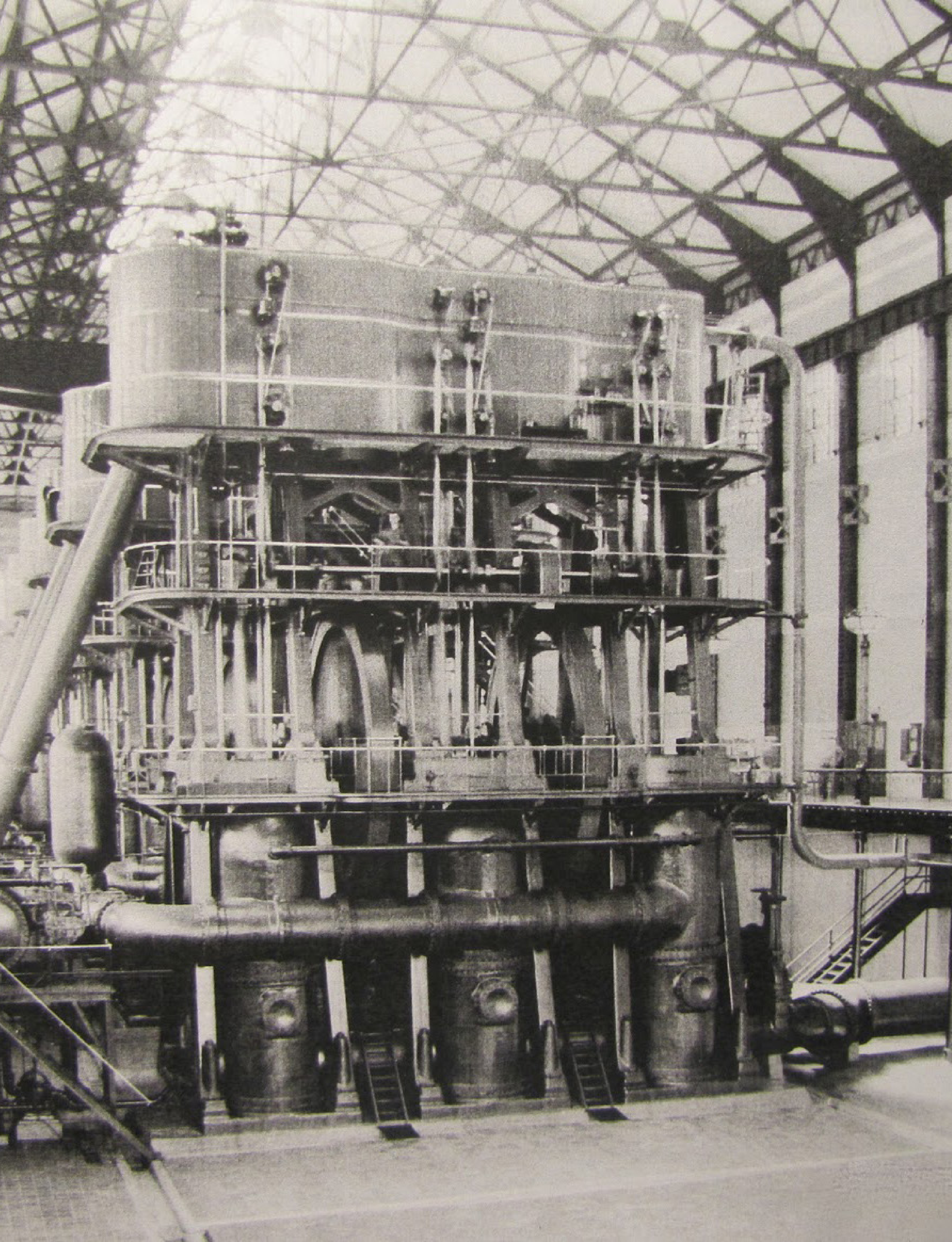
FOUR

METHODS

Successful implementation of green infrastructure requires a deep understanding of conditions on the ground in the priority CSO basins.

This chapter describes the work Buffalo Sewer conducted and the methods used for the analyses that form the basis of this report.



CONTEXT: Rain Check 1.0 and 2.0

Rain Check 1.0 identified key solutions that could be described as "low hanging fruit," or solutions that could be quickly implemented.

Rain Check 2.0 overlaid additional concerns such as equity and building communities of action on to the achievable and technical solutions described in Rain Check 1.0. The analysis was based on a three part approach.

Defining what is **POSSIBLE**. The team gathered more data on topography, runoff, and other place-based performance data that allowed the team to determine what is needed to meet the stormwater goals and the feasibility of basin-wide capture.

Defining what is **PROBABLE**. Additional data points were gathered through simulations, GIS information, and site investigations. Using this data the team was able to find projects and places that are more likely to be strong candidates for green infrastructure.

Suggesting a method for discovering what is **PREFERRED**. Lastly, the team added metrics for evaluation such as an equity analysis, and added recommended methods for engaging a broader community in the discussion to determine what types of green infrastructure would best serve the community.

The approach resulted in some new practices, such as:

- Working with key partners and creating programs to support projects through implementation.
- Leveraging green infrastructure to support community revitalization efforts.
- Focusing on areas where projects have greatest impact.
- Creating a knowledgeable advocacy community by learning internally and from successful programs in other cities.

Work conducted as part of Rain Check 2.0 falls into two main categories. Technical, analytical, place-based work and work related to engagement and consultation with stakeholders and technical experts.

The analytical place-based work focused on quantifying the current conditions of each priority CSO as they relate to development patterns, capacity for green infrastructure installations, canopy conditions and opportunity for expansion, and the equity conditions.

Work related to communication and outreach focused on engaging people on green infrastructure. This work created tools to enhance stakeholder outreach (see **Chapter Three | People** for findings) and address technical challenges for expanding green infrastructure implementation in Buffalo (see **Chapter Two | Place** for findings). This included conversations with public, local government agencies, private property owners, developers, and green infrastructure experts.

Retrofit Reconnaissance Investigations (RRI)

The Rain Check 2.0 initiative identifies opportunities to implement green infrastructure in places where no stormwater management measures are in place. These "Stormwater Retrofits" can be built throughout the landscape, in areas where green infrastructure practices can capture stormwater and are feasible. This project built on the approach described in the "Stormwater Retrofit Handbook" (CWP, 2007), including the following steps:

- A Desktop Analysis using available mapping data to identify potential locations and
- A Field Survey to develop design concepts at each location.

The **Desktop Analysis** identified individual parcels with the greatest potential to implement green infrastructure practices. The initial screening restricted the analysis to parcels of 0.5 acres or larger, and identified potential partners based on parcel land use. Next, this initial list of parcels was refined based on other factors.

The **initial screening** resulted in a list of 945 parcels, each with an area of at least 0.5 acres. Taken together, the parcels totaled 1915 impervious acres, exceeding the total impervious cover target within every CSO basin.

The desktop analysis also considered **key community partners**, including: Public Schools, Parks, Buffalo Urban Redevelopment Authority, Buffalo Urban Development Corporation, Buffalo Municipal Housing Authority, and religious centers. Their status as a keystone for engagement, often large building footprint, and diverse representation of the community, result in a logical starting place for green infrastructure implementation. The preliminary desktop analysis indicated that 10-15% of impervious reduction targets can be achieved through these partners alone.

Figure 4.1: Image of RRI Assessment tool

Type of Information	Data Collected
Administrative Data	Person assessing Date Retrofit ID Date/Time
Property Information	Ownership Land Use Existing Practices Present
Proposed Retrofit Description	Location Purpose Practice Type / Description Practice Site / Dimensions
Retrofit Area Description	Dominant Soils (if available) Available Hydraulic Head Light Availability Visibility Adjacent Land Uses
Potential Constraints or Conflicts	Land Use Conflicts Utilities Potential other site constraints (such as contaminated soils or large trees)
Other Data Collected	Site Photos Concept Sketches Drainage Area Delineation Site and Design Notes

Table 4.1: Key Information Collected during RRI Field Visits

Field surveys of potential retrofit sites were completed using a new electronic version of the Retrofit Reconnaissance Investigation (RRI; CWP, 2007) form, adapted to suit the needs of the Rain Check 2.0 project (Table 4.1). The purpose of the field survey was to: 1) narrow the list of potential parcels to include only those sites where green infrastructure practices are feasible; 2) delineate areas within each site that could be treated by these practices; 3) propose potential solutions appropriate to each site; and 4) identify potential implementation challenges at each site, such as utilities or parking conflicts.

Parcels with Feasible Retrofits

The primary goal of the RRI field surveys was to develop a list of properties from those identified during the desktop screening, where green infrastructure is feasible given existing conditions at each site. Of the 625 sites visited, 450 were suitable for some type of green infrastructure practice. Typically, sites were removed from the list due to major conflicts, such as presence of large utilities throughout a site (for example, an electrical substation) or soil contamination issues. The site investigators used GPS to identify the specific location where they completed the assessment and each point includes data describing if the site is feasible.

Drainage Area Treated

The initial desktop screening identified the area of each parcel, as well as an estimate of the total impervious cover based on land use. At the site level, however, a practice cannot typically capture the entire site area, due to site drainage patterns. During the site visits, team members delineated the boundaries of the drainage area that could be captured by a practice. For sites that were considered feasible, the result is a map of drainage areas that are then overlaid with existing land use and impervious cover to identify the total area of impervious cover that can be captured by green infrastructure practices identified in the field. Taken together, the total impervious area captured within the drainage areas is 482.1 acres with street drainage area included when found feasible in RRI field visits.

Retrofit Concepts and Implementation Concerns

At each site where retrofits were feasible, the investigator also developed a retrofit concept, including a simple sketch of opportunities at the site scale, and a description of the types of green infrastructure practices that may be appropriate. In addition, the investigator described and noted conditions at the site that are important to implementing the practices. Some of these are opportunities, such as potential partnerships or educational opportunities. Others include data needs, such as survey data or locations of drainage features, or constraints, such as existing utilities. These data, contained in the complete database of retrofit opportunities, will be useful when opportunities arise to implement individual practices.

Tree Canopy Analysis

Trees play an important role in stormwater management. To better understand their role in Buffalo, an in-depth analysis of the tree canopy was conducted for the entire City and also for each priority CSO Basin.

Analysis of Existing Canopy

The existing tree canopy was measured using 2014 LiDAR (Light Detection and Ranging) data and GIS software. This analysis allowed the team to determine gaps in tree canopy coverage and available spaces for "street trees"" (i.e. trees located at the front of the property between the sidewalk and the street). From this evaluation, potential locations were identified for tree planting to reduce stormwater runoff.

Opportunities for Expanding the Canopy

Identification of potential sites for additional tree planting focused on several areas:

- Within the street rights-of-way. Typically located between the sidewalk and the street, acceptable planting locations currently without trees were identified through previous evaluations conducted by the City in 2014. These trees are directly managed by the City.
- Outside the public rights-of-way, on both residential and non-residential properties. These locations were identified using U.S. Forest Service protocols with input from the Rain Check 2.0 Tree Technical Advisory Committee members (Tree TAC) to identify City-specific restrictions. The potential planting sites included pervious acres not already covered by tree canopy and excluded areas within 50 feet of a railroad and any vacant city-owned parcels due to potential maintenance challenges. Trees located outside the public rights-of-way are the responsibility of the property owner.

The identified locations require further investigation to ensure that they can support long-term tree growth and survival and that appropriate tree species are selected. The City does not have the capacity or resources to take on a large-scale street tree planting campaign; therefore, partnering with property owners for the planting and maintenance of trees outside the public right-of-way will be critical for stormwater management success as significant opportunities exist on private land.

Defining the Stormwater Benefits of Trees

In addition to analyzing the opportunities for tree planting in Buffalo throughout the City and in the priority CSO basins in particular, Buffalo Sewer also established a methodology to define the benefits of tree plantings for reducing stormwater volume. The development of such a framework was needed to evaluate the volume reduction benefits of trees as compared with other green infrastructure practices. Although trees are known to improve stream quality and watershed health by decreasing the amount of stormwater runoff and pollutants that reach local waters, no single accepted methodology exists to account for these benefits in a quantitative way, particularly for single storm events.

Figure 4.2: Historic Image of Buffalo's Street Trees (source: Buffalo Rising)

Buffalo Sewer developed a method that builds on a water balance modeling framework and incorporates the expertise of a Tree TAC that was assembled for this project to develop a method that takes into account the unique needs of the City of Buffalo and the Rain Check 2.0 effort. Technical experts in forestry were brought together from government agencies and academia, along with national and local practitioners. Buffalo Sewer convened these experts as the Tree TAC to advise on this effort. Through regular meetings and focused topic discussions they helped to translate national practices and specific tree criteria to inform the method. The framework builds on work done by the Center for Watershed Protection on developing a national Stormwater Performance-Based Credit for tree planting.

The Buffalo Rain Check 2.0 Framework includes two elements to account for tree planting: 1) a per-tree credit for future planting, and 2) a canopy based credit for tracking progress over time. These credits are also supported by basic assumptions regarding tree growth rates as well as ongoing data collected as part of routine tree inventories. The credit will quantify an event-based reduction in runoff volume associated with tree planting for the City of Buffalo.

Figure 4.3: Timon St. street trees in Buffalo, NY (source: Buffalo Rising)

Equity Analysis

A detailed analysis of equity in Buffalo and how equity considerations intersect with green infrastructure was completed. Integrating equity considerations into the decision-support framework for green infrastructure is an explicit goal of Buffalo Sewer and the City of Buffalo. Part of the rationale for adopting a green infrastructure approach to reduce stormwater runoff and prevent combined sewer overflows in Buffalo is that there are social, economic, and environmental benefits to be gained as green infrastructure is installed throughout the City. These potential benefits make the equitable provision of green infrastructure an important concern.

The Equity Analysis was grounded in the understanding that CSO basins are not familiar geographies to many people; instead, these areas are neighborhoods where people are born, live, learn, work, play, worship, and age. The Equity Analysis focused on vulnerable communities that have historic or contemporary barriers to economic and social opportunities and a healthy environment as a central concern of green infrastructure planning.

The Equity Analysis consisted of two approaches: (1) a citywide equity index and (2) individual CSO equity profiles. First, a composite index of seventeen variables was developed to compare census block groups across Buffalo on measures of need, deprivation, and risk. The index included two types of variables: socioeconomic variables related to disadvantage and vulnerability, and environmental factors related to both exposure to environmental risks and access to environmental amenities. Using geographic information systems (GIS), each of the seventeen variables and index values were mapped at the block group level. The index values and accompanying set of maps provide an easy, visual way for Buffalo Sewer and stakeholders to better understand the citywide distribution of need, deprivation, and risk and to compare different neighborhoods on various measures.

Second, a series of profiles was developed for the six priority CSO basins that were identified as target areas for Rain Check 2.0. Each equity profile offered an in-depth look at demographic, economic, health, and environmental conditions for the people living in the "neighborhoods" (census tracts) located in and around the CSO basin. The profiles also highlighted community assets and institutions, including major employers, community centers, schools and religious institutions in each CSO basin. Some of the variables included in the Equity Analysis were also examined in other work, such as land use patterns and tree canopy cover. This repetition was intentional; analyzing this data alongside or in combination with socioeconomic data offered a more balanced or holistic evaluation of challenges and opportunities in each CSO basin.

The Equity Analysis focused attention upon the community and economic benefits associated with green infrastructure, the neighborhoods that are located within priority sewer basins, and the inequitable distribution of disadvantage and vulnerability by

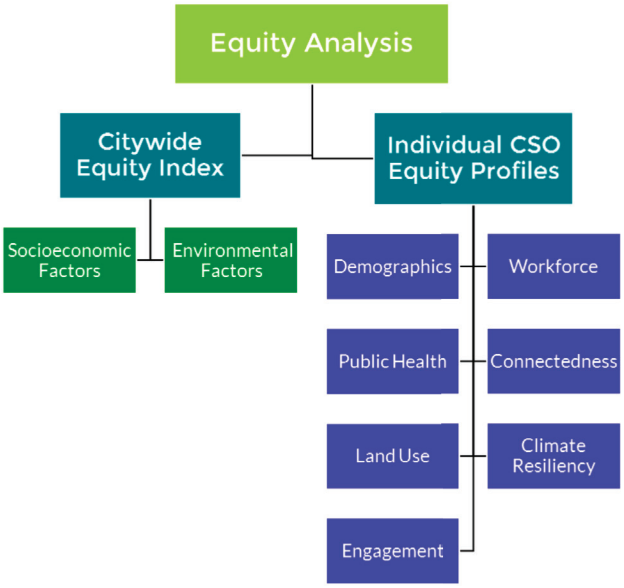


Figure 4.4: Data analyzed for City-Wide Green Infrastructure Index and Individual CSO Equity Profiles

neighborhood, race, and ethnicity across Buffalo. The equity index maps and equity profiles provided a more nuanced understanding of communities most in need of green infrastructure.

The equity index and equity profiles should not stand alone as planning tools absent community input on both the indicators and their importance. Instead, the index and profiles can be used to shape and strengthen community discussions about equity and green infrastructure. Both the index and profiles can be modified to include additional indicators.

As Buffalo Sewer targets interventions in other areas of the City, similar data can be collected and analyzed. Buffalo Sewer's methods and data were informed by engagement with the community and key stakeholders, which also set the stage for future partnerships.

More information on the Equity Index can be found in the Appendix A1.

Figure 4.5: Hoop house being installed (Source: PUSH Buffalo)

Engagement & Consultation

Private Engagement

Buffalo Sewer engaged developers, design professionals, property owners, business groups and institutional and non-profit land owners as part of the process of developing this report. Since the majority of Buffalo's land area is privately owned, engaging the private sector is key to achieving Buffalo's stormwater management goals. To engage with the private sector, Buffalo Sewer conducted one-on-one interviews with developers and private property owners, held focus group meetings, sent out email questionnaires, and researched programs used by other cities to engage the private sector in implementing green infrastructure.

Stakeholder Engagement

Buffalo Sewer engaged with the public and local government stakeholders to publicize past green infrastructure efforts in the City, discuss lessons learned, and develop approaches for local stakeholders to implement as they continue their projects. Meetings involved several one-on-one interviews as well as focus group discussions.

Technical Advisory Committees

Buffalo Sewer identified technical experts in the field of green infrastructure from government agencies, academia, community organizations, and local practitioners. Buffalo Sewer Authority convened these experts as a Technical Advisory Committee (TAC) to advise on the best possible green infrastructure network. The TAC members brought with them a wide range of knowledge and experience. Through regular meetings and focused topic discussions they helped to translate national practices to the Buffalo context.

The outcomes of each TAC meeting were summarized with recommendations prepared. The TAC meeting outcomes and recommendations were incorporated into the project process and also into this report where appropriate.

Next Steps

Buffalo Sewer's next steps are to continue the engagement and consultation process. This will include outreach to neighborhood groups and property owners in the priority CSO basins, creation of a grant program for green infrastructure implementation, green infrastructure training, and establishing partnerships.

Figure 4.6: Buffalo Sewer Waterworx educational session on soil science