Appendix E-5 – 3 Rivers Wet Weather GSI Project Identification Report

POTENTIAL GSI PROJECTS / OPPORTUNITIES & DRAINAGE AREAS

E.1 Introduction/Purpose

3 Rivers Wet Weather (3RWW) was invited by ALCOSAN to participate in the Source Control Study due to 3RWW's prior work in the ALCOSAN service area to develop a process to identify site locations for installation of green stormwater infrastructure (GSI). While almost any site can be adapted for the installation of GSI by soil modification or extensive drainage modifications, the 3RWW process uses established design criteria to identify site locations that may be well suited for GSI without extensive modification. The purpose of the 3RWW work, as described in this Appendix, was to provide municipalities with a graphical representation of the site locations where GSI would find favorable conditions. This would be the first step in the evaluation of various sites leading to improvements to decrease the volume of stormwater entering the combined sewer systems within their municipalities. Such improvements could be a component of alternatives to increased conveyance to the regional collection system.

E.2 Background

E.2.1 Pilot Project

3 Rivers Wet Weather (3RWW) and their Program Management Team (Michael Baker International; Lennon, Smith, Souleret Engineering; and Wade-Trim) developed a process to identify sites suitable for green infrastructure projects. The process was applied and refined in the Nine Mile Run, Girty's Run, and McNeilly Run sewersheds during 2012 and 2013. A report titled Evaluation of the Feasibility of Green Infrastructure Implementation was completed in May, 2013.

E.2.2 ALCOSAN Regional Source Control Study

A Green Stormwater Infrastructure (GSI) Evaluation process was subsequently applied for the ALCOSAN Source Control Study to identify potential projects for municipal and commercial implementation. The GSI Evaluation process was applied to twenty-nine specific Study Areas in the ALCOSAN service area. These Study Areas generally comprise the combined sewer areas tributary to the ALCOSAN regional conveyance/treatment system. The 29 Study Areas are listed on and shown graphically in a full size map, Figure E-1 – Potential GSI Retrofit Projects Study Areas.

E.3 Project Identification Methodology and Approach

E.3.1 Methodology Overview

The GSI Evaluation process is initiated with the application of the U.S. Environmental Protection Agency's (EPA) SUSTAIN (System for Urban Stormwater Treatment and Analysis IntegratioN) program Best Management Practices (BMPs) siting module. SUSTAIN utilizes GSI placement screening criteria and GIS mapping data to overlay and identify areas best suited to implement certain BMPs to control stormwater. The output from the SUSTAIN BMP siting module is a GIS Shapefile presenting polygons, or features that identifies these locations. A GIS-facilitated, engineering-judgment-based, post-processing screening methodology is then applied to refine the polygons and identify potential Concept GSI projects from the SUSTAIN features. Once the

Concept GSI projects were identified, software was used to determine the drainage areas to those projects. The software-generated drainage areas were then reviewed by the engineering staff to assess reasonableness of the results and to make adjustments as necessary. The outcomes for each of the 29 Study Areas are presented individually and summarized in the following sections of this Appendix.

E.3.2 EPA SUSTAIN

EPA's website describes SUSTAIN as "… a decision support system that assists stormwater management professionals with developing and implementing plans for flow and pollution control measures to protect source waters and meet water quality goals. SUSTAIN allows watershed and stormwater practitioners to develop, evaluate, and select optimal best management practice (BMP) combinations at various watershed scales based on cost and effectiveness." SUSTAIN has many components, however for this GSI Evaluation process, only the BMP siting module was used to identify the locations best suited to implement the following BMPs:

1. Permeable Pavement;
2. Bioretention Basins;
3. Infiltration Basins;
4. Grassed Swales;
5. Vegetated Filter Strips; and
6. Constructed Wetlands.

EPA SUSTAIN National (Default) BMP Siting Criteria

SUSTAIN performs a GIS layer overlay comparison of available databases of the following site characteristics: a)drainage area, b) drainage area slope, c) imperviousness, d) hydrological soil group, e) water table depth, f) road buffer distance, g) stream buffer distance, and h) building buffer distance against criteria established for each of the selected BMPs.

EPA SUSTAIN Revised BMP Siting Criteria

Initial analyses utilizing the default criteria produced features that were not consistent with known or identifiable ground conditions. As a consequence, these default values were reviewed by a committee of engineers and local green infrastructure professionals and were revised to better reflect conditions in Western Pennsylvania. During the initial pilot study, the results were reviewed for reasonableness and where necessary, the criteria were refined through successive SUSTAIN runs. The revised BMP siting criteria found to be more reasonable for Western Pennsylvania identified Land Uses are shown in Table E-1.

Table E-1: 3RWW Sustain BMP Placement Criteria

No.	BMP	Drainage Area (acre)	Drainage Slope (%)	Impervious (%)	Hydrological Soil Group	Water Table Depth (ft)	Road Buffer (ft)	Stream Buffer (ft)	Building Buffer (ft)
1	Bioretention / Rain garden	< 2	< 5	NA	A–D	> 2	>5	>25	>15
2	Constructed Wetland / Wet Pond	> 25	< 15	NA	B-D	>2	>25	> 100	>100
3	Grassed Swale / Bioswale	< 5	< 4	NA	A–D	> 2	< 100	NA	>15
4	Infiltration Basin / Trench	< 10	< 15	NA	A–B	> 4	>25	> 100	>25
5	Porous Pavement	< 3	< 5	> 0	A-D	> 2	NA	>100	NA
6	Vegetated Filter Strip / Grass Buffer	NA	< 10	NA	A–D	> 2	< 100	NA	>50

EPA SUSTAIN BMP Siting Module Results

The output from the SUSTAIN BMP siting module is a GIS Shapefile presenting polygons (features) that identify these locations as meeting the "revised" siting criteria applicable to the BMP.

The output from the SUSTAIN BMP siting module identified 561,372 features covering 43,260 acres and consisted of the following in Table E-2.

Table E-2: SUSTAIN BMP Siting Results

BMP Type	# of Features	Coverage Area (acres)
Permeable Pavement	108,953	7,742
Bioretention	177,273	14,585
Infiltration Basins/Trenches	44,271	6,951
Vegetated Filter Strips	98,416	8,597
Grass Swales	123,917	5,191
Constructed Wetlands	8,542	194

Locations of all identified BMP features are presented graphically on in a full size map in Figure E-2, SUSTAIN BMP Features.

E.3.3 Conversion of SUSTAIN BMP Features to Concept GSI Projects

Following identification of the BMP features, a GIS facilitated, engineering-judgment based, post-processing screening methodology was utilized to identify potential Concept GSI projects from the SUSTAIN features. This GSI Evaluation process resulted in the identification of three classes of Concept GSI Projects:

1. **Potential Municipal GSI Projects** –This class of projects is comprised of undertakings that offer the potential to be owned, operated, and maintained by a municipal entity. Potential projects included Permeable Pavement, Bioretention, Infiltration Basins, Grassed Swales, Vegetated Filter Strips, and Constructed Wetlands;
2. **Potential Commercial / Institutional GSI Projects** – This class of projects is comprised of undertakings that would be owned, operated, and maintained by a commercial/private land owner. Projects were limited to Permeable Pavement and Green Roofs;

3. **Potential Special Case GSI Projects** – This class of projects is comprised of undertakings with unclear or complicated ownership. Potential projects included Permeable Pavement on State or County Roadways, GSI projects along the Port Authority of Allegheny County (PAT) Busways, and GSI projects with access limitations along railroads.

Application of Screening Criteria for Municipal Projects

The following generally describes the guidelines used for identifying potential GSI projects for the three classes listed above from the SUSTAIN BMP siting module shapefile output.

As noted, the Concept Municipal GSI Projects represent GSI projects that could conceivably be owned, operated and maintained by local municipalities under the current Western Pennsylvania institutional framework. The feature to concept screening process employed to identify potential Concept Municipal GSI Projects was performed by an engineer, reviewing each feature in relation to the surrounding features, land use, and drainage patterns, as follows:

A. Overlay the SUSTAIN BMP features with GIS aerial imagery, state/county road GIS, and Google Earth's street view feature.

B. Focus on areas generally within the municipal rights-of-way or on vacant land that is easily accessible and that could potentially be acquired by the municipality. No projects were identified in backyards of residential areas or on property that is privately owned and being used, such as parking lots or athletic fields.

C. Avoid/exclude areas with existing tree cover.

D. Focus on BMP features that achieve the "source flow reduction" intent by offering the potential to capture upstream tributary stormwater prior to entering combined sewer systems (i.e. not "end-of-pipe" projects).

E. Focus on "Stand-Alone" BMPs, such as: Permeable Pavement, Bioretention, and Infiltration Basins.

F. Other BMPs such as Grass Swales and Vegetated Filter Strips were looked at only if they could be used in conjunction (conveyance purposes) with a "Stand-Alone" BMP.

G. Focus on Constructed Wetlands was limited to only areas where there was significant land available away from residential/commercial/institutional structures.

H. Avoid/exclude placing Permeable Pavement on arterial roads (e.g. PennDOT owned/high traffic volumes), private roads, brick roads, gravel roads, or dirt roads.

If the site was deemed suitable by meeting the above criteria for potential municipal GSI projects, a new GIS polygon was drawn by an engineer to represent a concept project at this location and it was these concept-project polygons that were carried forward in the analysis. It is recognized that these concept-project polygons are larger than the actual GIS facility would need to be. The facilities were not sized during this analysis but would be refined during the project-specific design process.

All newly drawn GIS polygons that represented potential Concept Municipal GSI Projects were given a Unique Identifier (UID) (BMP and Area) as listed in Table E-3:

Table E-3: Municipal GSI Project Identifiers

BMP Type	BMP Label	Area UID Label (starting number)
Permeable Pavement	PP	1
Bioretention	BR	1001
Infiltration Basins	IB	2001
Grassed Swales	GS	3001
Vegetated Filter Strips	VF	4001
Constructed Wetlands	CW	5001

Application of Screening Criteria for Commercial/Institutional and Special Case Projects

The process for identifying the Concept Commercial/Institutional GSI projects was similar to that for the Municipal Projects with the exception that the Commercial/Institutional projects did not have to be located within the public rights of Way. The screening process employed to identify potential Concept Commercial/Institutional GSI Projects by an engineer, reviewing each feature in relation to the surrounding features, land use, and drainage patterns, was as follows:

A. Screened aerial photography to identify parking lots and green space associated with commercial/institutional buildings. Parking lots and green spaces associated with BMP features were identified as potential projects.

B. The initial green roof screening was performed by identifying all buildings with a footprint greater than 5,000 square feet. Subsequent screening utilized aerial photography (Google Earth) to confirm flat roof status.

C. Project should be located outside of the public right-of-way.

D. Avoid placing Commercial/Institutional Permeable Pavement on any parking lot with a surface that is not completely impervious (e.g. brick, gravel, dirt, or heavily deteriorated asphalt).

Special Case GSI Projects were developed using the same criteria as the Municipal GSI Projects except projects were only identified on State Roadways, County Roadways, PAT Busways, or along railroad tracks.

All newly drawn GIS polygons that represent potential Concept Commercial/Institutional and Special Case GSI Projects were given a Unique Identifier (UID) (BMP and Area) as identified in Table E-4.

Table E-4: Commercial/Institutional GSI Project Identifiers

BMP Type	BMP Label	Area UID Label (starting number)
Comm./Inst. Permeable Pavement	CPP	6001
Green Roofs	GR	7001
Special Case	ALL	8001

E.3.4 Overall Project Statistics and Summary

Concept Municipal GSI Projects

Based on the BMP features, 8,998 Concept Municipal GSI Projects were identified covering 1012.6 total acres and consisted of the following:

- Permeable Pavement: 2,696 projects comprising 802.5 acres;
- Bioretention: 5,970 projects comprising 188.3 acres;
- Infiltration Basins/Trenches: 259 projects comprising 15.6 acres;
- Vegetated Filter Strips: 62 projects comprising 4.7 acres;
- Grass Swales: 7 projects comprising 0.4 acres; and
- Constructed Wetlands: 4 projects comprising 1.1 acres.

The Concept Municipal GSI Projects are shown for all 29 Study Areas in a full size map in Figure E-3.

Concept Commercial/Institutional GSI Projects

Based on the BMP features, 4,890 concept Commercial/Institutional GSI Projects were identified covering 2,243.6 total acres and consisted of the following:

The Concept Commercial/Institutional GSI Projects are shown for all 29 Study Areas in a full size map in Figure E-4.

Table E-5: SUSTAIN BMP Siting Results – Commercial/Institutional

BMP Type	# of Projects	Coverage Area (acres)
Commercial Permeable Pavement	1,939	722.5
Green Roofs	2,014	844.6
State Route Permeable	913	665.9
Busway Permeable Pavement	12	9.0
Busway Bioretention	12	1.6

E.4 Drainage Area Methodology and Approach

This description summarizes the methodology and approach used to delineate drainage areas to the GSI projects. Some methods used batch processes to increase efficiency.

E.4.1 Delineating Drainage Areas (Watersheds) To Green Infrastructure BMPs

1. Ensure that there are no geometry issues with the project polygons that would affect the creation of a raster from the polygons or subsequent processing.
2. Export each individual project polygon of interest as an individual shapefile. Include the Unique Identifier (UID) value in the new shapefile name (e.g. "Project_ [UID]").
3. Convert project polygons to rasters using the batch Spatial Analyst Polygon to Raster tool.
4. Delineate watersheds to each project area using the Spatial Analyst Watershed tool.
5. Convert watershed rasters to watershed polygons using the Spatial Analyst Raster to Polygon tool.
6. Add "UID" field to all watershed polygons using the same process in Step 2 in order to subsequently assign the project name to each delineated drainage area.
7. Populate the "UID" fields created in Step 6 using the batch Spatial Analyst Create Field tool to assign the project ID to the delineated drainage area.
8. Merge all delineated drainage area polygons into one shapefile using the Spatial Analyst Merge tool.

E.4.2 Appending Project Geometries and Attributes To The Delineated Drainage Area Shapefile

9. Make a copy of the merged delineated drainage area polygon by exporting and renaming to "wshed_append."
10. Append all project polygons to the delineated drainage area polygon shapefile using the Append tool to overlay delineated drainage area polygons with the project polygons.
11. Dissolve features in the delineated drainage area /project polygon shapefile based on UID to combine all features of the same UID (project and delineated drainage area polygons) into one feature, or one polygon.
12. Add new UID field to the Project Polygon shapefile to reflect change from a 20 character string to short integer.
13. Join the Project Polygon shapefile table to the wshed_dissolve Table.
14. Add the following fields (field name/precision/length) to the wshed_dissolve table.
    a. BMP, Text, 5
    b. Subcatch, Text, 30
    c. Comment, Text, 50

15. Populate "BMP" and "Comment" fields, using the Field Calculator, with the same values in the joined table (project polygon table).
16. Populate "Subcatch" and "Comments"
    a. Identify large drainage areas (relative to the project size) in the comments.

E.4.3 QA/QC of Delineated Drainage Areas

17. QA/QC final delineated drainage areas merged with the project polygons. Perform any manual editing to polygon delineations as necessary. Consider the following:
    a. Does the watershed include the entire project area?
    b. Are watersheds consistent, and sensible, with aerial maps and contours of the area?
    c. Are any of the watersheds seemingly "forced" to the project polygons? (Look for straight edges)
    d. Manually adjust watershed vertices where they incorrectly follow contours.

E.4.4 Delineated Drainage Area Statistics and Summary

Concept Municipal GSI Projects Drainage Areas

Based on the 8,998 Concept Municipal GSI Projects that were identified, drainage areas were delineated to each project covering 8,369.1 total acres and consisted of the following in Table E-5.

Table E-6: SUSTAIN BMP Siting Results - Municipal

BMP Type	# of Features	Coverage Area (acres)
Permeable Pavement	2,696	5,826.7
Bioretention	5,970	2,241.1
Infiltration Basins/Trenches	259	214.0
Vegetated Filter Strips	62	58.4
Grass Swales	7	1.4
Constructed Wetlands	4	4.5

The drainage areas, tributary to the Concept Municipal GSI Projects, are shown for all 29 Study Areas as a full size map in Figure E-5. The drainage areas shown on the maps and in the tables are the areas that would drain naturally to the Concept-Project if land features did not interrupt, capture, or divert the flow. Once a project is selected for further analyses and design, the drainage area would be refined. The refinement process would include a detailed drainage study to determine the effects of curbs, inlets, and local features precluding the natural flow to the project site. At that time decisions would be made on the target volume of runoff to be treated by the project and the cost-effective modifications to be made to the altered drainage area to capture the target volume of runoff. It is likely that the resulting drainage areas will be smaller than the estimates of drainage area provided in the current analysis.

E.5 Findings by Study Area

Section 5 of this Appendix E contains reports on the individual findings from each of the 29 study areas. Each report begins with a description of the study area followed by a description of the BMP GIS Features located therein. Next are listings of the total number of Municipal and Commercial/Institutional and Special Case projects identified delineated by BMP type. This is followed by map of the Study Area showing the locations of all potential projects color-coded by the various BMP types. Next is a listing of all of the Municipal projects identified followed by maps showing the Individual Project Drainage Areas for each project. Finally, a detailed list is provided of the Commercial/Institutional and Special Case projects and an additional map showing their locations.

GSI Retrofit Projects
Study Areas

- Study Area
- # Study Area Label

Existing Sewer System

- ALCOSAN WWTP
- Deep Tunnel Interceptor
- Shallow-cut Interceptor
- Combined Sewer Area
- Separate Sewer Area
- Non-contributing Area
- Runoff towards combined area

GRJSA GSI
Etna GSI
OS DSI
PH DSI
SG GSI
SP DSI
CP DSI
MR GSI

GSI Priority Area List	
Label	**Description**
1	Braddock
2	Homestead
3	Nine Mile Run
4	Hazelwood
5	Saw Mill Run
6	Southside
7	Sharpsburg/Aspinwall
8	Sto-Rox
9	Turtle Creek/Wilmerding
10	Turtle Creek/East Pittsburgh
11	Four Mile Run
12	Chartiers
13	Swissvale/Rankin
14	Upper Southside
15	Lower Southside
16	Lower Hill/Duquense
17	Downtown Mon
18	Highland Park
19	Corliss
20	Brighton Heights
21	Shadyside/Friendship
22	Strip District
23	Downtown Allegheny
24	Bates Street
25	West Homestead
26	Lower Northern Allegheny
27	North Shore
28	Upper Ohio
29	Woods Run
30	Lawrenceville

Direct Stream Removal Project Areas	
Label	**Description**
CP DSI	Carnegie Park Direct Stream Removal
OS DSI	Orr Street Direct Stream Removal
PH DSI	Pine Hollow Direct Stream Removal
SP DSI	Sheraden Park Direct Stream Removal

Additional GSI Project Areas	
Label	**Description**
Etna GSI	Etna Green Master Plan (Etna Borough)
GRJSA GSI	Girtys Run GSI Evaluation (3RWW Pilot Study)
MR GSI	McNeilly Run GSI Evaluation (3RWW Pilot Study)
SG GSI	Spring Garden GSI

N

0 1 2 4
Miles

Figure E-1

ALCOSAN

Allegheny County Sanitary Authority
Allegheny County, Pennsylvania

Potential GSI Retrofit Projects
Study Areas

Date: April 2014


ALCOSAN GSI Project
SUSTAIN BMP Features
N
W
E
S
0
2,000
4,000
6,000
8,000
Feet
1 inch = 2,000 feet
Bioretention
Constructed Wetland
Grassed Swale
Infiltration Basin
Permeable Pavement
Vegetated Filterstrip
Municipal Boundaries
Figure E-2


ALCOSAN GSI Project
Concept Municipal GSI Projects
N
W
E
S
0
2,000
4,000
6,000
8,000
Feet
1 inch = 2,000 feet
Bioretention
Constructed Wetland
Grass Swale
Infiltration Basin
Permeable Pavement
Vegetated Filter
Access Limitations
Municipal Boundaries

Figure E-3


ALCOSAN GSI Project
Concept Commercial / Institutional,
Green Roof, and Special Case GSI Projects
N
W
E
S
0
2,000
4,000
6,000
8,000
Feet
1 inch = 2,000 feet
Concept Commercial / Institutional Permeable Pavement Projects
Concept Green Roof Projects
Special Case
Municipal Boundaries

Figure E-4


ALCOSAN GSI Project
Concept Municipal GSI Projects
N
S
E
W
0
2,000
4,000
6,000
8,000
Feet
1 inch = 2,000 feet
Bioretention
Constructed Wetland
Grass Swale
Infiltration Basin
Permeable Pavement
Vegetated Filter
Bioretention Drainage Area
Constructed Wetland Drainage Area
Grass Swale Drainage Area
Infiltration Basin Drainage Area
Permeable Pavement Drainage Area
Vegetated Filter Drainage Area
Access Limitations
Municipal Boundaries
Figure E-5