ETNA GREEN INFRASTRUCTURE MASTER PLAN DEMONSTRATION PROJECT

BH 7690400

BUCHART HORN, INC.

LANDBASE SYSTEMS

MAY 2014

EXECUTIVE SUMMARY

This study was financed by a grant administered by the Pennsylvania Environmental Council (PEC). The objective of the study to assess the feasibility of reducing/eliminating proposed gray infrastructure alternatives by managing the 90% of Typical Year 2003 runoff through the implementation of green solutions within the Borough of Etna, a combined sewer system community.

The project used innovative site screening techniques developed by Landbase Systems to conceptually locate and size green stormwater infrastructure (GSI), also referred to as Best Management Practices (BMPs). The screening started not with availability of sites but identification and prioritization of high yield inlets via the Etna GIS where GSI could be most advantageously sited.

The Etna Borough GIS model was used in tandem with available soils, slope, and other land use/cover data to characterize the individual catchment areas contributing to the Etna combined sewer system. Each of the catchments was associated with a combined sewer overflow.

The calibrated SWMM Etna sewer system model is used to evaluate the impacts of GSI on the volume and rate of flow during the so-called Typical Year 2003. These impacts would be measured as changes in the frequency duration and volume of overflows. As the SWMM model extends to the ALCOSAN point of connection, it was possible to estimate the impacts on the volume to be conveyed and treated by ALCOSAN after implementation of a program of GSI in the Borough.

Based upon Municipal priorities, available funds, and GSI opportunities, the team established 5 phases for primary GSI projects (including 23 sites) and a future phase with up to 26 GSI sites.

The work done for this master plan estimates it is feasible to manage a total of 39.4 mg of runoff per year if all GSI sites are implemented.

Implementing all 23 projects detailed under the Master Plan will manage a total of 16.1 mg annually at an estimated cost of $6.1 million. This translates into a cost of $0.38/gal. This includes the Streetscape components not directly related to RO management. When these components are backed out of the total, the estimated cost for the GSI elements becomes $4.1 mil and $0.25/gal of RO managed.

Based our review of modelling results, the GSI will only have very limited benefits in the reduction of grey infrastructure requirements. This is due to the limited improvements to Etna Combined sewer system and the amount of capacity needed in the Etna Trunkline to convey sewage flows from upstream communities. However GSI may be of value in avoiding the cost of $ 1.3 million needed in Etna collection system improvements if the next Level of CSO Control is required.

The Existing Conditions SWMM model for Pine Creek estimates about 28% of reduced flow volume from GSI would benefit ALCOSAN operations and infrastructure.

ETNA AND SHALER GREEN INFRASTRUCTURE MASTER PLAN DEMONSTRATION

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EXECUTIVE SUMMARY

TABLE OF CONTENTS

ETNA AND SHALER GREEN INFRASTRUCTURE MASTER PLAN DEMONSTRATION

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1.0 INTRODUCTION

The Borough of Etna Allegheny County PA has received funding for this Master Plan under a grant from the Pennsylvania Environmental Council to address to demonstrate the opportunities for and limitations of green infrastructure to reduce combined sewer overflows in the region. This grant is administered by 3Rivers Wet Weather. A primary objective is to identify, quantify and cost the potential for GSI to complement proposed "grey infrastructure" under the Borough's draft Wet Weather Control Plan.

Green Infrastructure is being both considered and implemented by the Borough of Etna to achieve better Water Quality and Sustainability. It is also being evaluated as a means to address compliance and regulatory challenges facing the Borough. These requirements stem from the existing water quality criteria in the local streams that are not being met, some as a result of combined overflows.

Pine Creek is a 22.8 mile long tributary to the Allegheny River. Its watershed is 67.3 square miles in area and contains approximately 128 stream miles. Its watershed is located just north of the City of Pittsburgh and the land use varies from highly urban areas in the lower part of the watershed to typical suburban commercial and residential developments. The population within the watershed is estimated to be 91,000 persons. The estimated impervious cover in the watershed is 10.6%.

The Borough of Etna is the most downstream community in the watershed. The Borough is highly urbanized and densely populated. It contributes stormwater to adjacent sections of Pine Creek via its combined sewer system, dedicated stormwater facilities and direct runoff. The Pennsylvania Department of Environmental Protection's 2008 *Integrated Water Quality Monitoring and Assessment Report* identified several segments of streams within the watershed as impaired for one or more designated uses. The report lists nutrients, pathogens, and siltation as the types of pollutants affecting the waterway. These pollutants are primarily from urban runoff and storm sewers, but other sources include land development, on-site wastewater, small residential runoff, and unknown sources.

Consistent with its status as small CSO community, the Borough is electing to develop a range of Combined Sewer Overflow control alternatives that would meet one of EPA's criteria for the presumptive approach.

On March 8, 2013, Total Maximum Daily Loads (TMDLs) were established to address fecal coliform bacteria related recreational use impairments associated with unknown causes in the Pine Creek Watershed in southwestern Pennsylvania. The TMDL establishes reductions for Etna's CSO discharges as well as its dedicated stormwater facilities under the MS4 Permit Program.

The proposed Master Plan would also support active and planned local efforts by Etna to improve the Pine Creek Watershed by continuing to implement a PADEP and EPA 319 non-point source (NPS) pollution funded Watershed Implementation Plan (WIP) prioritized project designed to reduce urban runoff impacts in the lower Pine Creek basin.

The Borough is currently engaged in five Green Infrastructure (GSI) initiatives:

- Residential Downspout Disconnection Program
- Green Streetscape Phase I, IA and Phase II Projects currently funded by Section 319 Grants
- Green Infrastructure Specific projects: Community Pool Bioswale and School Street Municipal Parking Lot.
- Street Tree Planting

A critical consideration addressed under the GSI Master Plan Project is to determine where investment in GSI is indicated. Etna Borough as a CSO community wants to be able to integrate Green Infrastructure into its COA and NPDES Permit compliance. The Master plan addresses the major challenge is how anticipate CSO volume reductions and be able to write Green Infrastructure into a legally enforceable order/permit provisions.

However a second challenge is phasing the costs and funding a multi-year and multiple phase program, given the many uncertainties of long term implementation. These uncertainties are:

- Pending regulatory approval of the ALCOSAN Wet Weather Plan- particularly the schedule for implementation
- Pending regulatory approval of the Etna Draft Wet Weather Plan and final level of CSO control that might be required
- Implementation requirements for the Pine Creek TMDL
- Performance uncertainties associated with GSI
- Cost of GSI

The current level of political support for the Green infrastructure in the Borough of Etna is strong on part of its Council. In spite of its limited resources, the Borough has consistently supported GSI project proposals and provided matching funds when needed in order to advance GSI goals. It has implemented a residential downspout disconnection program via ordinance and voted to implement program incentive via environmental fee credits. Council has also supported residential outreach programs for GSI awareness. It has signed long term maintenance agreements with property owners for pervious parking areas. It has endorsed incorporating green features into public facilities such as parking lots. It has supported the acquisition of vacant tax delinquent land for “rain parks” under the Allegheny County vacant properties program. Borough government has regularly met with commercial district property and business owners to enlist support for the Borough’s Green Streetscape Program. Council members regularly attend presentations and sessions addressing Green Infrastructure issues. The Borough has sponsored and participated in educational presentations on GSI implementation.

The GSI Master Plan will provide a road map for the Borough and others. It is intended to demonstrate how planning for source reduction can be done to meet defined compliance objectives within the context of a densely developed urban community.

2.0 CURRENT CONDITIONS

Borough of Etna is a combined sewer community. Etna has comprehensively built a sewer system spatial database that incorporates physical survey data, connectivity and legacy information for its sewer pipe, manholes, regulator structures, combined overflow structures (CSOs), inlet catch basins and dedicated storm water management network (Appendix A). This GIS information is used to manage operation and track improvements to the Borough's sewer system (Figure 2-1 below).

Figure 2-1

Storm water is primarily managed by its combined sewer system but there are also a smaller number of dedicated municipal storm systems in the Borough. The account drain less than 55 acres in area (<11% 0f the Borough) and are redundant to the combined sewer system in many areas.

The Etna combined sewer system consists of smaller sub-systems that portions of the Borough and connect at various points to the Etna Trunkline via sewer mains. The Etna Trunkline eventually connects to the ALCOSAN System at Structure A-68. The following Figure 2-2 presents the delineated individual sewer catchments in the Borough.

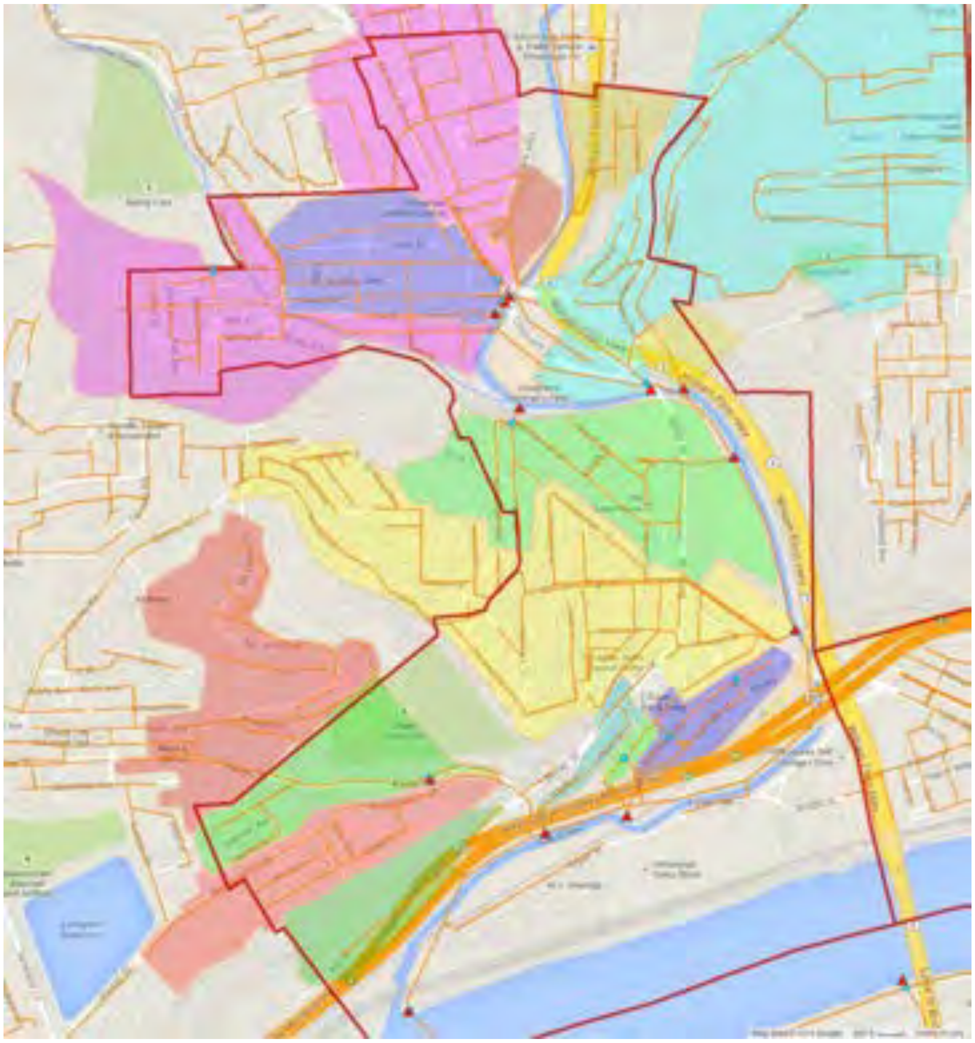


Figure 2-2

A number of Etna's collection sewers also service upstream catchment areas in Shaler Township that are directly connected into the Etna combined sewer system and are conveyed to the Etna Trunk line.

Due to the fact the Etna sewer system must manage both sewage and storm water, the system must regulate flow and incorporate points of relief to prevent backups and interruptions in service. The Borough of Etna combined sewer system has nine permitted overflows to Pine Creek; this includes an additional point of relief exists in the Etna-Shaler Trunkline at MH-7 added at the last NPDES Permit renewal. There are also two unpermitted points of discharge at MH-B23 (Parker Street) and MH-C108 (Maplewood). The following figure 2-3 shows the location of the CSOs and system regulators.

Figure 2-3

Because of hydraulic overloading of the Etna Trunkline, ALCOSAN system wet weather backups, regulator issues and limited collector system capacity, overflows occur to Pine Creek. Field observations and monitoring data indicate frequent overflow events occur from the Etna Combined Sewer system.

The existing Etna sewer system performance has been evaluated using the ALCOSAN/3RWW flow monitoring data and the calibrated ALCOSAN Storm Water Management Models (SWMM). The SWMM model results provide the system baseline for Grey Infrastructure and GI improvements under so-called Typical Year conditions, a regulatory wet weather benchmark for the ALCOSAN region.

During the Typical Year it is estimated that a total of 676 million gallons flow through the Etna sewer system. Of this amount, it is estimated that 66 million gallons or 10% of the total annual flow through the Etna collection system comes from upstream areas of Shaler Township. The model also predicted the frequency and volume of overflows.

Approximately an estimated 83 million gallons of sewage overflows annually to nearby Pine Creek and West Little Pine Creek or 13.6% of the total yearly sewer flow.

From the standpoint of the ALCOSAN Point of Connection (POC) and again based on the Typical Year, SWMM modeling estimates Shaler contributes 66% of the annual flow volume to A-68. Etna and Ross contribute 25% and 9% respectively of annual total. The estimated total annual volume of sewage conveyed is on the order of 2400 million gallons.

The Etna SWMM model was used to develop CSO statistics including the percent of combined sewage captured in response to the presumption approach of the CSO Control Policy. The model was run to determine how much of the wet weather combined sewage volume per year would be captured during the Typical Year 2003. Based on the analysis of wet weather events during the Typical Year, it was determined that baseline capture percent for the Etna combined sewer system was 65.83%. This fell below the minimum capture percent under the Presumption Approach of the CSO Control Policy.

The Etna SWMM model result were also employed to compute the baseline loads of pollutants identified as impairing receiving waters. Pine Creek is on the Section 303(d) list of impaired waters due to fecal coliform (FC) bacteria loads. Using accepted values for the fecal coliform in raw sewage, the SWMM model results were used to estimate the baseline FC loads from the Etna CSOs during the Typical Year 2003. The baseline annual FC load is estimated at 5.64E +14.

3.0 GSI SITE FACTORS

The Borough of Etna presents a densely developed urban setting that is challenging for GSI. Steep slopes, poorly draining soils, and dense development characterize much of the Borough.

As a major consideration of this study is relating the runoff management impacts of GSI sites on the Borough's CSOs, it is necessary to relate site factors with respect to each CSO tributary area or catchment that may limit or facilitate GSI performance. Figure 3-1 below again presents the respective catchments for the CSOs, shown as triangles in the combined sewer system.

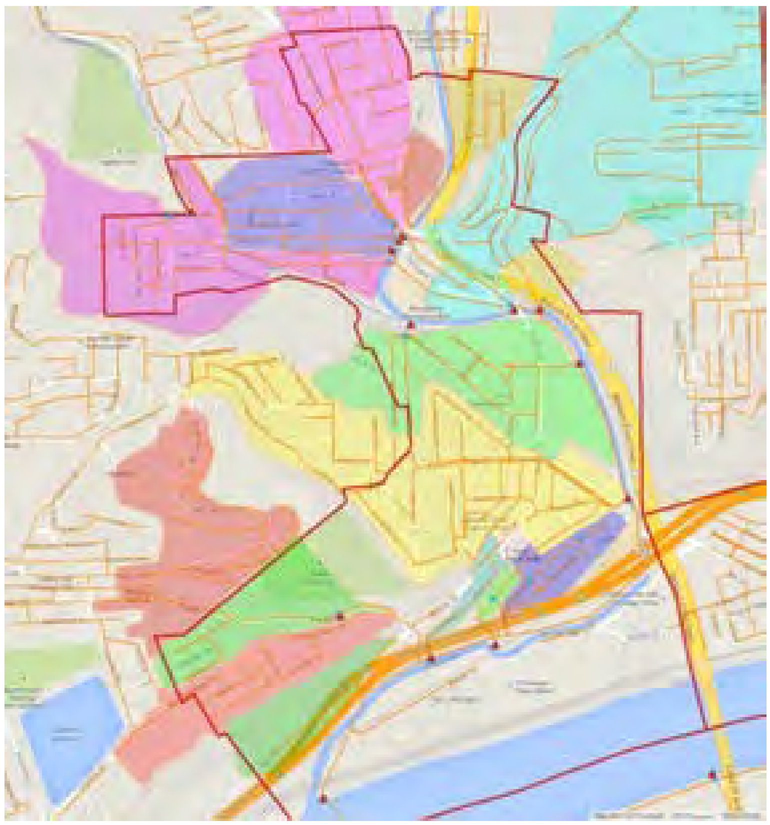


Figure 3-1

The detailed GIS analysis performed to characterize the respective slopes, soils, and impervious surfaces for each CSO tributary area is presented in Appendices B, C, and D.

SLOPES

Etna's CSO catchment topography is dominated by areas with steep slopes-more than 75% of the tributary areas have slopes greater than 5%. The table summarizes the GIS analysis performed to determine the acreage and overall percentage of catchment area represented by steep slopes (> 5%) in each catchment:

CSO Catchment	Total Catchment size Acres	Steep Slopes (>5%) Acres	% Steep Slopes (>5%)
1	84.1	58.6	70%
1A	47.1	26.7	57%
2	142.3	119.1	84%
3	157	131.9	84%
4	27.9	11.9	42%
5	60.5	46.1	76%
7	13.1	12.1	93%
8	15.44	6.1	40%
Parker B-23	96.87	75.2	78%
C-108A*	14.56	13.1	90%
Total:	644.31	487.7	76%
* Sub-Catchment CSO 1A			

With the exception of the catchments for CSO 4 and CSO 8, the majority of the Etna CSO catchment areas are mapped as steep slopes. Steep slope are an important factor limiting GSI facilities.

OPEN SPACE

The amount of open space is significant in providing general guidance with respect to development density and potential GSI sites. The table below present the amount of open space mapped for each catchment:

CSO Catchment	Total Catchment size Acres	Open Space (Acres)	% Open Space
1	84.1	1.9	2%
1A	47.1	0.6	1%
2	142.3	0.7	0%
3	157	4.9	3%
4	27.9	0.9	3%
5	60.5	2.2	4%
7	13.1	0.0	0%
8	15.44	2.3	15%
Parker B-23	96.87	5.4	6%
C-108A*	14.56	0.3	2%
Total:	644.31	18.9	3%

There is little available open space in the Borough's CSO catchments. Overall 3% of total area contributing to the CSOs is mapped as open space.

IMPERVIOUS AREA

The Borough is oriented along hydrologic features and transportation corridors. As can be seen in the Figure 3-2 below large amounts of roofs, parking lots and other impervious surfaces adjoin watercourses. The amount of impervious area is significant in providing general guidance with respect to potential GSI sites.

Figure 3-2

The following table summarizes the amount of impervious cover associated with each CSO catchment tributary area:

CSO Catchment	Project Boundary (sq ft)	Impervious Cover (sq ft)	Impervious Cover %
1	3,663,391	1,532,994	41.8%
1A	2,074,922	1,178,899	56.8%
2	5,923,925	1,011,666	17.1%
3	6,839,500	1,460,064	21.3%
4	1,214,743	702,245	57.8%
5	2,637,071	1,059,851	40.2%
7	569,502	56,812	10.0%
8	785,686	510,457	65.0%
Parker B-23	4,185,848	1,012,954	24.2%

SOILS

Soils are a critical determining factor in GSI design. Information on the availability of appropriate soils for infiltration is needed for GSI planning unless recourse is made to engineered soil materials. Figure 3-3 presents the mapping of soils by hydrologic soil group. In general, Hydrological soil group B (the green areas in the figure) are amenable to GSI installations. The remainder of the Borough is mapped as either group C (purple or orange) or C/D (yellow). However the extensive industrial land use and long term human habitation of the area has caused many areas to be mapped as Urban land reflecting the soil column disturbance and alteration that may have occurred. Unfortunately the reliability of the mapping is often compromised in this context and greater reliance must be placed upon field evidence or corroborating documentation.

Figure 3-3

The following table summarizes the relative mapped soils by hydrologic group by each CSP catchment:

CSO Catchment	Soil Hydro Group B	Soil Hydro Group C	Soil Hydro Group C/D
1	65%	35%	0%
1A	56%	22%	23%
2	7%	11%	82%
3	6%	5%	89%
4	0%	94%	6%
5	61%	16%	22%
7	49%	2%	49%
8	15%	85%	0%
Parker B-23	12%	25%	63%

As can be seen in the table, soils in Hydrologic Group B predominate in the areas tributary to CSOs 1, 1A, 5 and 7.

It has been discussed that problems with soils mapping often occur when tracts are mapped as Urban land. When the reliability of the soils mapping is in question, care must be taken in applying exclusionary criteria in GSI planning studies. A second hazard lies in that the hydrogeological context may be obscured. The Borough of Etna, sections of the City of Pittsburgh and similar situated municipalities on all three rivers are located on regionally significant Quaternary Alluvial formation, also known as the valley fill formation (Piper, 1933). Traditionally utilized for water supply and downtown building heating/cooling, (Gallager, 1973; Van Tuyl, 1951), this sand and gravel formation has potential opportunities and limitations with respect to GSI. Recent intensive hydrogeological investigations in Etna have yielded a majority of hydraulic conductivity results that fell in the range of 10 to 100 feet/day. The results also indicate infiltration should be done with provisions to avoid degradation. Consequently all GIS planning concepts that divert and remove stormwater from the combined sewer system employ some kind of treatment- green inlets, high rate bio-filtration, etc. –before storage for infiltration and/or discharge to the environment.

PARCEL SIZE

Along with the limitation imposed by soils and slopes, the available space on to which a GSI must be sited greatly influences GSI facility planning and implementation. Figure 3-4 below illustrates the property parcels within the Borough of Etna.

Figure 3-4

The following table average and median parcel size along the average building footprint in areas zones residential R-1 and R-2.

CSO Catchment	Total Catchment size Acres	Avg Parcel Size (SF)	Median Parcel Size (SF)	Ave Bldg Footprint Area Resid Zoning: R-1, R-2 (SF)
1	84.1	6,327	4,067	725
1A	47.1	10,934	4,021	725
2	142.3	8,969	2,741	773
3	157	13,561	5,835	988
4	27.9	4,801	2,568	823
5	60.5	6,195	4,654	802
7	13.1	6,867	5,087	840
8	15.44	3,778	2,484	1,112
Parker B-23	96.87	20,486	5,507	997
C-108A*	14.56	6,874	4,856	716
Total:	644.31			

* Sub-Catchment CSO 1A

The median parcel size ranges from 2500 square feet to 5800 square feet. The limited available land suggested that finding a well situated site for GSI may be challenging. It also suggested that source reduction technologies that are not as space consumptive as other techniques be examined closely for potential use in planning GSI in Etna.

4.0 REGULATORY REQUIREMENTS

Etna's Feasibility Report, mandated under its consent order, identified surcharging segments and associated surcharge levels projected for the Typical Year storms. Improvements are needed for higher levels controls as neither the existing combined sewer system nor the Etna Trunkline can convey required wet weather sewage volumes within the CSO activation range specified by regulatory guidance. Moreover, CSO volume reductions have been mandated under the Pine Creek TMDL to achieve water quality compliance. The TMDL also required load reductions from the Borough's stormwater outfalls under its MS4 permits.

Etna has evaluated the collection system conveyance improvements required to reduce the number of activations at its permitted overflows and the two unpermitted points of overflow from its combined sewer system unpermitted overflows MH-B23 (Parker) and MH-C108A (Maplewood).

Based on the above requirements, the Borough has concluded that the 8-12 overflows per year level of control is appropriate for the Etna combined sewer system for the following reasons:

1. It achieves the elimination or capture for minimum treatment of no less than 85% by volume of the combined sewage collected during precipitation events on a system-wide annual average basis. Table 1 below summarizes the capture statistics for these levels of control versus the computed Typical Year 2003 Baseline system wide capture.

CSO Level of Control (Activations)	Wet Weather CSS Capture Volume (%)
TY 2003 Baseline	65.8
0-3 CSO Events/ TY 2003	99.3
4-7 CSO Events/ TY 2003	99.1
8-12 CSO Events/ TY 2003	95.2

It can be seen that the 8-12 overflow level of control provides 95% capture.

2. It achieves 85% reduction in fecal coliform CSO loads to receiving waters. The 8-12 CSO level of control achieves an 88% load reduction from baseline TY 2003 loads.

The Borough's feasibility Study has been submitted and is under review by regulators. Although the proposed level of control has not been accepted by regulatory agencies, it provides a useful basis for the purposes of the Etna GSI Master Plan in demonstrating GSI in achieving compliance objectives.

5.0 GREEN VS GREY INFRASTRUCTURE

In recent years, Green Stormwater Infrastructure (GSI) has found their way into Combined Sewer Long Term Control Plans (LTCPs) and Wet Weather Plans (WWPs) as plan components. To date successful local and regional examples of GSI implemented for CSO control have been limited. Moreover it is unlikely that in most cases GSI technologies alone are sufficient to fully control CSOs. The current thinking appears GSI has a complementary role to play to "grey infrastructure"- traditional conveyance or treatment system improvements-as part of larger programs. Clearly that approach asks the question as to how much of the potential reduction can be achieved and at what cost.

For the purposes of this plan, GSI will also refer to source controls and other traditional stormwater BMPs in that they represent a sustainable stormwater management practice.

The Borough's current compliance strategy currently emphasizes "grey components" because of observed conveyance issues. The Etna Trunkline is subject to hydraulic overloading from upstream sources and from backwater conditions created by the ALCOSAN system. Both of these factors result in an excessive frequency and volume of combined sewer discharges to Pine Creek from the Etna sewer system discussed previously. As Etna contributes approximately 25% of the total annual flow to the ALCOSAN Point of Connection (currently A-68) it is difficult to envision GSI solutions implemented in Etna playing a central role sufficient to convey the combined peak sewer flows from Etna, Ross Township, Shaler Township, and other upstream municipal systems without hydraulic overload.

Limited improvements to Etna Combined sewer system are needed to accommodate TY 2003 flows without surcharge and remove local restrictions that influence the operation of the collection system. These costs appear to be on the order of $300,000 if a level of control of 8-12 overflows is assumed. However the costs associated with Borough collection system improvements rise sharply to $1.3 million if a level of CSO control of 4-7 CSO activations would be required.

Therefore under its 2013 Feasibility Study the Borough stated it would look to achieve further reductions in CSO frequency at selected CSO points via the use of targeted "green infrastructure" where appropriate. The Borough thus envisions compliance control goals can be achieved at least in part by implementation of Green Infrastructure in tandem with traditional grey facility improvements.

Among the benefits, the Borough wants to evaluate if GSI can potentially reduce stormwater peak flows and volumes in both its Combined (CSS) and MS4 systems so that:

- CSS Peak reduction will reduce conveyance facilities size and cost
- CSS Volume reduction will benefit both the Etna and the regional sewage treatment authority ALCOSAN/Regional system in reducing the amount of unbilled water to treat
- The frequency and volume of CSOs will be reduced for the Borough's NPDES mandated Long Term Control Plan.

Etna is also looking to see if GSI can be advantageously applied to mitigate the two unpermitted points of overflow from its combined sewer system at MH-B23 (Parker) and MH-C108A (Maplewood).

6.0 GSI TOOLBOX

GSI is designed to fit the surrounding land use and can depend on the following site specific factors:

- Slopes
- Soils
- Tributary area
- Depth to water
- Buffer distances to Roads, Streams, Buildings.

At the project inception, the following GSI measures were considered for inclusion under the Etna Master Plan:

a) Pervious pavement
b) Rain barrels/cisterns
c) Green roofs
d) Tree planting
e) Creation of green space on vacant lots such as Rain Parks
f) Green streets
g) Basin retrofits

Cisterns and rain barrels can be placed at most properties located within the sewershed without regard to soils, slope, perviousness, etc. There are no basins sited in the Borough that are candidates for retrofits for improved stormwater management. Likewise, the potential Green Roof installations involved private buildings other than the Borough Building and required a structural analysis to assess feasibility that was beyond the scope of this project. These were eliminated from the GSI analysis for this reason.

7.0 SCREENING BY RANKED LOCATIONS USING LBs GOAL PROCESS SOFTWARE

The RO Control Management strategy as well as the GSI facilities under the Etna Master plan need to reflect the physical realities of the Borough and the adjacent areas of Shaler Township. Runoff is generated from many small lots in steeply sloped upland areas in residential districts. This ultimately becomes surface water flowing along curb lines within public rights-of-way to be intercepted by the Etna combined sewer system.

The fundamental GSI philosophy under the Etna Master Plan is management of 90% of the runoff at “high yield” inlets that now enter the Borough’s sewer system as opposed to control of runoff from a percent of impervious surfaces.

The challenge is to retrofit GSI into an existing built environment rather than part of new construction. The most affordable and cost effective retrofit Green Stormwater Infrastructure (GSI) in combined stormwater areas are located and sized where:

- Installation sites are just above existing combined stormwater inlets that see higher flow. In the Etna and elsewhere in the Pittsburgh area, we have found that 5% of the inlets handle more than 30% of existing runoff flows. When comparing inlets it is possible rank them by the amount of water entering the combined sewer system at that point. It is thus possible to identify the top 5% higher ranked inlets.in the system. Similarly the top 10% of the system inlets handle nearly half (47.1%) of inlet runoff. Higher ranked inlets typically have more than 0.5 acre of drainage area with higher percentages of impervious surface.
- Land adjacent to the concentrated surface water flow paths (usually curb lines) need enough space and depth to intercept, pretreat, and slow release runoff preferably keeping any outflow from reentering the combined sewer network.

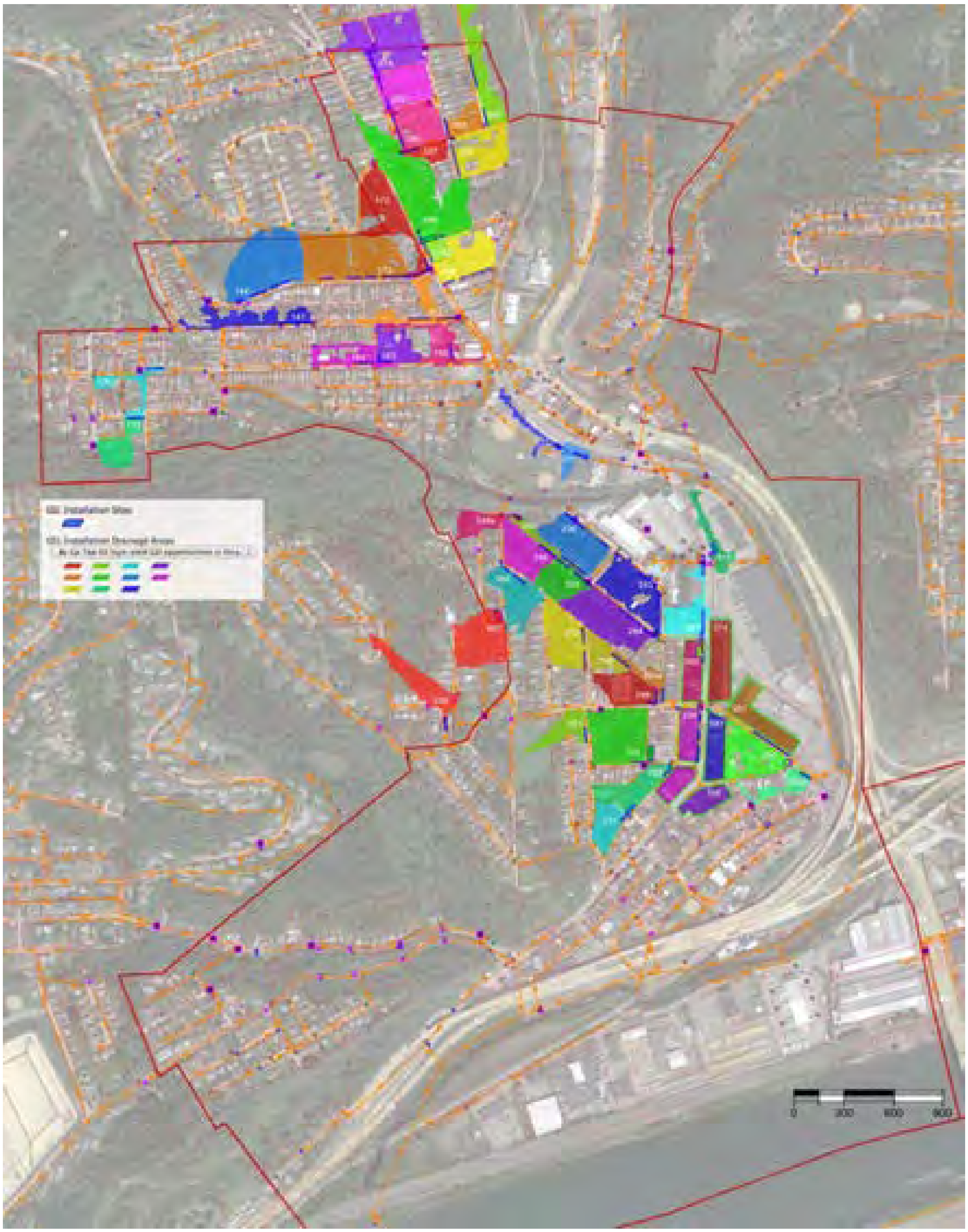
Therefore the starting point for the process is the base information for the Etna combined wastewater and stormwater network and the best available consistently integrated spatial databases containing overflow structures, catch basins (where surface water flows into the combined network), 3D surfaces, curbs, gutters, surface cover (paving, buildings, pervious surfaces), property ownership and uses.

The GOALprocess uses detailed 3D landform shape with curbs, gutters, buildings, surface cover, low points, and puddles to model how and where rain water flows through the landscape. Catch basins along curb lines and at low points are structures designed to get rainwater into the subsurface pipe network.

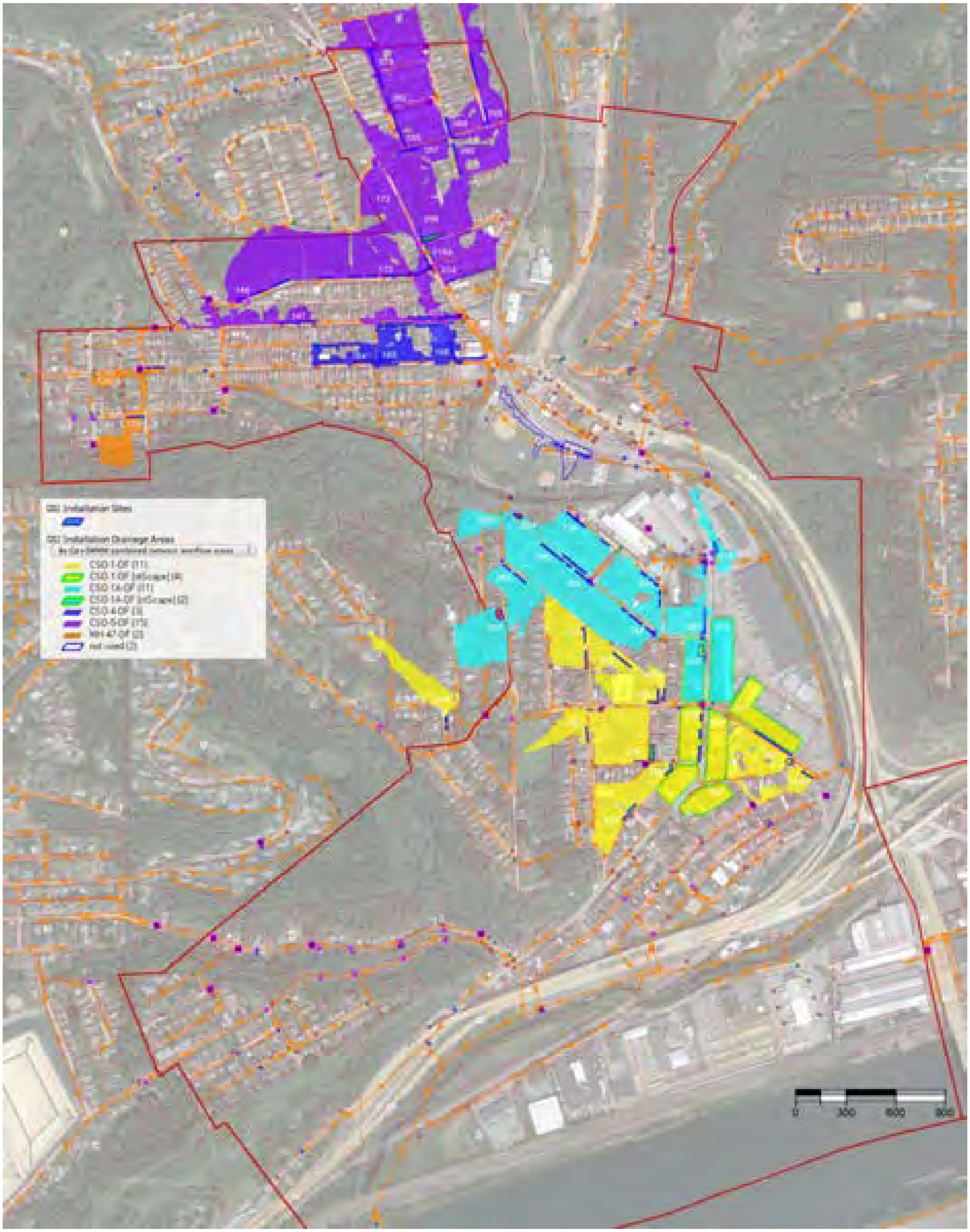
The following map shows where catch basins are located and ranks catch basins and their contributing drainage areas by annual rainwater runoff volume. Referring to the figure, 67.3 % of the runoff or 142.3 million gallons (mg) during the Typical Year 2003 would expected to reach 20% of the inlets identified as the two top ranked groups of inlets.


Municipal Boundaries
Outfall Structure Locations
combined only
separate only
Waste Water Pipe Network
2ft Topography
Allegheny County Parcels

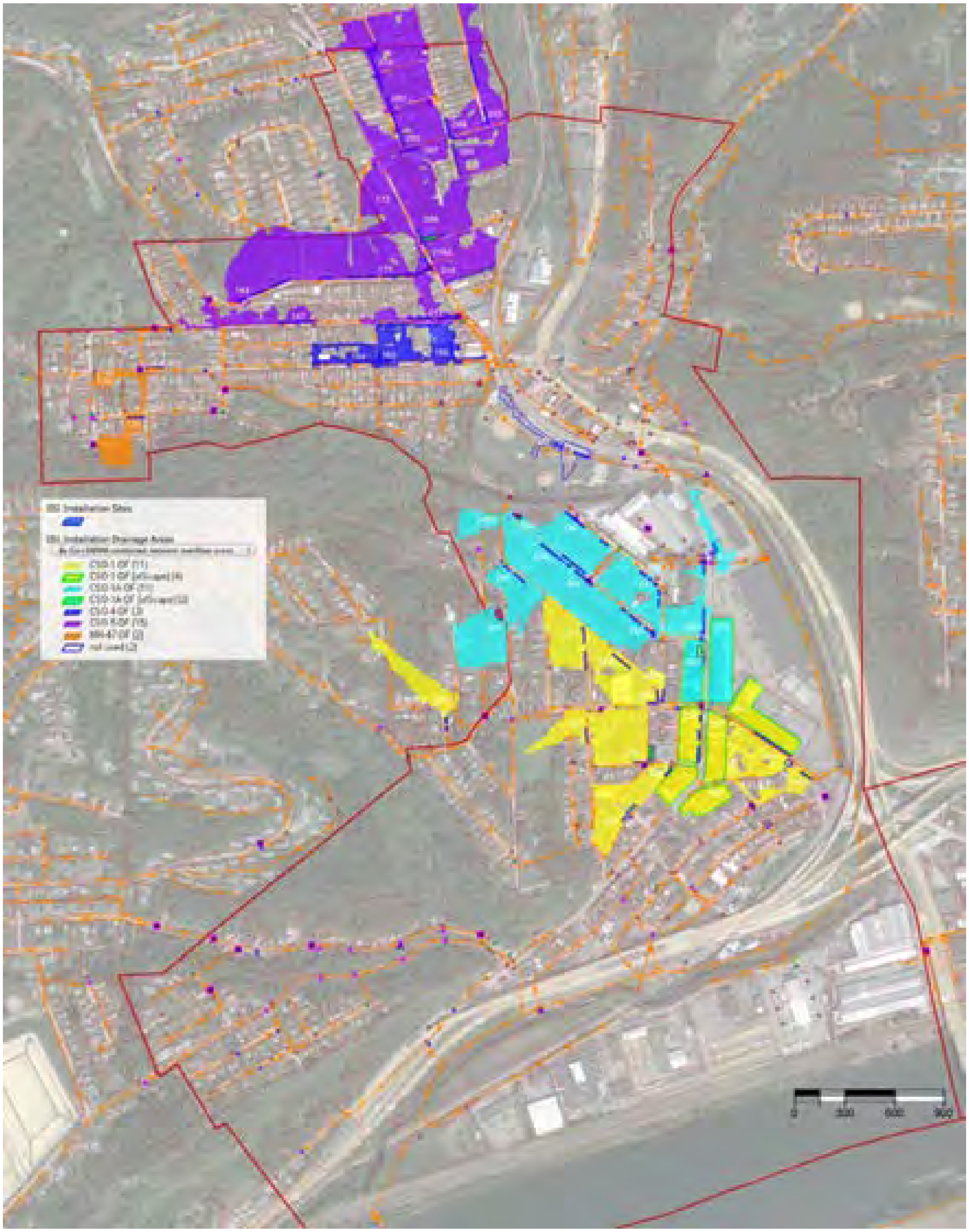
The top 50 high-yield potential surface water management sites are identified from the integration of the GOALprocess surface flow, the SWMM combined network model, and engineering evaluation of each site for its potential to intercept, filter or delay, and manage up to 90% of annual runoff from each drainage area. The Goal softwarewas able to determine potential contributing areas to each GSI site as can be seen below.



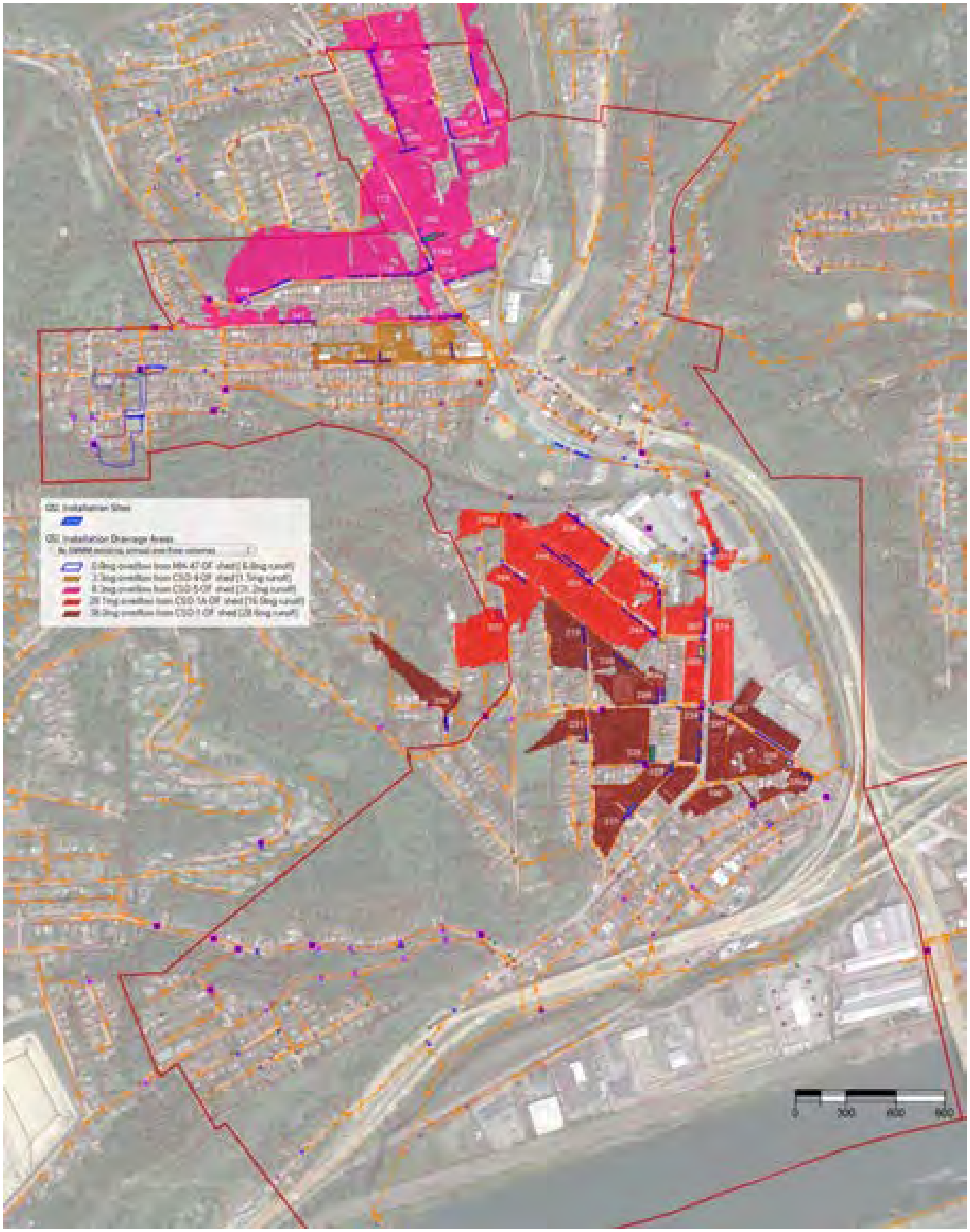
In order to evaluate GSI for compliance purposes it is necessary to group the potential GSI installation site and its associated drainage area by the CSO catchment where it is located.



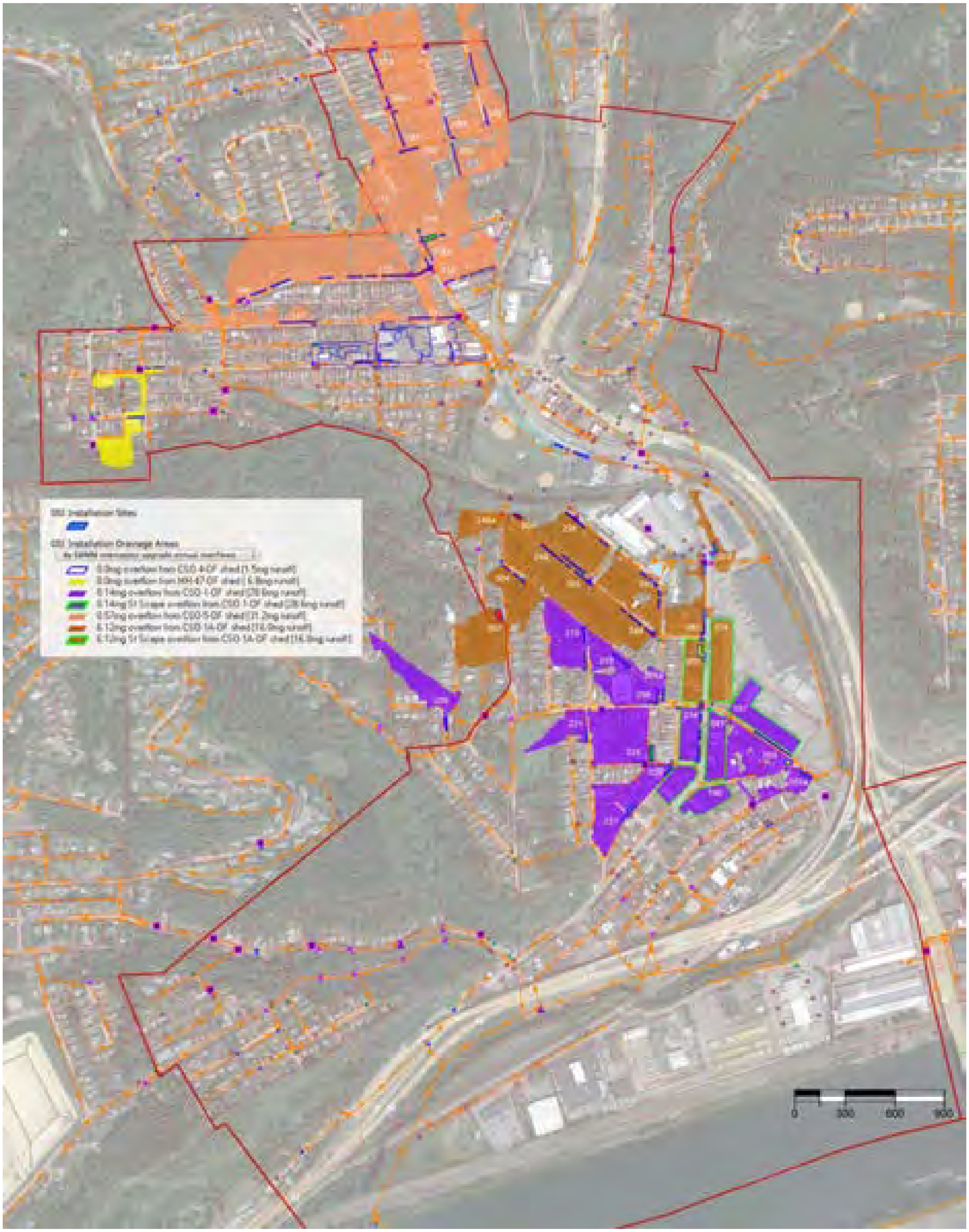
The following map groups and highlights the ALCOSAN Basin Planner defined SWMM (EPA Storm Water Management Model) catchment name in which each installation site and its associated drainage area is located. A SWMM catchment is a defined area that flows into the modeled pipe network. The relationship allows GSI installations to be evaluated using the SWMM model.



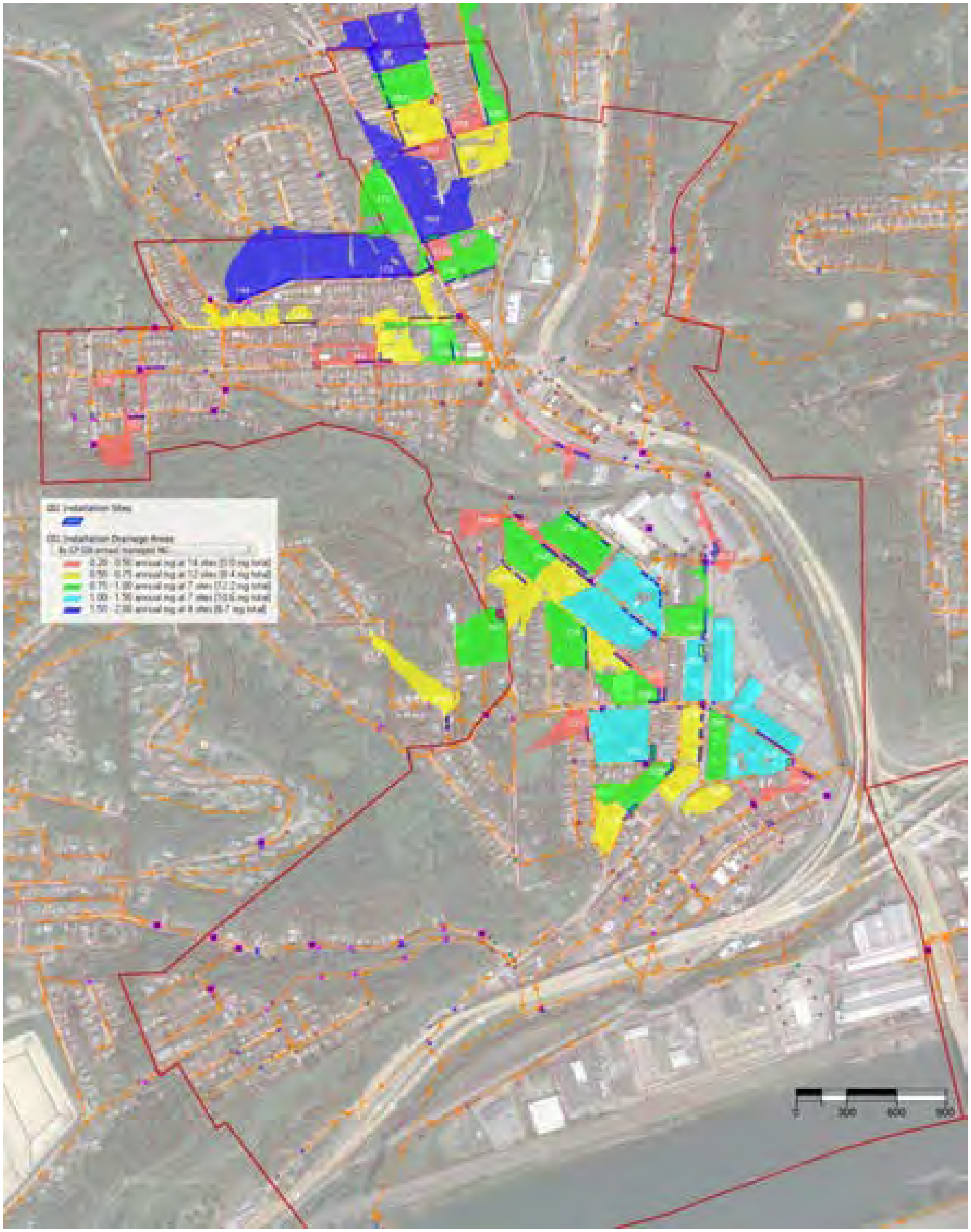
The following map presents the annual volume of overflow computed by the Etna Existing Conditions pipe network model using the TY2003 rainfall. It also presents the computed runoff component for each catchment.



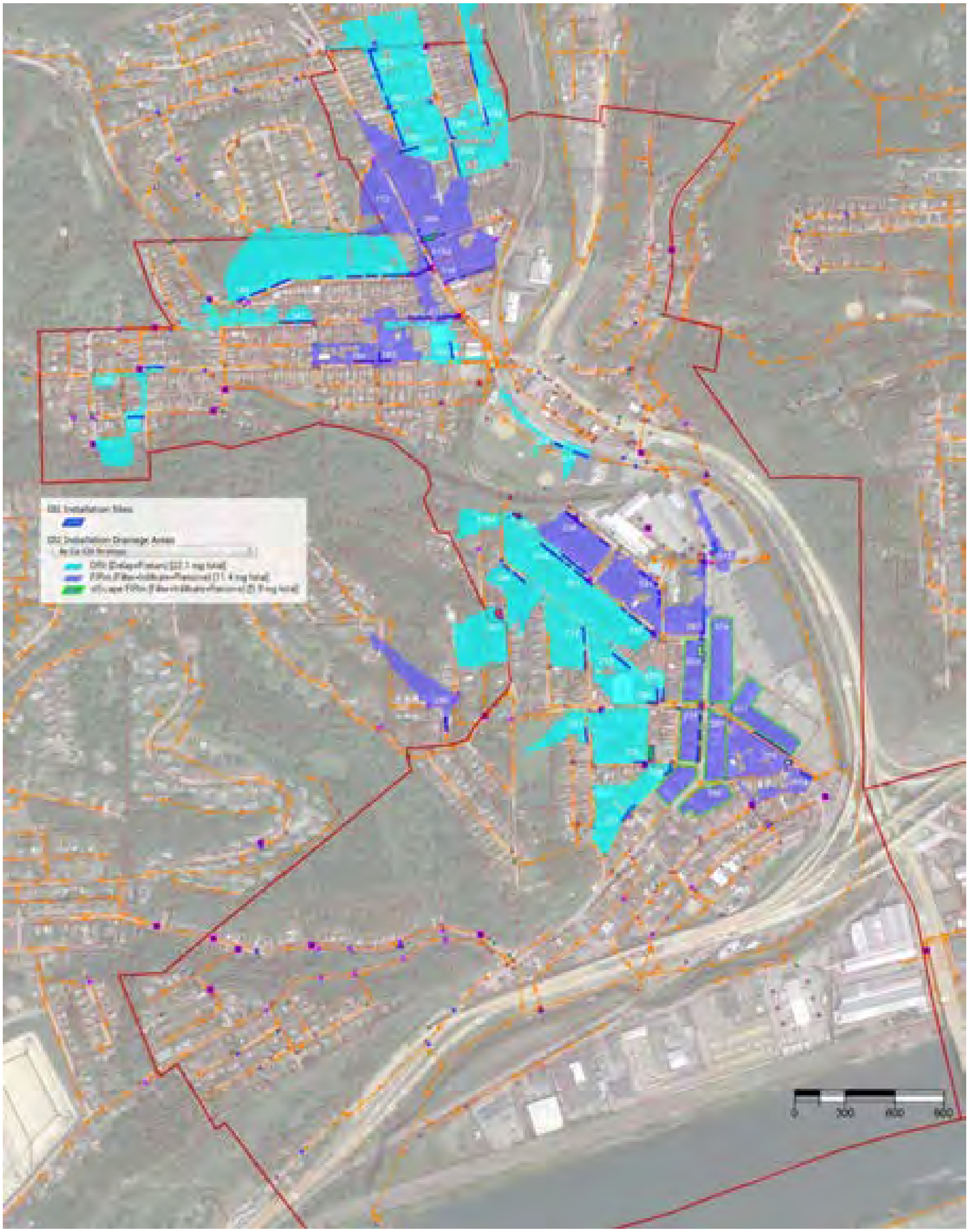
If the Etna Trunkline in Pine Creek is increased in size in accordance with Pine Creek Sewershed Joint Feasibility Study, this map groups and highlights the sharp reduction in TY 2003 modeled annual CSO volumes that would be discharged into Pine Creek following this gray infrastructure upgrade.



By varying storage and other GSI parameters, GOALprocess software was used to size GSI and surface water management features to achieve the desired 90% runoff management for the Typical Year 2003 rainfall. This map groups and displays the simulated performance of Etna GSI sites in Millions of Gallons of managed rainwater runoff for the typical year.



A final consideration is whether the GSI removes surface water via infiltration / evapotranspiration /diversion from the Etna sewer system (FIRm) or delays and return it via storage (DRt). Both management strategies are used depending on the location and the site specific considerations.



The map highlights two surface water management strategies. Both strategies illustrated here intercept surface water runoff along existing curb lines within public rights-of-way. The strategies differ based upon how they manage water and where the sites are located in Etna. A GSI strategy of 'Filter, Infiltrate, and Remove' (FIRm) is proposed for high flow sites on the lower and main streets of Etna that are close to Pine Creek or in locations that have been mapped as being in the Valley Fill (Quaternary) sands and gravel formation in Figure 7-1 below . Based on the modeling it possible to manage 17.3 mg annually in this manner.

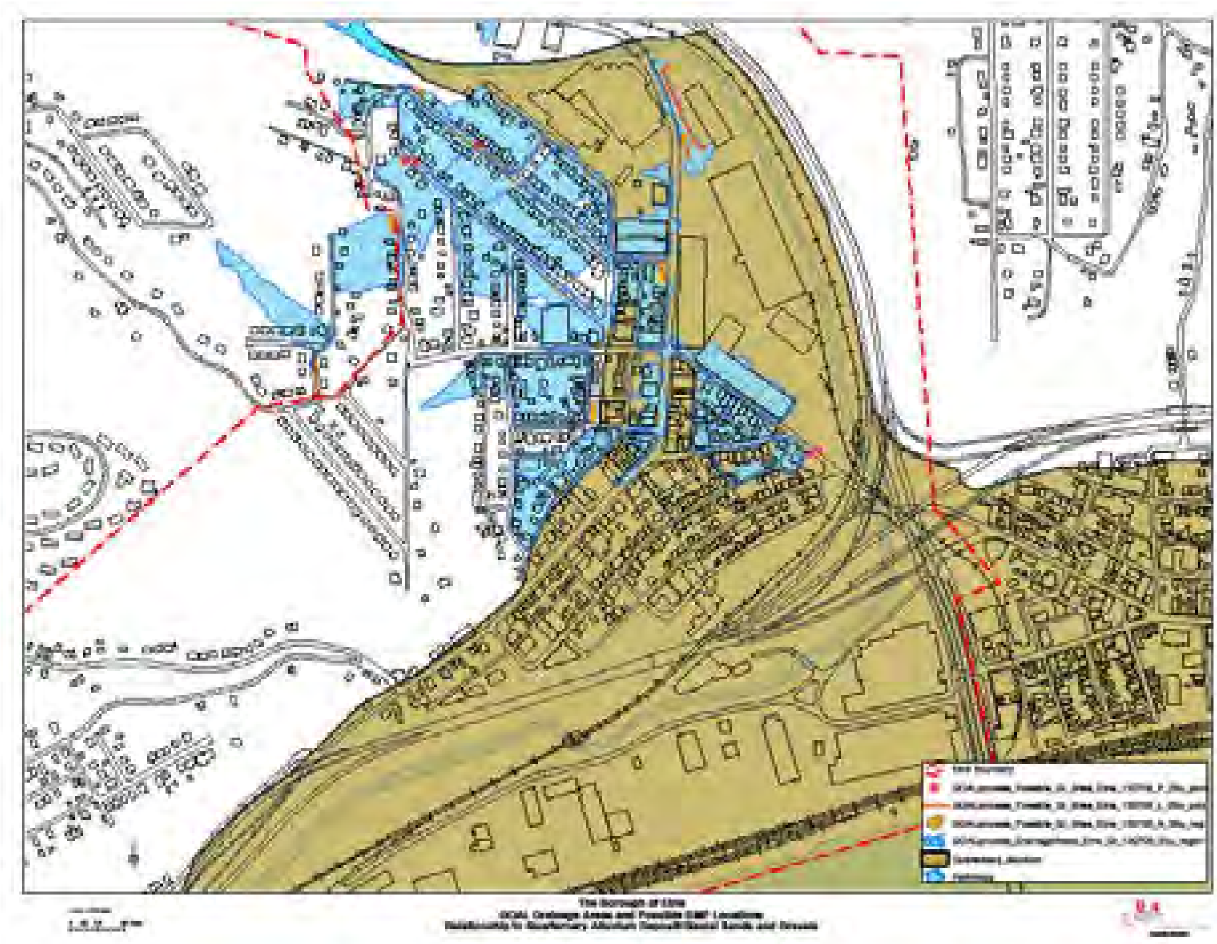


Figure 7-1

On the other hand, sites with steep slopes or far from Pine Creek would use 'Delay and Return' (DRt) with no or limited removal. In this strategy runoff is intercepted, delayed, and then returned to the existing network. The strategies are not mutually exclusive. If a DRt strategy is used, a future phase could extend a pipe down to a Green Stormwater infrastructure filtering and removal infiltration areas. Based on the modeling it is possible to manage 22.1 mg annually in this manner.

Based on the work done for this master plan it is feasible to manage a total of 39.4 mg year if all GSI sites are implemented. However, this level of RO management may neither be needed from a compliance perspective or affordable financially. The potential sites were then reviewed and prioritized with respect to the following factors:

- CSO Catchment
- Annual Volume RO Removed
- Annual Volume RO Managed
- Cost
- Implementation

Because of the emphasis on flow paths in locating GSI sites and the necessity for interception of surface runoff along curb lines in the functioning of GSI, it was appropriate to look to new technologies that would be suited for roadway right of way (ROW) GSI installations.

Permeable pavements were not suitable for ROW sites due to suppliers' concerns regarding sediment entrained in drainage run on and maintenance cost concerns. In addition, permeable pavements were not cost competitive as they involve a limited number of suppliers and installers. There were also concerns raised by PennDOT during the Highway Occupancy Permit process for the Phase 1 Green Streetscape project.

Permeable pavers appeared a better choice for municipal streets in that specialty installers were not required, they tolerate entrained sediment from run on, and maintenance was significantly easier and cheaper.

We have become convinced of the need to pretreat in the GSI process in advance of storage/infiltration facilities. Consequently we added "green" inlets to our revised GSI toolkits. A number of manufacturers are producing permanent pretreatment inserts for use in standard inlets. With minor design modifications, these appear to provide a degree of filtering as well as adsorbant and sediment control.

Because the necessity to pretreat/filter within the typical small lot size available in the Borough, we also looked proprietary high rate biofiltration systems and other technologies which can function within a smaller footprint. The Borough has installed one of these systems in order to evaluate their performance.

Lastly we looked for GSI technologies that are compatible with PennDOT standard designs as a number of locations involve installations within the PADOT ROW.

8.0 GSI COST ESTIMATES

The conceptual level costs presented under the Master Plan are based on retail materials costs, price quotes, and recent tabulated bid prices on GSI projects. PennDOT Street Restoration and Maintenance Bonds reflect actual costs for HOP security.

These are presented in the following table:

Cost Estimation	**Units**	**Unit Costs**
Project		
Design, Engineering, & Construction Mgmt	%	15.00
Outflow End Treatment	lump sum	$8,000
Each installation (23 installations total)		
Interception Structure	each	$6,500
Cubic Foot Volume Price	/cuft	$25.00
Square Foot Volume Price	/sqft	$10.00
Outflow Structure	each	$3,000
Outflow Pipe Length	/ft	$100
PADOT Bond (HOP ROW)	**$/1000**	**$30.25**
Contingency	%	25.00
Streetscape Portion		
Pavement	SF	$13.00
Curbing	/ft	$32.00
Grate	/ft	$300.00
Pervious Pavers	SF	$14.00
Trees	each	$520.00

Implementing all 23 projects detailed under the Master Plan will manage a total of 16.1 mg annually at an estimated cost of $6.1 million. This translates into a cost of $0.38/gal. This includes the Streetscape components not directly related to RO management. When these components are backed out of the total, the estimated cost for the GSI elements becomes $4.1 mil and $0.25/gal of RO managed.

9.0 MASTERPLAN

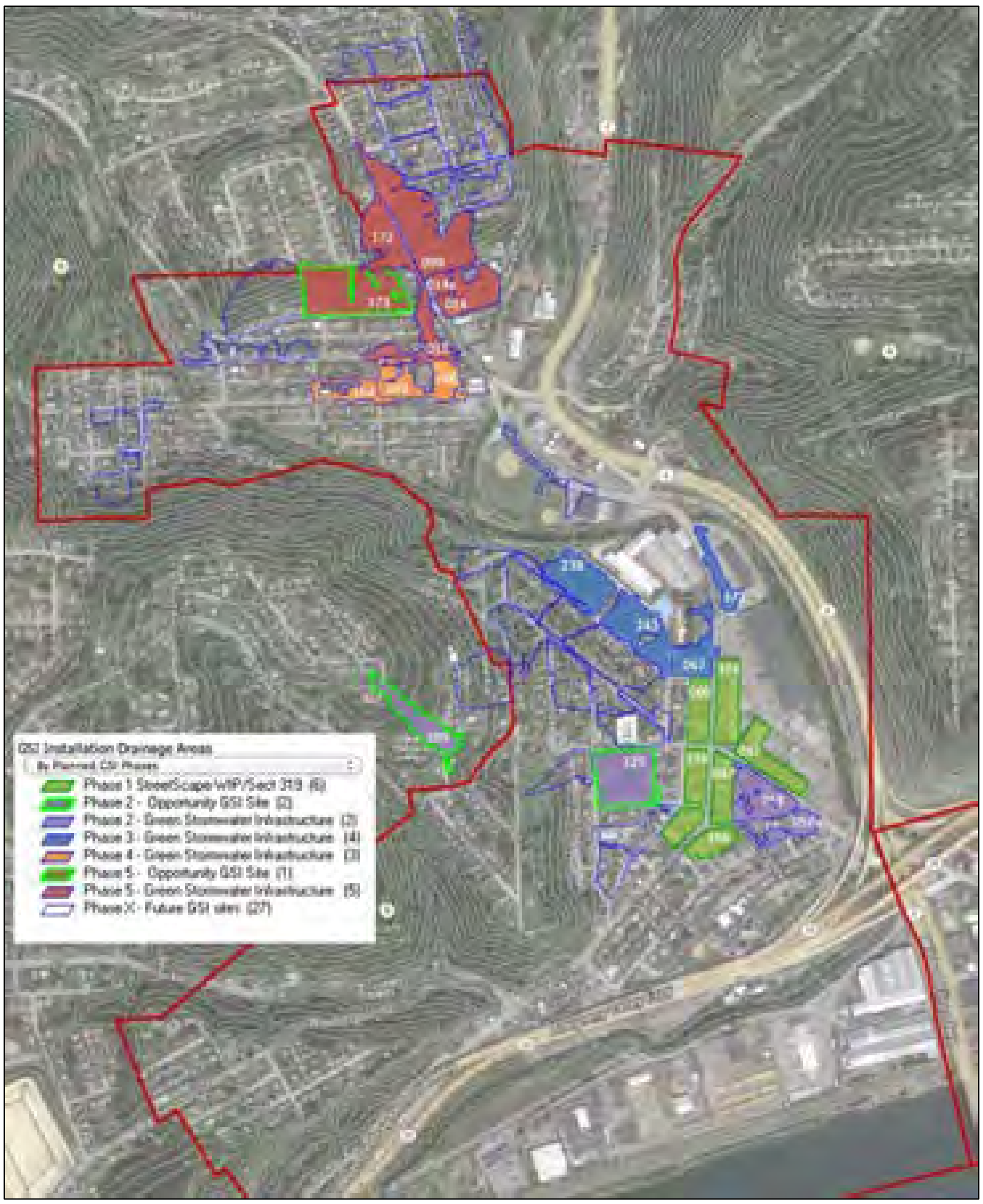
The Etna Borough Green Infrastructure Master Plan presents a prioritized program for the Borough consisting of:

- Green Stormwater Infrastructure (GSI) Projects
- Residential Downspout Disconnection Program
- Tree Planting (TreeVitalize)
- Vacant Property Opportunity Projects (Rain Parks)

Although all these measures carry benefits to the community beyond regulatory compliance, the Master Plan focuses on the potential for GSI, or more precisely source reduction, to achieve compliance objectives in densely developed urban setting.

9.1 GSI PROJECT DESCRIPTIONS

This section presents the planned and prospective GSI projects recommended for implementation in the Borough of Etna. Overall, the 23 projects represent a total of 33.6 acres GSI managed acres with 13.4 acres of managed impervious area. The Master Plan generally prioritizes projects into phases with respect to stormwater removal potential from the combined sewer system, benefits in meeting compliance goals such as CSO reduction, and their relationship to ongoing programs, e.g. Green Streetscape. Aside from the Green Streetscape, lower priority was given to GSI sites that required work within a state road right of way (ROW) because of permitting and bonding considerations. The figure below provides an overview of the Etna GSI Master Plan by phase and number of projects.



Phase 1: Green Streetscape

The objective of this multi-year multi-phase project is the removal of runoff from roofs and paved areas in the Borough of Etna Butler Street central business district from its combined sewer system with consequent reduction in the frequency and volume of combined sewer overflows as well urban runoff reduction. The project will retrofit new GSI features into the renovated streetscape.

The project will entail other improvements and traffic calming/safety features. By improving the aesthetics and function of Etna's commercial district with a green streetscape, the community will encourage development that serves the economy, community, public health and the environment.

The full implementation of the Green Streetscape project in Etna will create storage sufficient to retain the runoff generated from between 2- and 5-year 1-hour storm from the contributing business district roofs and pavements. This translates into an estimated 155,000 gallons in runoff reduction from the design event of 1.25 inches. The following table summarizes the estimated annual capture based on TY 2003 simulations as well as the combined sewer outfall that would see the reduction in flow.

GSI Site ID	Enta Green Stormwater Infrastructure (GSI) Phase	Combined Storm Outfall Structure	GSI Storage Volume (CF)	Estimated Annual Capture (MG)
047	Phase 1 StreetScape-WIP/Sect 319	CSO-1-OF	2,300	0.641
057	Phase 1 StreetScape-WIP/Sect 319	CSO-1-OF	3,450	1.019
196	Phase 1 StreetScape-WIP/Sect 319	CSO-1-OF	1,800	0.464
234	Phase 1 StreetScape-WIP/Sect 319	CSO-1-OF	3,650	1.014
060	Phase 1 StreetScape-WIP/Sect 319	CSO-1A-OF	2,250	0.621
374	Phase 1 StreetScape-WIP/Sect 319	CSO-1A-OF	3,700	1.039
			17,150	**4.799**

Individual site images are in Appendix F. A description of each Green Streetscape project phase follows:

Etna Green Streetscape Phase 1: Phase 1 of the project (047) is currently under construction- supported by PADEP Growing Greener and US EPA Section 319 Grants with a match by the Borough of Etna.

Acreage Managed: 0.598
Impervious Acreage Managed: 0.470
GSI Management Strategy: FIRm

This first phase would involve reconstruction of the east side of Butler Street between Bridge and Freeport Streets as well as the reconstruction of the north side of Freeport Street between Butler Street and Union Alley. This phase would involve installation of with 12 street trees, 2300 cubic feet of underground storage that would promote infiltration, 3900 square feet of pervious pavers, downspout disconnection and restatement to new conveyances and related work.

The project will entails other improvements and traffic calming/safety features: 562 feet of realigned curbing to create bump-outs, 4776 square feet of new concrete sidewalk, 403 feet of 12" wide decorative ADA compliant grate and trench, tree grates, four new curb ramps and two new inlets to accommodate parking area drainage.

Cost: $475,000 including engineering (Actual to date)

Etna Green Streetscape Phase 2: The design of the Phase 2 has been completed; supported by PADEP Growing Greener and US EPA Section 319 Grants. Construction is pending receipt of funding.

Acreage Managed: 0.621
Impervious Acreage Managed: 0.425
GSI Management Strategy: FIRm

This second phase (196) would involve reconstruction of the south side of Butler Street between Winschel and Freeport Streets as well as the reconstruction of the south side of Freeport Street between Butler Street and Cherry Alley. This phase would involve installation of planting areas with 9 street trees, 2400 cubic feet of underground storage in two locations that would promote infiltration, 1800 square feet of pervious pavers, a "Rain Park", downspout disconnection and restatement to new conveyances and related work. Phase 2 would also include planting areas adjacent to the municipal parking lot on Winschel Street.

The project will entails other improvements and traffic calming/safety features: 554 feet of realigned curbing to create bump-outs, 6280 square feet of new concrete sidewalk, 660 feet of 12” wide decorative ADA compliant grate and trench, tree grates, six new curb ramps and a new inlet to accommodate parking area drainage.

Cost: $571,550, including engineering and contingency (Estimate)

Etna Green Streetscape Phase 3: Phase 3 design is presently in the conceptual phase.

Acreage Managed: 0.829
Impervious Acreage Managed: 0.638
GSI Management Strategy: FIRm

This third phase (234) would involve reconstruction of the north side of Butler Street beginning opposite Praeger and extending to Walnut Street. It would also include the reconstruction of the west side of Butler Street between Walnut and High Streets. This phase would involve installation of planting areas with street trees, 3600 cubic feet of underground storage in two locations that would promote infiltration, downspout disconnection and restatement to new conveyances and related work.

The project will entails other improvements and traffic calming/safety features: feet of realigned curbing to create bump-outs, 7080 square feet of new concrete sidewalk, 640 feet of 12” wide decorative ADA compliant grate and trench, tree grates, five new curb ramps and a new inlet to accommodate parking area drainage.

Cost: $701,100, including engineering and contingency (Estimated)

Etna Green Streetscape Phase 4: Phase 4 design is presently in the conceptual phase.

Acreage Managed: 1.429
Impervious Acreage Managed: 0.815
GSI Management Strategy: FIRm

This fourth phase (060) would involve reconstruction of the west side of Butler Street beginning at High Street and extending to Maplewood Street. This phase would involve installation of planting areas with street trees, 2250 cubic feet of underground storage in two locations that would promote infiltration, downspout disconnection and restatement to new conveyances and related work.

The project will entails other improvements and traffic calming/safety features: 425 feet of realigned curbing to create bump-outs, 4400 square feet of new concrete sidewalk, 383 feet of 12” wide decorative ADA compliant grate and trench, tree grates, and new curb ramps.

Cost: $427,800, including engineering and contingency (Estimated)

Etna Green Streetscape Phase 5: Phase 5 design is presently in the conceptual phase.

Acreage Managed: 0.845
Impervious Acreage Managed: 0.747
GSI Management Strategy: FIRm

This fifth phase (374) would involve reconstruction of the east side of Butler Street beginning at Bridge Street and extending past Maplewood Street along the former industrial building frontage. This phase would involve installation of planting areas with street trees, 2250 cubic feet of underground storage in two locations that would promote infiltration, downspout disconnection and restatement to new conveyances and related work.

The project will entails other improvements and traffic calming/safety features: 425 feet of realigned curbing to create bump-outs, 4400 square feet of new concrete sidewalk, 383 feet of 12” wide decorative ADA compliant grate and trench, tree grates, and new curb ramps.

Cost: $828,200, including engineering and contingency (Estimated)

<u>Etna Green Streetscape Phase 5A:</u> Phase 5A design is presently in the conceptual phase.

Acreage Managed: 1.403
Impervious Acreage Managed: 1.273
GSI Management Strategy: FIRm

This sixth phase (057) would involve reconstruction of the north side of Bridge Street beginning at Butler Street and extending to intersection with Freeport Street. This phase would involve downspout disconnection from the large industrial building, restatement to new conveyance piping to 3450 cubic feet of underground storage.

The project will entails other improvements: 525 feet of curbing, 4400 square feet of new concrete sidewalk, 383 feet of 12” wide decorative ADA compliant grate and trench, tree grates, and new curb ramps.

Cost: $416,900, including engineering and contingency (Estimated)

All streetscape components are within the public right of way with two exceptions:

- The four private parking pads fronting Union Alley: permission to construct GSI has been secured by Agreements with owners.
- Potential use of a private gravel parking area as an infiltration area and storage for Green Streetscape Phases 3, 4, 5 and 5A (see figure below) This area would also be potentially used for Phase 2 project areas 056 and 056a. See figure below for the location of the subsurface infiltration area. The area would continue to be used for commercial vehicle parking.

The cost for the infiltration beds is proportionally included under the cost for each of the Streetscape phases. In the event the permission cannot be secured from the current owner of the parcel, subsurface storage and infiltration facilities would be incorporated into the respective streetscape phases as shown in the individual site images in Appendix F.

Phase 2 GSI Facilities

The objective of this phase is the management of runoff from areas tributary to CSO 1 that have potential for reductions in the frequency and volume of combined sewer overflows as well urban runoff reduction. Two sites (056 and 056a) adjoin the Borough of Etna Butler Street central business district and would complement Green Streetscape projects. The other two projects represent opportunity projects that could be implemented as funding opportunities present themselves. In the case of Site 225, GSI facilities have been funded by Three Rivers Wet Weather as project enhancement to the resurfacing of the Municipal Parking Lot No. 2. However additional GSI facilities are needed to manage remaining stormwater. Site 209 is located in Shaler Township but is tributary to CSO 1, therefore GSI implementation would benefit the Borough.

Refer to Individual site images in Appendix F.

The following table summarizes the estimated annual capture based on a 90/10 management strategy applied to TY 2003 simulations.

GSI Site ID	Enta Green Stormwater Infrastructure (GSI) Phase	Combined Storm Outfall Structure	GSI Storage Volume (CF)	Estimated Annual Capture (MG)
209	Phase 2 - Opportunity GSI Site	CSO-1-OF	2,200	0.559
225	Phase 2 - Opportunity GSI Site	CSO-1-OF	4,500	1.149
056	Phase 2 - Green Stormwater Infrastrcuture	CSO-1-OF	3,200	0.806
056a	Phase 2 - Green Stormwater Infrastrcuture	CSO-1-OF	1,200	0.308
			11,100	**2.823**

A description of each Phase 2 project follows:

Etna Phase 2 - Opportunity GSI Site 225:

Acreage Managed: 2.396
Impervious Acreage Managed: 0.744
GSI Management Strategy: FIRm

This Green Infrastructure design and construction project involves the installation of Green Infrastructure- runoff collection, proprietary high rate bio-filtration, subsurface stormwater management storage units with infiltration, plantings- during the resurfacing of the existing 4200 square foot municipal parking lot. The project will provide partial capture (approx. 25%) of estimated 1.15 mg runoff contributed annually by this catchment to the Etna Combined Sewer System. The screening identified a high yield inlet via the Etna GIS where GSI could be most advantageously sited. The project is funded by a combination of Borough funds and a 3Rivers Wet Weather Grant.

Full capture from the catchment under the 90/10 target would involve installation of an additional 4500 CF GSI facility in the Walnut Street ROW. The estimated cost for this additional GSI facility would be $190,000. The estimated cost is $ 0.22 per managed gallon.

Cost: $ 74,000 including engineering (Actual to date)

Etna Phase 2 - Opportunity GSI Site 209:

Acreage Managed: 1.365
Impervious Acreage Managed: 0.177
GSI Management Strategy: FIRm

This Green Infrastructure design and construction project involves the installation of Green Infrastructure- runoff collection, green inlet, 2200 cubic feet of subsurface stormwater management storage units with infiltration in the James Street ROW in Shaler Township. The facility would outlet to existing stormwater system.

Shaler Township cooperation would be required for this project to move forward.

Cost: $ 135,800 including engineering and contingency (Estimated)

Etna Phase 2 - GSI Site 056:

Acreage Managed: 1.481
Impervious Acreage Managed: 0.735
GSI Management Strategy: FIRm

GSI Site 056 involves the installation of Green Infrastructure- runoff collection, proprietary high rate bio-filtration, 3200 cubic feet of subsurface storage with infiltration, plantings to manage stormwater runoff from the street block bounded by Union Alley, Bridge and Freeport Streets. The preferred concept is to convey flow to subsurface infiltration facilities located in the existing gravel parking lot located across Bridge Street. Alternatively the GSI could be sited in the vicinity of the intersection of Freeport and Bridge Streets as shown in the site graphic in Appendix F. Bridge Street utilities may increase the project complexity and costs associated with conveyance to infiltration beds.

Cost: $ 128,700 including engineering and contingency (Estimate)

Etna Phase 2 - GSI Site 056a:

Acreage Managed: 0.578
Impervious Acreage Managed: 0.273
GSI Management Strategy: FIRm

GSI Site 056a project involves the installation of Green Infrastructure- runoff collection, proprietary high rate bio-filtration, 1200 cubic feet of subsurface storage with infiltration, plantings to manage stormwater runoff from the drainage area generally described by Cherry Alley, Cherry and Freeport Streets. As in the case of GSI Site 056, the preferred concept is to convey flow to subsurface infiltration facilities located in the existing gravel parking lot located across Bridge Street. Alternatively the GSI could be sited in the vicinity of the intersection of Freeport and Bridge Streets as shown in the site graphic in Appendix F. However, this would involve siting facilities within the PADOT ROW. Bridge Street subsurface utilities may also increase the project complexity and costs associated with conveyance to infiltration beds.

Cost: $ 56,800 including engineering and contingency (Estimate)

Phase 3 GSI Facilities

The objective of this phase is the management of runoff from areas tributary to CSO 1A that have potential for reductions in the frequency and volume of combined sewer overflows as well urban runoff reduction. Two sites (067 and 372) are located just north of the Borough of Etna Butler Street central business district and would complement Green Streetscape projects. The GSI Site 243 and 238 projects propose GSI management facilities in the Pine Street ROW that would convey flow to nearby Pine Creek.

The following table summarizes the estimated annual capture based on a 90/10 management strategy applied to TY 2003 simulations.

GSI Site ID	Enta Green Stormwater Infrastructure (GSI) Phase	Combined Storm Outfall Structure	GSI Storage Volume (CF)	Estimated Annual Capture (MG)
067	Phase 3 - Green Stormwater Infrastrcuture	CSO-1A-OF	3,000	0.744
238	Phase 3 - Green Stormwater Infrastrcuture	CSO-1A-OF	3,200	0.784
243	Phase 3 - Green Stormwater Infrastrcuture	CSO-1A-OF	3,300	0.819
372	Phase 3 - Green Stormwater Infrastrcuture	CSO-1A-OF	1,350	0.336
			10,850	**2.682**

A description of each Phase 3 project follows:

Etna Phase 3 - GSI Site 067:

Acreage Managed: 1.134
Impervious Acreage Managed: 0.904
GSI Management Strategy: FIRm

GSI Site 067 project involves the installation of GSI- runoff collection, proprietary high rate bio-filtration, 3000 cubic feet of subsurface storage with infiltration to manage stormwater runoff from the drainage area generally described by Pine, Maplewood and Butler Streets. This project would disconnect roof drainage presently entering the sewer system and collect runoff from two municipal parking lots. There is also the potential to disconnect the Etna Borough municipal building and convey this runoff to GSI facilities. However this needs to be further explored. There are a number of locations for the GSI in the vicinity of the municipal building in addition to the ones shown in the site graphic in Appendix F. Some of these would also involve siting facilities within the PADOT ROW. Butler Street subsurface utilities may also increase the project complexity and costs associated with conveyance to Pine Creek. With advanced planning, it may be possible to connect and share GSI facilities with the Green Streetscape Phase 5 (Site 374).

Cost: $ 124,000 including engineering and contingency (Estimate)

Etna Phase 3 - GSI Site 238:

Acreage Managed: 0.592
Impervious Acreage Managed: 0.305
GSI Management Strategy: FIRm

GSI Site 238 project involves the installation of GSI- runoff collection, high rate biofiltration and/or inlet treatment inserts, 3200 cubic feet of subsurface storage with infiltration to manage stormwater runoff from the Etna Town Centre. This project would disconnect parking lot drainage presently entering the combined sewer system and convey this runoff to GSI facilities. There are a number of locations for the GSI in the vicinity of the municipal building in addition to the ones shown in the site graphic in Appendix F. This project would also involve siting facilities and other work within the PADOT ROW. Butler Street subsurface utilities would also increase the project complexity and costs associated with proposed final conveyance to Pine Creek.

Cost: $ 325,800 including engineering and contingency (Estimate)

Etna Phase 3 - GSI Site 243:

Acreage Managed: 1.799
Impervious Acreage Managed: 0.471
GSI Management Strategy: FIRm

GSI Site 243 project involves the installation of GSI- runoff collection, new inlets with treatment inserts, 3300 cubic feet of subsurface storage with infiltration to manage stormwater runoff from areas tributary to west side of Pine Street in the block between Maplewood and Garrick Streets. This project would intercept drainage presently entering the combined sewer system and convey this runoff to GSI facilities shown in the site graphic in Appendix F. Pine Street subsurface utilities would increase the project complexity and costs associated with proposed final conveyance to Pine Creek.

Cost: $ 319,100 including engineering and contingency (Estimate)

Etna Phase 3 - GSI Site 372:

Acreage Managed: 1.835
Impervious Acreage Managed: 0.337
GSI Management Strategy: FIRm

GSI Site 372 project involves the installation of GSI- runoff collection, new inlets with treatment inserts, 3300 cubic feet of subsurface storage with infiltration to manage stormwater runoff from areas tributary to the west side of Pine Street between Garrick Street and the north end of the street. This project would intercept drainage presently entering the combined sewer system and convey this runoff to GSI facilities shown in the site graphic in Appendix F. Pine Street subsurface utilities would increase the project complexity and costs associated with proposed final conveyance to Pine Creek.

Cost: $ 175,400 including engineering and contingency (Estimate)

Phase 4 GSI Facilities

The objective of this phase is the management of runoff from areas tributary to CSO 4 that have potential for reductions in the frequency and volume of combined sewer overflows as well urban runoff reduction. Three sites are located just north of the Borough of Etna Butler Street central business district and would complement Green Streetscape projects. The GSI Site 163 and 164 projects propose GSI management facilities that would convey flow to nearby West Little Pine Creek via the Borough's dedicated stormwater conveyance facilities in Wendelin Street.

GSI Site 168 would manage drainage from the south side of Wilson Street via Church Alley and the adjacent parking areas for the All Saints Church complex and behind Alioto/Martin Tire. The following table summarizes the estimated annual capture based on a 90/10 management strategy applied to TY 2003 simulations:

GSI Site ID	Enta Green Stormwater Infrastructure (GSI) Phase	Combined Storm Outfall Structure	GSI Storage Volume (CF)	Estimated Annual Capture (MG)
163	Phase 4 - Green Stormwater Infrastrcuture	CSO-4-OF	2,200	0.571
164	Phase 4 - Green Stormwater Infrastrcuture	CSO-4-OF	1,500	0.393
168	Phase 4 - Green Stormwater Infrastrcuture	CSO-4-OF	2,350	0.613
			6,050	**1.577**

Etna Phase 4 - GSI Site 163:

Acreage Managed: 0.885
Impervious Acreage Managed: 0.704
GSI Management Strategy: FIRm

GSI Site 163 project involves the installation of GSI- runoff collection, new inlets with treatment inserts, 2200 cubic feet of subsurface storage with infiltration to manage stormwater runoff from Etna Technical Center parking lots and areas on the south side of Wilson Street. This project would intercept drainage presently entering the combined sewer system and convey this runoff to GSI facilities shown in the site graphic in Appendix F. GSI Site 163 project proposes GSI management facilities that would convey flow to nearby West Little Pine Creek via the Borough's dedicated stormwater conveyance facilities in Wendelin Street.

Cost: $ 101,300 including engineering and contingency (Estimate)

<u>Etna Phase 4 - GSI Site 164:</u>

Acreage Managed: 0.760
Impervious Acreage Managed: 0.320
GSI Management Strategy: FIRm

GSI Site 164 project involves the installation of GSI- runoff collection, new inlets with treatment inserts, 1500 cubic feet of subsurface storage with infiltration to manage stormwater runoff from residential block bounded by Martha, Sheridan, Wendelin and Dewey Streets. This project would intercept drainage presently entering the combined sewer system and convey this runoff to GSI facilities shown in the site graphic in Appendix F. GSI Site 164 project proposes GSI management facilities that would convey flow to nearby West Little Pine Creek via the Borough's dedicated stormwater conveyance facilities in Wendelin Street.

Cost: $ 76,200 including engineering and contingency (Estimate)

<u>Etna Phase 4 - GSI Site 168:</u>

Acreage Managed: 0.960
Impervious Acreage Managed: 0.706
GSI Management Strategy: DRt/FIRm

GSI Site 168 project involves the installation of GSI- runoff collection, new inlets with treatment inserts, 2350 cubic feet of subsurface storage with infiltration to manage stormwater runoff from the south side of Wilson Street via Church Alley and the adjacent parking areas for All Saints and Alioto/Martin Tire. This project would intercept drainage presently entering the combined sewer system and convey this runoff to GSI facilities shown in the site graphic in Appendix F. The removal potential for this project is not clear; currently it is classified under delay and return facility (DRt). Dewey and Crescent Street subsurface utilities adversely impact the feasibility of final conveyance to Pine Creek versus continued conveyance to the combined sewer system. Further work is needed to determine whether conveyance to the Wendelin Street stormwater facilities is a feasible alternative.

Cost: $ 155,600 including engineering and contingency (Estimate)

Phase 5 GSI Facilities

The objective of this phase is the management of runoff from areas tributary to CSO 5 that have potential for reductions in the frequency and volume of combined sewer overflows as well urban runoff reduction. There are four GSI sites and one Opportunity Project under Phase 5 as shown in the figure.

The following table summarizes the estimated annual capture based on a 90/10 management strategy applied to TY 2003 simulations:

GSI Site ID	Enta Green Stormwater Infrastructure (GSI) Phase	Combined Storm Outfall Structure	GSI Storage Volume (CF)	Estimated Annual Capture (MG)
173	Phase 5 - Opportunity GSI Site	CSO-5-OF	5,550	1.251
011	Phase 5 - Green Stormwater Infrastrcuture	CSO-5-OF	2,500	0.554
014	Phase 5 - Green Stormwater Infrastrcuture	CSO-5-OF	3,500	0.797
014a	Phase 5 - Green Stormwater Infrastrcuture	CSO-5-OF	1,000	0.227
099	Phase 5 - Green Stormwater Infrastrcuture	CSO-5-OF	7,000	1.582
172	Phase 5 - Green Stormwater Infrastrcuture	CSO-5-OF	3,000	0.682
			22,550	**5.093**

A description of each Phase 5 project follows:

Etna Phase 5 - Opportunity GSI Site 173:

Acreage Managed: 3.082
Impervious Acreage Managed: 0.403
GSI Management Strategy: FIRm

GSI Site 173 project involves the installation of GSI- runoff collection, inlet treatment inserts, 5550 cubic feet of subsurface storage with infiltration to manage stormwater runoff from the drainage area generally described by Lehr and Adele Avenues in Shaler Township and Vilsack Street in Etna. This project would intercept drainage presently entering the combined sewer system and convey this runoff to GSI facilities shown in the site graphic in Appendix F. Grant Avenue subsurface utilities may also increase the project complexity and costs associated with conveyance to Pine Creek.

Cost: $ 213,100 including engineering and contingency (Estimate)

Etna Phase 5 - GSI Site 011:

Acreage Managed: 1.005
Impervious Acreage Managed: 0.490
GSI Management Strategy: FIRm

GSI Site 011 project involves the installation of GSI- runoff collection, inlet treatment inserts, 2500 cubic feet of subsurface storage with infiltration to manage stormwater runoff from the drainage area generally described by Church Street and Wilson Street. This project would intercept drainage presently entering the combined sewer system and convey this runoff to GSI facilities located in the Wilson Street ROW as shown in the site graphic in Appendix F. Grant Avenue subsurface utilities may also increase the project complexity and costs associated with conveyance to Pine Creek.

Cost: $ 103,500 including engineering and contingency (Estimate)

Etna Phase 5 - GSI Site 014:

Acreage Managed: 1.564
Impervious Acreage Managed: 0.644
GSI Management Strategy: FIRm

GSI Site 014 project involves the installation of GSI- runoff collection, inlet treatment inserts, 3500 cubic feet of subsurface storage with infiltration to manage stormwater runoff from the drainage area generally described by Highland and Weible Streets and Angle Alley. This project would intercept drainage presently entering the combined sewer system and convey this runoff to GSI facilities located in the Grant Street ROW as shown in the site graphic in Appendix F. Grant Street subsurface utilities may also increase the project complexity and costs associated with conveyance to Pine Creek. This project would also involve siting facilities within the PADOT ROW which would impact implementation and costs.

Cost: $ 142,400 including engineering and contingency (Estimate)

Etna Phase 5 - GSI Site 014a:

Acreage Managed: 0.383
Impervious Acreage Managed: 0.249
GSI Management Strategy: FIRm

GSI Site 014a project involves the installation of GSI- runoff collection, inlet treatment inserts, 1000 cubic feet of subsurface storage with infiltration to manage stormwater runoff from the drainage area generally described by Highland Street, Angle Alley and Grant Avenue. This project would intercept drainage presently entering the combined sewer system and convey this runoff to GSI facilities located in the Grant Street ROW as shown in the site graphic in Appendix F. Grant Street subsurface utilities may also increase the project complexity and costs associated with conveyance to Pine Creek. This project would also involve siting facilities within the PADOT ROW which would impact implementation and costs.

Cost: $ 50,600 including engineering and contingency (Estimate)

Etna Phase 5 - GSI Site 099:

Acreage Managed: 4.189
Impervious Acreage Managed: 1.130
GSI Management Strategy: FIRm

GSI Site 099 project involves the installation of GSI- runoff collection, inlet treatment inserts, 7000 cubic feet of subsurface storage with infiltration to manage stormwater runoff from the drainage area generally described by the east side of Grant Avenue between Highland and Mt. Hope Streets. This project would intercept drainage presently entering the combined sewer system and convey this runoff to GSI facilities located in the Grant Street ROW as shown in the site graphic in Appendix F. Grant Avenue subsurface utilities may also increase the project complexity and costs associated with conveyance to Pine Creek. This project would also involve siting facilities within the PADOT ROW which would impact implementation and costs.

Cost: $ 270,800 including engineering and contingency (Estimate)

Etna Phase 5 - GSI Site 172:

Acreage Managed: 1.850
Impervious Acreage Managed: 0.474
GSI Management Strategy: FIRm

GSI Site 172 project involves the installation of GSI- runoff collection, inlet treatment inserts, 3000 cubic feet of subsurface storage with infiltration to manage stormwater runoff from the drainage area generally described by the west side of Grant Avenue above Vilsack Streets. This project would intercept drainage presently entering the combined sewer system and convey this runoff to GSI facilities located in the Vilsack Street ROW as shown in the site graphic in Appendix F. Grant Avenue subsurface utilities may also increase the project complexity and costs associated with conveyance to Pine Creek. This project would also involve siting facilities within the PADOT ROW which would impact implementation and costs.

Cost: $ 124,000 including engineering and contingency (Estimate)

Phase X GSI Facilities-Future

The remaining 27 sites identified for GSI are limited either by slope, soils, location or other factors that reduce their value as sites for the management of runoff from areas tributary to Etna combined sewer system. In most cases, these sites are limited to a delay and return strategy (DRt). Comparing DRt to GSI techniques that remove water via infiltration and evapotranspiration, storage facilities are increasingly found to have a limited potential for reducing the frequency and volume of combined sewer overflows as well as in urban runoff peak flow reduction.

The Phase X sites are of interest as target areas for the Borough's Residential Downspout Disconnection program discussed below.

9.2 RESIDENTIAL DOWNSPOUT DISCONNECTION PROGRAM

The Borough has enacted an ordinance that incentivizes those residents who elect to disconnect their roof leaders and install rain barrels and cisterns. There is an intrinsic value of the Borough's program in terms of fostering awareness of wet weather issues and participation in community control efforts. There is also an incremental value in any source reduction efforts. Cisterns and rain barrels can be placed at most properties located without regard to soils, slope, perviousness, etc. in contrast to other GSI that must fit the surrounding land use and depend on site specific factors to be effective. Many of Etna's residential sections are characterized by steep slopes and small sized parcels. Combined with their low cost, it is tempting to find a role for these GSI techniques in CSO compliance planning.

However the value of the Borough's residential downspout disconnection program is difficult to assess with respect to a CSO compliance master plan. A comparative performance analysis between cisterns, rain barrels and ROW GSI facility was performed using an example area on Maplewood Street tributary to CSO1A. Site solution options can be compared in Appendix G.

The following results of the performance analysis as summarized in the following table are instructive.

Comment	Solution Option Groupings	Description	Annual Modeled Capture & Removal (mg)	Acres Managed	Acres NOT Managed	Projected Installation Cost	Projected Installation Cost per Gal	Runoff Reduction	Maintainability
Best Option	**a1**	**ROW interception entire catchment**	**0.860**	**1.95**	**0.00**	**$167,038**	**$0.194**	**81%**	**H**
high cost	p2	ROW interception no roof areas	0.467	1.51	0.44	**$136,275**	**$0.292**	44%	H
no maintenance	p2+r3	ROW interception + 100% roof cisterns	0.839	1.95	0.00	**$205,275**	**$0.245**	79%	L
no maintenance	p2+r4	ROW interception + 100% roof rain barrels	0.609	1.95	0.00	**$150,075**	**$0.246**	58%	L
no maintenance	p2+r5+r6	ROW interception + 50% cistern +50% RB	0.724	1.95	0.00	**$177,675**	**$0.245**	68%	L
no maintenance	p2+r5	ROW interception + 50% cistern	0.653	1.73	0.22	**$170,775**	**$0.262**	62%	L
no maintenance	p2+r6	ROW interception + 50% rain barrel	0.538	1.73	0.22	**$143,175**	**$0.266**	51%	L
no peak control	r3	100% roof cisterns (24)	0.372	0.44	1.51	**$69,000**	**$0.185**	35%	L
no peak control	r4	100% roof rain barrel [RB] (24)	0.142	0.44	1.51	**$13,800**	**$0.097**	13%	L
no peak control	r5	50% roof cisterns (12)	0.186	0.22	1.73	**$34,500**	**$0.185**	18%	L
no peak control	r6	50% roof rain barrels (12)	0.071	0.22	1.73	**$6,900**	**$0.097**	7%	L

From the performance analysis summary table, the following observations can be made:

- The number of participating properties is critical in the effectiveness of rain barrels and cisterns.

- Rain barrels are the least cost GSI technology on per gallon basis- $0.097/gal.

- Rain barrels require at least 50% participation for minimal reductions; however even installing rain barrels on 100% of the roofs yields the smallest runoff reductions.

- ROW interception facilities consist of inlets with treatment inserts and subsurface storage/infiltration modules. They have the best combination of performance and cost versus either rain barrels or cisterns.

- Cisterns have better capture than rain barrels but are less cost effective than the ROW GSI:

  1) Cisterns alone have a significantly lower capture at approximately the same cost per gallon as ROW GSI;
  2) Cisterns in tandem with ROW facilities have a significantly higher cost per gallon as ROW GSI at roughly comparable capture rates.

- Combining GSI technologies improves capture but is less cost effective than ROW GSI alone.

The performance analysis points to properly located and designed ROW GSI facilities as the preferred option in achieving source reductions needed for cost effective CSO compliance under the Master Plan. However additional benefits can be achieved by incentivizing rain barrels and cisterns in high yield areas identified as Phase X Future under the Master Plan where conditions are not suitable for removal management techniques.

9.3 STREET TREE PLANTING

Street tree planting is often included as a component of GSI Plans. The Etna Green Streetscape includes street trees as a stormwater management component. The Borough has also partnered with TreeVitalize to begin a regular program aimed at increasing the number of street trees in the Borough.

In 2012 Allegheny County published the results of a county wide survey of tree canopy coverage. Tree canopy (TC) is the layer of leaves, branches, and stems of trees that cover the ground when viewed from above.

Establishing a tree canopy goal is crucial for communities seeking to improve their green infrastructure. For example, the City of Lancaster Green Infrastructure Plan has targeted increasing the urban tree canopy from the current 28% coverage to a goal of 40%. To put this goal in perspective, research by Goetz et al. (2003) indicates that watersheds with 37% tree canopy can be categorized as “fair” in a stream health rating; watersheds with 45% tree canopy can be categorized as “good.”

The current tree canopy coverage for the Borough was assessed using the Allegheny County Urban Tree Canopy (UTC) database. In keeping with the CSO compliance perspective of the GSI Master Plan, the TC coverage data was analyzed by CSO catchments. Appendix C presents the results of the GIS analysis of the Etna CSO contributing areas. The table below presents the existing canopy coverage for each CSO catchment.

Basin	Project Boundary (sq ft)	Tree Canopy (sq ft)	Tree Canopy %
CSO 1	3,663,391	1,262,330	34.5%
CSO 1A	2,074,922	681,753	32.9%
CSO 2	5,923,925	3,942,044	66.5%
CSO 3	6,839,500	4,142,132	60.6%
CSO 4	1,214,743	317,523	26.1%
CSO 5	2,637,071	1,020,999	38.7%
CSO 7	569,502	421,730	74.1%
CSO 8	785,686	52,373	6.7%
B24	4,185,848	2,462,404	58.8%

The compliance benefits and costs of increasing the tree canopy coverage to 40% in the five catchments falling below that coverage value were examined. Reductions were estimated in two ways. The Etna SWMM model was used to estimate reductions for the Typical Year 2003 increasing the acreage for tree canopy to 40% coverage in tandem with the following TR-55 Curve number values after Saunders, 1983:

TR-55 CN Values

Soil Class	Tree Canopy	Herbaceous Cover	Artificial Surfaces	Other
B	55	61	98	82
C	70	74	98	87

The analysis showed achieving a 40% TC coverage in the tributary catchments to the Etna CSO resulted in an overall reduction in runoff among the five CSO catchments on the order of 10%. As might be expected, the greater reductions were associated with catchments with the smallest existing TC coverage.

The potential reductions in runoff were also estimated using annual interception rates in gallons per year for small and medium trees (Source: McPherson et al, USDA Northeast Tree Guide PSW-GTR-202, 2007). The number of trees was estimated by dividing the required area to achieve 40% TC by the 10-year tree cover areas for small and medium trees, 125 SF and 175 SF respectively. (City of Richmond VA Planning Commission Tree Canopy Chart 2002). The resulting annual reduction volume was estimated by multiplying number of trees by the average annual interception rates. Smaller runoff reductions on the order of 5% (2.4-5.4 MG/year) were estimated using this method.

A range of costs is presented. Recent average bid prices for street trees for GSI projects for 2-1/2” caliber trees have been running at $520/tree installed. Low end cost were derived from retail installed tree prices by local landscapers. These have been approximately half the bid cost on GSI projects. These were used in preference to the installation cost per tree of $800 generally given for GSI projects.

Annual costs were estimated using a range of $9 per tree per year for small trees and $15 per tree per year for medium trees for 20 year old trees. (Source: McPherson et al, USDA Northeast Tree Guide PSW-GTR-202, 2007). Annual costs appear to increase with tree age with conflicts between trees and power lines, sidewalks, sewers, and other elements of the urban infrastructure. These are more likely to occur after trees pass 30 years of age.

The following table presents the estimated number of trees, cost and benefits for a 40% canopy cover for each Etna CSO shed:

40% Tree Cover								
	Req TC		Small Trees					
Shed	ACRES	SF	No of Trees	HI Cost ($)		Lo Cost ($)	Upkeep ($/yr)	Benefits (gal/yr)
CSO 1	4.66	203,026	1624	$	877,074.05	$ 406,052.80	$ 14,617.90	581,468
CSO 1A	3.40	148,216	1186	$	640,292.26	$ 296,431.60	$ 10,671.54	424,490
CSO 4	3.87	168,374	1347	$	727,376.54	$ 336,748.40	$ 12,122.94	482,224
CSO 5	0.78	33,829	271	$	146,143.01	$ 67,658.80	$ 2,435.72	96,887
CSO 8	6.01	261,901	2095	$	1,131,414.05	$ 523,802.80	$ 18,856.90	750,086
			6523	$	3,522,299.90	$ 1,630,694.40	$ 58,705.00	2,335,154

40% Tree Cover								
	Req TC		MediumTrees					
Shed	ACRES	SF	No of Trees	HI Cost ($)		Lo Cost ($)	Upkeep ($/yr)	Benefits (gal/yr)
CSO 1	4.66	203,026	1160	$	626,481.46	$ 290,037.71	$ 17,402.26	1,341,134
CSO 1A	3.40	148,216	847	$	457,351.61	$ 211,736.86	$ 12,704.21	979,071
CSO 4	3.87	168,374	962	$	519,554.67	$ 240,534.57	$ 14,432.07	1,112,232
CSO 5	0.78	33,829	193	$	104,387.86	$ 48,327.71	$ 2,899.66	223,467
CSO 8	6.01	261,901	1497	$	808,152.89	$ 374,144.86	$ 22,448.69	1,730,046
			4659	$	2,515,928.50	$ 1,164,781.71	$ 69,886.90	5,385,951

Both the number of trees needed and the cost of achieving 40% tree canopy coverage in 10 years are striking. Longer time frames for achievement of coverage need to be considered. Nevertheless, compliance time horizons for addressing wet weather issues are less than 15 years. It appears that measureable benefits will need to be realized at a faster rate than via tree canopy growth.

When the first year cost of trees are compared to the runoff reduction in gallons, then a cost per gallon in range of $0.47-$1.51 results. When significant leaf cover area is achieved and for the following 20 year time frame these costs drop to $0.04-0.10/gallon.

Although a goal of 40% tree canopy may not be achievable within wet weather compliance time frames, a longer view needs to be considered with respect to tree planting as GSI practice. It is worth keeping in mind the other benefits cited by the 2012 Allegheny County TC report:

Tree canopy provides many benefits to communities, improving water quality, saving energy, lowering the temperature, reducing air pollution, enhancing property values, providing wildlife habitat, facilitating social and educational opportunities, and providing aesthetic benefits.

Based on the results of the tree canopy coverage analysis, tree planting efforts in the Borough should be targeted at locations in the areas tributary to CSO 8 and CSO 4.

9.4 RAIN PARKS

The Borough has incorporated the concept of Rain Parks into its GSI Master Plan as potential GSI sites.

The Borough of Etna has identified several vacant properties for potential development as Rain Parks under the Allegheny County Vacant Property Recovery Program. The purpose of the Allegheny County Vacant Property Recovery Program is to take blighted and/or tax delinquent properties and resell them to an applicant to reuse as determined by their application and as approved by the municipality. The

Borough has looked to use the program and other programs to acquire land as Community Parcels, which can be used for green space as well as GSI sites.

The Borough has identified three such properties:

- 0 Freeport Street (formerly 6 Freeport Street)
- 14 Freeport Street
- 327 Butler Street

Conceptual layouts were done for the two Freeport properties and cost estimates made for their development as GSI/Green Space. The layout for the two properties as Rain Parks is presented below along with a sketch for 0 Freeport Street.

Based this initial work and its location with respect to the business district, 14 Freeport Street has been incorporated into the Green Streetscape Phase 2 design as a site for mini-park with high rate bio-filtration and subsurface storage/infiltration facilities. Ownership issues have complicated the acquisition of the second Freeport property. The intention is explore funding options and design following resolution of these issues. The planning level estimated cost for this Rain Park is $44,500. It should be noted that these properties are no longer buildable because of setback restrictions.

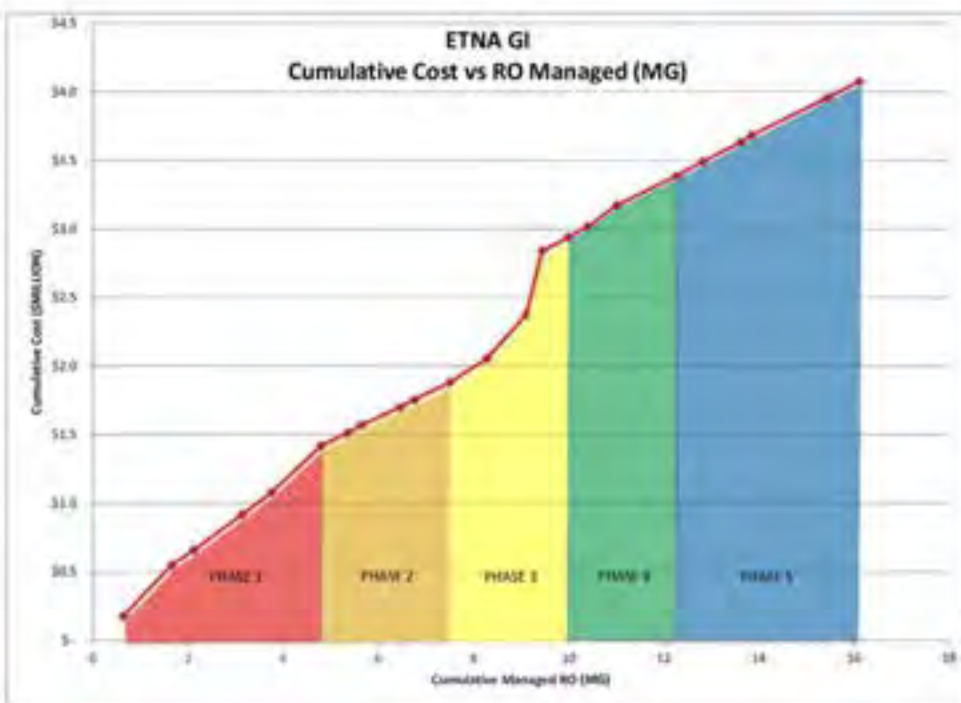
A conceptual plan for 327 Butler Street as municipal parking lot was also developed in the early phases of Green Streetscape planning incorporating pervious pavement, bioswales and other GSI features. Evaluation under this Master Plan did not reveal a potential for significant RO volume reduction for this site.

The compliance impact of these and other locations for GSI facilities are difficult to assess at this time but would be less significant than the ROW projects described previously.

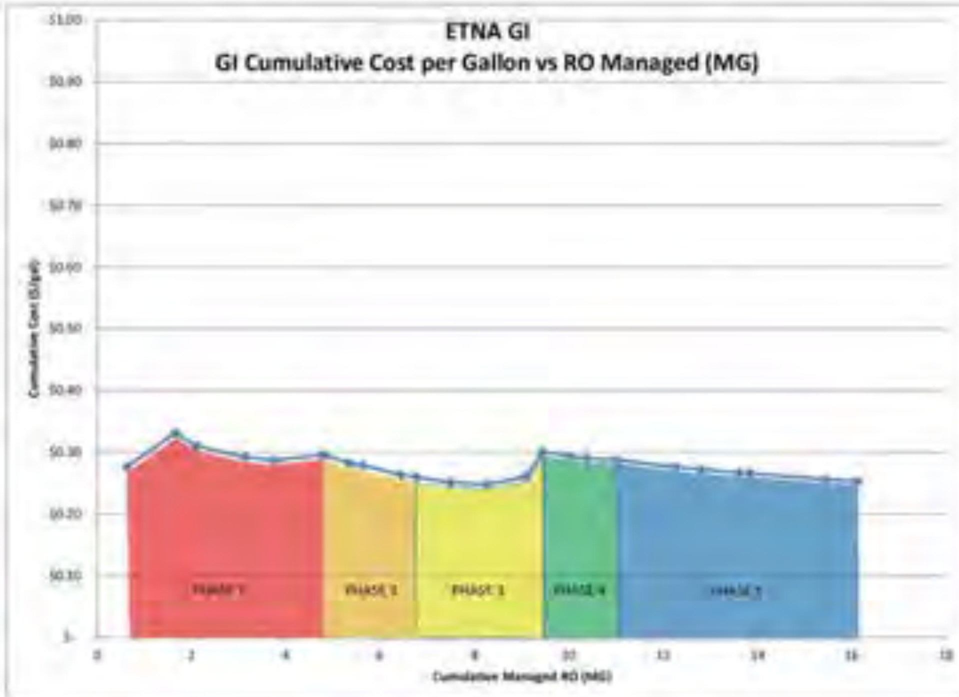
10. GSI IMPLEMENTATION COSTS

Implementing all 23 projects detailed under the Master Plan will manage a total of 16.1 mg annually at an estimated cost of $6.1 million. This translates into a cost of $0.38/gal. This includes the Streetscape components not directly related to RO management. When these components are backed out of the total, the estimated cost for the GSI elements becomes $4.1 mil and $0.25/gal of RO managed.

The figure below presents the cumulative cost versus the amount of runoff (RO) managed in mg for the five phases of GSI implemented under the Master Plan. This does not include decorative Green Streetscape elements not related to GSI functioning.



The figure below presents the cumulative cost per gallon versus the amount of runoff (RO) managed in mg for the five phases of GSI implemented under the Master Plan . This also excludes decorative Green Streetscape elements not related to GSI functioning.



Looking at the long term, the 35 year total cost to the Borough for the 23 GSI sites would be $8.46 million assuming annual O &M costs of $2000 per inlet structure/year for cleaning and media replacement. The estimated cost of GSI would be s $ 0.015 per gallon over the 35 year period but no capital replacement has been factored in.

11.0 POTENTIAL GSI BENEFITS WITH RESPECT TO GREY INFRASTRUCTURE

Based on the work done for this master plan it is feasible to manage a total of 39.4 mg year if all GSI sites are implemented. During the Typical Year it is estimated that a total of 676 million gallons flow through the Etna sewer system. The projected GSI Annual Reduction from Phase 1 through 5 is 5.8% of this total.

A proposed upsizing to the Etna Trunkline in Pine Creek could eliminate overflows at CSO-4 and reduce Etna overflow volumes at CSO-1 to 0.14 million gallons, at CSO-5 to 0.57 million gallons, and CSO-1A to 6.12 million gallons. These three overflows would continue to release about 6.83 million gallons (a reduction of about 70 million gallons or 91%). Because of hydraulic overloading of the Etna Trunkline, GSI cannot feasibly replace this project.

In the case of CSO1A further reductions in CSO volumes are feasible via GSI. It is possible to manage a total of 9.35 mg RO annually using GSI facilities. Of this amount, it appears feasible to remove 4.83 mg/ year to CSO1A using GSI.

Implementation of GSI will have some effect in the reduction of peak flow in the collection system. Each of the GSI facilities sited in the Etna plan intercepts runoff flows from about 156 to 1150 gallons per minute and releases a maximize controlled flow of between 2.6 to 19.0 gallons per minute.

Based our review of modelling results, the GSI will have only very limited benefits in the reduction of grey infrastructure requirements for the Borough. This is due to the limited nature of the improvements to Etna Combined sewer system that are needed to accommodate TY 2003 flows without surcharge and remove local restrictions that influence the operation of the collection system. These costs appear to be on the order of $300,000 if a level of control of 8-12 overflows is assumed.

Given the observed costs of GSI, it is unlikely that GSI can replace grey infrastructure for these improvements. However GSI may be of value in avoiding the cost of $ 1.3 million needed in Etna collection system improvements if the next Level of CSO Control is required.

GSI would also be able to reduce flow to CSO 1A and have an effect on residual CSO flow, although the situation is complicated by the large number of unknowns surrounding the factors bearing on the CSO MH 108A upstream.

However, it is less clear that GSI is an alternative approach to grey solutions in closing the unpermitted CSO at MH C108A. There is little potential to remove flow from the system at the hilltop location, therefore a DRt (storage) strategy needed to be applied. Based on a SWMM model evaluation, the grey solution for closing MH C108A required installing 40,000 CF storage plus extensive piping revisions downstream to avoid surcharging. On the other hand to attempt to by GSI would require the installation of 10,500 cf of ROW GSI at three upstream locations identified as high yield sites. However GSI alternative could only manage 1.8 mg in wet weather flow reductions from tributary areas which appears to fall short of the reductions needed. Based on our conceptual estimate this would cost approximately $410,000 which is roughly equal to the gray solution of a detention tank and downstream piping modifications.

The potential for GSI to address the overflow at MH B-23 was also examined. While it may be possible to use GSI to reduce loadings at the unpermitted CSO at the Manhole B-23, there are too many significant unknowns at this time to render an opinion either way.

There is however the potential for GSI to effect significant reductions in the ALCOSAN Treatment costs for the Borough.

Using ALCOSAN tabulated annual revenue requirements for regular operations and its proposed wet weather facilities per its draft Wet Weather Plan (Reference: ALCOSAN Draft Wet Weather Plan Table 11-7 Projected Annual Revenue Requirements ($ millions)) ALCOSAN will have 35 year total revenue requirement of $ 11,987,700,000. This only includes the 2026 Recommended Plan for $2.172 billion. During this period ALCOSAN will treat 227.6 trillion gals of wet weather flow and 2,643.2 trillion gallons of base wastewater flow. Under the current billing structure only metered water use can be used as a basis for billing. So treating wet weather flow a combined sewer community is presently a non-recoverable cost.

Dividing the 35 year total revenue requirements by the number of treated gallons yields a cost of $0.00417/gal. This cost would be conservative because it does not include the revenue requirements for the ALCOSAN Selected Plan cost of $3.77 billion which were not included in the Draft Wet Weather Plan report.

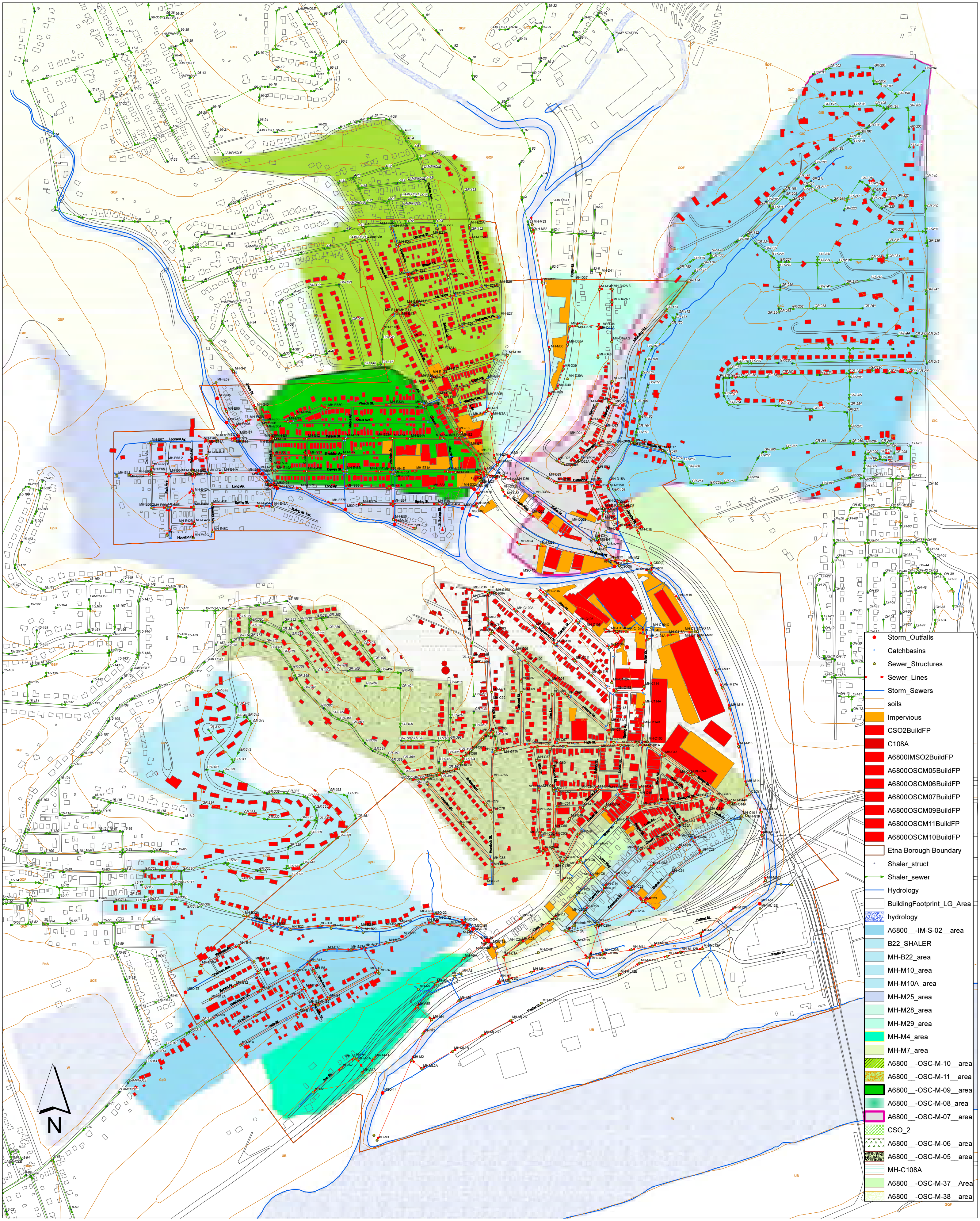
If Etna implements all 5 phases of its full GSI program it would reduce flow to ALCOSAN by 16.1 mg annually or a 35 year total of 563,936,375 gal. The 35 year savings in treatment costs to ALCOSAN from Etna GSI flow reduction would be $ 2,354,973.95.

At present, there are no avoided costs for the Borough to consider in conveying wet weather flow to ALCOSAN because they are billed on metered water use. However the basis for ALCOSAN service billing could change. The avoided cost for the Borough over a 35 year period would be approximately $3.1 mil based on the current ALCOSAN rate per gallon.

The incorporation of the SWMM model allows an estimate to be made on the benefits of the GSI reductions in Etna- both within its system and to the ALCOSAN regional conveyance system. Due to the large amount of flow originating from upstream communities that must be conveyed to the point of connection, the benefit in the Etna system comes from the reduction in CSO frequency and volumes based upon EPA SWMM models of the combined stormwater system. Any effect of reductions on the sizing of downstream grey infrastructure conveying flow to the ALCOSAN point of connection A-68 would be minimal.

From the perspective of the ALCOSAN system, there would also appear to be some downstream benefits from source reduction in Etna. Based on the Existing Conditions SWMM model for Pine Creek, about 28% of reduced flow volume from GSI would benefit ALCOSAN operations and infrastructure. This analysis is presented in Appendix H.

APPENDIX A



Etna/Shaler Contributing Area
Combined Sewer System in Pine Creek Watershed
Delineated Basins per Mainline Connection

1 inch = 225 feet

0 220 440 880 Feet

Created 11/29/12

APPENDIX B

APPENDIX B ETNA GSI GIS ANALYSIS - SLOPE

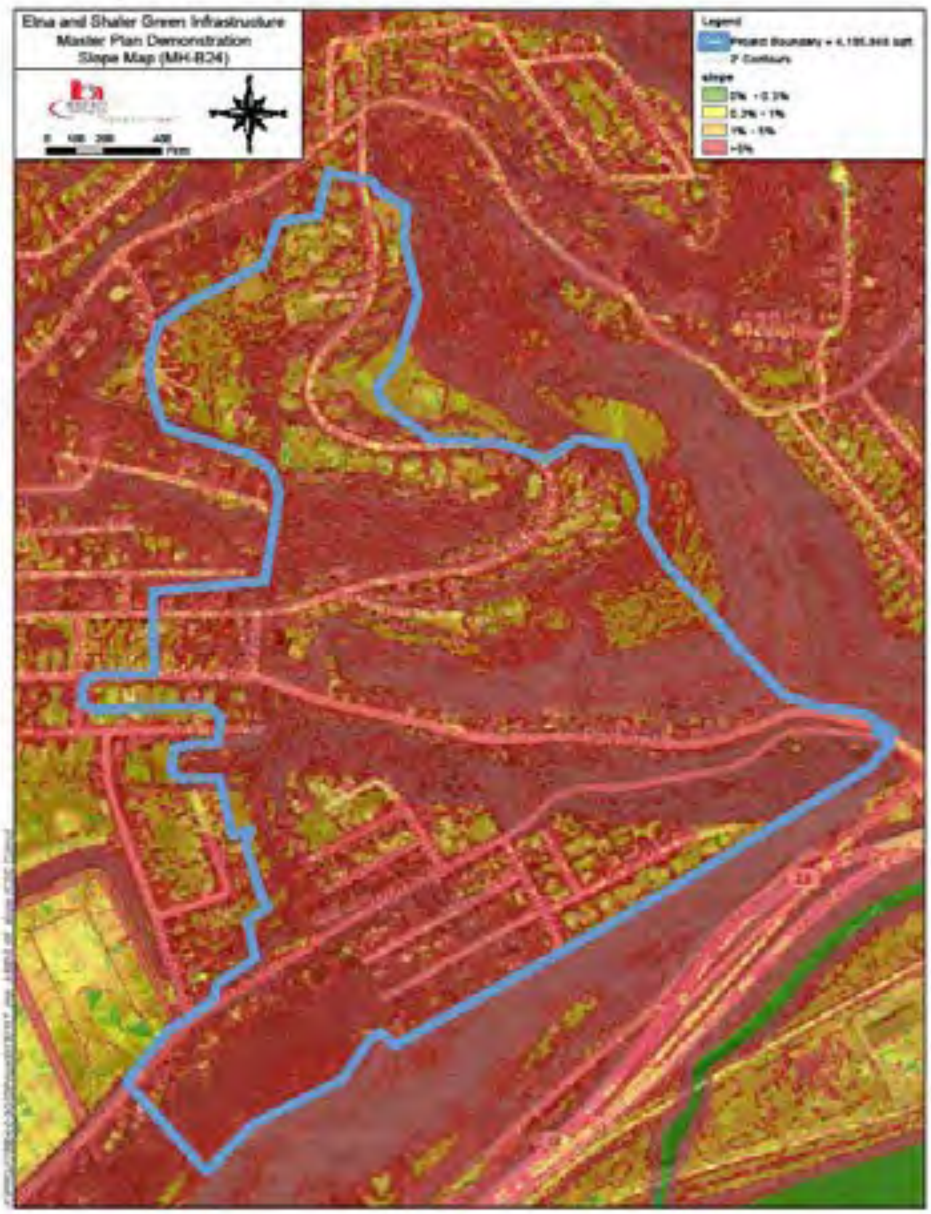
06

APPENDIX B ETNA GSI GIS ANALYSIS - SLOPE

05

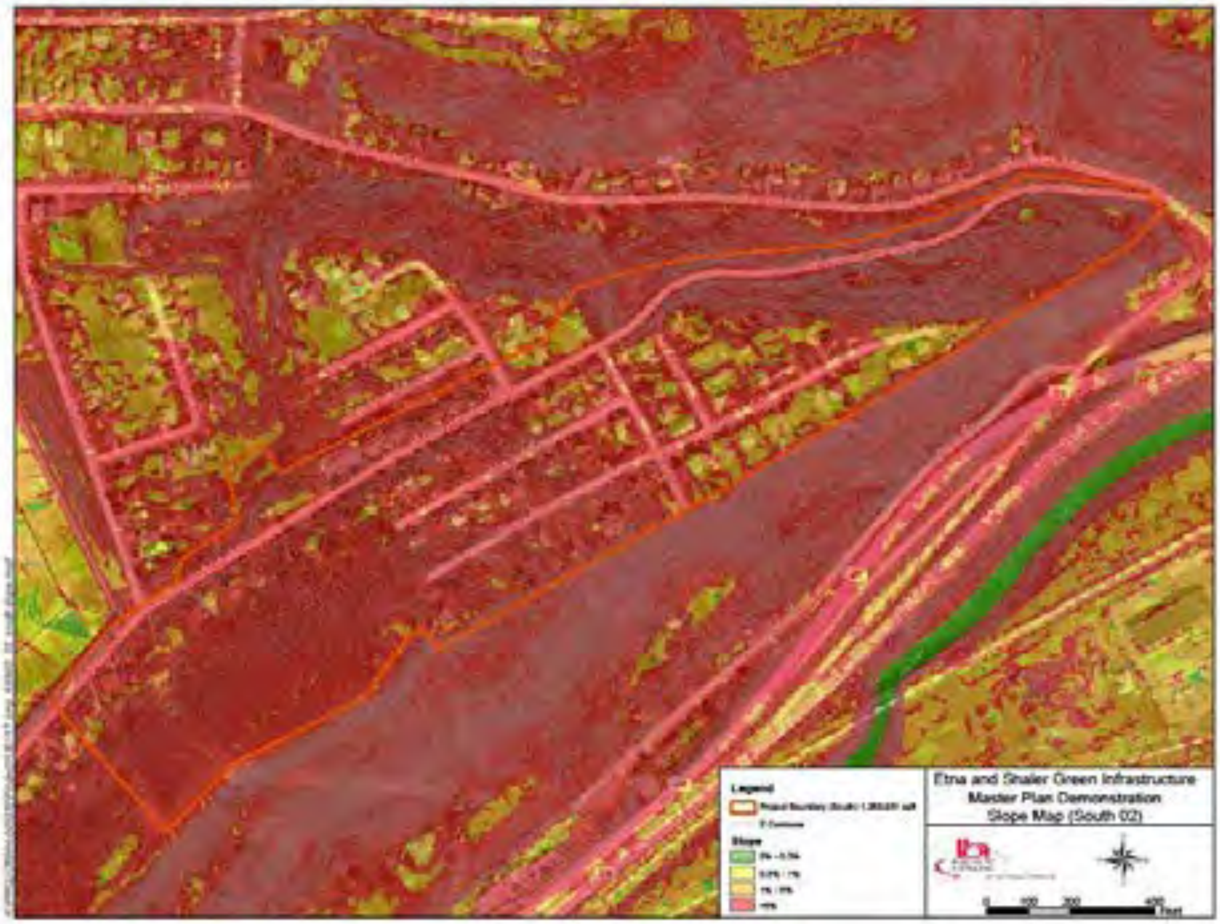
APPENDIX B ETNA GSI GIS ANALYSIS - SLOPE

02 MH-B24



APPENDIX B ETNA GSI GIS ANALYSIS - SLOPE

02 South



APPENDIX B ETNA GSI GIS ANALYSIS - SLOPE

07

APPENDIX B ETNA GSI GIS ANALYSIS - SLOPE

08

APPENDIX B ETNA GSI GIS ANALYSIS - SLOPE

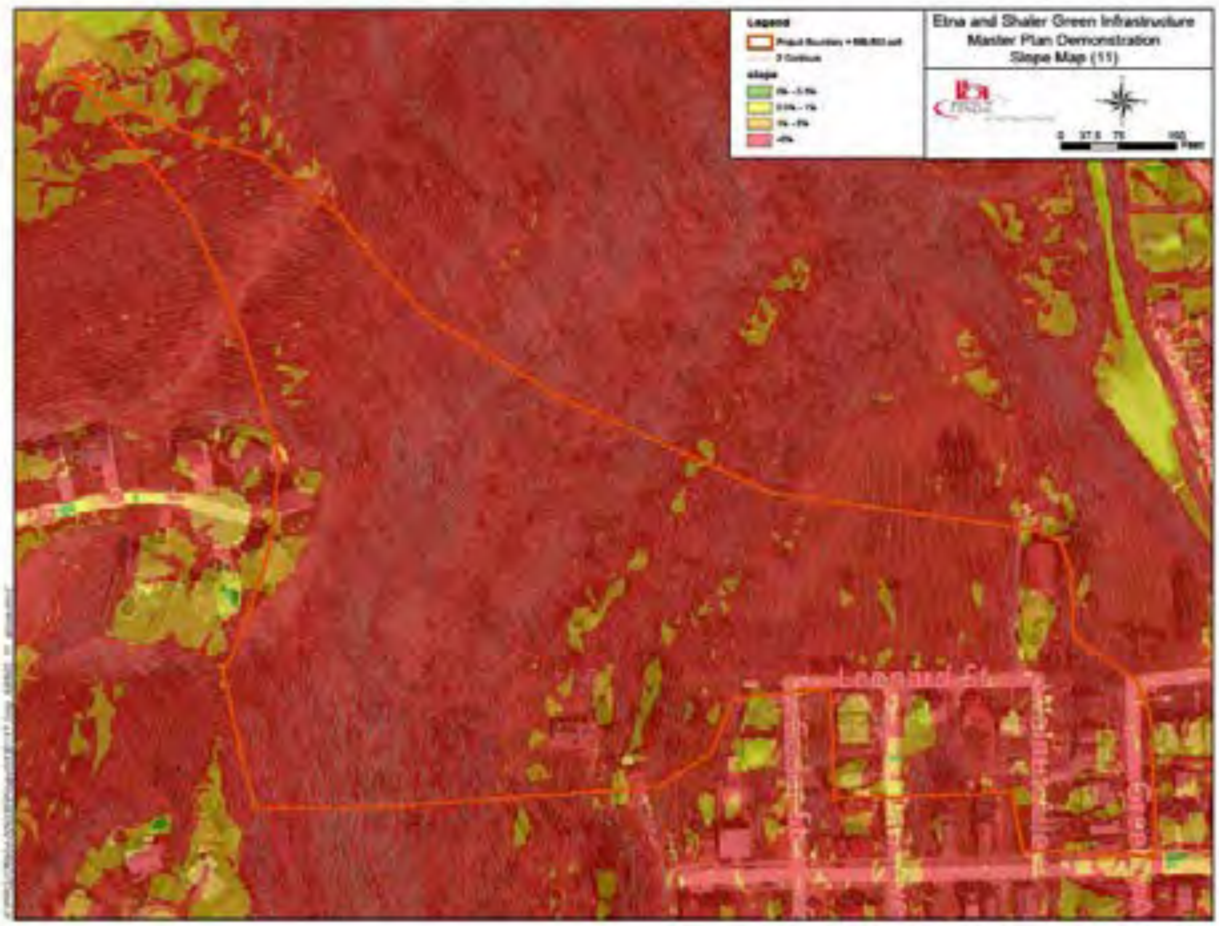
09

APPENDIX B ETNA GSI GIS ANALYSIS - SLOPE

10

APPENDIX B ETNA GSI GIS ANALYSIS - SLOPE

11



APPENDIX B ETNA GSI GIS ANALYSIS - SLOPE

37

APPENDIX C

APPENDIX C   ETNA GSI GIS ANALYSIS- IMPERVIOUS SURFACE

06

APPENDIX C   ETNA GSI GIS ANALYSIS- IMPERVIOUS SURFACE

05

APPENDIX C   ETNA GSI GIS ANALYSIS- IMPERVIOUS SURFACE

02 -MH-B24

APPENDIX C ETNA GSI GIS ANALYSIS- IMPERVIOUS SURFACE

02 South

APPENDIX C   ETNA GSI GIS ANALYSIS- IMPERVIOUS SURFACE

07

APPENDIX C   ETNA GSI GIS ANALYSIS- IMPERVIOUS SURFACE

08

APPENDIX C   ETNA GSI GIS ANALYSIS- IMPERVIOUS SURFACE

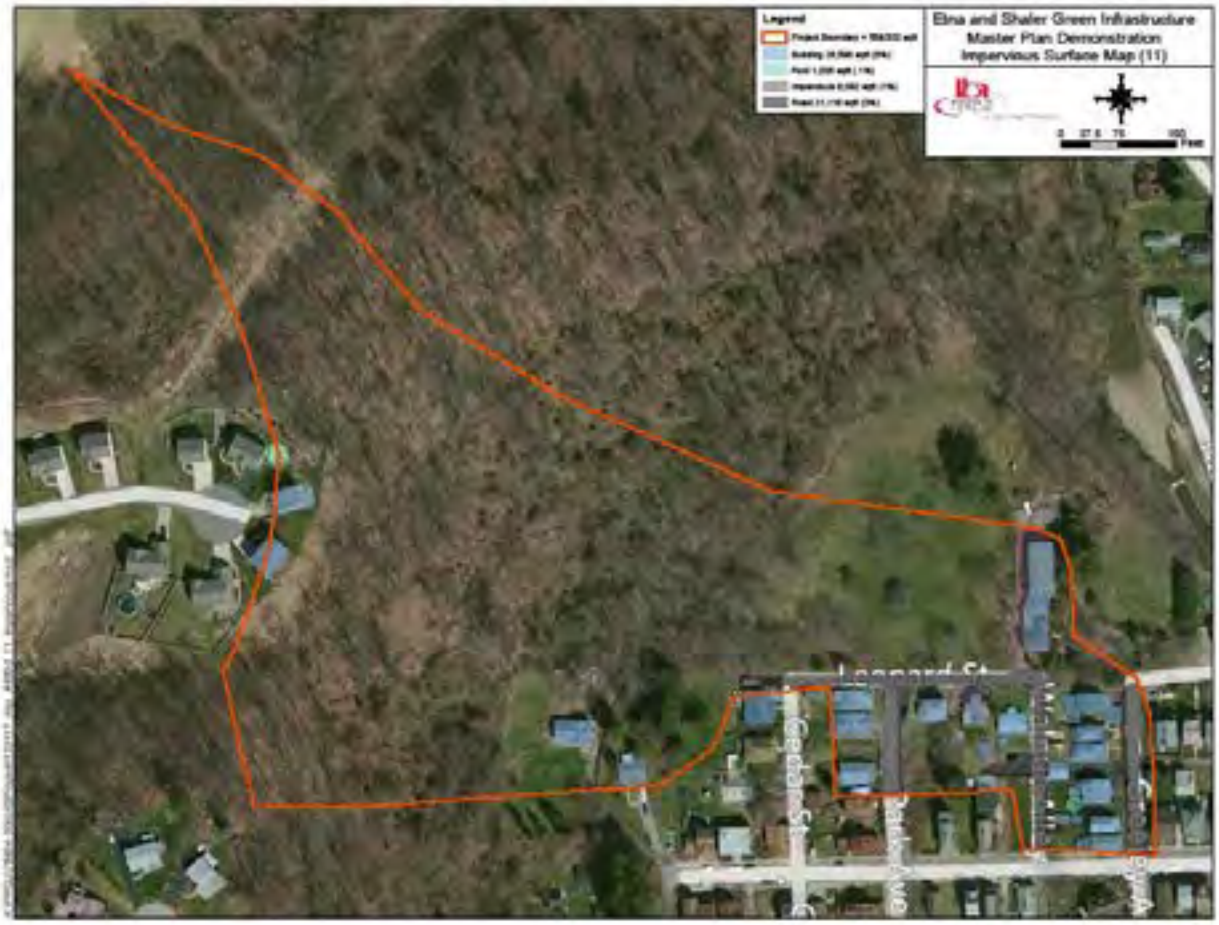
09

APPENDIX C   ETNA GSI GIS ANALYSIS- IMPERVIOUS SURFACE

10

APPENDIX C   ETNA GSI GIS ANALYSIS- IMPERVIOUS SURFACE

11



37


Cherry St
28
5A
Legend
Etna and Shaler Green Infrastructure
Master Plan Demonstration
Impervious Surface Map (37)
Feet

APPENDIX D

APPENDIX D ETNA GSI GIS ANALYSIS- SOILS

06

APPENDIX D ETNA GSI GIS ANALYSIS- SOILS

05

APPENDIX D ETNA GSI GIS ANALYSIS- SOILS

02 MH-B24

APPENDIX D ETNA GSI GIS ANALYSIS- SOILS

02 South

APPENDIX D ETNA GSI GIS ANALYSIS- SOILS

07

APPENDIX D ETNA GSI GIS ANALYSIS- SOILS

08

APPENDIX D ETNA GSI GIS ANALYSIS- SOILS

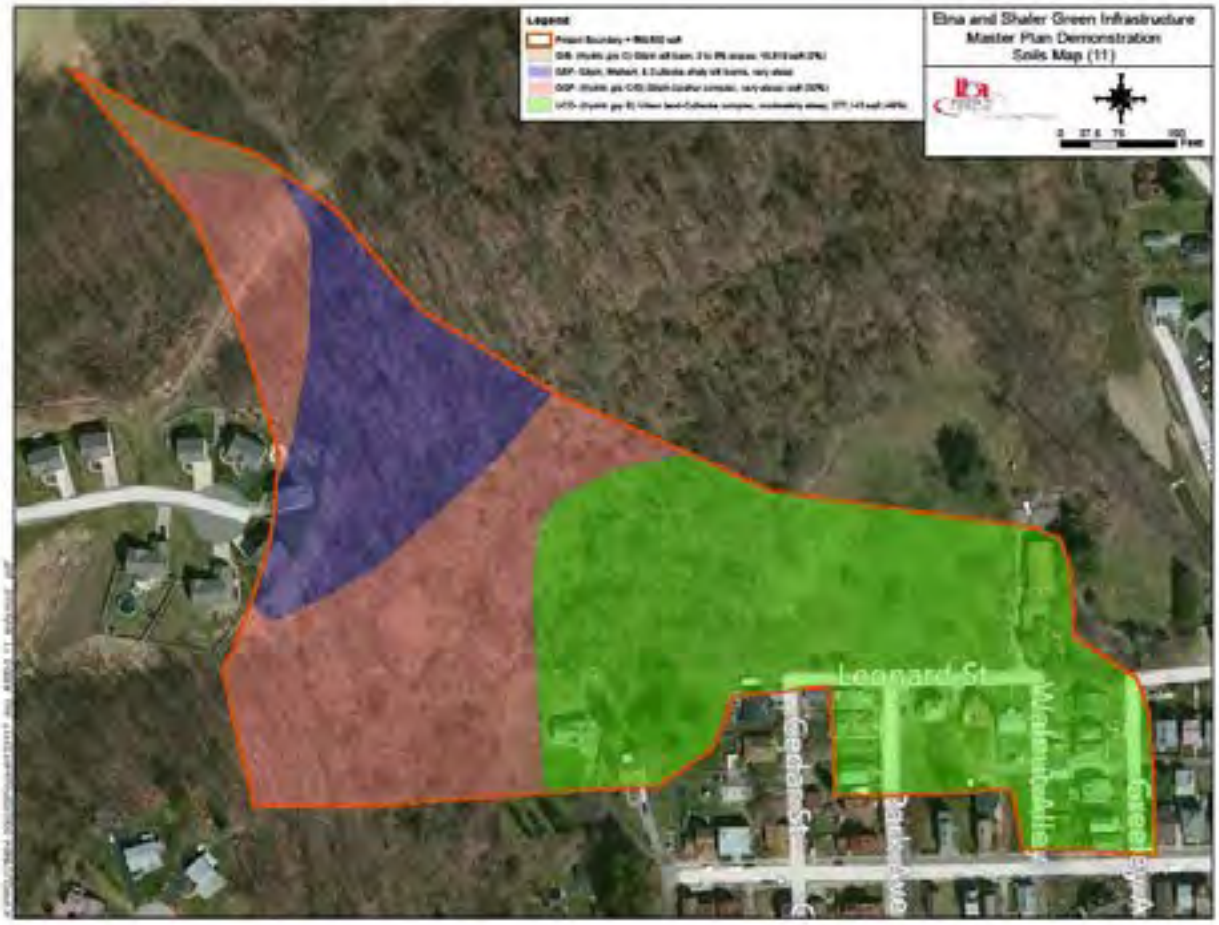
09

APPENDIX D ETNA GSI GIS ANALYSIS- SOILS

10

APPENDIX D ETNA GSI GIS ANALYSIS- SOILS

11



37


Cherry St
28
28
5A
28
Etna and Shaler Green Infrastructure
Master Plan Demonstration
Soils Map (37)
Legend
0 37.5 75 150
Feet

APPENDIX E

APPENDIX E   ETNA GSI GIS ANALYSIS – Tree Canopy

06

APPENDIX E ETNA GSI GIS ANALYSIS – Tree Canopy

05

APPENDIX E ETNA GSI GIS ANALYSIS – Tree Canopy

02 MH-B24

APPENDIX E ETNA GSI GIS ANALYSIS – Tree Canopy

02 South

APPENDIX E   ETNA GSI GIS ANALYSIS – Tree Canopy

07

APPENDIX E   ETNA GSI GIS ANALYSIS – Tree Canopy

08

APPENDIX E   ETNA GSI GIS ANALYSIS – Tree Canopy

09

APPENDIX E ETNA GSI GIS ANALYSIS – Tree Canopy

10

APPENDIX E   ETNA GSI GIS ANALYSIS – Tree Canopy

11

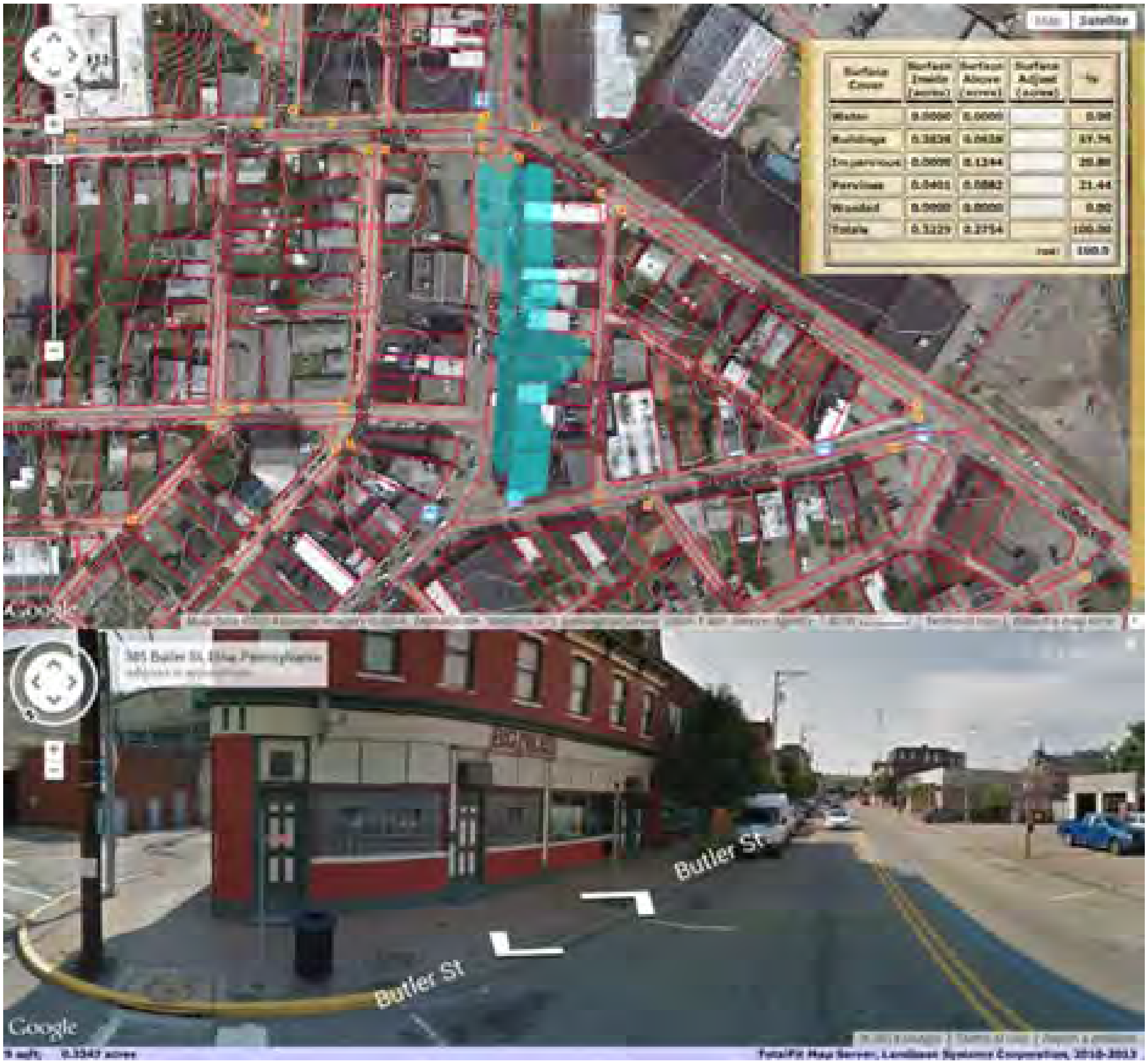
APPENDIX E   ETNA GSI GIS ANALYSIS – Tree Canopy

37

APPENDIX F

APPENDIX F   INDIVIDUAL GSI SITE REVIEWS: PHASE 1

PHASE 1 GSI SITE 047



PHASE 1 GSI SITE 057

PHASE 1 GSI SITE 196

APPENDIX F INDIVIDUAL GSI SITE REVIEWS: PHASE 1

PHASE 1 GSI SITE 234

PHASE 1 GSI SITE 060

PHASE 1 GSI SITE 374

APPENDIX F   INDIVIDUAL GSI SITE REVIEWS: PHASE 2

PHASE 2 GSI SITE 209

PHASE 2 GSI SITE 225

PHASE 2 GSI SITE 056

APPENDIX F INDIVIDUAL GSI SITE REVIEWS: PHASE 2

PHASE 2 GSI SITE 056A

APPENDIX F   INDIVIDUAL GSI SITE REVIEWS: PHASE 3

PHASE 3 GSI SITE 067

PHASE 3 GSI SITE 238

PHASE 3 GSI SITE 243

PHASE 3 GSI SITE 372

APPENDIX F INDIVIDUAL GSI SITE REVIEWS: PHASE 4

PHASE 4 GSI SITE 163

APPENDIX F INDIVIDUAL GSI SITE REVIEWS: PHASE 4

PHASE 4 GSI SITE 164

APPENDIX F INDIVIDUAL GSI SITE REVIEWS: PHASE 4

PHASE 4 GSI SITE 168

PHASE 5 GSI SITE 173

PHASE 5 GSI SITE 011

PHASE 5 GSI SITE 014

PHASE 5 GSI SITE 014a

PHASE 5 GSI SITE 099

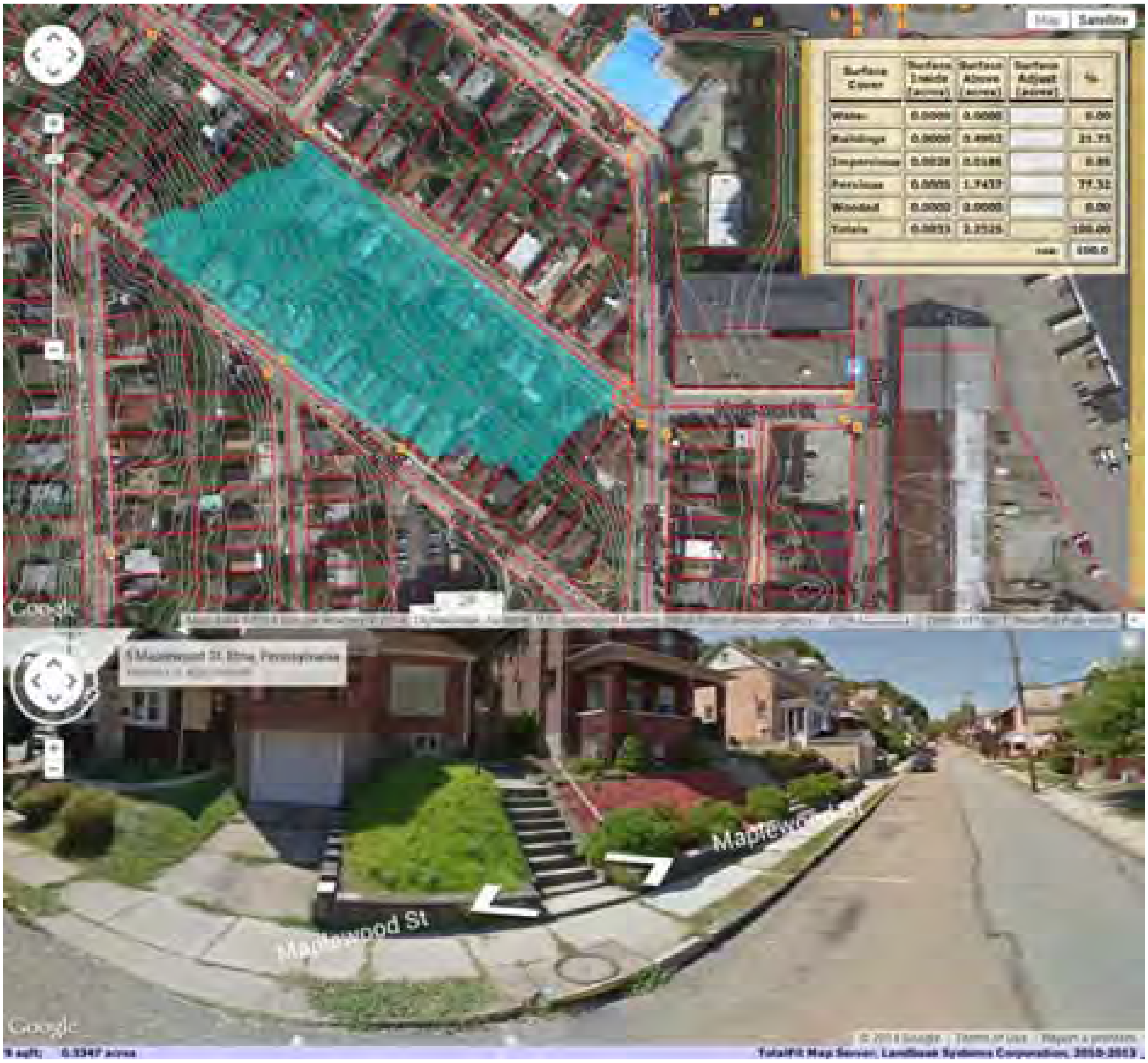
PHASE 5 GSI SITE 172

APPENDIX F INDIVIDUAL GSI SITE REVIEWS: FUTURE PHASE X

PHASE X GSI SITE 007

APPENDIX F INDIVIDUAL GSI SITE REVIEWS: FUTURE PHASE X

PHASE X GSI SITE 244



PHASE X GSI SITE 248a

PHASE X GSI SITE 248

PHASE X GSI SITE 304

PHASE X GSI SITE 305

PHASE X GSI SITE 384

APPENDIX F INDIVIDUAL GSI SITE REVIEWS: FUTURE PHASE X

PHASE X GSI SITE 219

PHASE X GSI SITE 221

APPENDIX F INDIVIDUAL GSI SITE REVIEWS: FUTURE PHASE X

PHASE X GSI SITE 229

PHASE X GSI SITE 231

PHASE X GSI SITE 256a

PHASE X GSI SITE 256

APPENDIX F INDIVIDUAL GSI SITE REVIEWS: FUTURE PHASE X

PHASE X GSI SITE 259

PHASE X GSI SITE 078

APPENDIX F INDIVIDUAL GSI SITE REVIEWS: FUTURE PHASE X

PHASE X GSI SITE 082

PHASE X GSI SITE 085

APPENDIX F INDIVIDUAL GSI SITE REVIEWS: FUTURE PHASE X

PHASE X GSI SITE 087

PHASE X GSI SITE 088

APPENDIX F INDIVIDUAL GSI SITE REVIEWS: FUTURE PHASE X

PHASE X GSI SITE 090

PHASE X GSI SITE 095

APPENDIX F INDIVIDUAL GSI SITE REVIEWS: FUTURE PHASE X

PHASE X GSI SITE 144

APPENDIX F INDIVIDUAL GSI SITE REVIEWS: FUTURE PHASE X

PHASE X GSI SITE 147

APPENDIX F INDIVIDUAL GSI SITE REVIEWS: FUTURE PHASE X

PHASE X GSI SITE 122

APPENDIX F INDIVIDUAL GSI SITE REVIEWS: FUTURE PHASE X

PHASE X GSI SITE 130

APPENDIX G

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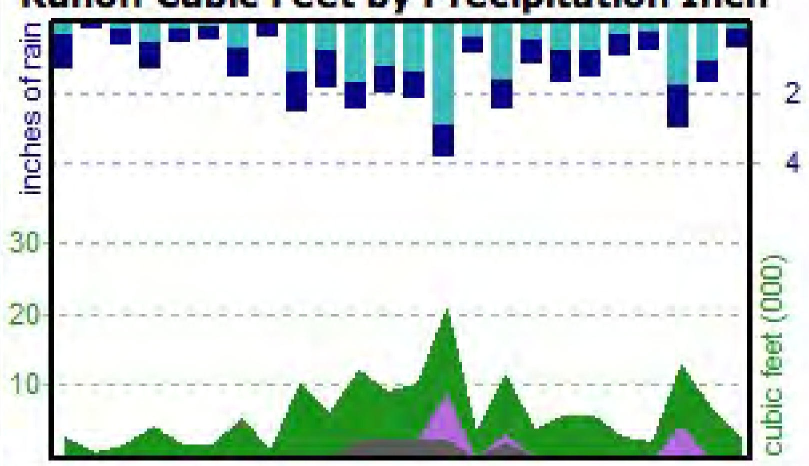
Runoff Cubic Feet by Precipitation Inch



Use 2003 Typical Year

With Green-Ampt Runoff (soil DB)

SWN Simulation Summary	Values	Units	%	Hour Delay
Precipitation Total	**36.81**	in		
Runoff Precip	19.99	in	54.3%	
Infiltrated Precip	16.82	in	45.7%	
Runoff Total	**141,415**	cf		
Runoff Intercepted	127,715	cf	90.3%	
Removed runoff	114,935	cf	81.3%	12.40
Returned runoff	0	cf	0.0%	0.00
Not Contained	12,781	cf	9.0%	
Bypassed + Ignored	13,700	cf	9.7%	
Drainage Area Total	1.95	ac		
Impervious Surface	0.46	ac	23.4%	
Control Feature Area	**0.02**	ac		
Gallons Intercepted	**0.955**	mg		
Gallons Removed	0.860	mg	90.0%	
Gallons Returned	0.000	mg	0.0%	
Gallons Not Contained	0.096	mg	10.0%	

Select Template

Run Simulation

Precipitation Target Rate 1.00 in/hr
Number to Install 1
Intercepted % & Shed Acres 100%

Feature Storage - Stage 1
Storage Volume 4550 cf
Storage Area 1000 sf

Removed from Network Drainage
Outflow Hours to Drain 48.00 hrs
ET Infiltration 0.00 in/hr

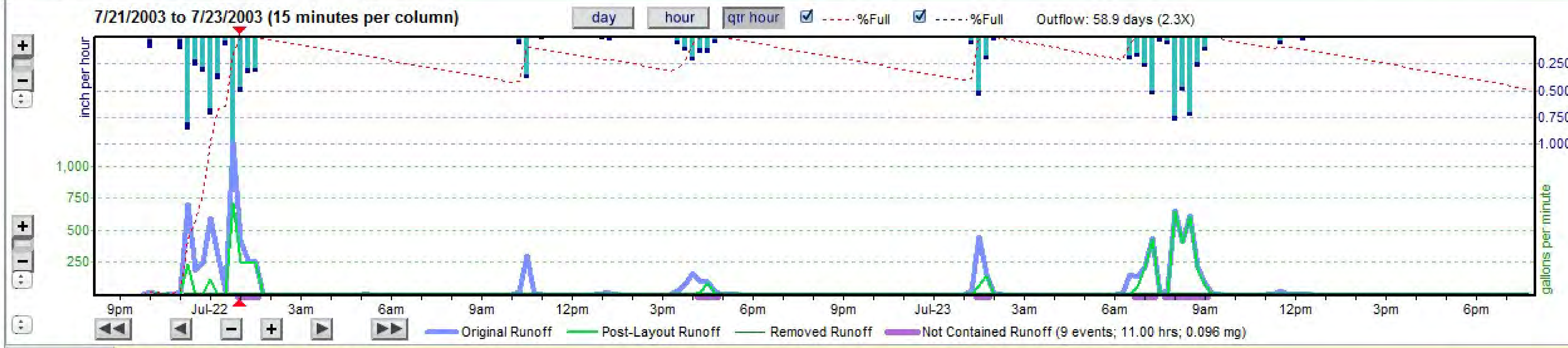
Return to Network or Stage 2
Hours to Drain 0.00 hrs
Percolation 0.00 in/hr

Stage 2 Storage
Storage Volume 1000 cf
Storage Area 1000 sf

Removed from Network Drainage
Outflow Hours to Drain 0.00 hrs
ET Infiltration 0.00 in/hr

Return to Network Drainage

7/21/2003 to 7/23/2003 (15 minutes per column) | day | hour | qtr hour | %Full | %Full | Outflow: 58.9 days (2.3X)



View

Trace

above below

Street View

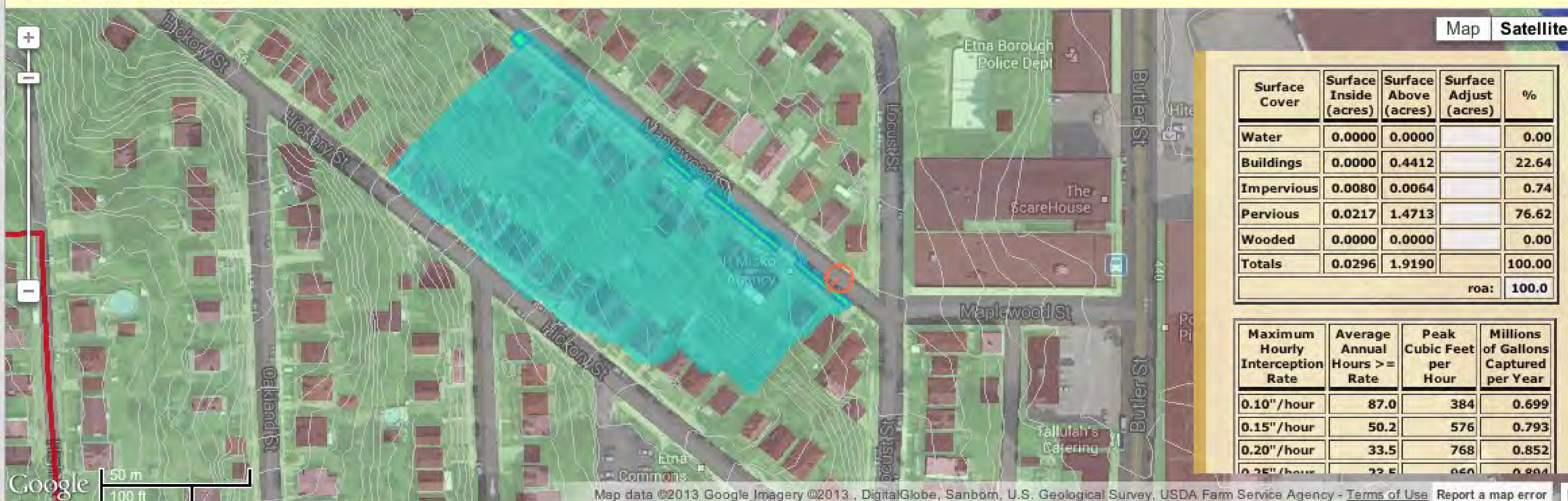
St View x

Add

Surface Trace

new

Select feature to Surface Trace



Surface Cover	Surface Inside (acres)	Surface Above (acres)	Surface Adjust (acres)	%
Water	0.0000	0.0000		0.00
Buildings	0.0000	0.4412		22.64
Impervious	0.0080	0.0064		0.74
Pervious	0.0217	1.4713		76.62
Wooded	0.0000	0.0000		0.00
Totals	0.0296	1.9190		100.00
			roa:	100.0

Maximum Hourly Interception Rate	Average Annual Hours >= Rate	Peak Cubic Feet per Hour	Millions of Gallons Captured per Year
0.10"/hour	87.0	384	0.699
0.15"/hour	50.2	576	0.793
0.20"/hour	33.5	768	0.852

[18] 40.499177,-79.944093

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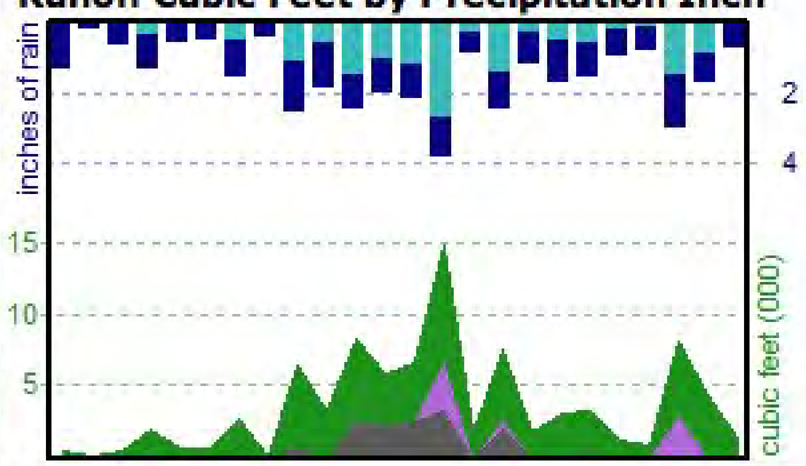
Runoff Cubic Feet by Precipitation Inch



Use 2003 Typical Year

With Green-Ampt Runoff (soil DB)

SWN Simulation Summary	Values	Units	%	Hour Delay
Precipitation Total	**36.81**	in		
Runoff Precip	15.29	in	41.5%	
Infiltrated Precip	21.52	in	58.5%	
Runoff Total	**83,668**	cf		
Runoff Intercepted	69,316	cf	82.8%	
Removed runoff	62,379	cf	74.6%	13.63
Returned runoff	0	cf	0.0%	0.00
Not Contained	6,937	cf	8.3%	
Bypassed + Ignored	14,352	cf	17.2%	
Drainage Area Total	1.51	ac		
Impervious Surface	0.01	ac	1.0%	
Control Feature Area	**0.02**	ac		
Gallons Intercepted	**0.519**	mg		
Gallons Removed	0.467	mg	90.0%	
Gallons Returned	0.000	mg	0.0%	
Gallons Not Contained	0.052	mg	10.0%	

Select Template

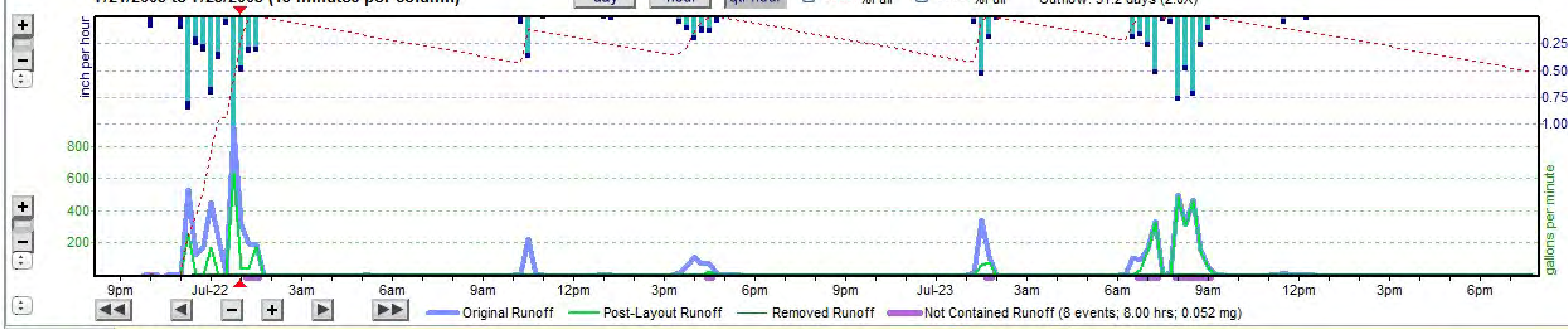
Run Simulation

Precipitation Target Rate 1.00 in/hr
Number to Install 1
Intercepted % & Shed Acres 100%

Feature Storage - Stage 1
Storage Volume 3480 cf
Storage Area 1000 sf
Removed from Network Drainage
Outflow Hours to Drain 48.00 hrs
ET Infiltration 0.00 in/hr
Return to Network or Stage 2
Hours to Drain 0.00 hrs
Percolation 0.00 in/hr

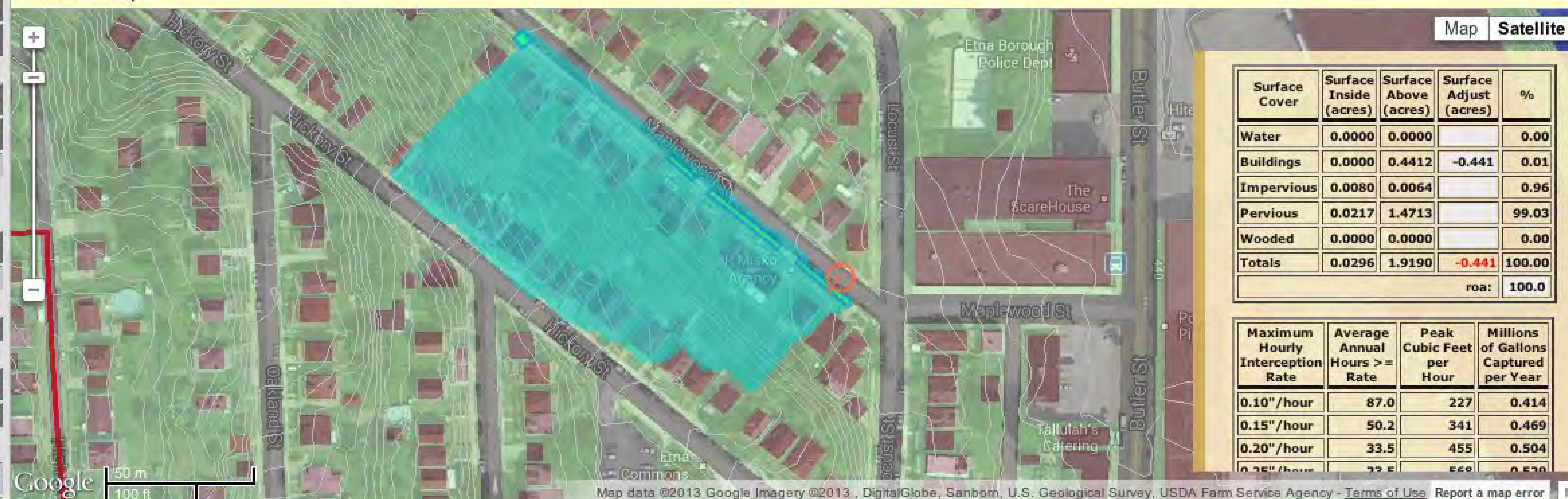
Stage 2 Storage
Storage Volume 1000 cf
Storage Area 1000 sf
Removed from Network Drainage
Outflow Hours to Drain 0.00 hrs
ET Infiltration 0.00 in/hr
Return to Network Drainage

7/21/2003 to 7/23/2003 (15 minutes per column) day hour qtr hour --- %Full --- %Full Outflow: 51.2 days (2.0X)



View
Trace
above below
Street View
St View x
Add
Surface Trace
new

Process Complete



Surface Cover	Surface Inside (acres)	Surface Above (acres)	Surface Adjust (acres)	%
Water	0.0000	0.0000		0.00
Buildings	0.0000	0.4412	-0.441	0.01
Impervious	0.0080	0.0064		0.96
Pervious	0.0217	1.4713		99.03
Wooded	0.0000	0.0000		0.00
Totals	0.0296	1.9190	-0.441	100.00
			roa:	100.0

Maximum Hourly Interception Rate	Average Annual Hours >= Rate	Peak Cubic Feet per Hour	Millions of Gallons Captured per Year
0.10"/hour	87.0	227	0.414
0.15"/hour	50.2	341	0.469
0.20"/hour	33.5	455	0.504

[18] 40.499177,-79.944093

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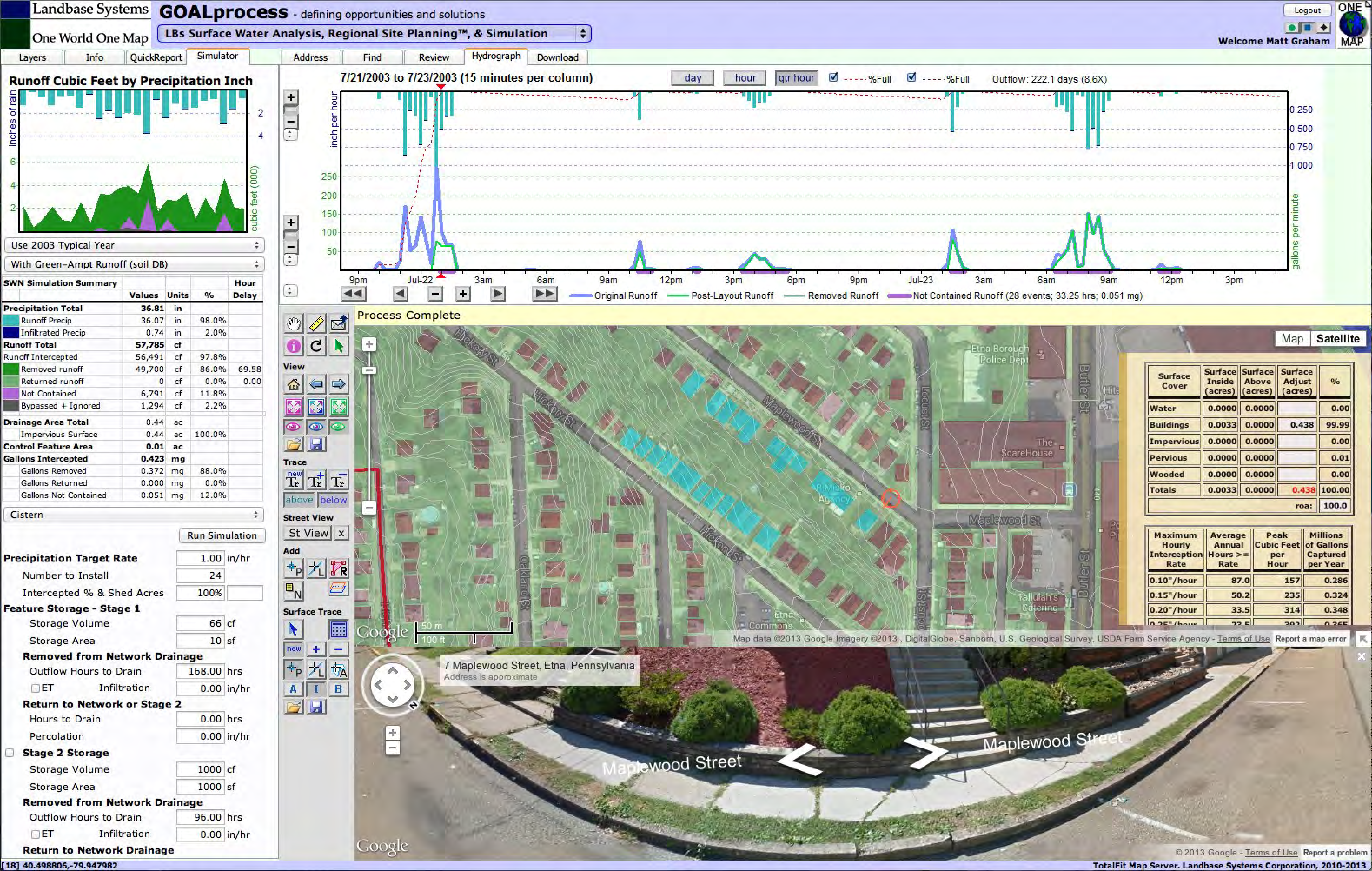

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Hydrograph
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Runoff Cubic Feet by Precipitation Inch
inches of rain
cubic feet (000)
Use 2003 Typical Year
With Green-Ampt Runoff (soil DB)
SWN Simulation Summary | Values | Units | % | Hour Delay
Precipitation Total | 36.81 | in
Runoff Precip | 36.07 | in | 98.0%
Infiltrated Precip | 0.74 | in | 2.0%
Runoff Total | 57,785 | cf
Runoff Intercepted | 56,491 | cf | 97.8%
Removed runoff | 49,700 | cf | 86.0% | 69.58
Returned runoff | 0 | cf | 0.0% | 0.00
Not Contained | 6,791 | cf | 11.8%
Bypassed + Ignored | 1,294 | cf | 2.2%
Drainage Area Total | 0.44 | ac
Impervious Surface | 0.44 | ac | 100.0%
Control Feature Area | 0.01 | ac
Gallons Intercepted | 0.423 | mg
Gallons Removed | 0.372 | mg | 88.0%
Gallons Returned | 0.000 | mg | 0.0%
Gallons Not Contained | 0.051 | mg | 12.0%
Cistern
Run Simulation
Precipitation Target Rate 1.00 in/hr
Number to Install 24
Intercepted % & Shed Acres 100%
Feature Storage - Stage 1
Storage Volume 66 cf
Storage Area 10 sf
Removed from Network Drainage
Outflow Hours to Drain 168.00 hrs
ET Infiltration 0.00 in/hr
Return to Network or Stage 2
Hours to Drain 0.00 hrs
Percolation 0.00 in/hr
Stage 2 Storage
Storage Volume 1000 cf
Storage Area 1000 sf
Removed from Network Drainage
Outflow Hours to Drain 96.00 hrs
ET Infiltration 0.00 in/hr
Return to Network Drainage
7/21/2003 to 7/23/2003 (15 minutes per column)
day
hour
qtr hour
%Full
%Full
Outflow: 222.1 days (8.6X)
inch per hour
gallons per minute
9pm Jul-22 3am 6am 9am 12pm 3pm 6pm 9pm Jul-23 3am 6am 9am 12pm 3pm
Original Runoff
Post-Layout Runoff
Removed Runoff
Not Contained Runoff (28 events; 33.25 hrs; 0.051 mg)
Process Complete
View
Trace
above
below
Street View
St View
Add
Surface Trace
Map
Satellite
Surface Cover | Surface Inside (acres) | Surface Above (acres) | Surface Adjust (acres) | %
Water | 0.0000 | 0.0000 | | 0.00
Buildings | 0.0033 | 0.0000 | 0.438 | 99.99
Impervious | 0.0000 | 0.0000 | | 0.00
Pervious | 0.0000 | 0.0000 | | 0.01
Wooded | 0.0000 | 0.0000 | | 0.00
Totals | 0.0033 | 0.0000 | 0.438 | 100.00
roa: | 100.0
Maximum Hourly Interception Rate | Average Annual Hours >= Rate | Peak Cubic Feet per Hour | Millions of Gallons Captured per Year
0.10"/hour | 87.0 | 157 | 0.286
0.15"/hour | 50.2 | 235 | 0.324
0.20"/hour | 33.5 | 314 | 0.348
Hickory St
Maplewood St
Locust St
Butler St
Etna Borough Police Dept
The ScareHouse
Tallulah's Catering
Etna Commons
Map data ©2013 Google Imagery ©2013 , DigitalGlobe, Sanborn, U.S. Geological Survey, USDA Farm Service Agency - Terms of Use
Report a map error
7 Maplewood Street, Etna, Pennsylvania
Address is approximate
Maplewood Street
Maplewood Street
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Report a problem
[18] 40.498806,-79.947982
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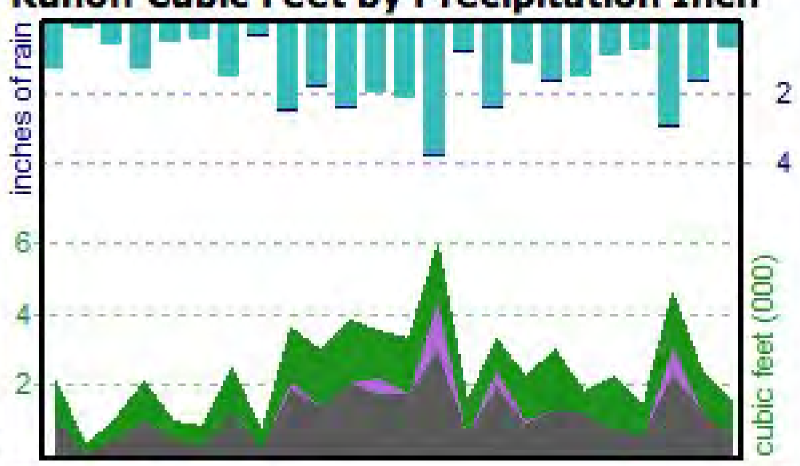
Runoff Cubic Feet by Precipitation Inch



Use 2003 Typical Year

With Green-Ampt Runoff (soil DB)

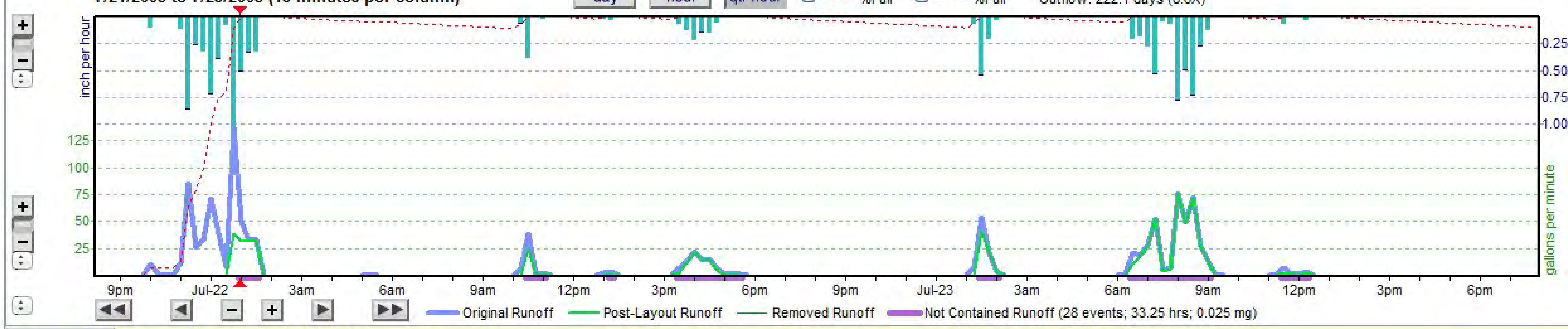
SWN Simulation Summary	Values	Units	%	Hour Delay
Precipitation Total	36.81	in		
Runoff Precip	36.07	in	98.0%	
Infiltrated Precip	0.74	in	2.0%	
Runoff Total	57,785	cf		
Runoff Intercepted	28,246	cf	48.9%	
Removed runoff	24,850	cf	43.0%	69.58
Returned runoff	0	cf	0.0%	0.00
Not Contained	3,395	cf	5.9%	
Bypassed + Ignored	29,540	cf	51.1%	
Drainage Area Total	0.22	ac		
Impervious Surface	0.22	ac	100.0%	
Control Feature Area	0.00	ac		
Gallons Intercepted	0.211	mg		
Gallons Removed	0.186	mg	88.0%	
Gallons Returned	0.000	mg	0.0%	
Gallons Not Contained	0.025	mg	12.0%	

Cistern

Run Simulation

Precipitation Target Rate	1.00	in/hr
Number to Install	12	
Intercepted % & Shed Acres	50%	
Feature Storage - Stage 1		
Storage Volume	66	cf
Storage Area	10	sf
Removed from Network Drainage		
Outflow Hours to Drain	168.00	hrs
ET Infiltration	0.00	in/hr
Return to Network or Stage 2		
Hours to Drain	0.00	hrs
Percolation	0.00	in/hr
Stage 2 Storage		
Storage Volume	1000	cf
Storage Area	1000	sf
Removed from Network Drainage		
Outflow Hours to Drain	96.00	hrs
ET Infiltration	0.00	in/hr
Return to Network Drainage		

7/21/2003 to 7/23/2003 (15 minutes per column)   day   hour   qtr hour   ----%Full   ----%Full   Outflow: 222.1 days (8.6X)



View

Trace

above below

Street View

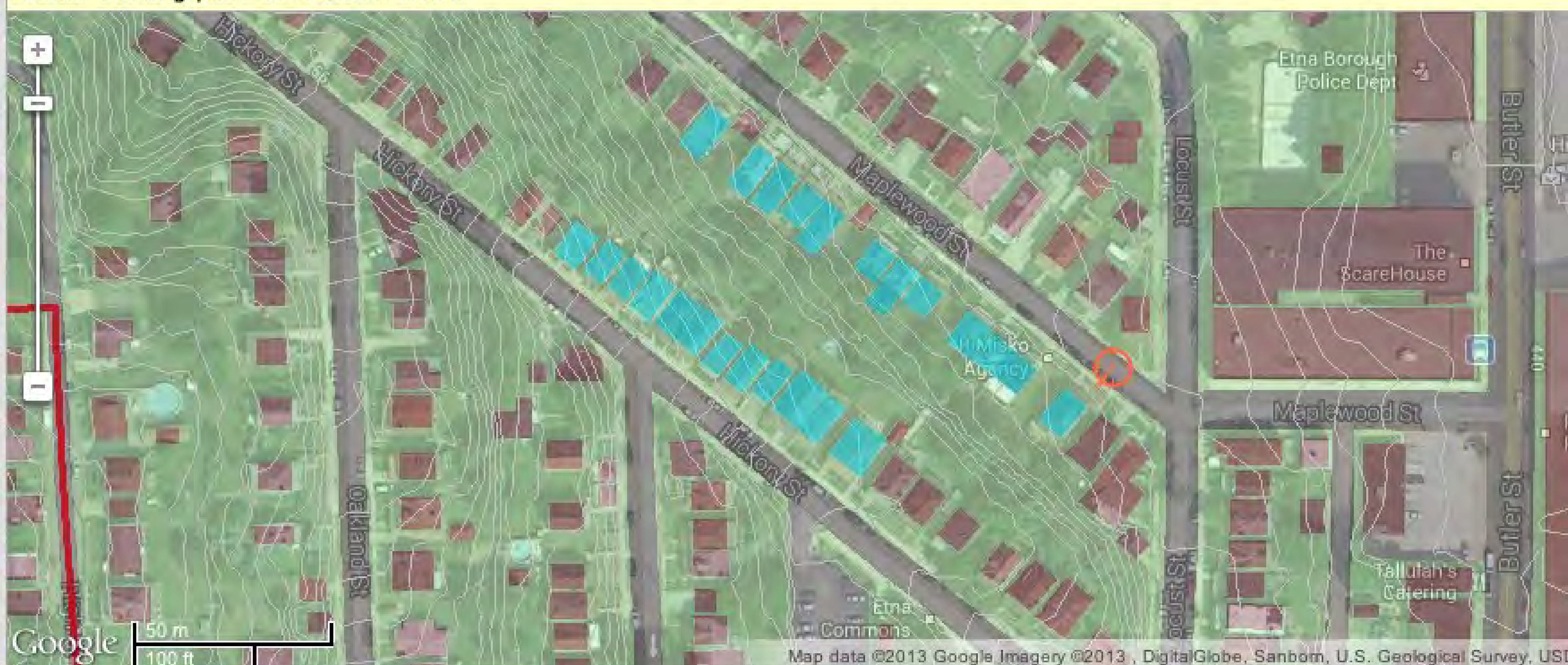
St View x

Add

Surface Trace

new

Select starting point of Surface Trace



Surface Cover	Surface Inside (acres)	Surface Above (acres)	Surface Adjust (acres)	%
Water	0.0000	0.0000		0.00
Buildings	0.0033	0.0000	0.438	99.99
Impervious	0.0000	0.0000		0.00
Pervious	0.0000	0.0000		0.01
Wooded	0.0000	0.0000		0.00
Totals	0.0033	0.0000	0.438	100.00
			roa:	100.0

Maximum Hourly Interception Rate	Average Annual Hours >= Rate	Peak Cubic Feet per Hour	Millions of Gallons Captured per Year
0.10"/hour	87.0	157	0.286
0.15"/hour	50.2	235	0.324
0.20"/hour	33.5	314	0.348

Report a map error

[18] 40.498957,-79.948052

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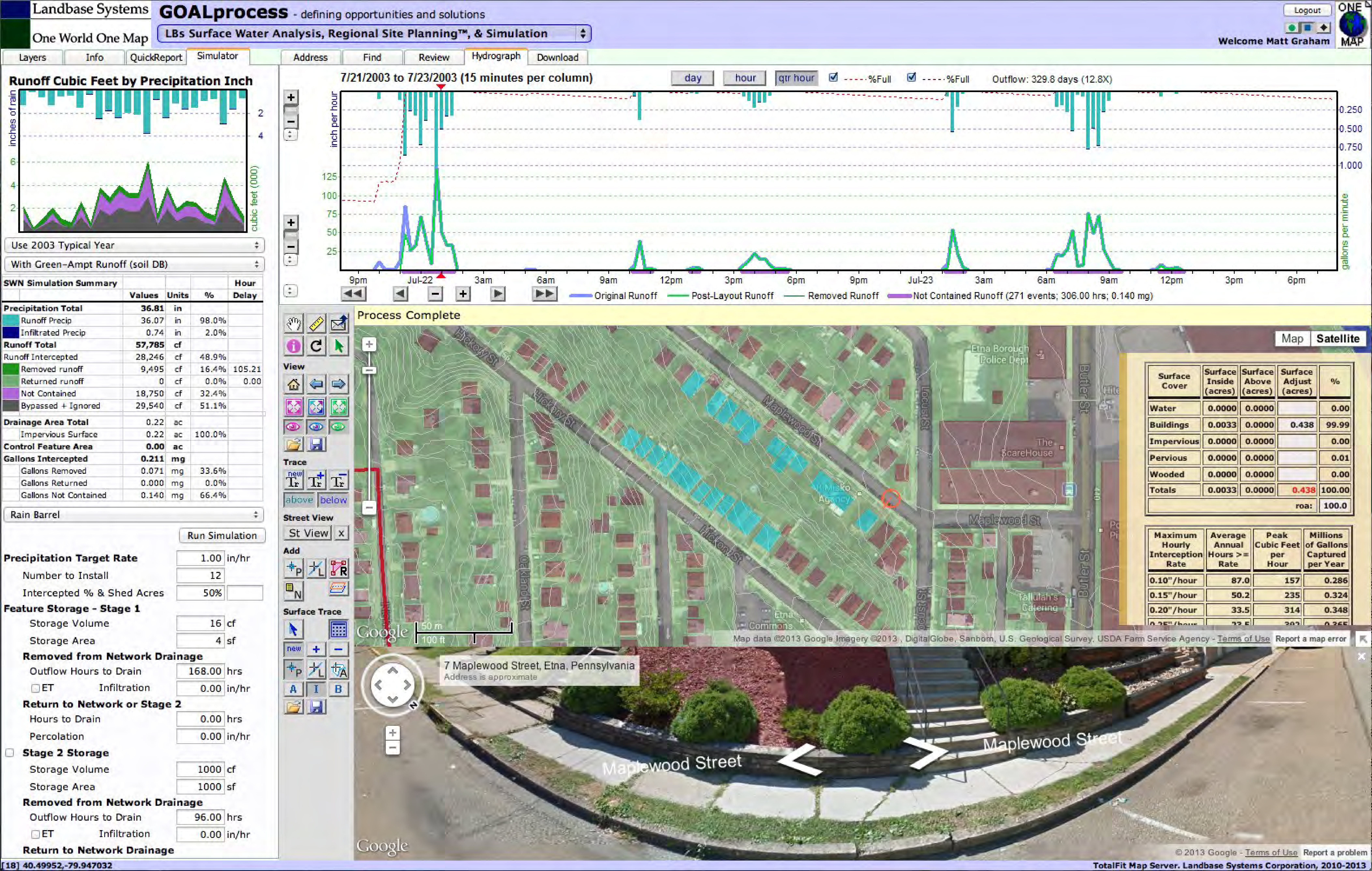

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Review
Hydrograph
Download
Runoff Cubic Feet by Precipitation Inch
inches of rain
cubic feet (000)
Use 2003 Typical Year
With Green-Ampt Runoff (soil DB)
SWN Simulation Summary
Values Units % Hour Delay
Precipitation Total 36.81 in
Runoff Precip 36.07 in 98.0%
Infiltrated Precip 0.74 in 2.0%
Runoff Total 57,785 cf
Runoff Intercepted 28,246 cf 48.9%
Removed runoff 9,495 cf 16.4% 105.21
Returned runoff 0 cf 0.0% 0.00
Not Contained 18,750 cf 32.4%
Bypassed + Ignored 29,540 cf 51.1%
Drainage Area Total 0.22 ac
Impervious Surface 0.22 ac 100.0%
Control Feature Area 0.00 ac
Gallons Intercepted 0.211 mg
Gallons Removed 0.071 mg 33.6%
Gallons Returned 0.000 mg 0.0%
Gallons Not Contained 0.140 mg 66.4%
Rain Barrel
Run Simulation
Precipitation Target Rate 1.00 in/hr
Number to Install 12
Intercepted % & Shed Acres 50%
Feature Storage - Stage 1
Storage Volume 16 cf
Storage Area 4 sf
Removed from Network Drainage
Outflow Hours to Drain 168.00 hrs
ET Infiltration 0.00 in/hr
Return to Network or Stage 2
Hours to Drain 0.00 hrs
Percolation 0.00 in/hr
Stage 2 Storage
Storage Volume 1000 cf
Storage Area 1000 sf
Removed from Network Drainage
Outflow Hours to Drain 96.00 hrs
ET Infiltration 0.00 in/hr
Return to Network Drainage
7/21/2003 to 7/23/2003 (15 minutes per column)
day
hour
qtr hour
%Full
%Full
Outflow: 329.8 days (12.8X)
inch per hour
gallons per minute
9pm Jul-22 3am 6am 9am 12pm 3pm 6pm 9pm Jul-23 3am 6am 9am 12pm 3pm 6pm
Original Runoff
Post-Layout Runoff
Removed Runoff
Not Contained Runoff (271 events; 306.00 hrs; 0.140 mg)
View
Trace
above
below
Street View
St View
Add
Surface Trace
new
Process Complete
Map
Satellite
Surface Cover | Surface Inside (acres) | Surface Above (acres) | Surface Adjust (acres) | %
Water 0.0000 0.0000 0.00
Buildings 0.0033 0.0000 0.438 99.99
Impervious 0.0000 0.0000 0.00
Pervious 0.0000 0.0000 0.01
Wooded 0.0000 0.0000 0.00
Totals 0.0033 0.0000 0.438 100.00
roa: 100.0
Maximum Hourly Interception Rate | Average Annual Hours >= Rate | Peak Cubic Feet per Hour | Millions of Gallons Captured per Year
0.10"/hour 87.0 157 0.286
0.15"/hour 50.2 235 0.324
0.20"/hour 33.5 314 0.348
Hickory St
Maplewood St
Locust St
Butler St
Oakland St
Etna Borough Police Dept
The ScareHouse
Tallulah's Catering
Etna Commons
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7 Maplewood Street, Etna, Pennsylvania
Address is approximate
Maplewood Street
Maplewood Street
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[18] 40.49952,-79.947032
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APPENDIX H

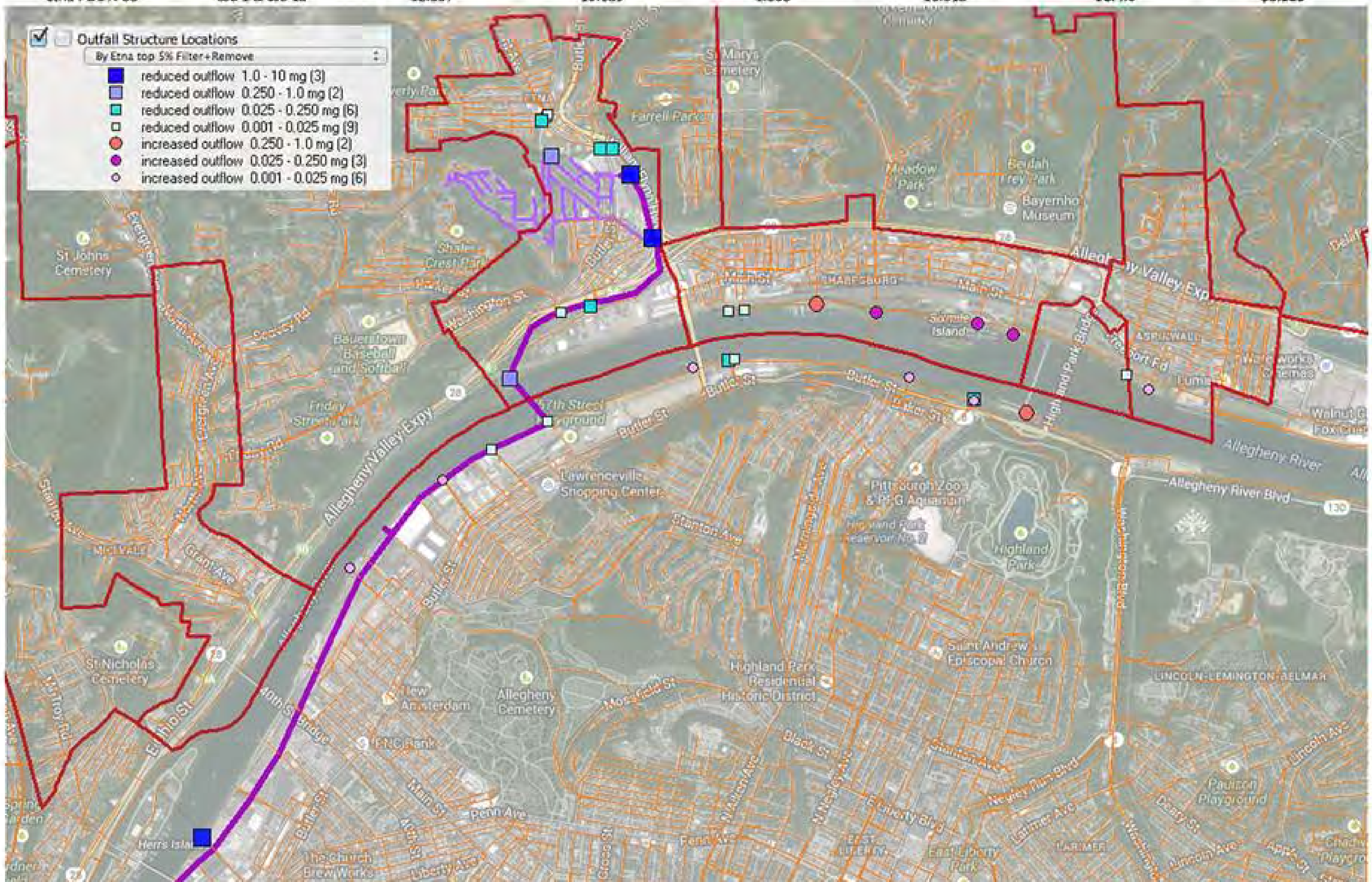
Etna GSI appears to reduce 10.5 million gallons of combined overflows

28% of Etna Green Stormwater Infrastructure (GSI) Overflow Reduction Benefits ALCOSAN

Overflow reductions effect upstream and downstream locations in the Municipal and ALCOSAN systems

Filter & Remove 85% of Runoff at Top High Yield Sites in Etna Above Overflows 'cso1' and 'cso1a':

Location	Next Downstream CSO	Runoff (mg) Total	Runoff (mg) Managed	Runoff (mg) Not Contained	Overall Basin Overflow Change (mg)	% Overflow Change of Managed Volume	Estimated $ per Reduced OF Gallon
Etna POC A-68	cso 1 & cso 1a	12.557	10.689	1.868	-10.513	-98.4%	$0.126



SWMM Overflow Reduction Results

Outfall Structure	Owned by Etna	Owned by ALCOSAN	Overflow Change
CSO-1-OF	-4.561		-4.561
A-23-DT-OF		-3.400	-3.400
CSO-1A-OF	-2.326		-2.326
MH-C108A-OF	-0.397		-0.397
A-68-OF		-0.277	-0.277
CSO-8-OF	-0.127		-0.127
MH-S32-OF		-0.105	-0.105
A-41-OF		-0.058	-0.058
CSO-2-OF	-0.055		-0.055
A-37-OF		-0.039	-0.039
CSO-3-OF	-0.037		-0.037
A-70-OF		-0.023	-0.023
CSO-4-OF	-0.014		-0.014
MH-M7-OF	-0.012		-0.012
CSO-5-OF	-0.006		-0.006
A-69-OF		-0.004	-0.004
A-34-OF		-0.003	-0.003
A-35-OF		-0.002	-0.002
A-37Z-OF		-0.002	-0.002
A-75-OF		-0.001	-0.001
A-36-OF		0.001	0.001
A-29-OF		0.002	0.002
A-76-OF		0.003	0.003
A-32-OF		0.009	0.009
A-40-OF		0.012	0.012
JCT121H005-OF		0.023	0.023
A-73-OF		0.036	0.036
A-74-OF		0.037	0.037
A-72-OF		0.125	0.125
MH122E001-OF		0.317	0.317
A-71-OF		0.369	0.369
Annual MG Reducion	-7.535	-2.978	-10.513
	71.7%	28.3%	

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