City of Austin

Watershed Protection Department

IMPLEMENTATION PLAN

Brentwood Study Area

J. Brandon Klenzendorf
1.6.2017

Prepared by

Geosyntec consultants

8217 Shoal Creek Blvd, Suite 200
Austin, Texas 78757
PH 512.451.4003
www.geosyntec.com
Texas Engineering Firm Registration No. 1182

FOR PLANNING PURPOSES ONLY

6 January 2017

Impact of Decentralized Green Stormwater Controls

Ecapris SubProject # 5282.090

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

1 INTRODUCTION

1.1 Purpose

The purpose of this Implementation Plan for the Brentwood neighborhood is to provide guidance, recommendations, and examples for how to successfully implement, construct, and manage a watershed-scale deployment of decentralized green infrastructure (GI) stormwater controls for flood mitigation purposes in combination with selected "grey" infrastructure. The Implementation Plan is based on modeling results for the hybrid green/grey solution, which includes retrofitting the neighborhood with a wide variety of GI practices, together with strategically located grey infrastructure improvements, to address flooding issues as described in the Modeling Results Summary report (Geosyntec, 2016a). The GI Plan (Geosyntec, 2016b) divided the study area into separate GI planning areas to break down the study into more manageable units and identified a menu of GI features that could best meet the study goals within each of the units. Additional descriptions of each GI feature were presented including the cumulative level of implementation within each planning area that would be needed to realize the level of service improvements described in the Model Results Summary report. This Implementation Plan builds on the findings of the previous documents and provides a practical recommended roadmap for how the GI Plan could be implemented.

The Implementation Plan is intended to serve and guide City staff within the Watershed Protection Department during the implementation of the GI Plan and provides information, considerations, and examples of successful implementation strategies. The Implementation Plan is also intended to serve as an over-arching document that brings together the findings of the modeling efforts and GI Plan into actionable items that can be applied specifically to the Brentwood neighborhood but also to similar areas within the City of Austin experiencing stormwater challenges that can be addressed with GI or GI in combination with selected grey infrastructure. The Implementation Plan can be adapted for use in similar areas within the City while taking into consideration local variations and distinctions and may require differences in GI emphasis or strategies.

The overall strategy for the Brentwood Study Area Implementation Plan starts with recommendations for design, construction, and sequencing of GI facilities, as well as an initial field scale pilot study to verify and/or revise local parameter estimates and other results as discussed in Section 6.1. As the performance and design of GI is realized during this initial phase, continued implementation on a wide-scale should be pursued through various possible routes in combination with the identified grey infrastructure improvements. Specifically, including GI within planned infrastructure projects (such as street improvements, etc.), encouraging community engagement and partnerships, and developing incentive programs and other funding opportunities will help increase the number of GI facilities and extent of area managed with GI and in some cases with grey infrastructure. Finally, ongoing maintenance activities will be

increasingly important as the number of GI facilities increases; implementation considerations of a maintenance program are discussed.

1.2 Study Overview

Stormwater management approaches in the City of Austin have evolved over time to reflect advancements in our understanding of urban stormwater hydrology, water quality, and sustainability as well as shifting context and goals of the focus of stormwater management throughout the City as a result of ongoing and recent flooding events. Traditional approaches to retrofitting or addressing stormwater problems in older existing neighborhoods include adding new inlets, drains, pipes, and other hardened conveyance features (typically referred to as "grey infrastructure") which are designed to efficiently convey the peak flow from a hypothetical design storm. These solutions are often cost prohibitive and can contribute to flooding, channel erosion, and/or water quality issues in downstream reaches as a result of increased rate of drainage from upstream neighborhoods. Integrating the City of Austin (City) Watershed Protection Department (WPD) missions of reducing the impact of flood, erosion, and water pollution is difficult and very costly with an entirely "grey" infrastructure approach for retrofit situations.

An approach that is considered to be more sustainable and provide additional benefits is to manage stormwater near its source through the creation of vegetated areas and other green infrastructure. With the Brentwood Green Infrastructure (GI) Study, the City examined opportunities to reduce flooding, channel erosion, and water quality problems in an existing neighborhood through the use of distributed, small-scale green stormwater infrastructure while considering strategically located traditional grey infrastructure components in areas of known drainage complaints or conveyance restrictions and/or where GI alone would not provide sufficient flood reduction. This "hybrid green/grey" approach allows for a combination of hydrologic controls together with localized drainage improvements to reduce the extents and durations of neighborhood-scale flooding while avoiding adverse impacts downstream reaches. In this case, downstream reaches include Arroyo Seco and Shoal Creek. It is also intended to improve the cost/benefit of system improvements over what grey infrastructure alone would cost.

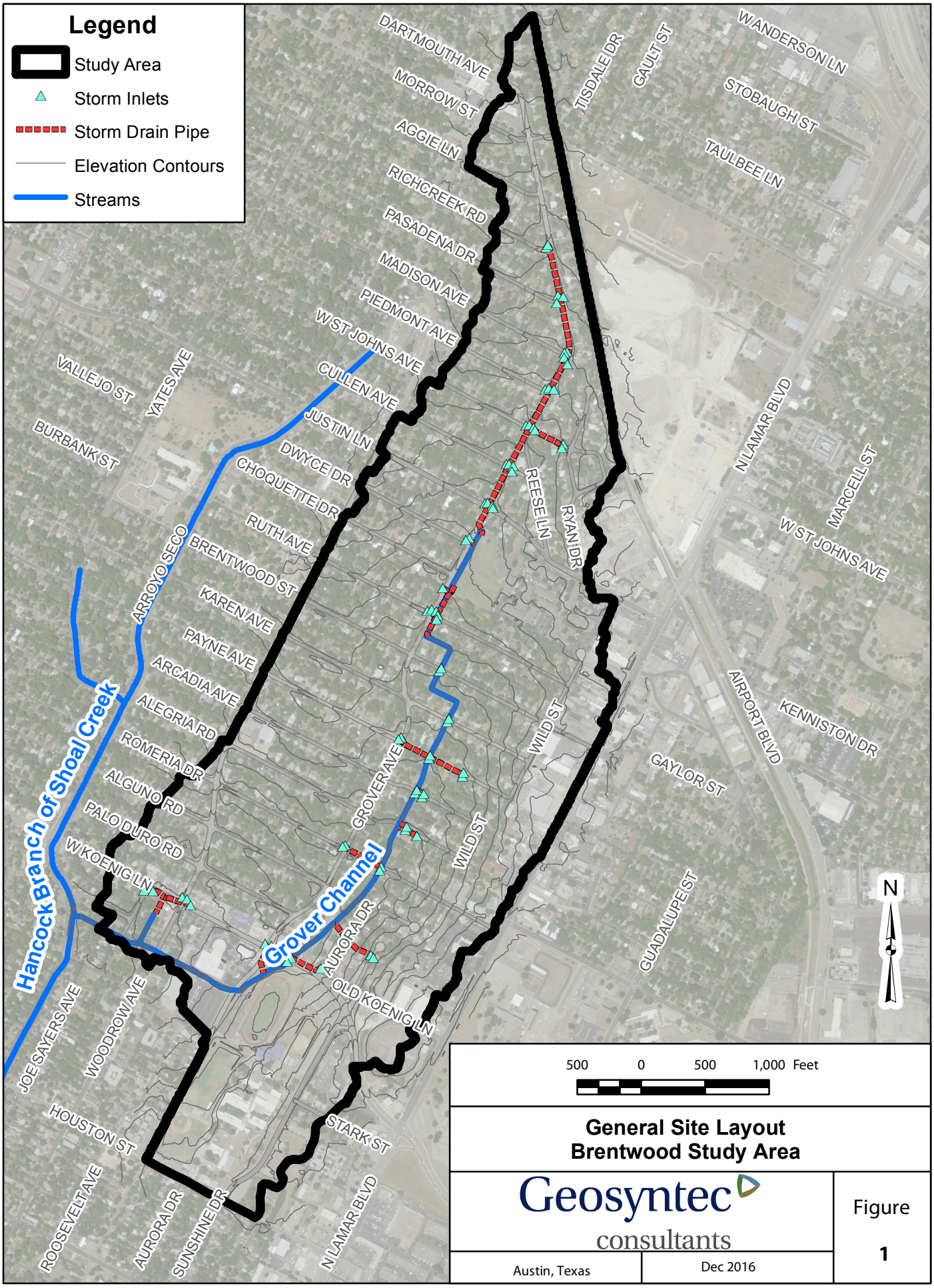
The Brentwood study area consists of approximately 360 acres of urban land that drains to the Grover Channel within the Shoal Creek Watershed (Figure 1). The study area primarily consists of single-family residential lots constructed from the late 1940s to early 1960s, with some high-intensity multi-family, commercial, and institutional development as well. Minimal flow control and drainage features exist in the study area, and the Grover Channel exceeds its conveyance capacity in storm events as frequent as a 2-year return period precipitation event, which results in relatively frequent flooding of streets, yards, and structures. Additionally, the Grover Channel and downstream reaches have suffered from erosion, and all receiving channels/creeks experience flooding in larger storm events. In a feasibility study (RCA, 2010), the City found it

would be cost prohibitive to bring the Brentwood area drainage system into compliance with the City's Drainage Criteria Manual (DCM) using traditional "grey" infrastructure solutions alone, including detention and/or major conveyance upgrades. The feasibility study also found that the use of traditional drainage improvements within the Brentwood project area would potentially result in downstream impacts associated with increased peak flow rates and volumes leaving the project area and increasing the frequency and/or severity of downstream flooding.

The objective of this study was to investigate and quantify the potential benefits of decentralized stormwater controls together with limited grey infrastructure improvements as described in the Modeling Results Summary report (Geosyntec, 2016a). A hybrid green/grey approach, which includes retrofitting the neighborhood with a wide variety of green infrastructure practices, together with strategically located "grey" infrastructure improvements, has potential to cost-effectively improve the level of service in the project area, while providing ancillary watershed management benefits such as reduction in pollutant loads, reduction in channel erosion, and reduction in potable water use for landscape irrigation with the use of native or WaterWise vegetation. Advanced modeling techniques were used to evaluate the extent to which decentralized GI features can be used to augment or replace traditional conveyance/detention approaches within the Brentwood storm drain system, to achieve the following goals:

1) Reduce the frequency, magnitude, and duration of peak flows to reduce the frequency of flooding;
2) Reduce the volume of runoff and increase the volume of infiltration;
3) Reduce or eliminate the anticipated life cycle costs of system-wide stormwater conveyance upgrades;
4) Reduce pollutant loads and erosion potential to receiving waters;
5) Reduce the use of potable water for landscape irrigation; and
6) Avoid adverse impacts to the base flood elevations of Shoal Creek.

The Brentwood study area was selected by the City because it is typical of many watersheds in the City that experience similar flooding and erosion issues. It has both neighborhood-scale flooding issues with the main drainage way (i.e., Grover Channel) as well as localized flooding issues associated with overland drainage pathways and poorly located concentration points. Further, it is located within a watershed that has downstream capacity limitations and experiences major regional flooding (Arroyo Seco and Shoal Creek). Additionally, the study area is relatively constrained with respect to opportunities for placement of regional systems. As a result, decentralized control solutions that work for this study area may be generally transferrable to other parts of the City.


Legend
Study Area
Storm Inlets
Storm Drain Pipe
Elevation Contours
Streams
DARTMOUTH AVE
MORROW ST
AGGIE LN
RICHCREEK RD
PASADENA DR
MADISON AVE
PIEDMONT AVE
W ST JOHNS AVE
CULLEN AVE
JUSTIN LN
DWYCE DR
CHOQUETTE DR
RUTH AVE
BRENTWOOD ST
KAREN AVE
PAYNE AVE
ARCADIA AVE
ALEGRIA RD
ROMERIA DR
ALGUNO RD
PALO DURO RD
W KOENIG LN
OLD KOENIG LN
AURORA DR
GROVER AVE
WILD ST
REESE LN
RYAN DR
TISDALE DR
GAULT ST
W ANDERSON LN
STOBAUGH ST
TAULBEE LN
N LAMAR BLVD
MARCELL ST
W ST JOHNS AVE
AIRPORT BLVD
KENNISTON DR
GAYLOR ST
GUADALUPE ST
VALLEJO ST
YATES AVE
BURBANK ST
ARROYO SECO
Hancock Branch of Shoal Creek
Grover Channel
JOE SAYERS AVE
WOODROW AVE
HOUSTON ST
ROOSEVELT AVE
AURORA DR
SUNSHINE DR
STARK ST
N LAMAR BLVD
N
500 0 500 1,000 Feet
General Site Layout
Brentwood Study Area
Geosyntec consultants
Austin, Texas
Dec 2016
Figure
1

1.3 Study Chronology

A preliminary draft GI Plan for the Brentwood study area was developed in May 2013 (Geosyntec, 2013) as the first step in this study to systematically assess the potential performance of hybrid GI and limited grey infrastructure solutions in meeting the goals stated above. The preliminary GI Plan was originally developed prior to conducting watershed-scale modeling and sought to identify the types of features and the extent of these features associated with a reasonable maximum degree of implementation (i.e., the "maximum GI" scenario). The development of this plan was informed by analysis of rainfall statistics and key events, evaluation of drainage complaints, and representative unit-area modeling methods.

Next, an existing conditions model was developed and calibrated, and the maximum GI scenario was developed from the basis of this model. Design storm and continuous simulation analyses of these two conditions were completed and results were interpreted in a draft modeling summary report in February 2014 (Geosyntec, 2014). Based on the results of modeling of the existing and maximum GI scenarios, a hybrid green/grey solution was developed to target improvements in level of service within the neighborhood while holding estimated construction costs at the same level as the maximum GI scenario and avoiding increases in peak flow rates leaving the neighborhood. The additional costs of grey infrastructure were offset by removing certain GI features in order to maintain a similar overall project cost. The hybrid green/grey solution included the following refinements:

- Change in spatial application of GI features (GI features were removed from the lower portions of the study area where there was much less connection of directly adjacent stormwater runoff to flooding within the neighborhood);
- Change in menu of GI features (the least effective GI feature was removed entirely); and
- Addition of strategically located grey infrastructure to alleviate localized capacity restrictions and increase conveyance within areas of known flooding.

Based on the updated Modeling Results Summary report published in January 2016 (Geosyntec, 2016a), the hybrid green/grey solution provides an approximately 25-year level of service in the areas of known drainage complaints and avoids increases in peak flow rate leaving the neighborhood.

An updated GI Plan was published in May 2016 (Geosyntec, 2016b) that focused on the hybrid green/grey solution recommended by the project team and selected by the City as the preferred alternative. The updated GI Plan divided the study area into separate GI planning areas to break down the study into more manageable units for planning and implementation purposes. The existing drainage problems and likely causes were presented describing existing flooding issues and known drainage complaints. A refined menu of GI features was used to focus on specific controls that could best meet the study goals. These GI features were categorized into public

right-of-way (ROW) projects or programs, private residential programs, private non-residential programs, and other specific projects. Additional descriptions of each GI feature were presented including proposed design criteria and the cumulative level of implementation within each planning area that would be needed to realize the level of service improvements described in the Model Results Summary report (Geosyntec, 2016a). Strategically located grey infrastructure improvements were identified to further increase the level of service beyond what GI alone can provide. In addition, the GI Plan focused to a greater extent on the next steps for plan implementation including estimated construction and whole life-cycle costs as well as recommended maintenance and monitoring plans.

This Implementation Plan focuses on recommendations for implementing the recommended hybrid green/grey solution. The full implementation of this solution is expected to take place over a number of years and should be viewed as an adaptive plan depending on opportunities that are available throughout the life of the implementation phase as well as observed results of implemented actions. If additional opportunities are presented during implementation that are not specifically noted in the hybrid green/grey solution, those opportunities should be evaluated and pursued, if feasible, provided the overall study objectives are being met.

This Implementation Plan describes details and recommendations related to implementation of the Green Infrastructure Plan (Geosyntec, 2016b) for the Brentwood Neighborhood study area. However, consistent with the intent of this study, this Implementation Plan is also intended to present broader recommendations that are transferrable to other locations in the City.

1.4 Document Organization

The remainder of this Implementation Plan is organized as follows:

- Section 2 presents the summary of the Implementation Plan Schedule consisting of ideas and topics that are discussed in more detail in subsequent sections;
- Section 2.6 discusses recent City of Austin planning efforts and how these relate (or could relate) to implementation of the Brentwood Green Infrastructure Plan;
- Section 4 summarizes the findings of modeling tasks conducted for this study as they related to implementation of the GI Plan;
- Section 5 describes recommendations for final design, construction, and sequencing of GI features;
- Section 6 introduces a possible field scale pilot study including performance monitoring for both specific projects and high priority residential block implementation, which are recommended steps as part of implementation;
- Section 7 discusses opportunities to incorporate GI features into other planned projects within the study area;

- Section 8 discusses community engagement and partnering with citizen groups;
- Section 9 presents possible incentive programs and other funding opportunities to encourage community support of the program; and
- Section 10 further discusses implementation of a GI operations and maintenance (O&M) program.

2 IMPLEMENTATION PLAN SCHEDULE

2.1 Implementation Methods

This Implementation Plan presents a number of proposed considerations, examples, methods, and recommendations in subsequent sections for efficiently implementing the GI Plan through the hybrid green/grey solution for flood mitigation in the Brentwood study area. The Implementation Plan schedule presented here describes a practical roadmap for how the features in the GI Plan should be implemented, including planning, phasing, design, construction, and maintenance. The remainder of this document is divided into categories to assist with the main topics and focus areas that are necessary for implementing the GI Plan; additional detail and further explanation and examples of these topics are provided in subsequent sections. The Implementation Plan schedule will help to organize considerations and tasks in a chronological order to allow for improved planning.

As there are other areas of the City with more severe flooding issues that continue to be a higher priority than the Brentwood area this Implementation Plan schedule is not designed for expedience or predicated on a pre-defined sequence or timeframe. Therefore, implementation of the GI Plan is likely to occur over a relatively long period on an “opportunistic basis.” The following sections identify a schedule of specific short term, medium term, and long term implementation steps.

Table 1 below summarizes the GI features in terms of categories for implementation (from the GI Plan). Each of these categories and/or implementation methods are discussed in more detail in the sections below. The categories are not exclusive and could include additional GI feature types that are not explicitly stated depending on the implementation method and specific opportunities available.

Table 1. Categorized List of Green/Grey Features for Implementation

Category	Land Owner (Implementation Method)	Green/Grey Features
Public ROW Projects and Programs	Public (Design by Public Works; Partnership)	• Biofiltration with underdrain connected to storm drain pipe • Biodetention (on-line) with overflow to street (sites with adequate grades) • Residential green streets program
Other Specific Projects	Public or Private (Partnership or Acquisition)	• Lions Field biodetention • Grover Avenue and Koenig Lane channel widening • Austin Energy tank blue roof
Private SFD Programs	Private Residential (Incentive, Partnership)	• Enhanced disconnection program (soil amendment, WaterWise landscaping, contouring, micro-depressions, rain gardens, new downspout disconnects) • SFD cistern program
Private Non-SFD Programs	Private Non-SFD (Incentive, Partnership)	• Commercial blue roof or cistern program • Green parking lot program (curb island retrofits, permeable pavement)
Strategic Grey Infrastructure Components	Public (Capital Improvement Projects)	• Tributary storm drain on Brentwood Street and Wild/Payne • Bypass pipe beneath Grover Avenue

2.2 Short Term Implementation Steps

Short term implementation steps can be incorporated in the initial implementation phase as precursors for medium and long term implementation steps. Many of these steps can be implemented immediately with little to no financial obligations. The recommended short term steps are expected to be implemented over a period of approximately two years.

- Initiate internal City coordination across departments. Watershed Protection Department should identify leaders and personnel in other City departments that could assist with incorporating GI into existing and future planning projects (such as street improvements, etc.) with minimal additional effort.
- Identify opportunities to incorporate GI features in planned CIPs already being conducted by the City as well as future CIPs. Although planned projects within the Brentwood study area may not be readily available, starting the conversation and coming to an agreement on the need for additional GI will be beneficial to future implementation projects.

- Establish a framework and minimum criteria for potential Public-Private Partnerships (P3s). Continue to observe the performance of stormwater P3s and identify potential lessons learned and contractual improvements that could be applied to the Brentwood neighborhood, if feasible.
- This Implementation Plan recommends that a pilot study be conducted as one of the first steps, as described in Section 6. Refine, plan, and select the pilot study area based on the criteria presented in Section 6. Determine the number, size, location, and design of GI facilities within the pilot study area to represent the level of GI proposed in the GI Plan.
- Begin community outreach efforts, focused on the pilot study area but also including neighborhood associations and schools and churches. Outreach efforts will increase awareness, gage community acceptance, identify the preferred GI facility types that are most desirable, and encourage community involvement and ownership of GI facilities.
- Identify non-profits that can help achieve desired goals. Coordinate outreach efforts and form, execute, and manage partnership opportunities. Focus on the goals for non-profits discussed in Section 8.3.
- Consider safety requirements and provide specific guidance on public safety implications of locally distributed GI components.
- Consider a quantitative review mechanism in the form of updates to the model to validate incremental additions of GI facilities (perhaps over a size threshold or periodically after some percent change). Model updates should be conducted throughout the duration of implementation.
- Develop improved reporting requirements for GI maintenance activities and cost data to better track the level of effort associated with maintenance and provide a basis for adaptive management of the maintenance program.

2.3 Medium Term Implementation Steps

Recommended medium term implementation steps include those that can be implemented over approximately two to five years, to inform longer term roll-out of a decentralized flood management approach.

- Implement the field scale pilot subwatershed study described in Section 6 based on resident survey responses. Construct the pilot study GI facilities and monitor the facilities and compare to expected performance.
- Construct specific large scale GI projects, such as the Lion's field biodetention. Although the GI Plan encourages small-scale decentralized GI controls, opportunities exist for several large scale projects which can provide significant flood mitigation benefits in the near term. These should be pursued and constructed to realize immediate large scale improvements.

- Formalize process and criteria for reduction or waiver of stormwater fees. One financial incentive the City can provide is a reduction to stormwater fees; developing a methodology for reducing this fee based on installation of lasting and effective control of runoff from impervious areas should be considered based on legal obligations and consideration of overall budgetary needs and restrictions.
- Issue and negotiate a RFP for pilot P3 approaches, if feasible/desirable. An RFP could be issued for the pilot study to gage private partner interest, evaluate cost effectiveness of this approach, and support the pilot study implementation.
- Develop and implement stakeholder engagement and community outreach plan. Develop outreach materials, identify community organizations and groups to contact, and plan and schedule workshops and meetings to incorporate the community into the implementation of the GI Plan.
- Develop formal partnerships with non-profits and conduct volunteer projects. Initial projects should be considered example projects in the neighborhood to showcase the numerous benefits of GI in addition to flood mitigation. These initial projects should be in high visibility areas in order to gain the attention of the community.
- Expand existing City of Austin rebate programs and develop potential new rebate programs or reduction to Drainage Utility Fee. Finalize the process for providing financial incentives to residents for constructing and maintaining GI on private property.
- Assist with construction of GI features on private property as a result of outreach efforts, development of incentives, and partnerships with other organizations. Track implementation of GI on private property as a mechanism to assess the level of GI implemented by residents.
- Initiate programmatic GI construction within the public right-of-way (ROW) in the form of green streets, biofiltration, biodetention, and other applicable GI feature types.

2.4 Long Term Implementation Steps

Recommended long term implementation steps relate to eventual broad-scale implementation of the GI Plan. In some cases, these steps are tentative and will be influenced by the outcomes of the short and medium term steps.

- Continue GI feature construction both within the public ROW and on private property through continued implementation of community outreach efforts and partnership activities.
- Continue monitoring of pilot study and/or expand monitoring efforts related to flood mitigation and water quality improvements as additional GI features are constructed. Conduct monitoring of life-cycle costs as a result of the maintenance plan and analysis of metered water use in the neighborhood for reduction in potable water use.

- Install strategic grey infrastructure as identified in Section 5.2 once sufficient GI has been constructed to offset the expected increase in peak flow rates from the grey infrastructure. The tributary grey infrastructure (along Brentwood Street and Wild/Payne) should be constructed first as the tributary areas are smaller and sufficient GI can be implemented in those areas more quickly. The Grover Avenue bypass pipe should be the last grey infrastructure component to be constructed due the larger contributing area and need for significant GI facilities to offset the increased peak flow rates.
- Formalize decentralized design approaches in the DCM and/or ECM. Incorporating the decentralized design approaches as well as including these approaches in retrofit, redevelopment, and rehabilitation projects should be considered in development of requirements and options for meeting requirements. Based on the successful implementation of such projects in the medium term steps, creating a requirement could have a lasting and significant impact on future development and re-development within the City.
- Implement award program incentives for successful private or non-profit GI projects. As more GI facilities are constructed, an award program will highlight the successes and further encourage the community to support and construct GI facilities.
- Track long term maintenance costs and adaptively manage the implementation of maintenance activities to identify cost savings, efficiencies, and opportunities for home owners to take responsibility for maintenance. Provide advanced training based on long term trends and data collected to maintain internal awareness of the evolving state of art and state of practice.

2.5 Summary of Implementation Steps

Table 2 presents the recommended implementation steps and tasks outlined above with desired outcomes. The City should assign tasks to specific staff to identify one point of contact responsible for implementing each task and achieve the desired outcome. Several of the tasks will require coordination with other City departments, community groups, and non-profits beyond the Watershed Protection Department.

Table 2. Summary of Implementation Steps and Outcomes

Implementation Phase	Potential Implementation Steps	Desired Outcome
Short Term Implementation (Year 0 to Year 3)	Initiate inter-department City coordination	• Develop relationships and identify point of contact in other departments to champion the addition of GI in future projects
	Incorporate GI into planned CIP projects	• List of CIP projects in preliminary design phase to include GI component plus mechanisms for future CIPs
	Establish framework for P3 criteria	• List of minimum criteria and draft RFP required for P3 based on lessons learned from existing P3s
	Refine field scale pilot study	• Select area for pilot study with number and size of GI controls • Monitoring plan refined for specific site
	Begin community outreach efforts	• Outreach materials sent to residents in pilot study area • Conduct interviews or surveys of residents in pilot study area
	Identify non-profits for partnering	• List of non-profits with similar goals in the neighborhood and resources to support GI construction activities
	Define safety requirements	• Safety considerations to be incorporated into final design of GI facilities
	Define criteria to update model based on GI installation	• Standard guidelines for model updates such as thresholds for when GI facilities should be incorporated into the model, schedule for model updates, or percent of GI installed resulting in model update
	Develop maintenance guidelines	• List of reporting data for GI maintenance • Schedule of maintenance/inspection activities
Medium Term Implementation (Year 3 to Year 10)	Implement field scale pilot study	• Installed GI on public and private property • Monitoring equipment installed for BACI analysis • Results obtained and verified with model
	Construct specific large scale projects	• Lion's field biodetention project completed • Larger bioretention facilities constructed, where appropriate
	Formalize criteria for reduction/waiver of DUF	• Recommendations to City Council for quantifying reductions in DUF for GI on private property
	Issue RFP for pilot P3 contract	• 2-3 year contract for P3 maintenance of GI in pilot study area
	Develop stakeholder engagement and community outreach plan	• Refine outreach materials based on previous experiences • Meetings with neighborhood groups • Continue surveys/interviews identifying residents to install GI • Advertise in community newspapers
	Develop non-profit partners; conduct volunteer activities	• Execute MOU with non-profits • Install GI on private property based on results of survey
	Expand City rebate programs	• Approval from City Council and/or Austin Water Utility for additional rebate funding of GI specifically in Brentwood area
	Assist with GI construction on private property	• GI facilities constructed on private property to increase the cumulative capture volume for flood mitigation
	Initiate programmatic implementation of GI	• Construct GI facilities in public ROW to increase the cumulative capture volume for flood mitigation

Table 2. Summary of Implementation Steps and Outcomes (continued)

Implementation Phase	Potential Implementation Steps	Desired Outcome
Long Term Implementation (Year 10 to Year 30+)	Continue private and public GI construction	• Increase the number, types, and cumulative capture volume of GI facilities within the study area
	Continue and expand monitoring activities	• Obtain data on long term benefits of GI as well as overall life-cycle costs and impacts on water usage
	Install grey infrastructure components	• Install storm drain on Brentwood Street and Wild/Payne once sufficient GI is installed • Install bypass pipe beneath Grover Avenue
	Formalize decentralized design approaches in DCM/ECM	• Draft changes to DCM/ECM requiring GI for retrofits • Notify City Council of proposed changes for approval
	Implement award program for successful GI projects	• Gain public awareness of GI projects
	Track long-term maintenance costs	• Improve understanding of long-term maintenance costs • Incorporate adaptive management and continuously improve maintenance activities

2.6 Potential for Land Acquisition as an Additional Implementation Strategy

The hybrid green/grey solution specifically did not include analysis of home buy-out and land acquisition options. Incorporating land acquisition as an option could potentially reduce the number of overall GI features. Land acquisition was investigated as part of the previous feasibility study (RCA, 2010) and contributed to exceedingly high costs.

Land acquisition could provide significant additional benefits, particularly if properties adjacent to Grover Channel are the focus of the buy-out program. Such benefits include the following:

- Reduce the number of drainage complaints by removing residences
- Restore Grover Channel to a larger creek system
- Restore a riparian buffer and floodplain adjacent to Grover Channel for flood mitigation, ecological, and habitat benefits
- Create a trail system to provide connectivity, walkability, and new green space to the community

All options and solutions should be considered to identify the most desirable solution taking into account construction costs, maintenance costs, outreach efforts, incentive costs, performance expectations, and achieving the study goals described above. Although buy-outs were not considered in the GI Plan, they may provide an additional benefit that could be worth the additional costs. Land acquisition options can be considered to achieve the several of the study goals described in Section 1.2 and do not necessarily conflict with the goals of distributed GI controls which is the focus of the Brentwood study. The recommended short term implementation steps described above will be needed regardless of whether the buy-out option is considered feasible.

Opportunistic property acquisition could be considered as a part of the recommended long term implementation steps, despite this option not being considered in the hybrid green/grey solution. If property becomes available adjacent to Grover Channel with an opportunity to alleviate flooding concerns, the City should consider purchasing the property and redevelop the area as open green space with a stormwater and flood mitigation purpose.

3 SUMMARY OF RELATED CITY OF AUSTIN PLANNING EFFORTS

Green infrastructure planning and construction and flood risk mitigation have also been recently considered and discussed in other City of Austin planning efforts, including the Imagine Austin Comprehensive Plan (Imagine Austin, 2012), the Flood Mitigation Task Force Final Report (FMTF, 2016), and the CodeNEXT Land Development Code update (CodeNEXT, 2016). A brief description of these efforts is presented here, focused specifically on discussions of incorporating green infrastructure into the City. This Implementation Plan was developed while considering the goals discussed in these plans and provides further expansion of these efforts in certain areas. Other City efforts have also investigated green infrastructure, but the Imagine Austin, FMTF Final Report, and CodeNEXT efforts are the most comprehensive efforts directly related to the recommended hybrid green/grey solution for the Brentwood study area.

3.1 Imagine Austin

The Imagine Austin Comprehensive Plan is a vision for Austin's future which is intended "to preserve, promote, protect and improve the public health, safety, comfort, order, appearance, convenience and general welfare; prevent the overcrowding of land and avoid undue concentration or diffusion of population or land uses; facilitate the adequate and efficient provision of transportation, water, wastewater, schools, parks, recreational facilities, housing and other facilities and services; and conserve, develop, utilize and protect natural resources."

Eight priority programs were identified in the Imagine Austin Comprehensive Plan to organize the key policies and actions into related groups in order to provide the structure and direction to implement the plan. These programs build on existing policies and initiatives to more efficiently coordinate operations, investments, and the provision of core services and consist of the following programs:

1) Invest in a compact and connected Austin
2) Sustainably manage our water resources
3) Continue to grow Austin's economy by investing in our workforce, education systems, entrepreneurs, and local businesses
4) Use green infrastructure to protect environmentally sensitive areas and integrate nature into the city
5) Grow and invest in Austin's creative economy
6) Develop and maintain household affordability throughout Austin
7) Create a Healthy Austin Program
8) Revise Austin's development regulations and processes to promote a compact and connected city

Although portions of each priority program are related to the Implementation Plan for the hybrid green/grey solution in the Brentwood neighborhood, "Priority Program 2" and "Priority Program 4" of Imagine Austin are directly related to the goals of this Implementation Plan. Priority Program 2 is to conserve water resources and improve watershed health including regional efforts, whereas Priority Program 4 is to use green infrastructure to protect environmentally sensitive areas and integrate nature into the City by increasing protection of environmentally sensitive land, improving tree cover in every neighborhood, improving health of the watershed, increasing access to parks, and linking these resources throughout the City. This program seeks to improve environmental, recreational, and transportation functions and improve the connection between people and the environment. It is noted that "green infrastructure" as described in the Imagine Austin Comprehensive Plan is broadly defined and includes trees, parks, and trails in addition to green stormwater infrastructure, which is the primary focus of the Brentwood Green Infrastructure Study.

According to the Imagine Austin Comprehensive Plan, the "benefits [of green infrastructure] to the environment are numerous and include enhanced stream health and improved water quality, reduced flood risk, and preserved and enhanced ecosystems and habitats. An integrated green infrastructure system can also reduce energy consumption and greenhouse gas emissions by providing alternatives to automobiles, reducing water use, and shading buildings." As discussed in this Implementation Plan, a summary of the modeling results quantifies the improved water quality and reduced flood risks associated with the implementation of the hybrid green/grey solution. Furthermore, other benefits of the scenario are discussed and identified which will be critical to convey to the public, elected officials, and other parties in order to gain support for the Implementation Plan.

Short-term goals of the Priority Program 4 that are directly related to the Implementation Plan include the following and are expected to be implemented within one to three years:

- Develop green infrastructure targets (such as percentage of tree cover, connectivity, or current or anticipated residents within walking distance of parks) and priorities for new areas for conservation, parks and open space, green streets, and urban trails.
- Include implementation strategies and approaches to promote interdepartmental, intergovernmental, and interagency coordination.
- Calculate direct and indirect costs and savings from green infrastructure projects, when compared with traditional "grey" infrastructure, including the asset value of ecosystem services and contribution to long-term risk management.
- Assess options to coordinate and expand incentives for residential and commercial property owners to install green infrastructure elements, such as green roofs, rainwater harvesting, pervious pavement, and rain gardens.

Ongoing and long-term (3+ years) goals of the Priority Program 4 that are directly related to the Implementation Plan include the following:

- Provide guidance on best practices for property owners interested in green infrastructure improvements. Develop demonstration projects and share information with residents and business owners.
- Identify approaches to track and monitor the costs and savings associated with green infrastructure projects. Solicit research and funding partners.
- Solicit partners, such as conservation and bicycle advocacy groups, to help implement the recommendations of the priority program.
- Hold public and educational events to share green infrastructure benefits and pursue program partnerships with local organizations.

Through activities implemented to meet the goals listed above, Priority Program 4 is expected to expand the amount of green infrastructure in Austin which will impact the City's ability to protect and conserve water resources (as set forth in Priority Program 2). By increasing the urban tree canopy and decreasing stormwater runoff, the priority program will contribute to reducing flooding, improving water quality, lessening the need for water treatment, and overall improvement in sustainability of water resources assets within the City.

The Imagine Austin Comprehensive Plan identifies other City initiatives that are related to the goal of green infrastructure implementation. These City initiatives should be considered for implementation of the Brentwood hybrid green/grey solution and include the following:

- Austin Climate Protection Plan
- Austin Strategic Mobility Plan
- Bicycle Master Plan
- Central Texas Greenprint Plan
- Healthy Austin Code
- Invasive Species Management Plan
- Parks and Recreation Department Long Range Plan
- Trails Master Plan
- Travis County Colorado River Corridor Plan
- Urban Forestry Management Plan
- Urban Parks Workgroup Report
- Watershed Protection Master Plan
- Town Lake Plan

The goals, benefits, processes, and recommendations of the Brentwood Implementation Plan align well with the existing Imagine Austin Comprehensive Plan and should be considered a part of the overall city-wide Imagine Austin plan.

3.2 Flood Mitigation Task Force

The Flood Mitigation Task Force (FMTF) was created by the Austin City Council in 2015 and directed to review existing flood mitigation and preparedness strategies, project and operational financing, affordability, planning and regulations, stakeholder collaboration, and citizen communication, and make recommendations for new strategies and policies. The Brentwood Implementation Plan of the hybrid green/grey solution is focused on localized flooding mitigation and includes many concepts and recommendations that align with the FMTF Final Report (2016).

Specific issues or recommendations identified by the FMTF that align with the goals and strategies presented in the Brentwood study include the following:

- Create partnerships with other jurisdictions (local, state, and federal) to solve common flooding issues.
- Initiate public education and outreach programs to ensure that Austin residents and visitors understand and prepare for floods to minimize impacts.
- Integrate green stormwater infrastructure with standard Capital Improvement Project (CIP) solutions (grey infrastructure), where appropriate.
- Be aggressive in implementing the recommendations specific to green infrastructure; many of which can be started immediately with no new funding.
- Set goals to reduce the number of habitable structures at risk of flooding based on all mitigation solution tools (e.g., retention and detention ponds, street gutters, drainage pipes, elevation differences or flood walls on individual properties such as garden walls, and maintenance of closed and open waterways).
- Buy-outs are a flood mitigation tool that should be used as a last resort when other structural or maintenance solutions are infeasible, ineffective, or have a disproportionately high cost relative to the benefits achieved.
- Develop a method for prioritizing individual or isolated properties which are at risk of flooding and are not part of a cluster of high risk properties.
- Consider the benefits of flood mitigation when considering acquiring properties for green space or environmental protection.

The FMTF identified additional recommendations and issues that extend beyond the concept of decentralized green controls and focus more on larger centralized facilities as well as property buy-out programs. Larger capital projects such as creek and storm drain system capacity improvements and property buy-outs were a recommendation of the FMTF for larger flooding

issues. Because these recommendations were focused more on larger flooding events that had implications for loss of life, they were not considered in the Brentwood hybrid green/grey solution presented in the GI Plan.

3.3 CodeNEXT

CodeNext is the City of Austin initiative to revise the Land Development Code which determines how land can be used throughout the City. The process is collaborative with a variety of stakeholders involved and was a priority program of the Imagine Austin Comprehensive Plan. The CodeNEXT revisions are currently ongoing and include a series of Code Prescription documents that include a preview of what the new Land Development Code will accomplish. The Natural and Built Environment Code Prescription (CodeNEXT, 2016) includes themes and prescriptions that are related to the Brentwood Implementation Plan and hybrid green/grey solution.

Specific issues or recommendations identified in the Natural and Built Environment Code Prescription cover a range of topics and ideas beyond what is applicable to the Brentwood study area. The recommendations that align specifically with the goals and strategies presented in the hybrid green/grey solution described in the Brentwood Implementation Plan include the following:

- Treating water like a resource with a conservation mindset.
- Addressing flooding through a variety of active and passive technologies.
- Find better ways to integrate nature into the City.
- Mitigate flood impacts with on-site detention in the upper portions of the watershed and provide conveyance improvements, where appropriate.
- Decrease off-site discharge through practices that infiltrate, evapotranspire, and/or harvest and use of rainwater through both passive and active green stormwater infrastructure.
- Use a combination of different tools to effectively address both flooding and water quality concerns.
- Reclaim excess right-of-way for green infrastructure.

The Green Infrastructure Working Group (GIWG) which met in 2015 as part of the CodeNEXT process examined how the code can encourage the vision of green infrastructure established by Imagine Austin. Stakeholder feedback and recommendations developed by the GIWG have helped shape the CodeNEXT issues and align with the goals of the Brentwood Implementation Plan.

4 SUMMARY OF FINDINGS FROM MODELING RELEVANT TO IMPLEMENTATION

The purpose of this section is provide a brief summary of modeling methods and findings. Specifically, this section identifies how the findings from modeling have been used to frame the recommended implementation approach.

4.1 Overview of Modeling Methods

Extensive and in-depth modeling of the study area was conducted and documented in the Modeling Results Summary report (Geosyntec, 2016a). A calibrated existing conditions model was developed and compared to two GI scenarios: the "maximum GI scenario" and the "hybrid green/grey scenario." A variety of modeling methods were incorporated in order to fully analyze the potential impacts of distributed GI controls throughout the study area and selected grey infrastructure. These included a 1D model including a complex network of catchments and conveyance elements, as well as a 2D model developed to simulate overland flow and flow around buildings in portions of the study area with known drainage complaints and expected inundation. These models were applied under hypothetical design storms (1D and 2D models) and for a 28-year continuous simulation period (1D models only). This allowed investigation of system response under a wide range of simulated flows and antecedent conditions and provided a quantification of the long-term potential performance of the system, including real storms where major flooding has been observed. The model developed for this analysis is one of the most extensive and in-depth models used for this purpose to date and is robust in terms of the state of current practice of stormwater modeling capabilities and use.

PCSWMM Professional 2D 2015 was used for model development and execution. This software includes a GIS-based user interface around the standard EPA SWMM 5.0.022 model engine. It also includes a number of key features to enhance model development efficiency, scenario management, results interpretation, and other functions. It also provides functionality to develop, edit, and manage a 2D hydraulic network using native hydraulic elements in EPA SWMM 5.0. Additional details of the model development are provided in the Modeling Results Summary report (Geosyntec, 2016a).

4.2 Overview of Modeling Results

As discussed in the Modeling Results Summary report (Geosyntec, 2016a), the maximum GI scenario was estimated to reduce flooding by a significant degree in more frequent storm events (e.g., 2-year, 5-year); however, the distributed GI stormwater controls became overwhelmed ("full") during larger rainfall events and could not achieve the desired level of service for the study area. Incorporating selected grey infrastructure (i.e., concrete storm drain pipes, inlets, and curb modifications) was identified as an option for further reducing the expected amount of flooding and improving the level of service for flood inundation within the watershed. The hybrid

green/grey solution combined the majority of (but not all) green infrastructure components modeled in the maximum GI scenario with strategically located grey infrastructure in areas of significant flooding.

Modeling of the hybrid green/grey solution showed significant reduction in the number of structures inundated as well as the areal extent of inundation when compared to the existing conditions model results. In general, the hybrid green/grey solution was estimated to reduce structure and arterial street flooding for approximately a 25-year design event. As with most grey stormwater conveyance upgrades, there is a potential to increase downstream peak flow rates and volumes leaving the watershed as a result of the increased drainage efficiency these features provide. Therefore, the green infrastructure component was an essential element in this scenario to provide a compensatory reduction in peak flow rates and volumes at the Brentwood watershed outlet. Having green controls in place prior to construction of the proposed grey improvements is necessary to mitigate the potential for adverse impacts to downstream conditions. In no case shall an element of the plan be implemented without consideration of consequent flood damage potential. This topic is discussed in detail in Section 5.2 below.

The modeled level of implementation for each GI feature is described in the GI Plan (Geosyntec, 2016b). The GI Plan focuses on separate Planning Areas within the study area and sets implementation targets for each Planning Area. These targets should be considered guidelines and can be modified based on actual opportunities available and experience with implemented components. However, GI implementation and selected grey infrastructure improvements consistent with these targets (or equivalent combinations) will be necessary to achieve the level of service estimated from modeling. The GI Plan (Geosyntec, 2016b) must be used a companion to this Implementation Plan to guide implementation.

4.3 GI Performance Findings

The Modeling Results Summary report (Geosyntec, 2016a) discussed the input parameters and model representation of each GI feature and grey infrastructure component as well as sizing and applicability assumptions. During the implementation phase, specific sizing and design parameters will vary based on location, but the modeling effort will serve as a guide for the general performance characteristics of each GI feature. In order to characterize the performance of each GI feature type, a step-wise modeling approach was taken to approximate the contribution of each GI feature to the overall reduction in peak flow and runoff volume. The impact of each GI feature type was evaluated by incrementally adding each feature type into the model for a 2-year, 24-hour design storm event. Table 3 presents the percent contribution of each GI feature type to the total reduction in peak flow and total runoff volume. This analysis provides a relative indication as to which GI features have the greatest contribution on peak flow reduction and volume reduction. A 2-year, 24-hour design storm event was selected for this initial

planning analysis because drainage complaints and flooding issues have been observed for smaller events at this frequency.

It should be noted that all GI features were assumed to operate under ideal conditions. For example, residential cisterns will be operated by home owners and the model results assume that capture volume is available on all cisterns prior to the rainfall event. In some cases, residential cisterns may not be operated ideally which will decrease the efficiency of the GI feature and may not result in the desired performance. If the reliability of a GI feature is less certain, more or larger GI measures should be implemented to provide the modeled level of service assuming some fraction of the measures are not fully functional. The City can develop agreements and inspections with property owners to encourage proper function and improve reliability as discussed in more detail in Section 10. This caveat should be taken into consideration when interpreting the results shown below. Furthermore, the desired level of service is on the order of a 25-year event, as opposed to the 2-year event results presented here. The smaller event allows for a more direct comparison of normal performance expected, but it should be noted that larger storm events may produce different results.

The results of this step-wise approach to analyzing the influence of each GI feature type on total peak flow reduction and runoff volume reduction indicate that the public ROW GI biofiltration and biodetention facilities have the largest impact. These feature types are important because of their relatively broad spatial application, as well as their strategic locations at confluence points. The residential green streets program and residential cisterns program also contributes significantly to peak flow and volume reduction at the implementation target levels used in the models. These programs were assumed to achieve relatively broad spatial application.

Considering GI performance alone does not account for cost considerations which are a significant portion of any system-wide flood mitigation solution. A whole life-cycle cost analysis was presented in the updated GI Plan (Geosyntec, 2016b) which considered construction costs and long-term maintenance and inspection costs for a 50-year design life. The whole life-cycle costs for the hybrid green/grey solution was estimated at approximately $48M for the GI portion with an additional $9M for the grey infrastructure component. Of the GI portion, Figure 2 below provides the relative contribution of each GI feature as a percentage of the net present value (NPV) of the expected whole life-cycle costs.

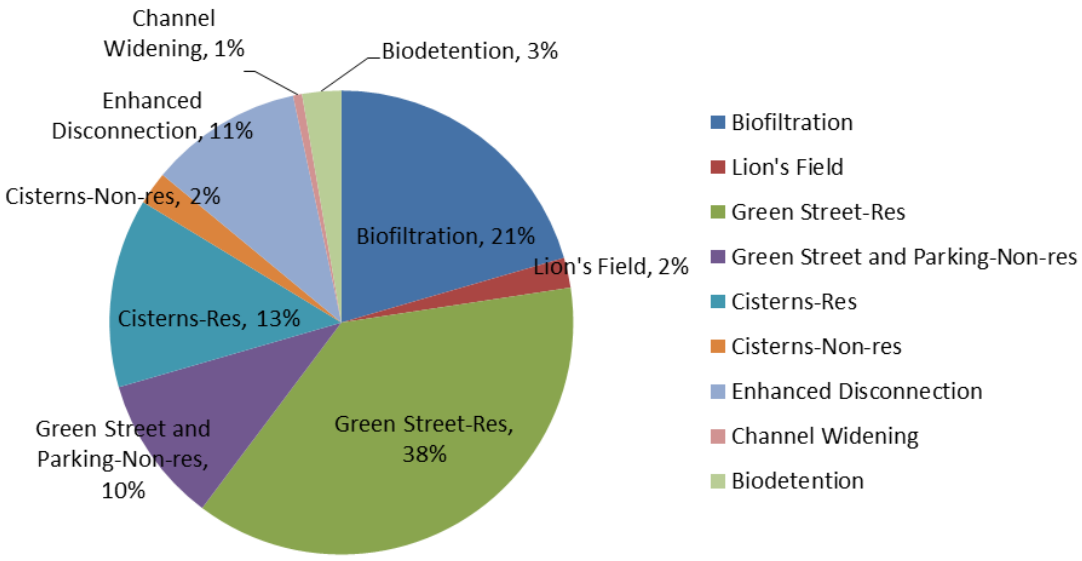


Figure 2. Approximate Contribution of GI Features to NPV of Design Life Whole Life-Cycle Costs

The relative cost of each GI feature can be compared to the relative contribution of GI feature performance to the total system-wide performance in order to select and prioritize the GI features that will provide the greatest benefit for the lowest cost as shown in Table 3. For example, public ROW GI features (such as biofiltration and biodetention) account for 35% of the total peak flow reduction and 26% of the total runoff volume reduction (corresponding to an average performance of approximately 30% of the reduction in hydrologic impacts), but these GI features only account for 21% of the total NPV for the scenario whole life-cycle costs. Therefore, since the public ROW GI features provide a greater contribution to the total GI performance (i.e., an average of 30%) than their relative cost (i.e., 21% of the NPV), these features are expected to be desirable and should be prioritized during the implementation phase.

Table 3. Ratio of Average GI Performance to Relative Cost

GI Feature Type	Peak Flow Reduction[1]	Runoff Volume Reduction[1]	Average GI Reduction	Relative NPV Cost[2]	Ratio of Average GI Reduction to Cost
Public ROW GI	35%	26%	30%	24%	1.28
Lion's Field	6%	2%	4%	2%	1.81
Green Streets-Res	18%	27%	23%	38%	0.60
Green Street and Parking-Non-Res	2%	6%	4%	10%	0.42
Cisterns-Res	18%	16%	17%	13%	1.29
Cisterns-Non-Res	11%	7%	9%	2%	3.72
Enhanced Disconnection	9%	17%	13%	11%	1.20

Notes: [1] Based on step-wise modeling approach taken to approximate the contribution of each GI feature to the overall reduction for a 2-year, 24-hour design storm event as discussed in the Modeling Results Summary report (Geosyntec, 2016a).

[2] Based on the whole life-cycle cost analysis presented in the updated GI Plan (Geosyntec, 2016b).

Table 3 quantifies the ratio of average GI performance to relative cost as a method for selecting which GI feature types are expected to have the greatest impact for the lowest relative cost. From this table, the non-residential cisterns program provides the greatest benefit based on the cost and should be considered high priority during the initial phases of implementation. Conversely, the green streets program (both in residential and non-residential areas) are expected to have a greater relative cost than the reduction in peak flows and volumes they can provide. This is attributed to the relatively small size of these GI features types yet high construction costs as a stand-alone feature. This analysis does not suggest that green street programs are not beneficial; instead, this shows the importance of implementing green streets programs in coordination with other planned projects to gain an economy of scale that may be shared across multiple City departments as discussed in Section 7 of this Implementation Plan.

4.4 Other Benefits

The addition of decentralized green stormwater controls throughout the study area provides other benefits beyond the desired reduction in flooding which are discussed above. These benefits are described in the project goals stated in Section 1.1 above and should also be taken into consideration for implementation when selecting and prioritizing GI feature types and gaining support of residents of the community. The Modeling Results Summary report describes these benefits in more detail, but an overview is presented here to describe the expected benefits as a result of implementation of the hybrid green/grey solution.

- A reduction in pollutant loads of approximately 25% is expected due to runoff volume reduction alone; however, this value is dependent on actual infiltration rates and direct use (of cistern water) rates which may vary. Additional pollutant load reduction (up to 10%) is possible due to treatment processes of certain GI features.
- Erosion potential is expected to be reduced between 45% and 75% depending on the exposed soil type within Grover Channel.
- The total estimated annual runoff volume reduction modeled for the hybrid green/grey solution is approximately 66 acre-feet per year (AFY). Of this volume reduction, the use of potable water for landscape irrigation is expected to decrease by approximately 10 AFY or 15% of the total estimated runoff volume reduction. An additional 46 AFY (or 70% of the total estimate runoff volume reduction) is expected to provide potential groundwater recharge.

Further economic, environmental, and social benefits of green infrastructure were not investigated in this study. Several of these benefits are discussed in the Center for Neighborhood Technology (CNT) *The Value of Green Infrastructure* report (CNT, 2010) and include the following additional benefits: reduction in energy use, improvement in air quality, reduction in atmospheric CO_2, reduction in urban heat island effect, improved aesthetics, improved recreational opportunity, reduction in noise pollution, improved community cohesion, improved habitat, and public education opportunities. CNT (2010) provides recommendations for quantifiable values assigned to each of these benefits and more. These benefits should be discussed and emphasized in public outreach campaigns as part of the Implementation Plan as described in Section 8 below.

4.5 Recommendations for Incorporating Modeling Results for Achieving Implementation

- Based on the lessons learned from the modeling efforts conducted for this study, it is expected that the hybrid green/grey solution can provide a level of service on the order of a 25-year design storm for the majority of the study area at a significant cost reduction when compared to providing a 100-year level of service using traditional grey infrastructure alone. Therefore, implementation of the hybrid green/grey solution is recommended to achieve flood mitigation and other benefits in line with the goals and recommendations of the City's overall approach to flood mitigation.
- Based on the lessons learned from the modeling efforts on GI performance and the whole life-cycle costs analysis, the proposed GI feature types can be prioritized based on their relative contribution to performance versus cost. Using this methodology, the GI feature types such as non-residential cisterns and larger GI features such as the Lion's field bioretention and biofiltration or biodetention features within the ROW provide the greatest flood mitigation benefits for the lowest contribution to total cost. These GI

feature types should be considered the highest priority during the initial phases of implementation.

5 FINAL DESIGN AND SEQUENCING CONSIDERATIONS GI FEATURES

In order to fully implement the proposed GI Plan, independent projects and opportunities within the study area must be identified where significant GI features can be incorporated into those designs to increase the pace of implementation. The GI Plan proposes the following GI features to be installed with rough estimates of the number of lots and units expected:

- Roughly 36 public ROW biofiltration units with an average footprint of approximately 1,500 ft^2 per unit
- Roughly 7 public ROW biodetention units with an average footprint of approximately 750 ft^2 per unit
- Roughly 360 residential lots (out of approximately 1,100 properties) with cisterns at an average volume of approximately 1,300 gallons per lot
- Roughly 16 non-residential lots with cisterns at an average volume of approximately 34,000 gallons per lot
- Roughly 62 ROW green street units installed in a programmatic approach on residential roads at an average footprint of approximately 1,000 ft^2 per unit
- Roughly 11 non-residential lots with green parking lot programs at an average footprint of approximately 2,000 ft^2 per lot
- Roughly 180 residential lots with enhanced disconnection measures at an average of approximately 2,700 ft^2 of pervious area amended per lot

These proposed GI features amount to roughly 670 individual features installed as separate projects or on individual lots. Aggressively assuming that the City could implement one individual GI feature every other week (including public outreach, siting, preliminary and final design, contractor or volunteer acquisition, and construction), the entire GI Plan could be implemented in roughly 26 years. The likelihood of implementing each of these projects independently at this frequency is infeasible and would result in an exceedingly long implementation duration as well as inflated design and construction costs.

Although the modeling results showed significant reductions in certain flood metrics as a result of the hybrid green/grey solution, the vast number of GI features required to achieve this level of service is potentially beyond the capability of the City to execute. An aggressive implementation goal for the level of GI controls was adopted and may not be feasible for the study area. Considerations discussed in this Implementation Plan will help address these restrictions but the duration of implementation may be exceedingly long in order to achieve the desired and modeled flood mitigation benefits. The hybrid green/grey solution is best suited for more modest flood mitigation benefits while taking into account the other water quality, erosion potential, and society benefits provided.

Realizing the significant number of GI features proposed by the GI Plan, it becomes necessary to identify efficiencies to improve or streamline the final design process. Furthermore, as more GI features are designed and constructed, the sequencing of GI features, especially with respect to installation of the grey infrastructure components, should be considered to avoid any downstream adverse impacts. This section will present considerations for final design and sequencing of the GI features throughout implementation of the GI Plan.

5.1 Final Design Considerations

The planning and modeling parameters established in the GI Plan and Modeling Results Summary reports are primarily applicable to modeling and costing at the modeled catchment scale. The stormwater modeling conducted for this analysis assumed recommended sizes for certain GI features based on available dimensions in a typical setting; other GI features were sized based on contributing drainage area and desired bypass flow rates. The modeled GI sizes should be used as guidance for overall desired capture volume but may not be representative of final design of GI features in all situations during the implementation phase. As opportunities arise or voluntary implementation begins to occur, these modeled designs need to be translated to a final design for each individual feature and further optimized for specific site characteristics as a part of realizing the overall watershed-scale benefits. The design sizes and considerations developed during the modeling effort provide a well-informed framework for the types of GI considered, opportunities and locations for GI implementation, how they should be designed specifically to meet flood mitigation goals, and how much GI in each planning area is necessary.

Final design of each GI feature should include additional site specific information such as the following:

- Site specific infiltration or percolation testing for infiltration facilities
- Tributary drainage areas
- Topography and slopes
- Engineered inflow and outflow structures
- Locations of existing underground utilities

Sizing and design considerations were presented in the GI Plan (Geosyntec, 2016b) for each type of GI facility. Information regarding the footprint sizing, inlet opening width, system profile, underdrain orifice (where applicable), and overflow structure sizing were provided and should be used to guide the final design of GI features. These design recommendations should be considered as goals to meet or exceed during final design. Based on site specific information and limitations, some goals may not be achievable, but using the guidelines in the GI Plan provides a basis for evaluating progress towards implementation and performance targets.

Public safety considerations should be incorporated into the final design so that interaction with GI facilities is accomplished in a safe manner while protecting the facility and vegetation within the facility. Steps should be taken to promote public safety, prioritize hazards, address mosquito control, and provide fencing when needed. ASCE (2014) provides guidance on public safety for urban stormwater facilities and should be considered during the final design phase of GI facilities.

Permitting and regulatory concerns should be considered for GI features being designed for construction based on a programmatic approach such that each individual feature is not required to obtain separate permit authorization. If a programmatic approach is employed for permitting GI, this route will speed the efficiency of construction and decrease design costs. Many GI controls can also be used to achieve landscaping requirements for commercial land use. However, additional concerns such as excavation within the Critical Root Zone of existing trees should be considered on both residential and non-residential lots. Proper permitting and sizing of GI features (when used to comply with regulatory water quality requirements) should be addressed during the final design process.

To further enhance the efficiency and performance of larger GI facilities (such as larger commercial cisterns, a series of biofiltration units, etc.), the use of real-time controls should be considered. Real-time controls can operate automatically and dynamically based on current water levels within the GI facility and weather forecasts to optimize capture volume for approaching rainfall events. Real-time controls have been shown to improve water quality, conserve water, and reduce wet weather flows, all of which are goals of this study. Furthermore, real-time controls can be monitored remotely to evaluate when maintenance is needed or equipment is malfunctioning. Passive monitoring via telemetry can also be used to remotely monitor larger GI facilities. However, without real-time controls or passive telemetry, corrective actions may only be identified during regularly scheduled maintenance or inspections of the site. Real-time controls can also better manage and enhance the benefits of flood control and water quality and conservation.

5.2 Prioritization and Sequencing

Many elements of the GI Plan provide standalone benefit and can be implemented on an opportunistic basis. However, some elements (specifically, conveyance improvements) must be carefully sequenced in combination with other approaches to avoid creating downstream issues in an interim condition. Prioritization of GI features is important to achieve the project goals in the quickest manner possible for the minimum level of effort and investment. As discussed in Section 4.3 above, certain GI features provide good performance at a lower cost than other GI features. If opportunities are available to construct the higher efficiency GI features prioritized above, those opportunities should be actively pursued. A list of the high priority GI features in order of general priority is included here for convenience:

- Biofiltration and biodetention public ROW controls
- Non-residential cisterns
- Residential cisterns
- Enhanced disconnection
- Residential green streets
- Non-residential green street and parking lots

The location of GI features within the study area is also important for maximizing the performance of the feature. GI features should be appropriately sited, taking into account infrastructure conflicts or natural drainage patters, and designed for the specific contributing drainage area and land use; however, certain locations in the study area have a higher priority than others for achieving flood mitigation impacts:

- Specifically, priority should be given to GI features located in the upper two-thirds of the study area with a specific emphasis on high impervious cover areas such as the commercial property along Lamar Boulevard (Planning Area 3 described in the GI Plan).
- Additional priority should be given to the areas of known drainage complaints in Planning Area 4 to the east of Grover Ave and upstream portions of the watershed that drain directly to this area.
- GI features located farther upstream (i.e., Planning Area 1) are also considered high priority as they can provide significant benefits downstream when sized for flood mitigation purposes.
- Lower priority areas are near the bottom of the study area (i.e., south of Koenig Lane) and near the western boundary (i.e., west of Grover Avenue and south of approximately Payne Avenue). Lower priority areas consist of Planning Areas 6, 7, and 8; however, if opportunities exist in these areas to construct GI features, they should actively be considered.

Implementation of the hybrid green/grey solution should be sequenced such that significant GI features are installed prior to construction of the grey infrastructure components. Furthermore, construction of the grey infrastructure components proposed in the hybrid green/grey solution can also be sequenced, if needed. Three main grey infrastructure upgrades were proposed: Grover Avenue bypass pipe, Brentwood Street storm drain pipe, and Wild Street/Payne Avenue storm drain pipe. These projects are not required to be constructed at the same time. Installation of grey infrastructure is expected to increase peak flows due to improved conveyance of the stormwater drainage system. In order to offset the expected increased peak flows, GI features will be required to be installed and functioning properly. Figure 3 below depicts a hypothetical scenario of the impact on peak flow rates versus the implementation time of the stormwater controls proposed in the hybrid green/grey solution.

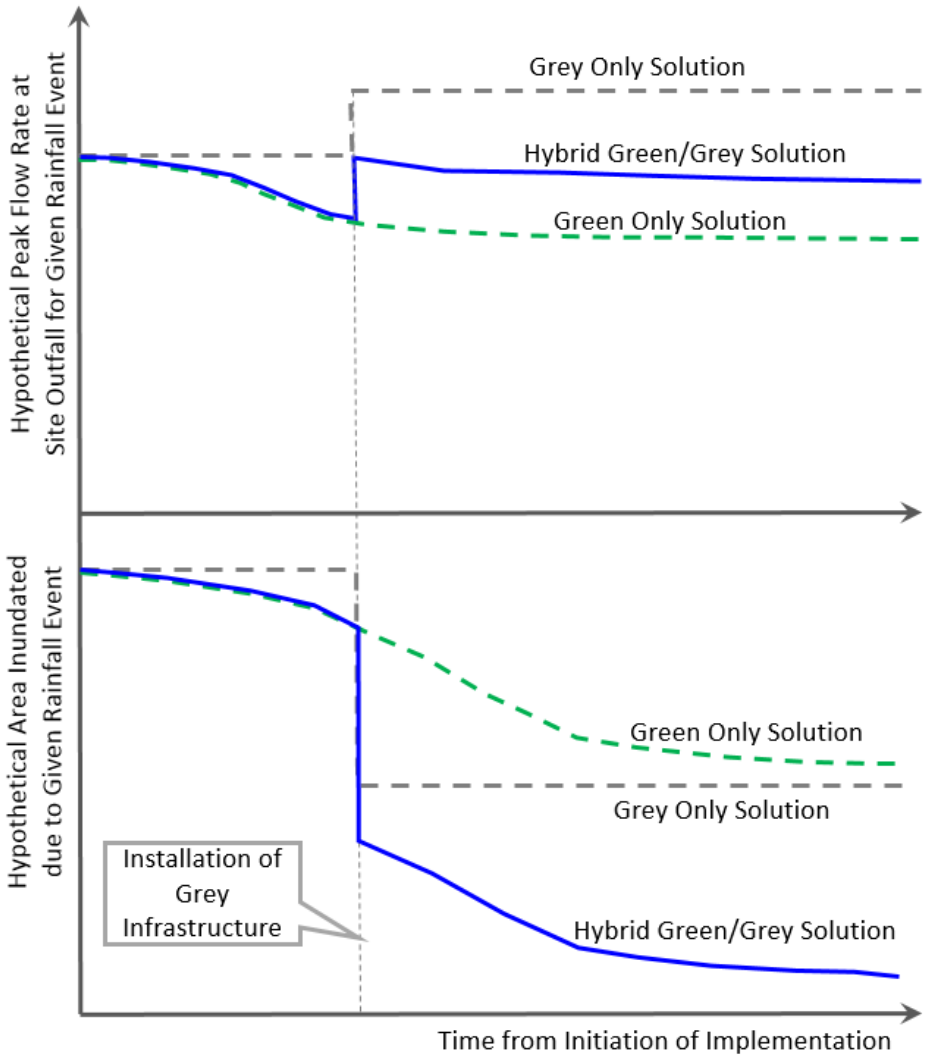


Figure 3. Effect of Green and Grey Infrastructure on Expected Peak Flow Rates

Additional modeling and analysis or a pilot field study (as discussed in Section 6.1) should be conducted as GI features are installed and prior to construction of the grey infrastructure components in order to ensure that no adverse downstream impacts are expected as a result of the grey infrastructure improvements. The minimum amount of GI needed to offset the adverse downstream impacts for each specific component of the grey infrastructure was not investigated for this study but should be considered for future analyses. Instead, the total amount of GI proposed was determined to offset the increases in peak flow rates as a result of the combined grey infrastructure improvements such that the result was a small but negligible net decrease in downstream flow rates resulting in no adverse impact downstream. In the event that the grey infrastructure components are constructed in phases, the amount of sufficient GI required to offset the expected increases in flow rates should be further investigated through additional modeling efforts. The investigation should consider the long-term performance and reliability of

the GI used to offset potential adverse impacts of the grey infrastructure. Updates to the model should be conducted throughout the duration of implementation in order to gain a better understanding as to the expected performance and benefits of the installed GI features. Furthermore, it should be noted that the basis for "no adverse impact" during future potential modeling efforts should be referenced to current existing conditions (as modeled during the calibration period). This reference point should be considered when determining whether the grey infrastructure component is expected to result in more than negligible downstream impacts.

5.3 Recommendations for Final Design and Sequencing of GI Features

- Final design of each specific GI feature should evaluate how to maximize the flood mitigation, water quality, and other benefits of each GI feature. The assumed design sizes and implementation targets discussed in the GI Plan were used for modeling purposes but can be improved during actual design. The goals presented in the GI Plan should be used as a guide for final design but should not place a restriction on the actual design and construction. Furthermore, additional site specific information should be taken into account during final design of each GI feature.
- As opportunities arise to implement GI features as a part of CIPs or private projects, these should be actively pursued and analyzed in order to take advantage of cost sharing, scheduling, and other efficiencies. However, specific GI features that are being designed and implemented (independent of GI implemented via a programmatic approach) should be prioritized and sequenced based on the maximum benefit provided for each GI feature type. In addition, the location within the study area should be considered in order to maximize the flood mitigation relief on downstream properties.
- The grey component of the hybrid green/grey solution should be installed only once sufficient GI controls have been constructed and are operational in order to offset the expected flow increases due to the improved drainage efficiency of the grey infrastructure. Proper sequencing is critical to avoid any downstream adverse effects as a result of the grey infrastructure to present day conditions. Additional modeling efforts will be required in order to ensure no adverse impact as compared to current conditions. The need for new or updated modeling would be triggered by grey infrastructure projects; the current level of GI within the watershed at the time of each grey infrastructure project would be reflected in the model.

6 FIELD SCALE PILOT STUDY

6.1 Pilot Study Considerations

A field scale pilot subwatershed study would include focused GI implementation at a subwatershed scale within the Brentwood neighborhood. The scale of this study could be 2 to 3 residential blocks, with the intent of encompassing the effects of a range of GI approaches, such as the combinations described in the GI Plan. The purpose of this pilot study includes the following:

1) Validate modeled performance of GI feature combinations or identify needed adjustments to model parameters/approaches,
2) Evaluate potential groundwater mounding or migration issues to determine the extent to which these need to be considered in broader application, and
3) Complete a trial implementation of GI features described in the GI Plan to "ground truth" various elements, including design approaches, permitting, costs, maintenance requirements, and community acceptance.

Overall, a pilot scale implementation would attempt to resolve key uncertainties to inform and improve confidence in broader implementation. In addition, an important element of a pilot study would be to assess the residents' acceptance of GI on private properties and determine whether current guidelines would result in value added to the neighborhood (e.g., increased property values). Resident acceptance is vital for the success of the GI Plan and a pilot study would help inform the level of acceptance.

The most robust framework for this pilot study would be a "before/after, control/impact" (BACI) approach, which would start with a baseline monitoring period for two subwatersheds, then transition into implementation of controls in one of the subwatersheds, followed by monitoring of both watersheds during the control period. Full field monitoring of the pilot subwatersheds could include rainfall, flow rates, hydraulic grade lines, groundwater levels, and water quality in order to compare a wide range of performance metrics. A period of 12 to 18 months for monitoring is likely adequate for each phase. The design of the GI retrofits could proceed in parallel with the "before" monitoring phase. Interpretation of results would follow the completion of this study. Overall, this could be completed in 3 to 4 years.

A high priority subwatershed should be selected to focus GI construction at the start of the implementation phase. The following criteria should be considered when selecting a location for a field scale pilot study:

- Select an area with known drainage complains or drainage conveyance limitations.
- Select an area with sufficient upstream contributing drainage area and impervious cover to generate measureable runoff volumes even for small, more frequent rainfall events.
- Select an area with some existing storm drain pipe to assist with flow measurements within the pipe and to incorporate biofiltration units with underdrains as this GI feature type has been shown to provide significant benefits.
- Select an area with significant residential lots to assess the implementation levels and performance of GI on private land.
- Select an area with substantial resident support for GI (as determined from a survey or questionnaire of home owners prior to implementation).
- Select an area with monitoring locations that are accessible and safe.

Based on the selection criteria listed above, an area within Planning Area 4 would be a good candidate for a field scale pilot study, assuming there is support from the residents in this area. Drainage complaints have been reported in Planning Area 4. The majority of the area is residential, but additional highly impervious areas are located upstream (in Planning Area 3). This location allows for trials of both residential and commercial GI features and implementation approaches, as well as GI features adapted to the public ROW on steeper roads. There are storm drain pipes along Payne Avenue near Grover Channel which could be used to monitor runoff from the tributary area without monitoring flow rates from all up gradient areas draining to Grover Channel. However, there is a potential for runoff to bypass the inlet structures, particularly during the extreme events of interest. In addition, backwater effects within Grover Channel may interfere with monitored observations within the storm drain pipe. Each east-west roadway serves to separate drainage areas and convey water directly into Grover Channel. As a control area for comparison, an up gradient residential block, perhaps draining to Karen Avenue could be used for comparison. The lack of storm drain pipe along other streets in Planning Area 4 will make flow monitoring of the control area challenging. Monitoring devices would be required to capture runoff in the curb and gutter to the east of the two inlet structures at Grover Channel.

If both control and impact areas can be monitored, the proposed areas would provide comparison for similar drainage patterns, land use, impervious cover, and total tributary area. This monitoring information can also be useful to help further validate or revise model estimates. Such a monitoring program will allow for combined, aggregated effects of long-term infiltration for a range of antecedent conditions.

If a pilot field study is considered, public outreach should be a significant component of the study. This will encourage home owner acceptance and allow outreach efforts to focus on a targeted area to determine which outreach methods are most effective. For the initial pilot study, the City should consider paying, partially paying, for or otherwise incentivizing GI installation on private property with the goal of proper design and construction of the facilities in order to gain

information on their effectiveness at a larger scale. These efforts will help shape and refine the public outreach efforts prior to implementing the campaign at a neighborhood scale. Additional information such as real-time monitoring on residential cisterns could be considered for this pilot study to obtain additional information about the control patterns that home owners would implement. If monitoring of the cisterns is conducted, the behaviors of the owners could be determined in order to verify whether the cisterns are being operated at an optimal level. However, if home owners are aware the cistern is being monitored, there is a greater likelihood that the cisterns will be operated by the owners at an optimal level when compared to cistern-users that are not being monitored. This could bias the expected performance during the pilot study and suggest more ideal operation that what would be expected on a larger scale implementation.

6.2 Recommendations for Pilot Study

- Monitoring using a BACI approach for a subwatershed within the Brentwood study area will provide additional information related to model uncertainties, potential groundwater mounding or migration issues, design approaches and construction costs, and community acceptance. It is recommended that a full BACI pilot study be conducted during the initial phase of implementation in order to gain a more complete understanding of the efficacy of distributed GI for the purposes of flood mitigation.
- Conducting a pilot field study will also help to refine and improve the public outreach campaign that will be required on a larger scale for future implementation of the entire study area. Insights gained during the pilot study will improve the impact of future public outreach efforts.

7 APPROACHES FOR IMPROVING EFFECIENCY OF IMPLEMENTATION

As previously mentioned, the large number of GI facilities proposed for the hybrid green/grey solution likely exceeds the City's capacity to implement as stand-alone projects. Therefore, approaches for improving the efficiency of implementing the GI Plan are discussed here, including seeking and identifying opportunities to integrate GI into other projects, seeking economies of scale, and developing partnerships. This section discusses routes that the City should consider for improving the pace of implementation using typical or specialized construction and procurement routes. Section 8 below discusses how to incorporate the community into the process; whereas Section 9 discusses ways the City can incentivize community involvement.

7.1 Partner on Projects to Share Costs

Construction of GI within the Brentwood study area can be efficiently implemented if GI is included in public right-of-way (ROW) projects, executed using a programmatic approach, and coupled with construction on private commercial properties. These mechanisms for improved efficiency are described in more detail below.

7.1.1 Public ROW Opportunities

Public ROW GI projects should be identified and implemented on an opportunistic basis and should be integrated into any planned City project regardless of the City department responsible for the project. A policy incentive could be implemented to require GI to be incorporated as a part of standard Capital Improvement Projects (CIP) within the neighborhood as discussed in Section 9.2 below.

Retrofitting existing sites with GI is typically more expensive than integrating GI features during new construction or reconstruction or when projects are planned for other purposes. Integrating GI construction with planned ROW projects can result in significant overall cost savings as well as cost sharing between City departments. The City should actively seek to promote interdepartmental coordination and create partnerships with community groups or non-profits (as discussed in Section 8 below) to solve common flooding and water quality issues where possible. Typical planned ROW projects that would be good candidates for integration of GI include the following:

- Upgrades of underground utility lines;
- Roadway repaving, roadway rebuilding, sidewalk, or bike lane improvements; and
- Complete streets programs proposed for mobility improvements.

These projects are likely to result in significant disturbance within the ROW and would be ideal to include GI facilities in the form of a green streets program or larger biofiltration or biodetention units.

GI can also be integrated into other City initiatives such as the Austin Art in Public Places program. Functional rainwater catchment or stormwater management facilities can be designed in an artful way to achieve GI benefits and to bring awareness of stormwater management issues while also achieving the goals of the Art in Public Places program. Partnering with this program would help achieve a community outreach element of the Implementation Plan and provide educational, recreational, and artistic aesthetics to the GI features. Not only would this make neighborhoods more desirable due to functional and artistic green spaces, it would also serve as an economic incentive and encourage businesses to participate. Many examples exist for using stormwater management facilities for artistic purposes while incorporating additional project goals (Phillips, 2014). The main goals to consider when coupling GI with public art are as follows:

- Educational goal – create conditions to learn about stormwater processes and issues.
- Recreational goal – create conditions for interacting with stormwater for relaxation, amusement, and refreshment.
- Safety goal – promote interaction with stormwater in a safe manner to mitigate public safety hazard/protect nature.
- Aesthetic goal – create an interesting experience with beauty or pleasure.

7.1.2 Programmatic Opportunities

Implementation of GI throughout the study area can be improved through a programmatic approach in both public ROW project and development on private property. Identifying programmatic opportunities such as this will result in programs with similar contracting and implementation mechanisms that will be ideal for repeatability within the neighborhood and throughout the City.

Identifying opportunities to construct large programmatic retrofit projects, such as green street programs on multiple roadways, will result in unit cost savings. Implementing multiple green street programs, for example, will decrease costs associated with contracting, mobilization, and other shared costs expected during construction of GI. In addition, construction efficiency can be realized when multiple features are constructed with similar designs by the same contractor. Finally, public-private partnerships can be initiated to further improve construction and costing efficiencies and reduce costs to the City as described in the following section.

During the design phase of GI features, economies of scale can be realized by increasing the capture volume and impact on flood mitigation for each GI feature. GI features should be site specific in order to take advantage of cost savings achieved by individual final designs. The model representation of GI features used for this study assumed representative design sizes but did not consider site-specific sizing based on physical restrictions. Therefore, incorporating final design may help to improve overall performance of the hybrid green/grey solution in areas where larger GI facilities can be constructed.

7.1.3 Private Opportunities

In addition to sharing costs with other City departments and realizing efficiencies using programmatic approaches, opportunities should also be identified with private developments to implement GI features and share costs. For example, larger private developments or redevelopments along Lamar Boulevard, Koenig Lane, and the apartment complex on Justin Lane should be evaluated as opportunities to implement GI or improvements to existing drainage systems while sharing costs with the private developments.

Businesses and commercial properties, particularly along Lamar Boulevard, should be contacted for outreach opportunities, engagement, and partnering opportunities. These properties generally have high impervious cover and can contribute a significant amount of runoff making them ideal for flood mitigation controls. Identifying these opportunities and properties will allow for mitigation of a significant amount of impervious cover by contacting or partnering with a small number of property owners. Commercial properties with GI focused on vegetation and walkability are likely to attract new businesses nearby and improve the customer's experience. Therefore, highlighting these benefits to businesses during the implementation process is critical to gaining support and acceptance.

7.2 Public-Private Partnerships (P3s)

A detailed discussion of Public-Private Partnerships (P3s) is presented here including a summary of a recent application of the P3 model for MS4 stormwater permit compliance regarding construction and long-term maintenance of GI controls in Prince George's County, Maryland. The City should seek policy updates to allow for the participation in P3s and leverage private development to increase investment in the GI Plan and long-term maintenance of GI features. A P3 is typically considered a government service or private business venture that is funded and operated through a partnership between the government entity and one or more private companies in which the private company provide a public service and assumes financial risk in, as well as reward from, the project.

Challenges are faced by governments at all levels regarding the construction and maintenance of public infrastructure. Public budget limitations during lean economic times can lead to delayed construction projects and deferred maintenance, repair, and replacement as immediate public needs and emergencies may appropriate available funds, including those designated for operation and management functions. The reality that emergencies tend to appropriate available funds has been observed recently within Austin due to larger flooding events resulting in property damage and loss of life; these larger events understandably have taken priority over the more localized flooding concerns seen in the Brentwood neighborhood.

An option for consideration are Public-Private Partnerships (P3s), which are contractual agreements between private sector entities and public agencies to deliver a service or facility for use by the public, as described more completely in the "Testing Tradition, Assessing the Added Value of Public-Private Partnerships" white paper (National Council for Public-Private Partnerships, 2012) included as Appendix A to this plan. P3s are filling a need with increasing frequency across the country, particularly transportation-related projects. Listed advantages include reduced risks, effective and timely project construction, and better on-going maintenance of a public facility while leveraging public sector resources and maintaining appropriate oversight and control over the project.

The P3 model has been used in transportation projects around the country, but the first agreement at this scale nationally using P3 for GI stormwater projects was signed in March 2015 in Prince George's County, Maryland and is referred to as the "Clean Water Partnership" (2015). The Clean Water Partnership is described in more detail below. Considerations for how the use of P3s in the Brentwood study area for the implementation of the GI Plan could be used are also discussed below.

7.2.1 Clean Water Partnership: Prince George's County P3

The Prince George's County and Corvias Solutions Public-Private Partnership, also named the "Clean Water Partnership", is an agreement to retrofit up to 4,000 acres of impervious cover using green infrastructure. The Clean Water Partnership leverages public sector best practices to deliver functional and sustainable infrastructure with reduced costs and accelerated timelines. The goal of the Clean Water Partnership is to reduce the costs and schedules typically associated with MS4 permit regulatory compliance while enhancing the program through effective project management. Prince George's County is federally mandated to complete the retrofit of 8,000 acres of impervious cover by 2017.

The integrated approach assumes to maximize the efficiencies and cost savings for the entire life cycle of the GI while transferring the short- and long-term risks associated with construction and maintenance to the private partner who is rewarded for this risk. The Clean Water Partnership is to also tasked with supporting local business opportunities and development by using local and County-associated small and minority owned firms for 30-40% of the total scope of the project.

The Clean Water Partnership Agreement includes the following:

- Prince George's County is committed to invest $100 million during the next three years to retrofit 2,000 acres in partnership with Corvias Solutions. Funding includes the planning, design, and construction of the 2,000 acres.

- An option for additional 2,000 acres after the initial three-year term is available if the County is satisfied with the progress of implementing the Agreement's arrangement with Corvias Solutions.
- Corvias Solutions' responsibilities include the design, construction, and long-term maintenance of GI stormwater controls in the initial 2,000 acres (or up to 4,000 acres if the option is utilized) covered by the program.
- During the first year of the Agreement, the County must review and approve of the Corvias County-wide work plan, which includes selected first-year project locations.
- The County is using its traditional procurement process to address impervious acres while Corvias Solutions is using the streamlined process outlined in the Partnership Agreement to treat the 2,000 acres of impervious cover. The purpose is to create a benchmark to determine if the P3 is delivering increased speed and decreased costs as compared to the County's traditional procurement process.
- The majority of the first year projects will be on public land, but some will have the Clean Water Partnership working with private land owners to address stormwater challenges.
- The program is being funded through a stormwater utility fee charged by the County to all property owners for three years but allows for Corvias Solutions to provide funding as well.

7.2.2 Considerations for P3 Options in the Brentwood Study Area

During implementation of the Brentwood GI Plan, P3s could be considered for construction and long-term maintenance of multiple GI facilities using a programmatic approach. As discussed above, a programmatic approach can result in similar contracting mechanisms and increased repeatability throughout the neighborhood which would make this an ideal situation for a P3 agreement. However, one would need to determine if the funds available to fund a P3 are sufficient to attract an investor. For example, are the current Drainage Utility Fees adequate to fund the purchase and operation (or subsidy) of a household cistern?

For the Brentwood study area, a P3 would consist of a private design firm and general contractor team that would be responsible for the final site-specific design of each GI facility; construction, permitting, and oversight of the installation; and long-term maintenance of the facilities for a specified number of years in exchange for a lump sum payment, ongoing payments, or a combination of these. The City would assist with identifying site-specific locations for installation during the design phase; contribute to public outreach, utility coordination, and permitting review during construction; and oversight of long-term maintenance to ensure that the facilities are performing as designed. An agreement for a specified number of facilities and/or drainage area managed together with a long-term maintenance plan and duration would be required for the private company. The City could have the option to extend this agreement for additional

contributing drainage area or continued maintenance into the future if the private entity is meeting specified goals and the GI facilities are performing as desired.

Pursuing a P3 option during a field scale pilot study may allow the City to identify contractual efficiencies for a smaller subwatershed. However, a small area may not prove to be financially beneficial to the private entity unless an incentive of expanding the P3 to the entire neighborhood is available. This type of agreement could be beneficial to the City since City staff and resources would not be required for design and maintenance of the large number of GI facilities. The private entity would take ownership of this portion of the project with City input and allow the City to focus their own staff and resources on larger flooding issues.

The Clean Water Partnership P3 should be closely watched to learn from the experiences, benefits, and results in Prince George's County before developing and executing a P3 agreement in the Brentwood neighborhood. Although the hybrid green/grey solution does appear to have opportunities which would be beneficial for P3 agreements, learning from the Clean Water Partnership P3 is recommended since this contractual method is new in the storm water management field.

7.3 Example Green Infrastructure Programs

Several municipalities have incorporated and implemented wide-scale green infrastructure programs, typically in response to federal regulations or consent decrees related to combined sewer overflows (CSO). Although these programs are not focused primarily on GI for flood mitigation benefits, successful GI plans have been successfully implemented and integrated with other projects. The hybrid green/grey solution for the Brentwood study area considered GI designs to maximize meeting the specific goal of reducing flood frequency, where as other municipalities primarily design for CSO control. Appendix B provides summaries of three GI programs that have been implemented with success by other municipalities. These example programs contain many of the elements proposed in this Implementation Plan and should be closely examined to identify long-term concerns or efficiencies.

8 STAKEHOLDER ENGAGEMENT AND OUTREACH OR PARTNERING WITH CITIZEN GROUPS

A key to successful GI implementation is to build community support and foster knowledge about the benefits of the program including planning, phasing, design, and construction. Methods of building community support include public engagement, outreach, and partnering. As input is received from local citizens and stakeholders, citizens are also educated about the specific scope of the GI Plan, significance of the green stormwater controls that offer a return to a more natural hydrologic condition, opportunities to volunteer, and prospects to partner in order to maximize efficiencies and leverage public sector resources and/or funds.

This section discusses some examples of public participation initiatives in Austin, followed by specific community outreach considerations and partnerships with non-profit organizations. Throughout the public engagement process, incentives should be considered to generate public support and contribute to implementation efforts. These incentives are described in more detail in Section 9 below.

8.1 Overview of Austin Public Participation Examples

Austin has a vibrant citizen population with a strong history of direct participation in local community initiatives that, over time, has contributed to Austin's unique character and natural beauty. This strong public participation extends to water-centric topics, and several different examples are provided below:

- Austin Flood Mitigation Task Force, Public Stakeholder Process – Final Report to Austin City Council 16 May 2016.
- Austin Water Utility, Water Conservation – Rebate programs for local residential customers and businesses that choose to retrofit on-site drainage systems to conserve water.
- Watershed Protection Department/Austin Parks Foundation – Green Stormwater Class (strategies and guidelines for creating and implementing water conservation features such as terraces, berms, and swales)
- Solicitations to help construct rain gardens at Austin public schools
    - Barbara Jordon Elementary School
    - Gus Garcia Elementary School

The last bullet item above entails the construction of numerous rain garden projects at public schools across the Austin area. Public participation in these GI construction projects included school faculty, students and family members; City of Austin staff; and local citizen volunteers from the neighborhood. These previous efforts serve as successful examples and should be expanded on specifically to the implementation of the GI Plan in the Brentwood neighborhood.

8.2 Specific Community Engagement and Outreach Considerations

When engaging the community to contribute to the implementation of the GI Plan, a variety of considerations should be examined and addressed throughout the process. These considerations are discussed in more detail here. The City should be aggressive in conducting community outreach efforts since success of the GI Plan largely depends on the use of GI on private property. These efforts could be initiated immediately and do not have to require significant additional funding to implement if existing outreach efforts are focused in the Brentwood study area. As outreach efforts grow and are refined specifically for implementation of the GI Plan, additional funding and dedicated City staff may be required in the future.

8.2.1 Outreach for Private Home-Owner Projects

A charrette process should be considered for stakeholder engagement and community support of the GI Plan. The Green Infrastructure Foundation (based out of Minneapolis, Minnesota) was founded in 2007 as a non-profit organization to respond to the need for greater awareness and resources to promote the design, installation, and maintenance of GI in local communities. The Green Infrastructure Foundation offers a Charrette Program to help communities create a vision for their neighborhoods that are redesigned with green infrastructure and includes a cost-benefit analysis. This program can be used as a model for effective stakeholder and home-owner engagement as part of implementation of the GI Plan. Providing informative visual graphics with financial analysis helps to create a vision for green infrastructure and informs community leaders the possibility of transforming their community while achieving modest flood mitigation and environmental benefits of GI.

Public outreach to individuals and community groups not involved in the charrette process is critical for encouraging voluntary action from home owners to install GI on their own property. Public outreach can be accomplished through a variety of routes including presentations at Brentwood Neighborhood Association meetings, advertisement or articles in the Brentwood Neighborhood Association newsletter, McCallum High School or PTA meetings, example projects on the McCallum High School campus, local church business meetings, and others. Developing partnerships with neighborhood associations, churches, or student groups could help further the acceptance of the GI Plan as well as identify volunteers who can assist with the implementation of the plan.

Through the public outreach process, residents and groups should be informed of what to expect with the installation of GI on their own property. In particular, on-site ponding of stormwater will occur after rainfall events which is a desirable affect and helps to better mimic a more natural condition. For many properties experiencing localized flooding issues, on-site ponding is currently being experienced. However, with the design of GI features on the property, the on-site ponding will be better managed and controlled in a way that will allow limited use of the pervious areas

as well as direct the ponded stormwater away from the building structure to minimize the drainage complaints. A better understanding of expected operations prior to installation of the GI will help increase home owner acceptance and satisfaction (or tolerance) of the feature. Residents should also be informed that extended ponded water in excess of 24 hours should be reported to allow maintenance or design corrections to be conducted. Ponded water beyond 24 hours has the potential to increase mosquito populations and should not be tolerated. By formalizing drainage patterns, preventing runoff from ponding in undesirable locations, and designing systems based on reliable estimates of infiltration rates, GI on private property has the potential to reduce mosquito populations by reducing excessive ponding.

During the community outreach process, guidance to home owners should be provided in the form of a menu of acceptable GI facilities to allow the individual an opportunity to choose what GI feature type is most desirable on their property. Additional guidance on maintenance and upkeep, including a schedule of required activities, will help ensure the performance of the GI in the future. In order to gain community support, the outreach process should highlight the additional benefits provided by GI, including the following (these topics are discussed in the CNT, 2010 document mentioned in Section 4.4 above):

- cost savings when compared to grey infrastructure,
- water quality improvements,
- habitat value,
- improved property value,
- reduced potable water use,
- managing traffic speed for green streets,
- improved safety and crime rates due to residents spending more time outside,
- improved health, and
- reduced urban heat island effect.

Beyond the additional benefits provided by GI, the following impacts to the average home owner should be presented and discussed in the outreach material:

- Level of financial incentive and/or rebate available per house.
- Expected return on investment for installing GI on private property in the long term.
- Expected decrease in potable water demand.
- Approximate flood mitigation impact and overall improvements to the environment.
- Time commitment for installation and maintenance required by home owner.

Additional community support and acceptance can be achieved by considering potential stormwater control measures not considered in the GI Plan. For example, permeable gutters and permeable sidewalks are expected to provide volume reduction and flow attenuation benefits

similar to a green streets program and could be considered as a neighborhood amenity for areas not served by sidewalks. Street trees can provide water quality benefits and also be viewed favorably by residents. Although the goal of the GI Plan is to prioritize GI features that provide the greatest hydrologic benefits, additional GI features may be necessary to gain community support and acceptance.

8.2.2 Outreach for Commercial or Institutional Property Projects

As mentioned above, community outreach should also extend to commercial and institutional properties such as businesses, churches, schools, office space, etc. These properties typically have higher impervious cover and, as a result, can potentially provide a greater flood mitigation benefit. In this watershed, many of these are located in “head water” areas that are a major source of downstream flood waters and therefore are high priority.

The GI facilities used on these properties will differ somewhat from the GI proposed for private residences. Green parking lots using parking lot islands for both a landscaping and flood mitigation benefit are applicable. In addition, larger cisterns can be considered on these properties and may serve multiple uses. Outreach efforts should be directed at the property owners and also include the communities that use the property, such as church members, student or parent groups at schools, and maintenance crews responsible for upkeep at the building.

Individuals involved with these commercial or institutional properties may reside outside the Brentwood study area and will therefore not be a part of the private home-owner projects. This will further expand the influence of the outreach efforts while addressing concerns within the study area. These properties will also likely have an existing plan in place for handling maintenance of the property. Incorporating GI into the existing plan while identifying ways for the to assist with proper maintenance of GI is critical to the outreach efforts.

8.2.3 Outreach for Public ROW Projects

Community outreach for public ROW projects will be minimal as the City will be responsible for all construction and maintenance. Outreach efforts such as distribution of simple fact sheets or post cards about the purpose and goal of GI features within the ROW will increase awareness, understanding, and support of the new facilities. These outreach efforts will also encourage individual ownership of the facilities will help to reduce maintenance requirements for the City since the home owners will assume some responsibility.

8.3 Partnering with Non-Profit Organizations

The benefits and goals of the GI Plan align well with the missions of many non-profit organizations active in the Austin area. Throughout the process of implementing the GI Plan, applicable non-

profit organizations should be identified and solicited for outreach and partnership opportunities. Multiple non-profits should be engaged to provide a range of services such as organizations with professionals that can consult with home owners on design of GI features, groups with equipment and materials available during the construction of private GI features, and groups with large membership to provide volunteers to help construct the GI features. Experience in all these areas will be critical to incorporate non-profit organizations with maximum efficiency.

The proposed process described in this section can be used to engage non-profit organizations specifically for the implementation of GI features on private residences. Similar processes can be used for GI features installed in commercial or public spaces. A list of potential non-profit organizations to consider is provided at the end of this section.

1) Engage with home owners in the form of a survey or questionnaire to identify individuals that would be willing to consider installing GI on their property.
2) Identify non-profit organizations with professional expertise that could coordinate with home owners and provide a consultation at the property to discuss the desired goals and constructability of the GI features. This process will increase the likelihood of home owner involvement with the guidance of a professional to provide a vision and answer specific questions.
3) Coordinate what materials and equipment will be needed. Partner non-profit organizations may be able to donate or provide equipment and materials necessary for the GI construction. This can include simple earth moving equipment as well as soil amendments, topsoil, mulch, plants, etc.
4) Identify sources of funding for other costs. The City of Austin WaterWise Rainscape Rebate and Rainwater Harvesting Rebate can be used, in part, for funding of private GI implementation (see additional information in Section 9 below). Providing an individual knowledgeable about the rebate process and information required to receive rebates will help encourage home owners to take part in the program.
5) Schedule a volunteer construction date and coordinate with the home owner and other non-profit organizations involved the execution and completion of the project.

This proposed process focuses on providing resources and individuals with expertise to the home owners to increase their likelihood of participating in implementation of the GI Plan. The partnerships provided by non-profit organizations will encourage involvement in the implementation of the GI Plan; provide a source of expertise and guidance; assist with the procurement of materials, equipment, and funding; and help ensure the completion of the project. Allowing home owners to see the alternatives, results, costs, and benefits of implementing GI on their property is likely to result in more successful engagement of the community.

A preliminary list of Austin-area non-profit organizations that should be considered is provided below. Additional organizations or community groups should be identified and added to this list as appropriate.

- Urban Patchwork
- Austin Youth River Watch
- Tree Folks
- Austin Parks Foundation
- Keep Austin Beautiful
- Environmental and Water Resources Institute (EWRI) Austin Chapter
- Shoal Creek Conservancy
- Local Boy Scouts and Girl Scouts of America

8.4 Recommendations for Implementation of Community Outreach Efforts

- The City should consider a dedicated employee in charge of managing community outreach and partnership efforts in order to ensure a consistent message to the public, to coordinate activities and management of various groups, verify that private GI facilities are installed in accordance with the GI Plan, and track efforts associated with community outreach.
- Develop a survey, questionnaire, or interview process to gather information on the public's willingness and acceptance of distributed GI facilities within the neighborhood. This process will identify opportunities for installation of initial GI facilities, increase awareness of the benefits of GI, and encourage acceptance of the GI Plan.
- Develop new outreach materials (or modify existing materials) describing the purpose, goals, and benefits of distributed GI facilities throughout the neighborhood specifically in accordance with the design and implementation goals described in the GI Plan. Outreach materials should be distributed to potential non-profit partners, community meetings and presentations, mailed to residences adjacent to ROW projects, and used for owners interested in installing GI facilities on their property.
- Identify and coordinate with non-profit organization to provide support of private home owners interested in installing GI on their property. Documenting these efforts and ensuring ongoing relationships is critical to the success of these efforts.

9 EXISTING AND POTENTIAL INCENTIVE PROGRAMS

An incentive program is designed to encourage and motivate and individual to perform an action such as involvement in the implementation of the GI Plan for flood mitigation purposes. Positive incentives such as financial incentives (where individuals receive a financial reward) and moral incentives (where individuals are rewarded for doing admirable activities) should be the focus of the incentive programs utilized as a part of implementation of the GI Plan. Other incentives exist such as policy incentives and can be utilized, but it is recommended that financial and moral incentives will be the most effective and should be pursued first in order to encourage individuals and businesses to contribute to implementation efforts. Policy incentives can be useful to implement additional GI controls for redevelopment projects from a regulatory perspective as discussed below. Incentive programs need to be well thought out such that the incentive amounts provided result in system performance that is cost-effective, while still leaving funds for other City responsibilities. For example, a 100 percent credit from the Drainage Utility Fee for an action could lead to utility funding shortfalls.

An overview of existing incentive programs is provided here as examples of successful incentives that have been implemented for other GI programs. Specific considerations with respect to the use of incentives as part of implementing the GI Plan are also discussed.

9.1 Existing Incentive Programs

Incentive programs exist within the City of Austin as well as other municipalities and are used to encourage private sector participation including grants, rebates, and credit programs. Several existing incentive programs are detailed below. These incentive programs could be used as models to refine the current City of Austin incentive programs or develop new incentives.

9.1.1 City of Philadelphia Stormwater Grants

The City of Philadelphia, through the Philadelphia Water Department and Philadelphia Industrial Development Corporation, has created the *Stormwater Management Incentives Program* (SMIP) grant and the *Greened Acre Retrofit Program* (GARP) grant to reduce the price for qualified non-residential applicants.

- SMIP provides grants directly to businesses, institutions, and other non-residential property owners who want to construct stormwater retrofit projects. A Grant Manual for the SMIP has been developed and is available online (Philadelphia, 2014a).
- GARP provides grants to contractors, companies, and/or project aggregators who can build large-scale stormwater retrofit projects across multiple properties in the combined sewer area only.

The grants allow businesses, institutions, and other non-residential customers to reduce their investment in stormwater infrastructure by providing funding for the design and construction of stormwater infrastructure projects. The project must reduce the amount of runoff generated by impervious surfaces on the property. Infrastructure must be designed to capture the first inch of runoff from the impervious areas.

The City of Philadelphia has established conditions necessary to receive the SMIP grants which include the following:

- Grantee must enter into a grant agreement and comply with its terms.
- Grantee must file a deed restriction in the form of an Access, Operations and Maintenance Agreement to ensure that the stormwater infrastructure funded from the grant shall remain in place and be properly maintained for a period of at least 45 years. A template of the agreement is included in the SMIP Grant Manual.
- The Philadelphia Water Department must be provided access to the stormwater infrastructure so that the Department may enter the property for testing, inspecting, maintaining, operating, repairing, and replacing the infrastructure if necessary.
- Grantee must prepare an Economic Opportunity Plan (EOP) that establishes overall contract goals for Minority, Women, and Disadvantaged business participation in the design and construction of the GI project. A template of the EOP is included in the SMIP Grant Manual.

The City of Philadelphia uses both financial incentives for businesses and/or contractors to encourage participation in improving their watersheds, reducing combined sewer flows, and improving water quality throughout the City.

9.1.2 City of Lancaster Stormwater Incentives

The City of Lancaster, Pennsylvania has developed a Green Infrastructure Plan (Lancaster, 2011) which proposes the following policies and incentives for residential and commercial property owners.

<u>Policy, Actions, Standards, and Incentives</u>

1) First flush requirement: Requires property owners who are adding new impervious cover areas to capture first inch of runoff from their property and not allow the runoff to discharge into the combined sewer system.
2) To facilitate GI control construction and to commit the owner to long-term maintenance, the City offers an “early adopters” program through Pennsylvania’s PennVEST (State

Revolving Funds[1]) loan that offers private property owners with planned improvement projects suitable for cost-effective green retrofit inclusion (parking lots, roofs, etc.) assistance with GI construction costs.

3) Under the PennVEST program, private property owners provide 10% of the construction costs related to the GI stormwater improvements and the City executes a 40-year operation and maintenance agreement with the owner (owner maintained) in exchange for the City's contribution of 100% of design and 90% of construction. These projects are also eligible for a reduction in their stormwater fee.
4) All properties in the city are eligible for a stormwater fee credit based upon the impervious area managed by an appropriate BMP. GI controls are eligible for a maximum of 50% stormwater fee credit.
5) The City of Lancaster does not provide credit for rain barrels since the City does not have capacity to enforce the drawdown between storms.
6) The City of Lancaster also requires private properties to install stormwater management facilities on all improvement projects that include 100-square feet or more in the stormwater management ordinance.
7) For private properties that may not develop in the foreseeable future, the City of Lancaster continues to evaluate programs that can incentivize owners to construct GI retrofits.

The City of Lancaster program operates using grant dollars that can be used to implement demonstration projects on private property. The Lancaster GI Plan proposes a GI Grant Fund to support the marginal cost (e.g., cost difference to install a green roof instead of a conventional one) of constructing GI on private property.

Education Credits

The City of Lancaster also provides education credits to all public and private schools or school systems (K-12). In order for a school or school system to receive a Stormwater Management Fee (SWMF) education credit, the school must implement an educational program that educates and informs the students on the importance of preserving and restoring the source and integrity of water resources (stormwater, groundwater, and/or surface waters). The educational program may include educational posters, take-home materials, classroom lessons, field trips, etc.

[1] In Pennsylvania, PennVEST manages the State Revolving Funds (SRF) as loans to "any owner and/or operator of a water, sewer, or municipal storm-water system with a project to construct a new system or improvements necessary to correct public health, environmental, compliance or safety deficiencies." Additional information on the SRF related to the Clean Water Act can be found online: http://www.pennvest.pa.gov/.

9.1.3 San Antonio River Authority Rebates

The San Antonio River Authority (SARA) frequently uses a Watershed Wise Rebate program to rebate construction costs of on-site stormwater BMPs for either new construction or retrofitting on property. BMPs must be designed using SARA's San Antonio River Basin Low Impact Development Technical Guidance Manual (Dorman et al, 2013). Projects must have a minimum reimbursement request of $15,000 and a maximum of $100,000. The rebate is proportional to runoff volume from a 1.5-inch storm and calculated based on unit rates for volume or area of the BMP. The rebate is open to public, private, or environmental non-profit projects in surrounding counties. Selection criteria is defined based on the percent of runoff volume treated, project visibility, confidence in performance, and design details. A Memorandum of Understanding (MOU) must be signed which covers operations and maintenance of the BMPs after installation for a period of two years and requires the property owner to account for these activities. The City of San Antonio does not require GI to be installed for new development. Instead, the requirement for on-site detention in order to maintain pre-development peak flows can be met with GI as one option. Alternatively, a fee-in-lieu of detention option is available. The SARA rebate programs encourage the use of GI to meet these requirements, as well as landscaping or tree preservation requirements.

9.1.4 City of Austin – Austin Water Rebates

The Austin Water utility currently has three ongoing rebate programs in place that could be leveraged or adapted as part of implementation of the GI Plan. A brief description of each program is provided here.

<u>Rainwater Harvesting Rebate Program</u>

Applicants must be a customer of Austin Water or an eligible water provider. Steps for participation in the Rainwater Harvesting Rebate Program include the following:

1) If installing less than 500 gallons, applicants may install the rain barrel and submit a rebate application within 30 days of purchase.
2) If installing 500 gallons or more, the application is submitted for pre-approval prior to purchasing or installing system.

The Rainwater Harvesting Rebate Program includes the following rebates:

1) $0.50 per gallon of capacity for non-pressurized systems (rain barrels).
2) $1.00 per gallon of capacity for pressurized systems (large cisterns with a pump).
3) For tax purposes, commercial and multi-family properties must submit a completed IRS Form W-9.

4) The rebate may not exceed 50% of the system cost and there is a life-time rebate limit of $5,000 per site.
5) A rebate application may be submitted once every 12 months for system expansions until the life-time rebate limit of $5,000 is met.

WaterWise Landscape Rebate

Converting healthy turf grass to native plant beds can produce major water savings by reducing or eliminating the need for extra watering. Residential customers may receive $35 for every 100 square feet (minimum 500 square feet) converted from healthy turf grass to native plant beds with a maximum life-time rebate limit of $1,750. This rebate could be used in conjunction with the residential enhanced disconnection program measures proposed by the GI Plan as a part of the hybrid green/grey solution. Applications are accepted twice per year for spring and fall installations; however, only one application will be accepted per year. Additional application may be submitted in subsequent years until the $1,750 limit is reached. The applicant must use native/adapted plants to replace turf grass and achieve at least 50% plant cover. Requirements exist for allowed plants, the addition of compost and mulch, tilled soil, and weed barrier. Pre-installation and post-installation inspections may be required and Austin Water may track water usage after the project.

WaterWise Rainscape Rebate

Homeowners and schools may receive up to $500 ($0.30 per square foot with a minimum of 100 square feet) for installing landscape features such as berms, terraces, swales, rain gardens, porous pavement, and infiltration trenches that direct and retain rainwater on the property. Applications are accepted twice per year for spring and fall installations. The rainscape must cover a minimum of 100 square feet and customers may enter the program more than one time if they have another eligible area that can be converted to a WaterWise rainscape. Installations must be approved prior to beginning work and a pre-inspection may be required by Austin Water staff. After completion of the installation, final photographs and applicable receipts must be submitted by the applicant and a post-inspection may be required prior to issuing the incentive check.

9.1.5 City of Austin – Public Works Neighborhood Partnering Program

The City of Austin Public Works Department's Neighborhood Partnering Program (NPP) provides opportunities for cost-sharing to assist neighborhood organizations in implementing improvement projects on public lands. The NPP consists of four subprograms which can be leveraged for the installation and maintenance of GI features within the Brentwood neighborhood by community groups. The four subprograms are described below:

1) The Neighborhood Cost Share Program provides cost sharing to neighborhood groups for small- to medium-sized improvement projects in the right-of-way or on City-owned property. The program assists with the development, funding, and execution of projects and could be leveraged for GI implementation within the right-of-way. Neighborhood groups must provide a minimum of 30% of the total project costs through cash contributions, in-kind materials or professional services, or volunteer labor. Contributions are allowed from the planning and design phase, construction phase, and through a two-year maintenance period.
2) The Grant Assistance Program provides matching funds by the City in order to enable applicants to meet cost sharing requirements for projects seeking external grant funding. The program can fund up to 50% of any local match requirement.
3) The Adopt-A-Median Program allows approval for community groups to adopt, beautify, and maintain medians or other right-of-way areas. This program could be useful for ensuring and encouraging long-term maintenance of GI features in the Brentwood neighborhood. The program requires installation of approved landscape elements and to maintain the installation for the life of the median.
4) The Parking Benefit Project Coordination Program assists neighborhood groups with identifying, scoping, and coordinating improvement projects for which Parking Benefit District revenue can be dedicated. The Parking Benefit Districts dedicate a portion of parking revenue for local improvements that promote walking, cycling, and transit use and could be coupled with GI features.

9.2 Specific Incentive Program Considerations

Specific considerations regarding the use of incentive programs to help achieve the goals of the GI Plan in the Brentwood neighborhood are listed below. The incentive programs used as a part of this Implementation Plan should be promoted and incorporated in the community outreach campaigns discussed in Section 8 above.

1) To encourage participation in the implementation of the GI Plan, the existing Austin Water rebates discussed above should continue to be utilized and possibly expanded for both residential and commercial owners. Rebate dollars from Watershed Protection Department could be contributed to the existing rebate programs when on-site controls are designed to provide flood detention benefits. Increased rebates could be considered for systems that use a smart or real-time controller to ensure that detention volume is available when needed. This would optimize the effectiveness of the control and could also allow the City to monitor performance and ensure correct operation of the facility. Given the role of potential GI features in flood risk mitigation, the consequences of private GI not being maintained in an operable condition are higher than for water conservation.

Therefore, an ongoing incentive coupled with periodic inspection and verification should be considered.

2) Policy incentives/requirements should be considered in the Brentwood neighborhood which would require the integration of green stormwater infrastructure with standard capital improvement program (CIP) projects related to grey infrastructure. The addition of GI on all CIP projects would serve to offset potential increases in peak flows created as a result of more efficient drainage conveyance. This is a critical concern with the hybrid green/grey solution in that the grey component of the solution will serve to increase peak flows and should be offset by the benefits of GI prior to construction.
3) Consider a policy including watershed-specific design criteria for stormwater management for redevelopment projects within the watershed to help lead to GI designs that are consistent with the GI Plan.
4) Consider a one-time discount to the City's Drainage Utility Fee for flood detention facilities that exceed regulatory requirements. Since the Brentwood neighborhood is nearly completely developed, primarily redevelopment or retrofit projects will be constructed; regulatory requirements are relaxed in most of these cases. Therefore, the addition of GI controls for flood mitigation in redevelopment applications could be incentivized by discounting the Drainage Utility Fee based on the capture volume of the GI facility.
5) Create an award program as a moral incentive for properties or residential blocks that achieve high compliance with GI controls. Display the winning properties with photos in a public outreach campaign or on neighborhood billboards or advertisements. Such a program would encourage others to participate in implementing GI while rewarding those already participating and providing awareness of local projects which can be used as examples for future projects.
6) Consider a simpler version of the bullet above that primarily includes recognizable signage to acknowledge participation in the program. The Backyard Habitat Certification Program (https://backyardhabitats.org/) is an example program with recognizable signage in the Portland, Oregon area. It crosses over multiple areas of land and watershed management, including stormwater management.

In addition to providing financial and moral incentives to encourage private sector and home owner participation in implementation of the GI Plan, the public outreach activities play an important role in the success of any incentive program. Therefore, these two implementation strategies should be closely coordinated and include overlapping goals. The City should develop a guidance document including a menu of equivalent GI options from which voluntary participants can select. The guidance document and menu of equivalent GI will include design information, infographics, example projects, material lists and costs, construction guidance, and maintenance considerations to help ensure that GI facilities are construction in a manner

consistent with the GI Plan. This would serve to inform the participants what options are available to receive rebates or other incentives while achieving the goals and benefits of the GI Plan. An agreement would be required designating maintenance responsibilities to the property owner while allowing the City access to inspect the GI feature on an as needed basis.

10 MAINTENANCE IMPLEMENTATION

Maintenance of GI facilities is essential to the long-term performance and flood mitigation benefits needed for the success of the GI Plan in the Brentwood study area. The ability to perform effective maintenance (or ensure that it is being done) must be a primary consideration in implementation of the GI Plan. Implementation of a maintenance plan should include tracking conditions of GI and the need/frequency for maintenance, effectively completing maintenance tasks, and tracking and monitoring the costs associated with green infrastructure maintenance to help identify more efficient ways of conducting maintenance over time. For GI on private land, much of this maintenance will be conducted by owners and agreements should be developed so the owner acknowledges responsibility for ongoing maintenance. The City will be responsible for GI facilities within the ROW and funding partners may be available to increase the efficiency in ongoing maintenance for these facilities.

Long-term performance and maintenance of GI features on private property presents a special challenge because the City does not have direct control over or access to these facilities. As discussed below, measures can be put in place such as agreements with the owners and periodic inspections by the City to encourage proper functioning of the GI facilities. Data from other municipalities regarding long-term performance of privately operated GI is not readily available. Even with agreements and inspections in place, the reliability of GI on private land may be less than that of City maintained facilities. Therefore, implementing additional or larger GI facilities beyond what is proposed in the GI Plan may be required to account for GI that is not functioning properly.

The performance of non-structural GI features, specifically those in the enhanced disconnection program, may be difficult to verify since they are typically integrated into the landscape. Enhanced disconnection practices such as impervious cover disconnections, soil amendments, drought tolerant landscaping, and contouring/micro-depressions depend on widely dispersed surface and subsurface unit processes that are difficult to measure and observe in the field. These practices are the result of specific landscaping and stormwater management practices conducted by home owners geared primarily towards reducing runoff. Conversely, home owners can take actions in the landscape to concentrate flows, increase impervious cover (e.g., small sheds, patios or walkways), and compact soil . Such practices can increase runoff and contribute to flooding issues. The wide range of pervious area management approaches demonstrates the need for sufficient outreach and education so that home owners are encouraged and inspired to implement and maintain GI measures that will reduce runoff at the source.

Appendix C provides summaries of three GI maintenance programs that have been implemented with success by other municipalities. These examples contain many of the elements proposed in the maintenance plan and should be considered specifically for long-term maintenance tracking and costs.

10.1 Specific Maintenance Implementation Considerations

Although GI is expected to have a smaller upfront construction cost when compared to traditional grey infrastructure, long-term maintenance costs are generally larger and can result in ineffective infrastructure if not implemented properly. This section describes multiple considerations for the implementation of GI maintenance to create a more effective program.

Maintenance costs of GI features throughout the Brentwood study area are expected to be less than preliminary estimates described in the GI Plan as an economy of scale will be realized as more features are installed. Integrating maintenance tasks with other planned services will further reduce O&M costs. With a significant amount of GI, dedicated service crews or competition for maintenance can be utilized to achieve good pricing. Constructing GI facilities with pre-defined standard design features such as inflow structures, overflow structures, and similar vegetation will result in similar maintenance requirements and improved efficiency for completing maintenance. Incentivizing the maintenance contractor to use the same personnel and encourage training and lessons learned for new personnel will further improve efficiency, reduce costs, and recognize the economy of scale benefits available.

Dedicated service crews could be hired by the City specifically for the Brentwood study area or through a contract agreement. A reliable payment basis and verification of successful and necessary execution of maintenance tasks is necessary to ensure proper and effective maintenance activities. Rules and incentives for the maintenance contractor are critical to ensure effective maintenance is being conducted at the needed level so that the maintenance contractor does not work to maximize profits on unneeded maintenance tasks. Contractor qualifications are also important for ensuring proper maintenance activities, but many landscaping contractors could be qualified to conduct these tasks. The contractor's experience, necessary facilities, and financial resources to furnish the items of a GI maintenance contract should be examined by the City.

Although the hybrid green/grey solution is expected to provide significant flood mitigation benefits based on the modeling analysis conducted, distributed GI can have negative impacts if not properly maintained. For example, effective maintenance of GI systems in some situations could introduce pollutants into the drainage system, such as fertilizer or compost applications. For maintenance conducted solely by home owners, the owners must be informed that proper maintenance is necessary for successful adoption and ongoing success of GI in the neighborhood; more maintenance will be needed after large events due to erosion or washing away of plants at high flows. Maintenance should also consist of removing inappropriate vegetation and accumulated debris. Outreach to the public and providing appropriate manuals or guidelines for ensuring proper implementation of these maintenance activities is important to the success of maintenance of GI facilities. The City should develop maintenance manuals specific to the GI Plan as well as working with non-profit partners to encourage private maintenance, especially after

larger rainfall events. Table 4 below presents the recommended initial maintenance/inspection schedule for each GI category included in the GI Plan. The maintenance and inspection frequency should be conducted for the first two years during vegetation establishment. After the second year, the maintenance and inspection frequency should be evaluated and adjusted as needed (i.e., following an adaptive management approach) based on inspection results, maintenance needs to date, and observed performance. For example, if residential rain garden inspection documentation demonstrates good performance (e.g., inflow and outflow points are in good condition and drawdowns are timely) with minimal maintenance requirements, the property owner inspection frequency may be reduced to once per year and the City inspection frequency may be reduced to once every 3 to 5 years.

When implementing the maintenance plan recommendations presented in the GI Plan, the City should consider developing a list of ideas or principles necessary for proper ongoing maintenance. Such a list will be useful for home owner maintenance activities as well as to identify qualities important for a Contractor or maintenance crew to successfully implement maintenance activities on a larger scale.

The following recommendations should be considered by the City during the implementation of maintenance of GI facilities:

- Maintenance of GI within the City ROW will be primarily conducted by City staff or a contractor. The following maintenance considerations apply to ROW GI facilities:
    - City staff and/or hired contractors are responsible for maintenance and should be adaptively managed to adjust maintenance activities based on observations and maintenance conducted on behalf of residents. It is critical that the maintenance plan adopted for the Brentwood neighborhood be adaptive based on residents' assumed responsibility.
    - The City and/or contractor's activities could be supplemented with resident or non-profit volunteers providing some maintenance services. For example, minor trash removal.
    - Maintenance costs should be tracked to gain a better understanding of the expected long-term costs and identify efficiencies or improvements over time. The Maintenance Plan within the GI Plan (Geosyntec, 2016b) presents a recommended list reporting data for GI maintenance costs.
- Maintenance of GI on private property (including residential, commercial, and institutional properties) will be primarily conducted by property owners. The following considerations apply to private GI facilities:
    - City staff should conduct periodic inspections to ensure the GI facilities are being maintained and performing as desired. An initial inspection should be conducted upon completion of installation with an additional inspection within the first two

years of operation. Based on the results of the second inspection, the frequency of inspections may need to be increased or reduced based on the documented maintenance needs and performance.

- A memorandum of understanding between the City and the private property owner should be considered to ensure the owner takes responsibility for maintaining the GI facility for a specified duration.
- Private property owners should be provided with a maintenance guide describing the activities they are responsible for and identifying potential problems.
- Maintenance reporting by the property owner should be considered to document when maintenance activities are being conducted.

Table 4. Initial Maintenance/Inspection Schedule

GI Feature Type	Property Owner Frequency	City Frequency	Notes
Public ROW GI	N/A	Quarterly	Adjacent home owners encouraged to take ownership in the maintenance of Residential Green Streets. City is responsible for maintenance and schedule can be adapted based on performance and maintenance activities conducted during first two years of operation.
Lion's Field Bioretention	N/A	Quarterly	Should be maintained using current City schedules for larger, centralized facilities.
Residential Green Streets	N/A	Quarterly	Adjacent home owners encouraged to take ownership in the maintenance of Residential Green Streets. City is responsible for maintenance and schedule can be adapted based on performance and maintenance activities conducted during first two years of operation.
Non-Residential Green Street and Parking Lots	Quarterly	Upon installation and once per year	Property owners should be responsible for maintenance. City should conduct annual inspections to verify maintenance is being conducted.
Residential Cisterns	Quarterly	Upon installation and once per year	Property owners should be responsible for maintenance. City should conduct annual inspections to verify maintenance is being conducted.
Non-Residential Cisterns	Quarterly	Upon installation and once per year	Property owners should be responsible for maintenance. City should conduct annual inspections to verify maintenance is being conducted.
Enhanced Disconnection	Quarterly	Upon installation and once per year	Property owners should be responsible for maintenance. City should conduct annual inspections to verify maintenance is being conducted.

11 REFERENCES

ASCE (2014), *Public Safety Guidance for Urban Stormwater Facilities*, Task Committee on Public Safety Considerations for Urban Stormwater Management Facilities, American Society of Civil Engineers, Environmental and Water Resources Institute, Urban Water Resources Research Council, Reston, Virginia.

Clean Water Partnership (2015), *The Prince George's County Clean Water Partnership*, Largo, Maryland, http://thecleanwaterpartnership.com/.

CNT (2010), *The Value of Green Infrastructure: A Guide to Recognizing Its Economic, Environmental and Social Benefits*, Center for Neighborhood Technology, Chicago, Illinois.

CodeNEXT (2016): *The Next Austin: Manage our Growth, Keep our Character*, Natural and Built Environment Code Prescription, March 2016, CodeNEXT Advisory Group, Austin, Texas.

Dorman, T., M. Frey, J. Wright, B. Wardynski, J. Smith, B. Tucker, J. Riverson, A. Teague, and K. Bishop (2013): *San Antonio River Basin Low Impact Development Technical Design Guidance Manual*, v1. San Antonio River Authority, San Antonio, Texas.

EPA (2014), *The Economic Benefits of Green Infrastructure, A Case Study of Lancaster, PA*, EPA Green Infrastructure Technical Assistance Program, EPA 800-R-14-007, available online: https://www.epa.gov/sites/production/files/2015-10/documents/cnt-lancaster-report-508_1.pdf.

FMTF (2016), *Flood Mitigation Task Force: Final Report to Austin City Council*, submitted 16 May 2016, Austin, Texas.

Geosyntec (2013), *Green Infrastructure Plan*, Ecapris SubProject #5282.090, Prepared by: Geosyntec Consultants, Inc., Prepared for: City of Austin Watershed Protection Department, 30 May 2013.

Geosyntec (2014), *Modeling Results Summary*, Ecapris SubProject #5282.090, Prepared by: Geosyntec Consultants, Inc., Prepared for: City of Austin Watershed Protection Department, 28 February 2014.

Geosyntec (2016a), *Modeling Results Summary*, Ecapris SubProject #5282.090, Prepared by: Geosyntec Consultants, Inc., Prepared for: City of Austin Watershed Protection Department, revised 29 January 2016.

Geosyntec (2016b), *Green Infrastructure Plan*, Ecapris SubProject #5282.090, Prepared by: Geosyntec Consultants, Inc., Prepared for: City of Austin Watershed Protection Department, revised 20 May 2016.

Imagine Austin (2012), *Imagine Austin Comprehensive Plan*, adopted by City Council 15 June 2012, Austin, Texas.

Lancaster (2011), *Green Infrastructure Plan*, City of Lancaster, prepared by CH2M Hill, April 2011, http://cityoflancasterpa.com/sites/default/files/documents/cityoflancaster_giplan_fullreport_april2011_final_0.pdf.

National Council for Public-Private Partnerships (2012), *Testing Tradition – Assessing the Added Value of Public-Private Partnerships*, Arlington, Virginia.

Onondaga County (2013), *Save the Rain Program Green Infrastructure Maintenance Manual*, Onondaga County, New York, prepared by CH2M Hill, April 2013, available online http://savetherain.us/wp-content/uploads/2012/03/MaintenanceBinder_Rev-april2013.pdf.

Philadelphia (2006), *A Homeowner's Guide to Stormwater Management*, Philadelphia Water Department, Office of Watersheds, Volume 1, January 2006, available online http://www.phillywatersheds.org/doc/Homeowners_Guide_Stormwater_Management.pdf.

Philadelphia (2011a), *Consent Order and Agreement*, Commonwealth of Pennsylvania, Department of Environmental Protection, City of Philadelphia Water Department, 1 June 2011, http://phillywatersheds.org/doc/LTCP_COA_2011_Complete.pdf.

Philadelphia (2011b), *Amended Green City, Clean Waters Program Summary*, The City of Philadelphia's Program for Combined Sewer Overflow Control, Amended 1 June 2011, http://www.phillywatersheds.org/doc/GCCW_AmendedJune2011_LOWRES-web.pdf.

Philadelphia (2012), *Green City, Clean Waters Comprehensive Monitoring Plan*, Consent Order and Agreement Deliverable III, Commonwealth of Pennsylvania, Department of Environmental Protection, Philadelphia Water Department, 1 December 2012, http://phillywatersheds.org/ltcpu/GCCW%20Comprehensive%20Monitoring%20Plan%20Sections%201-10.pdf.

Philadelphia (2014a), *Stormwater Management Incentives Program Grant Manual*, Philadelphia Water Department, Philadelphia Industrial Development Corporation, available online: http://www.phillywatersheds.org/doc/SMIP_Grant_Manual_FY14_rev.pdf.

Philadelphia (2014b), *Green Stormwater Infrastructure Maintenance Manual*, Philadelphia Water Department, http://phillywatersheds.org/doc/GSI%20Maintenance%20Manual_v1.pdf.

Phillips, B. (2014), *Adding Creativity to Urban Stormwater Treatment Design – "Rainwater Art"*, California Stormwater Quality Association 10th Annual Conference, PACE Advanced Water Engineering, Garden Grove, California, https://www.casqa.org/asca/adding-creativity-urban-stormwater-treatment-design-rainwater-art.

Portland (2004), *Innovative Wet Weather Program*, City of Portland, Bureau of Environmental Services, Prepared for: U.S. Environmental Protection Agency, EPA Financial Assistance Agreement ID #XP-97045801-0, April 2004, http://www.portlandoregon.gov/bes/35941.

Portland (2007), *Green Streets Cross-Bureau Team Report*, Phase 2, City of Portland, March 2007, http://efiles.portlandoregon.gov/Record/4520852.

Portland (2012), *The Green Street Steward's Maintenance Guide*, Green Street Care and Maintenance Guide, City of Portland, Bureau of Environmental Services, available online: http://www.portlandoregon.gov/bes/article/319879.

RCA (2010), *Feasibility Engineering Report – Shoal Creek Brentwood Storm Drain Improvements*, CIP No. 5789.030, Prepared By: Raymond Chan and Associates, Inc. and Eclipse Environmental and Engineering, Inc., Prepared For: City of Austin Watershed Protection and Development Review Department, Watershed Engineering Division, August 2010.

APPENDIX A

PUBLIC-PRIVATE PARTNERSHIP (P3) WHITE PAPER

National Council for Public-Private Partnerships (2012)

Testing Tradition

Assessing the Added Value of Public-Private Partnerships

THE NATIONAL
Council For
Public-Private
Partnerships
PARTNERSHIPS FOR PROGRESS

Published by the National Council for Public-Private Partnerships
2000 14th Street, North • Suite 480 • Arlington, VA 22201
703.469.2233 • 703.469.2236 (FAX) • ncppp@ncppp.org • www.ncppp.org

Publication Development Team

Publisher	Richard Norment, Executive Director
Writer	Kimberly S. Meyer, Research Associate
Layout/Design	Sue De Angel, Communications Coordinator

Cover photos:
Top and bottom: JFK Airport International Terminal; Middle: Presidio Parkway.

Executive Summary

Today, governments at all levels – federal, state and local – face challenges related to the upkeep and construction of a wide range of public infrastructure. Budgetary limitations; delayed projects; deferred maintenance, repair, and replacement; and population growth have led to questions of how to best address these public needs. One option that is being entertained with increasing frequency is use of Public-Private Partnerships (PPPs), contractual agreements between public agencies and private sector entities that allow delivery of a service or facility for public use.

The advantages of this innovative form of project delivery are well-documented. PPPs can reduce development risks, provide more cost effective and timely infrastructure delivery, offer the potential for better ongoing maintenance, and leverage limited public sector resources, all while maintaining the appropriate level of public control over the project. While PPPs may not be appropriate in all cases, these partnerships can address public needs in the areas of facilities, real estate development, energy, information technologies, transportation, education and healthcare, and water/wastewater. In each case, unlike under privatization, the public sector retains a high level of ownership and control over the project and its outcomes.

Despite the advantages, there are also misperceptions about PPPs that lead to criticism and quick dismissal without the proper evaluation. This white paper addresses one of the most common misperceptions – that PPPs are a more expensive form of project delivery. This idea is based upon difference in interest rates for obtaining capital when sources of public funding such as tax-exempt municipal bonds or general revenue sources are compared to private capital costs. If decision makers conduct a proper evaluation of all options, including a complete financial analysis using a Value for Money (VfM) assessment, however, the comparison can provide a more complete picture of the true total costs for project delivery. Many may find it surprising that PPPs can provide products and services at comparable or lower costs than those associated with public financing while also providing the equal or greater value to the public.

A complete and proper evaluation of project delivery incorporates a number of considerations that provide a more comprehensive look at the total costs associated with procurement than is traditionally conducted. While this assessment of each option is a more complex process than traditionally performed, the potential benefits that can be achieved make its use attractive. The analysis can expose the potential benefits and drawbacks to both project delivery options, and choosing the right option for each scenario may make the difference between being able to deliver a project and leaving needs unmet.

This white paper provides a description of the evaluation as part of the decision making process, with the hope that these tools may be used to help meet the demands for infrastructure and improved public services.

> *"The real difficulty in changing the course of any enterprise lies not in developing new ideas but in escaping from the old ones."*
>
> *— John Maynard Keynes*

PPPs Defined

According to the National Council for Public-Private Partnerships, a PPP is defined as:

"A contractual agreement between a public agency (federal, state or local) and a private sector entity. Through this agreement, the skills and assets of each sector (public and private) are shared in delivering a service or facility for the use of the general public. In addition to the sharing of resources, each party shares in the risks and rewards potential in the delivery of the service and/or facility."

New Orleans Wastewater Facility

Commonly-Used Abbreviations

FLC – Full Life-Cycle

NPV – Net Present Value

O&M – Operation and Maintenance

PPP – Public-Private Partnership

PSC – Public Sector Comparator

RFP – Request For Proposals

VfM – Value for Money

Table of Contents

James F. Oyster Bilingual Elementary School

The Current Environment: What's the Problem?

State and local decision makers who employ traditional approaches to project delivery face a multi-dimensional problem: they often lack capital to fund necessary infrastructure projects but then also face added costs associated with inaction or deferral of projects. In FY 2012, 42 states had budget shortfalls totaling $103 billion, and a shortfall totaling $54 billion across 30 states is forecast for FY 2013.[1] In an effort to try to close these gaps, 46 states have been forced to cut services and 30 have raised taxes.[2] When these steps do not close the budget gap, localities are often forced to defer projects. In a survey conducted by the National League of Cities in 2011, 60 percent of cities said they delayed or canceled capital projects that year due to fiscal conditions.[3] In light of these circumstances and the call for both new facilities and renovation of existing infrastructure, the funding gap is unlikely to improve, especially since deferrals will lead to further deterioration of the structures – both in terms of physical condition and value – and therefore added expenses.

Traditional procurement involves the planning and design of a project, appointment of advisors to issue public debt, and, after securing funds, selection of a contractor to complete the project. Once the construction phase is complete, assets are turned over to the public for continued operations and maintenance (O&M). The costs of O&M then become subject to annual appropriations debates, opening up the potential for budget cuts, deferred maintenance and repairs, and politicized concerns about the use of adequate user rates or tax increases to cover continuing costs. All of this usually occurs in sequence, with O&M often financed only after construction is complete. In contrast, the PPP option can consider the design, finance, construction, operation, and maintenance phases of a project in a single procurement contract. This reality means decision makers are forced to approach project delivery from a long-term, macro-perspective, rather than looking at each phase separately.

As implied above, there are significant costs associated with deferred maintenance, repair, and replacement. Studies demonstrate that deferring timely maintenance to the point of a breakdown event can increase the total cost of repair by a factor of at least 15-to-1 and at times as high as 40-to-1.[4] For this reason and because of the other risks and costs associated with old infrastructure, not all projects can or should be deferred. When deciding the best course of action on a potential project, decision makers must compare the current cost of delivery and continued O&M to the estimated cost at a future date, which should then include the costs associated with project deferral. Due to inflation and breakdown costs, future construction or replacement is generally more expensive; however, many decision makers do not know this because analysis to project costs to a future date (for instance, postponing a project for five years, as a comparison) is rarely performed.

James F. Oyster Bilingual Elementary School

To make the problem worse, municipal revenues have also declined in many jurisdictions.[5] These fiscal woes are not perceived as a short-term problem: in fact, a large majority of public officials expect the changes implemented in response to the recession to be permanent, touting "a new normal."[6] For this reason, waiting until the economy improves may not be an option. Unable to counteract that trend without utilizing significant tax and user fee increases, state and local governments are then left with two options: innovation or

inaction. Decision makers will soon be forced to make difficult decisions in order to meet the estimated need for $300 billion in urgent infrastructure projects over the next 5-7 years.[7] When new construction and renovations are added in, the estimate rises to $2.2 trillion over five years.[8] Under the "new normal" funding levels, decision makers must find a "new normal" for infrastructure and service delivery – one that takes all project delivery options into consideration.

Seeking Alternatives

Rather than consider alternatives for financing[9] public projects, many localities have chosen to increase revenues, defer spending, or both. Again, however, deferral does not solve the infrastructure problem. With this in mind, decision makers should seek out other options for project delivery, including the use of PPPs. However, this option is sometimes discounted because private financing is often preconceived as being more "expensive" than the use of general revenues or municipal bonds. Despite this negative perception, cost reductions in other areas often make PPPs cost competitive with more traditional options and in many cases provide additional benefits to localities.

"Those which we call necessary institutions are simply no more than institutions to which we have been accustomed."

— Alexis de Tocqueville

The primary obstacle to establishing PPPs for municipal projects is the perceived cost of money. Although there are added costs associated with utilizing private funds for public projects, savings are often derived from PPP-based projects in the long-run. This is true because the public sector can share the risks and responsibilities associated with the project with the private sector, therefore saving money.[10] Likewise, long-term planning measures utilized as a part of the PPP development process can lead to cost savings.

In many cases, however, a comprehensive evaluation is neither contemplated nor completed, leading many decision makers to dismiss a project delivery option that could potentially protect the public interest while maintaining cost effectiveness. To prevent this mistake, decision makers should conduct a comparison of value derived from projects when undertaken via each delivery option. The assessment of value earned as a result of spending is termed "Value for Money."

This estimation is intended to provide a long-term assessment of the total cost incurred by the public sector under a PPP arrangement and compare it to costs under the traditional process. When completed, the analysis sheds light upon not only the comparative costs between the options but also the potential affordability and feasibility under either option. Often, cost savings will be realized under PPPs. This is not to say that PPPs are the best way to deliver all projects, but they do provide an option worthy of greater attention.

This white paper will demonstrate the importance of performing a careful cost analysis of all project delivery options. By fully analyzing all options for project delivery, public sector decision makers can make more informed decisions about project delivery and, in turn, realize the fullest potential benefits of their spending decisions.

A Context for Change

Historically, public debt has been undertaken to finance projects because of the low interest rate associated with tax-exempt debt. Bonding initiatives were common, and the tax-exempt savings of about 2 to 4% over private financing seemed like the best option for getting the necessary funds for capital projects. Today, though, limits on tax exemptions make this option less appealing, and low interest rates on private, taxable issuances decrease the magnitude of that perceived advantage.

The historic difference between tax exempt interest rates and taxable interest rates has narrowed substantially as a result of the current financial environment. Further, the tax-exempt bond market has also been disrupted by the declining success in bonding initiatives and referenda. While the market for public investment has become more challenging, there remains a very strong interest in infrastructure investment by many private capital sources including banks, institutional investors, pension funds, and private equity firms. This leaves a potentially viable option in the form of using PPPs to finance public capital projects.

Today, there are also new factors that must be incorporated into financing decisions. Previously, project feasibility studies only considered physical needs such as building capacity and facility life expectancy. The various alternatives now available for procurement bring into question the most appropriate institutional arrangements, financing strategies, and methods of planning, designing, constructing, operating, and maintaining facilities. One such example can be seen in government provisions such as the low-interest TIFIA loans given for qualifying transportation projects, which provide new financing options. Because of the new factors and alternatives to consider today, there are more questions to consider when choosing the best method of procurement.

The common gap between available public funds and the cost of traditional procurement indicates that projects might be made more feasible by leveraging a combination of funding sources. Augmentation of public funding by incorporating private investment into the mix may allow decision makers to meet the total project costs efficiently. Thus, because of the political and economic limitations to the amount of public funding available for projects, decision makers would be wise to at least explore alternative methods of both securing immediate funds for procurement and financing for continued operations.

The PPP Option: One Alternative

In light of the challenges described above, PPPs, in their many forms, may provide an alternative to the common practices of cutting spending, raising taxes and fees, deferring projects or payments, or borrowing from other agencies. It is imperative, however, to note that using PPPs does not mean privatizing public services or assets. While frequently used interchangeably, the two terms are not synonymous, and PPPs actually provide distinct benefits. Most notably, PPPs, "joint ventures," or "collaborative enterprises" retain a high level of public control and oversight, while avoiding the negative perceptions associated with the "selling" of public assets or responsibilities that is frequently associated with privatization.

Private Investment

There is a substantial private investor base with a significant appetite for investment in public infrastructure projects, thus making PPPs a viable option in spite of a "turbulent" capital market.[11] Fundraising in the infrastructure sector has remained fairly strong in recent years, resulting in a pool of approximately $250 billion in 2011.[12] Even if the current pool of funding is exhausted, the likelihood of additional growth in the future is high due to continued investor interest.[13] [14]

Unfortunately, these funds are not being tapped due to weak demand levels among public agencies, which is a result of decision makers' stated belief that PPPs will be more expensive than traditional procurement. There are several common beliefs reinforcing this misperception of PPP costs:

- Loss of public control will cause unnecessary user rate increases (and therefore unfair private profit) and loss of public assets.
- Private financing is more expensive than using public debt, making the PPP option more expensive than using tax revenues and municipal bonds.
- Contract negotiations for PPPs are too difficult and costly to yield a positive outcome.

Fortunately, it seems that each of these perceptions is often false. The misinformation associated with each of these perceptions is further described in Appendix B.

Despite the skepticism surrounding PPPs, benefits can be realized. One municipal official in Woonsocket, RI stated that the immediate availability of private financing could result in time (and therefore cost) savings, especially where there is potential for costs to rise with inflation.[15] Further cost savings can be realized over the course of the contract term as well, despite higher base financing costs. The decision cannot be reached haphazardly, though: full commitment is needed from public decision makers in order to achieve successful partnerships, so the option must be investigated thoroughly. The large amounts of funding currently available do not signal "free money." Rather, as with any procurement method, there are risks associated with PPP use, and some of those risks are retained by the public sector. For this reason, the PPP option must be carefully considered using VfM analysis.

Assessing PPPs: Value for Money

One way of assessing the potential benefits associated with a PPP is through VfM analysis, which compares the cost of PPP-based provision to that of traditional project delivery, providing decision makers with a quantitative tool and data to help them make the case for selecting the most appropriate mode of project delivery. A comprehensive analysis of options should include the following key components to VfM:

- Public Sector Comparator (PSC) use, to assess the public sector cost of traditional delivery and compare it to PPP or privatized options
- Full Life-Cycle (FLC) cost and revenue analysis for each option
- Determination of most appropriate risk sharing scenario
- Assessment of public opinion and maintenance of transparency

VfM analysis is currently used widely in Canada, the United Kingdom, the Netherlands, Australia, South Africa, and Hong Kong but is less common – though emerging – in the United States.[16]

This tool for assessing the potential value derived using one mode of project delivery over another can facilitate good decision making in two main ways. First, it is useful for comparing several options. Likewise, it can provide insight into how to achieve the greatest likelihood of project delivery in a timely and cost effective manner, while achieving the highest value for the amount invested, which, of course, should be a decision maker's primary goal. While this method of analysis does require various qualitative and quantitative assumptions to be made about operations, finances, and risks associated with projects, it can be an effective and objective evaluation tool when conducted with fairness and transparency.

The Public Sector Comparator

VfM analysis is based on a comparison of the public cost of traditional project delivery to the public cost of using a PPP. The first step in conducting the analysis, then, is to establish the cost of delivery under traditional delivery methods, which is known as the PSC. This value is later compared to each private or PPP option in order to determine whether any alternative can provide positive added value.

The PSC is intended to provide "an estimate of risk-adjusted costs" to the public sector when delivering the project itself.[17] Within the PSC, all project costs, revenues, and risks must be projected over the full life of the project. These include, but are not limited to:

- Capital/construction costs (during construction and for ongoing O&M, determined by precedent)
- Operating costs (core functions, non-core supporting services, maintenance, insurance, personnel, replacement and replenishment of supplies and equipment over time)
- Taxes
- Project income (based on public sector ability to generate revenue, i.e., from user fees)
- Risk-related costs

Because all of these costs are included in the PPP proposal, all are necessary in order for the PSC to show an accurate comparison. For instance, if risks of cost overruns or time delays are not incorporated into the PSC based on previous public sector experience, the comparator will be inaccurate. To this end, decision makers should aim for a realistic assessment in order to create a fair comparison of the options. Once the total public cost has been determined for public delivery, it can be compared to the cost of delivery through other alternatives. The amount saved by using the cheaper option is termed "Value for Money" and claimed by whichever option has the lowest total cost. Decision makers should choose the project delivery method that offers the optimal combination of quality, features, and price over the whole of a project's life, which can fall in favor of either option but often favors PPPs.[18]

Full Life-Cycle Cost Analysis

VfM analysis further allows decision makers to determine whether a project is affordable based upon costs incurred over the full life of the project. By considering not only construction costs but also financing and continued O&M costs, decision makers gain insight into the best method of project delivery. Components of a FLC cost analysis include initial construction, operations, maintenance, and other anticipated costs such as those associated with future expansion of the project. While including all of these costs

in the assessment of the PPP option may show higher costs in the short-term, savings are often realized due to savings on long-term O&M due to higher quality of design and construction, warranty requirements, and other benefits to using private partners.[19]

One critical problem with current valuation efforts is that costs are often omitted or underestimated.[20] This occurs because traditional project delivery does not require bidders to account for the costs of future O&M. Particularly for high-cost components such as personnel wages and benefits, the omission of these expense categories can significantly alter budgets. Likewise, for building projects, the majority – 50 to 75 percent – of the life cycle budget is dedicated to O&M.[21] Thus, a comprehensive analysis of all life cycle costs must be considered – not only capital expenditures.

Optimizing Risk Allocation

Another critical component to VfM is the concept of risk allocation between the partners. By using VfM to evaluate PPP projects, decision makers may also account for the potential benefits that arise from effective risk allocation. Regardless of the method of procurement, effective risk allocation is a prerequisite to achieving positive VfM, where *effectiveness* is defined as allocating risk to the party best able to manage it.[22] One common scenario of risk reallocation is shown in Appendix A. In the case of PPPs, large proportions of project risk are generally either shared with or reallocated to the private sector. Effective risk allocation and mitigation helps to keep the project on budget and schedule, thus saving the money often lost due to delays.[23]

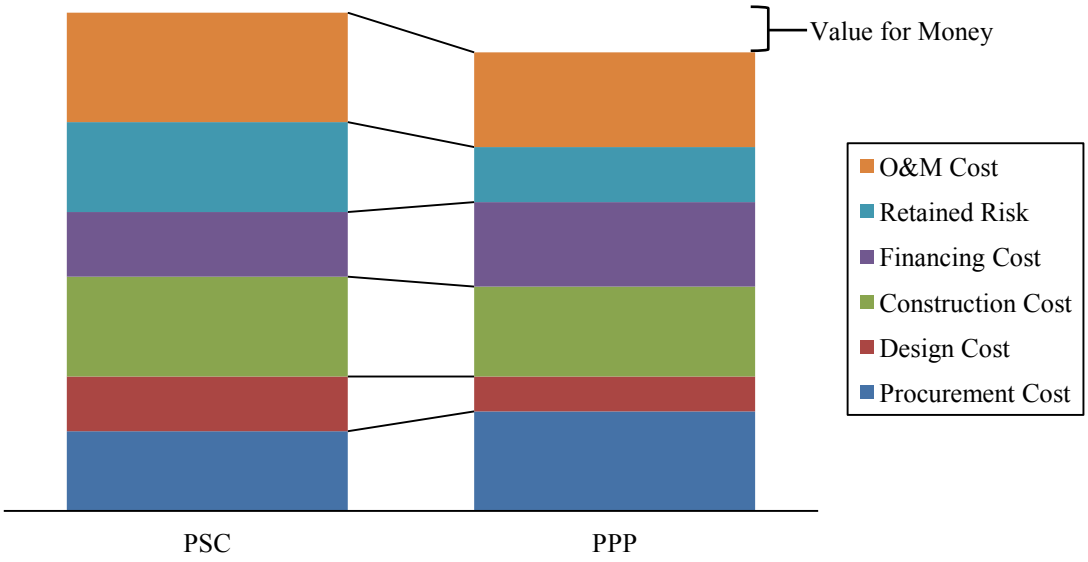
It should be noted that not all risks can be reallocated to the private sector, even under a PPP contract. This is inefficient and may make the project prohibitively expensive, so risk allocation must instead be based on economics.[24] Rather than allocate as much risk as possible to the private partner, risks (and, likewise, benefits) should be shared, with the party best able to manage it accepting each risk. With that in mind, however, it has been shown that private organizations today are willing to shoulder more risk than in the past.[25]

Total Cost Comparison of PPPs vs. Public Delivery

Thorough analysis often reveals that cost savings are possible when PPPs are used, with many estimates providing a 7-10 percent savings over the life of the project, though one study reflected a 24 percent advantage.[26] Admittedly, procurement[27] and financing costs[28] may be higher for PPPs; however, the FLC analysis shows savings over time due to the reduced costs associated with risk allocation,[29] design,[30] construction,[31] and long-term O&M.[32] While not to scale, this is shown graphically in Figure 1, wherein the PSC column represents the estimated total project costs under traditional procurement and the PPP column represents estimated total costs incurred by the public sector under the alternative proposal. In short, this estimated sample graph demonstrates that the higher procurement and financing costs associated with PPPs are more than offset by a reduction in other costs. While this "positive" VfM is not guaranteed under PPPs, it is often found when careful analysis is performed.

Sources of public funding such as municipal bonding are tax-free and this basic knowledge may make those options attractive to public decision makers, leading them to question the advantages of PPP use. This interest payment, however, is only a fraction of total financing costs – and an even smaller portion of total project cost. As

Figure 1: Public sector cost of project delivery[33]



such, the cost of financing should not be the deciding factor pointing to public delivery of a project.

Under the public-private contract, this difference in financing costs is recovered later, by way of the cost savings associated with risk transfer to (or absorption by) the private partner as well as reduced design, construction, and O&M costs. A 2008 GAO study on PPPs for highway construction confirmed that although these financing costs are higher under PPPs and there is money lost due to the lack of tax exemptions for private sector financing, there are other reasons – financial and otherwise – to use PPPs, which benefit parties in both sectors.

When private financing is used, the private sector receives payments over the course of the contract term, leading to a return on investment over time. Likewise, the private sector may benefit from completion payments paid once a project is finalized. The public sector also frequently benefits from risk transfer to and absorption by the private sector, and both parties can potentially achieve cost savings due to operational efficiencies implemented by the private partner, as in the case of improved maintenance practices.[34] Other potential areas for cost reduction, among others, include scheduling (because design and build phases can overlap, rather than waiting on a bidding process), bulk purchasing (because orders can be merged when a private entity operates multiple facilities), early construction start, and life cycle O&M efficiencies and innovations. These cost advantages of using PPPs often outweigh the potential for increased expenses related to the transaction costs incurred under private financing.[35]

Need more reasons? Additional Benefits of Choosing PPPs

Although high VfM does not guarantee that PPPs will be more cost effective (or that they are even affordable), this test can bring to light the potential benefits to using these arrangements. If used, additional benefits may be realized for both public agencies and their private partners. These benefits to the public sector include:

- Maximization of public and private sector strengths
- Reduction or sharing of risks

- Reduction in public capital investment
- Mobilization of excess or underutilized assets
- Improvement of efficiencies/faster project completion/guaranteed maintenance
- Better environmental compliance
- Improved service to the community while maintaining public oversight
- Improved cost effectiveness[36]

This paper focuses specifically on those advantages that can yield high cost effectiveness over the life of the project: guaranteed maintenance of the asset, enhanced public oversight, long-term planning, and faster project delivery.

Guaranteed Maintenance

One reason for choosing a PPP is the guarantee of continued maintenance, repair, and replacement of the public asset. As noted previously, deferring maintenance can cause the total cost of improvements, once finally made, to be 15-40 times the original cost.[37] Thus, decision makers must consider future maintenance when determining whether to proceed with new projects. Because future maintenance costs are accounted for within PPP contracts, they are removed from the general budget debate. This means the project O&M costs are guaranteed and continued maintenance is not in jeopardy with each budget cycle.

Enhanced Public Oversight

One significant concern of public sector decision makers considering PPPs is the ability to guarantee performance and retain oversight of the project and continued maintenance. PPP contracts, however, should contain clear performance standards and maintenance requirements for the full life of the project, thus enhancing the likelihood of successful O&M through the end of the contract term.

One way of further promoting accountability is through availability payments. When this measure is included in the contract, the private partner is only paid in full if the contracted deliverables meet pre-arranged quality and time standards. The payment is intended to cover earlier private sector investment in the project, not as an additional profit. If the project falls behind schedule or does not meet the prescribed standards, however, the payment is reduced on the basis of non-performance.[38] Because most private partners will abide by contract standards with the payment in mind, the payments are generally effective, providing incentive for the private sector to perform to standards while also promoting accountability to the public interest.

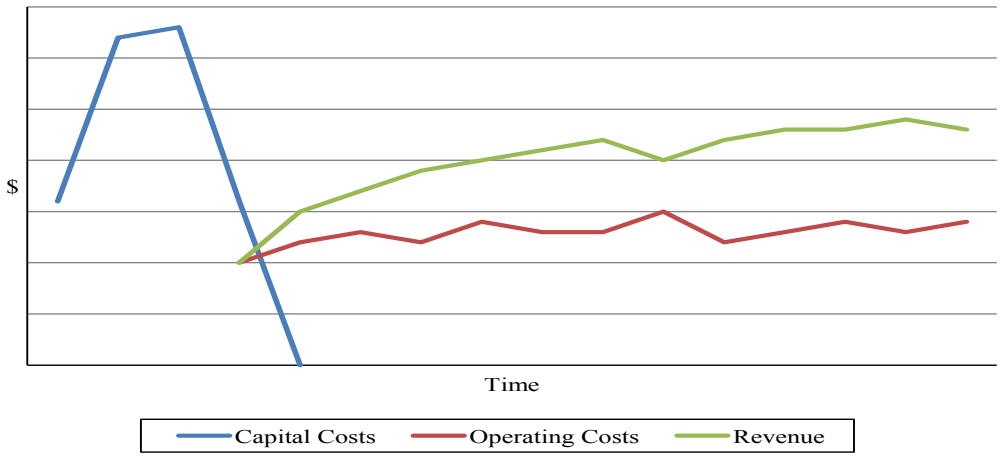
Long-Term Budgeting Perspective

Since PPP cost estimates can include ongoing O&M costs, decision makers should consider the long-term affordability of a project. Moreover, when projects are assessed using figures in Net Present Value (NPV),[39] stakeholders are able to consider both immediate and future costs at once, allowing them to determine whether the project is truly affordable in both the short- and long-run. By evaluating project costs from this perspective, decision makers look at the true total costs before moving forward and determining how much funding they will need to secure from partners or other sources in order to begin construction and see the project to completion.

Similarly, the long-term perspective forces decision makers to consider costs over the full life of the project and to compare them with expected revenues. The long-term approach can save money on O&M because those expenses are specified in the PPP contract, whereas inflation-related price increases may make maintenance more

expensive under traditional arrangements. Further, by considering O&M expenses from the outset, the project timeline and life cycle can be set up to improve the likelihood that revenues generated from the project balance the initial capital costs and later provide a return for both public and private partners, as shown in Figure 2. In this example, the project life cycle must be long enough so that the total cost of the project – the total area under the blue and red lines – is offset by the revenue generated, which is represented by the area under the green line.

Figure 2: Payments and revenue under PPP model[40]



Use of a long-term perspective may also yield other benefits for partners in both sectors. When private partners use a long-term perspective, they may realize additional savings from using cost-effective design, construction, and maintenance options, and these savings are often shared with the public sector. The corresponding likelihood of proper and guaranteed maintenance, repair, and replacement for the whole term of the PPP provides asset protection for investors in both sectors, thus protecting the public interest.

Faster Project Delivery

PPPs have consistently been found to deliver more projects on-time and on-budget than traditional arrangements.[41] By making a procurement decision based on FLC costs and with a long-term perspective, however, the public sector may not only be able to deliver cheaper projects but also those that might otherwise be cost-prohibitive in the short-term. Public sector expenditures under traditional arrangements tend to be high during the construction phase at the beginning of a project, and additional O&M costs are incurred over the rest of the project life. In contrast, PPPs often utilize private financing for up-front costs, thereby allowing the public sector to make more moderate payments back to the private partner(s) later in the process. Because private funds can be used for up-front costs, the likelihood of time lost due to pre-construction fundraising delays is reduced, and, in turn, the design and construction processes may be expedited. Public payments are then made later, after construction is underway and user fees or other revenues are generated. Particularly for large-scale, high-value projects, the use of private funds for capital expenses can mean that PPP-based projects achieve faster groundbreaking and more rapid construction once negotiations are complete, rather than waiting to secure public financing. Again, while the PPP option may not eliminate all delays, this decreased likelihood of launch delays and/or schedule

slippage can be a significant advantage to using PPPs.[42]

The ability to efficiently finance up-front costs and use revenues for repayment allows public decision makers to budget more effectively while also potentially reducing overall project costs. For this reason, PPPs may provide one way to circumvent short-term budgetary concerns. Such was the case with New York's JFK Airport international terminal, where the Port Authority would not have been able to afford the necessary infrastructure improvements without use of a PPP.[43]

Cautious Optimism

Again, despite these potential advantages to PPP arrangements, there can be instances where they are not appropriate for use. To this end, decision makers must be sure that projects are financially viable, regardless of the results of a VfM analysis. Likewise, they must consider whether they have the resources necessary for successful contract negotiation and implementation, as described in Appendix D. For these reasons, significant financial and logistical analysis must be completed before embarking on a PPP.

[PPPs] may be helpful for acquiring new infrastructure or extracting value from existing assets. That said, they are "not a panacea" and significant up-front analysis is needed to determine whether a [PPP] or any other arrangement is in the public interest.

— GAO, Highway Public-Private Partnerships

Conclusion

In general, PPPs can offer long-term savings on capital expenditures, in addition to the other advantages described above. Private financing of capital expenditures can lead to significant capital savings on the design, build, and operation phases, with additional savings possible through technology investment on operating expenditures. When considering those cost savings and adding in the savings that result from risk transfer, the tax exemptions previously thought by some to be an advantage of traditional procurement are rendered ineffectual. For this reason, decision makers must consider the final, bottom line dollar amount required for the full life of the asset in question, not just the construction and financing costs. Thus, comprehensive analysis must consider not only construction bids but also ongoing O&M and all risks, whether retained, transferred, or shared.

Because of the potential cost savings associated with PPPs and the large amounts of private equity currently available to fund them, this method appears to be an option that should be considered for procurement of public projects. Again, PPPs can be advantageous in many cases; however, these arrangements are not "free money" or miraculous solutions to public budget problems. Decision makers must consider the long-term consequences of investment upon taxpayers, economies, and the environment. The best way of considering all of these factors is through careful analysis including Value for Money assessment.

Appendix A: Critical Components of Value for Money

In addition to providing an estimate of the true costs associated with a project, VfM also provides insight into how much government funding is necessary under each option, therefore helping decision makers to determine whether any delivery option is financially feasible. In addition to providing information to the public sector, it can also be useful as an objective way to manage stakeholder and public perceptions. In order to achieve these benefits, however, the VfM analysis must be comprehensive, including several critical components: comparison of the PSC and PPP alternative using FLC analysis and risk estimates set in Net Present Value (NPV).

The Public Sector Comparator

As Dave Zelenok, Director of Public Works for the City of Centennial, Colorado, states, the key to developing a valid PSC is accounting for all direct and indirect costs related to the project over its full life.[44] These include human resource, construction, operation, maintenance, future capital improvement costs, and ancillary expenses (such as legal fees for traditional contractor negotiations or the cost of balloting and implementing bonding initiatives). To prepare this figure, the public agency needs to define the project scope and realistically determine project requirements and consequent costs and revenues.

One category that is often omitted from the PSC but incorporated into the private business plan is that of human resource costs. These costs are guaranteed under private partnerships but may be subject to changes under public procurement, especially when pensions and other varying costs are incorporated. This simple example demonstrates the importance of including all expenses and risks into the PSC: to make an accurate comparison, the public and PPP estimates must measure the same components.

Risk Allocation and Transfer

Effective risk transfer is one of the keys to achieving high VfM under PPP contracts. Although the base cost of financing is often higher when using private funds, risk allocation is one of the primary areas where those costs are recovered and, often, real cost savings is realized. With that in mind, decision makers should seek to allocate risk to the party best able to manage it. Under PPP arrangements, many project risks traditionally shouldered by the public sector are transferred to the private sector, as in the table below. While this scenario is not necessarily reflective of every case, the principle of risk transfer contained within is applicable to many PPP environments.

Figure 3: Typical Risk Transfer Scenario Under PPP Arrangements[45]

	Responsibility for Risk		Transferred?
	Public/DBB	PPP	
Development Risks			
Performance	Public	Private	X
Interface	Public	Private	X
Design Risks			
Scope	Public	Shared	X
Errors and Omissions	Public	Private	X
Interference/Coordination	Public	Private	X
Life Cycle	Public	Private	X
Construction Risks			
Performance	Private	Private	
Schedule	Public	Private	X
Cost Overruns	Public	Private	X
Changes in Scope	Public	Public	
Force Majeure	Shared	Shared	
Financing Risks			
Schedule Slippage Additions	Public	Private	X
Interest Rate Risk	Public	Private	X
Vehicle Supply Risks			
Supply/Performance Risk	Private	Private	
Financing Risks	Public	Private	X
Defects	Private	Private	
Maintenance and Life Cycle Risks			
Maintenance Level	Public	Private	X
Deferred Maint/Repair/Repl	Public	Shared	X
Defective Components	Private	Private	
Residual Value	Public	Shared	X
Operations Risks			
Revenue	Public	Shared	X
Service Level and Quality	Public	Shared	X

Net Present Value

Because many costs associated with public project delivery can be incurred over a long time period, they should all be estimated into dollars at Net Present Value (NPV). This allows for easier comparison of figures, without decision makers having to account for cost increases due to inflation. Thus, by bringing all future costs into present terms and basing them on the current dollar value, comparisons between the PSC and PPP cost estimates can be made more easily.

PPP Valuation

For more information on how to assign values to non-monetary costs, risks, and other components of VfM, see *Public Sector Decision Making for Public-Private Partnerships: A Synthesis of Highway Practice*, by the Transportation Research Board National Cooperative Highway Research Program (Washington, D.C.: National Academies Press, 2009).

Appendix B: Facts and Myths about PPP Use

Myth: PPPs are just another method of 'privatization,' leading the public sector to lose control over its assets.

There are significant differences between PPPs and other practices known as 'privatization.' While similar, PPPs allow the public sector to retain ownership and control over the project, unlike some privatization schemes that require the public sector to sell some of its assets. In contrast, however, "under a PPP agreement, the public sector *never* losers ownership of the facility, … [even when] some responsibilities are transferred to the private sector."[46] Specifically, the public sector retains control over establishment of user rates, operating standards, and other legal requirements, to which the private partner must adhere. The degree to which responsibilities are retained or shared is defined in the contract, and well-negotiated contracts that include monitoring and enforcement of performance standards can ensure that public interests are protected. To this end, many different types of PPPs can be used to realize the intended benefits without losing public control.

Myth: A PPP can work to meet any infrastructure need.

PPPs, like other options for project delivery, need to be thoroughly investigated. Not all projects are viable opportunities for partnerships. The following are factors to consider when determining whether a PPP might be useful for meeting project needs:

- Presence of a legal/institutional framework facilitating for PPP arrangements
- Favorable investment environment, including public opinion and willingness of potential private partners
- Economic viability, both from the public (VfM) and private (compensation) perspectives
- Reliability of prospective partners, including technical strength and adherence to performance and method specifications
- Appropriateness of risk allocation via reliable contractual arrangements

These and other keys to successfully managing PPPs are described in greater detail in Appendix D.

Myth: Private money offered through a PPP is a good way for the government to access "quick cash" to close budget gaps.

While the immediate availability of money from private investment sources may entice some decision makers to choose PPPs, it is important to remember that there is no such thing as "free money." The up-front payments seen in some arrangements can provide funds for immediate use in the applicable project (or, in some cases, for unrelated projects), but there are often restrictions on whether and under what circumstances private funds can be used to finance public projects. Appropriate uses of up-front payments should be spelled out in the contract. This possibility and other similar tradeoffs between advantages and restrictions are inherent in PPPs, meaning that these arrangements are not necessarily the answer to all budget shortfalls or infrastructure needs.

Myth: Private partners make excessive returns as a result of PPPs.

Earning a return on investment is one objective of the private sector when pursuing PPP contracts – this makes sense, given the profit motive common in that sector. However, there are many ways to prevent the private sector from siphoning undue benefits from the arrangement. Options such as revenue sharing provisions, refinancing regulations, and contract rebalancing provisions can be negotiated with the help of experienced PPP advisors and explicitly spelled out in the PPP contract, thus providing reassurance to the public sector that the agreement will be beneficial for both entities.

Myth: PPPs are difficult and expensive to negotiate, thus negating their benefits.

The perception that these agreements are difficult to reach has led to a general unwillingness to even try negotiating contracts, especially on the part of public sector decision makers. While PPP contracts can be subject to expensive and complex negotiations, they should remain an option to investigate and consider. Most reluctance is the result of unfamiliarity: one study of state and local officials revealed that 90% of those who had experience with PPPs expressed a willingness to pursue them again.[47] Luckily, there are many experienced firms and advisors able to educate potential public and private partners on PPPs and to help negotiate contracts that will be advantageous to both.

Appendix C: Case Studies

City of Centennial Public Works Department

Centennial, Colorado – 2007

The city of Centennial, Colorado was founded in 2001 by a group of community members who wanted to create a more cost efficient city with more effective public works services than had previously been delivered from the county. Through the use of a Public Sector Comparator, the Director of Public Works found that a PPP would narrowly win over the cost of in-house provision, and the winning proposal was implemented in 2007, following competitive bidding.

The city and private partner agreed to a $40 million contract for five years, but the city is permitted to review and re-approve the agreement annually. The $40 million payment by Centennial was allocated over five years, and costs are expected to decrease after the initial contract period because start-up costs have been paid. Moreover, the partnership has brought cost efficiencies and grant money to the city. During the first 12 months of the contract, $352,294 was collected for 564 right-of-way permit fees and $50,000 was saved by changing snow and ice control materials. The department was also awarded $160,215 in federal funds for new traffic signal equipment and $531,112 for three energy projects.

Today, the Public Works Department boasts just 48 employees, with remaining human resources provided by the private partner and everyone working as a unified team to form the largest public works partnership in the country. Through this partnership, the city has achieved cost savings, earned grant funding, and elevated performance standards. Services including transportation planning; traffic engineering and operations; pavement management; street and traffic infrastructure maintenance; capital improvement programs; city permit processing; and citizen call center operations are provided for 100,000 residents.

For more information on the Centennial case, see: http://www.ncppp.org/cases/Centennial.shtml.

Regional Transportation District (RTD) FasTracks Commuter Rail Lines

Denver, Colorado – 2010

The Regional Transportation District (RTD) of Denver, Colorado, is dedicated to achieving high levels of Value for Money on its FasTracks projects. For its largest contract to build and operate commuter rail lines – budgeted at $2.3 billion under public procurement – a PPP was established following competitive bidding in 2010. The winning proposal is estimated to save $300 million over the PSC and open the main rail line 11 months ahead of the anticipated deadline, both while being rated the higher technical proposal of the two bidding teams. Once complete, the project will bring 47 miles of new rail to the RTD system, more than doubling its existing light rail holdings.

Other RTD FasTracks projects are also planned to expand rail and bus service by building a total of 122 miles of commuter and light rail and 18 miles of bus transit service, add 21,000 new parking spaces in the service area, and redevelop Denver's Union Station. In all, the initiative is projected to create more than 10,000 construction jobs during the peak construction period and bring tourist and other money into the regional economy.

Project funding for FasTracks is derived from a combination of funding sources, including a voter-approved sales tax increase, municipal revenues, federal funding (including TIFIA funds), and PPP investment. In addition, one goal of RTD is to constantly reevaluate the technical aspects of their projects in order to find ways to provide greater VfM, especially through improvements in efficiency and cost-effectiveness. The program is also evaluated annually using an Annual Program Evaluation (APE). As part of the APE, staff analyzes the cost of the program, specifically looking for changes that can lower program costs without changing the current or future plans for FasTracks.

For more information on the FasTracks case, see: http://www.rtd-fastracks.com.

U.S. Food and Drug Administration, White Oak Campus, Phase III

Silver Spring, Maryland – 2010

Phase III of the U.S. Food and Drug Administration's ("FDA") landmark campus build-out project implements energy conservation measures at the White Oak facilities. Initiated in 2001, the public-private partnership between the FDA, General Services Administration ("GSA") and an Energy Services Company ("ESCO") is expected to generate $1.02B in total savings. At the forefront of this $195M phase is the expansion of the Combined Heat and Power/Cogeneration Central Utility Plant, which will support the heating and cooling loads of the facilities constructed in the earlier phases. The expanded plant is capable of producing up to 20MW of electricity, 6,000 tons of cooling, 112 MMBtu/hr of heating, and sufficient process steam to meet a 35,700 pph requirement.

The utilization of a PPP and third-party financing, in conjunction with the DOE's Super Energy Savings Performance Contracting Program, is estimated to save more than $200M over 20 years, according to the PSC analysis. Furthermore, the project significantly mitigates construction and financing risk through a fixed price contract and savings guarantee. The project improves the performance and efficiency of the Central Utility Plant, which will allow the FDA to meet budget and performance measure challenges. Over $90M in capital appropriations are freed up to meet mission critical and functional requirements of the FDA.

Initially, the project was to be funded through an appropriation of $45M for energy equipment and $165M in third party financing. The repayment of the money would be through energy and water savings, O&M savings, and utility rebates and incentives realized through a demand response program with the local utility. Ultimately, the $45M originally appropriated was funded by third party financing after a modification to the task order in 2012. This alteration allowed for further budget flexibility and cost savings.

When completed, this project will be invaluable to achieving energy security at the FDA, and achieving federal objectives outlined by Executive Order 13514 for the reduction of energy consumption and greenhouse gas emissions.

For more information on the White Oak case, see: http://www1.eere.energy.gov/femp/financing/superespcs_fda.html

JFK Airport International Terminal

Jamaica, New York – 1999

When capital improvements were necessary to enhance and expand the international terminal at New York's JFK Airport, the Port Authority of New York and New Jersey had limited debt capacity to finance the improvements. A PPP allowed for concurrent operation of the old facility and construction of the improvements, which would have encountered "significant" delays and logistical challenges if completed by traditional means.

Following a competitive solicitation involving international consortia of private developers, operators, and financiers, a private company entered into a 28-year lease with the Port Authority. The arrangement allowed private partners to design, finance, build, operate, and manage the new 16-gate, 1.5 million square foot facility. This contract allowed project debt to be secured by the private sector in a timely manner while the private partner received income from terminal operations (including gate fees) and retail activity, which it could use for lease payments to the Port Authority.

Value added by construction of the new terminal includes accommodation of an additional 1,200 arriving passengers hourly, profit during construction of the new terminal, a 100,000-square-foot retail concourse, and several areas for relaxation.

For more information on the JFK Airport case, see: http://www.ncppp.org/cases/jfkairport.shtml.

James F. Oyster Bilingual Elementary School

Washington, District of Columbia – 1993

In 1993, the James F. Oyster Bilingual Elementary School was in danger of permanent closure due to its crumbling facilities. Both the city of Washington, DC and the school district lacked the capital funds necessary to renovate the building, so concerned parents and the principal led efforts to save the school through establishment of the 21st Century School Fund, a non-profit set up with the goal of financing the necessary capital improvements. The partnership between DC Public Schools, the DC government, and a national real estate development company allowed for the use of alternative financing sources to complete the project, exceeding community expectations in the process.

The partnership allowed the project to be funded through a combination of payment in lieu of taxes (PILOTS) funds, an $11 million DC bond, and sale of a portion of the property to the private partner.

Through the PPP, a new, state-of-the-art 48,000-square-foot building and an adjacent 211-unit apartment building were constructed at no cost to taxpayers. Community-use areas, exterior playgrounds, and parking areas also contribute to the current, more efficient use of the site.

For more information on the Oyster School case, see: http://www.ncppp.org/cases/oyster.shtml.

Presidio Parkway

San Francisco, California – 2007

Like many other parts of the nation's infrastructure, the south access road to San Francisco's Golden Gate Bridge, known as Doyle Drive or Route 101, was "structurally and seismically deficient" due to continual use since its original construction in 1936. The new roadway, re-envisioned as "Presidio Parkway," is an opportunity for both structural and design improvements to be made. Planners aimed to reduce its biological and natural resource impacts as much as possible, while respecting neighborhoods, historic landmarks, and the surrounding Golden Gate National Recreation Area.

In 1996, a study began to assess the status of the road and determine the most appropriate course of action for improvement. The project was planned in two phases, with Phase I (2009-2012) delivered through traditional procurement and Phase II (2011-2015) through a PPP. This arrangement was negotiated in order to take advantage of federal stimulus money and begin construction sooner, achieve seismic safety as quickly as possible by diverting traffic onto completed Phase I work at the midpoint of the project timeline, and to shorten the total construction schedule. The PPP contract requires the private partner to design, build, finance, operate, and maintain the project for 30 years, reducing overall costs, transferring risks to the private partner, and guaranteeing high maintenance standards over the contract term, in exchange for a milestone payment of $185 million and a completion payment of $91 million.

For more information on the Presidio Parkway case, see: http://www.presidioparkway.org/.

Appendix D: Keys to Successfully Managing PPPs

The following are the "7 Keys to Successful PPPs," as developed by the National Council for Public-Private Partnerships. They are to be considered "best practices" in the development of these arrangements, though it is recognized that the methodology for implementation of PPPs can vary depending on the nature of a given project and local concerns.

1. **Public Sector Champion** – Recognized public figures should serve as the spokespersons and advocates for the project and the use of a PPP. Well-informed champions can play a critical role in minimizing misperceptions about the value to the public of an effectively developed PPP.

2. **Statutory Environment** – There should be a statutory foundation for the implementation of each partnership. Transparency and a competitive proposal process should be delineated in this statute. However, unsolicited proposals can also be a positive catalyst for initiating creative, innovative approaches to addressing specific public sector needs.

3. **Public Sector's Organized Structure** – The public sector should have a dedicated team for PPP projects or programs. This unit should be involved from conceptualization to negotiation, through final monitoring of the execution of the partnership. This unit should develop Requests For Proposals (RFPs) that include performance goals, not design specifications. Consideration of proposals should be based on best value, not lowest prices. Thorough, inclusive VfM calculations provide a powerful tool for evaluating overall economic value.

4. **Detailed Contract (Business Plan)** – A PPP is a contractual relationship between the public and private sectors for the execution of a project or service. This contract should include a detailed description of the responsibilities, risks and benefits of both the public and private partners. Such an agreement will increase the probability of success of the partnership. Realizing that all contingencies cannot be foreseen, a good contract will include a clearly defined method of dispute resolution.

5. **Clearly Defined Revenue Stream** – While the private partner may provide a portion or all of the funding for capital improvements, there must be an identifiable revenue stream sufficient to retire this investment and provide an acceptable rate of return over the term of the partnership. The income stream can be generated by a variety and combination of sources (fees, tolls, availability payments, shadow tolls, tax increment financing, commercial use of underutilized assets or a wide range of additional options), but must be reasonably assured for the length of the partnership's investment period.

6. **Stakeholder Support** – More people will be affected by a partnership than just the public officials and the private sector partner. Affected employees, the portions of the public receiving the service, the press, appropriate labor unions and relevant interest groups will all have opinions, and may have misconceptions about a partnership and its value to all the public. It is important to communicate openly and candidly with these stakeholders to minimize potential resistance to establishing a partnership.

7. **Pick Your Partner Carefully** – The "best value" (not always lowest price) in a partnership is critical in maintaining the long-term relationship that is central to a successful partnership. A candidate's experience in the specific area of partnerships being considered is an important factor in identifying the right partner. Equally, the financial capacity of the private partner should be considered in the final selection process.

References

American Society of Civil Engineers. "Report Card for America's Infrastructure." Accessed June 12, 2012. http://www.infrastructurereportcard.org/.

Bidne, Dawn, Amber Kirby, Lucombo J. Luvela, Benjamin Shattuck, Sean Standley, and Stephen Welker. "The Value for Money Analysis: A Guide for More Effective PSC and PPP Evaluation." American University. Presentation at American University, Washington, District of Columbia, April 23, 2012. http://www.ncppp.org/resources/papers/Value%20for%20Money%20Analysis.5.10.12.docx.

Center on Budget and Policy Priorities (CBPP). *States Continue to Feel Recession's Impact*. By Elizabeth McNichol, Phil Oliff, and Nicholas Johnson. Washington, D.C., May 24, 2012. http://www.cbpp.org/cms/index.cfm?fa=view&id=711.

"City of Centennial Public Works Department." National Council for Public-Private Partnerships. Accessed August 31, 2012. http://www.ncppp.org/cases/Centennial.shtml.

Deloitte. *Partnering for Value: Structuring Effective Public-Private Partnerships for Infrastructure*. By Tiffany Dovey, William D. Eggers, Michael Flynn, Irene Walsh, and Jim Ziglar. New York, 2010. http://www.deloitte.com/assets/Dcom-Global/Local%20Assets/Documents/Public%20Sector/dtt_ps_partneringforvalue_090710.pdf.

Geaslin, David Tod. "The Disasterous Effects of Deferring Maintenance." The Geaslin Group. http://www.airsolutioncompany.com/news/articles/news-disasterouseffects.pdf.

"History of Union Station." Union Station, Washington, D.C. Accessed August 31, 2012. http://www.unionstationdc.com/info/infohistory.

"International Air Terminal 4 at John F. Kennedy Airport." National Council for Public-Private Partnerships. Accessed August 31, 2012. http://www.ncppp.org/cases/jfkairport.shtml.

"James F. Oyster Bilingual Elementary School." National Council for Public-Private Partnerships. Accessed August 31, 2012. http://www.ncppp.org/cases/oyster.shtml.

Kaufmann, K. "Public-Private Partnerships: Wide Ranging Views and Successful Approaches." *Urban Land*, October 31, 2011. http://urbanland.uli.org/Articles/2011/Fall11/KaufmanPartnership.

Lever, David. "Public School Construction: Investigating the P3 Alternative." Maryland Interagency Committee on School Construction. Presentation at the Association of School Business Officials of Maryland and DC Spring Conference, Ocean City, Maryland, May 22, 2012.

Moss, Rodney. "First Steps in the Process: Guidelines on How to Utilize SB 1048." Balfour Beatty Capital. Presentation at the Implementing Public-Private Partnerships in Texas: Practical Steps for SB 1048 Workshop, Dallas, Texas, May 15, 2012. http://www.ncppp.org/calendars/Dallas_1205/Moss.pdf.

National League of Cities. *City Fiscal Conditions in 2011*. By Christopher W. Hoene and Michael A. Pagano. Washington, D.C., 2011. http://www.nlc.org/File%20Library/Utility%20Navigation/News%20Center/Media%20Relations/RB_CFC2011--5-.pdf.

National Research Council. *Privatization of Water Services in the United States: An Assessment of Issues and Experience*. Washington, D.C.: National Academies Press, 2002. http://www.nap.edu/catalog/10135.html.

Norment, Richard. "The Framework of Public-Private Partnerships." National Council for Public-Private Partnerships. Presentation at the Implementing Public-Private Partnerships in Connecticut Workshop, New Britain, Connecticut, June 14, 2012. http://www.ncppp.org/publications/CT_1206/Norment.pdf.

Office of Transportation Public-Private Partnerships. *PPTA Value for Money Guidance*. Commonwealth of Virginia. Richmond, VA, 2012. http://www.vappta.org/resources/VDOT_VfM_guidance_document_August2012.pdf.

Posner, Paul, Shin Kue Ryu, and Ann Tkachenko. "Public-Private Partnerships: The

Relevance of Budgeting." *OECD Journal on Budgeting* 9 (1). http://www.oecd.org/dataoecd/43/32/43410287.pdf.

"Presidio Parkway: San Francisco's Gateway." Presidio Parkway. Accessed August 31, 2012. http://www.presidioparkway.org.

PricewaterhouseCoopers. *Public-Private Partnerships: The US Perspective*. New York, 2010. http://www.pwc.com/us/en/capital-projects-infrastructure/publications/assets/Public_Private_Partnerships.pdf.

Raymond, Peter. "PPPs and Use of Availability Payments." PricewaterhouseCoopers LLC. Presentation at the Implementation of Public-Private Partnerships for Transit Workshop, Chicago, Illinois, May 20, 2009. http://www.ncppp.org/publications/TransitChicago_0905/workshop_Chi.shtml.

"RTD FasTracks." FasTracks Regional Transportation District of Denver, Colorado. Accessed August 31, 2012. http://www.rtd-fastracks.com.

Simmons, Larry and Tarzan A. Frazier. "Operations and Maintenance." Greater Orlando International Facility Management Association Chapter. Presentation at the Certified Facility Manager Roundtable Webinar, Orlando, Florida, February 9, 2010. http://www.ifmaorlando.org/cfm/cfm_feb10.pdf.

Sphere Consulting. *Benefits of Private Investment in Infrastructure*. Washington, D.C., August 2011. http://www.sphereconsulting.com/images/stories/private_investment_in_infrastructure_update_august1.pdf.

Sugarman, Dan. "Developing Relationships: Water and Wastewater PPPs." United Water. Presentation at the Toyo University Delegation Workshop, Washington, D.C., February 8, 2010. http://www.ncppp.org/councilinstitutes/Toyo_2010/Sugarman-Toyo_1002.pdf.

Syal, Rohit. "Alternative Infrastructure Delivery Approach with Public Private Partnerships." Loop Capital Markets. Presentation at the Government Finance Officers Association 106th Annual Conference, Chicago, Illinois, June 9, 2012.

Toppston, Aaron. "Alternative Construction Delivery." Aon Risk Services. Presentation at the Aon D.C. Construction Forum, Washington, D.C., April 2, 2012.

Transportation Research Board National Cooperative Highway Research Program [TRB]. *Public Sector Decision Making for Public-Private Partnerships: A Synthesis of Highway Practice*. National Research Council. Washington, D.C.: National Academies Press, 2009.

"Union Station Metro Station, Washington DC." National Council for Public-Private Partnerships. Accessed August 31, 2012. http://www.ncppp.org/cases/unionstation.shtml.

United States Conference of Mayors. *Survey on City Fiscal Conditions*. Washington, D.C., 2009. http://www.usmayors.org/pressreleases/uploads/SurveyonCityFiscalConditions11709.pdf.

United States Government Accountability Office [GAO]. *Wastewater Infrastructure Financing: Stakeholder Views on a National Infrastructure Bank and Public-Private Partnerships*. GAO-10-728. Washington, D.C.: U.S. Government Printing Office, 2010. http://www.gao.gov/assets/310/306947.pdf.

Walters, Jonathan. "Solutions for the New Normal: How Do We Dig Out?" Governing. Presentation at the Outlook in the States and Localities Conference, Washington, D.C., January 31, 2012.

Winder, Peter. "Generating Private Financing for Rail and Transit." Balfour Beatty Capital. Presentation at the Partnerships in Transit Workshop, Denver, Colorado, June 12-13, 2008. http://www.ncppp.org/publications/TransitDenver_0806/workshop_Denver.shtml.

Zelenok, David. "The First Steps in the Process: What Should Public Agencies Do?" Presentation at the Implementing Partnerships for Infrastructure Workshop, Michigan State University, Lansing, Michigan, May 11, 2011.

Endnotes

[1] Center on Budget and Policy Priorities (CBPP), *States Continue to Feel Recession's Impact*, by Elizabeth McNichol, Phil Oliff, and Nicholas Johnson (Washington, D.C., May 24, 2012), http://www.cbpp.org/cms/index.cfm?fa=view&id=711.

[2] CBPP, *States Continue to Feel Recession's Impact*.

[3] National League of Cities, *City Fiscal Conditions in 2011*, by Christopher W. Hoene and Michael A. Pagano (Washington, D.C., 2011), 7, http://www.nlc.org/File%20Library/Utility%20Navigation/News%20Center/Media%20Relations/RB_CFC2011--5-.pdf.

[4] David Tod Geaslin, "The Disasterous Effects of Deferring Maintenance," The Geaslin Group, http://www.airsolutioncompany.com/news/articles/news-disasterouseffects.pdf.

[5] National League of Cities, *City Fiscal Conditions in 2011* See also: United States Conference of Mayors, *Survey on City Fiscal Conditions* (Washington, D.C., 2009), http://www.usmayors.org/pressreleases/uploads/SurveyonCityFiscalConditions11709.pdf.

[6] Jonathan Walters, "Solutions for the New Normal: How Do We Dig Out?" Governing (presented at the Outlook in the States and Localities Conference, Washington, D.C., January 31, 2012).

[7] K. Kaufmann, "Public-Private Partnerships: Wide Ranging Views and Successful Approaches," *Urban Land*, October 31, 2011, http://urbanland.uli.org/Articles/2011/Fall11/KaufmanPartnership.

[8] American Society of Civil Engineers, "Report Card for America's Infrastructure," accessed June 12, 2012, http://www.infrastructurereportcard.org/.

[9] It is important to note that "financing" a project is different than "funding" it. A "financing" mechanism must be repaid with a rate of return, whereas "funding" mechanisms are options that do not have to be repaid such as grants, tax revenues, or user fees (i.e. tolls or fares).

[10] For more information on risk allocation and transfer, see Appendix A.

[11] Sphere Consulting, *Benefits of Private Investment in Infrastructure* (Washington, D.C., August 2011), http://www.sphereconsulting.com/images/stories/private_investment_in_infrastructure_update_august1.pdf.

[12] Ibid.

[13] PricewaterhouseCoopers, *Public-Private Partnerships: The US Perspective*, New York, 2010, http://www.pwc.com/us/en/capital-projects-infrastructure/publications/assets/Public_Private_Partnerships.pdf.

[14] For more information on the use of private equity within PPP arrangements, see Rohit Syal, "Alternative Infrastructure Delivery Approach with Public Private Partnerships," Loop Capital Markets (presented at the Government Finance Officers Association 106th Annual Conference, Chicago, Illinois, June 9, 2012).

[15] United States Government Accountability Office [GAO], *Wastewater Infrastructure Financing: Stakeholder Views on a National Infrastructure Bank and Public-Private Partnerships*, GAO-10-728 (Washington, D.C.: U.S. Government Printing Office, 2010), 30, http://www.gao.gov/assets/310/306947.pdf.

[16] Dawn Bidne, et al., "The Value for Money Analysis: A Guide for More Effective PSC and PPP Evaluation," American University (presented at American University, Washington, District of Columbia, April 23, 2012), 3, http://www.ncppp.org/resources/papers/Value%20for%20Money%20Analysis.5.10.12.docx.

[17] Deloitte, *Partnering for Value: Structuring Effective Public-Private Partnerships for Infrastructure*, by Tiffany Dovey, William D. Eggers, Michael Flynn, Irene Walsh, and Jim Ziglar (New York, 2010), 16, http://www.deloitte.com/assets/Dcom-Global/Local%20Assets/Documents/Public%20Sector/dtt_ps_partneringforvalue_090710.pdf.

[18] For more information on the PSC, see Appendix A.

[19] Transportation Research Board National Cooperative Highway Research Program [TRB], *Public Sector Decision Making for Public-Private Partnerships: A Synthesis of Highway Practice*, National Research Council (Washington, D.C.: National Academies Press, 2009).

[20] Syal, "Alternative Infrastructure Delivery Approach with Public Private Partnerships."

[21] Larry Simmons and Tarzan A. Frazier, "Operations and Maintenance," Greater Orlando International Facility Management Association Chapter (presented at the Certified Facility Manager Roundtable Webinar, Orlando, Florida, February 9, 2010), http://www.ifmaorlando.org/cfm/cfm_feb10.pdf.

[22] Rodney Moss, "First Steps in the Process: Guidelines on How to Utilize SB 1048," Balfour Beatty Capital (presented at the Implementing Public-Private Partnerships in Texas: Practical Steps for SB 1048 Workshop, Dallas, Texas, May 15, 2012), http://www.ncppp.org/calendars/Dallas_1205/Moss.pdf.

[23] For more information on the potential benefits of risk sharing and transfer that can be realized through PPPs, see: Peter Raymond, "PPPs and Use of Availability Payments," PricewaterhouseCoopers LLC (presented at Implementation of Public-Private Partnerships for Transit Workshop, Chicago, Illinois, May 20, 2009), http://www.ncppp.org/publications/TransitChicago_0905/workshop_Chi.shtml.

[24] Peter Winder, "Generating Private Financing for Rail and Transit," Balfour Beatty Capital (presented at the Partnerships in Transit Workshop, Denver, Colorado, June 12-13, 2008), http://www.ncppp.org/publications/TransitDenver_0806/workshop_Denver.shtml.

[25] National Research Council, *Privatization of Water Services in the United States: An Assessment of Issues and Experience* (Washington, D.C.: National Academies Press, 2002), 49-50, http://www.nap.edu/catalog/10135.html.

[26] The study discussed in Aaron Toppston, "Alternative Construction Delivery," Aon Risk Services (presented at the Aon DC Construction Forum, Washington, D.C., April 2, 2012) found an average of 24% cost savings on DBFMO projects in Canada from 2006-2010.

[27] Typical procurement costs include issuance of the Request for Proposals [RFP] (including advertising, stipends) and contract negotiation costs.

[28] Financing costs under the PSC may include the cost of issuing municipal bonds, negotiating user fees, or levying taxes. Under PPP arrangements, financing costs include the amount spent on private investment (equity and debt), tax-exempt and taxable bonding, and other financing options.

[29] Risk allocation includes the monetary values assigned to various types of risk, which may include cost overruns, schedule slippage, deferred maintenance, private efficiencies, and other factors. For more information on risk allocation, see Appendix A.

[30] Design costs may include oversight, engineering or design consultants, project need analyses, etc.

[31] Construction costs typically include engineer and contractor costs (whether outsourced or done in-house), labor, materials, etc.

[32] Long-term O&M costs may include employee wages, power and materials needed for full operation, and routine and capital maintenance costs.

[33]Costs estimated in this graph are based upon a number of projects but can vary significantly from case to case. Graph is adapted from Office of Transportation Public-Private Partnerships, *PPTA Value for Money Guidance*, Commonwealth of Virginia (Richmond, VA, 2012), 19, http://www.vappta.org/resources/VDOT_VfM_guidance_document_August2012.pdf.

[34] Dan Sugarman, "Developing Relationships: Water and Wastewater PPPs," United Water (presented at the Toyo University Delegation Workshop, Washington, D.C., February 8, 2010), http://www.ncppp.org/councilinstitutes/Toyo_2010/Sugarman-Toyo_1002.pdf.

[35] David Lever, "Public School Construction: Investigating the P3 Alternative," Maryland Interagency Committee on School Construction (presented at the Association of School Business Officials of Maryland and DC Spring Conference, Ocean City, Maryland, May 22, 2012).

[36] For more information on the benefits to using PPPs, see: Richard Norment, "The Framework of Public-Private Partnerships," National Council for Public-Private Partnerships, presentation at the Implementing Public-Private Partnerships in Connecticut Workshop, New Britain, Connecticut, June 14, 2012, http://www.ncppp.org/publications/CT_1206/Norment.pdf.

[37] David Tod Geaslin, "The Disasterous Effects of Deferring Maintenance."

[38] For more information on availability payments, see: Raymond, "PPPs and Use of Availability Payments."

[39] For more information on the importance of using figures in NPV, see Appendix A.

[40] Figure adapted from Raymond, "PPPs and Use of Availability Payments."

[41] Paul Posner, Shin Kue Ryu, and Ann Tkachenko, "Public-Private Partnerships: The Relevance of Budgeting," *OECD Journal on Budgeting* 9 (1): 11, http://www.oecd.org/dataoecd/43/32/43410287.pdf.

[42] GAO, *Wastewater Infrastructure Financing*.

[43] The case of JFK Airport is described in Appendix C.

[44] David Zelenok, "The First Steps in the Process: What Should Public Agencies Do?" (presented at the Implementing Partnerships for Infrastructure Workshop, Michigan State University, Lansing, Michigan, May 11, 2011).

[45] Table derived from Raymond, "PPPs and Use of Availability Payments."

[46] Emphasis added. TRB, *Public Sector Decision Making for Public-Private Partnerships.*

[47] PricewaterhouseCoopers, *Public-Private Partnerships*, 11-12.

Sustaining* and Sponsor Members:

Alliant Insurance Services, Inc.*
Alvarez & Marsal Public Sector Real Estate Services, LLP
American Iron & Steel Institute
Aon Risk Services
Aon Construction Services Group*
Associated Builders And Contractors
Balfour Beatty Construction
Bank Of America Merrill Lynch
Bostonia Partners LLC
Brownstein Hyatt Farber Shreck
CH2M Hill*
Deloitte Consulting LLP*
Fluor Enterprises, Inc.
Fort Bend County, Texas
Grant Thornton LLP
Hawkins, Delafield & Wood
Herzog Contracting Corporation
Hunt Companies Inc.*
Jacobs
Johnson Controls
K & L Gates
Lochner MMM Group LLC
Longbow Partners LLP
Management Analysis, Incorporated
Mckenna Long & Aldridge
Metropolitan Atlanta Regional Transit Authority*
MWH
National Association Of Water Companies
Nossaman LLP
Pannone Lopes Devereaux & West LLC (PLDW)
Reason Foundation
Southwest Water*
United Water*
Veolia Water North America*
Xerox, Inc.

APPENDIX B

EXAMPLE GREEN INFRASTRUCTURE PROGRAM SUMMARIES

B EXAMPLE GREEN INFRASTRUCTURE PROGRAM SUMMARIES

Detail summaries of three GI programs have been developed and are discussed below, including:

- City of Philadelphia, Pennsylvania
- City of Lancaster, Pennsylvania
- City of Portland, Oregon

Since these GI programs have been implemented primarily in CSO communities and CSO areas more emphasized within these communities, the GI is targeted primarily for smaller, more frequent events as opposed to flood reduction/mitigation. The GI features and programs proposed for the Brentwood study were developed primarily to address flooding associated with larger events. As a result, some inherent differences are expected between these programs. However, the overall theme of widespread GI use to reduce wet weather flows and increase infiltration are applicable, and programs from CSO communities are expected to provide valuable insights and lessons learned for implementation that could be applied to the Brentwood basin or other parts of Austin.

B.1 City of Philadelphia GI Program

On 1 June 2011, the City of Philadelphia entered into a Consent Order and Agreement (Philadelphia, 2011a) with the Pennsylvania Department of Environmental Protection that included approval of Philadelphia's CSO Long Term Control Plan Update and its supplements, called the "Green City, Clean Waters Program". On 10 April 2012, Philadelphia entered into a partnership with EPA to support and advance GI facilities for urban wet weather pollution control (Philadelphia, 2011b). The partnership agreement demonstrates EPA's support for sustainable stormwater management with multiple benefits that reduce sewer overflows. Discrete green infrastructure projects that Philadelphia will begin to implement in the short term are also included.

Philadelphia's "Green City, Clean Waters Program" (Program) is a green stormwater infrastructure plan that will covert approximately one-third of the City's impervious surfaces, or 4,000 acres, into impervious cover areas managed by green stormwater infrastructure that will filter with slower releases or store and infiltrate the first inch of runoff. The goal is to move from grey infrastructure to GI and provide man-made structures that mimic the natural systems. The Program includes a $1.2 billion net present value (in 2011 dollars, representing $2.4 billion of capital construction plus O&M costs) in terms of actual future expenditures over a 25-year period with metrics and milestones developed to measure progress along the way.

Within the first five years of the Program, Early Action Areas were implemented in clustered areas to help create small GI "districts" throughout the City. The first five years of the Program

implementation is identified as the proof of concept phase. A carefully designed pilot program of specified GI projects is being implemented. The vision of the Program is to "unite the City of Philadelphia with its water environment, creating a green legacy for future generations while incorporating a balance between ecology, economics, and equity" (Philadelphia, 2011b).

The Program is based on a Presumption Approach (based on the National CSO Policy which is allowed if water quality data collected by a community do not provide a clear picture of the level of CSO controls necessary to protect water quality standards) to manage state and federal water quality requirements. The City will construct and place into operation the controls described in the Program to achieve the elimination of the mass of pollutants that would be removed by treatment of the capture of 85% by volume of the combined sewage collected during precipitation events on a system wide average annual basis. The Program's vision includes the following elements (from Philadelphia, 2011b):

- Large-scale implementation of GI to manage runoff on public lands and reduce demands on combined sewer infrastructure.
- Requirements and incentives for GI to manage runoff on private land and reduce demands on combined sewer infrastructure.
- Large-scale street tree program.
- Access and improvements for recreational opportunities along green and stream corridors.
- Open space used to manage runoff at its source.
- Convert vacant and abandoned properties to open space and sustainable redevelopment.
- Restore streams with habitat enhancements.
- Additional infrastructure-based controls when necessary to meet appropriate water quality standards.

To implement the Program, the City of Philadelphia developed eight "Land-Based Green programs." These include green streets; green schools; green public facilities; green parking; green parks; green industry, business, commerce, and institutions; green alleys, driveways, and walkways; and green homes. Implementation based on land use has allowed for repeatable projects using specific characteristics of the contributing drainage area. The Program also focuses on waterway restoration and community partnerships. Community partnerships include public workshops, clean-up events, gathering public input through surveys and interviews, educational facilities and materials, and other watershed-scale partnerships with larger jurisdictions. The City of Philadelphia also created two grant programs to encourage private development of GI as described in Section 9.1.1 of the Implementation Plan.

The City of Philadelphia has developed a Comprehensive Monitoring Program (CMP) which describes how the Philadelphia Water Department is to assess Program effectiveness (Philadelphia, 2012). The major elements of the CMP include:

- Monitoring of GI controls and Program implementation efforts including goals to assess surface water, groundwater, rainfall, combined sewer discharges, sewer flows, and GI performance.
- Modeling of the hydrologic and hydraulic performance of the GI controls, the combined sewer system, and the effect on receiving waters including:
    - Hydrologic, hydraulic, hydrodynamic, and water quality modeling
    - Apply data to characterize GI functions, runoff reductions, CSO volume reductions, pollutant loads, and receiving water quality improvements
    - Assess performance and validate assumed hydrologic and hydraulic functions

The Program includes an analysis of triple bottom line benefits. This includes economic benefits such as GI jobs that reduce the social cost of poverty and are expected to result in 250 people employed annually in green jobs. Social benefits such as GI enhancing recreation that are expected to be achieved by increasing recreational and stream visits by an increase of up to 10 percent and GI improving communal quality of life by reducing up to 140 fatalities caused by excessive heat in the next 45 years. Environmental benefits such as:

- GI improving air quality through benefits from full-grown trees,
- GI energy savings and off-setting carbon emissions, and
- GI restoring ecosystems by water quality and habitat improvements.

The City of Philadelphia has also created “A Homeowner’s Guide to Stormwater Management” (Philadelphia, 2006) which is a public education document addressing the active role local residents, partners, homeowner’s associations, and municipalities can have in managing stormwater that will restore watersheds. The guide provides homeowners with actions the homeowner can take to improve stormwater management on the property or in the community. The guide includes significant information on:

- Vehicle maintenance and washing
- Lawn and garden care
- Pet waste
- Tree planting
- Caring for your backyard stream
- Planters
- Rain barrels (instructions for building a rain barrel)
- Rain gardens (instructions for creating a rain garden)

- Creating a wildflower meadow
- Dry wells
- Infiltration tests

B.2 City of Lancaster GI Program

The City of Lancaster, PA is a historical community of approximately 80,000 citizens covering approximately 7.4 square miles and served by a combined sewer system. During rain storms and other wet weather events, Lancaster's Advanced Wastewater Treatment Facility becomes overwhelmed with overflow discharges. Each year it is estimated that Lancaster is responsible for discharging about one billion gallons of untreated combined sewer discharges into the Conestoga River and eventually into the Chesapeake Bay. The Chesapeake Bay watershed includes the Conestoga River watershed, and TMDLs have been set for nitrogen, phosphorous, and sediment.

Over the past 12 years, Lancaster has invested $18 million in the wastewater system but overflows persist. The estimated cost to store and treat the billion gallons of annual overflows is over $250 million, not including the annual costs for energy and personnel to run the new grey systems. The City of Lancaster has a stormwater fee based on impervious cover.

The City proactively developed a GI Plan (Lancaster, 2011) to address the problem of the untreated discharges with techniques that are more cost effective and environmentally friendly. The Lancaster GI Plan is a strategy that lays out a pathway to stormwater management and environmental preservation in a more sustainable and economically viable City.

EPA and City of Lancaster participated in a 2014 case study estimating the value of several of the cost benefits of the Lancaster's GI Plan. The case study highlighted the importance of including the multiple benefits of GI in cost-benefit assessments and adding GI into already-planned improvement projects (e.g., repaving a parking lot with permeable pavement instead of conventional pavement) (EPA, 2014).

The Lancaster GI Plan involved a three-step process including evaluating impervious cover by type and land ownership, identifying potential GI project sites and grant funding for early implementation to understand cost/benefit for each, and determining potential city-wide benefits and provide actions and policy direction to institutionalize GI in the City.

Twenty (20) initial projects were identified that are to be used as demonstration projects for each GI technology. These demonstration projects will remove an estimated 21 million gallons of urban runoff from the sewer every year (approximately 3% of the total volume of runoff required to be removed). 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.

The City of Lancaster undertook an extensive community outreach and participation initiative during the development of the Green Infrastructure Plan (Lancaster, 2011) and leading up to the implementation of a new stormwater fee to recover costs of services the City is required to provide in reducing combined sewer overflows. Much of this was done with staff and partner agencies, but a Green Infrastructure Advisory Committee comprised of representatives from various stakeholders was also formed that provided input to the GI Plan and the stormwater fee program. The community overall was supportive of the GI Plan and is believed to value the improvements being implemented, especially since they are done in cooperation with planned capital improvement projects (seen as a responsible use of taxpayer dollars).

B.3 City of Portland GI Program

Between 2002 and 2009, the City of Portland received $3.4 million from the EPA to fund over 30 innovative public and private projects that demonstrate sustainable, low impact stormwater management. The City developed an Innovative Wet Weather Program (Portland, 2004) to support projects that management stormwater at the source and use vegetation to treat runoff. The City gathers performance data to quantify the benefits, improve design and function, and lower maintenance costs. The program promotes GI, such as green streets, ecoroofs, and trees, through education and outreach opportunities. Much of these efforts are more focused on the CSO areas of the City, but include separated areas as well for some of the GI types.

The City used a two phase approach to create a city-wide Green Streets Program to include green streets in planned projects (Portland, 2007). Phase 1 of the program identified opportunities and solutions to address challenges across City departments and for site-specific locations which ultimately led to a citywide programmatic approach to implementation of green streets. Phase 2 of the program included developing a new citywide policy that establishes goals for the Green Streets Program; evaluated CIP projects as a mechanism for integrating green street projects; evaluated the need for flexibility in the Green Streets Program to address parking, utilities, and street trees; and developed a funding proposal for projects and maintenance.

The City of Portland funds the construction of green streets through the “% for Green” program. Any City of Portland funded development, redevelopment or enhancement project that is not required to meet stormwater regulations but requires a street opening permit or occurs in the right-of-way, is required to pay into the “% for Green” fund at an amount of 1% of the construction costs for the project. Exceptions exist for smaller projects that are within the right-of-way but are not required to pay into the fund. The funds are distributed to GI projects that are not being constructed to meet regulatory requirements; the GI must go above and beyond the stormwater requirements for projects that manage stormwater from the right-of-way.

Projects are monitored periodically and evaluated for effectiveness in meeting objectives for gallons of runoff managed, geographic distribution by watershed and neighborhood, and pedestrian and bicycle enhancement.

APPENDIX C

EXAMPLE GI MAINTENANCE PROGRAM SUMMARIES

C EXAMPLE GI MAINTENANCE PROGRAM SUMMARIES

C.1 City of Philadelphia Maintenance Program

As part of the 2011 Consent Order and Agreement (Philadelphia, 2011), Philadelphia Water Department is implementing a pilot program during the first five years to assess the "Green City, Clean Waters Program" feasibility, opportunity, and cost effectiveness while also defining GI maintenance standards and supporting development of design standards. This program is described in the Comprehensive Monitoring Plan (CMP). Lessons learned from pilot projects will support efforts to improve design, construction, and GI maintenance procedures.

The City of Philadelphia has developed a "Green City, Clean Waters Program" GI Maintenance Manual (Philadelphia, 2014b) which includes GI maintenance protocols for stormwater management practices currently in use by the Philadelphia Water Department. The protocols include a schedule and frequency for maintenance tasks that group the maintenance according to *Surface Maintenance* and *Subsurface Maintenance* elements. GI features addressed include the following:

- Stormwater Tree Trench
- Rain Garden
- Stormwater Planter
- Stormwater Bump-out
- Stormwater Wetland
- Stormwater Swale
- Stormwater Basin
- Stormwater Tree

The GI Maintenance Manual also includes GI maintenance protocols for stormwater management practices in limited practice or not yet in use by the Philadelphia Water Department. These additional practices were developed based experience to date and a review of the literature of best practices. Several years of data will need to be collected on practices in limited practice or not yet in use before maintenance activities can be fully described. The limited practice or not yet in use controls include the following:

- Cisterns/Rain Barrels
- Green Roofs
- Pervious paving
- Blue Roofs
- Green Gutters
- Stormwater Drainage Well

C.2 Onondaga County, New York Maintenance Program

The Onondaga County, New York GI Maintenance Manual (Onondaga County, 2013) developed standard maintenance procedures for 13 GI feature types. In addition, pilot asset lists and maintenance schedules were prepared for several of the 2010 GI Projects to test uploading of information into the County's computerized maintenance management system (referred to as Maximo).

The manual summarizes the GI feature types, maintenance tasks, and the GI asset requiring the associated standard maintenance procedure. GI maintenance is categorized using the Maximo hierarchy and organization. The manual also defines the full suite of green assets that are part of each GI category and includes the unit of measurement. This forms the basis of a look-up table for each project asset to efficiently track maintenance activities and status.

The City of Lancaster, PA uses the Onondaga County GI Maintenance Manual to guide their maintenance activities. The City of Lancaster uses City staff to conduct maintenance in the right-of-way and uses the stormwater budget to pay for street sweeping/vacuuming staff and/or landscape crews to conduct GI maintenance. For GI facilities on private property, the City of Lancaster inspects the facility during construction at the time of excavation to verify that required depths are being achieved and the material for backfill or filtration media meet the specifications. A second inspection is conducted by the City at the time of final stabilization. Additionally, the City requires Operations and Maintenance Agreements for all large projects (i.e., new or reconstruction of more than 1,000 square feet of impervious area) which requires maintenance in perpetuity and is recorded as a legal covenant on the property. Part of the Agreement allows the City to perform maintenance if the property owner is not properly maintaining the facility, and the property owner must reimburse the City for any maintenance costs plus a 10% penalty.

C.3 City of Portland, Oregon Maintenance Program

The City of Portland, Oregon has over 15 years of experience in green infrastructure implementation including approximately 1,400 green streets that the City maintains. Portland utilizes an adaptive management approach to maintenance which allows for analyzing and modifying the ongoing maintenance activities. Adaptive management relies on observation and understanding the human response to activities and adjusting accordingly. This technique allows for flexibility in scheduling maintenance work and provides a feedback look for improved engineering and design of new GI facilities.

Portland defines a level of service to each GI facility defined by funding limitations and the volume of required work. The goal is that the GI facility is functional all year, more than 75% of the vegetation is desirable and healthy, and that the facility is not allowed to degrade to a lower level of service. Performance criteria is based on the following:

- Open inlet structures
- Weed coverage tolerable
- Leaf litter and debris are not compromising function
- Healthy plants
- Excess sediment removed

Portland uses three full-time staff, of which one staff is devoted to project management, planting design, and plan review, whereas the other two staff are devoted to field operations and contract management. The City of Portland partners with other City groups for construction inspection and community outreach.

Contractors hired for GI maintenance are private landscape companies hired under Annual Supply contracts. The contractors work on a lump sum basis and the contract length is typically three to five years. Training with City staff is required and includes knowledge of the plants selected, how to work in small areas without damaging plants, and correct techniques for removal of weeds, leaf litter and sediment.

A schedule of maintenance tasks has been developed based on the season and includes the following treatments:

- Spring planting (from March to May)
- Weeding (from March to September)
- Irrigation (from June to September, as needed)
- Fall planting (from October to November)
- Leaf litter removal (from November to December)
- Sediment removal (from November to March)
- Post-storm event monitoring (from November to March)

The costs for the maintenance implementation is approximately $3.00 per square foot of facility area within the first two years during the establishment period. Beyond that initial period, the costs typically drop to $1.50 per square foot, primarily because irrigation is not required after two years. The City works with a volunteer program of interested citizens to support the maintenance including trash removal, light weeding, clearing inlets, etc. This program improves performance and reduces long-term maintenance costs. Volunteers are provided a “Green Street Steward’s Maintenance Guide” to guide the volunteer activities (Portland, 2012).