EXECUTIVE SUMMARY

GREEN INFRASTRUCTURE PLAN

the city of Lancaster
a city authentic

March 2011

The City of Lancaster is one of about 770 cities nationwide with a combined sewer system (EPA). Combined sewer systems collect and transport both domestic sewage (wastewater from plumbing in buildings) and rainwater that flows from downspouts, streets, sidewalks, parking lots and other impervious surfaces common in urban areas. Eighty-five percent of the time, the City's Advanced Wastewater Treatment Facility is able to manage and clean the volume of wastewater flowing through this combined system. However, during intense rainstorms and other wet weather events, the system becomes overwhelmed. Each year, this causes about 1 billion gallons of untreated wastewater (mixed sewage and stormwater) to overflow into the Conestoga River. These events are referred to as combined sewer overflows (CSOs) or simply "overflows".

At the time that combined sewer systems were being built across the country 100-200 years ago, they were considered a highly efficient method of treating all forms of waste from urbanized areas since they collected stormwater, sanitary sewage and industrial wastewater all in the same pipe and conveyed them to a treatment plant to be processed before discharging treated water to the nearby streams. What better way to keep streams pristine, fishable and swimmable than to treat **all the waste including runoff**? But as urbanized areas grew and eventually overwhelmed these systems, the methods used did not change or keep up with development. Our forefathers kept adding onto the same system.

Efforts to clean up our local waterways and the Chesapeake Bay have brought renewed federal, state and regional attention on initiatives designed to protect and restore the network of polluted streams and rivers in the Chesapeake Bay watershed, many of which fail to meet water quality standards. The Conestoga River is one such river. The Environmental Protection Agency, for example, has begun enforcing limits on nitrogen, phosphorous and sediment pollution, referred to as a Total Maximum Daily Load (TMDL). The TMDL, or "pollution diet," sets accountability measures for communities located within the 64,000 square mile watershed to ensure that cleanup commitments are kept. The TMDLs are being promulgated not only for combined sewer systems, but also for municipal separate stormwater systems (MS4s) across the Bay watershed. So the costs to comply with these new regulations are going to be felt by every community.

With this backdrop, Lancaster City has been working proactively to reduce combined sewer system overflows and at the same time, to identify economically viable, long-term strategies for mitigating the negative impact of wet weather overflows on our water quality. To date, most of the strategies under consideration have been limited to "gray infrastructure" options, such as increasing the capacity of the City's wastewater conveyance and treatment infrastructure; adding storage or holding tanks to detain wastewater flows until treatment capacity returns; or providing some form of wastewater treatment to the overflow discharges.

Over the past 12 years, the City has aggressively pursued upgrades to its existing gray infrastructure. More than $18 million has been invested in the City's wastewater system including construction of the first wastewater treatment system in the Commonwealth to meet nutrient removal requirements. These nutrient removal projects are being implemented at other treatments plants in the Chesapeake Bay watershed now that the TMDLs are going into effect. Additional capital investment has increased the efficiency of pumping stations to optimize the flow of wastewater to the treatment facility and these investments have resulted in further capture of wet weather flows for treatment.

Despite this progress, there remains a significant amount of untreated combined sewage overflowing into the Conestoga River. Based on prior evaluations and experience in many other communities, gray infrastructure options are expensive to construct and maintain. One storage tank alone in the City's Northeast section of the City has an estimated price tag of $70 million and this would only manage 1/10 of the City's annual CSO volume. The estimated price tag to store and treat the billion gallons of annual overflows would be well over $250 million. This cost does not include the annual operational costs in energy and personnel to run the new gray systems.

Given the expense of gray infrastructure modifications, the City has instead opted for a two-prong strategy for reducing the volume of stormwater entering the combined sewer system:

1. Increase the efficiency and capacity of the City's existing gray infrastructure; and
2. Employ "green infrastructure" methods of stormwater management.

Green infrastructure encompasses a variety of technologies that replicate and restore the natural hydrologic cycle and reduce the volume of stormwater entering the sewer system. This, in turn, reduces overflows. Green infrastructure generally includes stormwater management methods that:

- infiltrate (porous pavements, sidewalks, and gutters; linear infiltration systems)
- evaporate, transpire and reduce energy consumption (vegetated roofs, trees, planter boxes)
- infiltrate and transpire (rain gardens and bioretention)
- capture and reuse rainfall (rain barrels, cisterns, irrigation supply systems, and gray water systems)

In contrast to gray infrastructure, a green infrastructure approach often has a higher return on investment and offers multiple benefits:

- *Environmental* – recharges ground water, provides natural storm water management, reduced energy usage, improved water quality.
- *Social* – beautifies and increases recreational opportunities, improves health through cleaner air and water, improves psychological well-being.
- *Economic* – reduces future costs of stormwater management and increases property values.

In May 2010, the City of Lancaster began to develop Pennsylvania's first- Class 3 Green Infrastructure Plan (GI Plan). Building upon the Lancaster County Comprehensive Plan as reported in the Planning Commission's *Greenscapes: The Green Infrastructure Element*, Lancaster City's plan was developed in conjunction with LIVE Green, the Lancaster County Planning Commission, PA Department of Environmental Protection (DEP), PA Department of Conservation and Natural Resources (DCNR) as well as local stakeholders. The City's GI Plan clearly articulates a vision for Lancaster:

To provide more livable, sustainable neighborhoods for City residents and to reduce combined sewer overflows and nutrients.

The goals of the GI Plan are equally clear:

1. Strengthen the City's economy and improve the health and quality of life for its residents by linking clean water solutions to community improvements (e.g. green streets).
2. Create green infrastructure programs that respond comprehensively to the multiple water quality drivers (e.g. TMDL, CSO and stormwater regulations) to maximize the value of City investments.
3. Use GI to reduce pollution and erosive flows from urban stormwater and combined sewer overflows to support the attainment of the Watershed Implementation Plan for the Chesapeake Bay and to improve water quality in the Conestoga River.
4. Achieve lower cost and higher benefit from the City's infrastructure investments.
5. Establish Lancaster City as a national and statewide model in green infrastructure implementation.

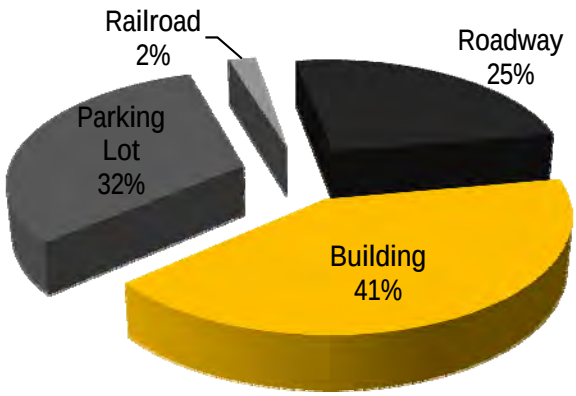
ASSESSMENT

The study involved a three-step process:

(1) evaluate impervious cover by type and land ownership;

(2) identify potential GI project sites and grant funding for early implementation to understand cost/benefit for each; and

(3) determine potential citywide benefits and provide actions and policy direction to institutionalize GI in the City.



The impervious cover analysis revealed that 41 percent of the city's impervious surface is attributable to buildings, 32 percent to parking lots, 25 percent to roadways and 2 percent to railroads. In addition, most of the impervious area besides roads is on privately held lands which shows why private investment is necessary to make this a successful program. The City cannot solve this problem cost effectively on its own.

Further analysis of land ownership identified more than 50 existing and potential GI projects in various locations:

- Streets, Alleys & Sidewalks
- Parking Lots
- Rooftops
- Parks
- School and City-owned properties

From these locations, the GI Plan provides conceptual designs and cost estimates for 20 initial projects that the City can use to demonstrate each green infrastructure technology. These demonstration projects will remove an estimated 21 million gallons of urban runoff from the combined sewer system per year, and, at the same time the demonstration projects will provide much-needed data on the long-term effectiveness of employing green infrastructure strategies on a broader scale to reduce urban stormwater runoff and combined sewer system overflows. GI project types were determined to be capable of scaling to significant implementation levels when applied to specific land uses common in urban setting such as Lancaster City:

STREETS, ALLEYS AND SIDEWALKS

Green streets, alleys and sidewalks use existing roadways and the public right of way to manage stormwater runoff with tree trenches, porous sidewalks, curb-extensions, and sidewalk planters. Initial demonstration projects are being located at street corners undergoing ADA ramp upgrades and in areas slated for streetscape improvements. The City has identified approximately 20 blocks of streets that are either scheduled for repair or ADA ramp upgrades in 2011. These blocks will serve as green street prototypes that can be incorporated into the City's on-going street repair program. If the City's current rate of road repaving and reconstruction were adapted to include GI, this will result in approximately 468 blocks of green street development over the next 25 years. Another key strategy in developing green streets is enhanced street tree planting. Lancaster City has an estimated 8% tree canopy. Various studies indicate that a 40% tree canopy in urban areas can provide a substantial reduction in stormwater runoff.

This potential is being verified by the City in a separate DCNR funded study to evaluate existing tree canopy using a top down (high resolution aerial imagery) and bottom up approach (walking inventory). This will provide a baseline measure of the city's existing tree canopy, assess the age and health of existing trees, and identify possible locations for additional plantings. The GI Plan proposes to increase the City's urban canopy tree with 6,250 trees or about 250 plantings per year over 25 years. When complete, the enhanced tree canopy will manage stormwater runoff from approximately 45 acres of impervious area.

PARKING LOTS

Green parking lots are usually created by excavating a portion of an existing lot and installing a stone subsurface infiltration bed in conjunction with porous pavement or water quality inlets that redirect stormwater into the stone bed. Runoff from adjacent areas such as streets and buildings can also be redirected into the infiltration bed. Tree trenches can also be integrated with the design to increase the tree canopy and promote evapotranspiration.

These projects are most cost effective when the pavement is in need of replacement or the lot requires reconfiguration for other reasons. The GI Plan includes conceptual designs for four public parking lots in need of restoration. The GI Plan calls for retrofitting and, managing runoff from 130 acres of primarily privately-owned parking lot over 25 years.

ROOFTOPS

Multiple strategies can be employed to manage the rainwater that falls on rooftops. Lancaster City currently has 51,000 square feet (well over 1 acre) of green roofs. This translates into almost 1 square foot per resident – perhaps more than any municipality in Pennsylvania. Building on the success and lessons learned from the Lancaster County Roof Greening Project administered by the Lancaster County Planning Commission and implemented by LIVE Green, the GI Plan calls for an additional 2 acres of green roofs in the next 5 years and over 30 acres in the long term.

Water from rooftops can also be managed through disconnection of downspouts. Most downspouts in the City go directly into the combined sewer system. Water from downspouts can be redirected to open green space, rain barrels, cisterns, rain gardens or stormwater planters. Through its Urban Watershed Initiative LIVE Green has been providing rain barrels to residents seeking low-cost solutions. The work of LIVE Green demonstrates how the installation of 250 rain barrels and rain gardens can reduce the amount of stormwater that enters the municipal sewer system and local streams by over 3 million gallons per year. The GI Plan calls for an additional 2,000 buildings to disconnect their downspouts.

PARKS

The GI Plan leverages the City's previous investment in the Urban Park, Recreation and Open Space Plan completed in 2009 as it moves forward with recommended park restoration and reconstruction projects. The GI Plan proposes green infrastructure retrofits of 26 of the City's 30 Parks to manage water runoff from 17 acres of impervious surface area. The GI Plan lays out specific concepts for the renovation and restoration of 3 parks and uses these park areas to manage storm water runoff from adjacent roadways and other impervious areas. An example is the recently completed Sixth Ward Memorial Park project that employs a porous basketball court and infiltration bed to reduce runoff from adjacent roadways and other impervious areas by an estimated 700,000 gallons per year. The new court was designed and built at half the cost of separate grey infrastructure designed to achieve the same level of benefit.

1 - The 6th Ward Park porous basketball court provides runoff reduction at 1/2 the cost of separate grey controls, while also providing community improvements

SCHOOLS AND CITY-OWNED PROPERTIES

The GI Plan establishes a long term goal of greening 38 acres of impervious surface area associated with 15 public schools. Implementing a variety of green infrastructure techniques to mange stormwater generated on-site can also manage additional impervious areas from adjacent properties. Libraries and other publicly owned facilities offer the same green infrastructure and storm water management opportunities as schools. The GI Plan includes conceptual designs for the Lancaster Public Library and two public schools.

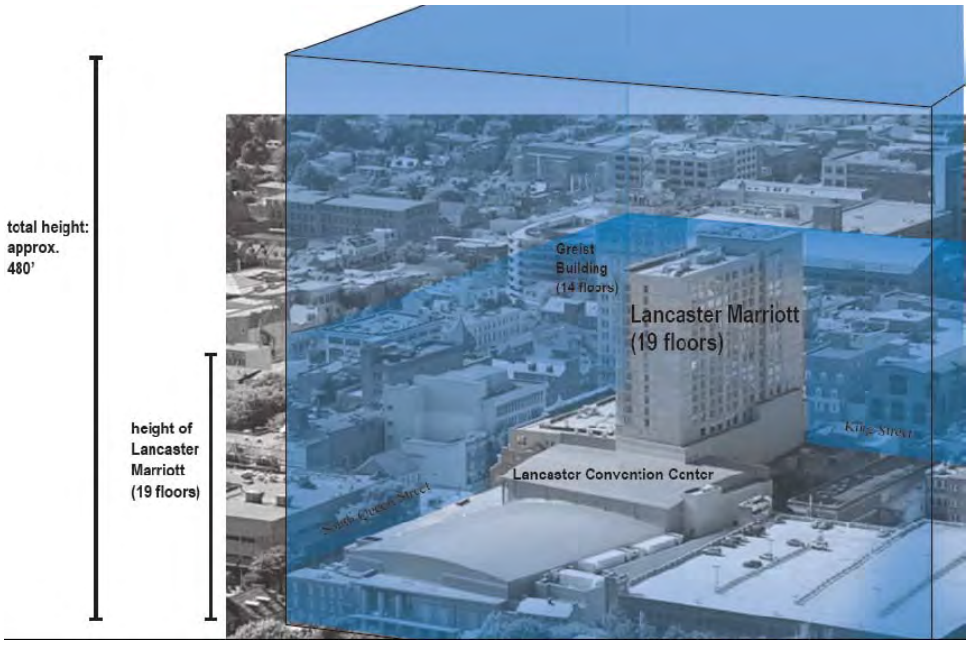
INCENTIVES FOR RESIDENTIAL AND COMMERCIAL PROPERTIES

To fully institutionalize green infrastructure into the City of Lancaster's urban landscape, the GI Plan proposes a combination of policy actions, incentives for residential and commercial property owners, and innovative funding approaches to support ongoing implementation costs.

POLICY ACTIONS: ORDINANCES & STANDARDS- As part of its stormwater ordinance, the City currently has a "first flush" control requirement that requires property owners who are adding new impervious surface areas (e.g., a building addition, driveway, garage or impervious patio) to manage the first 1-inch of rainfall on their property and not allow it to discharge to the combined sewer. The GI Plan recommends that the City's Stormwater regulations be extended to control the first flush from the impervious area within the entire disturbed area of the redevelopment project. For example, if an addition to a building was being built on top of an existing parking lot, runoff from the addition would fall under the ordinance and would need to be managed for the first flush (but runoff from the existing building would not). Over time, this change will gradually reduce stormwater runoff to the combined sewer. In addition to this revision of the storm water ordinance, the GI Plan recommends that the City evaluate other ordinances that may impact green infrastructure implementation, and review its current Streetscape Design Standards to incorporate green infrastructure options.

INCENTIVES - For private properties that may not redevelop in the foreseeable future, the City continues to evaluate programs that can incentivize owners to construct green infrastructure retrofits. The existing efforts have focused on securing grant dollars that can be used to implement demonstration projects on privately-owned property. The GI Plan proposes the establishment of a Green Infrastructure Grant Fund to support the marginal cost (e.g., the cost difference to install a green roof instead of a conventional one) of constructing GI on private property.

FUNDING - The City is evaluating a utility structure that would allocate the costs of stormwater management and water pollution control based on the amount of impervious surface area on each parcel. Known as a "stormwater utility," this would apportion the costs of controlling combined sewer overflows and storm water based on each parcel's proportionate use (as determined by impervious area) of the wastewater collection and treatment facilities. Because controls are now required for wet weather flows, this method of cost allocation would be based on actual use of the sewer system and treatment services and allow reductions in a bill if a property owner installed green infrastructure to manage his or her impervious area and reduce flows to the sewer.



Over 1 billion gallons of stormwater is projected to be removed through long-term implementation of this GI Plan. This would fill a cube 480 feet high over the block containing the convention center and hotel.

BENEFIT AND COST

The GI Plan evaluated the runoff reduction benefits of the initial demonstration projects, a conceptual 5-year implementation scenario and a long-term scenario that might be expected to be achievable over a period of about 25 years or so based on typical rates of redevelopment and renewal rates for other City infrastructure like roads and sidewalks. Based on the characteristics of the demonstration projects, the potential benefits and costs associated with GI were estimated for each implementation scenario. The projected benefits of the program over the long term scenario are summarized below.

Table 1-1 - Summary of GI Plan benefits for 5 year and long-term implementation scenarios

Parameter	5-year Implementation	Long-Term (25-yr) Implementation
Impervious Area Managed by Green Infrastructure (ac)	221	1,265
Average Annual Runoff Reduction (MG/yr)	182	1,053
Average Annual Total Suspended Solids (TSS) Reduction (lb/yr)	252,000	1,457,000
Average Annual Total Phosphorus (TP) Reduction (lb/yr)	4,800	27,800
Average Annual Total Nitrogen (TN) Reduction (lb/yr)	10,700	61,600
Total Marginal Cost	$7,800,000	$77,000,000
Total Capital/Implementation Cost	$14,000,000	$141,000,000
Marginal Cost Per Gallon CSO Reduction ($/gal)	$0.06	$0.10
Total Cost Per Gallon CSO Reduction ($/gal)	$0.10	$0.18

RECOMMENDATIONS

To achieve these benefits and put the GI Plan to action, the following recommendations are made in four key areas described as follows.

1. **Implement a comprehensive demonstration program** to allow the details of each project type and technology to be worked through and adapted for the specific requirements of the City's unique land use types and
   a) **Establish a prioritized capital program for GI implementation** within Department of Public Works;
   b) **Apply a screening process to review existing City capital programs for possible green infrastructure project opportunities** (e.g. roofing, pavement restoration and other projects that restore or reconstruct impervious surfaces);
   c) **Create a Green Infrastructure Grant Fund to incentivize action** by funding the marginal cost of the green portion of improvements on private property.

2. **Implement the recommended policy actions including:**
   a) **Institute a GI advisory committee** comprised of City leaders to discuss and remove implementation barriers and endorse selected implementation programs and projects;
   b) **Convene a review process to evaluate City Codes to include Green Infrastructure Options**
   c) **Revise City Standard Design Guidelines and Details;**
   d) **Evaluate and revise the First Flush Ordinance to manage all impervious area in the full area of disturbance for redevelopment;**
   e) **Implement an impervious cover-based storm water rate to equitably apportion the cost of wet weather controls;**
   f) **Develop a program to utilize vacant land (publicly and privately owned) for management of stormwater runoff.**

3. **Implement partnering and outreach including:**
   a) **Develop and manage a list of key partners and volunteers** to help deliver outreach messages, host workshops, and provide support for grant funding pursuits;
   b) **Develop partnerships and volunteer efforts to implement the results of the Urban Tree Canopy Project** being conducted by PA DCNR and evaluate additional models for expanding street tree programs;
   c) Coordinate with County efforts to **implement the state and federal pollution reduction requirements;**
   d) Coordinate with County efforts to **implement the Greenscapes Plan;**
   e) **Develop a GI Portal on the City website** to disseminate information to the public about GI technologies, program updates, and what home owners can do to help;
   f) **Develop a homeowner's guide to GI;**
   g) **Provide GI Fact Sheets and education materials** on the Portal and brochures for selected audiences;
   h) **Develop a public outreach plan, presentation materials and schedule** for outreach to key neighborhood groups, business leaders, the Mayor, City Council, and other stakeholders through **public meetings;** and

i) **Leverage learning through local and state key stakeholders** to inform the adoption and implementation of green infrastructure in other urban centers.

4. Implement other studies & technical tools including:

a) **Conduct a Green Streets workshop** to support the selection and development of projects and approaches to demonstrate green streets in various types of road and alley reconstruction practices;

b) **Update the City Hydrologic and Hydraulic Models to simulate green infrastructure** improvements in relation to other grey infrastructure alternatives;

c) **Update the CSO LTCP** to include GI Plan recommendations;

d) **Expand the GI Plan to evaluate the required implementation levels of the Chesapeake Bay TMDL and the nutrient reductions required for Lancaster** in the PA Watershed Implementation Plan (WIP) and **develop an integrated strategy for meeting CSO reduction and nutrient reduction objectives at the least cost and highest benefit to the City;**

e) **Partner with PA DEP in the development of the revised WIP** for meeting the Chesapeake Bay TMDL requirements;

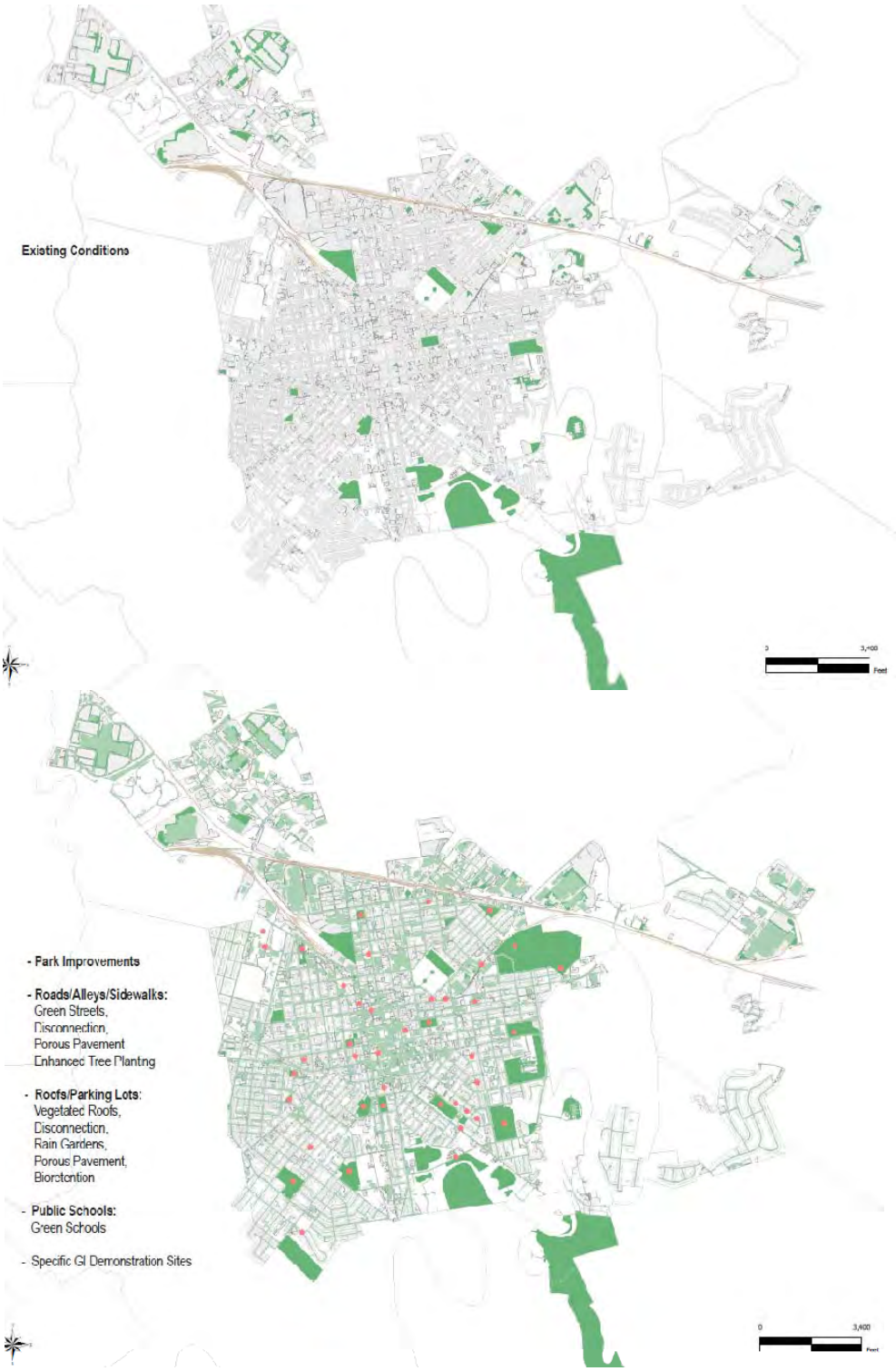
f) **Develop a project tracking system** to document GI Implementation projects including the first flush projects and the area that they control; and

g) **Identify direct stream inflow sources for potential removal from the combined sewer system.**

h) Prepare a comprehensive Tree Management Plan by analyzing and developing a more specific tree planting goal based on the results of the Urban Tree Canopy Project and street tree inventory;

i) Address GIS data needs and update parcel-based landuse data, impervious area data, and parcel ownership information

By implementing these recommendations, the needed investment in expensive, separate new grey infrastructure for water quality improvement can be significantly reduced and the City can realize many additional environmental, social and economic benefits.



The top map shows the existing City green space that does not contribute significantly to runoff problems. The lower graphic illustrates the 1,265 acres of impervious area proposed to be managed over the long term through the GI Plan.