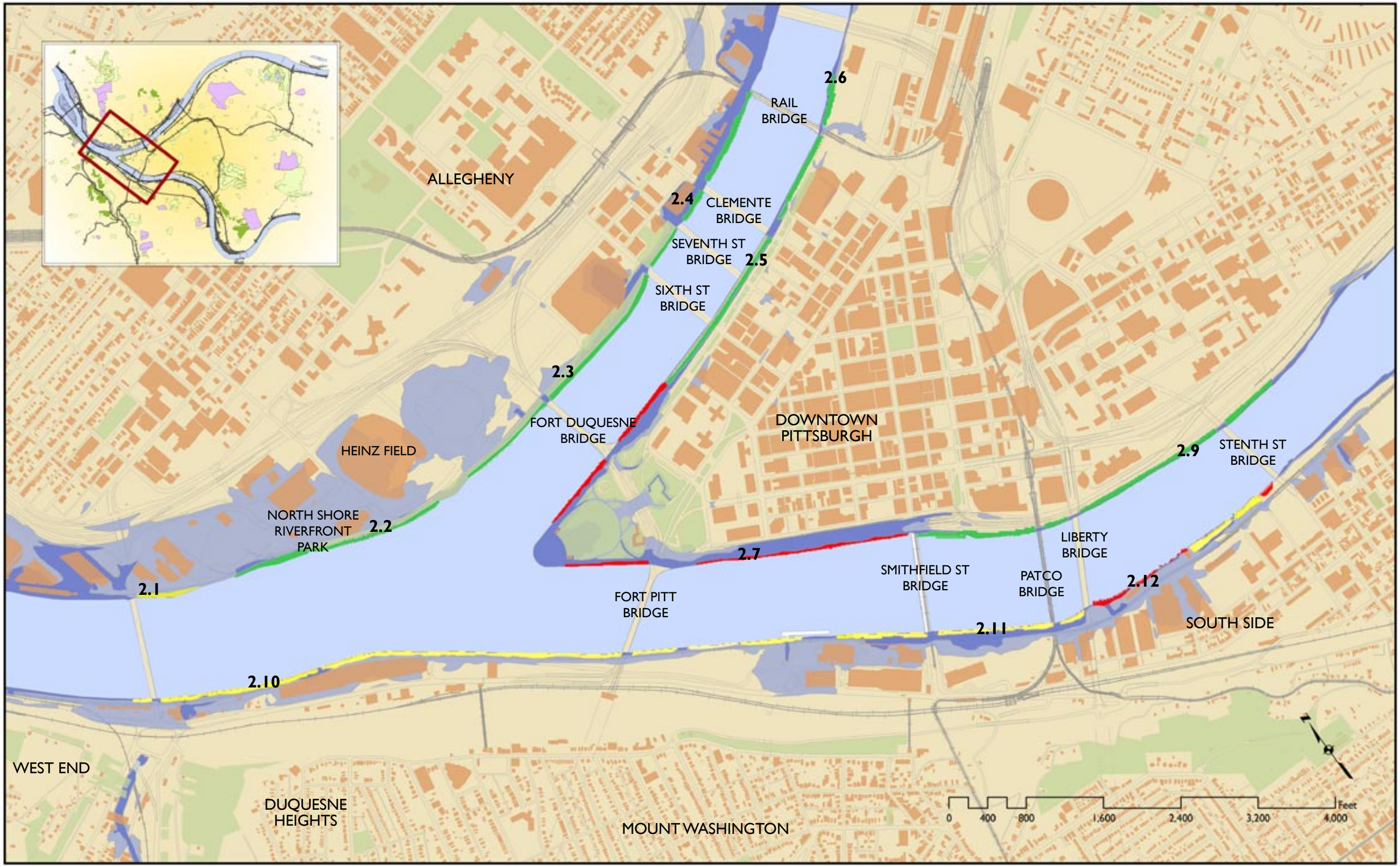

2.9


2.10


2.11


2.12

MAP 2. (opposite page). The Confluence & Three Rivers Park


ALLEGHENY
2.6
RAIL BRIDGE
2.4
CLEMENTE BRIDGE
SEVENTH ST BRIDGE
2.5
SIXTH ST BRIDGE
2.3
FORT DUQUESNE BRIDGE
DOWNTOWN PITTSBURGH
HEINZ FIELD
2.9
STENTH ST BRIDGE
NORTH SHORE RIVERFRONT PARK
2.2
2.7
LIBERTY BRIDGE
SMITHFIELD ST BRIDGE
PATCO BRIDGE
2.12
2.1
FORT PITT BRIDGE
2.11
SOUTH SIDE
2.10
WEST END
DUQUESNE HEIGHTS
MOUNT WASHINGTON
0
400
800
1,600
2,400
3,200
4,000
Feet

MAP 3 MONONGAHELA RIVER | SOUTH SIDE

LAND USE | Condition

Situated just below Interstate 376, the north banks of the Mon between S. Tenth Street Bridge and the Birmingham Bridge are narrow and steep. The land use becomes solidly industrial at Hanson Aggregates property below the Birmingham Bridge, with moorings for barges hauling aggregates. Above the Birmingham Bridge, a former steel mill site has been redeveloped as the Pittsburgh Technology Center industrial park. The south banks tend to be steep, with an elevation of twenty feet and mostly held by seawalls. The industrial/ commercial character of the south bank is gradually converting to mixed commercial and residential use, a trend exemplified by the recent transformation of the former LTV Steel plant to Southside Works, a commercial, residential and entertainment complex. Also on the south bank is Southside Park, which is managed by the City as a public park with a trail and boat launch.

BANK | Vegetation Character

The north bank above the S. Tenth Street Bridge has fairly continuous canopy vegetation on steep banks until it changes to seawall at the site of an old river lock. Above the bridge and below the Technology Center, the banks are nearly vertical slag formations with intermittent shrub vegetation. The south bank is fairly steep with vegetation above S. Tenth St. Bridge becoming more intermittent as the rail corridor approaches the upper bank. Southside Park, with shallower slopes and intermittent planted trees, begins around 18th Street and continues underneath the Birmingham Bridge. Invasive vegetation, bare soil and mown lawn dominate the groundlayer at Southside Park.

PUBLIC ACCESS | River Use

Access from the north bank is limited to industrial and barge uses. The south bank has one public access landing, the City Boat Landing at the Birmingham Bridge. Parking under the bridge fills quickly with cars and boat trailers during the boating season. Informal fishing spots and a marked canoe launch area occur along the shallow banks within Southside Park.

MANAGEMENT ASSESSMENT

North Bank

3.1 Actively used industrial properties, such as this prominently sited sand and gravel plant, are not current targets for restoration.

3.2-3.3 The Technology Center has steep slag banks from its previous use; these can be managed using live stakes and soil confinement systems to hold soil on the banks. This is a desirable site for management, due to single ownership and its updated function for cutting edge technology. River edge management should commence by assessing areas where vegetation is better established and use these as planting prototypes for adjacent slopes.

South Bank

3.4 The river edge near the Birmingham Bridge is a well used public access area – controlled access with stairs and floating docks is needed. Banks should be planted with native willows and sycamores to hold soil.

3.5 Much of Southside Park lacks a viable landscape. The river edge – due to its popularity for boating and fishing – is a very desirable location for planting and management. Areas under restoration will need to be fenced with signage provided to prevent trampling.

3.6 As invasives are removed and banks replanted, river access should be provided in select areas – such as this one – with steps and rock jetties for fishing.

3.1

3.2

3.3

3.4

3.5

3.6

MAP 3 (opposite page). Monongahela River South Side

MAP LEGEND

ontinuous canopy
parian vegetation
otential for access

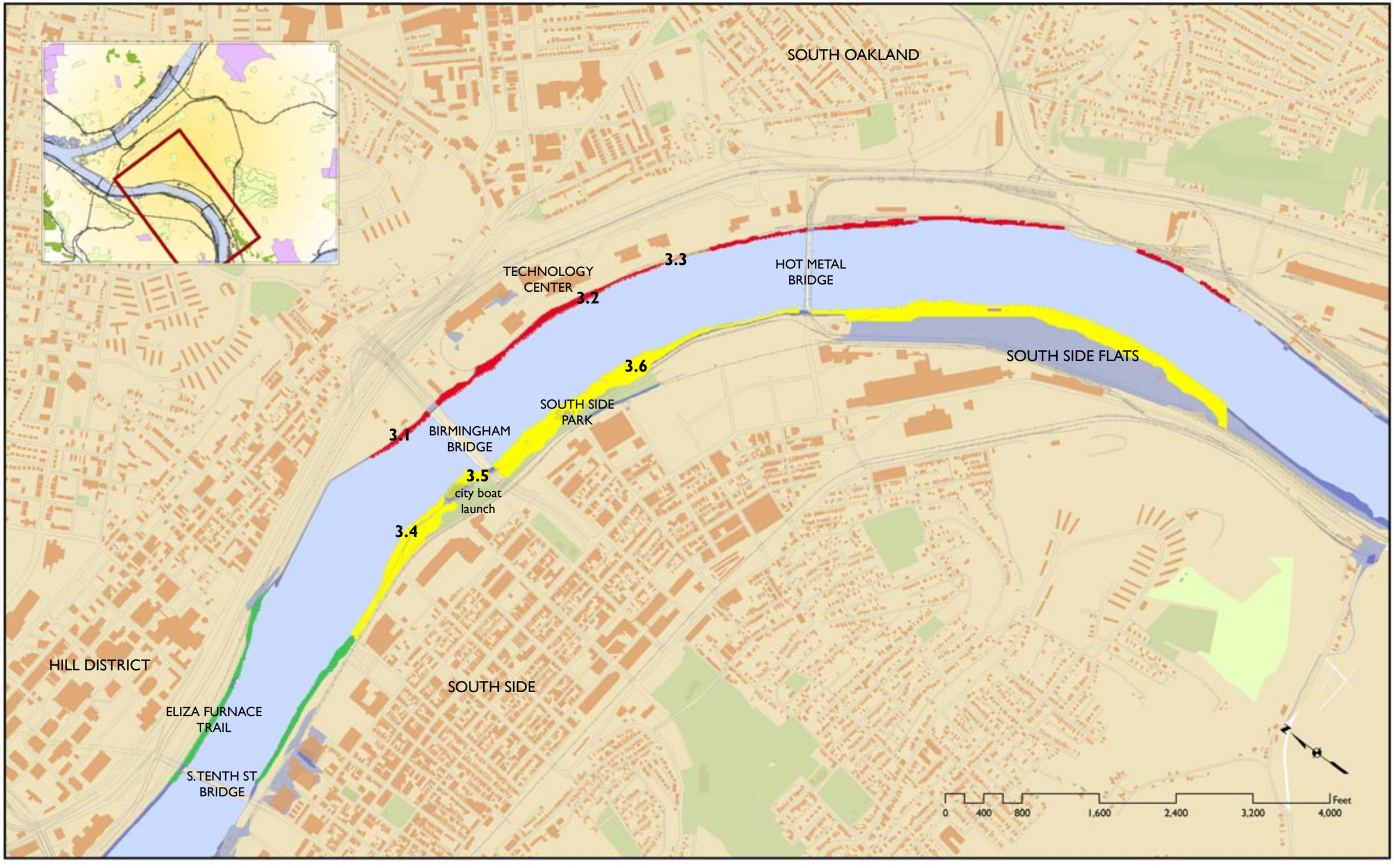
ıtermittent canopy
xotic vegetation
otential for access

aried canopy
ardened edges
roblems for access

004 Hurricane Ivan
1 ft flood crest
within 50 ft managed bank

arks
reenway trails

cemetery


SOUTH OAKLAND
TECHNOLOGY CENTER
3.3
3.2
HOT METAL BRIDGE
SOUTH SIDE FLATS
3.6
SOUTH SIDE PARK
3.1
BIRMINGHAM BRIDGE
3.5
city boat launch
3.4
HILL DISTRICT
SOUTH SIDE
ELIZA FURNACE TRAIL
S. TENTH ST BRIDGE
0
400
800
1,600
2,400
3,200
4,000
Feet

MAP 4 MONONGAHELA RIVER| HAZELWOOD

LAND USE | Condition

Located on the north banks are industrial lands, once steel mills, with steep slag banks and seawalls. Above Hot Metal Bridge, barge mooring posts line the river at the former LTV Coke Works site in Hazelwood. The south bank is mixed woodland and the land use becomes entirely commercial/industrial in character.

BANK | Vegetation Character

The north banks are steep slag banks and seawalls, remnants from the former mills' site. Parts of this area are continuously vegetated with riparian species, although some invasives like Ailanthus have a foothold. The south edge varies. Extractive industry and some dumping have degraded the banks near the LTV site. Riverbanks of Hays Woods are well vegetated and important for river edge continuity with uplands, despite the active rail corridor in between.

PUBLIC ACCESS | River Use

The steepness of the banks and use of the property as an industrial area and rail yard prohibits public access along the north banks. The south banks are accessible in places, particularly at the Sandcastle entertainment area above the railroad bridge.

MANAGEMENT ASSESSMENT

North Bank

4.1-4.3 The former LTV site offers a large scale opportunity to manage a significant portion of urban river corridor. Despite the intensive industrial use, the river edges still possess riparian vegetation, including canopy species. When the site is developed as a planned community, river edge management with good public access and restoration planting ought to be part of the program.

South Bank

4.4 Fairly continuous seawall exists to protect the rail corridor – at present, there is little development at the river edge. The sports facilities could develop a tie-in with river events; if so, this would suggest an opportunity for increased management.

4.5 Submerged barges along the Monongahela are nearly obscured by volunteer riparian trees and shrubs, suggesting an interesting adaptation for management and restoration.

4.6 Sediment deltas such as this one at Streets Run will eventually become colonized by young Poplars and Sycamores; these can be harvested for river edge restoration before they get carried away by floods.

4.1

4.2

4.3

4.4

4.5

4.6

MAP LEGEND

continuous canopy
riparian vegetation
potential for access

intermittent canopy
exotic vegetation
potential for access

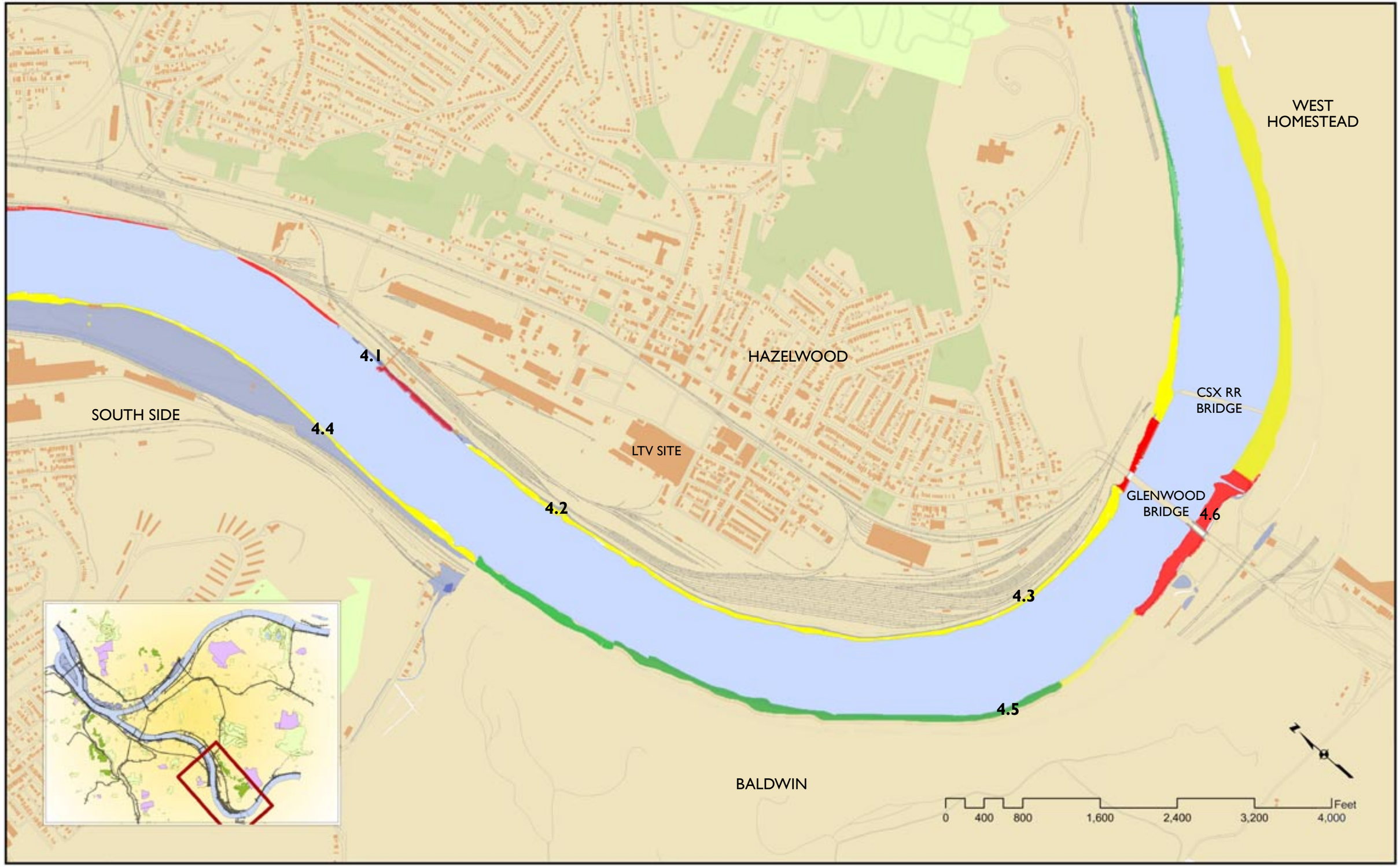
varied canopy
hardened edges
problems for access

2004 Hurricane Ivan
31 ft flood crest
*within 50 ft managed bank

parks
greenway trails

cemetery

MAP 4 (opposite page). Monongahela River Hazelwood


WEST
HOMESTEAD
HAZELWOOD
4.1
SOUTH SIDE
4.4
LTV SITE
CSX RR
BRIDGE
GLENWOOD
BRIDGE
4.6
4.2
4.3
4.5
BALDWIN
0
400
800
1,600
2,400
3,200
4,000
Feet

MAP 5 MONONGAHELA RIVER| NINE MILE RUN

LAND USE | Condition

On the north bank of the Monongahela is a rail line that runs below a vegetated hillside. Of all the land in the study area, this particular stretch is the closest, in both form and function, to the original natural landscape. Most of the south bank between Streets Run and the Homestead Bridge is former industrial edge that has an active rail line. Located above the Homestead Bridge, the Waterfront mall is an open air shopping center, built on the former U.S. Steel's Homestead Works plant site.

BANK | Vegetation Character

The north bank is steep and well vegetated and it is difficult to see the bank condition underneath – it appears to be an old seawall for part or possibly all of its length. The north bank below Nine Mile Run is disturbed, with a notable amount of sediment at the mouth of Nine Mile Run. Above Nine Mile Run, the river edge is fully vegetated with a continuous canopy. The south bank, although possessing relatively shallow banks, has only intermittent canopy. Many trees appear to have been removed along the edge of Homestead Works.

PUBLIC ACCESS | River Use

There is very little boat access to the north bank – one mooring site – and the railroad cuts the river off from the land edge. Above Nine Mile Run, it appears possible to access the river from a boat, although no landings are apparent. The south bank is accessible by foot, car or boat in many places because of the proximity to developed land at Homestead Works – including a large parking area – along the river edge.

MANAGEMENT ASSESSMENT

North Bank

5.1 This section of the Monongahela in the vicinity of the Homestead High Level Bridge has significant forest canopy. Future development needs to preserve this riparian corridor.

5.2 Nine Mile Run is undergoing restoration at the time of this photograph, which will improve water quality and perhaps reduce sediment at the mouth of the stream. Ideally, this stream will be monitored and the river edge managed as forest.

South Bank

5.3 Special destinations such as Sandcastle require a significantly greater investment in river edge management than occurs at present. Education can be instrumental in persuading owners and managers that a viable, healthy river edge can contribute to special markets such as ecotourism.

5.4 Industrial relics of the old Homestead Mill should be assessed for their stability but could be maintained as part of a sustainable cultural landscape.

5.5 The Homestead river edge is, at present, managed in an uncoordinated fashion. Trees appear to have been cut down to maintain views to the river. As noted above, education and coordinated management is important to achieve both ecological health and to promote this site as a destination. Where possible, relics of the old Homestead Mill should be stabilized and preserved to interpret this significant piece of industrial history.

5.1

5.2

5.3

5.4

5.5

MAP LEGEND

continuous canopy
riparian vegetation
potential for access

intermittent canopy
exotic vegetation
potential for access

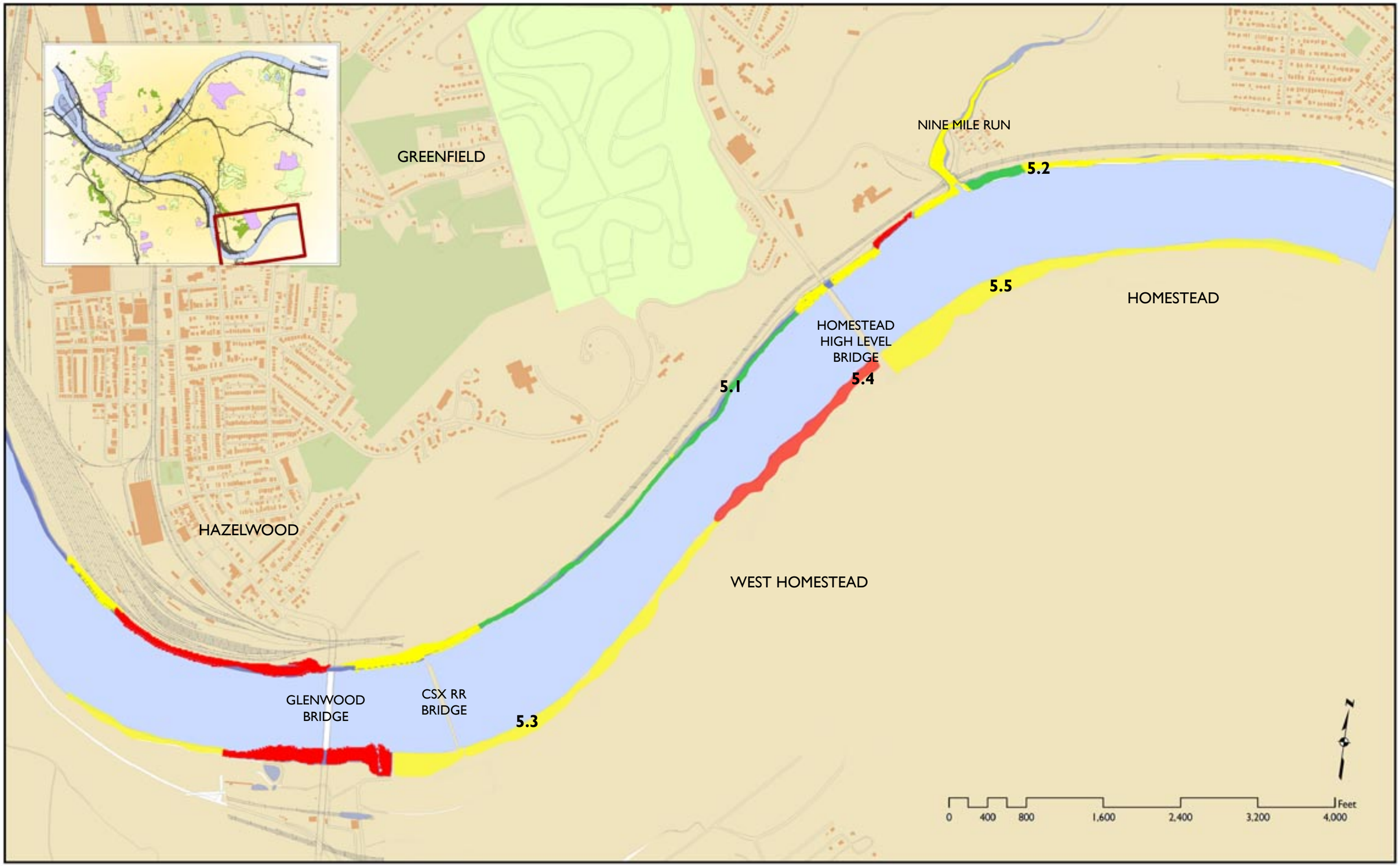
varied canopy
hardened edges
problems for access

2004 Hurricane Ivan
31 ft flood crest
*within 50 ft managed bank

parks
greenway trails

cemetery

MAP 5 (opposite page). Monongahela River Nine Mile Run


GREENFIELD
NINE MILE RUN
5.2
5.5
HOMESTEAD
HOMESTEAD HIGH LEVEL BRIDGE
5.4
5.1
HAZELWOOD
WEST HOMESTEAD
GLENWOOD BRIDGE
CSX RR BRIDGE
5.3
0
400
800
1,600
2,400
3,200
4,000
Feet

MAP 6 ALLEGHENY RIVER | STRIP DISTRICT

LAND USE | Condition

The north bank is entirely commercial/industrial use, including the HJ Heinz Factory and an active rail line. The North Shore Trail runs along the upper part of the bank between River Rd. and the Allegheny River for most of this segment. At Herr's Island, the bank faces a narrow channel that separates Herr's Island from Troy Hill. On the river side of Herr's Island is the Washington Landing development, with townhomes, a restaurant, boat storage and marina. At the north end of Washington's Landing there is an office park with a recreation area.

The south bank of the Allegheny is used primarily for commercial/industrial activities, including the Seagate industrial park. The Armstrong Cork Factory, also situated on the south bank, is currently being redeveloped as a residential complex. The remaining area is largely parking for the Strip District. The Strip District Trail is complete between Seagate and the 16th Street Bridge.

Bank | Vegetation Character

The north bank is mostly large riprap, which retains a narrow band of intermittent canopy trees up to the 16th Street Bridge. Above the 16th St Bridge, the canopy vegetation is continuous and in good condition, including silver maples, sycamores and box elders. Herr's Island is largely a reinforced edge at its south end.

The Allegheny south bank is partly concrete seawall – some in dilapidated condition and partly riprapped. On occasion, streets lead directly to the river edge, facilitating informal access. Vegetation has been cleared in sections for utility lines and is otherwise intermittent in character. Above the 40th Street Bridge tree canopy is absent with mostly Japanese Knotweed covering the bank.

PUBLIC ACCESS | River Use

The north bank is accessible for fishing, from overlooks on the North Shore Trail and from informal locations atop boulders at the toe of the bank. The North Shore Trail receives heavy use during seasonable weather and people scramble down the banks to fish or watch the river. Washington Landing has a large marina and is a popular river access area.

The south bank has a riverfront club and restaurant as well as a marina – reconstructed after Hurricane Ivan – above the 16th Street Bridge.

MANAGEMENT ASSESSMENT

North Bank

6.1 The North Shore Trail could benefit from tree planting along the trail. Views could still be maintained between the tree trunks.

6.2 The Heinz lofts is a key component of the North Shore Trail – an important recreational link between Washington's Landing and the sports stadiums. This area is well stabilized and requires mostly additional tree planting.

6.3 The Trail ends in the vicinity of the 31st Street Bridge. Landscape management here can incorporate understory vegetation along the slope because the viewshed is to Herr's Island vs. the long views across the river.

South Bank

6.4 Sections of the Strip District Trail are well cared for – this overlook could be repeated in a number of places along the bank.

6.5 The Trail ends before the Cork Factory, where the bank was damaged by storms. Terracing will be needed to establish a basis for new sycamores.

6.6 The Three Rivers Trail is incomplete between the 16th Street Bridge end and 23rd Street (at pilings). Once completed, this link will require new canopy vegetation and coordinated management to maintain the same quality as the North Shore Trail.

6.1

6.2

6.3

6.4

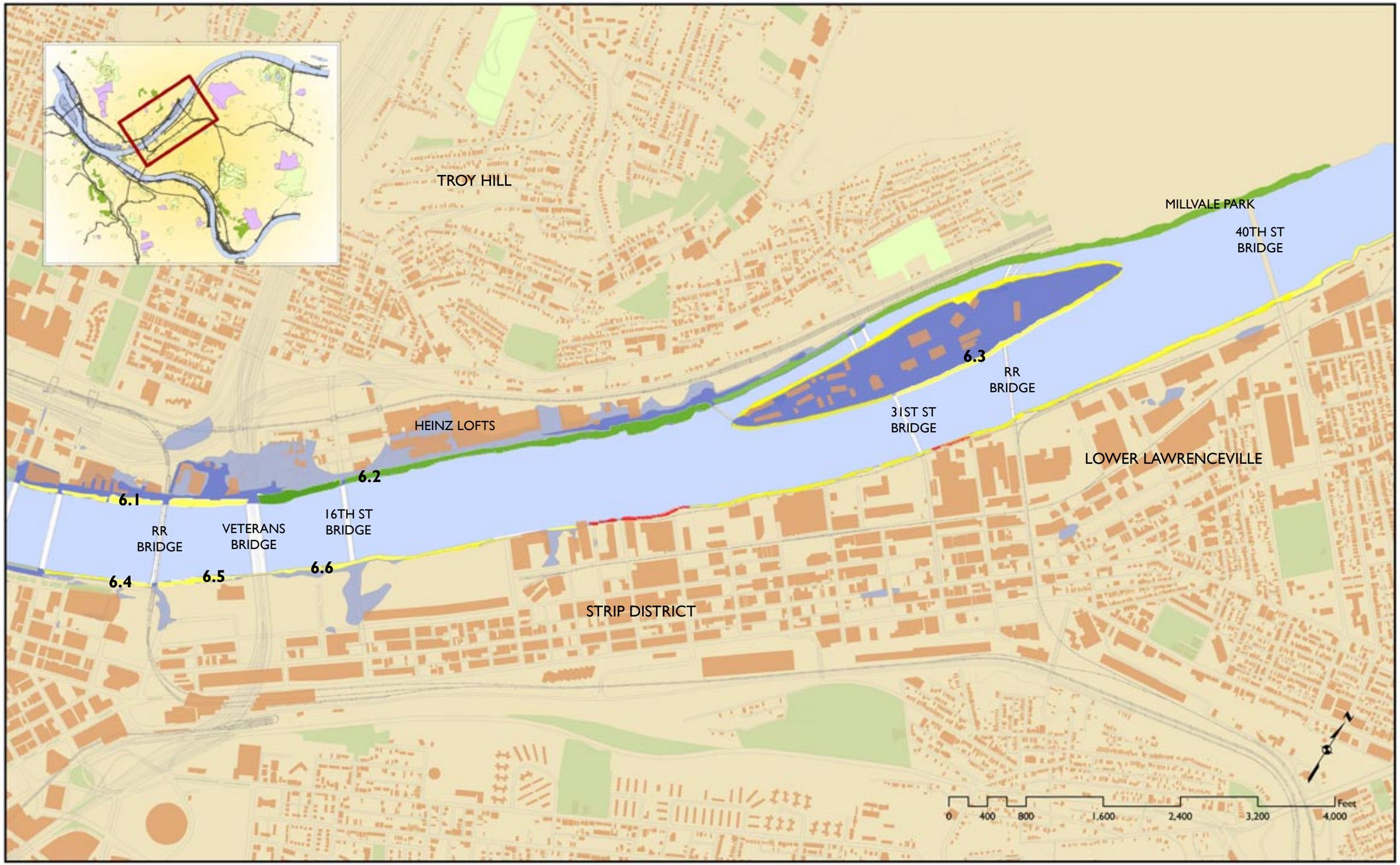
6.5

6.6

MAP LEGEND

- continuous canopy riparian vegetation potential for access
- intermittent canopy exotic vegetation potential for access
- varied canopy hardened edges problems for access
- 2004 Hurricane Ivan 31 ft flood crest
- 41 ft flood crest
- parks greenway trails
- cemetery

MAP 6 (opposite page). Allegheny River Strip District


TROY HILL
MILLVALE PARK
40TH ST
BRIDGE
6.3
RR
BRIDGE
31ST ST
BRIDGE
HEINZ LOFTS
LOWER LAWRENCEVILLE
6.2
6.1
RR
BRIDGE
VETERANS
BRIDGE
16TH ST
BRIDGE
6.4
6.5
6.6
STRIP DISTRICT
0
400
800
1,600
2,400
3,200
4,000
Feet

MAP 7 ALLEGHENY RIVER | MILLVALE & LAWRENCEVILLE

LAND USE | Condition

Below the town of Millvale, the river edge is Millvale Park, associated with canoeing, kayaking and family activities. The land on the north edge of Millvale is primarily used as a transportation corridor. Both the Route 8 highway and an active rail line are located in this area and extend for several miles. The south bank is completely industrialized and still in use.

Bank | Vegetation Character

Millvale Park has managed the river edge slopes, cutting woody shrubs and small trees that apparently obstructed views. At the mouth of Pine Creek, sediment and gravel deposits have built sufficiently to support a floodplain community of silver maple and sycamore. This stand of trees appears to have the greatest extent of floodplain character observed in the study area. The south bank, by contrast, is less well vegetated, with old seawalls, barge moorings and concrete outfalls at regular intervals.

PUBLIC ACCESS | River Use

Millvale Park has significant public access, including small craft boat launches and foot access along the bank. The Gateway Clipper fleet docks below the 40th Street Bridge. Above the bridge is a large boat launch area and marina. Upstream to the 62nd Street Bridge, the rail line prevents most river access. The south river bank has informal, unmanaged access from street deadends.

MANAGEMENT ASSESSMENT

North Bank

7.1 Millvale Park should receive immediate management attention because of excessive tree clearing along the bank. The management plan for this target area is included in the last section on page 12.

7.2 Sections of the Allegheny north bank illustrate how river access can occur while still maintaining riparian vegetation. Canopy tree management is of key importance.

7.3 Gravel bars have formed at mouth of Pine Creek, providing a substrate for temporary successional vegetation that will mitigate powerful erosive flows during storms. Culvert outfall should be kept free of large debris.

South Bank

7.4 Lower Lawrenceville has an active civic group who could be mobilized to manage this stretch of river corridor. The bank has been cleared along the top, perhaps due to adjacent industrial use and parking; canopy tree planting should begin immediately along the Lawrenceville Trail between 36th and 46th streets.

7.5 Banks such as this one that are cleared for access often invite dumping. The bare slopes to either side of the stairway should be stabilized with soil containment geotextiles and replanted with sycamore trees and silver maples.

7.1

7.2

7.3

7.4

7.5

MAP LEGEND

- continuous canopy riparian vegetation potential for access
- intermittent canopy exotic vegetation potential for access
- varied canopy hardened edges problems for access
- 2004 Hurricane Ivan 31 ft flood crest
- 41 ft flood crest
- parks greenway trails
- cemetery

MAP 7 (opposite page). Allegheny River Lawrenceville

SHALER

ETNA

PINE CREEK

7.3

7.2

7.1

7.5

62ND ST
BRIDGE

40TH ST
BRIDGE

7.4

LAWRENCEVILLE

UPPER LAWRENCEVILLE

0 400 800 1,600 2,400 3,200 4,000 Feet

MAP 8 ALLEGHENY RIVER | HIGHLAND PARK

LAND USE | Condition

The adjacent rail use continues to the 62nd Street Bridge and an old factory site. Above the bridge, the town of Sharpsburg is separated from the river edge by several lines of railroad track. The south bank is industrial, with buildings and paved areas situated very close to the river edge, at times with very little separation from the river. Above Lawrenceville, the rail line swings over to the top of the bank.

An old factory sits near the north bank at the upper end of Sharpsburg. Beyond the factory and opposite Six Mile Island is a large recreational marina. Along the south bank, the rail line runs parallel to the river edge through Morningside up to Highland Park.

BANK | Vegetation Character

The north river bank is mostly rock or concrete to the 62nd St Bridge, with intermittent vegetation in a narrow strip below the railroad. A sunken barge lies next to the bank above the bridge. Beyond 62nd St Bridge, the bank is well vegetated with floodplain species and water willows up to the Sharpsburg marina. The banks are cleared at the Sharpsburg marina. Along the south bank, the banks vary from moderately sloped to sheet pilings, with intermittent vegetation and a disturbed character from the adjacent uses. The rail corridor is better vegetated, with trees overhanging the river edge.

PUBLIC ACCESS | River Use

There is one marina in Sharpsburg – cars can park directly at the river edge. Another marina on the south bank is located just below the 62nd Street Bridge. The marina above Sharpsburg has two boat launch areas, one just below the dam. The south bank has no public river access.

MANAGEMENT ASSESSMENT

North Bank

8.1 An example of the water-willow/smartweed riverbed community, a native plant community that becomes established where depositional sediment develops along vegetated banks, or among rocks in the river.

8.2 Six Mile Island represents a terrific opportunity for conservation and ecological management. In the interim, it has become a deforested campsite with compacted, degraded banks.

South Bank

8.3 This river access is in better condition than many. Of significance is the fact that the banks remain well vegetated.

8.4 This section of river, above and below the Highland Park-Aspinwall Dam, represents a great opportunity for coordinated restoration and management with the Park.

8.1

8.2

8.3

8.4

continuous canopy
riparian vegetation
potential for access

intermittent canopy
exotic vegetation
potential for access

varied canopy
hardened edges
problems for access

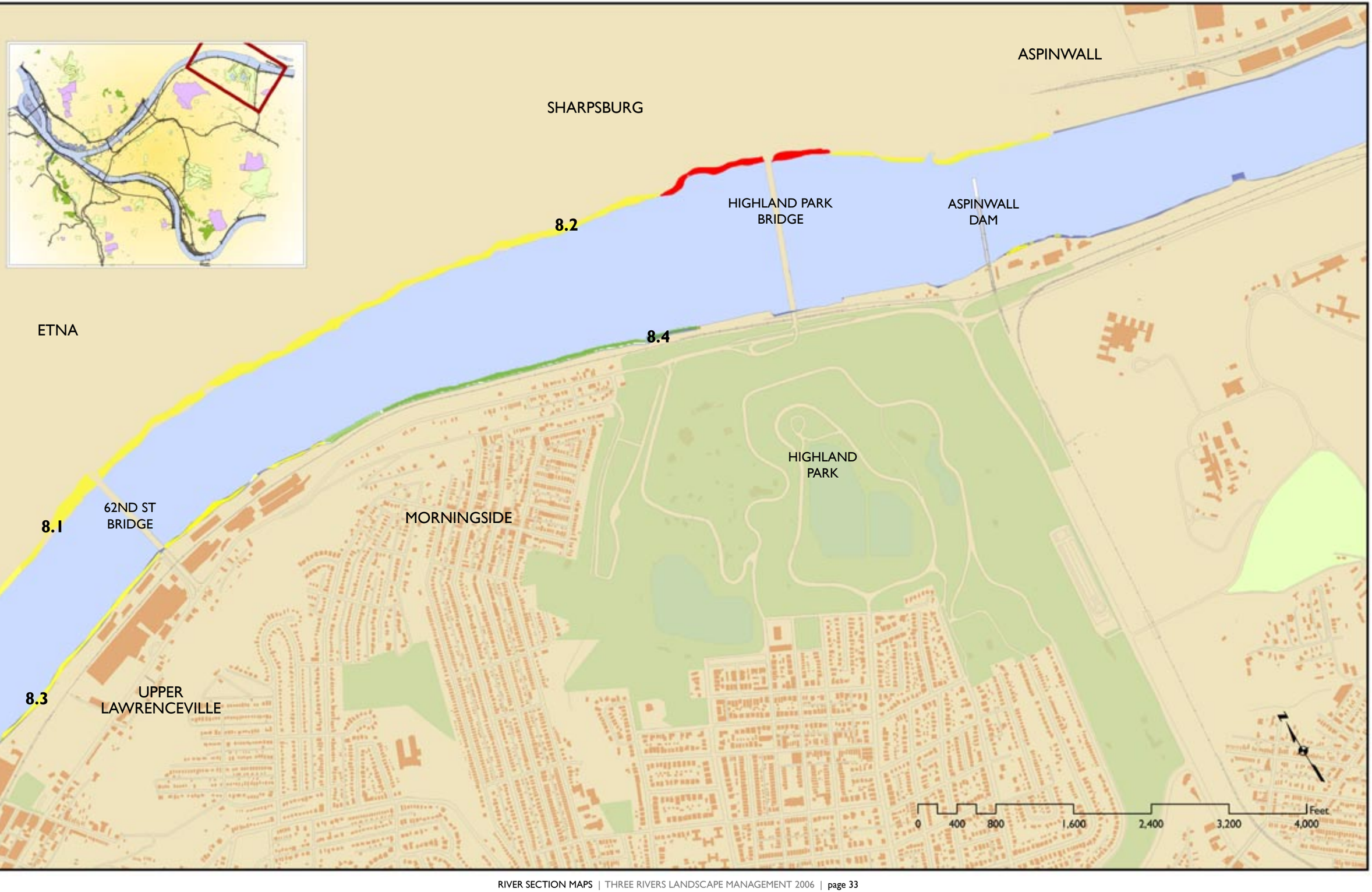
2004 Hurricane Ivan
31 ft flood crest

41 ft flood crest

parks
greenway trails

cemetery

MAP 8 (opposite page). Allegheny River HIghland Park


ASPINWALL
SHARPSBURG
HIGHLAND PARK BRIDGE
ASPINWALL DAM
8.2
ETNA
8.4
HIGHLAND PARK
62ND ST BRIDGE
8.1
MORNINGSIDE
8.3
UPPER LAWRENCEVILLE
0
400
800
1,600
2,400
3,200
4,000
Feet

MANAGEMENT TECHNIQUES

"the presence of relatively intact floodplain River Bed / Bank Forest complexes and elements of the native forests throughout the region means that restoration of our riverbanks could be expected to have a high probability of success" Kalisz and Dunn (2002) p4.

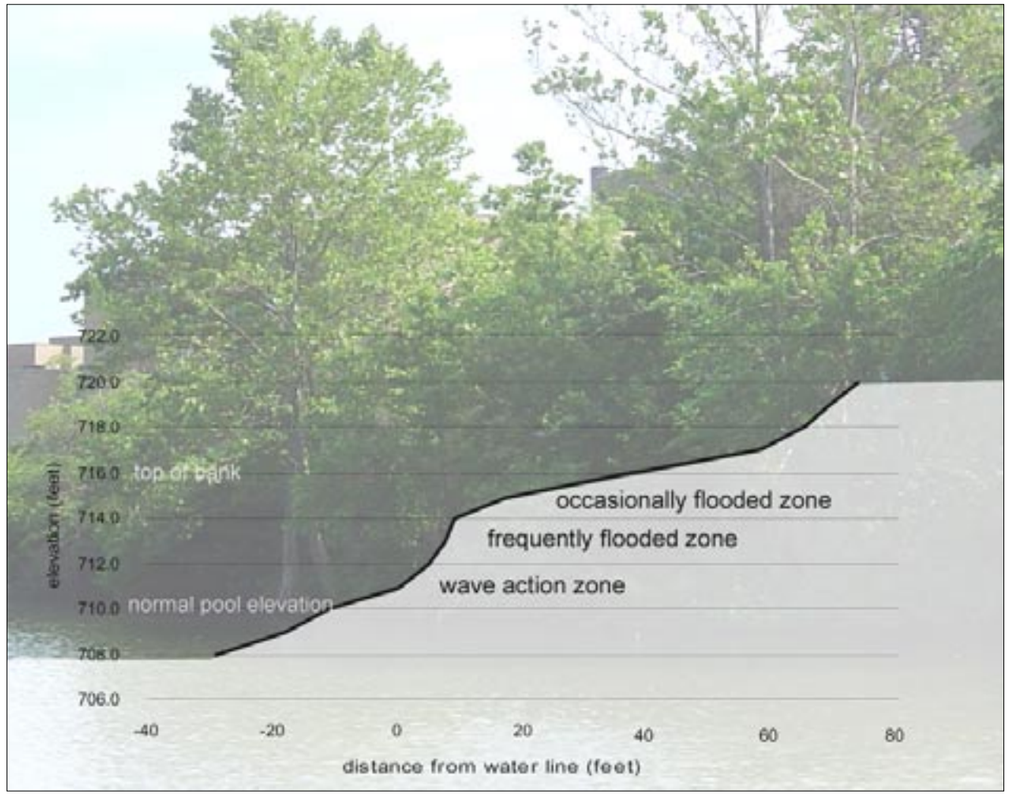


FIGURE 13. Riparian Zones within the Pittsburgh Pool

At Millvale Park flood waters have scoured banks below the 712 elevation – shown as dotted line. Bioengineering is needed to establish plants in this zone.

RIVER EDGE ZONES

A riverbank is the dynamic interface between flowing water, plants and soils of the surrounding lands. Consequently, it is the focus of restoration efforts for waterfront properties. Flood events affect the shoreline differently than normal water levels and river flows. Wave and wake action impact the river bank at all times and need to be mitigated in some way that avoids the use of hardscape materials – such as seawalls and standard rip-rap. A combination of plantings and soft armoring strategies can impart long term stability for the banks, preserving property values and provide accessibility to the river edge.

The river edge is divided into zones, as shown in Figure 11, representing different elevations above the mean pool elevation of +710 feet above sea level. These zones suffer from different stresses in the varying stages of water levels and therefore require different methods of stabilization.

Wave Action / Ice Scour Zone at +710 to +712 elevation

From the normal pool level to approximately two feet above mean low water (MLW), wave action and ice scour are the dominant forces shaping the riverbank. Whether they are wind-driven waves or the wake of passing commercial and recreational vessels, the frequent occurrence of waves creates an environment that is difficult to repair and vegetate. Even if a seed finds its way onto an open patch of shoreline, the likelihood that it will survive to maturity is low. Waves dislodge soil particles and create a shifting river bank that remains in a perpetual state of early succession. Without woody vegetation to absorb the energy of waves crashing into the shoreline, the cycle repeats itself with each growing season. In winters that see the rivers freeze over, pack ice scours the shorelines further removing soils and young plants from the lower portion of the bank. When enough material is removed from the base of the bank, the undermined soils above slough off and replenish the "beach" at the rivers edge. Within the urban environment however, the armoring of slopes behind the river bank prevents this replenishment from occurring. This explains the lack of vegetation in the urban riverfronts and the lack of shallow banks/ beaches.

In this wave-ice action zone, several tools can jumpstart plant succession to produce mature vegetation stands which will stabilize the shoreline. Geotextile soil socks can be filled and buried in the bank parallel to the river to provide stable, fertile soil for restoring plant communities. Geocellular mats can be stacked and filled with soil on steeper slopes. Boulders and large logs can be strategically placed to protect plantings as well, and can serve the dual purpose of providing human access points to the water.

Plantings in this wave-ice action zone can be installed by traditional methods of seeding, containerized plants and balled-and-burlapped (B&B) plants. Brush layering, wattling, and live staking are also possible as these areas are well within the capillary zone, which is the soil area above the water table where water can rise up slightly through the cohesive force of capillary action. Riverbank soils wick moisture from the river itself even during low water periods and can thus sustain the tender vegetation generated by these techniques. Seeds and container or B&B plantings must be adequately protected from wave and ice action to succeed. The boulders and logs can provide this while maintaining a natural appearance to the shoreline. Wattling, layering and live stakes can be installed within the geocellular or geotextile sock installations provided there is adequate moisture to support such techniques. Plant species in this zone will be typically floodplain species adapted to frequent flooding, potentially during the growing season. See appendix for a list of species.

Frequently Flooded Zone at +712 to +714 elevation

Above the wave-ice zone is a zone 2-4' above MLW which is less frequently disturbed by wave and wake action. This infrequent wave-ice zone is however still within the capillary fringe and can be revegetated with similar techniques to the wave-ice action zone just downhill. Where soils have been lost to erosion, replacement can occur with geocellular confinement and live staking and brush layering. Traditional B&B and container plantings can be more liberally used in this zone but still need to be protected with boulders or similar natural armoring to prevent plant loss during large flooding/pack ice events. Plant species for the infrequent ice-wave zone will include species that occur in both wetland and upland environments in nature.

Occasionally Flooded Zone at +714 to +715 elevation

Beyond MLW+4', wave and ice action are very infrequent and have less impact on planting restoration methodologies. Soil at four feet above the river still lies on the fringe of available capillary water, and cannot support live staking and brush layering techniques. Herbaceous seeding, containerized and B&B plantings can be used in areas four feet above the river surface to restore a site, and as the land rises further away from the waters edge, plantings must be adaptable to dry conditions as well as the potential for flooding.

Top of Bank Zone at +715 elevation and above

Above MLW+5, bioengineered methods are not effective as this elevation is above the fringe of available capillary water. Containerized and B&B plantings of woody vegetation are recommended for their greater root mass and increased capacity to hold the river bank in place.

RECOMMENDED PLANTS BY RIVER EDGE ZONE

Wave Action / Ice Scour Zone +710 to +712
Frequently Flooded Zone +712 to +714

The plant palette for this zone is based on the box-elder sycamore floodplain forest typical of the Monongahela River (Kalisz 2003). The emphasis is on plants that can be used in live staking and brush layering – these are annotated in the list as such. Herbaceous plants are suggested for context – the bulk of the planting needs to be woody vegetation. Plants and bioengineering materials listed here are available at Ernst Conservation Seeds, www.ernstseed.com.

From left to right: Shrub dogwood, Elderberry and Black willow are excellent for bioengineering within flood zones

Trees	
Acer negundo	Box Elder
Alnus serrulata - L	Smooth Alder
Platanus occidentalis	Sycamore
Salix nigra - L*	Black Willow

**not recommended for areas needing knotweed suppression*

Shrubs	
Aronia arubutifolia	Red Chokeberry
Aronia melanocarpa	Black Chokeberry
Aronia prunifolia	Purplefruit Chokeberry
Amorpha fruticosa - B	False Indigo
Cephalanthus occidentalis - L	Buttonbush
Cornus amomum - LB	Silky Dogwood
Cornus stolinifera - LB	Red Osier Dogwood
Ilex verticillata	Winterberry
Lindera benzoin	Spice Bush
Lyonia ligustrina	Huckleberry
Physocarpus opulifolius	Nine Bark
Rhododendron arborescens	Sweet Azalea
Rhododendron nudiflorum	Pinxterbloom Azalea
Ribes americanum	American Black Current
Saliz discolor - L	Pussy Willow
Salix lucida - LB	Shining Willow
Salix sericea	Silky Willow
Salix exigua - L	Sandbar Willow
Sambucus canadensis - B	Elderberry
Spiraea alba	Narrowleaf Meadowsweet
Spiraea tomentosa	Hardhack Spiraea
Viburnum dentatum - B	Arrowood Viburnum

L = live stake
B = brush layering

Perennials/Ferns/Grasses/Vines	
Asclepias incarnata	Swamp Milkweed
Chelone glabra	Turtlehead
Elymus riparius	Riverbank Wild Rye
Eupatorium purpureum	Joe Pye Weed
Juncus effusus	Soft Rush
Lobelia cardinalis	Cardinal Flower
Lobelia spicata	Great Blue Lobelia
Matteuccia struthiopteris	Ostrich Fern
Mimulus ringens	Monkey Flower
Vernonia noveboracensis	New York Ironweed

FIGURE 14. Wave action zone planting relies on easily established species - sycamores and willows

FIGURE 15. Occasionally flooded river edges should be planted with vigorous plants that compete successfully with weeds

From left to right: Joe pye weed, New York ironweed and Ox-eye sunflower tolerate inundation and also thrive in more upland environments

Occasionally Flooded Zone +714 to +715

The plant palette for this zone is derived from the silver maple floodplain forests typical of the Allegheny River banks (Kalisz 2003). The emphasis is on tough, adaptable plants that thrive in more upland riparian environments.

Trees

Acer negundo	Box Elder
Acer rubrum	Red Maple
Acer saccharinum	Silver Maple
Carya ovata	Shagbark Hickory
Fraxinus pennsylvanica	Green Ash
Platanus occidentalis	Sycamore
Populus deltoids	Eastern Cottonwood
Prunus serotina	Black cherry
Quercus bicolor	Swamp White Oak
Ulmus americana	American elm
Ulmus rubra	Slippery elm

Shrubs

Cornus racemosa	Gray Dogwood
Physocarpus opufolius	Ninebark
Rubus alleghenensis	Allegheny Blackberry
Rubus occidentalis	Blackcap Raspberry
Salix humilis	Prairie Willow
Staphylea trifolia	Bladdernut
Viburnum dentatum	Arrowwood viburnum

Perennials/Ferns/Grasses/Vines

Adiantum pedatum	Maidenhair Fern
Aquilegia canadensis	Wild Columbine
Arisaema triphyllum	Jack in the Pulpit
Aster novi-belgii	New York Aster
Aster umbellatus	Flat-topped Aster
Cimicifuga racemosa	Black Snakeroot
Elymus canadensis	Wild rye
Eupatorium purpureum	Joe Pye Weed
Helianthus heliahthoides	Oxeye Sunflower
Lilium superbum	Turk's Cap Lily
Mertensia virginica	Virginia Bluebells
Mimulus ringens	Monkey Flower
Osmunda cinnamonea	Cinnamon Fern
Polygonatum pubescens	Solomon's Seal
Sanguinaria canadensis	Bloodroot
Sisyrinchium angustifolium	Blue-eyed Grass
Smilacina racemosa	False Solomon's Seal
Vernonia noveboracensis	New York Ironweed

Top of Bank Zone +715 and above

The plant palette for this zone is primarily that of an upland mesic successional community. Most of the trees from the previous lists will do well, assuming they are planted within the riparian area. Emphasis for both planting and maintenance should be on establishment of a solid native groundlayer.

Trees	
Acer rubrum	Red Maple
Amelanchier canadensis	Serviceberry
Celtis occidentalis	Hackberry
Cercis canandensis	Redbud
Cornus florida	Flowering Dogwood
Fraxinus pennsylvanica	Green Ash
Juniperus virginiana	Red Cedar
Liriodendron tulipfera	Tulip Poplar
Platanus occidentalis	Sycamore
Populus deltoids	Eastern Cottonwood
Quercus alba	White Oak
Quercus rubrum	Red Oak

Shrubs	
Cornus racemosa	Gray Dogwood
Cornus alternifolia	Alternate-leaved Dogwood
Hamamelis virginiana	Witch Hazel
Rhododendron maximum	Rosebay Rhododendron
Rhus typhina	Staghorn Sumac
Rhus glabra	Smooth Sumac
Rubus alleghenensis	Allegheny Blackberry
Rubus occidentalis	Blackcap Raspberry
Viburnum dentatum	Arrowwood viburnum
Viburnum nudum	Swamphaw viburnum
Viburnum prunifolium	Blackhaw viburnum

Perennials/Ferns/Grasses/Vines	
Andropogon virginicus	Broomsedge
Asclepias tuberosa	Butterflyweed
Aster cordifolius	Heart-leaved aster
Aster novae-angliae	New England aster
Chasmanthium latifolium	River Oats
Clematis virginiana	Virgin's Bower
Coreopsis spp.	Coreopsis
Helianthus spp.	Sunflower
Monarda didyama	Bee Balm
Panicum virgatum	Switchgrass
Penstemon digitalis	Beard Tongue
Tiarella cordifolia	Foam Flower
Parthenocissus quinquefolia	Virgina creeper
Physostegia virginiana	Obedient Plant
Schizacrium scoparius	Little Bluestem
Sorghastrum nutans	Indiangrass

FIGURE 16. Upland meadow buffers planted next to lawn – as illustreated here at Southside Park – can slow runoff to rivers

Upland plantings can be managed as informal parkland where adjacent to trails and other recreational uses

PLANTING TECHNIQUES

These are common techniques employed by most landscaping companies. The key things to remember are planting depth – neither too deep nor too shallow – and having an adequate size root-ball hole. Plants, whether woody plants or herbaceous plants, should be planted so that the base of their stems is level with the soil, and the entire root mass is below grade in direct contact with soil. Larger woody plants require a larger hole – up to 3 x the size of the root – or at the least an area of loosened soil to allow the roots expansion room. As the roots go, so grows the plant.

Containers and Balled-and-burlapped plants: This is the most conventional method of planting, used in the vast majority of plantings in commercial and residential projects. They allow the largest size of trees and shrubs to be installed and provide instant effect.

Bare root trees and shrubs can be planted at less expense, but sizes are limited and the species selection is not as broad as container and B&B plants.

Cuttings is a long-established method of propagation, commonly used in the nursery trade, and is the basis for live stake and live pole plantings. Willows (*Salix spp.*) propagate well, followed by *Alnus spp.*; *Cornus spp.; Populus spp*. Plant species that have less than 30% rooting ability ought not to be considered for use. Plants one to three years in age are best, but older plants can be used as well. Plants are best harvested while the plants are dormant, stored for no more than one week, and planted at the beginning of the growing season as the buds begin to break. If stored, cuttings should be sprayed or immersed in water. Rooting hormones may be desirable for species such as *Amelanchier, Betula, Corylus, Prunus* or *Rubus*.

Herbaceous plugs are basically like flats of annuals that most people are familiar with from planting flowers at their homes. Plugs are grown deeper (5"+) to allow installing a larger plant for a lower cost and are typically used on restoration projects with limited budgets. Plugs are effective methods of establishing meadow and wetland habitats.

Seeding is the cheapest method of plant introduction but takes the longest to establish. While we typically think of seeding being used for lawns, it can also be used for meadow plantings of warm-season grasses and flowering perennials Meadows are an underutilized landscape type in properties that cannot afford concentrated landscape maintenance. Seeding can also be used in combination with plug plantings to augment the diversity of a site with little additional cost.

- When obtaining seed for meadow planting, always ensure that pure live seed is being purchased, free of stems, chaff and – most particularly – weed seeds.

Sod is also thought of as solely for turf grasses but several growers are producing sod with meadow plantings, green roof plantings and wetland restoration plantings and this type of planting should be considered where a more instant restoration to native plants is desired.

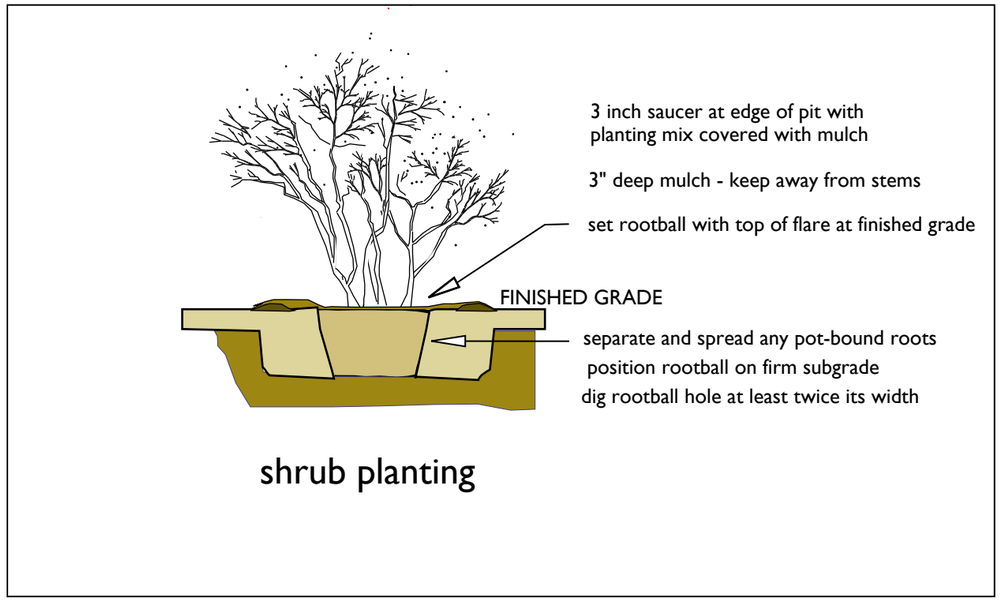


FIGURE 17. Typical Panting Detail – emphasizes care of root mass



Drill seeding is an effective way to establish a meadow planting
From left to right: Drill seeder, drill seeded pattern on prepared site, seeded meadow 2 years after seeding

BANK STABILIZATION TECHNIQUES

In the past riverbanks were stabilized with bulkhead seawalls, rip-rap and other hard materials to "fix" the problem of erosion which we now recognize as a normal, natural process. With existing development in close proximity to the rivers' edge the need to stabilize the banks has not gone away, but design professionals now have a number of softer techniques which use nature's ability to stabilize river banks without the use of artificial materials. Some methods rely on some synthetic materials to help jumpstart plantings along the riverbank, but eventually these techniques rely on plant roots to stabilize the river bank.

Bioengineering

Another method to decrease costs for installation of large swaths of plants along river banks is to propagate plants in situ from live cuttings. Although the species list is limited, these methods can help stabilize a steep river bank where the slope steepness and erosive forces of floodwaters prevent planting using traditional methods. Willows (Salix spp.) naturally contain rooting hormones within their bark and will take root and grow in a riverbank if properly harvested and installed. Other native species that can be used alongside Willows in vegetative methods include Cornus sericea, Red-osier dogwood; Physocarpus opulifolius, Nine-bark; Cephalanthus occidentalis, Buttonbush; Populus deltoides, Eastern cottonwood and Bigtooth aspen. These species can only be a small percentage of plants used, as they do not root as readily as do Willows. Methods of propagation vary as to the riverbank environment and type of vegetation needed. *See Planting Techniques* on page 39 for information on gathering cuttings.

Three sizes of live-cut plant material are used in the various techniques briefly described below. Live poles are 3+ inches in diameter and typically come from main branches of large trees being harvested. Live stakes are 1-3 inches in diameter, 1 ½ - 3 feet long, and can come from trees or large shrubs. Bundled stems are 8-12 inches in diameter with the stems of varying size (3/8-2 inches in diameter) with terminal buds remove to encourage branching.

Live Stake Plantings (also called cuttings)

Live stakes are one of the least expensive and most effective ways to secure the toe and lower slope of a streambank. Live stakes are always harvested when dormant and planted just before dormancy breaks in late winter / early spring.

- Cut stakes from live shrubs or trees. Use the base of the plant, not the growing tip.
- Cut lengths at least 18 inches to 3 feet long
- Make a point on the butt end of the stake with a sharp tool
- Tamp the cutting into the bank using a shot filled or wood mallet – tap gently to avoid damaging root sprouting capability
- The deeper the cutting is set, the better. Bury up to 4/5 of stem in ground.

Live Pole Plantings

These are larger cut branches/trunks installed vertically in bored holes in river bank. Post plantings may be installed into riprapped banks to begin revegetating barren areas of the river edge. Willows and Cottonwoods work especially well.

- Technique similar to live staking
- Cut lengths from main branches of trees, 4-10 feet long, 3+ inches in diameter
- Remove lateral branches with chain saw
- Make a point on the butt end of the pole with a sharp tool
- Make a hole in the bank by hammering in a length of rebar. The hole ought to be at least 1/2 the length of the pole.
- Drive the pole in using a board to protect the top. Plant at least half the pole in soil.
- Cut off the top damaged portion of pole.

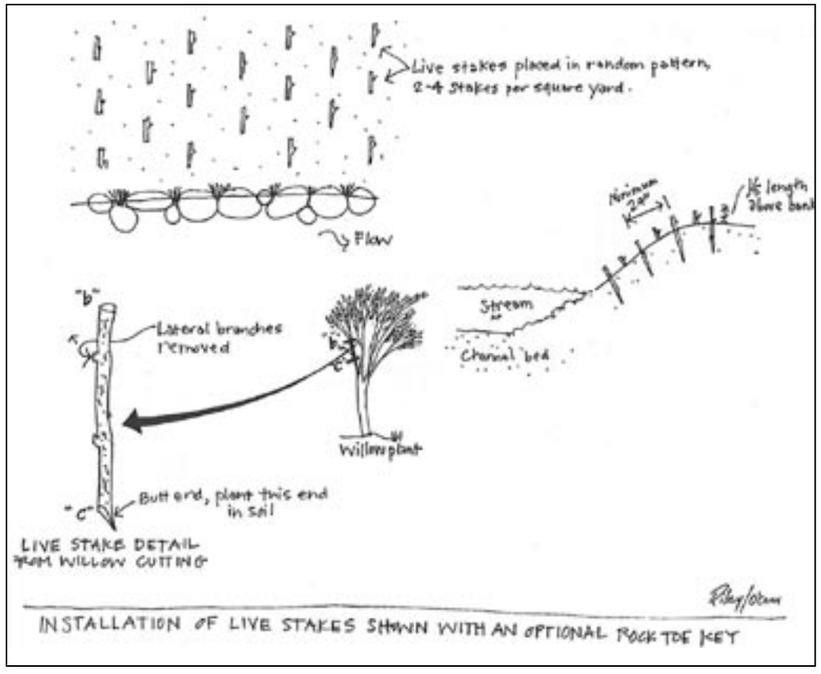


FIGURE 18 Diagram of Live Stake Installation (Riley, Restoring Streams, p373)

Photograph of restored stream on corporate campus planted with live willow stakes inserted into fiberschines. The fiberschines not visible.

Brush Layering

An old technique given new emphasis by the modern stream restoration movement, brush layering is a method of stabilizing slopes by layering in live or dead branches in terraces parallel to the contours. Key points to remember:

- Begin cutting terraces at the toe of the slope
- Grade individual terraces down into the slope so branches can root along their length
- Branches should be at least 3 feet long and should not stick out of the terrace more than 1/5 or 1/4 of their total length
- Mix branches of different species as well as different age and thickness
- Combine with erosion control fabric for uphill stabilization

Brush Mattresses

Similar to brush layering, these are mats of cut stems laid on top of the riverbank, embedded in the toe of the slope. Can be combined with fiberschines, fascines/wattles, seeding, plugs, live stakes.

Brush Trench or Fence (also called hedge brushlayer)

These are vertical bundles parallel to the shoreline buried in one or more trenches at the top of the bank. Brush trenches or hedges are good for filtering runoff at top of bank and top of bank stabilization.

Photo of Nine Mile Run stream restoration courtesy of Nine MIle Run Watershed Association

FIGURE 19. Diagram of brushlayer construction: The Practical Streambank Bioengineering Guide

FIGURE 20. Diagram of brushlayering showing different sizes of plant material and slope of trench (Schiechtl, Bioengineering, p54)

FIGURE 21. Brushlayering in terraces (Riley, Restoring Streams, p378)

FIGURE 19.

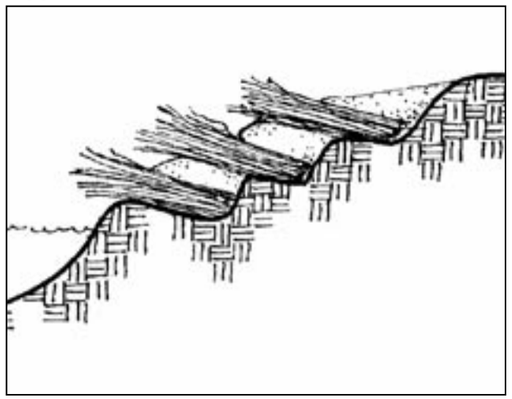
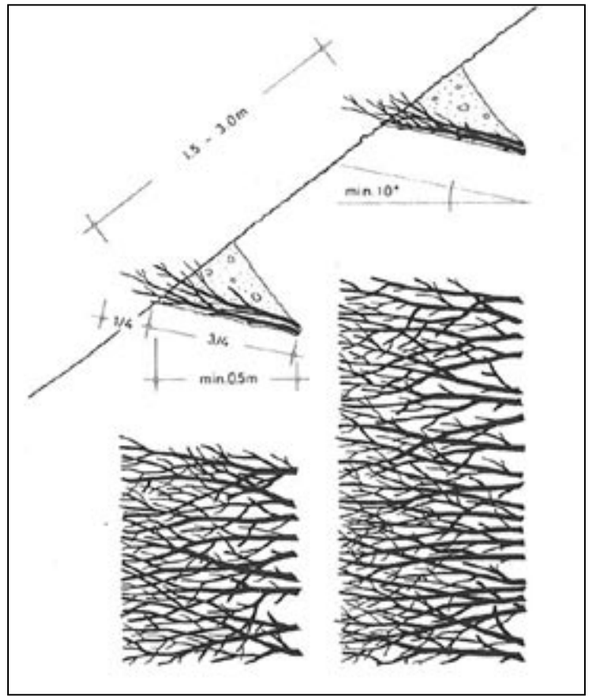


FIGURE 20.



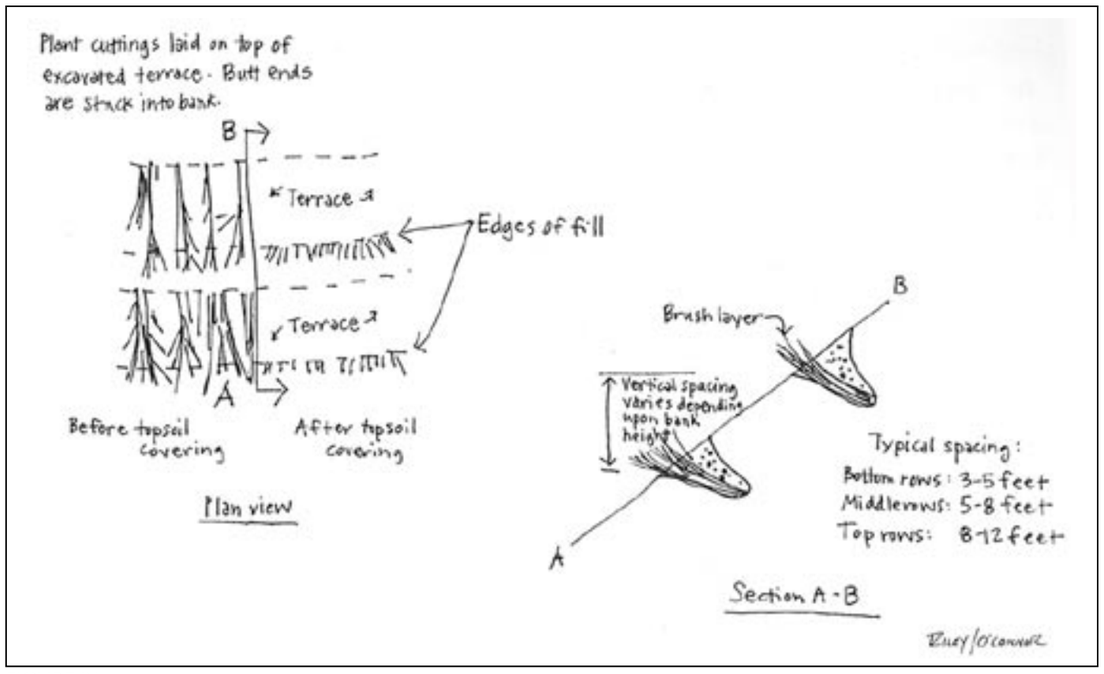


FIGURE 21.

Fascine Bundles or Wattles (also called fiberschines)

Like brush layering, fascines are an old European technique for revegetating slopes. Fascines are built from live branches or stakes into long sausage-like bundles, about 6-10 inches in diameter. The fascines are tied together with wire or cord at distances of approximately two feet and buried lengthwise in trenches parallel to river edge at toe of or in the middle of the bank.

- Cut very long live branches for fascines – 6 to 12 feet – during the dormant season.
- Mix cuttings from a few riparian species to increase chances of survival.
- Bundle fascines alternating butt ends together with growing tips.
- Place fascines into trenches cut along the slope contours and secure with live or dead pegs.
- Drive pegs completely through fascines and into ground, minimum 12 inches deep.
- Cover fascines completely with soil. Tamp by walking over trench so that branches are embedded and can take root.

COMBINED VEGETATED | STRUCTURAL TECHNIQUES

Fiberschines (Coir Logs or Tubular Geotextiles)

As a variant on fascine bundles, fiberschines, or long "sausages" of ground coconut fibers, can be staked into the toe of a bank at the rivers edge to prevent wave action from eroding the slope further. As long as the fibers are in contact with the river or ground water and remain moist throughout the year, small plants (plugs) can be installed directly in the fiber "log." As the plants mature over several growing seasons and develop a root mass that can protect the shoreline from eroding, the fiber logs are no longer needed and break down to nourish the soil and plants.

Fiberschines can also be used further up the slope for erosion control, by shortening the length of the river bank. Water gets held behind the miniature berm and has a chance to infiltrate into the soil. When used higher up the bank, the logs will dry out in warmer weather and plants can only be installed up or downhill from the logs, not directly in the fibers, but the stabilization effect is the same.

From Pinelands Nursery Website www.pinelandsnursery.com
Coir Log Installation Guide

"Proper staking is critical for a successful installation. An adequate number of stakes must be used to insure that the logs are not dislodged from the shoreline. On very low energy sites, such as small ponds, as few as 7 stakes per log can be used. The stakes should be placed on the water side of the log and inserted through the netting. On medium energy sites, at least 10 stakes should be used per log. If there is any chance that the log could be moved by fast water or lifted by ice in the winter, the logs should be cinched to the bottom using the technique shown in Figure 3. On high energy sites, such as large lakes or fast moving bodies of water, a minimum of 17 stakes should be used."

"The logs should be placed so that about 1/2 of the log is submerged. Normally, the plants are installed in a "zig-zag" pattern into the top of the log. Try to install the plants an inch or so deeper into the log than the depth of the plant plug. It is very important that the plants have an adequate amount of moisture wicking up through the coir fiber to their root systems. When the logs are installed in low water conditions, it is acceptable to install the plants into the side of the log. Under no circumstances should plants be installed into logs that are not at least partially in the water unless the plants can be irrigated."

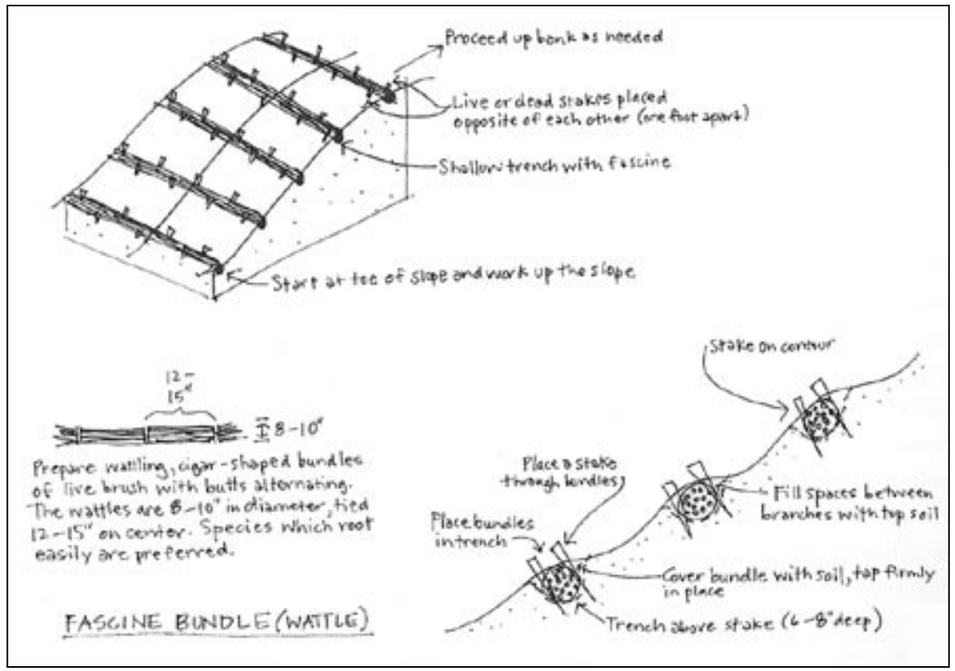


FIGURE 22. Diagram of Fascine Installation (Riley, Restoring Streams, p376)

Photo of fiber roll, a commercially produced stream stabilization product with a similar concept to fascines. Fiber rolls are usually made of rolled coconut fiber secured with webbing. They may be shipped with wetland plugs inserted into the rolls.

Brush/Tree Revetment

Live or dead tree/brush anchored in place at toe of slope to encourage sedimentation to allow for plantings along slope.

- Used for slope toe stabilization
- Use in combination with plantings and bioengineering methods

Root Wads

Large stumps or logs with roots still attached

- Used for slope toe stabilization and anchoring ends of bioengineering methods.

Boulders

Naturally-cleft local stone used to armor slopes where vegetative methods

- Used for slope toe and mid slope stabilization
- Used to anchor ends of bioengineering methods such as fiberschines, fascines, brush layering, etc.

Erosion Control Fabric

Coconut fiber (coir), jute, or straw blankets laid on the river bank to temporarily increase erosion resistance of soil.

- Used for slope stabilization
- Combine with seeding, plugs, live staking
- Used in combination with most other bioengineering methods

Photos of Nine Mile Run restoration showing root wads and natural boulder stabilization

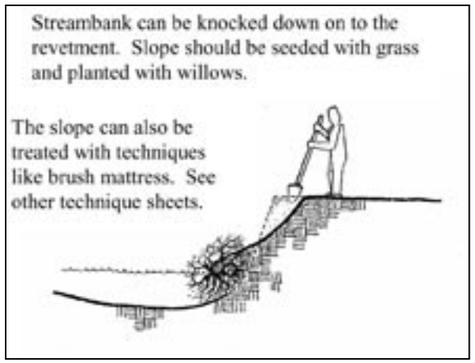


FIGURE 23.

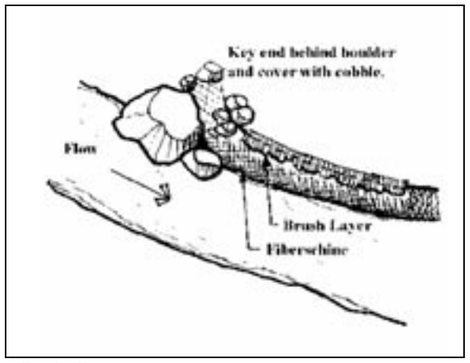


FIGURE 24.

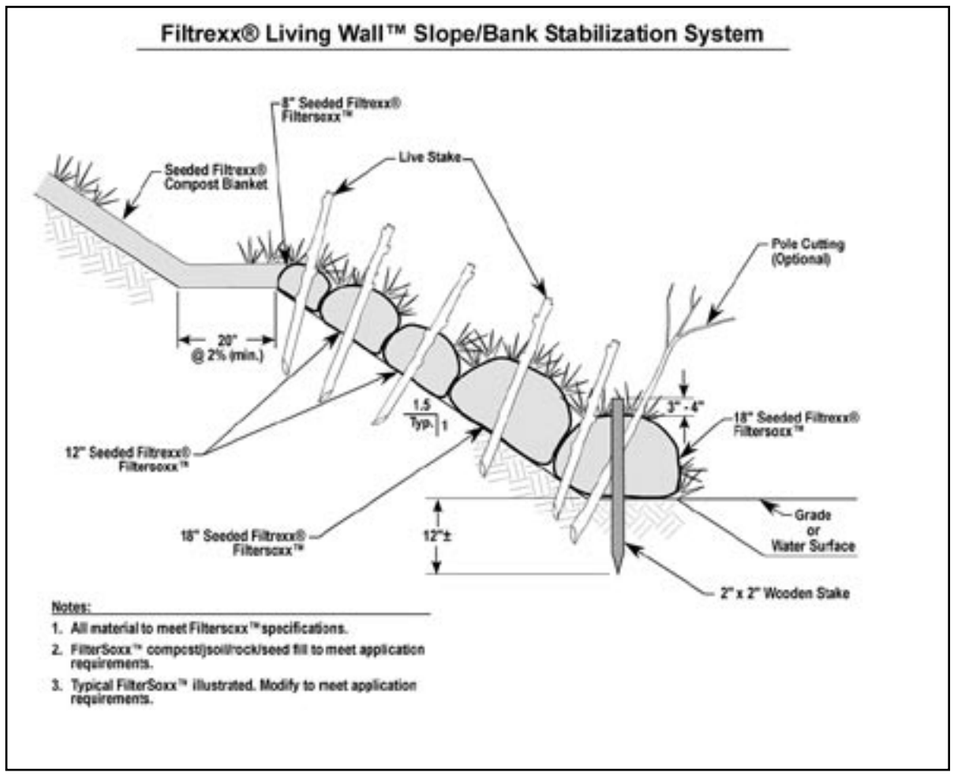


FIGURE 25.

FIGURES 23 & 24. Ilustrations of Revetments and Boulders anchoring edge of toe stabilization, The Practical Streambank Engineering Guide
FIGURE 25. Detail of Filtresx Living Wall, www.filtrexx.com

SOIL BINDING TECHNIQUES

These techniques are useful where wave action and scour undermine vegetative stabilization. They can be particularly useful when replacing gabions or armored slopes. TRMs and geocellular mats work with or without vegetation, though vegetation aids in the stabilization process. Professional assistance from engineers or experienced contractors is recommended for design and installation.

- Technical information on these techniques can be found at Soil Stabilization Products (www.sspco.org, www.fixsoil.com, or many state highway department websites)

Soil Sock Stabilization Systems

Soil socks can be staked or dug into banks to provide greater protection and bank security. Like erosion blankets, they are best used in combination with vegetative systems.

- Proprietary systems include Filtrexx Living Wall System (www.filtrexx.com)

TRMs (Turf reinforcement mats)

Turf reinforcement is a method where the natural ability of plants to protect soil from erosion is enhanced through the use of geosynthetic materials. A flexible, three-dimensional matrix retains seeds and soil, stimulates seed germination, accelerates seedling development and meshes with developing plant roots and shoots. Composite turf reinforcement mattings contain both degradable organic and nondegradable synthetic components, which work together to increase the erosion resistance of vegetation to that of 24 inch rock riprap.

- Technical information available at North American Green (www.nagreen.com)

Geocellular Containment Structures

Geocellular Containment Structures were developed in partnership with the US Army Corp of Engineers as an alternative to sheet pilings, concrete retaining walls and riprap for stabilizing highly scour prone channels. Geocellular containment systems achieve their stability by means of a honeycomb-like structure up to 20cm (8 inches) thick. Once in place, the system can be backfilled with soil, sand or gravel. The cells can be seeded with riparian plants prior to backfilling; however, vegetation is not recommended in highly scour-prone situations. In such instances, the cells can be filled with concrete or grout to create a hard-armor system that is easy to install.

- Proprietary Geoweb® system available from Presto Products Company (www.alcoa.com)

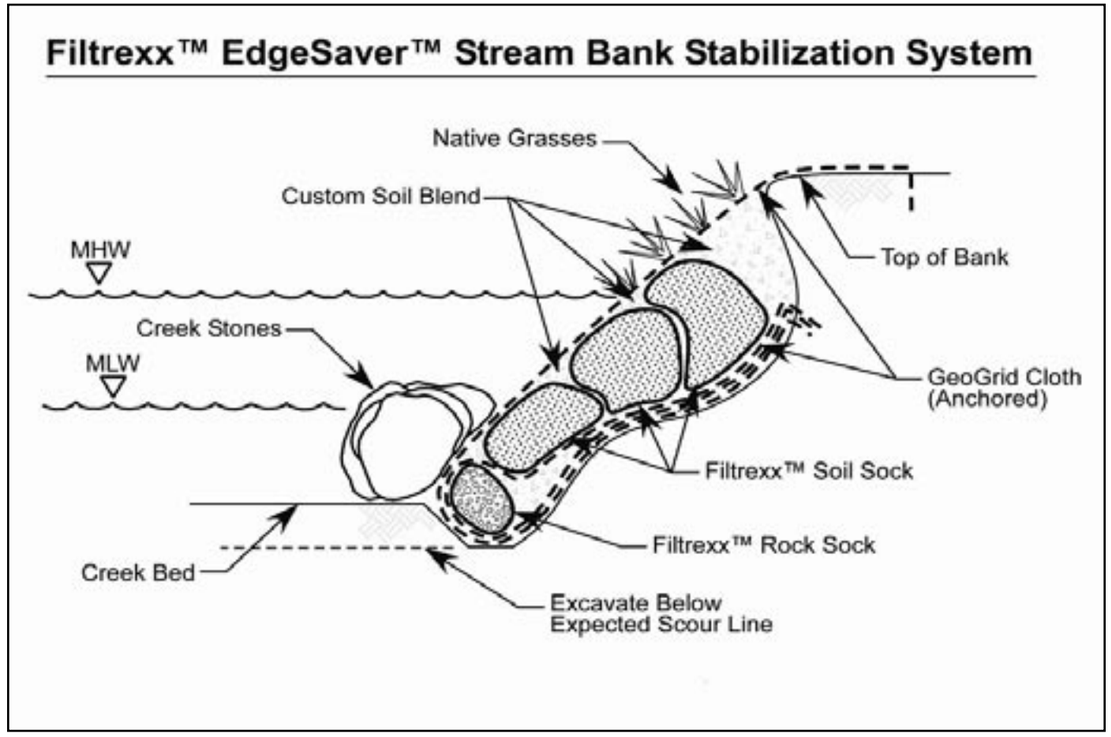


FIGURE 26. Toe Protection requires anchoring stabilization system below expected scour line to prevent undermining of slope

INVASIVE SPECIES IDENTIFICATION

Many resources now exist for learning about invasive plants and control measures. This section is not intended to be inclusive, but to give an overview of the most problematic invasive exotic plants within the Pittsburgh Poolwaterfront and to provide an introduction to methods of controlling their spread. The Pennsylvania DCNR website maintains a list of invaaive exotic plants (http://www.dcnr.state.pa.us/forestry/invasivetutorial/List.htm), along with resources and guidelines for eradication and treatment.




TREES

Tree of heaven	Ailanthus altissima

SHRUBS

Amur honeysuckle	Lonicera maacki
Rosa multiflora	Multiflora rose

FORBS

Purple loosestrife	Lythrum salicaria
Japanese knotweed	Polygonum cuspidatum

VINES

Oriental bittersweet	Celastrus orbiculatus
Japanese dodder	Cuscuta japonica



All photos except japanese dodder courtesy of USDA Forest Service, Invasive Plants of the Eastern Unitied States CD-ROM USDA APHIS PPQ Archives (www.invasive.org/eastern)
Upper row: Tree of heaven, Amur honeysuckle, Multiflora rose, Purple loosestrife
Lower row: Japanese knotweed, Oriental bittersweet, Japanese dodder (photographed at Southside Park August 2005)

INVASIVE SPECIES MANAGEMENT

RULES OF THUMB

Avoid use of invasive species in landscapes. Although many states list ornamental species as invasive plants, local nurseries still sell them to the public. Owners need to insist upon using native species or at a minimum non-invasive exotic species on their properties.

Minimize disturbance and revegetate disturbed areas. First and foremost, protect intact native plant communities. Enhance remnant communities with additional plantings and reduce disturbances to the ground plane – install protective fences for construction sites, confine pedestrian/bicycle use to trails, etc. Many invasive species are pioneer plants that colonize a site after disturbance (fire, landslide, flood, human development, etc.).

Plant canopy trees. By planting disturbed areas with native species quickly after a disturbance occurs, invasives can be kept in check more easily. Amur honeysuckle, for example, is shade-intolerant, so one of the best methods of control is to establish a native canopy.

Monitor. Monitor property regularly for invasive species and when they do appear, remove them quickly before the have a chance to become established. Rapid removal will prevent formation of extensive root systems, which make eradication of invasives difficult, if not impossible.

Fertilize minimally – or not at all. Over fertilization increases weed numbers and increases nutrient loads in runoff.

TREATMENT METHODS FOR INVASIVES

Manual hand pulling: Best done following rain, this is still the most effective means for removing herbaceous weeds or small seedlings of woody plants. This method is recommended for young Ailanthus seedlings – care must be taken to remove the root, since ailanthus can sprout from root suckers. Tools:

- Weed Wrench (http://www.weedwrench.com/)
- Root Jack: developed by Jack McGowan-Stinski of the Nature Conservancy, available from multiple sources.

Mulching: A thin layer of organic material can prevent less invasive seedlings from sprouting. Wood mulch is recommended for woody plant material. Straw mulch (not hay – this will bring weed seeds) is recommended for meadow areas. Heavy black plastic –- 4 mil or greater – can be staked over oriental bittersweet or japanese knotweed, effectively cooking the plants.

- Edges of the plastic must overlap so that the stems cannot grow between the sheets and into the light.
- Plastic should remain in place for one growing season to provide effective control.

Mowing: Some annuals are susceptible to regular mowing, but this limits landscape to turf or meadow grasses. Some invasives – multiflora rose for example – are encouraged by mowing.

Burning: A valid method in more rural areas because it promotes mineral-based soil and greatly assists with non-native weed suppression. Burning is the most effective method for eliminating Japanese dodder, since this plant loses its contact with the ground once it spreads. Propane torches can be used to spot treat individual plants but should be used with extreme caution to not cause larger fires. Users should check with local officials for legality of open flame use. Due to the complex nature of the task, it is recommended that burning be carried out by professionals.

Biological controls: Most invasive species do not have proven, commercially available biological control agents. Cornell University mass produces beetles for control of purple loosestrife, a very effective measure if the beetles are released in sufficient quantity.

- Contact Cornell website (www.dnr.cornell.edu/bcontrol/weeds.html)

Boiling water: Steam or hot water may be used to kill weeds, but this method will kill beneficial plants and soil organisms as well.

Tilling: For large areas of infestation, tilling can uproot and kill many species, but it will also kill natives and can increase species that multiply via underground rhizomes.

Herbicides: Herbicides must be applied by a licensed applicator and always used with care to avoid killing desirable natives. Use the least persistent pesticide available to accomplish the job, and exercise caution around water bodies due to the susceptible nature of aquatic organisms. Herbicides are the most effective means of destroying tree of heaven, multiflora rose and oriental bittersweet.

- The non-selective herbicide glyphosate (e.g., Roundup®, Rodeo®, Accord®), will kill or injure almost any plant, herbaceous or woody, contacted by the spray.
- Triclopyr (e.g., Garlon® 3A, Garlon® 4) is selective for broadleaf and woody plants and will not kill grasses contacted by the spray.
- Glyphosphate and triclopyr can be used as foliar sprays (applied to leaves of growing plant at a 2% solution) applied to cut stumps to prevent further regeneration (use a 25% solution – reapplication necessary) and applied to the basal bark of shrubs (also a 25% solution).

Using a weed wrench to remove Norway Maple seedlings

Target Species: *Polygonum cuspidatum* Japanese knotweed

Japanese knotweed is the most abundant of the invasive species found in the riparian corridor of the Three Rivers Park. It is a serious threat to biodiversity and wildlife habitat potential due to its prolific reproductive capacity. Although propagation by seedlings is possible, it seems that vegetative reproduction is the more common means of spreading. Even the smallest fragment of rhizome is capable of producing a new plant. Spreading rhizomes allow the plant to expand into a dense clump which outcompetes all other vegetation on the ground plane.

Stands of knotweed cover large swaths of the Three Rivers' shorelines, Brunot's Island is a typical worst case example.

Rhizomes are carried downstream by floodwaters from existing clumps and deposited along freshly eroded areas to form new infestations. Prevention of the further spread of this weed will require numerous methods from the previous list.

The first step for knotweed control is preventing new infestations. Monitoring property for new plants and immediately removing the new sprouts by hand is a must to keep an area knotweed free. Hand pulling is not feasible for larger clumps, but can eliminate newly established plants. Proper disposal of plant parts is critical to prevent further spread. Plants should be bagged and sent to a landfill. They should not be composted as improper composting can spread the plant further.

When bringing in fill, be 100% sure that the soil does not contain rhizomes of the plant. Plant clumps have become established in areas away from watercourses and are a serious problem. Rhizomes can extend several feet beyond a clump and the tiniest piece in imported fill can cause new infestations.

Tilling is not recommended as it will only cut and leave rhizomes in place. Mulching, burning, boiling water are not listed in the literature as effective. Mowing is generally not feasible as the stands are often on steep banks and interspersed with trees and shrubs. Mowing also has the potential to spread the plant further by scattering pieces of rhizome or stems on nearby soil.

Japanese Knotweed is not likely to invade forest habitats because low light conditions do not favor its growth. Reestablishing forest canopy in habitats along the rivers will help in controlling the spread of the species. The effect shading has on growth provides an opportunity to educate the public on the pervasive nature of the species. Bright yellow fabric canopies could be erected in key visible areas (parks, shorelines, islands) to cover small clumps of Japanese Knotweed. These canopies could be used to experiment with shading as a control method, but more importantly could incorporate interpretive signage that addresses the problem and provides the public with information about what they can do as individuals. With a large number of canopies along the Pittsburgh Pool shorelines, this environmental art project could increase public awareness about Japanese knotweed and the other issues that plague our water based ecosystems. Canopies could be moved each year to new locations to increase public exposure and increase the number of clumps of knotweed that receive this shade "treatment."

FIGURES 27 & 28. Illustrations show black and gold canopies identifying japanese knotweed infestations being treated with black plastic mulch shading. Digital images by Andropogon.

MONITORING

Adopting protocols for recording new assessments and management activities is very important for several reasons. *First*, it allows information to be recorded in a common database, specifically the GIS database of river edge conditions developed by the Studio for Creative Inquiry 3R2N team during 2000-2004. *Second*, it provides a mechanism for updating the inventory and sharing current information that is vital for decision making and selection of new management and restoration projects. *Third*, it allows river managers and stewards to identify trends, such as the spread of invasive species. *Fourth*, information that is systematically collected and recorded is a prerequisite for grant funding from many foundations. *Fifth*, it provides a feedback system to evaluate the success of planting and restoration efforts.

The *Once and Future Forest* (Sauer, 1986) reiterates the importance of careful recording as a key recommendation for monitoring and management:

- Monitor and record all restoration projects.
- Consider keeping a complete photographic record with an accompanying descriptive narrative of site observations as a first step in site documentation. (Sometimes just paying attention gives the best information!)
- Aim high despite current limitations on time, funding and experience.
- Work closely with local scientists.
- Develop a system for recording site information that is permanent and convenient.

Three strategies are key to developing an effective monitoring program:

- Restoration Team that coordinates management activities and is responsible for monitoring.
- Site Database and Management Log that documents conditions, actions and consequences.
- Landscape Restoration Model that serves as a reference ecosystem and a standard for evaluating success of the project. (Sauer, 214-215)

Information Management

The 2000-2004 3R2N GIS database of river edge conditions should serve as the baseline for ongoing information collecting and monitoring. It is crucial that this inventory database be made "live" and maintained by the Restoration Team responsible for restoration and management activities. As the 3R2N inventory is spatially referenced in GIS, use of a portable or handheld GPS device is highly desirable for recording new assessments and updating the database with ongoing management activities.

Monitoring Records

Acceptable methods of ecological monitoring vary, but all depend on a methodology of trained observation and data recording. Well-designed, standardized field survey sheets should be used to maintain the consistency and quality of data collecting. In general, the types of ecological information that should be monitored during management include:

1. Site location mapped to GIS database
2. Extent of forest continuity
3. Plant community description noting dominant species and successional vegetation
4. Substrate condition noting presence of manmade elements
5. Slope height and steepness
6. Extent of invasive plants and species identification
7. Recent flooding indications
8. Observed uses by people or animals
9. Restoration documentation, including planting plan and photographs
10. Dates of activity, numbers of people involved, labor and funds expended

The data can be entered into digital form either in the field using laptops or handheld computing devices, or it can be collected on paper and transferred later. Each method has advantages and disadvantages. Digitally entering data in the field is immediate and may result in better information; electronic devices may malfunction under less than desirable field conditions. Entering data on paper restricts length of entries (often a good thing!) but increases the chances of errors later when data is manipulated. A sample field data form is included here; participants should develop additional measures or more specific records if necessary.

Restoration project monitoring

At restoration sites, follow up monitoring can include the following categories:

- Percent or number of plants which have survived
- Number of shoots per linear foot of fascine, wattle, brush layer, etc.
- Height of shoots
- Species present

Landscape Restoration Model

Though the edges of the rivers within the Pittsburgh Pool have been greatly altered from their historical condition, there are sections of the river edge – identified with green on the management maps that can serve as vegetation models for restoration. These vegetated bank sections – some adjacent to relatively high quality watersheds such as Hays Woods, others adjacent to Downtown – remind us that high-quality landscapes can still be achieved within an urban, industrialized context.

Integrating Monitoring and Management

Monitoring is not busywork – it is a well recognized practical tool for keeping ecological management on track. Stewards tend to be action-oriented and impatient with record keeping, but without careful monitoring, there is no means of evaluating success and little chance of coordinating efforts. Conducting monitoring is the most effective way for others to study the results of management – the database will prove essential for identifying changes over time and for reporting the work in scientific publications.

A web-based GIS system can simplify monitoring and assist with coordination by having participants work from a real-time information system. Web-based databases are still relatively young but are attracting much interest because of their rapid updating, democratic access, non-hierarchial management structure and de-emphasis of professional specialists in favor of expert, focused amateur researchers.

As a case study in point, The Audubon Society has partnered with the Cornell Laboratory of Ornithology to present a website that provides birders with a way to share their observations with the rest of the birding community online. Called ebird, the website gives citizen scientists an opportunity to partipate in an extensive data collecting and analysis efforts. (http://www.audubon.org/bird/citizen/index.html).

Sample Restoration and Management Field Data Form

SITE			
Property owner		Owner contact	
Field team		Date	
GPS coordinates	lat.	long.	

PLANT COMMUNITY TYPE				
Extent of forest continuity	No gaps	<10% gaps	10-25% gaps	>25% gaps
Dominant trees			Number	Condition / remarks
Understorey and groundcover			Extent	

SLOPE	Height	Steepness	
SUBSTRATE (circle or check)	Soil	Riprap or fill	Concrete or asphalt
	Seawall	Other	
SUBSTRATE INTEGRITY			
NOTES			

INVASIVE PLANTS			Extent
FLOODING	Erosion	Debris	Watermarks
Flooding height		Flood date if known	
USES	Trail use	Fishing	Boating
	Birding / viewing	Illegal dumping	Other
ANIMAL EVIDENCE			

Sample Restoration and Management Activity Record

RESTORATION ACTIVITY			
Date		Weather	
Personnel		Hours	
Equipment used			
Invasive control method			

Planting list (attach if needed)

Plant name	Quantity	Size	Source

Photographs taken
Drawing record

SOURCES

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---. 2004. *Monongahela River Navigation Charts: Pittsburgh, Pennsylvania to Fairmount, West Virginia.*
---. 2003. *Ohio River Navigation Charts: New Martinsville, West Virginia to Pittsburgh, Pennsylvania*.

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Schiechtl, Hugo. 1980. *Bioengineering for Land Reclamation and Conservation*. University of Alberta Press, Canada.

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Useful Links

2004 American Standard for Nursery Stock www.anla.org
Biological Control of Invasive Weeds www.ars.usda.gov
Cornell University Biological Control of Pests www.dnr.cornell.edu/bcontrol/weeds.html
Erosion Control. Official Journal of the International Erosion Control Association. www.erosioncontrol.com
Federal Interagency Stream Corridor Restoration Working Group.
www.nrcs.usda.gov/technical/stream_restoration
Invasive Plants of the Eastern United States Identification and Control www.invasive.org/eastern/
Soil Stabilization Products www.sspco.org
Trail Maintenance and Management http://americantrails.org/resources/ManageMaintain/index.html
Wisconsin Manual of Control Recommendations for Ecologically Invasive Plants
www.dnr.state.wi.us/invasives/pubs/manual

Plant and Materials Sources

Ernst Conservation Seeds (also has bioengineering materials) www.ernstseed.com
Octararo Nursery
Pinelands Nursery

GIS METHODOLOGY

The guidelines are supported by scientific investigation and data collection performed by the CMU Studio for Creative Inquiry, Three Rivers Second Nature. The 3R2N work has been compiled in an extensive GIS database that spatially references riverbank conditions along the Allegheny, Monongahela and Ohio Rivers at 1/10th mile intervals. 3R2N made use of prior GIS analysis performed by Allegheny County Department of Planning to develop maps and reports describing terrestrial, botanical and hydrological conditions of the three rivers at an unprecedented level of detail.

Andropogon used the GIS data from the 3R2N study to develop a matrix and rank the restoration potential of each 1/10th mile interval of the riverbanks. Forest canopy continuity was considered to be the most important factor for evaluation of restoration potential. The condition of the substrate was next, followed by bank slope, and percentage of knotweed invasion. The data was divided into two groups within each category and assigned numeric values as seen below. The GIS layers were then overlaid to determine where coincidence of each of the four factors occurred. When the numeric values are additively combined, it is possible to determine the underlying input values because each combination produces a unique result. Sixteen possible combinations result, with the lowest rank representing the optimal conditions for restoration potential. Therefore, the ideal target for restoration would have good forest canopy continuity, unconsolidated substrate, a moderate slope and have limited Japanese knotweed invasion.

Andropogon carefully field verified these conditions to target pilot projects for restoration. It should be noted that the database serves to inform restoration targets, but it is necessary to ensure that the site's realities are in line with the assumptions before committing to action.

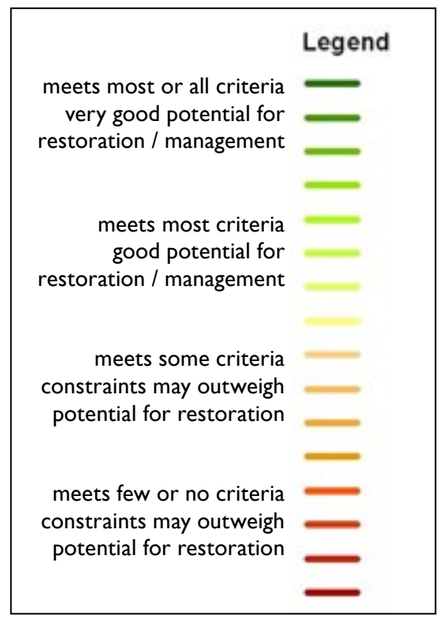
GIS MAPS

MAP 9 RESTORATION POTENTIAL

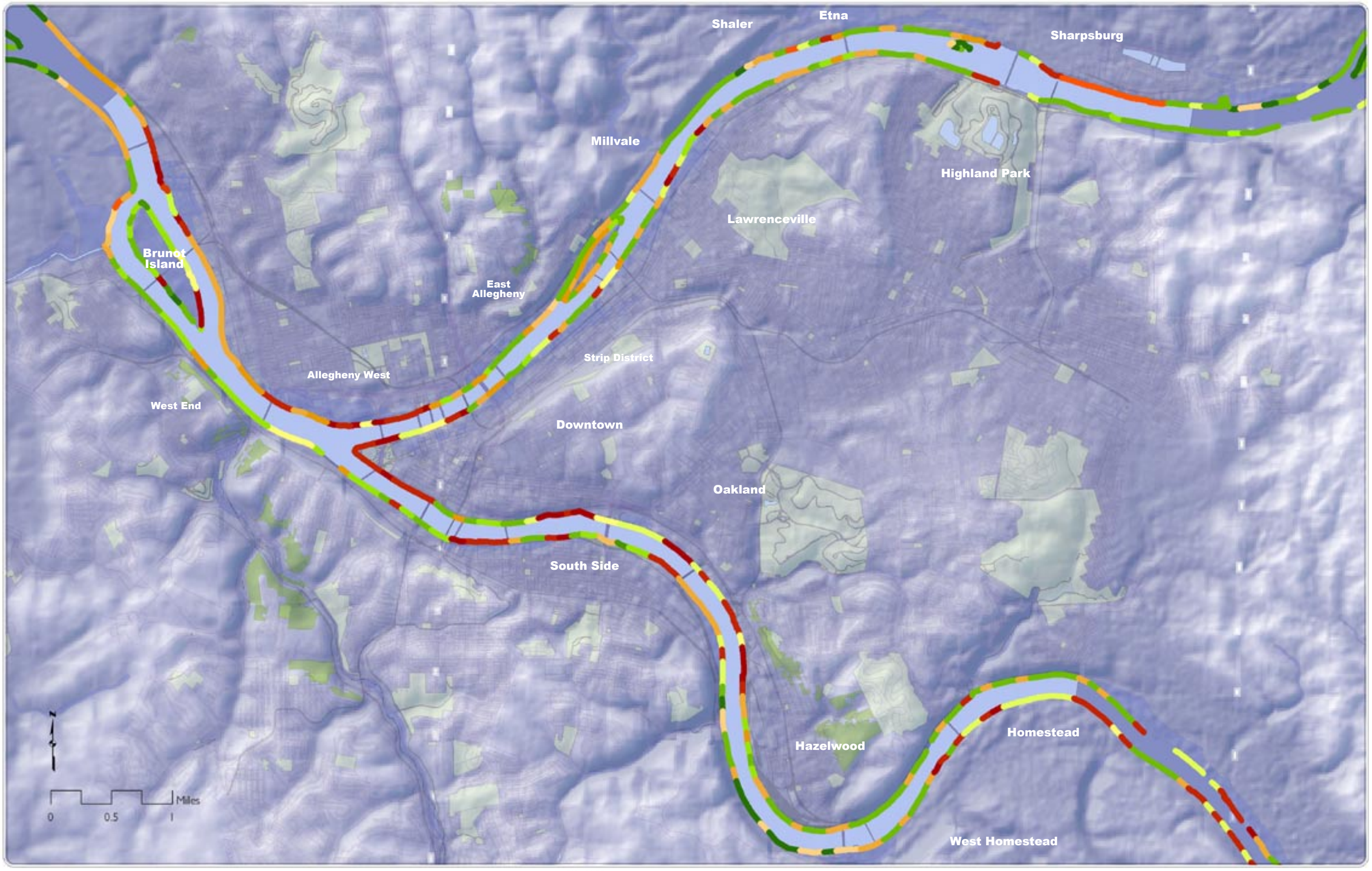
Andropogon used GIS data from the Three Rivers Second Nature study (3r2n.cfa.cmu.edu) and Allegheny County to develop a matrix of criteria and rank the restoration potential of each 1/10th mile interval of the riverbanks. Forest canopy continuity was considered to be the most important factor for evaluating restoration potential, primarily because canopy trees take twenty-five years to reach maturity. The condition of the underlying substrate was second, because it is less adaptable than slope conditions. Slope steepness was third, with steep and vertical slopes considered more difficult sites for restoration. Invasive plant presence, expressed as percentage of Japanese knotweed extent, was the final criteria.

The data for each criteria were ranked, using numeric values from 1 through 4, with 1 being optimal conditions for restoration and management. This gave a possible sixteen different combinations of conditions. The GIS layers were overlaid to determine where coincidence of the four factors occurred and the results mapped in MAP 9. MAP 9 represents a summary of all of the factors, each of which is mapped individually in the following map pages.

This data was simplified and correlated with Andropogon's field observations and aerial photographs to produce MAPS 1-8 on the preceding pages. In some cases the two maps may vary. The chief reason for this is that the 3R2N data did not take management factors into account, such as ample space for staging, access via pickup truck and proximity to communities and neighborhoods. The GIS information is extremely useful, nonetheless, because it represents a set of correlated data based on observations conducted by biologists and geologists from local universities during 2001-2004.



MAP 9 (opposite page). GIS Restoration Priority Map ranks all river edge sites in terms of suggested management priority


Shaler
Etna
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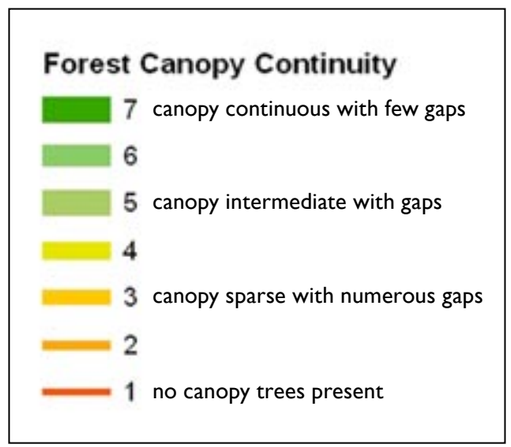
MAP 10 FOREST CONTINUITY

One of the many useful products from the study was an evaluation of forest continuity. A value of forest continuity was assigned by the 3R2N botany team to each 1/10 of a mile section of the Allegheny County riverbanks. The values 1-7 represent an increasingly intact forest. The rating of continuity is described as follows:

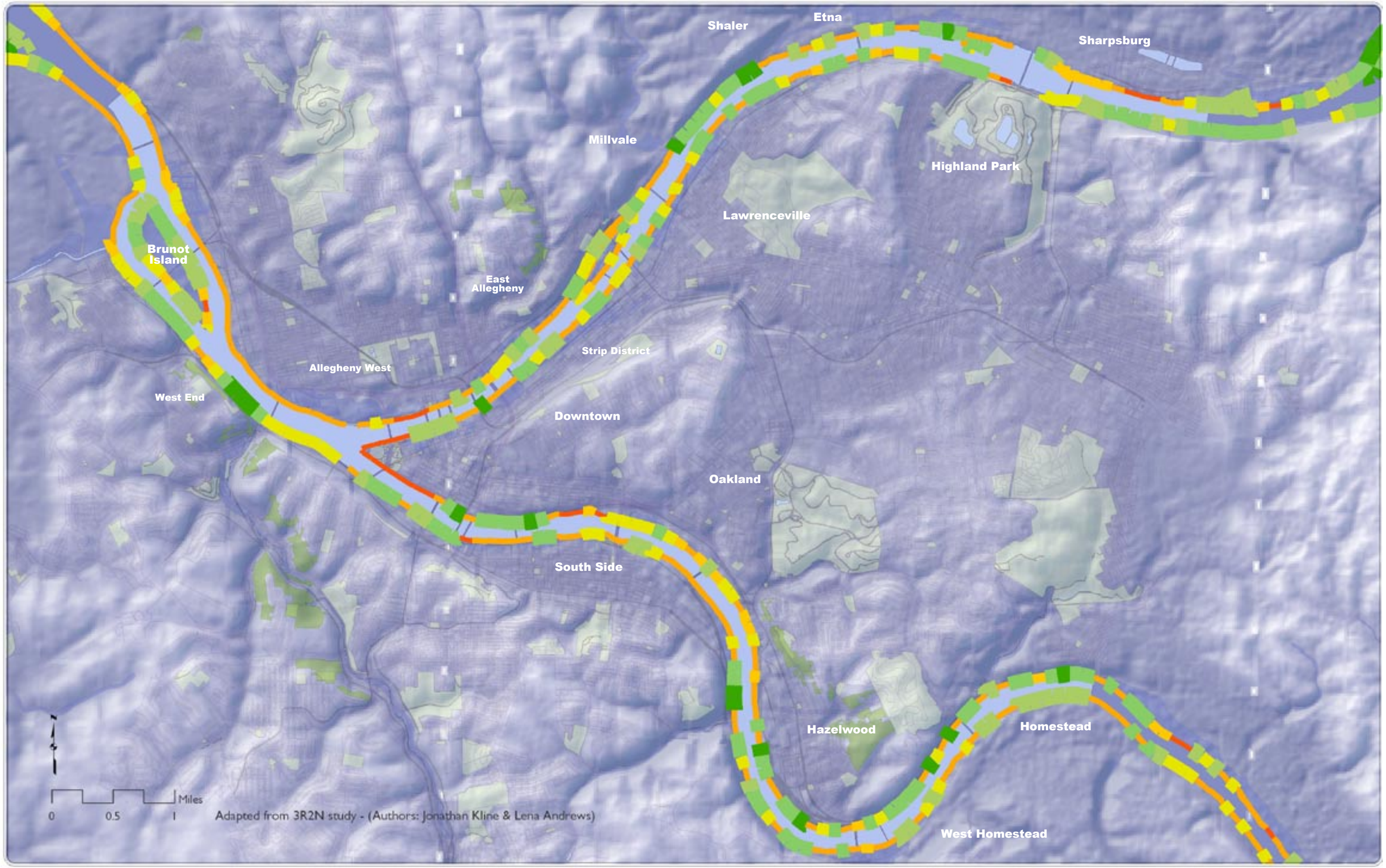
1 No or almost no woody vegetation
2 Little woody vegetation with no forest structure
3 Fragments of remnants of forest structure (i.e. scattered trees and shrubs but not forested)
4 Presence of forested areas with large or several breaks in continuity (e.g. power lines)
5 Presence of forested areas with some breaks in continuity
6 Forested area with very few breaks in canopy continuity or completely continuous forested area but with no or little understory species
7 Intact forested area with no breaks in canopy continuity as well as presence of a vegetated understory

Forest continuity is important from a restoration standpoint because the establishment of a mature vegetated plant community is very difficult in Pittsburgh's urbanized river systems. The pressures placed upon the natural systems within the urban area are quite different from those of a less populated region. The riverbanks are particularly challenging areas for native plant communities to become established and thrive. The river systems do not function as they do in rural areas. Controlled elevations of the "pool" lead to a hydrologic regime that has less frequent small flood events – which are important for sediment and seed transport and distribution. Larger floods with less regularity allow for greater destructive forces on the riverbanks. Higher water levels with increased volume and rate cause tremendous bank scour and prevent effective annual establishment of woody species in particular. These conditions favor fast growing herbaceous species adaptable to poor soil conditions with efficient reproductive strategies. Japanese knotweed is highly adapted to this scenario and has great competitive advantage over many native floodplain plant species.

Riverbank areas with mature trees that create continuous canopy and support multi-layered understory plant associations seem to be most resistant to invasion by Japanese knotweed. Restoration potential is likely to be greatest where high quality existing forest communities can be enhanced. Potential is likely lowest where there is no existing vegetation, no natural substrate, and steep to vertical bank slopes.



MAP 10 (opposite page). GIS Map of Forest Continuity uses forest continuity as a measure of potential for restoration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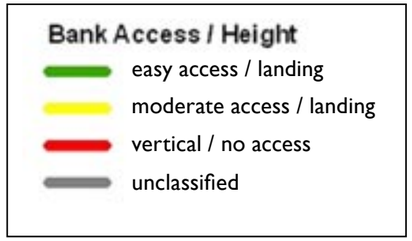
Adapted from 3R2N study - (Authors: Jonathan Kline & Lena Andrews)

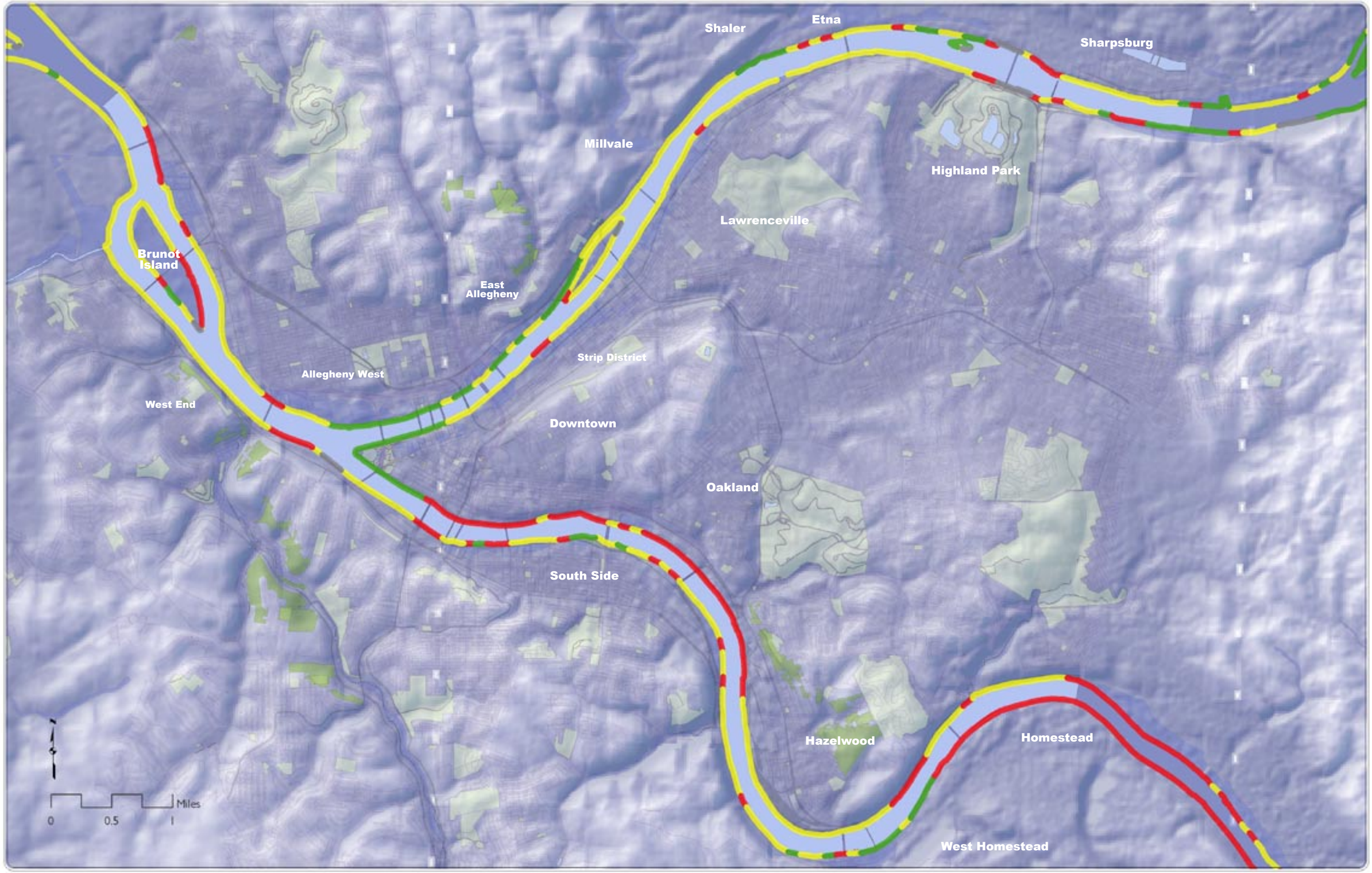
MAP 11 RIVERBANK ACCESS | BANK HEIGHT

Public access correlates to public interest – where access is impossible, interest is low. Where access is good, interest will be keen, and investment in recreational and "green" infrastructure will be more likely to garner support and funding. The Pittsburgh riverfronts have become more inaccessible to the public over time, a trend that Three Rivers Park and the 3R2N studies have identified and seek to counter. The reason for this is due less to bank height than to the proliferation of railway lines and highways along much of the Allegheny County riverbanks.

Bank height does not always preclude access to the river edge – bank edges are accessible by boat, for the most part. The 3R2N study compiled heights of all riverbanks and used this as one indicator of restoration potential in their final series of maps. Note that options have been presented earlier for restoration or adaptive re-use for all riverbank conditions, including vertical seawalls.



MAP 11 (opposite page). GIS Map of River Access ranks riverbank access according to height from water edge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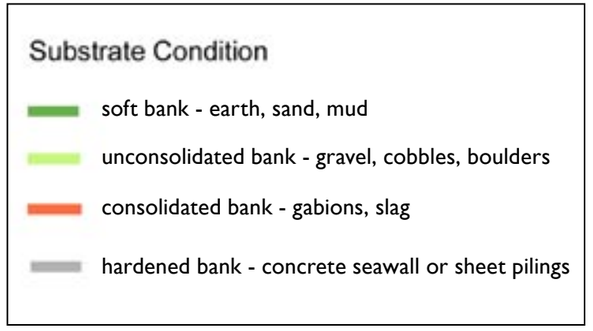
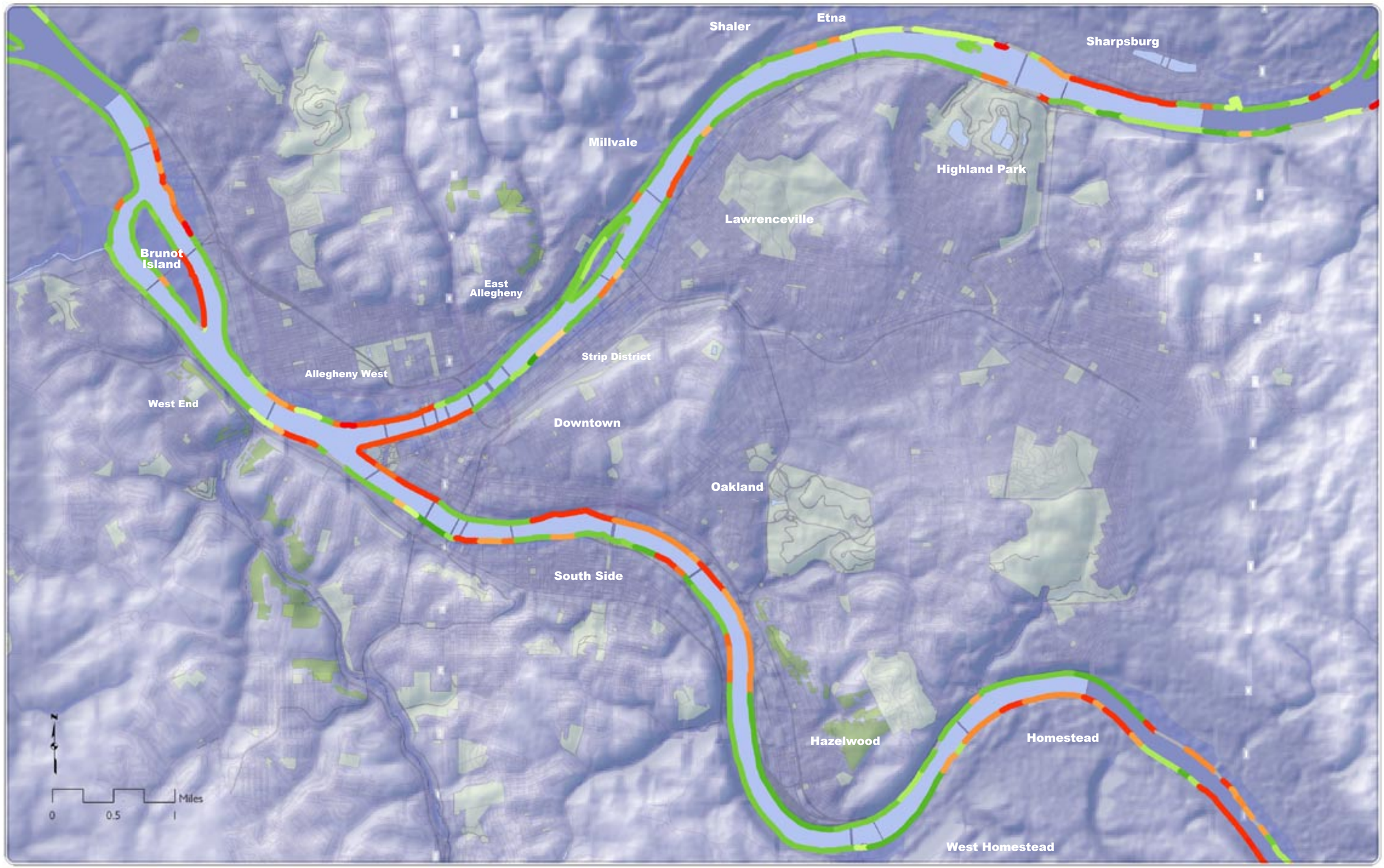
MAP 12 SUBSTRATE ASSESSMENT

The riverbank substrate is a fundamental concern for management and restoration. In some cases, it can be altered – such as replacing gabion walls with geocellular containment systems. More often, the substrate will be a limiting factor in terms of the type and extent of new vegetation that can be established.

The substrate conditions were mapped in the 3R2N studies. The information, re-presented here, shows substrate ranked in terms of its potential for allowing riverbank restoration. The ideal condition is a soft bank of earth, sand and mud. Next best would be an unconsolidated bank of gravel, cobbles and boulders because it could be stabilized and soil added relatively easily. A consolidated bank, generally slag, concrete or asphalt debris is challenging to re-store because it hinders the exchange of water, nutrients and air if soil is simply placed on top of it. Finally, concrete seawalls, sheet pilings and other hardened, often vertical banks, offer limited landscape restoration possibilities, except at the top and bottom, but may be well suited to other adaptive re-use possibilities.



MAP 12 (opposite page). GIS Map of Substrate Condition ranks restoration potential according to physical condition of substrate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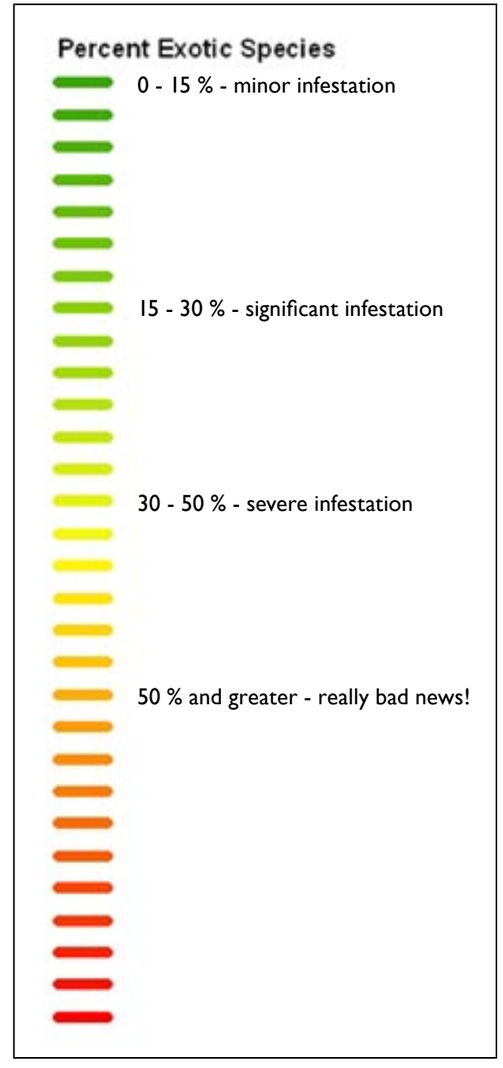
MAP 13 INVASIVE SPECIES - JAPANESE KNOTWEED

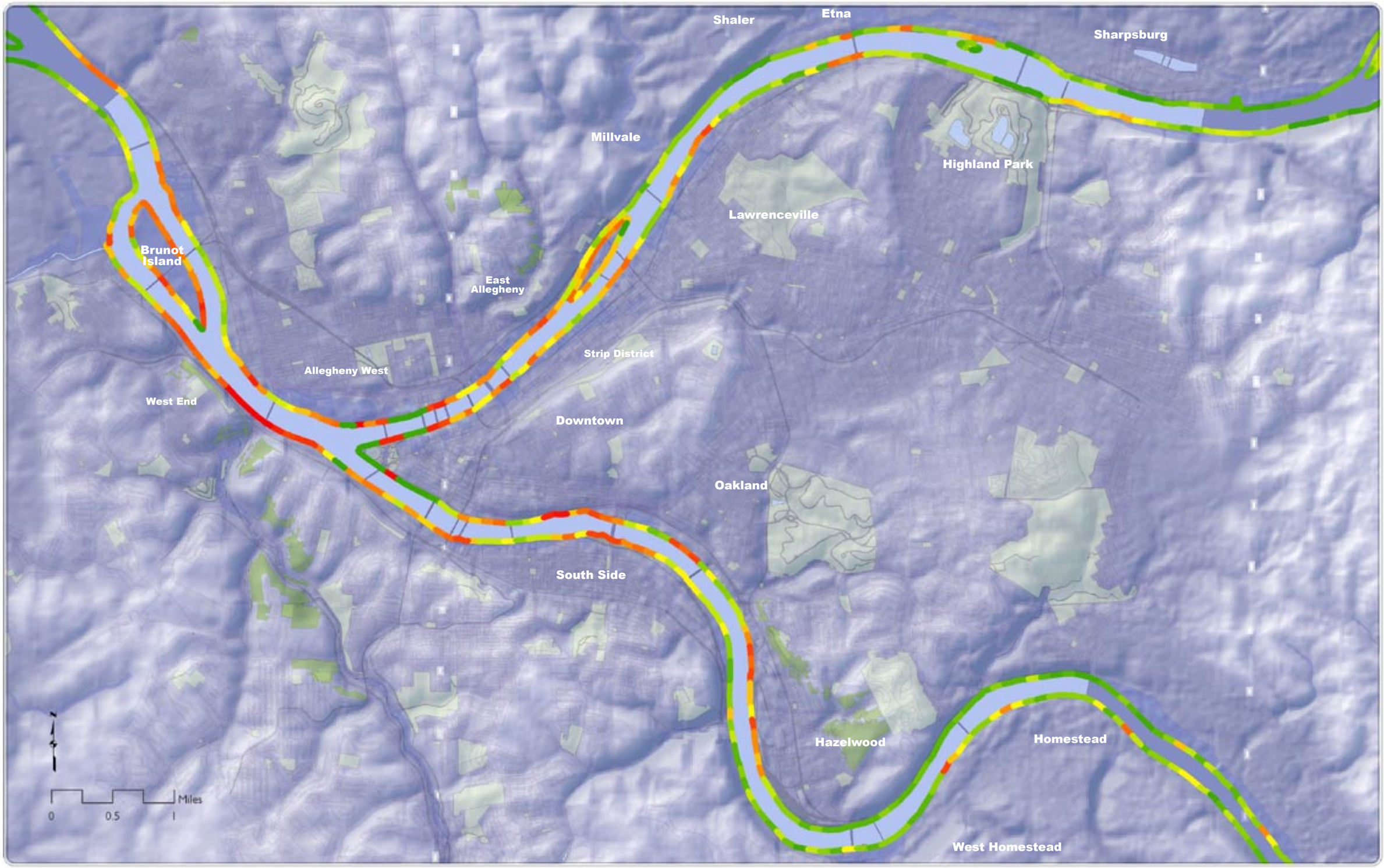
Japanese Knotweed is one of the most ubiquitous and aggressive plant invaders of the region. As shown earlier in the document, once it becomes established, it is expensive and difficult to remove. Restoration efforts in this study area may succeed or fail based on the colonization pattern of this species. Because it is such a concern, it became one of the four primary factors in determining restoration potential.

The mapping records of the 3R2N study, recreated here, show high percentages of Knotweed invasion throughout the study area, with concentrations generally increasing around the confluence of the rivers and sporadically appearing in areas disturbed by construction or storm events. Field verification for the preparation of this report (several years after the 3R2N data collection), showed that the invaded areas were noticeably increasing in both number and extent.

The legend on this page shows the percentage range of Japanese Knotweed invasion. Once 50% or more of a site is colonized by the plant, it changes the ecological relationship of the surroundings. Monitoring and removal efforts will need to be targeted appropriately to eliminate this threat.



MAP 13 (opposite page). GIS Map of Invasive Species ranks presence of Japanese knotweed on percent basis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