

BLUE CITIES GUIDE: ENVIRONMENTALLY SENSITIVE URBAN DEVELOPMENT

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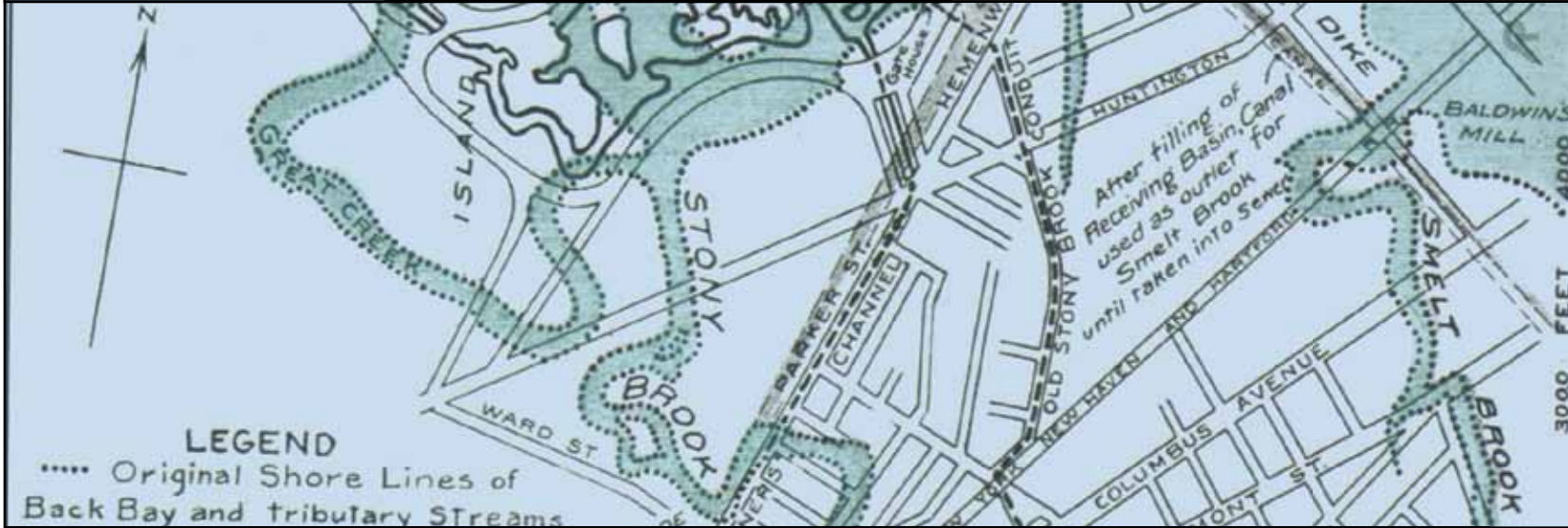


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Mark Garfinkel © Boston Herald

Introduction:

Building Blue Cities: Water in Urban Development

With 80% of the United States population now living in cities, urban environmental challenges – air quality, energy consumption, transportation needs – are widely recognized. This Guide focuses on a less publicized issue that is likely to prove the most critical of all: water resource failure, and what can be done about it.



Erosion along the Charles River in North Allston



Litter in a stream in the Longwood Medical Area



Stormwater problems in the Zakim North area

Many U.S. cities face water-related disasters. Clean water supplies are becoming scarce; flood damage is widespread; water tables are unstable; rivers, lakes, and ponds are polluted; crumbling sewer and drain infrastructure demands repair. Fortunately, a convergence of new technologies and a growing interest in urban revitalization makes it possible to rethink urban water management and apply solutions to make our cities more sustainable.

Charles River Watershed Association (CRWA) has developed a suite of tools and an approach to the urban environment that will help create a new kind of place: a Blue City. Bringing together techniques such as Low Impact Development (LID), Green Buildings, Green Infrastructure, Green Corridors, and stormwater management, the Blue Cities approach provides a way to solve problems and build a sustainable urban future. Using water as a foundation for planning and design leads to a whole host of benefits: more pleasant streets; integrated public open space; a cleaner, more accessible river; and infrastructure that is flexible and resilient.

New England receives over 40 inches of rainfall a year on average. Properly managed, this water can cool buildings (directly and through strategically-used vegetation), improve air quality, add aesthetic amenities, reduce flooding, and relieve drought. By restoring natural hydrologic function, Blue Cities initiatives can improve human and aquatic ecosystems. We can redesign our cities to capture

and cleanse water and convey it to rivers, lakes, and harbors gradually through natural, vegetated channels.

Blue Development incorporates designs for the built environment that engage with every stage of the water cycle. It identifies critical watershed problems, finds potential solutions, and brings people together to support restoration efforts. Blue Development is a new paradigm for the urban environment, solving problems with techniques that improve today's environment, and protect tomorrow's.

Using water as a foundation for planning and design leads to a whole host of benefits: more pleasant streets; integrated public open space; a cleaner, more accessible river; and infrastructure that is flexible and resilient.

THE BLUE CITIES GUIDE

The Blue Cities Guide offers a comprehensive approach for addressing problems typical of most urban water environments. Flooding, declining base flows in streams, groundwater recession, water quality violations, eutrophication, build-up of contaminated sediments, loss of habitat and recreational opportunities, polluted stormwater runoff, combined sewer overflows, and excessive thermal loading are persistent examples. The overarching goal is to let the urban watershed function like a natural watershed - collecting rainfall, filtering it through plants and soils, storing it for dry seasons, and releasing it, clean and cool, to the river.

When policy and design innovations converge to restore natural water function in the built environment, water quality improves, flooding is mitigated or eliminated, habitat is restored, groundwater recharge is unimpeded, and beautiful, safe networks of pedestrian corridors and open space can be built and sustained. In Boston, water-sensitivity in architecture, landscape design, and civil engineering is already improving the health of the Charles River and surrounding neighborhoods.

This Guide presents three case studies, each of which helped CRWA develop the comprehensive Blue Cities approach. While every place has its own site-specific needs and potential, this Guide

establishes a consistent framework for analysis, understanding and advocacy. The Template for Blue Cities Restoration (page 37) lays out the process in its simplest terms.

CASE STUDIES

In 2005, the Charles River Watershed Association embarked on an ambitious three-year project to explore in detail opportunities

for redesigning densely developed urban areas with a focus on water. The studies concentrated on three diverse critical areas: the North Allston neighborhood in Boston, where Harvard University is building a new, 200-plus acre campus; the Longwood Medical and Academic Area (LMA), also in Boston, on the banks of the Muddy River and Back Bay Fens; and Zakim North, a mixed residential and industrial neighborhood in Boston, Cambridge, and Somerville, already undergoing dramatic transformation through redevelopment.

Despite the differences among the sites – size, population, land use, infrastructure, environmental problems, and development pressures – our fundamental approach includes consistent elements. We chose the sites to be large enough, in size and scope, to demonstrate environmental improvements on a neighborhood scale, but small enough to make it possible to track solutions in detail at building- and site-scale. In all cases, we analyze problems; integrate the regulatory and planning contexts; address the concerns of residents and stakeholders; and identify, develop, and evaluate design opportunities.

Our case sites differ in development agendas, planning timeframes, and regulatory frameworks. But all three reflect classic problems of impaired hydrology. Our proposed solutions, therefore, have broad applicability.

Case Study - North Allston

Harvard University's 50-year project to develop a new campus on more than 200 acres in North Allston, a neighborhood of Boston that borders the Charles River, presents an opportunity to transform the area from a deteriorating, environmen-

Since its origins in the early 17th century as an agricultural and cattle-raising outpost of Cambridge, the area has witnessed intense transformations: from a market town and center for the beef industry; to a streetcar suburb built along Western Avenue, which continues to serve as North Allston's Main Street; to a major rail transportation center, vestiges of which are visible today in the Allston Yards; to textile factories once located where the Brighton Mills shopping center now sits; to the small- and medium-sized industrial businesses scattered through the neighborhood.

- North Allston Strategic Planning Framework issued by Boston Redevelopment Authority, June 2004

tally degraded condition into a model of environmentally sensitive, "water friendly" development. This major urban redevelopment project presents

tremendous opportunities to improve the physical environment, reversing degradation and pollution, and changing current development practices through an environmentally sensitive approach to planning. When urban redevelopment incorporates environmental restoration, the proven economic and aesthetic benefits generate widespread public support. CRWA's goal is to ensure that major infrastructure improvements to the water and sewer systems, transportation systems, open space and pedestrian amenities, and the urban ecosystem are incorporated into large-scale urban redevelopment projects like Harvard's new campus in North Allston.

EXISTING CONDITIONS ANALYSIS

Historical evolution and current site analysis

The Charles River borders North Allston on three sides. Much of the area was historically a tidal marsh, which was gradually drained and filled as the city expanded in the 1800's (see Figure 1.1). Today, North Allston's former creeks and wetlands are completely buried. The natural legacy of the former marsh remains, however, and poor drainage and unstable river banks present constant challenges.

CRWA's existing conditions analysis identified additional environmental issues, including lack of open space and street trees, poor connectivity to the river and riverfront parks, and limited access via public transportation. We also found a number of water-related problems, in particular street flooding, park erosion, polluted discharges to the Charles River, overloading of combined sewer systems, and stormwater run-

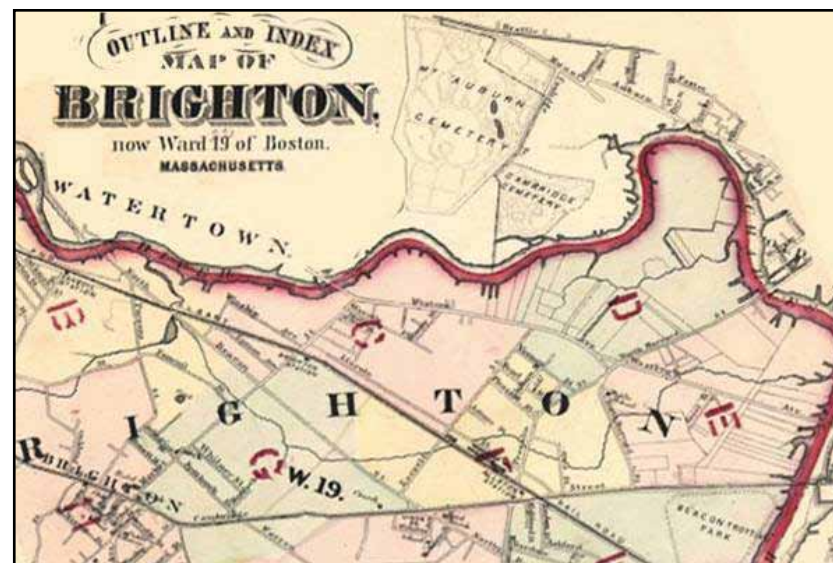


Fig. 1.1 Historic map circa 1875 (Courtesy Brighton Allston Historical Society)



Fig. 1.2 Street flooding and puddling in North Allston

off and reduced infiltration created by impervious areas. These problems can be traced directly to the area's natural history, development patterns, and infrastructure design.

Identification of issues and opportunities and field verification

In North Allston, as in most urban communities, the man-made ("built") infrastructure was developed without much attention to preserving a functional relationship between land and water. Natural drainage systems were eliminated and historic tidal areas (saltwater marshes) were filled, reducing natural infiltration, altering groundwater flow patterns, and creating a large volume of

polluted stormwater runoff. The infrastructure - roads, buildings, sidewalks, parking lots, etc. - was designed without regard to preexisting hydrology. Rainfall and groundwater were treated as a nuisance, to be managed with engineering. As Allston continued to grow, the basic problems inherent in the engineered hydrologic cycle became more and more severe: flooding, pollution, groundwater fluctuations, and riverbank instability are all issues we identified in the area. The increase in the amount and rate of runoff has already deprived Allston of at least two acres of parkland by eroding the riverbank (See Fig 1.3).



Fig. 1.3 Increased stormwater resulting in riverbank erosion

Plate 1.1 Analytical Mapping of Sub-watersheds in North Allston

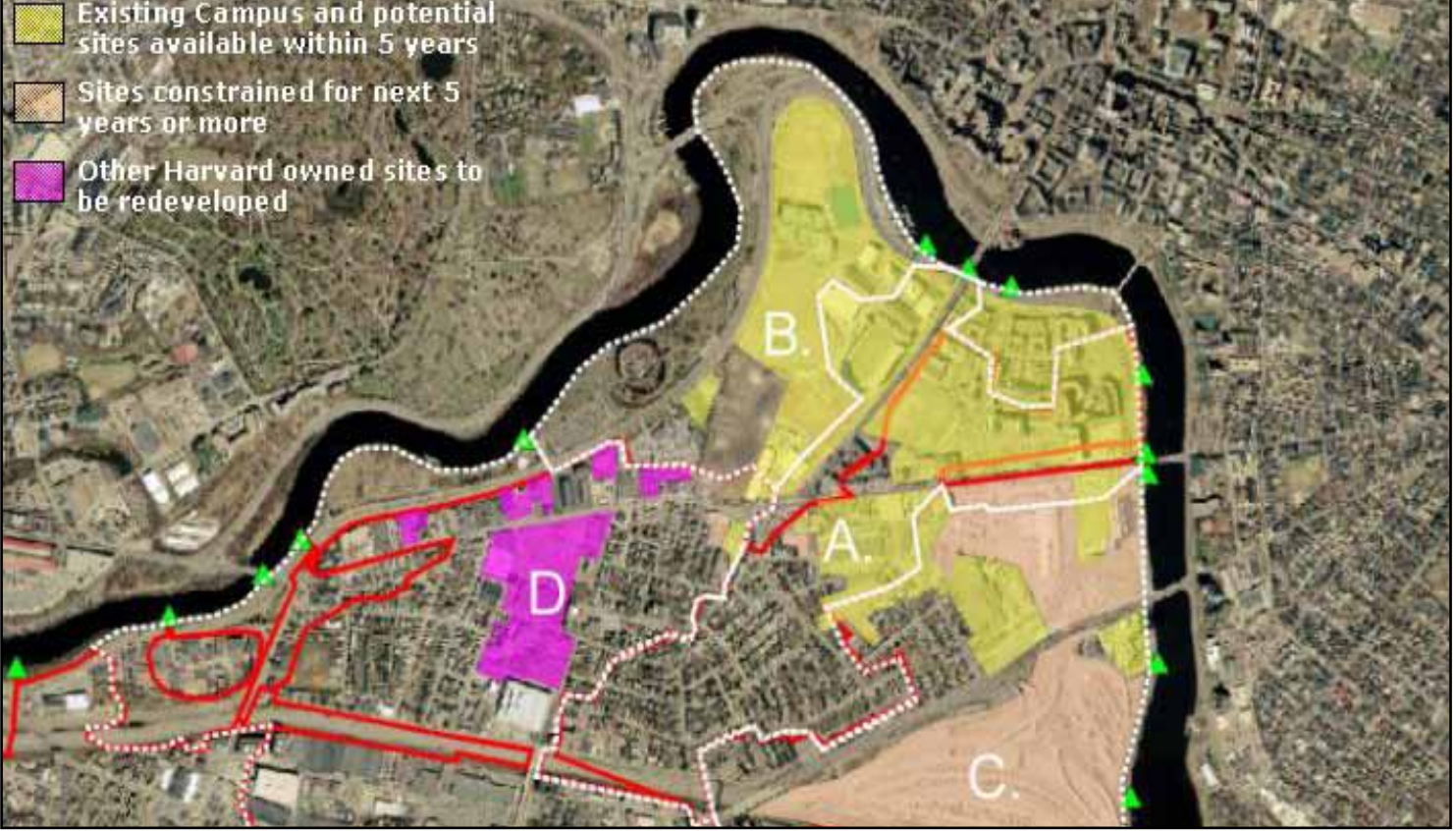
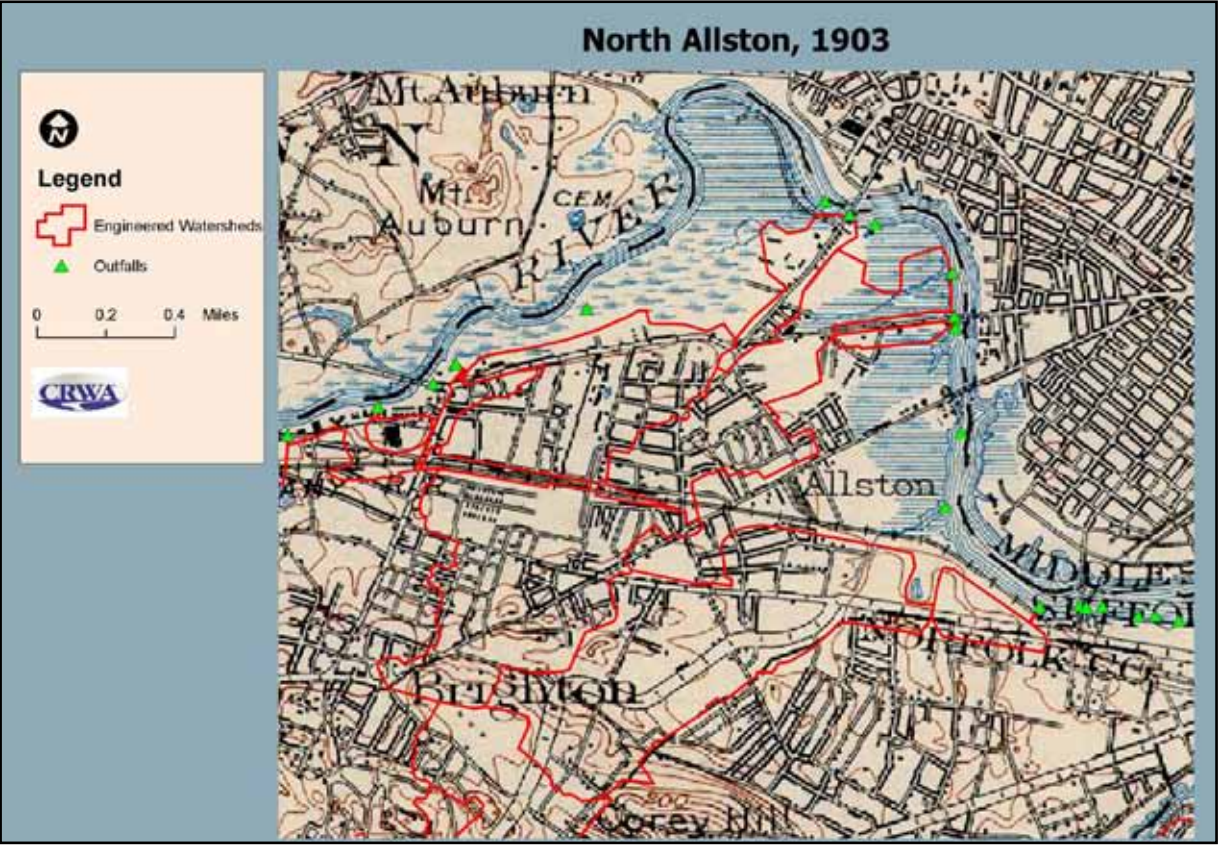
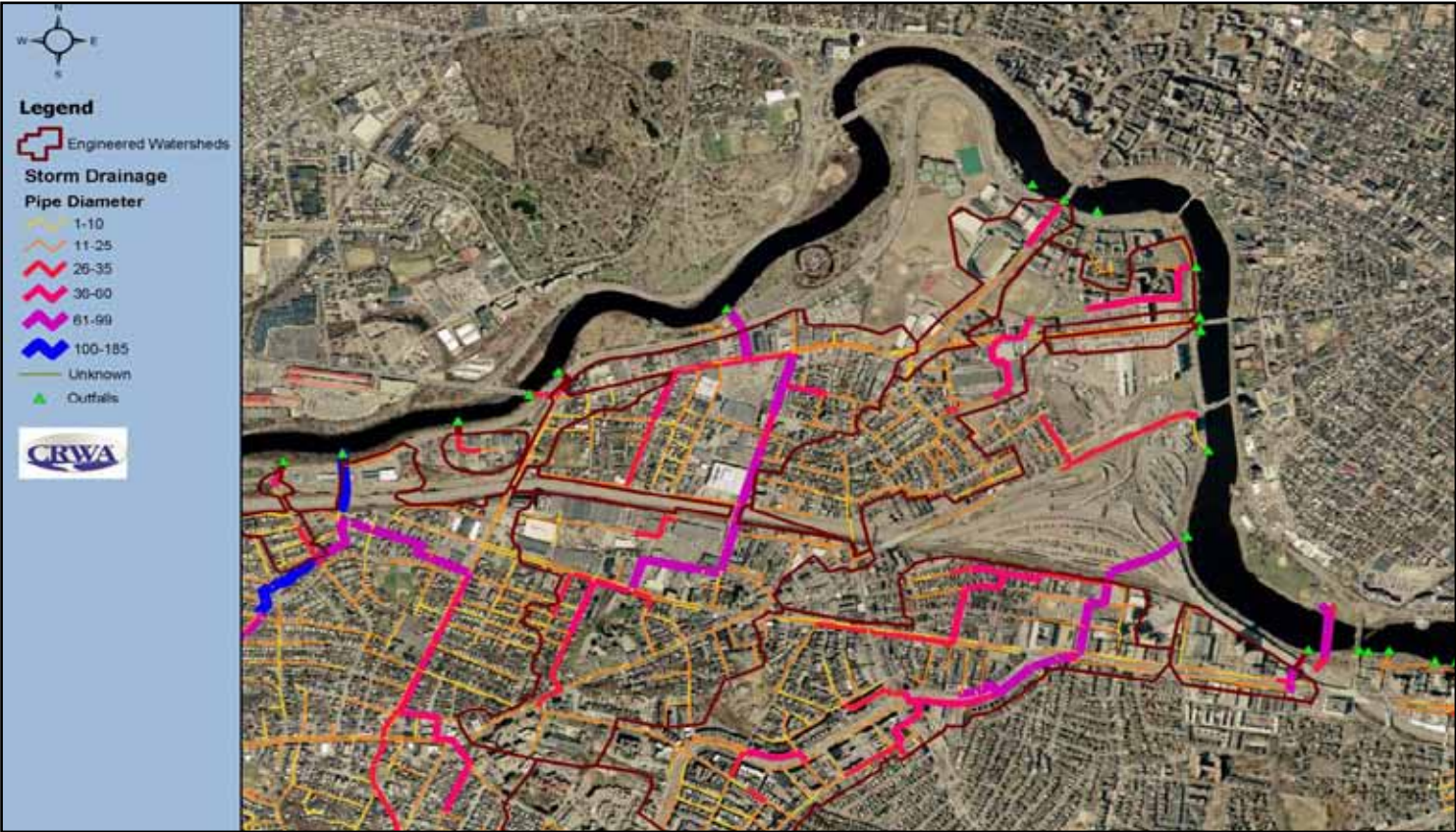
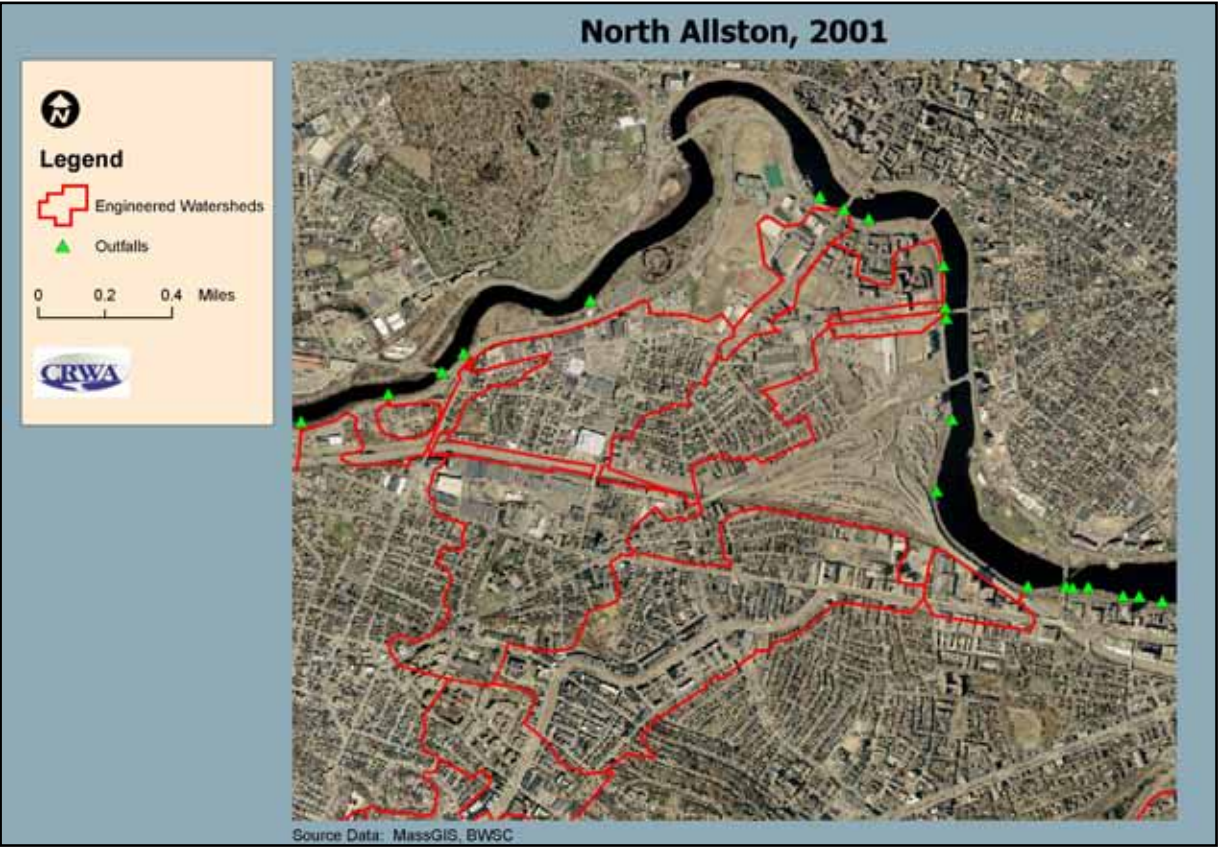


Plate 1.2 Existing Conditions Analysis & Sub-watershed Modeling

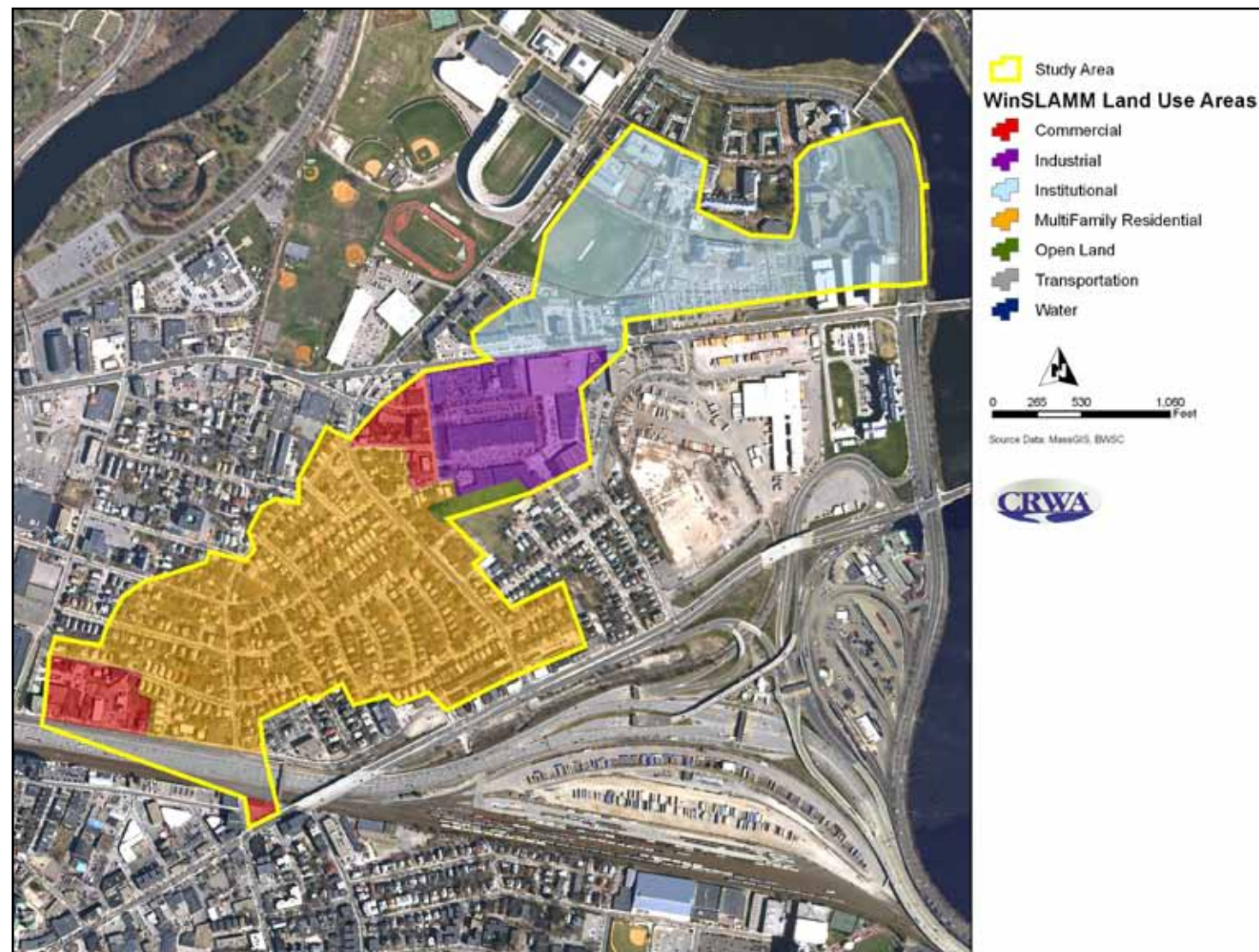


Figure 1.2.1 WinSLAMM land use areas

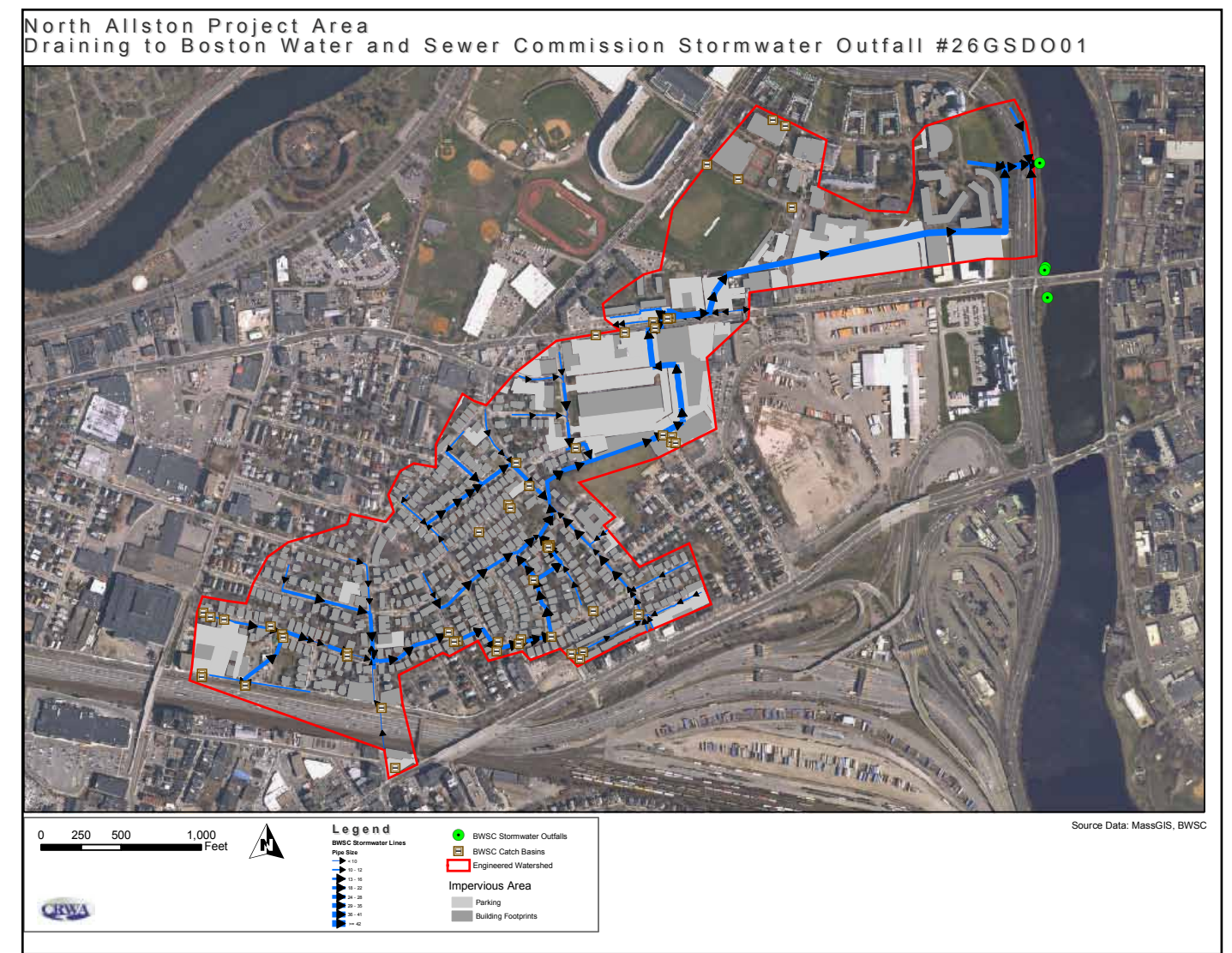


Figure 1.2.2 Impervious areas mapping in the Allston Creek sub-watershed

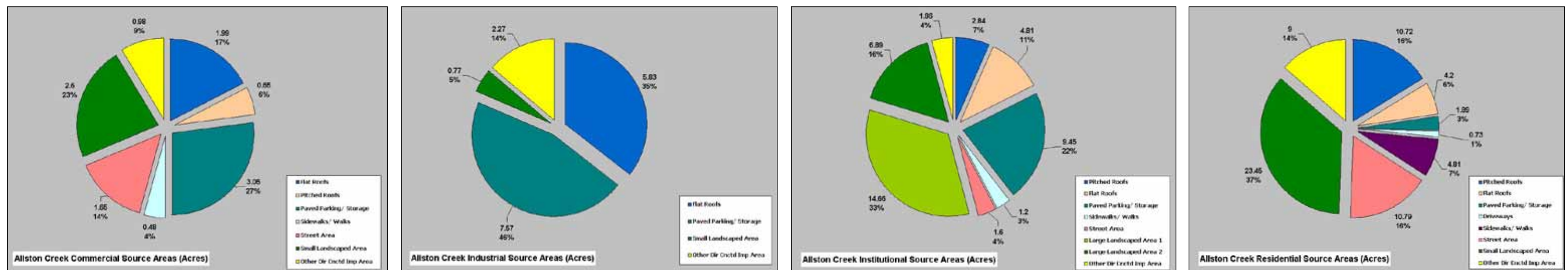


Figure 1.2.3 WinSLAMM outputs for existing conditions categorizing by land use (commercial, industrial, institutional and residential) within the Allston Creek sub-watershed



Fig. 1.4 Limited pedestrian access to parklands in North Allston

Analytical mapping and sub-watershed modeling

CRWA selected one major sub-watershed in North Allston for detailed analysis and design (see Plate 1.1). The Allston Creek sub-watershed in the North Allston area of Boston (see Plate 1.2) is defined by the Boston Water and Sewer Commission (BWSC) engineered drainage system, which enters the Charles River at the outfall 26G001.

The sub-watershed area is approximately 146 acres, 45% of which is residential, 30% institutional (Harvard-owned property), 8% commercial, 11% industrial, 5% freeway, and 1% “other”, which captures the “Open Land” polygon displayed in Fig. 1.2.1.

CRWA used the WinSLAMM model to simulate the site’s hydrology under existing conditions, as well as under potential future conditions (refer to Appendix A for details regarding the modeling process). The existing conditions model was run with the site area classified as industrial, which typically has higher pollutant loadings from industrial processes and more intensive land-uses than areas classified as institutional (see Plate 1.2 for existing conditions outputs).

PLANNING CONTEXT AND STAKEHOLDER OUTREACH

Planning background and existing regulatory framework

North Allston will be dramatically reshaped by the expansion and redevelopment of Harvard University’s campus. Numerous planning and regulatory processes are under way, many of which CRWA has participated in to ensure a broad focus on water-sensitive design and environmental restoration.

The Boston Redevelopment Authority (BRA) reviews development projects in the City of Boston and creates neighborhood planning documents that prescribe land use, zoning, and other planning and design criteria for development in various neighborhoods within the City. The Allston-Brighton neighborhood lies within its sphere of authority. In 1996 the BRA undertook a four-year planning process to create the North Allston Strategic Planning Framework with the assistance of the North Allston Planning Group. This group consisted of members of the Harvard University Allston Campus Task Force, representing residents, community organizations, and businesses, along with other community interests and representatives from the University.

Harvard Allston Task Force

In 2006, when Harvard initiated its planning for updating its Institutional Master Plan (IMP), the BRA reconstituted the Harvard Allston Task Force. This group has since undertaken an extensive review process to ensure that the resident community and other stakeholders play a meaningful role in evaluating the IMP. The Allston Development Group (ADG) is leading the planning effort on behalf of Harvard.

Citizen Advisory Committee

In late 2007, the state Secretary of Environmental Affairs appointed CRWA to the newly-created

Citizens Advisory Committee (CAC) for Harvard University’s Allston Campus IMP. CRWA is one of four CAC members not from the BRA’s Task Force, and the only CAC member with environmental expertise. CRWA will play an active role in state environmental review of the IMP through the Massachusetts Environmental Policy Act (MEPA) process both in our role on the CAC and as an independent advocacy organization.

Building relationships and working with stakeholders

CRWA has been working directly with Harvard University, local environmental groups, neighborhood groups, the City of Boston, and various State agencies as Harvard’s campus planning process unfolds. We have developed partnerships with a range of stakeholders involved with the planning process and are working with each one of them to further the goal of environmental sustainability.

Harvard University:

CRWA has worked directly with ADG and Harvard’s planning and design team on the University’s current water management programs and future plans for incorporating specific sustainability practices for managing water resources on a campus-wide scale. Through periodic meetings, we have been able to influence decision-making and identify numerous shared goals. CRWA adopted a set of principles to govern ADG’s approach to environmental restoration. Our goal is for ADG to adopt a set of urban restoration guidelines that will integrate sustainable water management and design as a part of the IMP. In addition to engaging formally with the ADG and the project consultants, CRWA is working with the Harvard Green Campus Initiative, which has supported our goals and presented our work to the staff at the Center for Health and Global Environment and to faculty and students at the Harvard Design School.

City of Boston:

Working primarily with the BRA and the Boston Environment Department (BED), CRWA has be-

REGULATORY AGENCIES, PUBLIC LANDOWNERS & STAKEHOLDERS (WITH ABBREVIATIONS)

Harvard University:

- Allston Development Group (ADG)
- Harvard Green Campus Initiative (HGCI)
- Center for Health and Global Environment
- Harvard Graduate School of Design

City of Boston Agencies

- Boston Redevelopment Authority (BRA)
- Boston Environment Department (BED)
- Boston Transportation Department (BTD)
- Boston Water and Sewer Commission (BWSC)

Massachusetts State Agencies:

- Department of Conservation and Recreation (DCR)
- Executive Office of Environment and Energy Affairs (EOEEA)

Neighborhood Groups:

- Allston Civic Association (ACA)
- Allston Brighton Community Development Cooperation (ABCDC)
- Allston Brighton Green Space Advocates (ABGSA)

gun to integrate planning for water resources with the City’s Green Building campaign. CRWA is a regular participant in the biweekly Harvard Allston Task Force meetings organized by the BRA to review Harvard plans as they evolve, and is a



Fig 1.5 CRWA’s Blue Cities Forum in North Allston



Fig 1.6 ABGSA's Greenspace Connections Plan Project

part of its subcommittee on open space and public realm improvements. Given that the BRA review processes will guide Harvard's expansion, we see significant potential to leverage Blue Development as a means to achieve water-friendly buildings and neighborhoods.

RESTORATION GOALS

Sub-watershed level:

- Mimic natural hydrologic response
- Be in "water balance"
- Reduce and slow down stormwater runoff
- Maximize groundwater recharge
- Capture pollution – bacteria, sediment, nutrients
- Minimize summer water use
- Upgrade/separate sewers
- Reduce inflow and infiltration (I/I) to sewers
- "Daylight" buried streams

Site level:

- Post development water cycle to mimic pre-development cycle
- Keep rainwater clean and on site; store for later use; eliminate runoff
- Minimize water use
- Maximize reuse
- Minimize impervious surfaces

State Agencies and Departments:

The MA Department of Conservation and Recreation (DCR) owns and manages a large part of the park system on the Charles. CRWA is therefore working with DCR to ensure that all potential issues and opportunities for open space restoration and public realm improvements are addressed. Public access, the protection of "viewsheds," and planning for capital improvements and

maintenance are all vital issues in this process. CRWA will play an active role in state environmental review of the IMP through the MEPA process both in our role on the CAC and as an independent advocacy organization.

Neighborhood groups:

Through participation in ongoing neighborhood meetings, CRWA has been drawing substantial attention to the North Allston neighborhood's environmental needs, emphasizing the connections between water resources and open space. In addition to coordinating with the Task Force involved in the IMP process, CRWA is working closely with the Allston Brighton Green Space Advocates (ABGSA) to discuss issues of open space planning and design and public realm improvements in the neighborhood. CRWA has partnered with Allston Brighton Community Development Corporation and the National Parks Services on an initiative called "Green Space Connections," formally launched in February of 2006 (Figure 1.6). We have worked with this group to build support for its efforts to green streets and interconnect various open spaces in the Allston Brighton neighborhood, and to strengthen residents' understanding

OPEN SPACE AND PUBLIC REALM RESTORATION GOALS

Public access to Charles River

- Enhance access – both visual and physical – to the Charles River from the residential neighborhoods and other parts of the community.
- Ensure that any new academic and other development will not wall off the river from the neighborhood physically or visually.
- Create greenways or non-linear open space corridors with pathways for pedestrian, wheelchair and bicycle access that will provide clear public access and include way finding signs which make clear that the river is publicly accessible through the campus.

Preserve existing open space and create new parks

- Expand the limited number of neighborhood parks by creating new parks and improving access to Smith Field.
- Preserve existing urban wilds and create new usable open space (such as pocket parks or community gardens) through "greening" existing hard-scaped lots and under utilized parcels
- Improve access to and condition of existing open spaces to make them more user friendly (active and passive uses) and ecologically functional (landscape retrofits)
- Enhance parkland all along the river in collaboration with the Massachusetts Department of Conservation and Recreation, and retrofit sections on the riverfront area to reduce/minimize erosion and improve water quality/habitat values.

Green Streets and other public realm improvements

- Retrofit key neighborhood streets with Low Impact Development (LID) techniques to alleviate flooding in the neighborhood and improve streetscape environment.
- Use vegetation and signage to help establish gateways, connections and nodes of pedestrian activity, and to reinforce North Allston's sense of place.
- Convert Western Avenue into an amenity-rich, pedestrian-friendly commercial district, with streetscape designs and improvements that reflect these new uses.
- "Green" parking lots and retrofit other hard-scaped areas with green infrastructure best management practices.

of water in the urban context.

Stakeholder education and involvement

CRWA has hosted numerous public forums on environmental issues in the Harvard Allston campus neighborhood. We have invited various stakeholder groups to participate as a way to engage them in the process. The primary goal of these forums is to build local awareness of environmental issues and of opportunities to link improvements to larger-scale, regional infrastructure and the park system with the Harvard Allston campus development. In addition to coordinating with various state agencies on this initiative, CRWA has also been working with the Massachusetts Executive Office of Energy and Environmental Affairs (EOEEA) and Coastal

Zone Management on incorporating Low Impact Development (LID) Best Management Practices in retrofitting an urban area like North Allston.

PROJECT GOALS AND VISION FOR RESTORATION

Sub-watershed restoration goals and priorities

The primary goal of the project is to assess ways in which the development of Harvard's new campus can bring significant environmental improvements to North Allston and to support a broad and inclusive process for evaluating environmental improvements. The project aims to identify restoration approaches that will restore hydrologic integrity by incorporating green infrastructure

Plate 1.3 Concept Design and Vision for Restoration

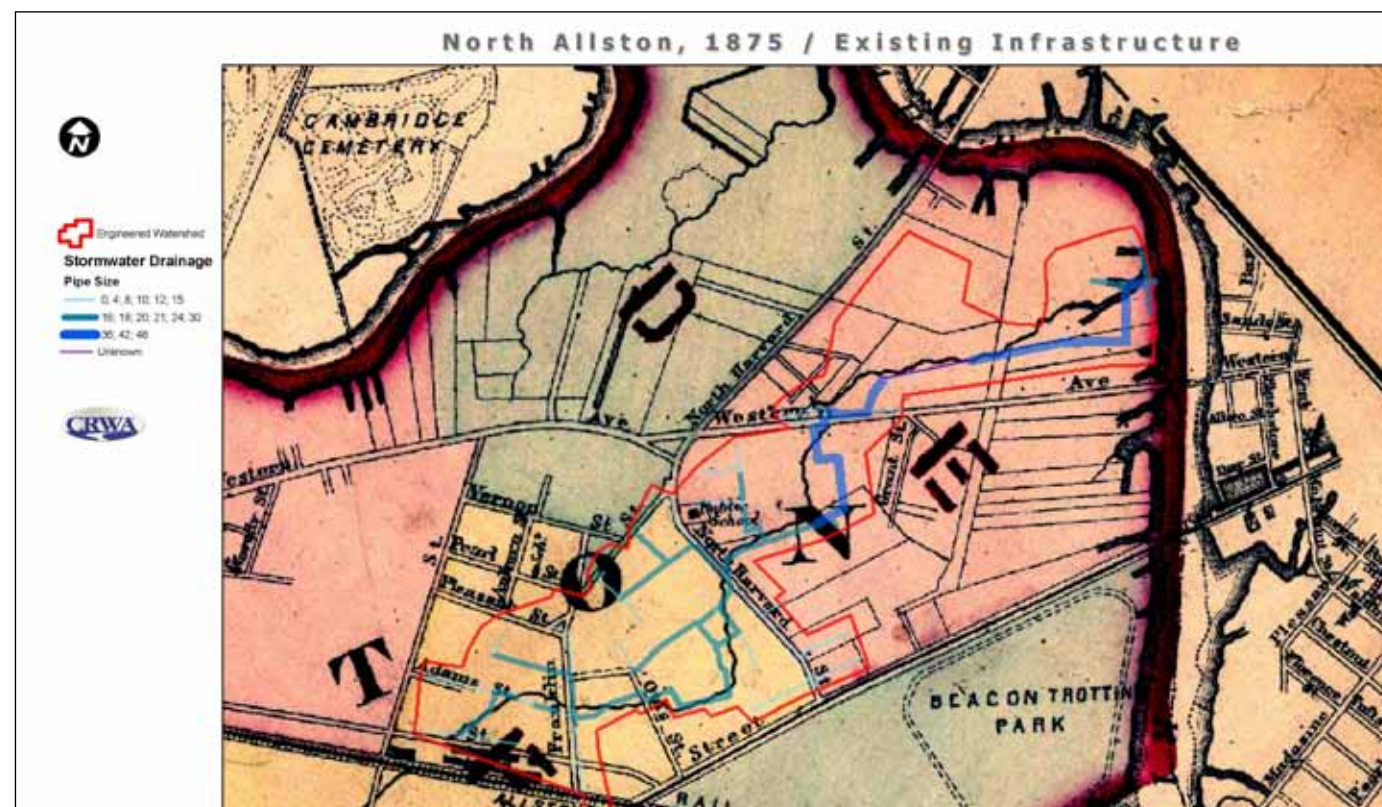
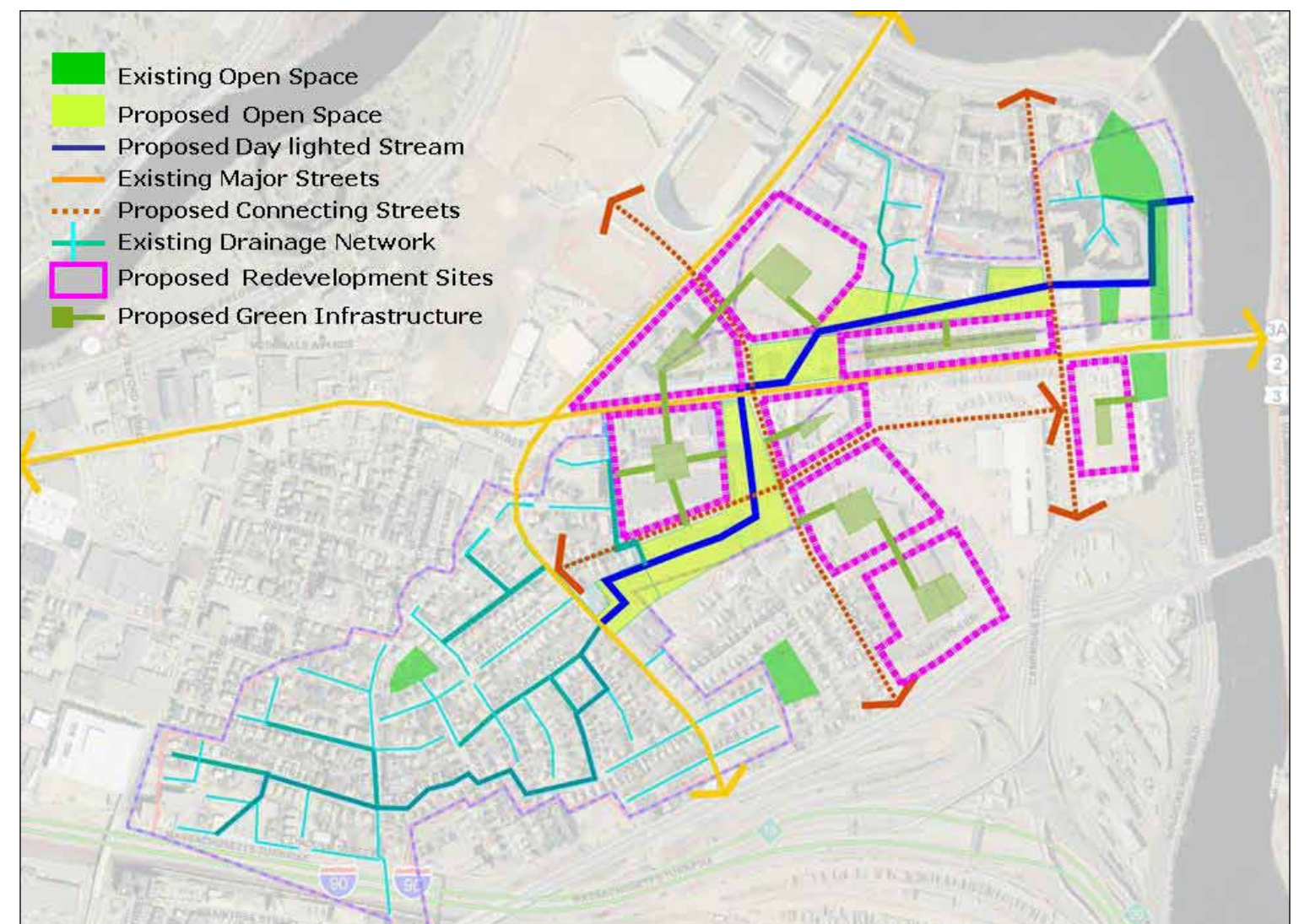
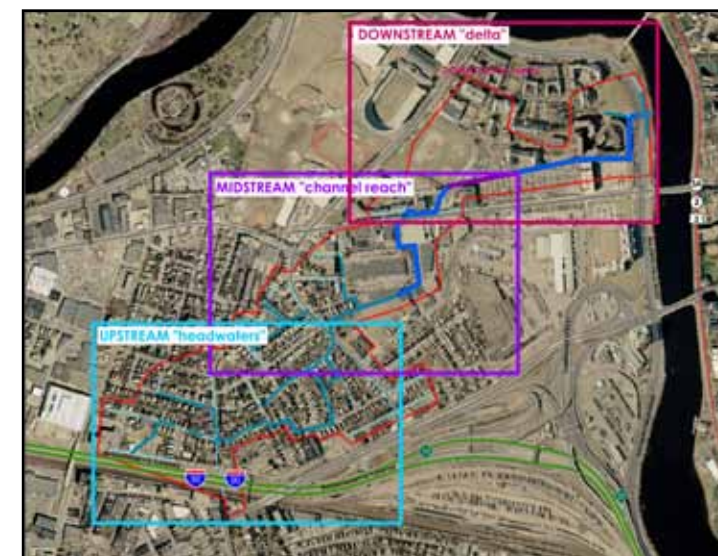
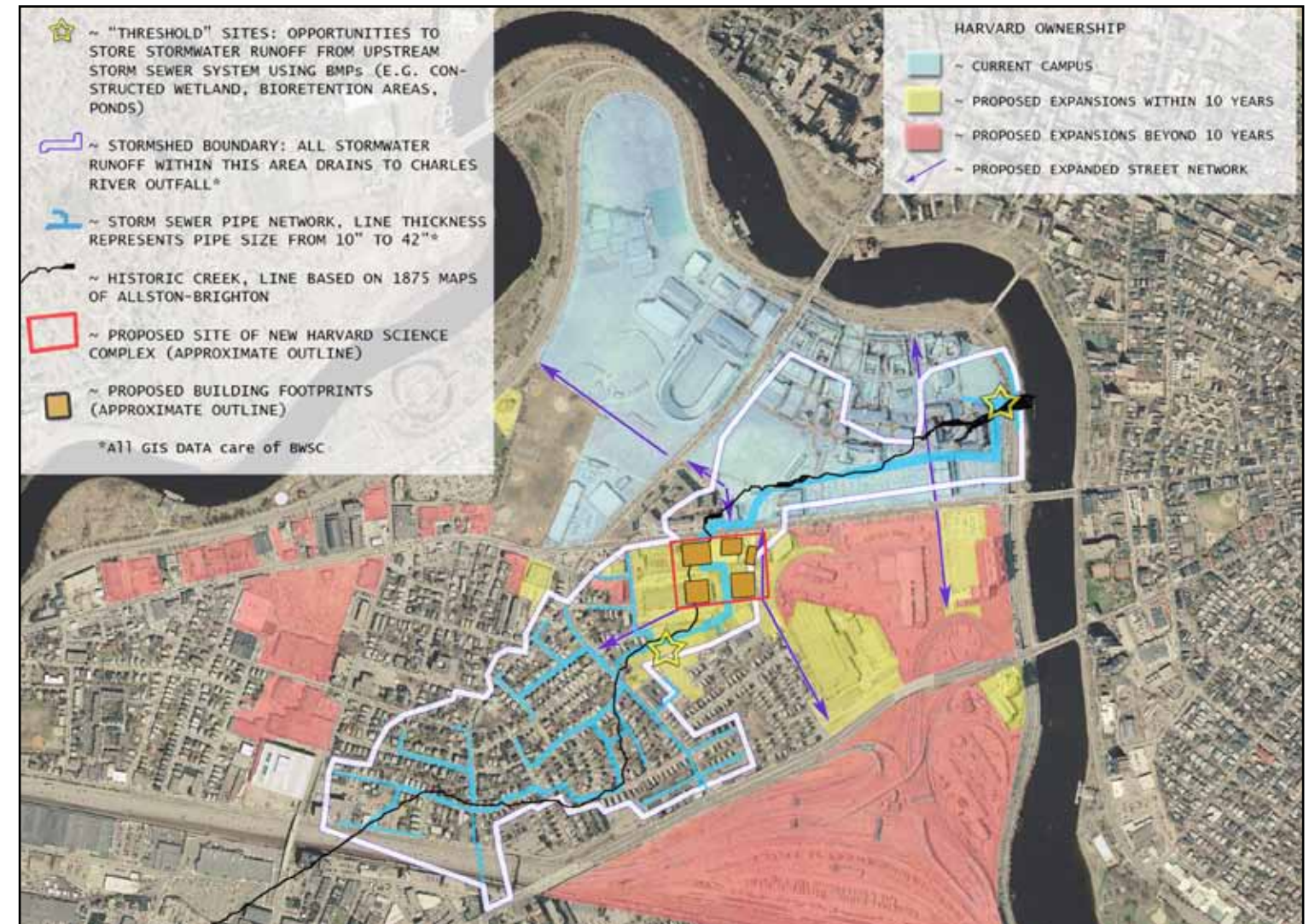
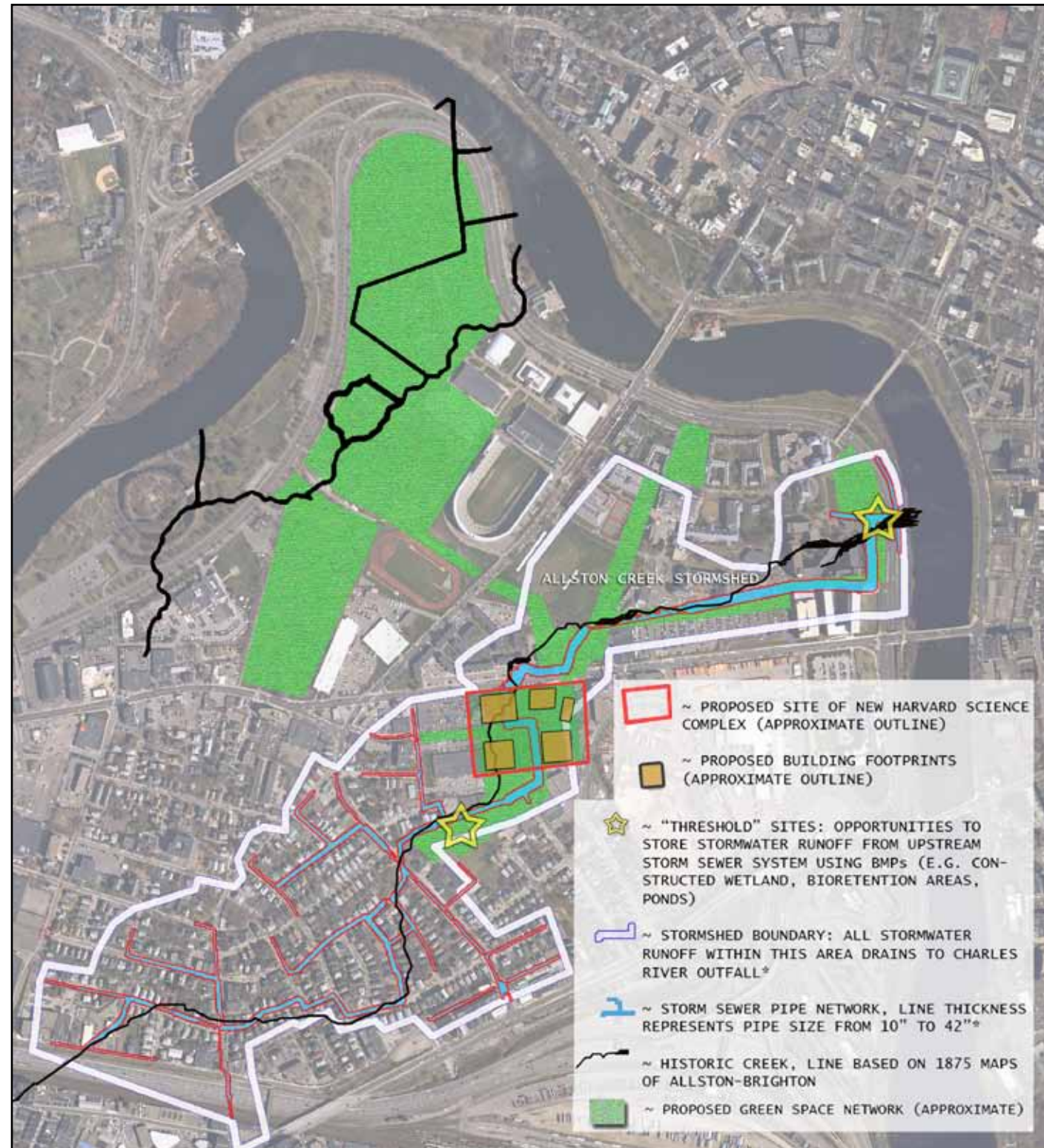


Plate 1.4 Concept Design and Vision for Restoration

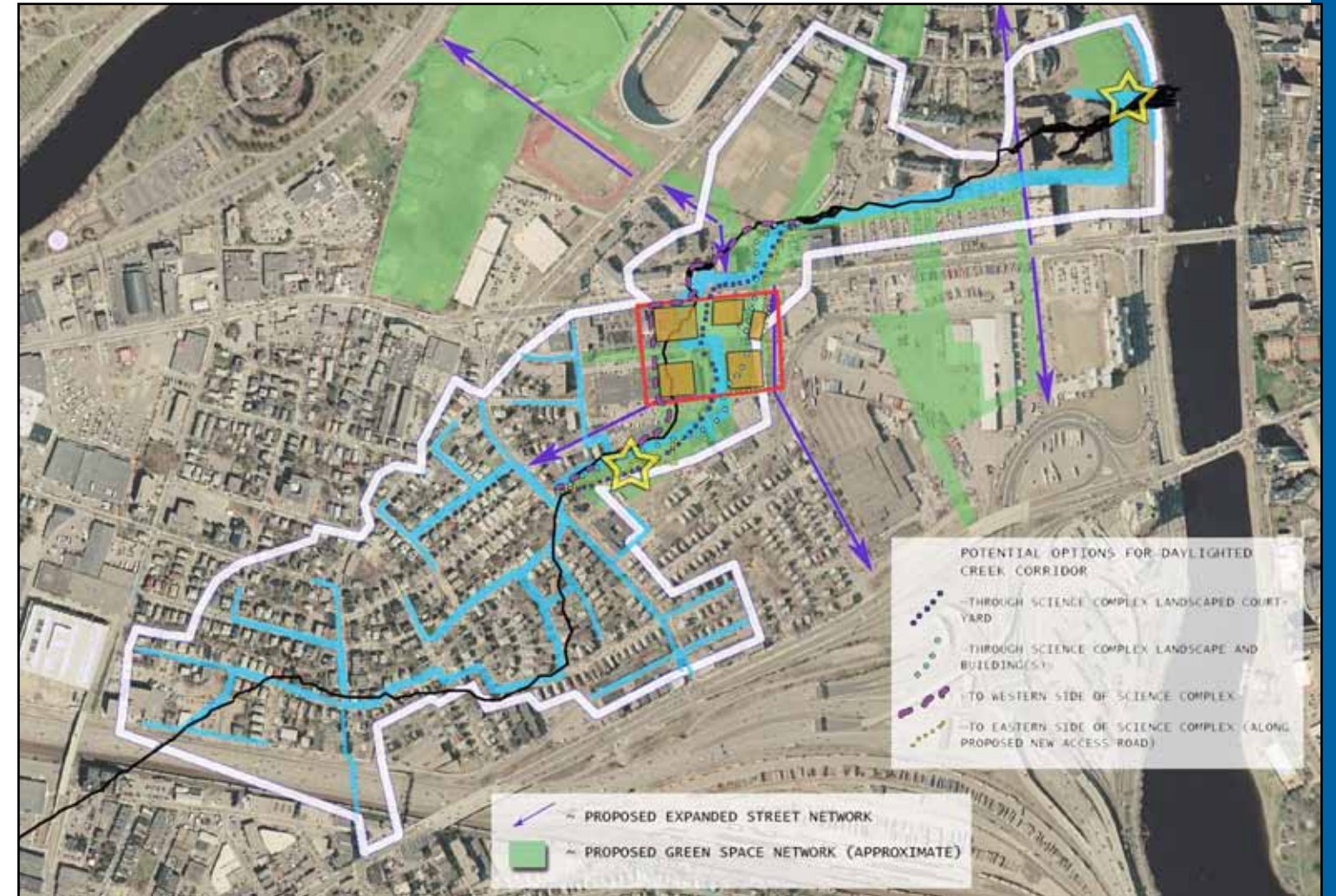


Concept plan for Allston Creek sub-watershed: proposed green space network along a daylighted stream corridor with threshold sites for storing and treating stormwater runoff in bioretention areas, constructed wetlands or ponds.

Plate 1.5 Recommendations for Sub-watershed Scale Restoration



Before and after scenarios for proposed Travis Street greening (top left), constructed wetland adjoining Harvard Business School (bottom left), daylighted stream corridor adjoining Honan Allston Library (bottom right) and restoration of Allston Creek sub-watershed (top right).



practices throughout the campus and the surrounding neighborhood, and also to take advantage of this major redevelopment project to drive sub-watershed scale solutions and to build on and link to existing open space, public health, and public realm needs. We have articulated several specific goals on a sub-watershed and site level respectively (see text boxes below and on page 8).

Concept design and vision for restoration

True urban environmental sustainability means going beyond green to Blue Development - in other words, developing designs for the built environment that engage constructively with every stage of the water cycle (See Plate 1.3 and 1.4 for Concept Design and Vision for Restoration). CRWA's vision for Harvard's campus centers around

a sub-watershed that functions like nature: collecting and filtering rainfall through plants and soils and releasing it through small streams that flow to the Charles River. Streams also function as natural green corridors for people and wildlife, connecting the neighborhood, the campus and the river. Today's technology and design allow urban environments to be energy-efficient, water sensitive, and attractive while still meeting the needs of development. In addition to the campus redevelopment, CRWA has identified numerous other restoration opportunities that can be leveraged with Harvard's efforts, such as improvements to City-owned infrastructure to improve the area's drainage and runoff, and management and capital improvements in the DCR parklands.

RECOMMENDATIONS BASED ON TIME FRAME OF REDEVELOPMENT (SHORT AND LONG TERM)

Short and medium term restoration projects

- Design and build Rena Park as a part of the Allston Creek Greenway (open space connection from library park through the new Science Complex to the river with pedestrian and bike trails possibly along a daylighted stream corridor) connecting residential neighborhood to the Charles River
- "Green" Everett Street as per guidelines developed by Allston Brighton Green Space Advocates and improve access to Herter Park across Soldiers Field Road.
- Plant street trees along major boulevards (Western Ave., North Harvard St. and Cambridge St.) and where feasible retrofit sections with stormwater best management practices.
- Bury overhead electric and utility wires, rebuild sidewalks and add amenities (benches, flower planters, public art) along other neighborhood streets and where feasible accommodate bike lanes/paths.
- Remove chain link fences that create barriers between community and University open space, especially along North Harvard St.
- Improve the appearance of Harvard owned property all through North Allston and Brighton through landscape buffers.

Long term restoration projects

- Connect Harvard, BC, BU, and the river community with each other via new "Emerald Bracelet."
- Bury Soldiers Field Rd in the vicinity of Everett Street or create pedestrian friendly street crossings to Herter Park in coordination with DCR (continuation of "Riverwalk" from North Harvard across Smith Field through to the river).
- Open space to connect neighborhood seamlessly with the Harvard facilities.
- Implement the DCR's Charles River Master Plan for sections of the Charles River in Allston and convert Herter Center to community use - docks, boat rental/storage, community center.
- Alleviate flooding conditions in Smith Field through improved stormwater management including possible daylight of underground stream through Harvard's recreational fields (opportunity to restore lagoon and build connection from Herter Park to Harvard Boat House).

Building a constituency for implementing the restoration approach

CRWA has recommended several specific restoration strategies for North Allston, developed detailed plans and built a broad base of support. Our work with neighborhood groups such as the AB-GSA and the Allston Brighton Task Force has entailed a significant commitment of staff resources to regularly attend evening meetings, host gatherings, and communicate transparently with residents, business owners and political leaders. These relationships have significantly improved our own understanding of local issues and experiences. The have also built trust and cooperation, critical elements in developing a shared vision.

APPLYING THE VISION AND ASSESSING RESTORATION OPPORTUNITIES

Site and sub-watershed scale design and modeling

CRWA has developed detailed plans and a schedule for development-driven restoration that meshes with Harvard's development schedule. Our redevelopment and restoration recommendations range in detail according to scale – from building-, to site-, and neighborhood-scale (see text box). Several recommended plans for the Harvard Allston area include landscape designs for public realm improvements, and anticipated restoration outcomes.

CRWA undertook extensive technical analysis to demonstrate the effectiveness of using specific LID Best Management Practices (BMPs) at a sub-watershed scale and modeling using specialized software called WinSLAMM. (For more details regarding the modeling please refer to Appendix A.) The modeling analysis was carried out based on certain assumptions about what percentage of land-use categories will undergo redevelopment and thus incorporate LID stormwater retrofits, rather than assigning specific LID treatments to a portion of a source area. The analysis assumes that a certain

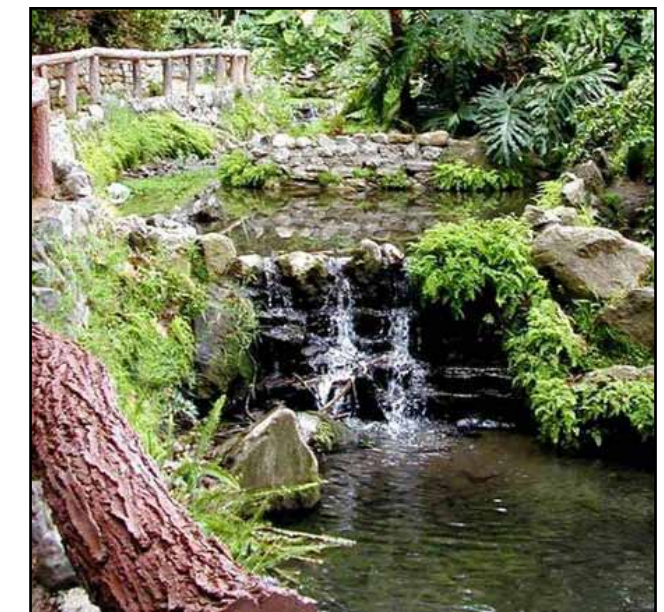


Figure 1.7 A green corridor and daylighted stream similar to CRWA's vision for Harvard was created in Berkeley, CA: before (top) and after (bottom) images of Blackberry Creek. Photos: http://www.forester.net/sw_0111_daylighting.html

percentage of all source areas (rooftops, roadways, etc.) will be treated by LID with an assumed pollution removal efficiency factor derived from literature. Applying removal efficiencies or loading reduction factors at the “Land Use” rather than at “Source Area” level, does not underestimate or not account for the pollution removal from treatments that, in the real world, can accept stormwater flows from other impervious source areas. (See Plate 1.5 for Recommendations for Sub-watershed Scale Restoration and Plate 1.6 for Sub-watershed Design and Modeling Results.)

Under proposed conditions, 50% of the industrial area (Harvard’s future Science Complex) as well as 50% of the institutional areas are assumed to undergo redevelopment and experience LID retrofits. 25% of the residential and commercial areas are assumed to be treated by a proposed stormwater wetland, pond or treatment train proposed in the “Open Land” section (Refer to Figure 1.2.1 in Plate 1.2).

Toolkit of best management practices and technologies

In an effort to provide useful technical support for our recommendations, CRWA has developed a set of matrices and fact sheets to help planners and designers assess specific techniques, referred to as Low Impact Development (LID) Best Management Practices (BMPs).

See Appendix B for these matrices and information sheets.

RECOMMENDATIONS BASED ON REDEVELOPMENT SCALE

Building scale:

- Design buildings with green roofs to absorb stormwater.
- Re-use water wherever possible; “double-plumb” buildings to allow for reuse.
- Design water supply systems with zone controls, pressure variability, networked water control systems, automatic shut-offs, etc.
- Use water efficient cooling and heating methods.
- Install flow monitors on sewers, track wastewater flows, and identify wastewater that can be eliminated from the sanitary sewer network.

Site scale:

- Mimic the water cycle by design: infiltrate flows from impervious surfaces, reduce total annual runoff volume from the site by at least 50% over existing conditions, and maximize evapotranspiration (minimum of 20% vegetative cover overall).
- Use green infrastructure as primary stormwater collection system, emphasizing surface level gravel, soil, and vegetation based treatment and infiltration systems over in-ground structures.
- Connect water and open space in the Science Complex to larger water and open space network at neighborhood scale. Preserve corridor for possible “daylighting” of the historic tributary to the Charles, currently piped beneath the Science Complex site.
- Make landscape design features such as green roofs, treatment wetlands, bioretention areas, and transportation-related stormwater storage and treatment systems a visible part of the site’s landscape design.
- Treat all stormwater discharges to meet water quality standards before water leaves site.
- Vegetate the site with deep-rooted native and/or drought-tolerant vegetation and, use only organic fertilizers and pesticides, if necessary.
- Use soil amendments (i.e., compost and topsoil) and tilling to improve existing soil structure and infiltration and remove soils with poor infiltration qualities.
- Use non-potable water for irrigation and use groundwater displaced from underground structures as a part of a site and neighborhood scale water management system, instead of discharging to piped infrastructure.

Neighborhood scale:

- Improve neighborhood public realm by creating new public open space and Green Streets to alleviate flooding, improve air quality and provide aesthetic and public health benefits.
- Integrate water features with public open space through providing interpretive signage for Allston Creek corridor and stormwater wetland garden as a part of a greenway connecting the neighborhood to the Charles River.
- Establish an information and educational program including reporting monthly water use to laboratory directors and facilities managers as well as employee incentives and award programs.

Plate 1.6 Sub-watershed Scale Design and Modeling Results



WinSLAMM outputs for proposed scenario for LID retrofits in Allston Creek Sub-watershed

Case Study - Zakim North Area

EXISTING CONDITIONS ANALYSIS

Historical evolution and current site analysis

The Zakim North area lies north-west of the Zakim Bridge, and includes large areas of East Cambridge, Somerville, and the Charlestown neighborhood of Boston. This land formerly drained into the Millers River. The river, once a 6-mile long tributary of the lower Charles, has been almost completely eliminated and now consists of less than a quarter-mile of open water (see Plate 2.1, Fig 2.1 and text box below for details of the transformation brought about by the filling of the tidal flats).

Today, much of the Zakim North area is a flat industrial and rail complex. In addition to suffering from severe stormwater runoff problems, with street flooding and sewer backups, the area currently has a combined sewer system (with pipes carrying both stormwater and sanitary sewage) so

By 1795 the area of the Boston peninsula had been increased, primarily by “wharfing out”- the process of constructing wharves outward from the shore and later filling the slips between them. While on one hand wharfing out added land to the southwestern shore of the Charlestown peninsula, on the other Mill dams had been built across the head of the cove between Charlestown and what is now Somerville. By 1852 new passenger bridges linked Boston, East Cambridge, Charlestown, and Somerville, but even more striking was the proliferation of railroad bridges. By 1880 the southern shore of Charlestown had also been increased almost to the present line by the filling of Prison Point Bay and most of the Millers River.

- Page 17, Mapping Boston, edited by Alex Krieger and David Cobb, MIT Press 1999.

overloaded that it cannot handle even moderate rainfall. This area, however, is poised for large scale redevelopment and is expected to change dramatically in the coming decade, transforming into a vibrant, pedestrian-friendly urban neighborhood.

Sizeable new development is currently planned in the lower watershed portion of the Zakim North area. The 45-acre NorthPoint project includes plans for approximately 20 buildings with a mix of uses, new parks and open space, new transportation elements - including a new Massachusetts Bay Transit Authority (MBTA) stop - and new infrastructure. Adjoining the NorthPoint project, the Charles E. Smith Residential Development site is composed of three parcels covering 5.7 acres and expected to provide approximately 767 residential units in two buildings with an underground parking garage containing 870 parking spaces. The buildings will also contain office space, cafés with outdoor seating areas, a fitness center, and a 2,400 square-foot retail store. The area between the old dam at the Museum of Science and the new Charles River dam and locks also has five new parks, constructed with mitigation funds from the Central Artery Project. The above projects, along with the redevelopment planned in Brick Bottom and the Inner Belt, in close proximity to the river and the new parks, offer major opportunities for improving the current urban environment.

Identification of issues and opportunities and field verification

CRWA undertook extensive site visits and field work, including both dry and wet weather water sampling, to understand the complex physical and infrastructure issues that are causing serious water problems in the Zakim North Area. We identified extensive street flooding and sewer back-ups in parts of East Cambridge and Somerville; the release of untreated sewage directly to the Charles

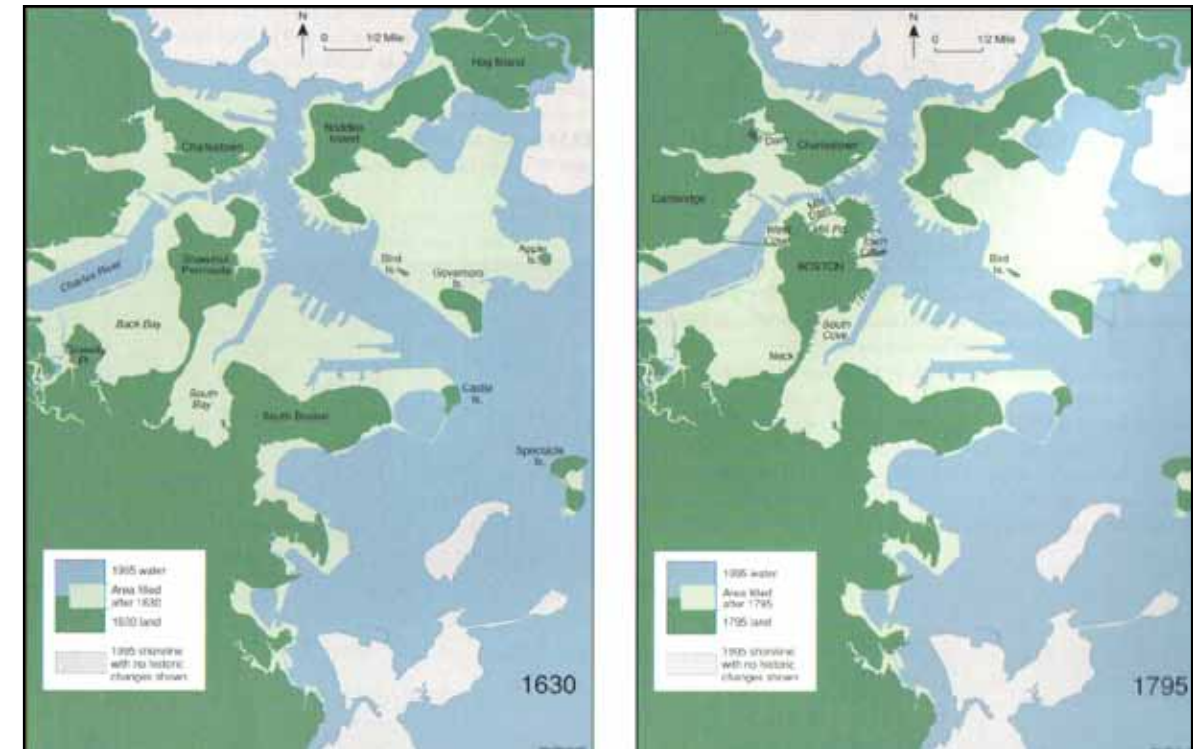


Fig 2.1 Diagramming the Growth of Boston 1630-1795 (Courtesy Mapping Boston, edited by Alex Krieger and David Cobb, MIT Press 1999)

River; and contaminated runoff from the MBTA’s Boston Engine Terminal into the Cambridge sewer system, as well as into the Millers River. These problems are all linked to the historic filling of the Millers River, which once provided drainage for the entire area. Field collection of important information about stormwater quality and flow proved that flooding, overloaded combined sewers, and undocumented stormwater infrastructure cover all scales, from the single-site scale to the whole sub-watershed. The magnitude of these problems requires the participation of multiple stakeholders to design and implement comprehensive solutions on a watershed scale. While highlighting the seriousness of the stormwater issues plaguing the Zakim North area, CRWA has identified numerous restoration opportunities on a variety of scales that not only provide solutions to the technical challenges we found but can also improve the overall environ-



Fig. 2.2 Extensive street flooding in the Zakim North Area

Plate 2.1 Historical Mapping of the Millers Watershed and Existing Conditions

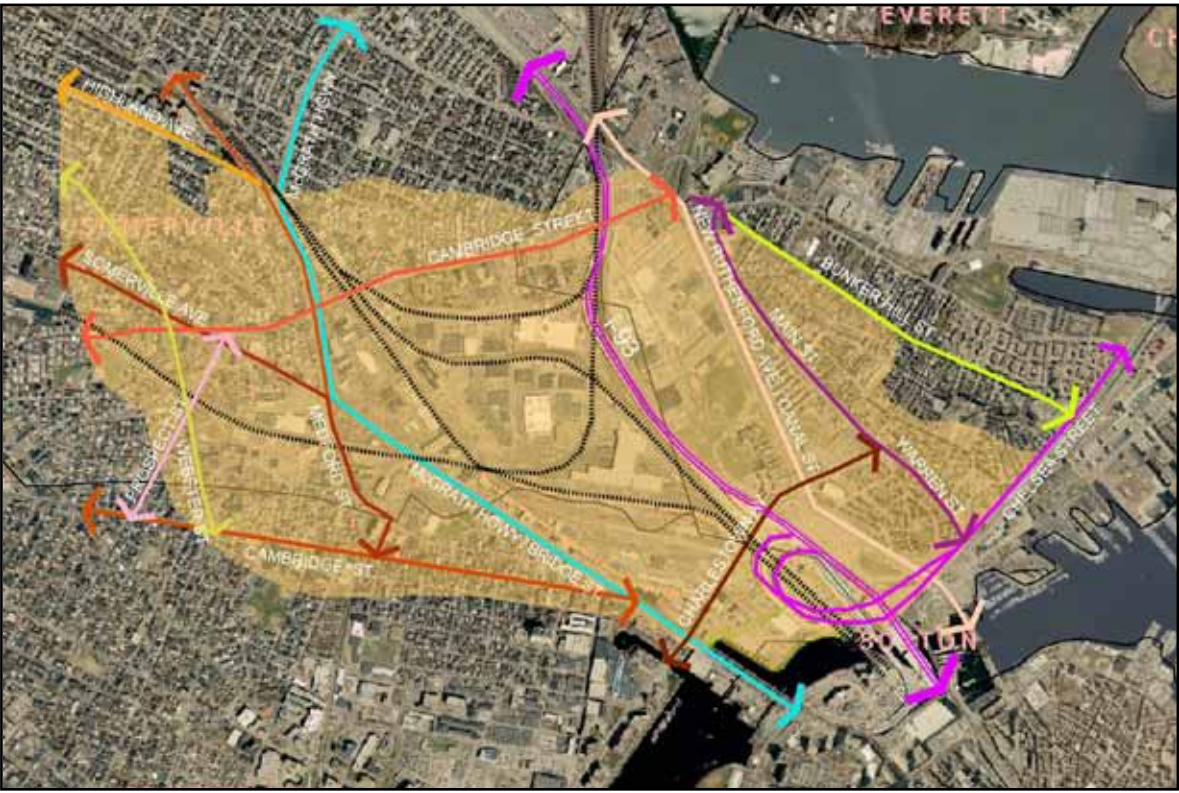
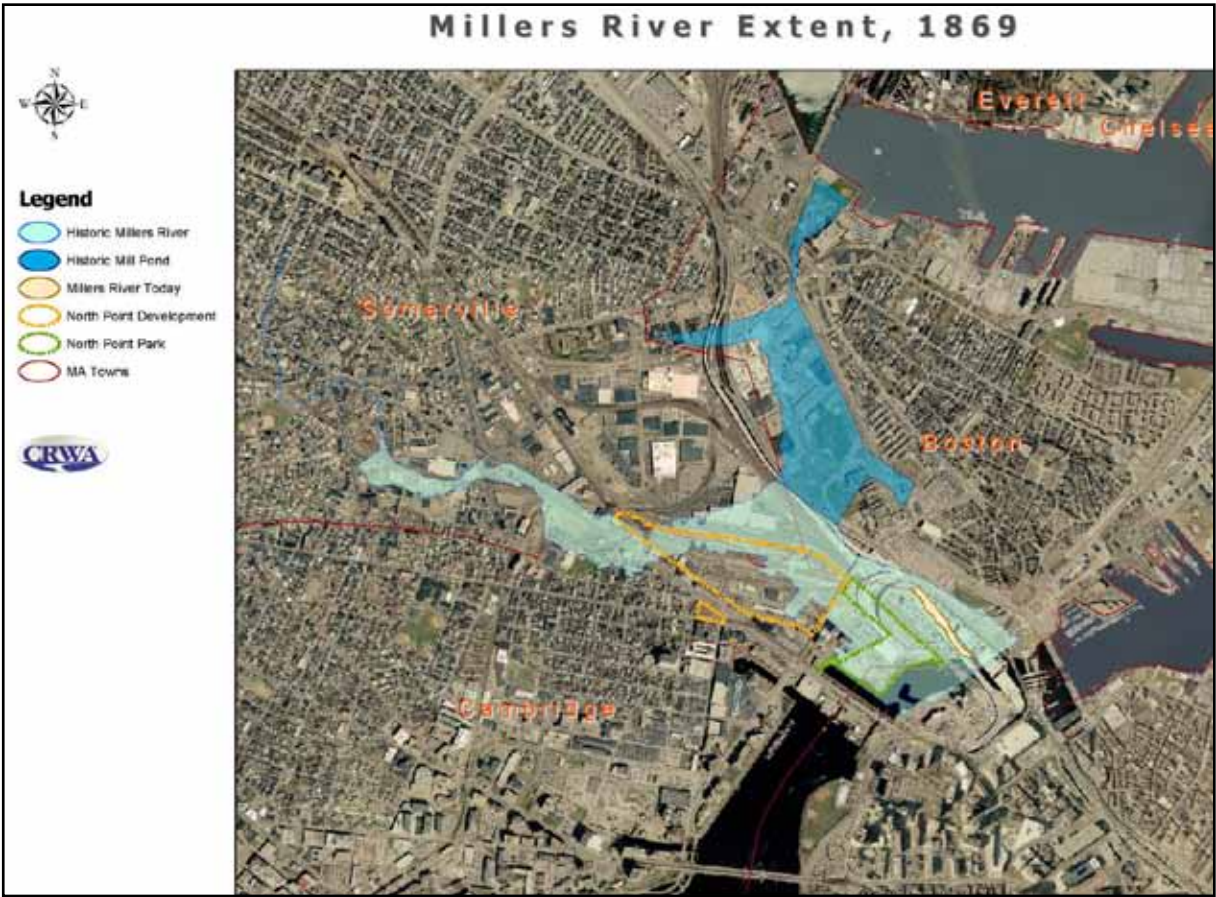
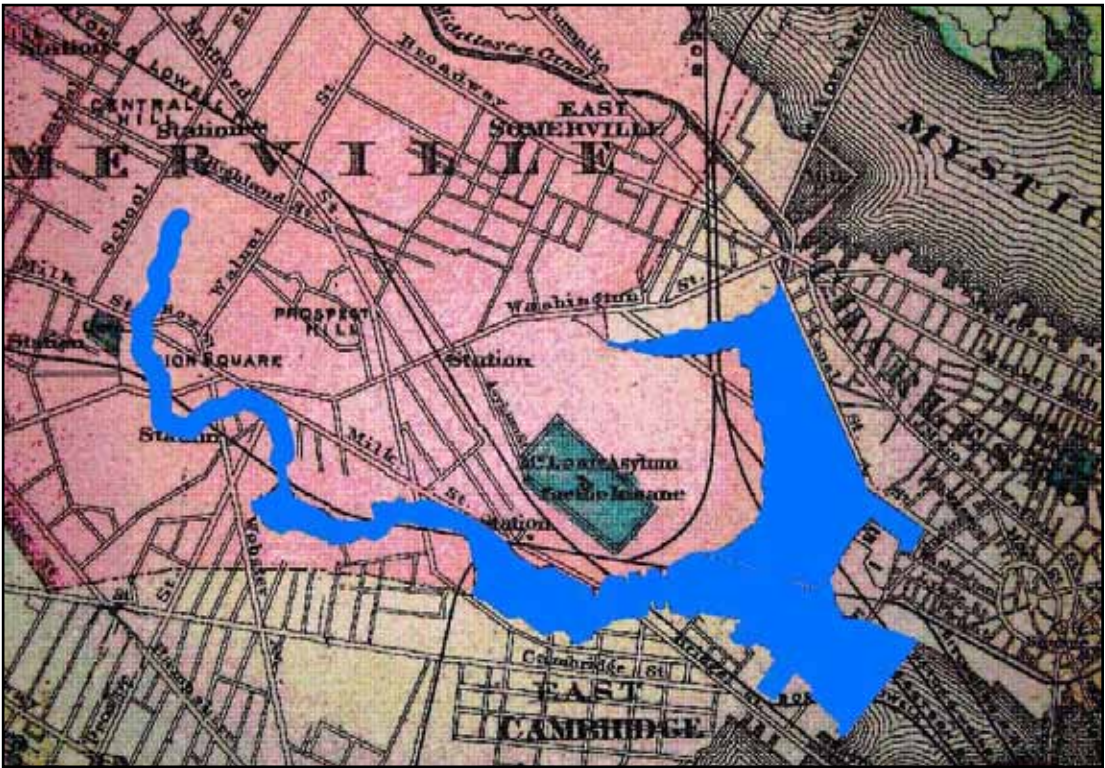


Plate 2.2 Existing Conditions Analysis & Sub-watershed Modeling



Figure 2.2.2 WinSLAMM outputs for existing conditions categorized by source area within the Inner Belt for runoff volume and loading for Total Phosphorous, Total Suspended Solids and Total Copper

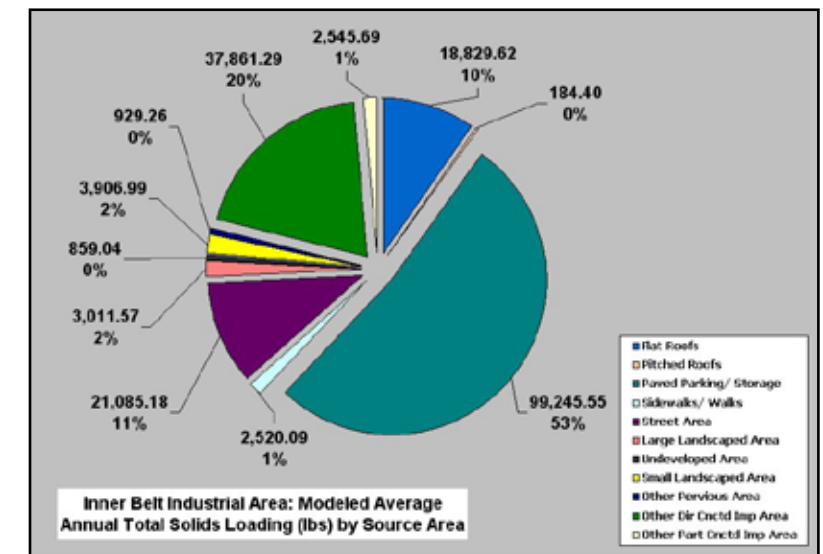
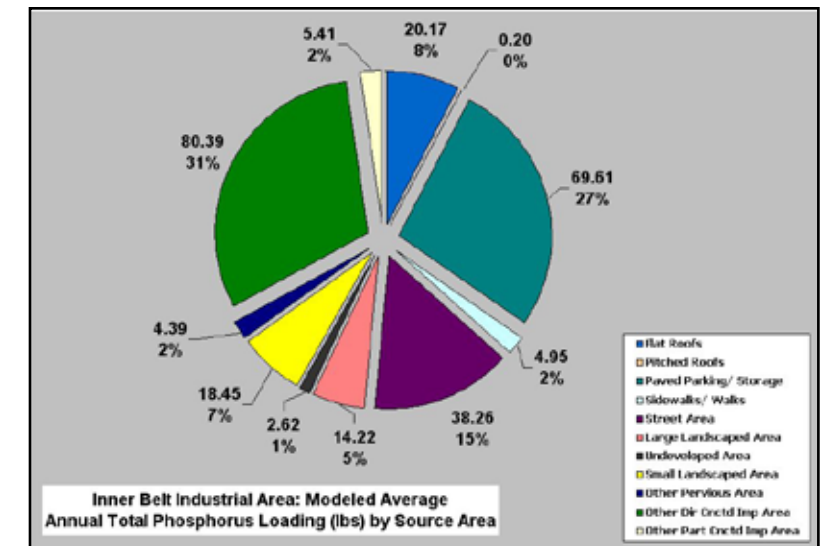


Figure 2.2.1 Impervious area mapping in the Inner Belt

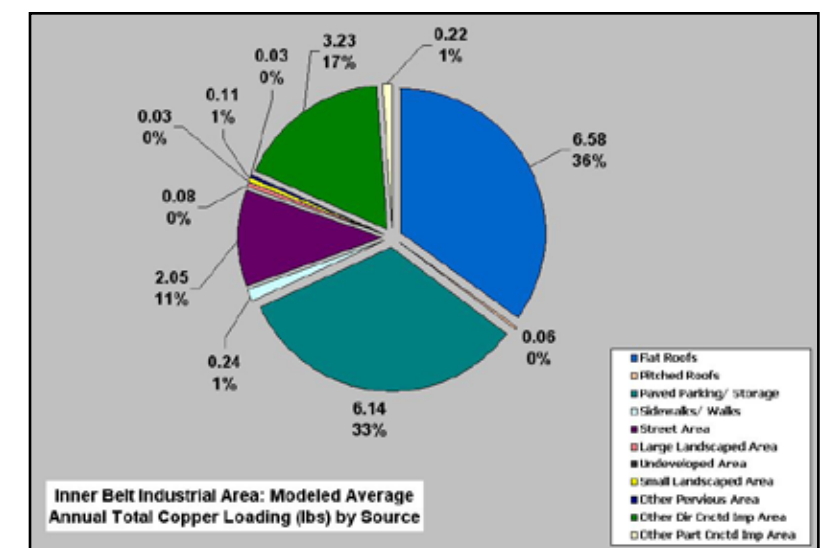
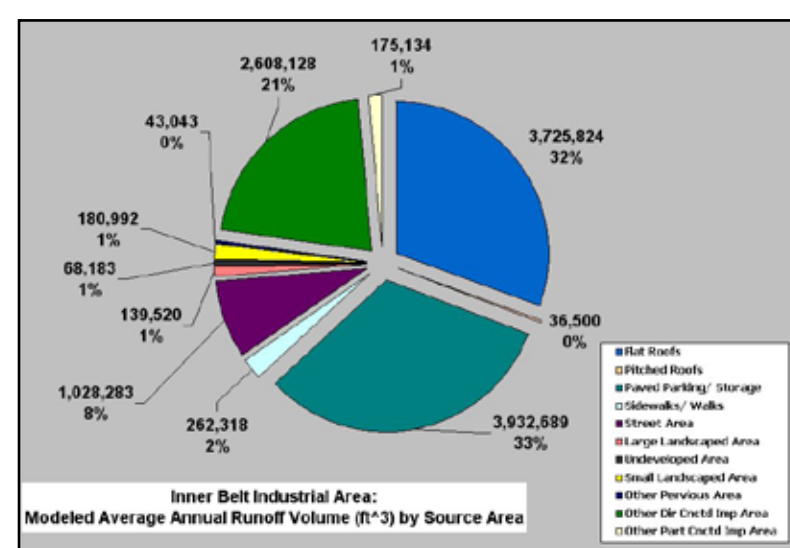
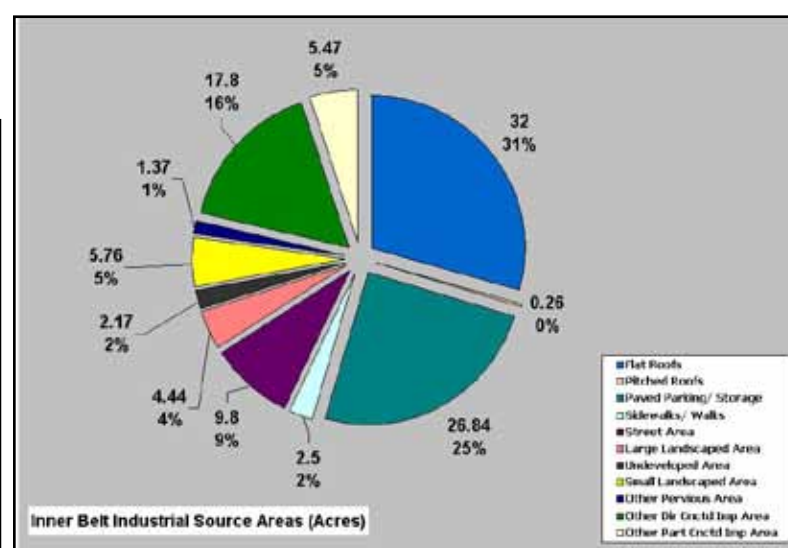
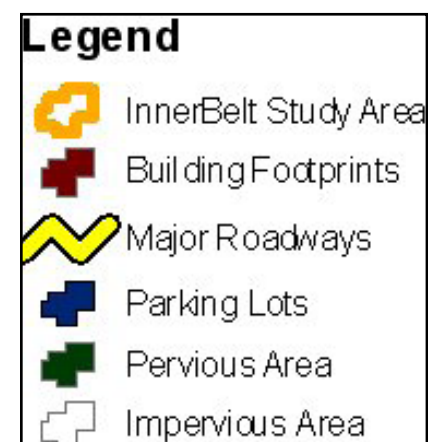




Fig. 2.3 Puddling along the Millers drainage corridor

mental health of the neighborhoods, and provide a sound, water-based foundation for designing this new area as a Blue City.

Analytical mapping and sub-watershed modeling

The Zakim North Inner Belt study area is located primarily in Somerville, bordered to the north by Washington Street, to the south and west by MBTA commuter rail tracks, and to the east by I-93 (Figure 2.4). A portion of the northwest corner crosses the border into the Charlestown neighborhood of Boston. Much of the study is classified as industrial (Figure 2.4, purple shaded) with a small portion of the northeast boundary classified as residential (Figure 2.4, orange shaded) as defined by the Resource Mapping Project conducted by UMass Amherst whose land use spatial data layer is served out by MassGIS. Since many of the proposed retrofits and Low Impact Development (LID) treatments are proposed for the industrial area, this report presents results from the Inner Belt industrial area. (See Plate 2.2 for existing conditions analysis and sub-watershed modeling.)

The Inner Belt Industrial study area is approximately 109 acres, a staggering 90% of which are impervious. Of the impervious area, most is comprised of flat rooftops, paved parking and storage,

and other directly connected impervious area which includes the train tracks, and a variety of impervious areas (Figure 2.2.1 in Plate 2.2).

Not surprisingly, the high degree of impervious land in this area creates tremendous water resource problems. CRWA's modeling and analysis of this area indicates that a combination of small scale decentralized LID Best Management Practices (BMPs) designed to reduce the amount of directly connected impervious area, and larger infrastructure improvements to handle flood flows, are needed to resolve the problems in this area. See Plate 2.6 and Appendix A for detailed descriptions of CRWA's modeling.



Fig. 2.4 Study area boundary for the Inner Belt: area shaded purple is industrial, orange is residential.

PLANNING CONTEXT AND STAKEHOLDER OUTREACH

Planning framework and existing regulatory background

Since the Zakim North area includes parts of three different cities (Cambridge, Somerville and Boston), the regulatory framework involves zoning and planning guidelines issued by three different city planning agencies. In addition various State and Federal agencies exercise regulatory authority (see text box).

As mentioned before, a number of redevelopment projects are being undertaken in the Zakim North

Area, including the NorthPoint project, Charles E. Smith Residential development, projects within the Brickbottom and the Inner Belt district as well as planning for the Green Line extension and the Urban Ring. The area's major area landowners are the MBTA, which operates the Boston Engine Terminal and tracks; MA Department of Conservation and Recreation (DCR), which owns North Point Park; and Archon Group, which has recently acquired the rights to develop NorthPoint from Boston Maine Corp., and Cambridge NorthPoint LLC. Other important stakeholders include Massachusetts Water Resources Authority (MWRA), U.S. Environmental Protection Agency (USEPA), MA Department of Environmental Protection (DEP) and several other private sector parties. In ad-

dition to convening a working group of regulators, property owners and municipal officials, CRWA has conducted complex research into the deeds, licenses, permits and obligations of the various parties to determine their stormwater management obligations.

Building relationships and working with stakeholders

CRWA has been working with the cities of Cambridge, Boston and Somerville, neighborhood and community groups, and park advocacy groups concerned with the lower Charles River to ensure that the redevelopment in the Zakim North area,

REGULATORY AGENCIES, PUBLIC LANDOWNERS & STAKEHOLDERS (WITH ABBREVIATIONS)

Federal agencies:

- US Environmental Protection Agency (USEPA)

State agencies:

- Massachusetts Department of Environmental Protection (DEP)
- Massachusetts Water Resources Authority (MWRA)
- Department of Conservation and Recreation (DCR)
- Massachusetts Bay Transit Authority (MBTA)

City agencies:

- Cambridge Conservation Commission
- Cambridge Department of Environmental and Transportation Planning
- Community Development Department
- Cambridge Department of Public Works (DPW)
- Cambridge Water Department
- Somerville Office of Strategic Planning & Community Development (OSPCD)
- Somerville Department of Public Works (DPW)
- Boston Redevelopment Authority (BRA)
- Boston Transportation Authority (BTD)
- Boston Water and Sewer Commission (BWSC)
- Boston Public Works Department (PWD)

Plate 2.3 Concept Design and Vision for Restoration

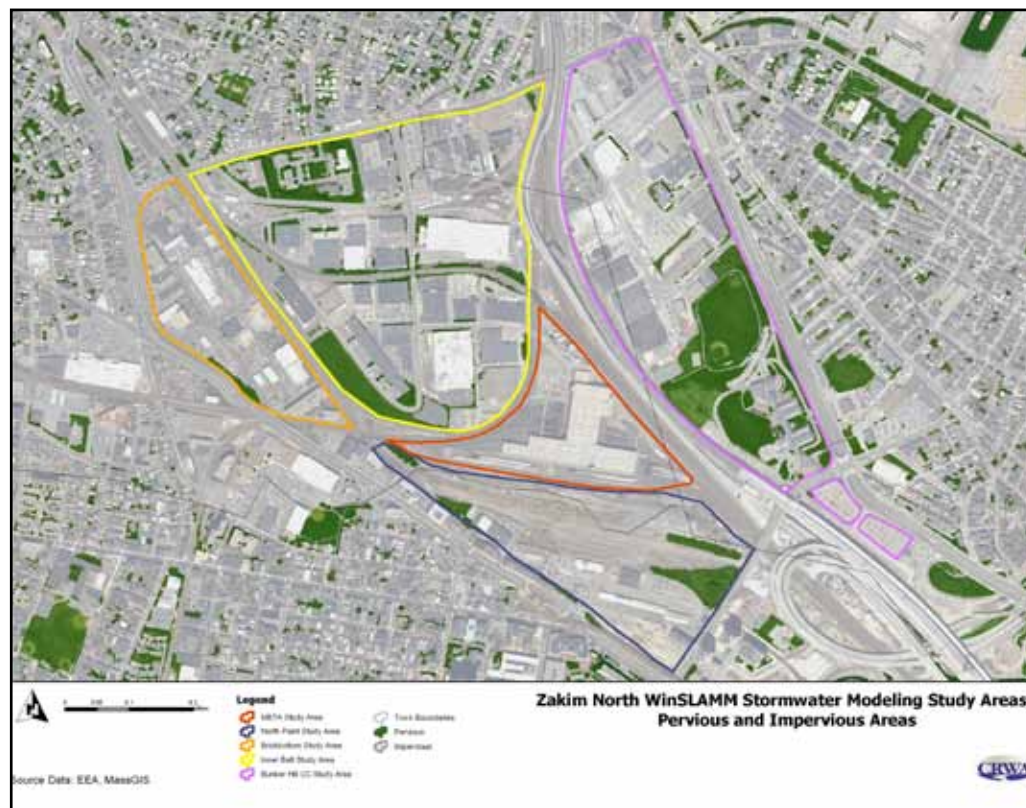


Figure 2.3.1 (above and below) Sub-area delineation based on existing neighborhood boundaries.

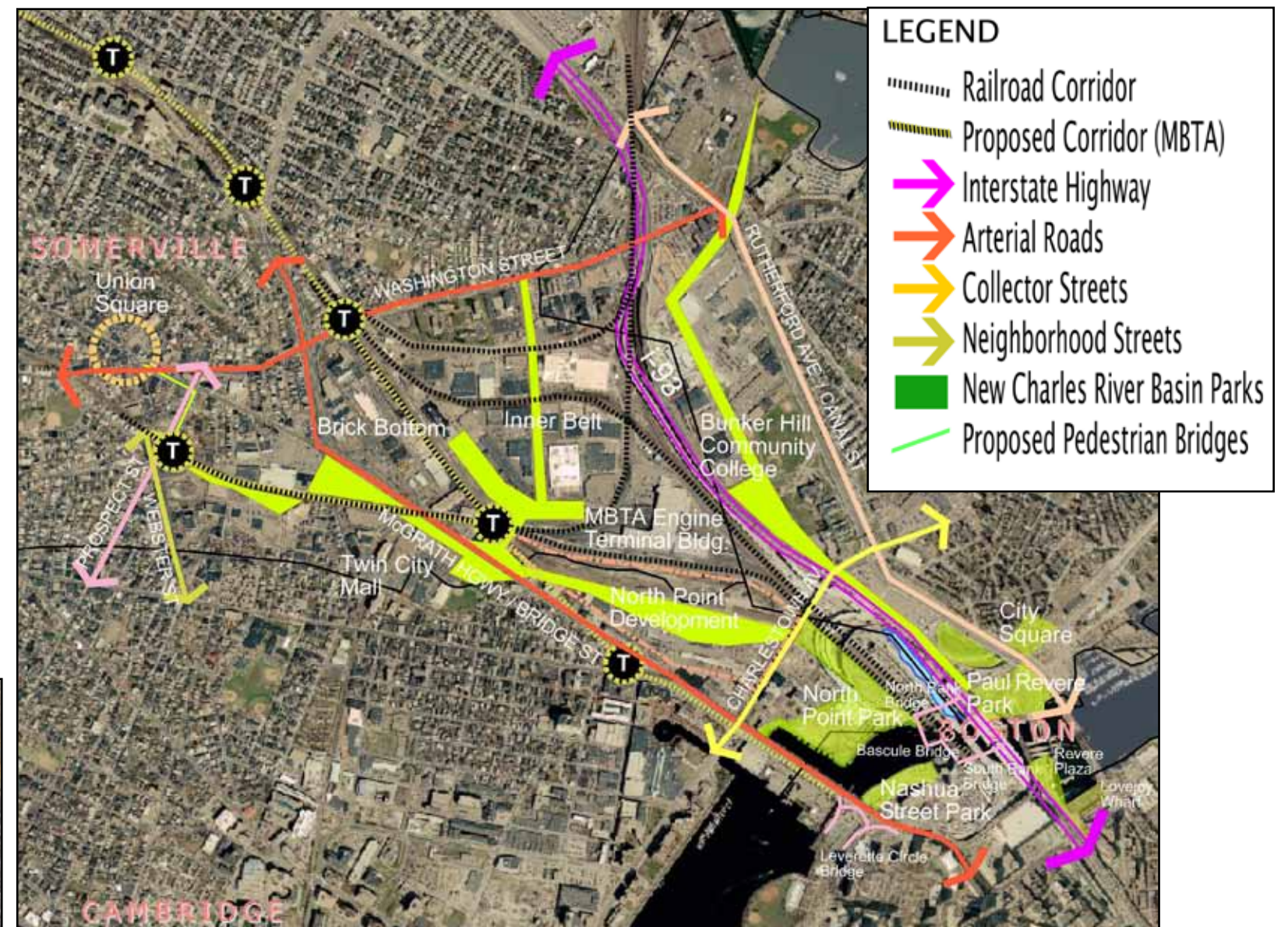


Figure 2.3.2 (above and at right) Concept plan and analog image for proposed network of greenways with water features along the Millers River corridor, tying together the various neighborhoods in the watersheds.



Plate 2.4 Recommendations for Sub-watershed Scale Restoration



Figure 2.4.1 Analog images for proposed retrofits in the Brickbottom district (green streets, linear pocket parks, plazas with permeable pavers and raingardens, water features to store and treat stormwater runoff).

Figure 2.4.1 Analog images for proposed retrofits in the Hood Office Park and Bunker Hill Community College sub-areas (bioretention areas, low-irrigation landscaping, porous asphalt and pervious pavers in courtyard areas).

Plate 2.5 Recommendations for Sub-watershed Scale Restoration



Before and after scenarios for proposed retrofits in the Inner Belt (greening of streets and parking lot) at top right and bottom right; analog images for stormwater planters within the public right of way and green roof retrofits on existing buildings, at left.

RECOMMENDATIONS FOR REDEVELOPMENT IN THE ZAKIM NORTH AREA

- Keep drainage open wherever possible (channels, swales, wetlands rather than pipes)
- Design water quality treatment throughout system
- Design system so it is easy to maintain
- Determine whether there are any areas in the former Millers River watershed where recharge is appropriate
- Enforce legal obligations for various parties depending on ownership and maintenance requirements laid out in various permits issued.

as jump-started by the NorthPoint project, actually benefits the river, park system, and surrounding environment. Several critical regulatory and legal processes have made progress in this area slow. A lengthy enforcement process between the DEP and the MBTA (principal landowner in the study area) has limited our ability to work directly with the MBTA or other property owners. In addition, a citizen group appealed a Chapter 91 license, issued by the State to the NorthPoint project. This proceeding resulted in a decision in favor of the citizen group, but it was soon reversed when the Legislature passed a bill in November 2007 that effectively exempted non-waterfront properties on filled tidelands from stringent licensing requirements under state laws.

CRWA formed a partnership with Conservation Law Foundation to determine the legal environmental obligations of key stakeholders, and to ascertain how to use the various permit processes to bring all parties to the table to develop and fund a comprehensive solution. The technical and legal complexities of title, licensing obligations, permit requirements and enforcement have all contributed to a protracted and as yet unresolved development and design process.

Stakeholder education and involvement

In June, 2005, after several months of data collection, site visits, attending public hearings, and examination of permits and licenses, CRWA convened a meeting of the major stakeholders. Our first step towards implementing a long-term solution to the area's drainage problems was to undertake an analysis of potential engineering solutions. As a follow-up to that meeting, CRWA prepared a draft scope of work for an engineering feasibility study, which could provide a detailed examination of opportunities to restore the area's water environment. We met with the same stakeholder group six months later to finalize the scope of work and discuss opportunities to fund it.

The objective of the engineering feasibility study was to collect, compile and analyze all of the reports and data that had been prepared to date. Significant engineering studies had already been conducted in the area, including several studies of the storm drains and sewers systems conducted for the MWRA and the City of Cambridge and technical reports prepared for the MBTA as part of their construction project to improve the Boston Engine Terminal. We held interviews with relevant managers and staff from Cambridge, Boston, Somerville, the MBTA, MWRA, DEP and private landowners in the area to develop potential design solutions which would form a part of the restoration approach.

CRWA supported the Office of Strategic Planning and Community Development (OSPCD) at the City of Somerville in applying for a 403 (b) grant from DEP to fund the engineering feasibility study and conduct the required public outreach and stakeholder coordination needed as a part of the study. This grant, however, was not awarded, so this study has not been funded to date. CRWA also worked very closely with OSPCD to influence the development of the lower McGrath Highway corridor, through its involvement with a design competition titled "Edge as Center" that the City of Somerville and Boston Society of Architects launched in January of 2006.

CRWA thus built a solid understanding of the actual conditions on the ground, as well as their causes, and then moved to begin building support for restoration. In instances where property owners and regulatory bodies have not participated, CRWA is attempting to enforce the legal environmental obligations of key stakeholders by researching various permit processes to use as leverage to encourage parties to collaborate in developing and funding a more comprehensive solution.

PROJECT GOALS AND VISION FOR RESTORATION

Sub-watershed restoration goals and priorities

Zakim North will undergo significant redevelopment in the coming years. This provides a unique opportunity to implement design and planning that will reverse damage to the watershed, address stormwater challenges, improve pedestrian access and open space, and enhance the river. CRWA identified possible technical solutions to the stormwater management issues as well as numerous restoration opportunities at a sub-watershed level including the feasibility of "daylighting" (opening up) portions of the now-filled Millers River.

Our primary design goal for the Zakim North area would be to maximize natural rainwater storage, provide adequate carrying capacity and improve water quality while also providing public amenities and riparian and aquatic habitat improvement. Specifically, CRWA has the following priorities for the project:

1. Improve wet weather water quality in the Millers and Charles Rivers,
2. Eliminate uncontrolled/untreated stormwater runoff,
3. Reduce volume of stormwater entering the combined sewer system,
4. Increase wet weather capacity of MWRA branch sewers before the Mystic River siphon.
5. Eliminate sewer system back-ups in Somerville and Cambridge,

6. Reduce Combined Sewer Overflow (CSO) activations at Prison Point.
7. Find the most cost effective way to obtain as many benefits as possible to the most involved parties.

Concept design and vision for restoration

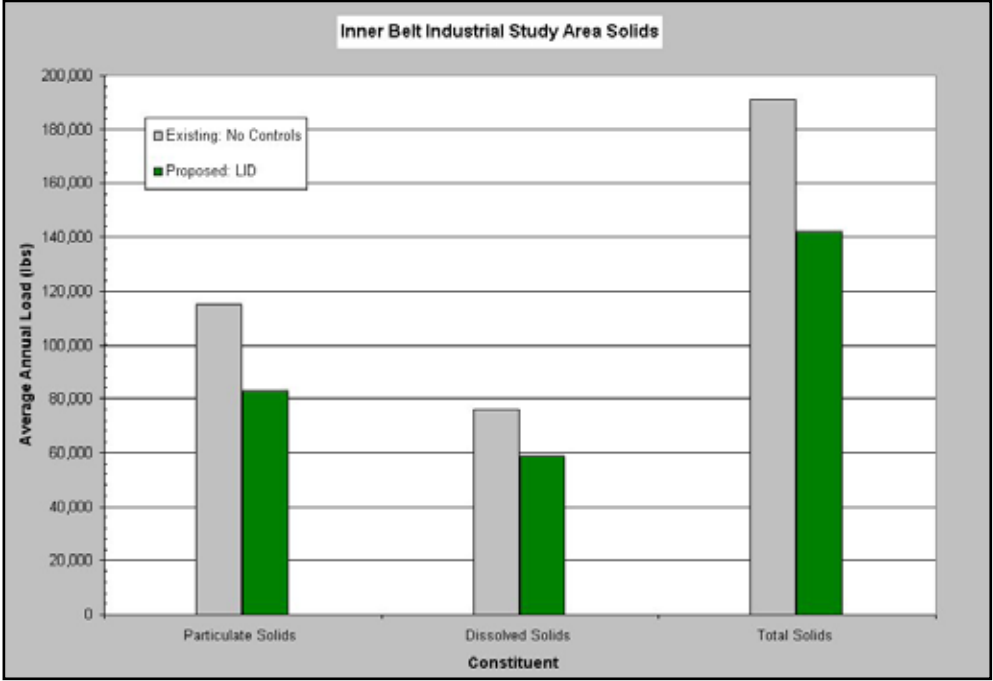
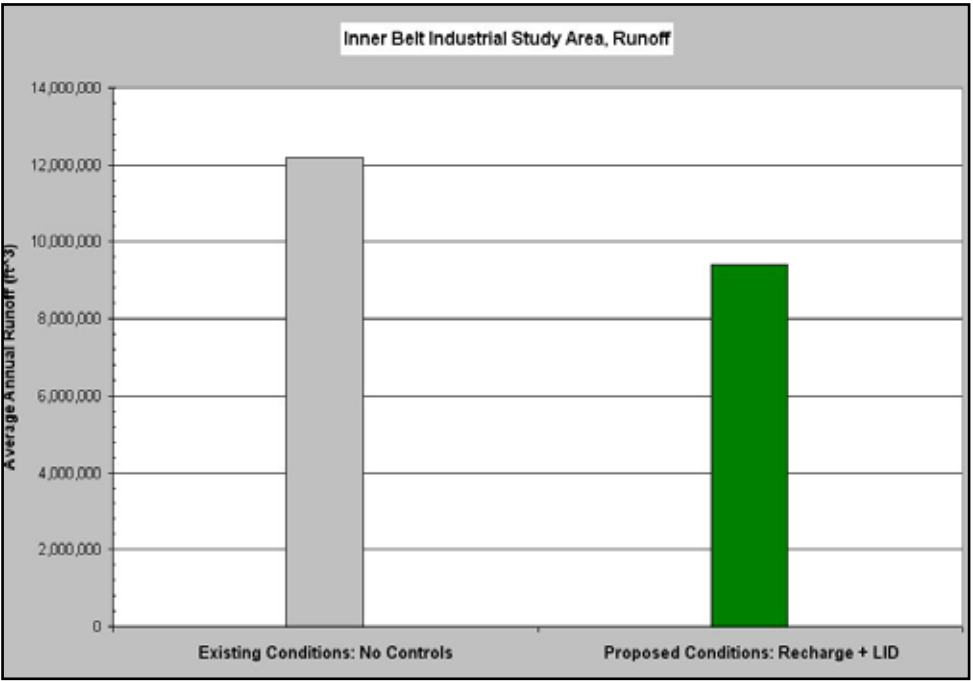
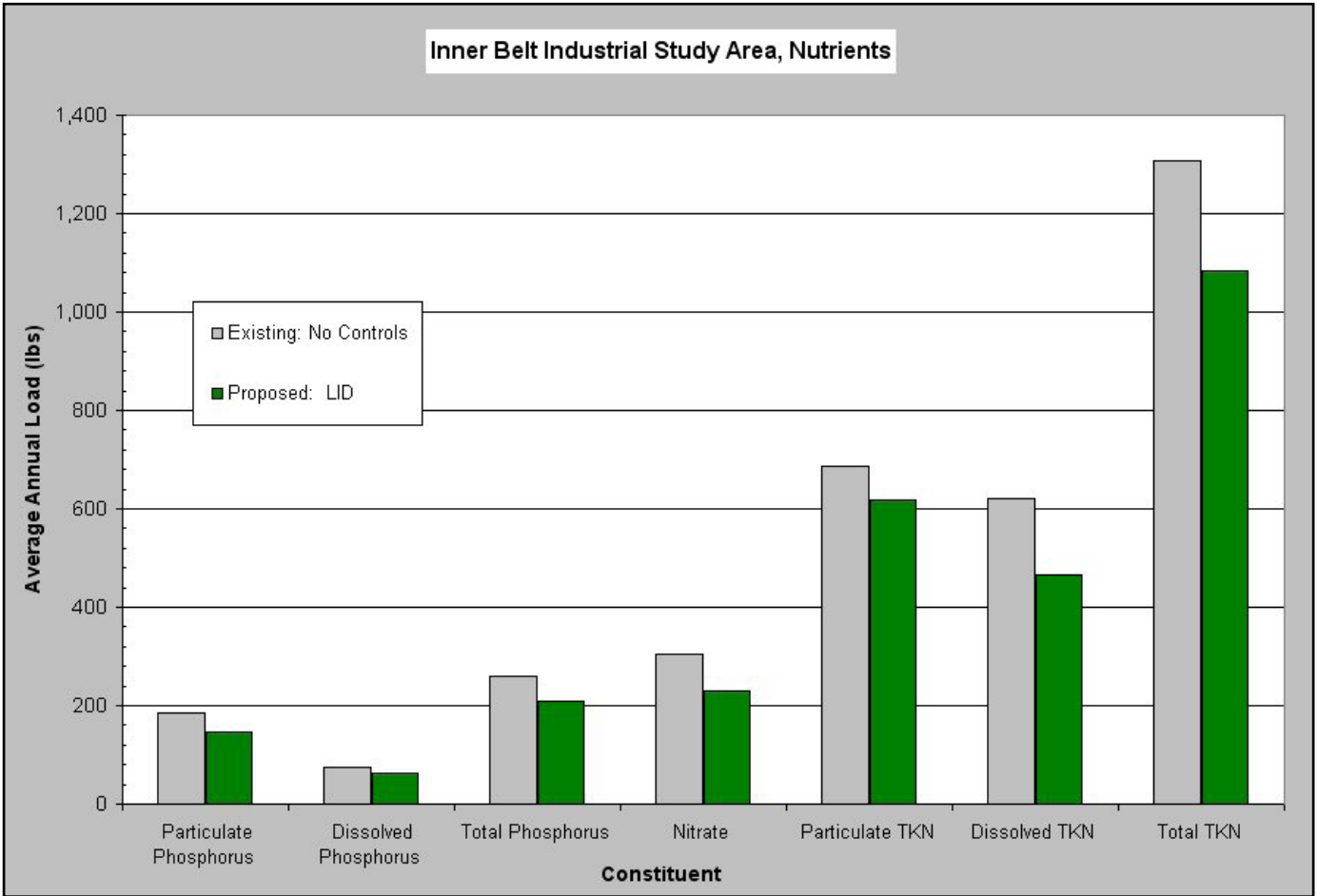
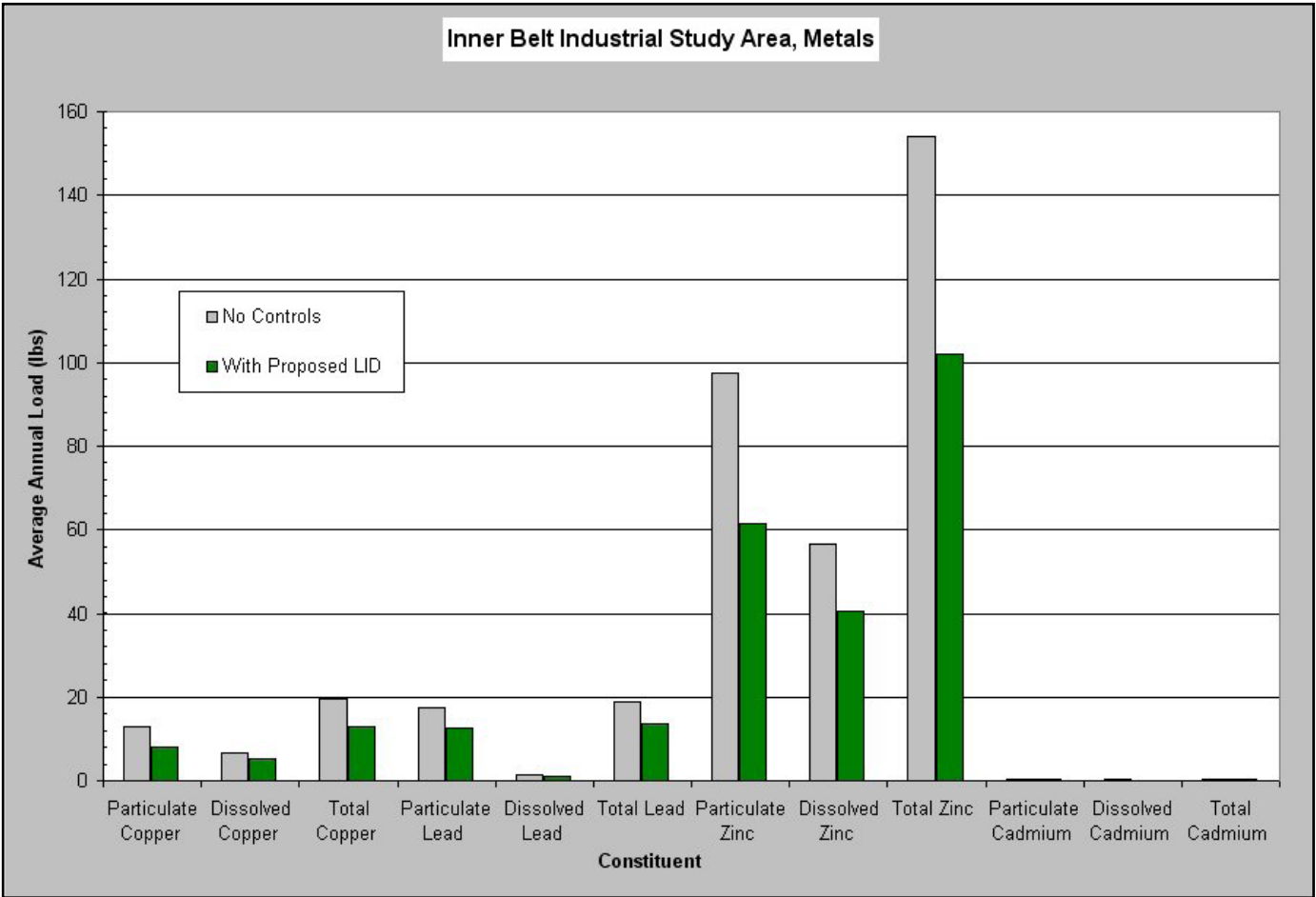
CRWA has developed a framework for identifying opportunities for green infrastructure development, which include daylighting portions of the now-filled Millers River, and retrofitting streets and other hard-scaped areas with LID BMPs (see Plate 2.3). Restoring the Millers River corridor or watershed would include the design and construction of a new stormwater drainage system to carry stormwater from the area once drained by the river (over 300 acres), perhaps in phases. The project goal would be to provide stormwater drainage for the MBTA, NorthPoint, portions of Charlestown, Somerville, and Cambridge, and perhaps include other private sector neighbors like the CE Smith development and Boston Sand and Gravel.

The most cost effective solution would involve a multi-layered design approach with numerous small, site scale BMPs to clean and treat small rainstorms and the first flush of larger storms; channels, swales and other open conveyance systems to handle moderate flows in natural drainage patterns; and large conventional infrastructure (pipes and pumps) to prevent flooding during large rainfall events.

Building a constituency for implementing the restoration approach

CRWA continues its efforts to build political and financial support for the development of a feasible engineering solution to the area's flooding and water quality problems. It is crucial that the above study includes construction phases and costs and acknowledges all responsible parties in implementing the solution. Given the complexity of ownership, licensing, and permitting issues in the area, legal research and enforcement play a vital role in

Plate 2.6 Sub-watershed Scale Design and Modeling Results



WinSLAMM outputs for proposed scenario with LID retrofits in the Inner Belt area (showing reduction in runoff and loading for metals, nutrients and solids)

ensuring that the right outcome is achieved. From an area-wide perspective, the willing participation of all the stakeholders would clearly lead to a much better solution. CRWA is currently on the Citizen Advisory Committee for the New Charles River Basin Parks project, which is responsible for overseeing the project implementation, and has consistently advocated for access and open space connections to and along the river in this area.

APPLYING THE VISION AND ASSESSING RESTORATION OPPORTUNITIES

Recommendations based on scale of redevelopment

Numerous LID BMP's have been developed for urban areas like Zakim North. Among the benefits of implementing these are reduced flooding, better water quality, and numerous environmental and aesthetic improvements to local businesses and residences. Given the contamination levels in certain areas of the watershed, however, we do not recommend infiltrating stormwater in many areas. The following BMP's could be lined with an impermeable layer to avoid infiltration, while still improving the health, aesthetics, and quality of the Millers River - and ultimately, the Charles, into which it flows:

- Sidewalk rain gardens to improve water quality, reduce peak storm flows, and improve street aesthetic. The rain gardens would receive and treat water flows from the street through an inlet in the sidewalk instead of letting it flow untreated into a storm sewer network,
- Green roofs which slow and filter runoff while insulating buildings and reducing the urban heat island effect,
- Bioretention areas in parking lots, courtyards, and other paved areas to capture and filter rainwater,
- Porous pavement and pavers to allow rainwater to filter down into a subsurface granite bed,
- Street trees.

Site and sub-watershed scale design and modeling

In order to assess the effectiveness of the proposed BMPs, the WinSLAMM Model was used to determine both pollutant removal as well as reduction in runoff from the Inner Belt area (refer to Plate 2.6 for Sub-watershed Scale Design and Modeling Results). The removal calculations from this study area are very conservative and underestimate the effects of the proposed treatments. Pollution loadings were removed solely from the source area receiving treatment and not removed from untreated source areas that could flow to treatments. Also, dissolved constituents are modeled to be removed by recharge alone, based on the recharge multiplier which was developed for 0.5 inches of recharge for proposed LID retrofits. No phytoremediation, biotransformation or other physical and chemical processes are factored in the removal of dissolved pollutants from proposed green infrastructure.

Under proposed conditions, average annual runoff volume is reduced by nearly 22%, total solids, by nearly 25%, total phosphorus by 18%, nitrate by 24%, total Kjeldahl nitrogen (TKN, which is the sum of organic and ammonia nitrogen) by 16%, total copper by nearly 33%, total lead by 28%, total zinc by 34%, and total cadmium by 29%.

Toolkit of best management practices and technologies

See Appendix B for the Low Impact Development (LID) Best Management Practices (BMP's) matrices and information sheets.

Case Study - Longwood Medical and Academic Area

EXISTING CONDITIONS ANALYSIS

Historical evolution and current site analysis

The Longwood Medical and Academic Area (LMA), one of Boston's densest urban neighborhoods, is undergoing some of the most ambitious redevelopment efforts in the city. The complexity of the area, and the scale of the planned redevelopment, present some of the greatest challenges - as well as opportunities - for restoring and enhancing parkland, improving the environment, and, most particularly, correcting and improving problems related to water. Such problems include flooding, pollution, the unstable condition of the water table, and many sub-watershed issues.

In 1876 the Boston City Park Commission proposed a system of ten parks, but only one, what is now the Back Bay Fens, was approved in 1877 - and not because it would provide a recreational area but because it would solve a sewage problem. The full basin of Back Bay had become very polluted by the sewage draining into it from Stony Brook and the Muddy River. The city's plan was to build new sewers to carry these two streams directly into the Charles River and to turn the full basin into a holding area for storm overflows from Stony Brook. The plan was modified somewhat by Frederick Law Olmsted whose plan called for a great deal of dredging, filling, and construction of bridges, and the park was not completed until the 1890s. (The design of the Back Bay Fens soon became obsolete, however, when the Charles River Dam was built in the first decade of the twentieth century, turning the waterway in the park from salt to fresh and removing the need for a holding basin, and the park was then altered.)

- Page 131, *Mapping Boston*, edited by Alex Krieger and David Cobb, MIT Press 1999.

The LMA occupies critical terrain beside the Muddy River, a celebrated local landmark that is also the most polluted tributary of the lower Charles River. Building density, transportation demands and the sort of haphazard infrastructure design typical of older urban areas combine to pose a host of environmental challenges in the LMA. With a beautiful urban park system - part of Frederick Law Olmsted's fabled "Emerald Necklace" - at its front door, the LMA, while already overbuilt, nonetheless faces a further redevelopment. The impact of such building - in terms of traffic, noise and shadow - is widely recognized. Its impact on the Emerald Necklace is far less understood or appreciated.

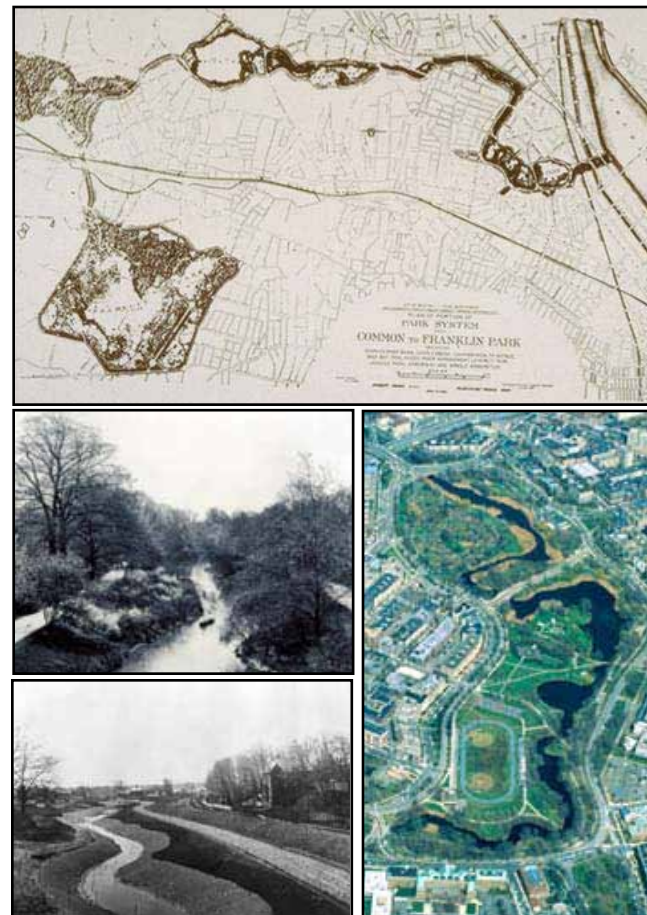


Fig 3.1 Historic map (circa 1894) and photos of the Emerald Necklace and aerial photo of the Muddy River Fens (Courtesy Emerald Necklace Conservancy).

The LMA is situated three miles from downtown and is adjacent to the Mission Hill, Audubon Circle and Fenway residential neighborhoods of Boston. It encompasses approximately 210 acres of land with approximately 14 million square feet of building floor area, another 2.6 million square feet of currently proposed development, and approximately 13,000 parking spaces. The LMA has reached a point where the transportation infrastructure serving the area cannot easily accommodate additional growth while maintaining a desirable functionality without significant improvements and a comprehensive master plan to guide future development. There are also significant impacts on the environment, urban design and the surrounding residential neighborhoods, as well as opportunities for economic and workforce development, that need to be addressed.

- *Longwood Medical Area Interim Guidelines* issued by the Boston Redevelopment Authority, February 2003

Identification of issues and opportunities and field verification

In the LMA, as in many areas of the city, impervious urban development, subway and infrastructure tunnels, groundwater pumping, leaking pipes, and the characteristics of urban fill all contribute to a falling water table. This has been a hidden problem for years in Boston, but as its scale and scope have continued to expand, it has clearly become one of the most important water resource problems now facing the city. Therefore CRWA has identified a need for developing guidelines for sustainable site and building design, which would address the above concerns through restoration driven by institutional redevelopment.

Because the current building density of the LMA



Fig. 3.2 Flooding in the Muddy River in October 1996 and June 1998 (photos courtesy Emerald Necklace Conservancy and MBTA).

leaves very little room for growth other than by building new, larger buildings on the sites of older buildings, the LMA provides an excellent model for studying how carefully planned redevelopment can improve a rapidly-changing neighborhood. Linking the Muddy River restoration and improved park stewardship to growth in the LMA provides a unique opportunity to simultaneously address water issues including storm water management, groundwater, and water supply.

CRWA has conducted numerous site visits to the study area and documented existing conditions as they relate to stormwater management within the LMA and its impact on the Muddy River. In addition to verifying observations in the field, we have

Plate 3.1 Historical Mapping of the Muddy River and the Fens Basin

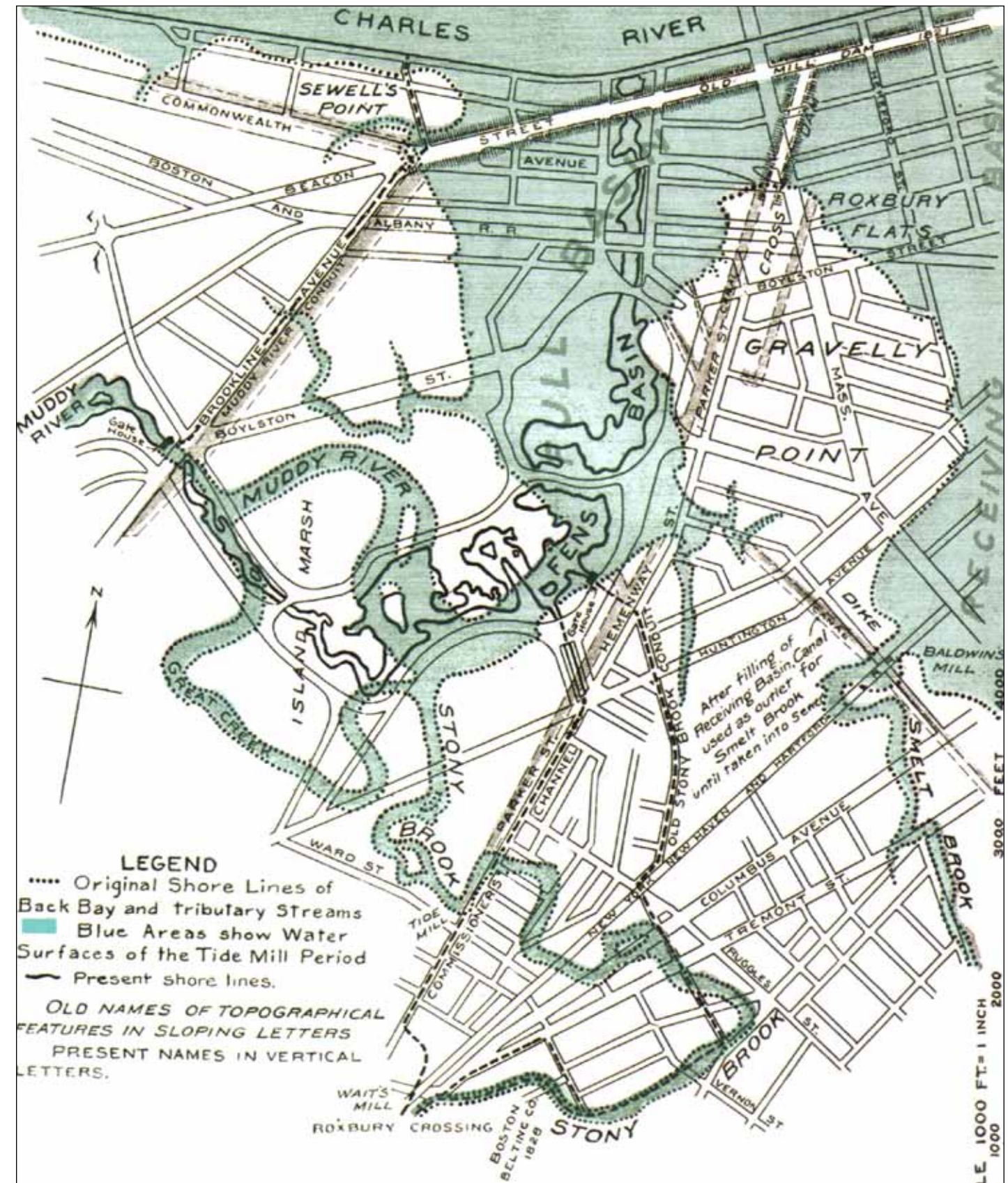
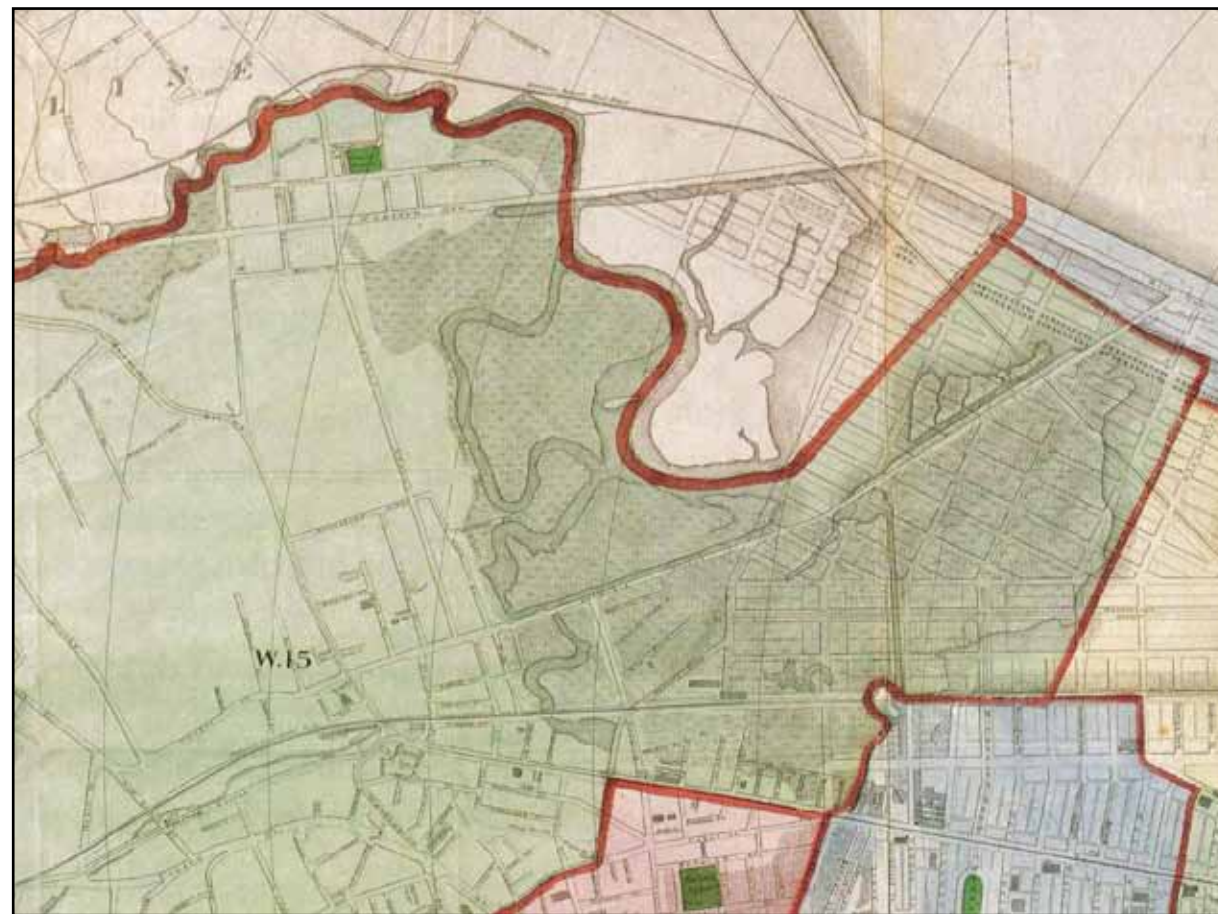
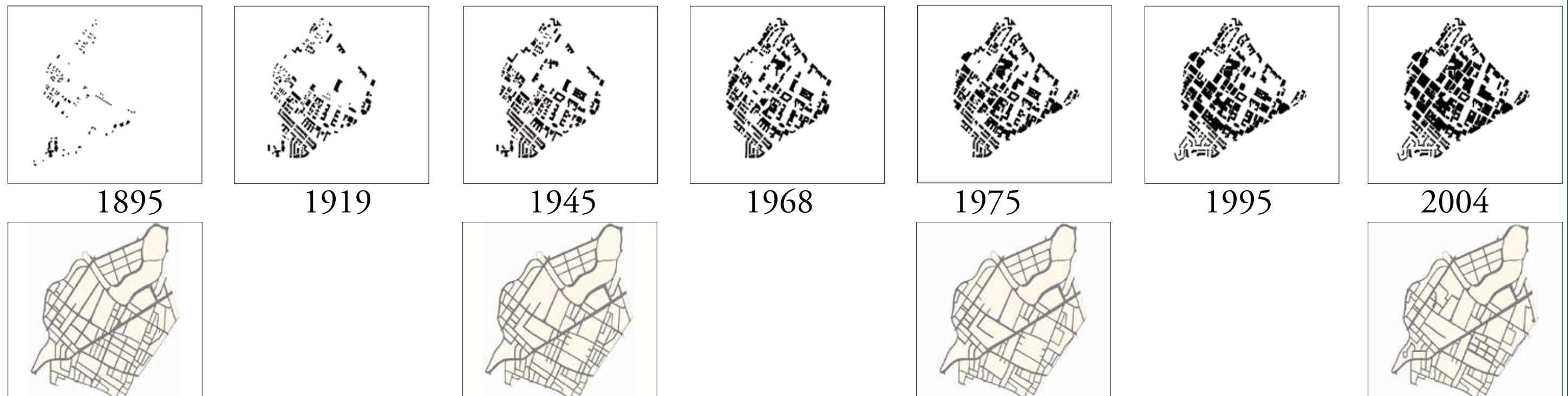
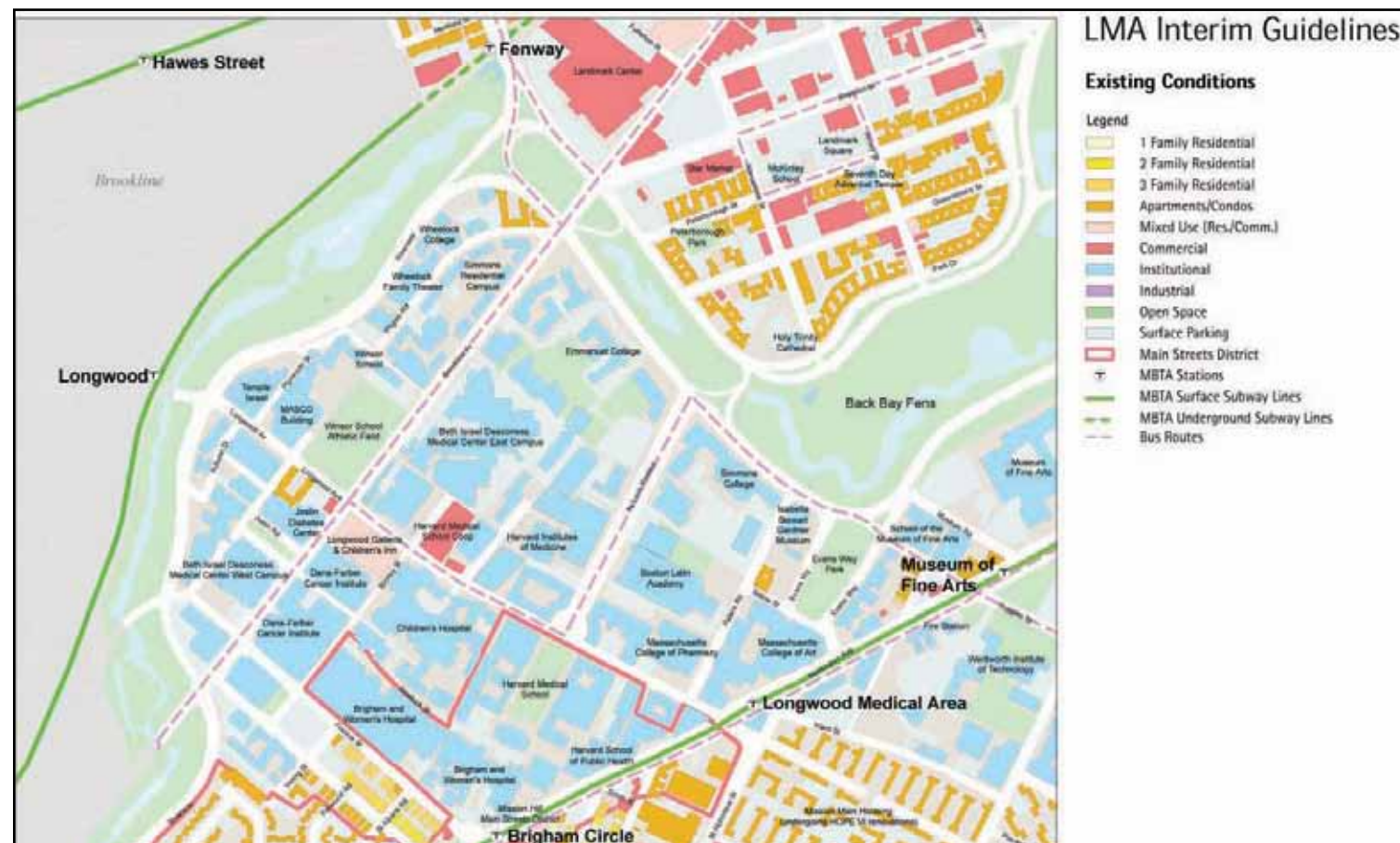


Plate 3.2 Existing Conditions and Historical Evolution of the Longwood Medical Area



Maps courtesy Boston Redevelopment Authority (BRA) and Medical, Academic and Scientific Community Organization (MASCO).

also conducted both dry and wet weather sampling at the outfalls of the Muddy River, documented erosion hot-spots, and modeled runoff volume and pollutant load concentration using WinSLAMM software, as part of our engineering analysis at a sub-watershed level.

Analytical mapping and sub-watershed modeling

The Longwood Medical Area study area boundary is the engineered drainage area as defined by Boston Water and Sewer Commission's stormwater infrastructure and spatial data as shared with CRWA in March 2005.

The LMA study area is approximately 84 acres. In terms of its modeled runoff and pollution source



Figure 3.3 Some of the many impervious areas in the LMA

areas, it is comprised mainly of flat roofs (38%; ~ 32 acres), followed by "other directly connected impervious area" (16%; ~ 14 acres). Other source areas of note are paved parking (15%), street area (14%), and landscaped areas (10%) lumped into the "large landscaped area" category.

After defining the existing conditions, average annual runoff and pollution loadings were calculated. As most source areas are impervious and directly connected to a storm sewer system, runoff patterns follow, for the most part, the percent by area of the source areas. The landscaped areas are the only exception to the rule, which account for 10% of the land area but only 3% of the runoff (Figure 3.4.1).

PLANNING CONTEXT AND STAKEHOLDER OUTREACH

Planning framework and existing regulatory background

The Boston Redevelopment Authority (BRA) has primary regulatory responsibility for planning and redevelopment in the LMA. Each building project goes through a formal review process with the City of Boston and a separate review process under the Massachusetts Environmental Protection Act (MEPA), depending on the size and scale of the project and applicable impact thresholds. Over the years, however, the rate of development in the LMA and the relative lack of comprehensive planning have caused great concern about cumulative environmental impacts on both the local and regional level.

In February 2003 the BRA issued a set of Interim Guidelines to govern proposed development, prevent ad hoc growth in the LMA, and control growth in a fair and equitable manner. These guidelines were intended to inform the BRA's considerations while reviewing projects and Institutional Master Plans in this area, and be implemented through the BRA's development review process as outlined in Article 80 of the Boston Zoning Code. During the

period in which the Interim Guidelines were to be in effect, the existing zoning and approval process would remain the primary control.

Soon after the Interim Guidelines were issued, the BRA and the Office of Jobs and Community Services - in conjunction with the Boston Transportation Department (BTD) and area residents and institutions - were supposed to develop a master plan for the LMA to guide future change and, when appropriate, direct institutional expansion away from the LMA to locations elsewhere in the City of Boston. The LMA Master Plan never materialized, however, so the Interim Guidelines still constitute the primary framework for comprehensive planning in the LMA.

Building relationships and working with stakeholders

The Medical Academic and Scientific Community Organization (MASCO) is a non-profit organization established in 1972 by its member institutions - consisting mostly of educational institutions and hospitals - to plan, develop and enhance the LMA for the benefit of all who obtain medical assistance, study, and work in the area. MASCO's mission is to pursue programs that promote a sense of community among its members and to create and deliver services more effectively. MASCO also organizes the LMA Forum in coordination with the BRA. The Forum meets on a regular basis to review various continuing development/redevelopment projects in the area, and is responsible for ensuring that institutional development creates minimal impact on the surrounding neighborhood, in terms of issues like traffic, noise and shadow. The Forum has not, however, developed a comprehensive understanding of the impacts of new development on the Emerald Necklace and the Muddy River. CRWA has, therefore, been working with other local groups to raise local awareness of the impacts of the new development on the natural resources that surround the neighborhood. In addition we have reached out to the individual institutions in the LMA to explain and advocate for our recommen-

dations for "water-friendly" design at the building and individual site level.

Stakeholder education and involvement

CRWA has invested resources into collecting information and identifying potential solutions, and also into building support for implementation. Given our experience with and knowledge base of the Muddy River Restoration Project, which is being implemented in close proximity to the LMA, we see a significant opportunity to apply lessons learned there to restoration in the LMA. In addition to hosting our own public forum in May 2007, CRWA has modeled runoff volume and pollutant load concentration using WinSLAMM software as part of our engineering analysis at a sub-watershed level. CRWA is also helping to set high standards for stormwater management and public realm improvement through both the BRA's Large Project Review and the MEPA review processes. We are not only evaluating existing conditions and opportunities for environmental restoration, but also working closely with park advocates to ensure that the public benefits package in each of the project applications adequately addresses the priorities outlined for park maintenance and river restoration.

REGULATORY AGENCIES & STAKEHOLDERS (WITH ABBREVIATIONS)

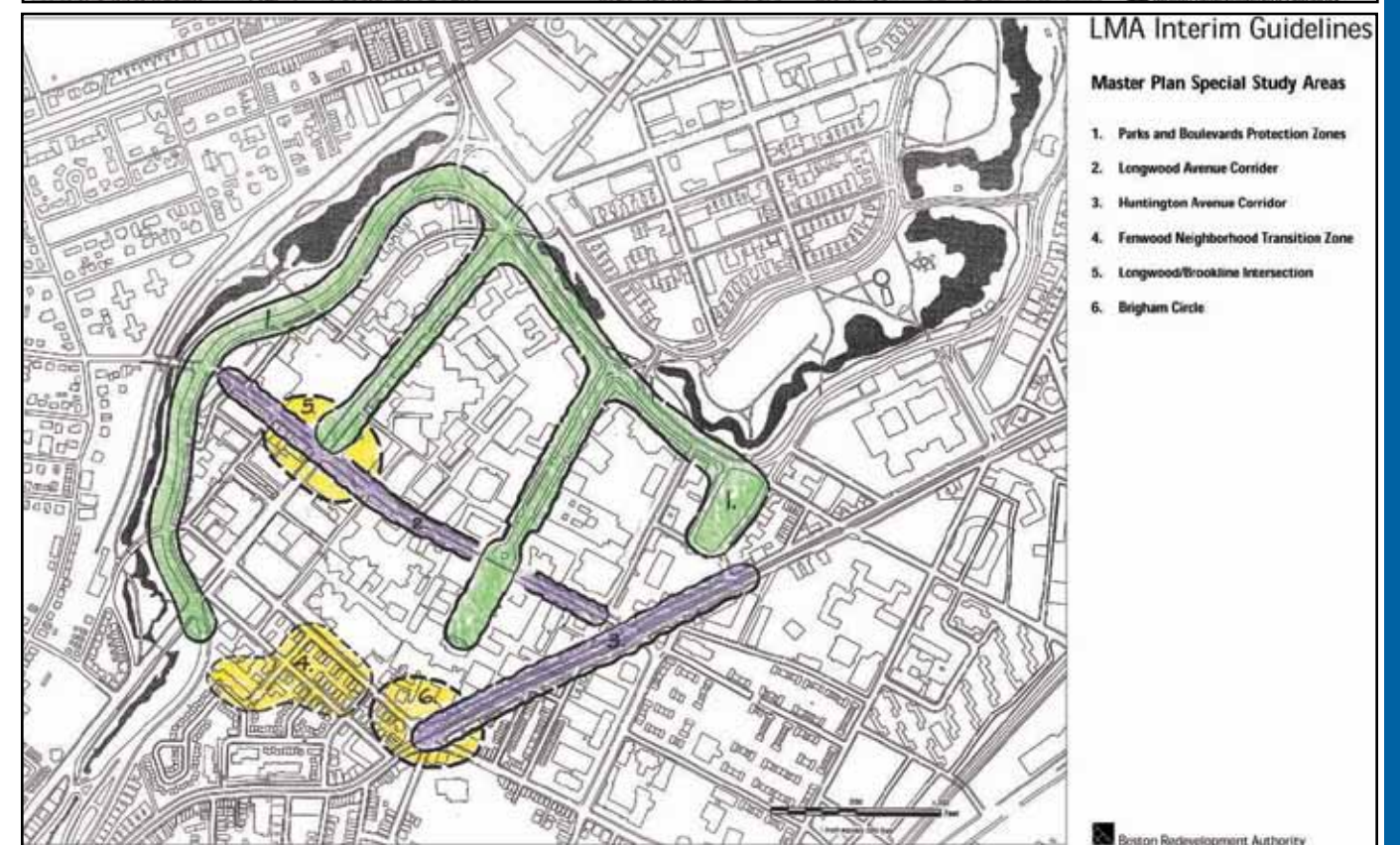
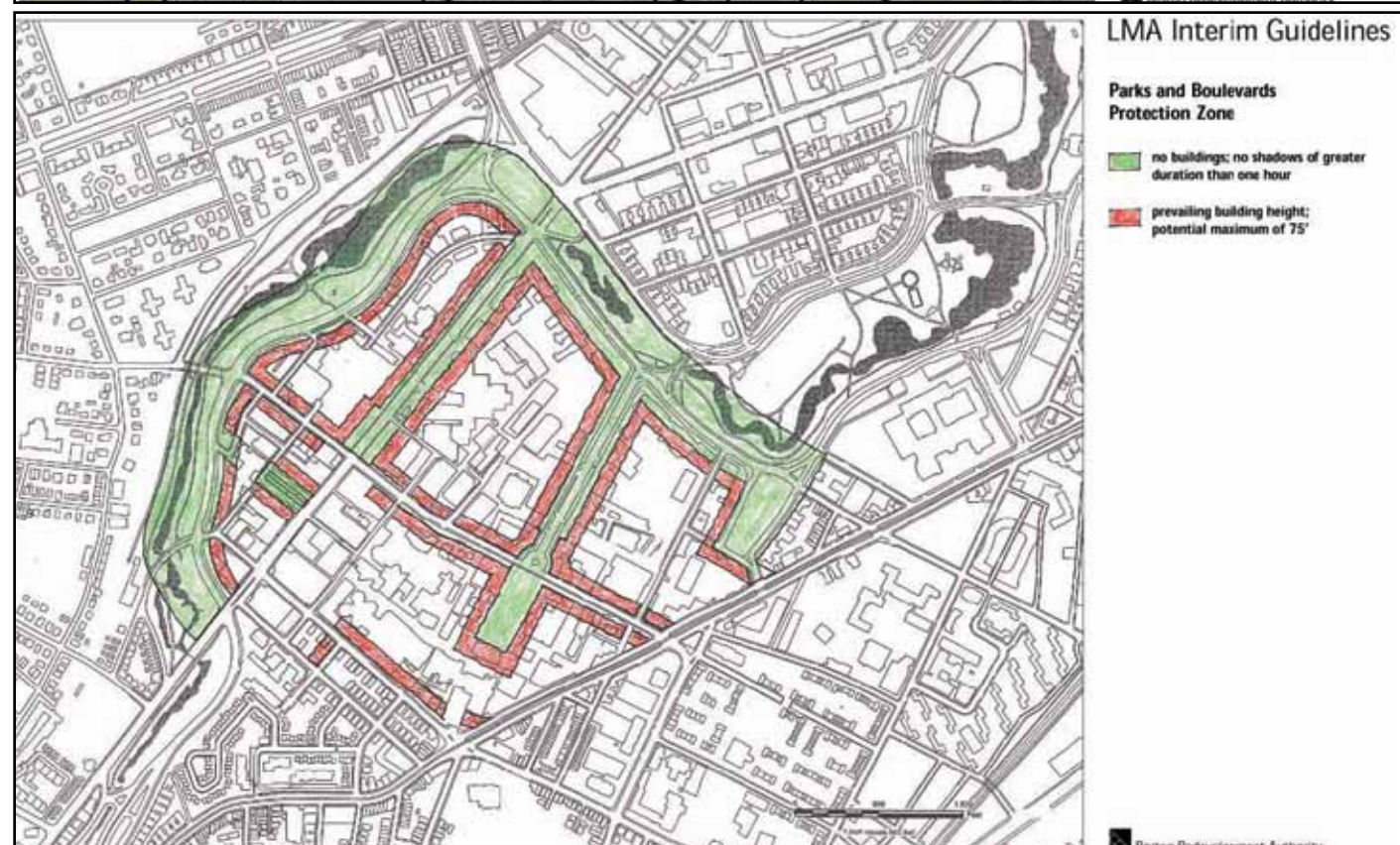
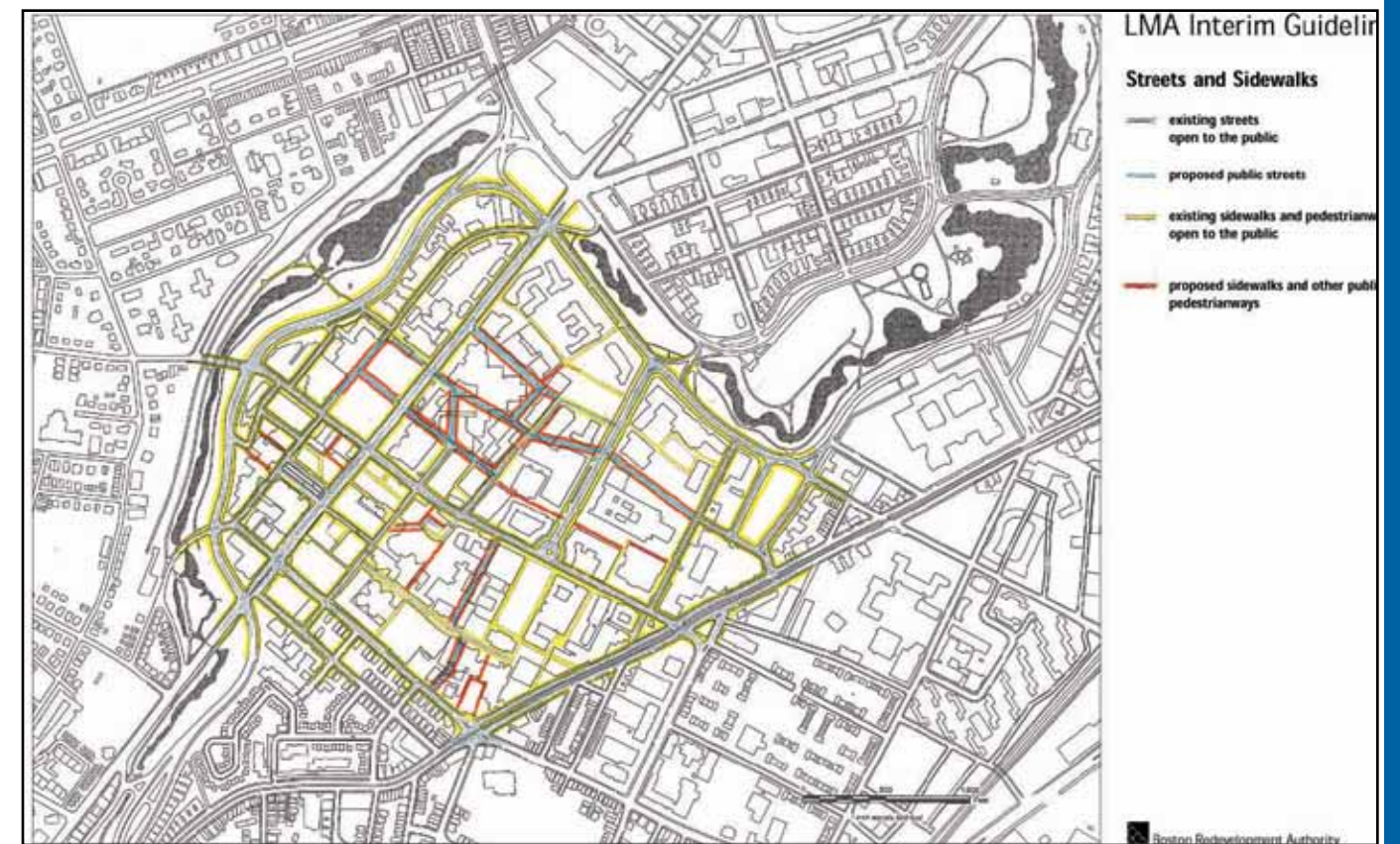
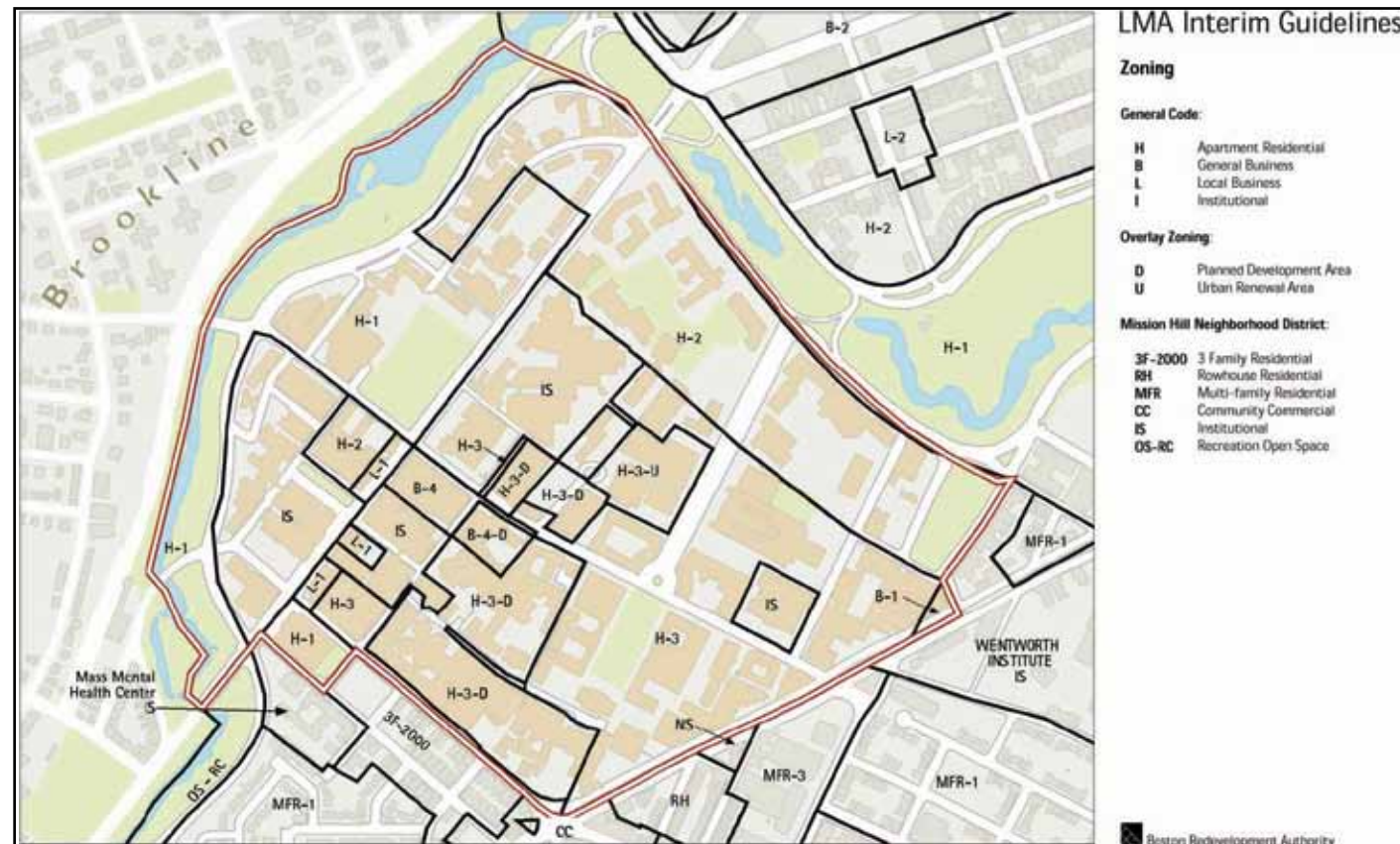
City agencies:

- Boston Redevelopment Authority (BRA)
- Boston Transportation Authority (BTD)
- Boston Water and Sewer Commission (BWSC)

Stakeholders:

- Medical Academic and Scientific Community (MASCO)
- Muddy River Maintenance and Management Oversight Committee (MMOC)
- Emerald Necklace Conservancy (ENC)
- Fenway Alliance
- Fenway Civic Association

Plate 3.3 LMA Interim Guidelines



Maps courtesy Boston Redevelopment Authority (BRA).

Plate 3.4 Existing Conditions Analysis & Sub-watershed Modeling

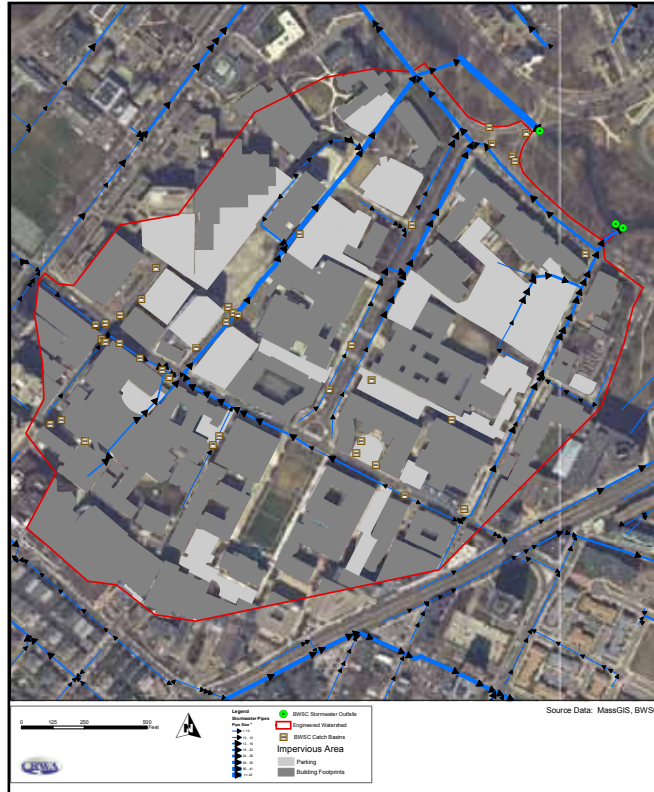


Figure 3.4.1 Analysis of Pervious & Impervious areas for WinSLAMM modeling for delineated sub-watershed

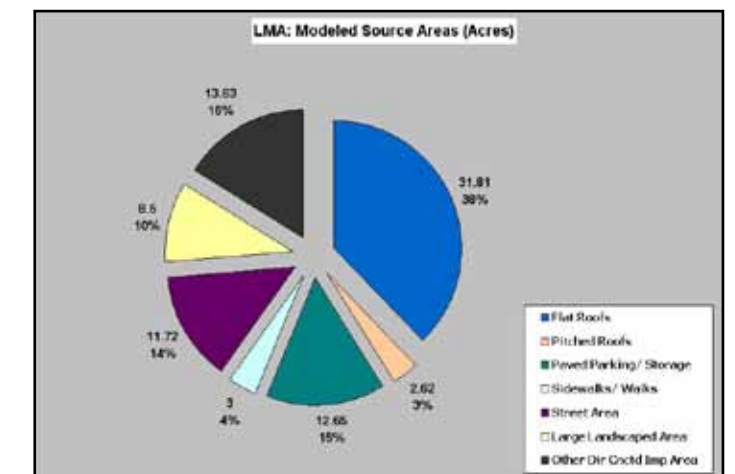
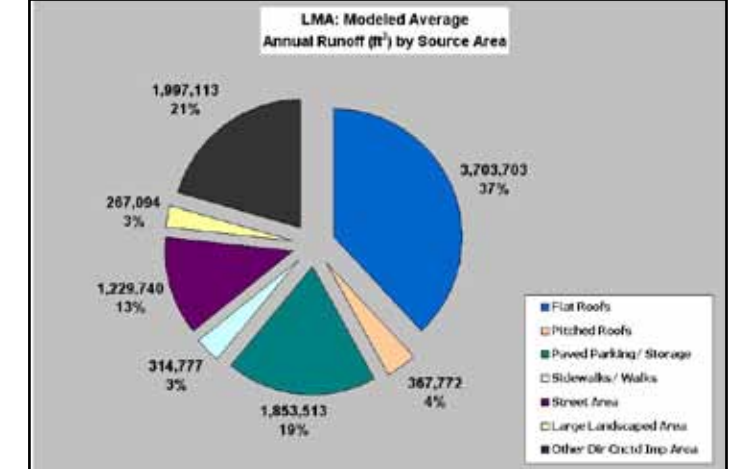
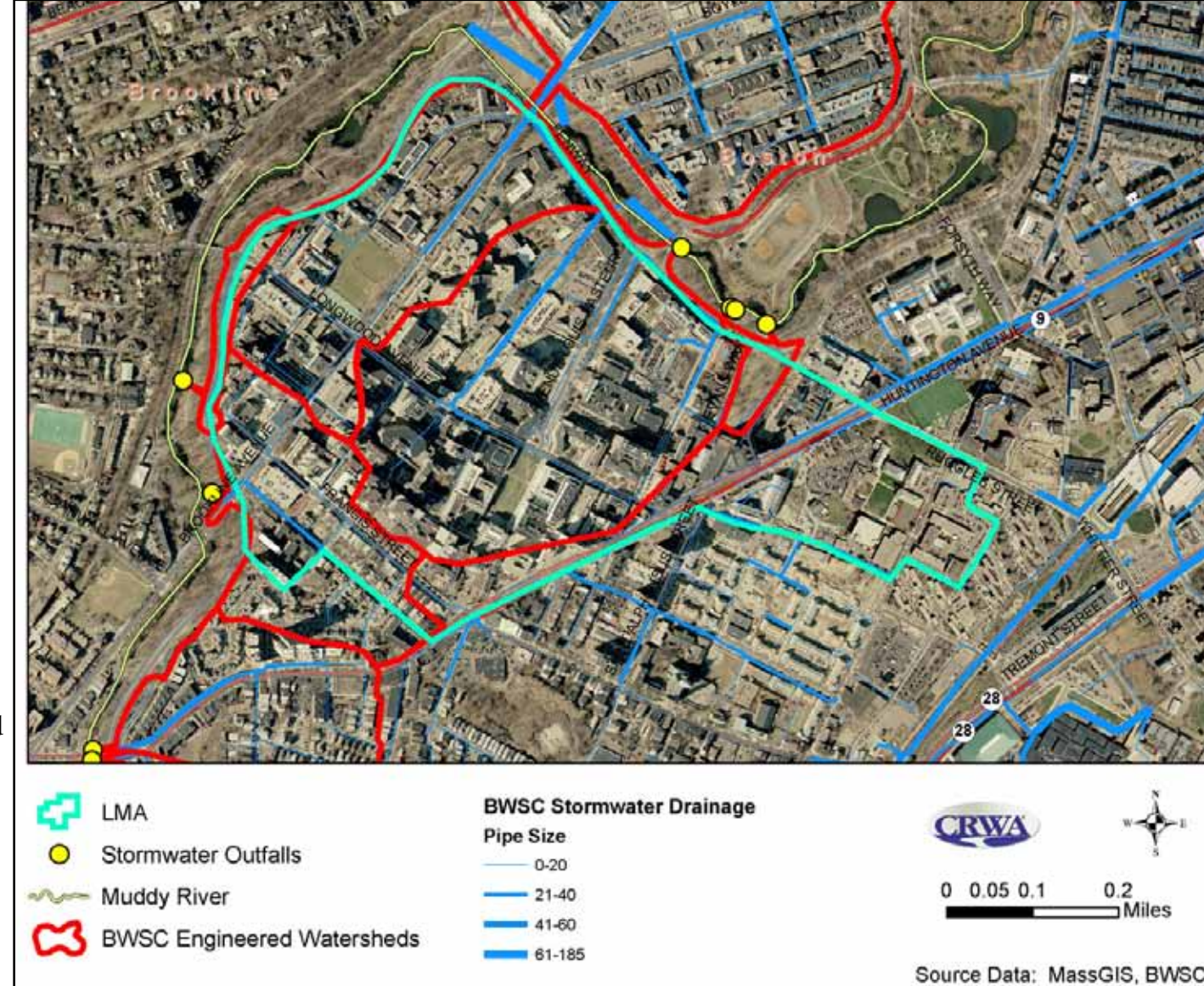
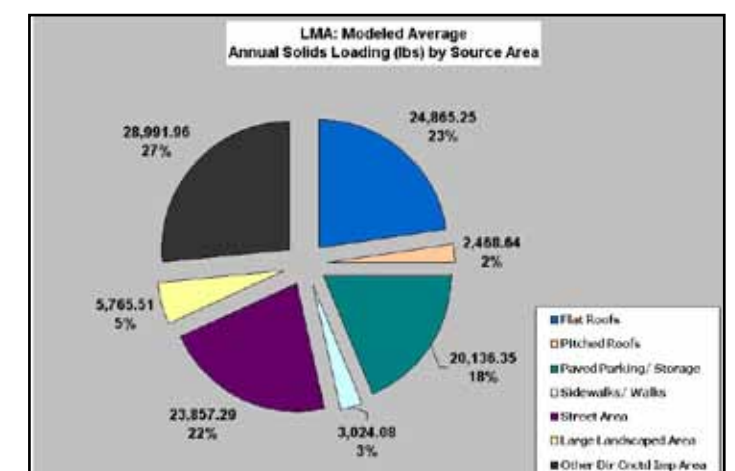
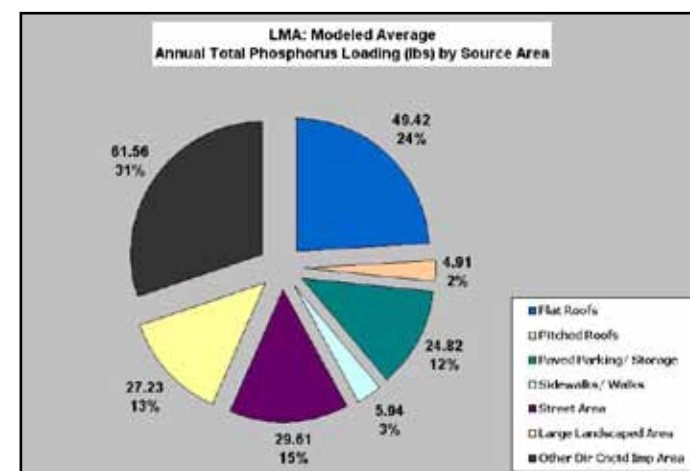
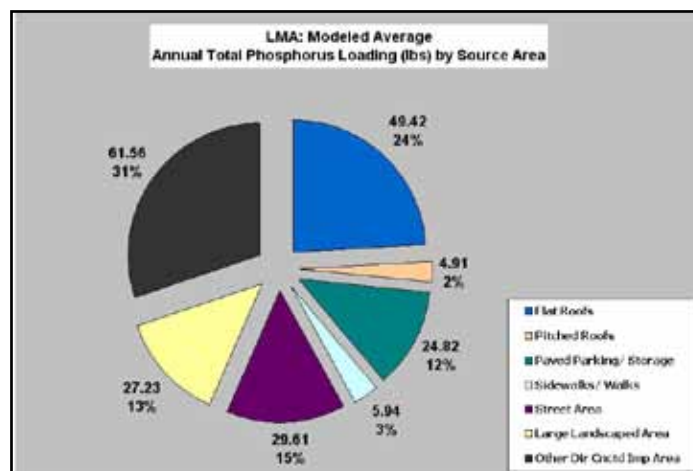


Figure 3.4.2 WinSLAMM outputs for existing conditions categorized by source area within LMA sub-watershed for runoff volume and loading for total Phosphorous, total Suspended Solids and total Copper



PROJECT GOALS AND VISION FOR RESTORATION

Sub-watershed restoration goals and priorities

CRWA's main goal in the LMA is to ensure that the growth in the LMA is environmentally sound, and to help citizens, developers and public agencies ensure that watershed management is improved even in this ultra-urban setting. Properly guided, development in the LMA can improve the park system through capital projects and increased maintenance and oversight. More specifically CRWA's priorities include:

1. Incorporate green infrastructure concepts into LMA strategic/master plans,
2. Develop stormwater standards for site and building scale development,
3. Engage the public and Muddy River/Emerald Necklace advocates,
4. Work with City of Boston agencies and departments, and with MASCO and LMA institutions to incorporate design concepts and find pilot projects.

Concept design and vision for restoration

Redevelopment projects present opportunities to restore natural hydrologic functions; create a healthier, more pedestrian-friendly urban environment; and offer potential solutions to problems including flooding, excessive pollution, urban heat, and lack of groundwater recharge. CRWA therefore supports pursuing policy and design innovations to help improve water quality, reduce flooding, provide habitat, contribute to groundwater recharge, and promote beautiful networks of pedestrian corridors and open space. Water-sensitive design incorporated into the architecture, landscape architecture, and engineering of the LMA can improve the health of the Muddy River and its surrounding neighborhoods (see Plate 3.5).

Building a constituency for implementing the restoration approach

As mentioned above, CRWA is advocating for improved stormwater management, better public access to the park system, and improved maintenance of the parkland through commenting on projects at various stages of the City and State review process. CRWA is working with MASCO and each institution involved in redevelopment to incorporate stormwater management approaches in both the public and the private realm, and to achieve improved water quality and restoration of the pre-development water cycle at a sub-watershed level.

CRWA is closely scrutinizing each redevelopment proposal to ensure that the public benefits package in each project adequately addresses the priorities outlined for park maintenance and river restoration. Because the historically significant Emerald Necklace is already under great stress from poor maintenance, impaired water

RECOMMENDATIONS BASED ON SCALE OF REDEVELOPMENT

- Maximize infiltration, slow runoff from the site, maximize the use of vegetation, capture rooftop runoff for irrigation, minimize imperviousness and minimize sediment and nutrient loading.
- LID retrofits for stormwater treatment which also provide infiltration to recharge groundwater levels in the area.
- Recycle and reuse wastewater and capture roof runoff for infiltration and/or storage for slow release to recharge groundwater levels.
- Improve the conditions of the park, as a part of its community benefits package.
- Go beyond green building (LEED and Green Guide for Health Care) standards to address environmental restoration at a neighborhood level

quality, and heavy traffic, the parkland restoration approach includes several critical elements:

1. Establishing a methodology for assessing the existing use levels, and the potential impacts of redevelopment on the park system,
2. Evaluating existing opportunities for improved access and enhancement,
3. Examining the opportunities for mitigating impacts that increased use will create,
4. Identifying opportunities to work with the existing public private partnerships that have been institutionalized, such as the Emerald Necklace Conservancy and the Fenway Alliance.

As a part of the restoration approach, CRWA is also working with public, private, non-profit and business groups to address the groundwater depletion problem in areas of Boston, including the Fenway. Our work on urban water infrastructure makes us natural partners in efforts underway to address this problem. We consider the issue critical because it ties into many urban water problems, such as Combined Sewer Overflows, stormwater management, wastewater planning, inflow and infiltration and public water resource education. To address this issue CRWA is working actively with the City-State ground water working group that was established in the fall of 2005 to implement stricter standards for groundwater recharge in the areas included within the groundwater overlay district. In addition to this, CRWA has formed a partnership with the Green Roundtable to complement their efforts on green building, as applied on a neighborhood scale. The effort is aimed at integrating Leadership in Energy and Environmental Design (LEED) green building standards and Low Impact Development (LID) strategies to achieve a much larger impact through the greening of infrastructure at a neighborhood level.

APPLYING THE VISION AND ASSESSING RESTORATION OPPORTUNITIES

Site scale and sub-watershed scale design and modeling

In order to assess the effectiveness of the proposed Best Management Practices (BMPs), the WinSLAMM Model was used to determine both pollutant removal as well as reduction in runoff from a delineated sub-watershed (refer to Plate 3.6 for Sub-watershed Scale Design and Modeling Results). The removal calculations from this study area are very conservative and underestimate the effects of the proposed treatments. One reason being, the loadings are removed solely from the source area receiving treatment and not removed from untreated source areas that could flow to treatments. For example, untreated rooftop runoff abutting a proposed green street is not assumed to be treated by proposed rain gardens, tree pits or other LID. Also, dissolved constituents are modeled to be removed by recharge alone, which is assumed to be one inch for all areas proposed for LID retrofits. No phytoremediation, biotransformation or other physical and chemical processes are factored in the removal of dissolved pollutants from proposed green infrastructure.

Under proposed conditions, total runoff volume is reduced by 34%, total phosphorus by 25%, nitrate (from recharge alone) by 40%, total Kjeldahl nitrogen (TKN) (the sum of organic and ammonia nitrogen) by 27%, total copper by 42%, total lead by 47%, total zinc by 47% and total cadmium by 45%.

Toolkit of best management practices and technologies

See Appendix B for the Low Impact Development (LID) Best Management Practices (BMP's) Matrices and Information Sheets.

Plate 3.5 Concept Design and Vision for Restoration



Figure 3.5.1 Before (above left) and after (above right) scenarios for proposed green street retrofits along specific segments of Brookline Avenue.



Figure 3.5.2 (above left and left) Concept plans for green infrastructure retrofits (green roofs, green streets and open spaces - legend below). At left, Phase one retrofits proposed for projects currently being redeveloped.

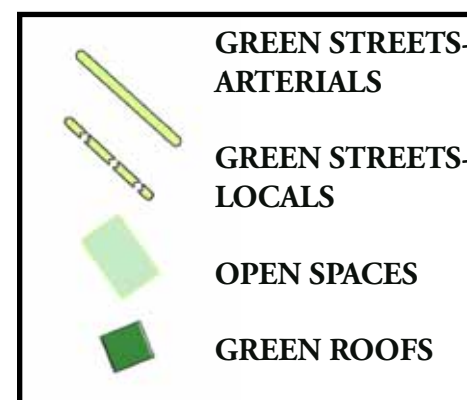
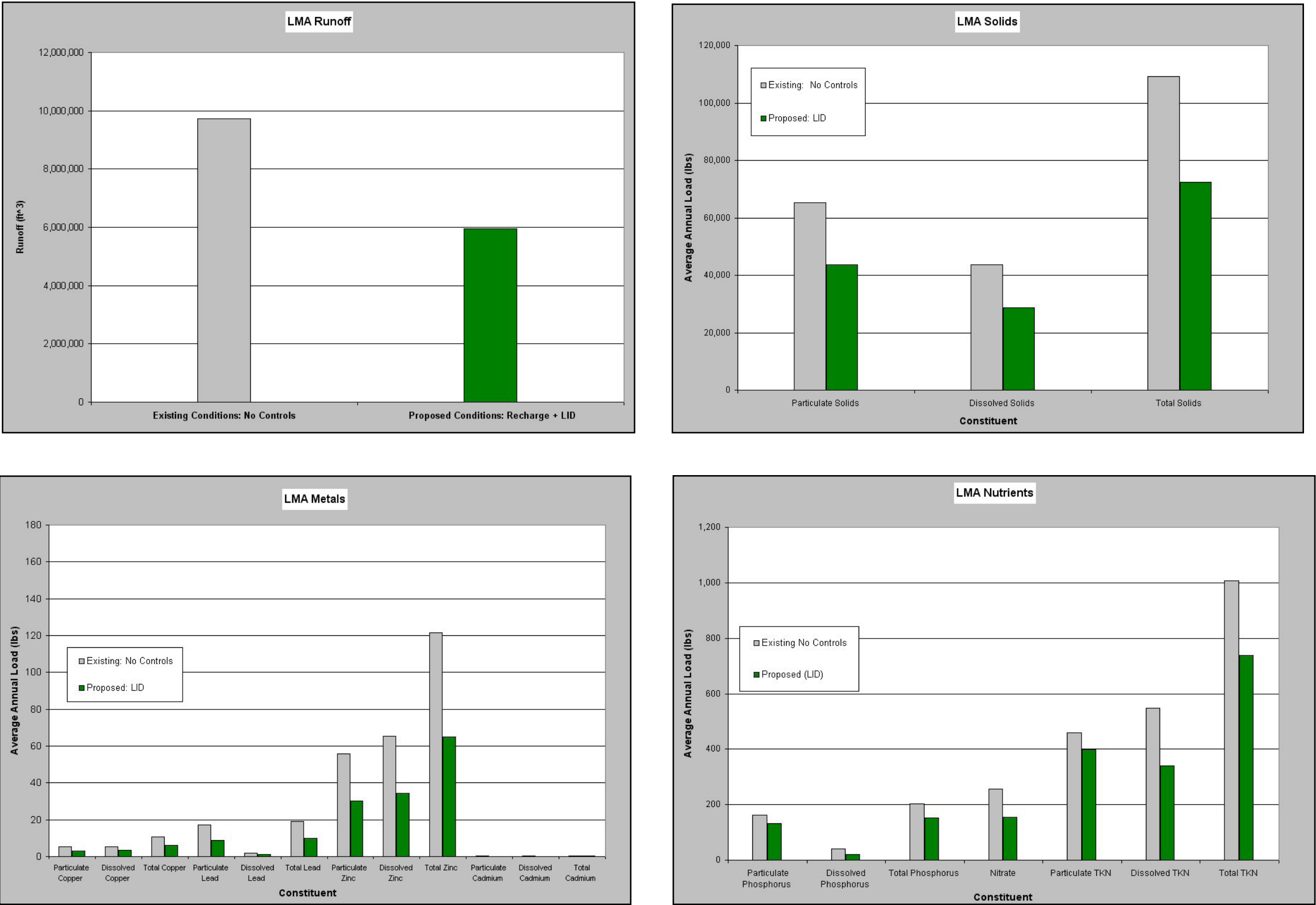


Figure 3.5.3 (right) Proposed hierarchy of Green Streets in LMA (ranging from arterials to local).

Plate 3.6 Sub-watershed Scale Design and Modeling Results



WinSLAMM outputs for proposed scenario with LID retrofits in delineated sub-watershed (showing reduction in runoff and loading for solids, metals and nutrients)

Conclusions and Lessons Learned

During three years of analysis, planning, design, community outreach, and advocacy, CRWA's emphasis on integrating water and land in urban areas generated excitement in residents, developers, planners and public officials alike. Designs that we developed as watershed restoration techniques held particular appeal for residents. Green Streets, greenways that follow "daylighted" streams, and ponds and wetlands in parks all held great appeal. These attractive design elements produce tangible benefits: they slow traffic, clean the air, reduce heat effects, improve the pedestrian environment, and increase open space. Our work also demonstrates the practicality of many Blue Cities concepts, even in densely developed urban neighborhoods. Small-scale solutions, applied across a broad area, can generate meaningful, measurable improvements.

**Our cities must change.
We can influence how they
function and look, and
how we will feel in them.**

Our experiences in the three study areas highlighted common issues. The Template for Blue Cities Restoration (page 37) includes a set of steps that we recommend for any urban area: getting to know stakeholders; understanding historic and current conditions; and developing restoration plans that integrate public and private priorities.

Obstacles encountered in the three study areas also yielded valuable lessons. Typically, the greatest challenges were not technical. Cost is an obstacle for some design ideas, but surprisingly many "soft" green solutions are actually competitive with conventional "hard" piped infrastructure solutions. When ancillary benefits are factored in, Blue Cit-

ies designs are often excellent investments.

The most persistent obstacle we found involved human factors. Owners and managers need to trust designs for effectiveness and economic benefit. Members of the public need to feel confident that recycled stormwater in open spaces and along streets (in swales, rain gardens, and fountains, for example) will not attract litter and vandalism or support mosquitoes or other pests. Regulators need to be confident that new designs will meet legislated standards. Questions about system maintenance, cold climate performance, and tolerance to climate change are all legitimate. There is a profound need for pilot projects here in the Boston area to find reliable answers.

Even taking these concerns into account, we note that Philadelphia, Seattle, Portland, Chicago, Kansas City, and many other urban areas have implemented Blue Cities design elements, from rain gardens to green alleys and stormwater fountains in public parks. We recommend that Boston continue to adopt and adapt this design approach. New England must promote broader acceptance of the functionality, beauty and longevity of these designs. Education, site visits, pilot projects, and evolving regulatory programs all play roles in this necessary evolution.

Regulatory requirements can encourage green development by making public and private sector land owners recognize the need for prompt action. But regulations are typically performance-based; in and of themselves they cannot achieve Blue Cities goals. Ongoing discussions and working sessions are the most valuable tools for progress in these areas. A process of continuing, non-confrontational problem-solving meetings involving all stakeholders is most likely to yield success. Several specific lessons deserve particular emphasis.

1. USE STRONG VISUAL MATERIALS

Our public outreach program has taught us the effectiveness of visual illustrations as tools to elucidate the benefits and feasibility of Blue Cities designs. Whether at large public meetings or small sessions with a few decision-makers, the graphic analysis of a region, demonstration of how water functions in the environment, and beautiful design concepts that we have developed and illustrated have excited audiences and made people want to work with us.

The success of our public forums in Allston, the LMA and Zakim North was primarily based on convening multiple interest groups (including municipal officials working in environmental or planning organizations, representatives from various institutions and organizations, and neighborhood residents) to present a compelling vision of Blue Cities through a variety of media. Creating and exhibiting a plan to show how the neighborhoods would look and function after Blue Redevelopment turned out to be the most powerful advocacy tool we have for this project. Compared to economic arguments, environmental compliance demands, and even explanations of serious public health issues, visual demonstrations proved vastly more effective. We have used drawings, photographs, computerized renderings, and other conceptual design tools. Across the board, we believe



Figure 4.1 Neighborhood residents listen intently at one of CRWA's community meetings

that visual illustrations are essential to communication and persuasion.

2. EVALUATE YOUR PROGRESS AND MODIFY YOUR PROGRAM

The Template for Blue Cities Restoration provides a solid outline for urban redevelopment with restoration of watershed function. Nevertheless, specific development pressures, environmental conditions, changing regulations, pre-existing infrastructure conditions, the roles of key players, and many other factors will all help determine the best way forward. In concept, the steps we took in all three study areas were similar, but the specifics varied so greatly that in the same time period, we could not achieve the same level of design in all three projects. Nor did it make sense to put equal effort into all three areas. As we worked at the sites, we were alert to differences as they emerged, became clearer, and took their own courses. Con-



Figure 4.2 An example of CRWA's visual materials: before (above) and after (below) scenarios of greening Coolidge Road in North Allston.

stant evaluation dictated changes in tactics. Without such adaptation, we would have wasted our resources, with little or no perceptible benefit.

For example, early in this project, we realized that Harvard University's project timeline presented an opportunity for us to make progress in North Allston. We concentrated resources there accordingly, and our efforts have borne fruit. University planners are adopting and testing our practical suggestions as part of the Master Plan. The University is now briefing CRWA as it works to weave Blue Development into the emerging campus plan.

Other circumstances govern progress at Zakim North. For two years this redevelopment project seemed to be sidelined by regulatory wrangling between the MBTA and DEP. But the site has suddenly emerged as a potentially enormous opportunity for Blue Development as Somerville embarks on a major planning effort related to building a major league soccer stadium in the area. We stand ready to furnish water-friendly design solutions and resume the efforts that we began three years ago.

Flexibility and the ability to respond to site-specific issues with technologically sound, exciting, and practical solutions are critical to making meaningful progress. It is also vital to recognize situations in which it is wiser to protect resources than invest them unproductively.

3. BUILD A DIVERSE TEAM

The Blue Cities approach requires integrating numerous goals and finding designs that achieve multiple benefits. Expertise in planning, urban design, landscape architecture, hydrology, water quality and engineering are essential. So is a keen understanding of regulations, policy, and the law. It would be foolish to underestimate the value of knowing the players. A team that brings a wide array of technical and advocacy tools to the table and supports this with experience by working with the

community has the best chance of building a Blue City.

4. BUILD PARTNERSHIPS WITH OTHER GROUPS

Redesigning a city is a tremendous task. It takes vision, technical knowledge, and determined players with a wide variety of interests. CRWA's working relationships with Harvard University, numerous departments in the City of Boston, neighborhood groups, and state officials have all proven critical at different stages of these projects. Blue Cities concepts need "buy-in" from other groups, and the input and feedback from other groups can refine the fundamental concepts and adapt them to individual sites.

Our cities must change. We can influence how they function and look, and how we will feel in them. With creativity, flexibility and unshakable will we can implement change that treats water as the precious, sustainable resource that it is. It is our responsibility to do so.

Blue Development Glossary of Terms

BIORETENTION

The collection and treatment of stormwater runoff, typically in a shallow depression, using a conditioned soil bed and plant materials to reduce runoff and treat and infiltrate it at its point of origin. Bioretention can involve both physical (filtering and absorption) and chemical (biological) water treatment.

BLUE DEVELOPMENT

Development that seeks to restore natural hydrologic function, by whatever means fit the site and the project. Blue Development can include high-technology and low-technology elements like rain-gardens and rain barrels, which divert captured rainwater to irrigate lawn and gardens. Blue Development addresses the water cycle at every point, in order to correct problems (like flooding and pollution) and improve the health of the water supply. Blue Development goes hand in hand with Green Development.

BMPS

Best Management Practices, or BMPs, are environmental design practices used to improve, preserve, and protect the quality of stormwater by removing/reducing harmful pollutants that may enter the earth. These include not only management practices, but designs, techniques, and technological devices such as rain gardens, vegetated swales, stormwater tree planters, permeable pavers and pavements, green roofs, and other bioretention systems.

DAYLIGHTING

Uncovering waterways like rivers and streams that once flowed into larger rivers or bodies of water, and cleansed their areas, but now flow (often in culverts) below paved surfaces. Daylighting waterways addresses problems like flooding, pollution, stormwater and sewage back-up, and excessive heat in summer.

EVAPOTRANSPIRATION

The process by which water is returned to the atmosphere by the combined effect of evaporation (from the surface of the soil and bodies of water) and transpiration (from plants).

GREEN DEVELOPMENT

Wikipedia defines Green Development as a concept beyond Green Building that encompasses a broad “land use planning concept that includes consideration of community-wide or regional environmental implications of development, as well as site-specific green building concepts. This includes city planning, environmental planning, architecture, and community building.” (See http://en.wikipedia.org/wiki/Green_development)

GREEN INFRASTRUCTURE

The network of green spaces that manage and improve the quality of stormwater to better the overall health of the environment. The concept emphasizes the importance of making decisions based around the natural environment. Green Infrastructures are planned and include parks, greenways, and other vegetated areas.

IMPERVIOUS/PERVIOUS

Impervious means not permeable, or not allowing water to penetrate (pass through); pervious means permeable, or allowing water to penetrate (pass through).

INFLOW AND INFILTRATION, OR I/I

The two ways stormwater and/or groundwater enter underground hydraulic systems. Inflow is the volume of incoming water into a downspout or drain. Infiltration is the absorption process of water entering the ground, subgrade surface and/or into a perforated pipe.

LEED

Leadership in Energy and Environmental Design (LEED) is the certification system of the non-profit U.S. Green Building Council, which has developed the nationally accepted benchmark for the design, construction, and operation of green buildings. LEED offers owners and managers tools to implement and measure their performance. Criteria for certification include sustainable site development, water savings, energy efficiency, materials selection, and indoor environmental quality.

LID

Low Impact Development, or LID, is a design approach used to manage stormwater runoff in the most efficient and protective manner in order to preserve natural resource systems and reduce overall infrastructure costs.

NATURAL INFILTRATION

The process of water naturally entering the ground or other natural resource systems.

RECHARGE

Replenishment of groundwater in a zone of saturation by the process of percolation (infiltration) of rain and snow through the soil.

SUB-WATERSHED

Everything below the surface of any particular watershed. (See “watershed”.)

VIEWSHED

An area of land, water, and other environmental elements visible from a particular vantage point.

WATERSHED

The whole area that drains into a given river, river system, or other body of water.

WINSLAMM

A Windows modeling program called the “Source Loading and Management Model (SLAMM). This software allows users to model pollutant mass discharges and control measure effects for a wide variety of potential conditions. WinSLAMM highlights polluted water flows, especially stormwater runoff and end-of-pipe discharges. For more information, visit <http://www.winslamm.com>.

A Template for Blue Cities Restoration

This template is intended to help guide the development of water-friendly environmental sustainability in any large urban development or redevelopment project. Based on the lessons learned from three lower Charles River basin case studies (North Allston, Zakim North and the Longwood Medical and Academic Area), the template provides a step by step guide to formulating a set of hydrologic and water quality goals for urban development; a methodology for bringing together, educating and involving key constituencies in meeting these goals; and an analysis of key design solutions for sustainable water management and water friendly development.

The Blue Cities approach synthesizes hydrologic restoration with goals that improve transportation systems, open space, pedestrian amenities and infrastructure systems. The template includes a toolkit of design elements for water resource management problem-solving that will be useful in any public or private development that seeks to be environmentally sustainable.

STEP 1. SUB-WATERSHED ANALYSIS AND IMPACT ASSESSMENT

- Identify historical and existing natural features and infrastructure for a given sub-watershed using historical maps, photographs and reports.
- Identify built infrastructure, including underground utilities, drainage, land use and pipe outfalls, both historic and current.
- Construct overlay maps showing historic and current conditions.
- Identify hydrologic and water quality “problem areas” and locations of special concern.
- Identify opportunities at the interface of the natural and the built environment and verify observations in the field to the extent possible.

STEP 2. UNDERSTAND THE PLANNING AND IMPLEMENTATION CONTEXT

- Research the existing planning background and historical evolution of the redevelopment site and its context.
- Identify the existing regulatory framework and process, as well as critical phases in terms of timeframe for redevelopment.
- Carry out an extensive stakeholder analysis and build relationships with key agencies, community organizations and stakeholder groups as early in the process as possible.
- Invest appropriate time and energy into public outreach and education of key stakeholder groups and the public at large through a variety of media.

STEP 3. DEVELOP GOALS

Once the sub-watershed analysis is completed and placed in the particular planning context of the development, specific goals need to be articulated. At an overall level all Blue Cities projects should include the following goals:

- Identify restoration approaches that will restore hydrologic integrity.
- Develop green infrastructure concepts.
- Use redevelopment to drive sub-watershed scale solutions.
- Build on and link to existing open space, public health and public realm needs.

STEP 4. FORMULATE THE RE-DEVELOPMENT STRATEGY AND STANDARDS

Strategies based on planning timeframe

Incorporate the goals identified at various scales into planning (short, medium and long term) and regulatory (state and city level review process) doc-

umentation. Explore various avenues for influencing decision making and implementation of the Blue Cities approach.

Standards based on planning/design scale

In order to achieve the goals stated in the previous section, certain standards need to be formulated at various scales ranging from the building scale to the site scale. These standards not only dictate the minimum requirements for end of pipe water quality and flow but also establish broader goals at a sub-watershed scale.

Toolkit of possible retrofit options

Once the standard for various scales of development are established, a matrix of specific technologies, designs and Best Management Practices (BMPs) needs to be established in order to achieve the standards (refer to Appendix B).

STEP 5. IMPLEMENTATION AND EVALUATION

Sub-watershed level restoration plans

Restoration plans at a sub-watershed scale ensure the most effective strategies are employed. Evaluate goals and standards at various scales and phases of the redevelopment. Consider construction mitigation for the specific project site, transportation and public realm improvements in the overall site context, and long term commitments to redevelopment in the neighborhood. Specific restoration goals and performance standards need to be established and incorporated in various development documents prior to their approval by the various regulatory agencies to ensure that the project achieves the desired standards at every stage and scale of development.

Regulatory requirements and advocacy

Implementing a sub-watershed restoration plan requires strong regulatory requirements and a

shared vision. It is important to establish a regulatory mandate for environmental sustainability in development, even if all stakeholders agree with the concept in principle. A variety of strategies can be employed to educate multiple interest groups about the merit of the Blue Cities approach and its applicability in achieving their own goals. Develop short, medium and long term strategies and initiatives for implementing various restoration plans.

Flexibility and persistence

It is crucial to measure the effectiveness of the various technologies and design standards employed in meeting the goals, and re-evaluate the implementation strategy on an ongoing basis. The goals for environmental restoration have to align very closely with and be made a part of the communities’ short, medium and long term initiatives. Working with one primary lead entity is more likely to produce results than trying to bring many entities together. Projects with overlapping goals and objectives (water quality, flood reduction, pedestrian connectivity, open space, recreational opportunities, etc.) are more likely to succeed. Recognizing stakeholders’ multiple interests (construction schedules, transportation needs, legal and permit obligations) does not mean environmental goals take a back seat (environmental goals and the permitting framework that structures their accomplishment can, in fact, be a cohesive element across varying stakeholder interests). Having the ability to pull in a variety of expertise in the fields of science, law, policy, engineering, planning and advocacy as per the need of the situation may underpin the advancement of environmental sustainability goals.



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