Herbert, Rowland & Grubic, Inc.
Engineering & Related Services

369 East Park Drive
Harrisburg, PA 17111
(717) 564-1121
www.hrg-inc.com

AUGUST 2015

MS4 TMDL STRATEGY
FOR
DISCHARGES TO IMPAIRED WATERS WITH A TMDL
GOOSE CREEK WATERSHED

PREPARED FOR:
WEST GOSHEN TOWNSHIP
PAI 130532

WEST GOSHEN TOWNSHIP
CHESTER COUNTY, PENNSYLVANIA

HRG Project No. 004194.0430

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TMDL STRATEGY
FOR
GOOSE CREEK WATERSHED
WEST GOSHEN TOWNSHIP, CHESTER COUNTY, PENNSYLVANIA

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1.0 EXECUTIVE SUMMARY

A report published by the Unites States Environmental Protection Agency (US EPA) has established total maximum daily loads (TMDL) for municipalities with a municipal separate stormwater system (MS4) discharge permit within the Goose Creek Watershed in Chester County, Pennsylvania.

West Goshen Township is assigned pollutant reduction goal of 53.9% for total phosphorus. Based on this proposed MS4 TMDL Strategy, total phosphorus loading is anticipated to be reduced by 55% with the implementation of effective best management practices (BMPs), namely detention basin retrofits, stream bank stabilization, riparian buffer restoration, and street sweeping. Iterative implementation of the proposed BMPs is set to begin upon approval and continue through the next four permit cycles.

I hereby certify that, to the best of my knowledge, the stormwater management best management practices described herein are designed in conformance with the conditions of the *Notice of Intent for Coverage Under NPDES General Permit for Stormwater Discharges (PAG-13) from Small Municipal Separate Storm Sewer Systems (MS4s)* and the *Pennsylvania Stormwater Best Management Practices Manual* (Document No. 363-0300-002), as amended.

Matthew S. Bonanno, PE073374

2.0 INTRODUCTION

The following Total Maximum Daily Load (TMDL) Strategy addresses how the Township of West Goshen, Chester County, Pennsylvania intends to meet the pollutant reduction requirements listed in the TMDL report dated June 30, 2008 entitled, "Nutrient Total Maximum Daily Load in Goose Creek Watershed, Pennsylvania" as established by the United States Environmental Protection Agency Region III.

Located in eastern Chester County, Pennsylvania; West Goshen Township is an MS4 community (PAI 130532) currently in its second permit term. The entire township is classified as an Urbanized Area (UA) according to the United States Census Bureau's 2000 census. The western portion of the township lies within the Brandywine Creek Watershed and the central and eastern portions make up part of the Chester Creek Watershed. The above mentioned Goose Creek Watershed is a sub-watershed of the Chester Creek Watershed, encompassing approximately 1,488 acres in the south central region of West Goshen Township. Many of the stream segments within the Goose Creek Watershed have been classified by the Pennsylvania Department of Environmental Protection as impaired, including those located within West Goshen Township. The EPA's Goose Creek Watershed TMDL Report establishes a Total Phosphorus (TP) TMDL for the Goose Creek Watershed and provides a total phosphorus Waste Load Allocation (WLA) to each of the MS4s in the watershed. Table 1 below lists West Goshen's current and allocated TP loads, as well as the reduction requirement as spelled out by the Goose Creek TMDL Report. The EPA established these values using the Water Quality Simulation Program (WASP 7.2) and the Generalized Watershed Loading Functions (GWLF) based BasinSim model.

3.0 GOOSE CREEK WATERSHED TMDL STRATEGY

The following strategy provides the information requested in the Authorization Form – Part C, items a, b, and c, as applies to the content of a complete TMDL Strategy. Tables 1, 2, 3, and 4 provide information in tabular form as requested in the guidance document.

i. TMDL Report Title:

Nutrient Total Maximum Daily Load in Goose Creek Watershed, Pennsylvania
Established by United States Environmental Protection Agency Region III, June 30, 2008

ii. Watershed Name:

Goose Creek Watershed
HUC 2040202

iii. West Goshen Township MS4 Waste Load Allocations (WLA) and Required Reduction:

Table 1: West Goshen MS4 Total Phosphorus (TP) Loads and Required Reduction*			
MS4 Permittee	**Current TP Load (lb/day)**	**WLA (lb/day)**	**Reduction Requirement**
West Goshen Twp.	1.16	0.54	53.9%

*Current TP load as listed in TMDL Report. See section 3.2 for recalculated baseline TP load.

iv. Municipalities Subject to TMDL:

Table 2. Municipalities in HUC 2040202	
Municipality	**County**
Thornbury Township	Chester
Thornbury Township	Delaware
West Chester Borough	Chester
West Goshen Township	Chester
Westtown Township	Chester

v. Counties Subject to TMDL:

See Table 2 above. Chester and Delaware Counties are subject to the Goose Creek TMDL.

Summary of Surface Waters with TMDLs:

Table 3. Surface Waters Receiving Stormwater Discharge from West Goshen Township MS4**			
Stream Name	**Designated Use**	**Impaired**	**TMDL**
Goose Creek	TSF-MF	Yes	Yes
UNT to Goose Creek	TSF-MF	Yes	Yes
UNT to Goose Creek	TSF-MF	Yes	Yes
UNT to Goose Creek	TSF-MF	Yes	Yes

**Stream classification maps are located in Appendix A.

West Goshen Township MS4 Outfalls Located in Goose Creek Watershed:

Table 4: West Goshen Township MS4 Outfall Identification Numbers (see Stormwater Facility Map in Appendix F for outfall locations)						
1	21	37	75	107	178	184
2	22	38	76	109	179	185
3	23	54	84	112	180	186
4	24	56	85	147	181	187
5	31	72	97	176	182	188
9	36	73	98	177	183	

vi. Determination of Baseline Load

Baseline Total Phosphorus loading for the Goose Creek Watershed was determined using the MapShed modeling software. MapShed is a "GIS-based watershed modeling tool that uses hydrology, land cover, soils, topography, weather, pollutant discharges, and other critical environmental data to model sediment and nutrient transport within a watershed."[1] All GIS data used to create the Goose Creek Watershed Total Phosphorus baseline loading model was sourced from the MapShed Download web site.[2] The baseline model was created using existing land use data, without the addition of proposed control measures or BMPs. Existing detention basins located within the Township limits of the Goose Creek Watershed were added to the baseline model at an assumed average depth of three feet. This was done to provide a model that represented the current hydrologic conditions of West Goshen Township. A list of all detentions basins included in the baseline Mapshed model can be found in Appendix B. Using MapShed's Urbanized Area Viewer, the baseline Total Phosphorus load for West Goshen Township was determined to be 0.95 pounds per day. This is a reduction of 0.21 pounds per day from the Current TP Load listed in the Goose Creek Watershed TMDL Report. See Appendix C for all MapShed modeling results.

vii. Pollutant Load Reduction Required & Reduction Strategy

West Goshen Township has developed a strategy to achieve their required reduction of 53.9% of the current Total Phosphorus load being discharged to Goose Creek through the implementation of stormwater detention basin retrofits, streambank stabilization, riparian buffer restoration, and street sweeping. The introduction of these Best Management Practices (BMPs) to the Township's portion of the Goose Creek Watershed and provide water quality benefits to surface runoff prior to it reaching receiving waters; and in the case of detention basin retrofits, reduce the volume of stormwater being discharged to the stream. The Township Engineer and staff collaborated with and their engineering consultant Herbert, Rowland & Grubic, Inc. (HRG) on the selection of the types of BMPs to utilize for compliance. Their respective locations came as a result of a feasibility investigation performed in the Spring of 2015. The investigation led to the conclusion that retrofitting existing detention basins to allow for infiltration and/or bioretention offered the most promising and cost effective means of achieving the required TP load reduction. The Township and HRG identified candidate basins that offered the greatest potential for runoff reduction in locations in which the Township felt property owners would likely be cooperative. Once all of the candidate basins were identified, modeling was conducted by HRG using Pennsylvania State University's GWLF-E-based MapShed watershed modeling software (version 1.3.0) to determine the pollutant reductions each basin retrofit could yield.

A street sweeping program was also included in the MapShed model. The Township proposes conducting township-wide street sweeping once per month during the months of April through October to provide further TP reduction. This was deemed as a practical control measure since the Township had no street sweeping program, residents have desired the service, and sweeping would also help achieve the Township's required sediment load reduction mandated by the Brandywine Creek Watershed TMDL Report.

The results of the modeling revealed a need for further reduction of phosphorus to achieve the 53.9% reduction requirement. The options of streambank restoration and riparian buffer restoration were investigated and determined by the Township and HRG to be a viable means to generate a greater TP reduction, as well as a way to reduce sediment loads resulting from in-stream erosion. The Township identified sections of stream along municipally owned properties that would allow for access to the streambank and buffer areas without requiring the procurement of easements from Township residents. The addition of the streambank and riparian buffer BMPs to the MapShed model resulted in the Township meeting its reduction requirement, as shown in Tables 5 and 9.

Table 5: West Goshen MS4 Baseline TP Load & Proposed TP Load Reduction

MS4 Permittee	Current TP Load (lb/day)	Reduction Requirement	Proposed TP Load (lb/day)	WLA (lb/day)
West Goshen Twp.	0.95	53.9%	0.51	0.54

viii. Proposed BMPs and Control Measures

The total phosphorus reductions achieved through the implementation of the proposed BMPs described herein were determined through the use of the same MapShed model used to determine the Township's current TP loads. Each of the proposed BMPs, their locations, implementation schedule, functionality, proposed pollutant reductions, and maintenance requirements are listed below.

Streambank Stabilization and Buffer Restoration BMPs

Streambank stabilization prevents further erosion and degradation of disturbed or cut back streambanks ultimately resulting in lower sediment and nutrient loads being released into the stream. Where practical, the Township will implement vegetative streambank stabilization to promote plant uptake of nutrient laden runoff in order to reduce the amount of nutrients eventually reaching the impaired waterways. Vegetative stabilization relies on the root structures of established plantings to stabilize the streambank and provide scour protection. This method offers a relatively inexpensive means of stabilization and provides a naturalized appearance to the rehabilitated streambank.

West Goshen Township intends to perform riparian buffer restoration on the segments of stream to be stabilized. The goal of the riparian buffer projects is to naturalize the existing floodplain and reestablish buffer areas along the stream segments to a minimum width of 35 feet. The restorations will include the removal and replacement of dead and diseased vegetation; as well as new plantings in areas where buffers have diminished in size. The riparian buffer restoration project will be implemented concurrently with the stabilization projects in order to maximize the nutrient load reduction potential of each segment of stream to be enhanced. The locations of the proposed streambank stabilization and riparian buffer restoration projects are displayed on the location map in Appendix D.

Operation and maintenance requirements for the streambank stabilization and buffer restoration projects shall include:

- Regular watering of plantings during first growing season. Planting in the fall may reduce the need for additional watering.
- Conduct monthly site visits to ensure plantings are healthy and well watered, weeds are properly managed, sufficient mulch is in place until site is stabilized and planting have become established.
- Conduct annual inspections once streambank is stabilized and plants have become established.
- Immediately upon notice; repair any rills, gullies, or streambank cutting that may occur.
- Remove weeds and invasive plant species during each growing season. Naturally growing native vegetation should be left intact to promoted stabilization of the streambank and surrounding area.
- Replace mulch as needed
- Remove accumulated trash and debris as noticed.
- Remove and replace dead and diseased plantings.
- Keep machinery and vehicles away from stabilized areas.

Table 6 summarizes the anticipated reductions achieved by individual streambank stabilization and buffer restoration projects.

Table 6: Proposed Streambank Stabilization and Buffer Restoration BMPs

Location ID	**Stream Name**	**Length of Stream Segment**		**Implementation Permit Term**	**Reduction Achieved**
SS 1	UNT to Goose Creek	550 m	1,804 ft	2	2%
SS 2	UNT to Goose Creek	425 m	1,394 ft	3	2%
SS 3	UNT to Goose Creek	310 m	1,017 ft	4	2%

Street Sweeping Program

Street sweeping reduces the amount of sediment, nutrients, trash, and debris often found in stormwater by removing these potential contaminants from the road surface prior to it being swept up by stormwater runoff and carried through the storm sewer, eventually to the receiving waters.

West Goshen Township intends to conduct street sweeping once per month during the months of April through October.

Operation and maintenance requirements for the street sweeping control measure shall include:

- Develop and adhere to a regimented sweeping program that includes maps of sweeping areas, sweeping schedules, and maintenance schedules.
- Maintain sweeping equipment in good working order.
- Maintain a sweeping log to include: daily sweeping locations, operator's name, weight and volume of sweepings, and means of disposal.
- Dispose of sweepings in a manner deemed satisfactory by PADEP

Table 7 summarizes the anticipated reductions achieved by streetsweeping.

Table 7: Proposed Street Sweeping BMP Summary				
Location ID	**Frequency Of Sweeping**	**Months Per Year**	**Implementation Permit Term**	**Reduction Achieved**
Township	Monthly	7	2	10%

Detention Basin Retrofit

Detention basins are relatively simple basins designed to receive, temporarily hold, and discharge stormwater at a controlled rate. While they can provide rate and volume control, detention basins offer limited water quality benefit. Detention basin retrofits transform these simple catch, store, and release ponds into BMPs that provide infiltration, bioretention, and improved sediment and nutrient removal capabilities. This is achieved by extending the storage time, improving soil conditions to allow for greater infiltration rates, and naturalizing the basins with native and/or wetland plant species.

West Goshen Township conducted a detention basin retrofit on a large basin in 2009. The basin, known as the Bicking Basin, serves as the main stormwater management facility for a large residential development in the southeast corner of the Township. Finding that the retrofitted basin produced substantial water quality and aesthetic value, the Township expressed interest in conducting more retrofits in order to achieve the Total Phosphorus reduction requirements mandated by the Goose Creek TMDL.

The Township proposes to perform three additional detention basin retrofits at locations within the Township limits of the Goose Creek watershed. While the extent and nature of the retrofits will rely on the results of future engineering investigations, each basin retrofit will reduce the quantity and increase the quality of the stormwater runoff reaching the impaired streams. The locations of the proposed detention basin retrofit projects are displayed on the location map in Appendix E.

Operation and maintenance requirements for the street sweeping control measure shall include:

- Conduct regular inspections until site is stabilized and plantings are established.
- Immediately upon notice, repair and erosion issues in the basin.
- Remove and replace dead of diseased plantings.
- Remove weeds and invasive species from the basin.
- Remove accumulated sediment and debris.
- Mulch as necessary.
- Use no chemical herbicides or pesticides.
- Maintain a “No Mow Zone” around the perimeter of the basin.

Table 8 summarizes the anticipated reductions achieved by detention basin retrofit projects.

Table 8: Proposed Detention Basin Retrofit BMPs Summary			
Basin Location ID	**Street Location**	**Implementation Permit Term**	**Reduction Achieved**
RF 1	Bicking Drive	Completed 2010	26%
RF 2	Westtown Road	2	3%
RF 3	South Bolmar Street	3	4%
RF 4	Willowbrook Lane	4	6%

ix. BMP Modeling Results

As shown in Table 9 below, the combination of BMPs West Goshen Township has installed and proposes to implement will achieve a reduction in Total Phosphorus of 55% of the current baseline load. Detailed modeling results can be found in Appendix B.

Table 9: Summary of MapShed Modeling Results			
Current TP Load w/out BMPs (lb/day)	**Proposed TP Load w/ BMPs (lb/day)**	**Reduction Achieved (%)**	**Reduction Required (%)**
0.952	0.531	55	53.9

x. Implementation Schedule

Permit Term 2 (current term)

- Create MS4 TMDL Design Detail.
- Explore funding opportunities.
- Consider establishing a stormwater authority.
- Explore street sweeping options.
- Implement street sweeping program.
- Document all street sweeping activities.
- Maintain records of all MS4 / TMDL related activities.
- Encourage land owner participation in stream improvement projects.
- Conduct Westtown Road Basin Retrofit (RF 2).
- Conduct Stream Enhancement Project on Stream Segment One (SS 1).
- Conduct annual inspections of installed BMPs included in TMDL Plan.

Permit Term 3 (2017 – 2022)

- Conduct South Bolmar Street Basin Retrofit (RF 3)
- Conduct Stream Enhancement Project on Stream Segment Two (SS 2)
- Conduct annual TMDL Plan evaluations. Adjust plan to meet goal as necessary.
- Update TMDL records no less than annually.
- Reevaluate sweeping program and increase frequency if beneficial.
- Continue to seek public involvement in MS4 / TMDL related projects.
- Continue to explore funding opportunities.
- Conduct annual inspections of installed BMPs included in TMDL Plan.

Permit Term 4 (2022-2027)

- Conduct Willowbrook Lane Basin Retrofit (RF 4)
- Conduct Stream Enhancement Project on Stream Segment Three (SS 3)
- Conduct annual TMDL Plan evaluations. Adjust plan to meet goal as necessary.
- Update TMDL records no less than annually.
- Reevaluate sweeping program and increase frequency if beneficial.
- Continue to seek public involvement in MS4 / TMDL related projects.
- Continue to explore funding opportunities.
- Conduct annual inspections of installed BMPs included in TMDL Plan.

xi. Effectiveness Evaluation

The effectiveness of the selected BMPs will be evaluated each permit year. The efforts completed to date will be documented and compared to the intent of the MS4 TMDL Strategy. If necessary, the MS4 TMDL Strategy will be revised each year in order to revise the implementation schedule to include reasonable activities and maximize pollutant reductions. The intent of this MS4 TMDL Strategy is to be adaptive, iterative, and dynamic to show measurable progress toward meeting pollutant load reductions.

4.0 SUMMARY OF FINDINGS

The information presented in this TMDL Strategy serves as sufficient evidence that West Goshen Township has taken the proper steps to produce an achievable plan of action to meet the 53.9% reduction of Total Phosphorus, mandated by the "Nutrient Total Maximum Daily Load in Goose Creek Watershed, Pennsylvania," as established by the United States Environmental Protection Agency, Region III on June 30, 2008.

5.0 REFERENCES

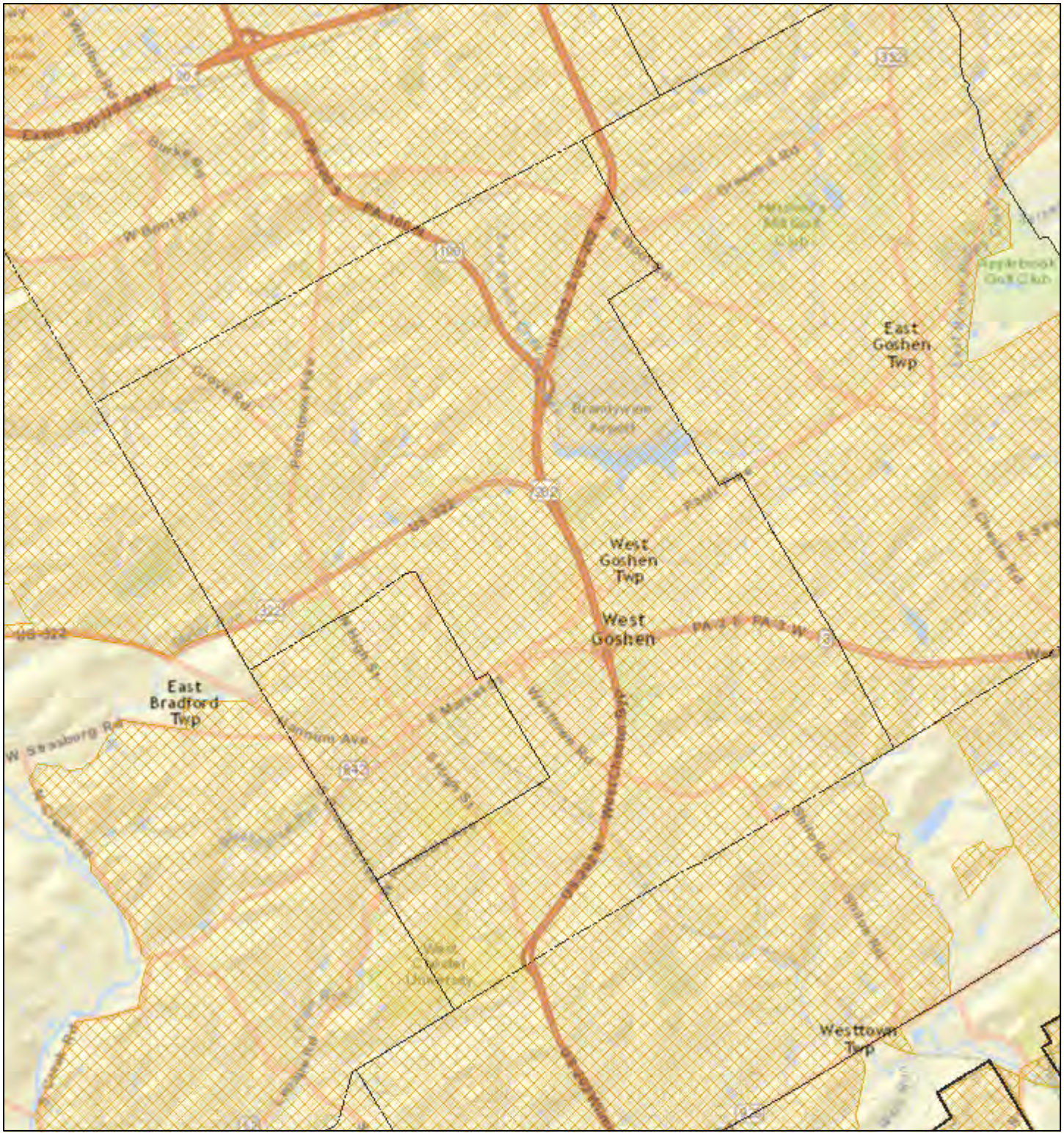
1. Evans, B., & Corradini, K. (n.d.). MapShed Overview Page. Retrieved August 18, 2015, from http://www.mapshed.psu.edu/overview.htm.

2. Evans, B., & Corradini, K. (2015) MapShed Download Page. Retrieved August 15, 2015, from http://www.mapshed.psu.edu/download.htm.

3. PA DEP. (2006) Pennsylvania Stormwater Best Management Practices Manual. Commonwealth of Pennsylvania.

APPENDIX A

STREAM CLASSIFICATION MAPS



August 21, 2015

1:72,224

0 0.5 1 2 mi

0 1 2 4 km

- County Boundaries
- Municipalities
- Urban Areas 2000

West Goshen Township Urbanized Area Map (2000 Census)

Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), MapmyIndia, © OpenStreetMap contributors, and the GIS User Community
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and

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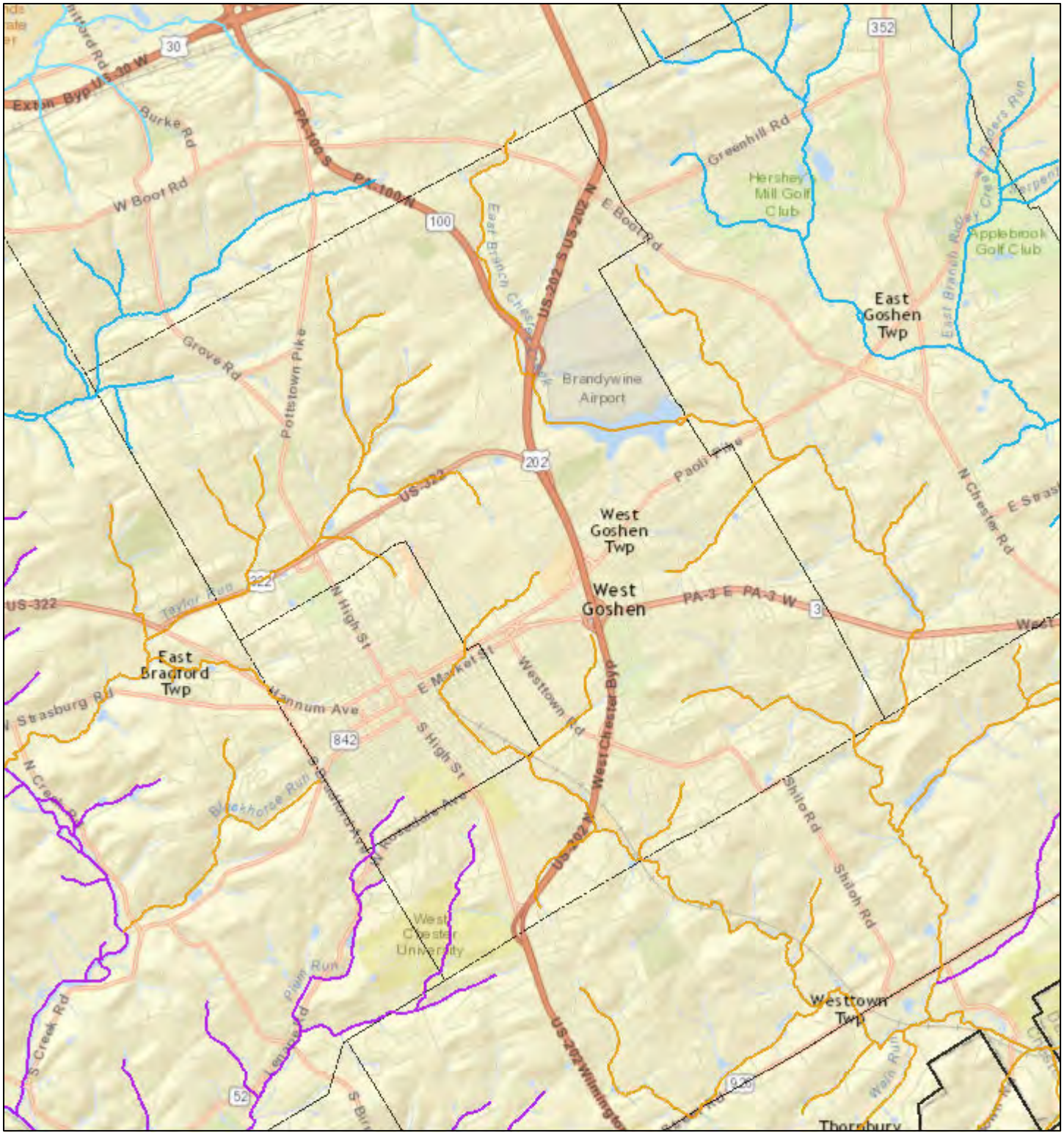

August 21, 2015

1:72,224

0 0.5 1 2 mi

0 1 2 4 km

- Cold Water Fish
- Exceptional Value
- High Quality
- Trout Stocking
- Warm Water Fish
- Overlap
- Missing from CH93
- County Boundaries
- Municipalities

West Goshen Township
Stream Designated Use Map

Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), MapmyIndia, © OpenStreetMap contributors, and the GIS User Community
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and

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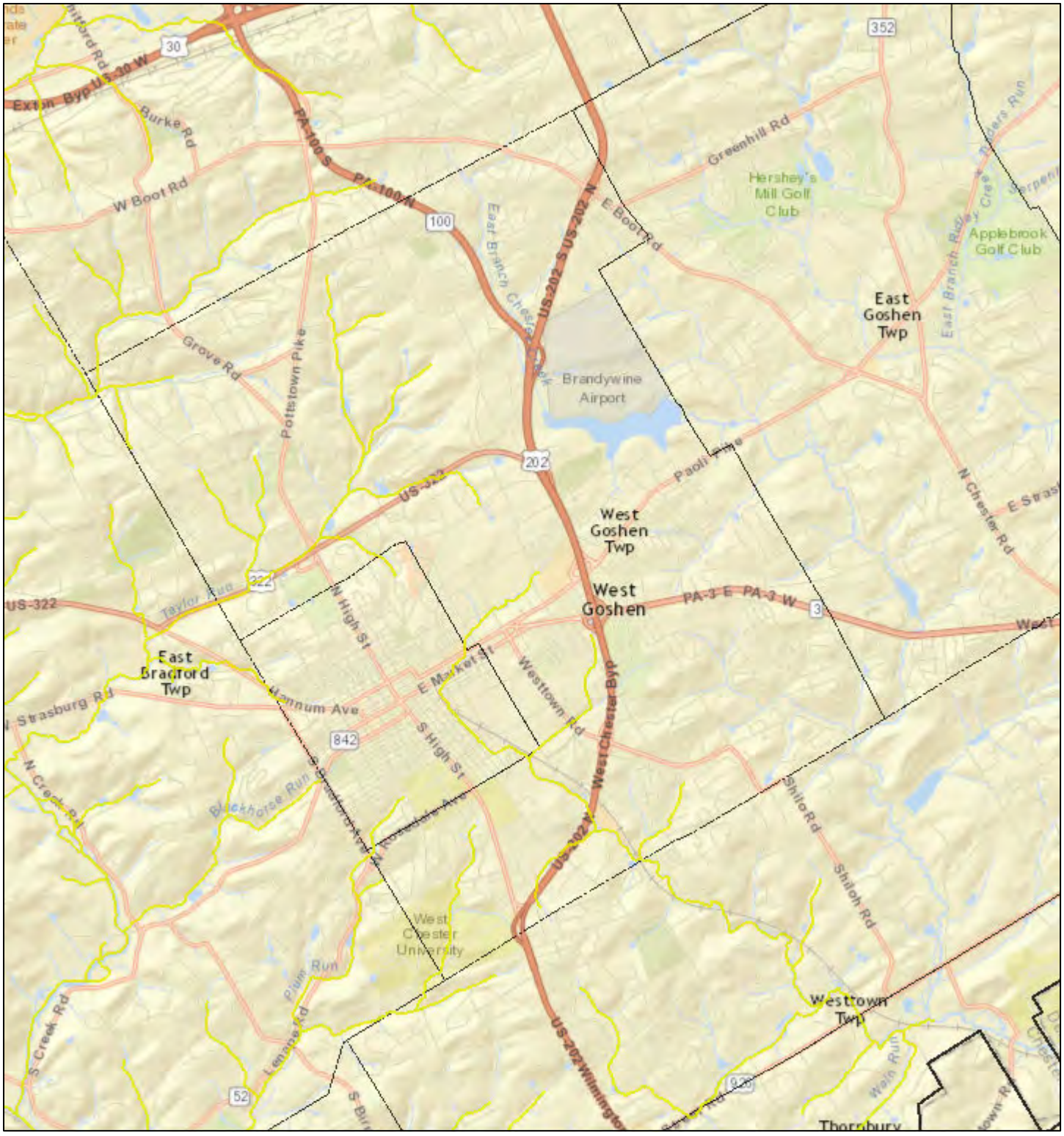

August 21, 2015

1:72,224

0 0.5 1 2 mi

0 1 2 4 km

- Final
- Tenative
- County Boundaries
- Municipalities

West Goshen Township TMDL Stream Map

Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), MapmyIndia, © OpenStreetMap contributors, and the GIS User Community
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and

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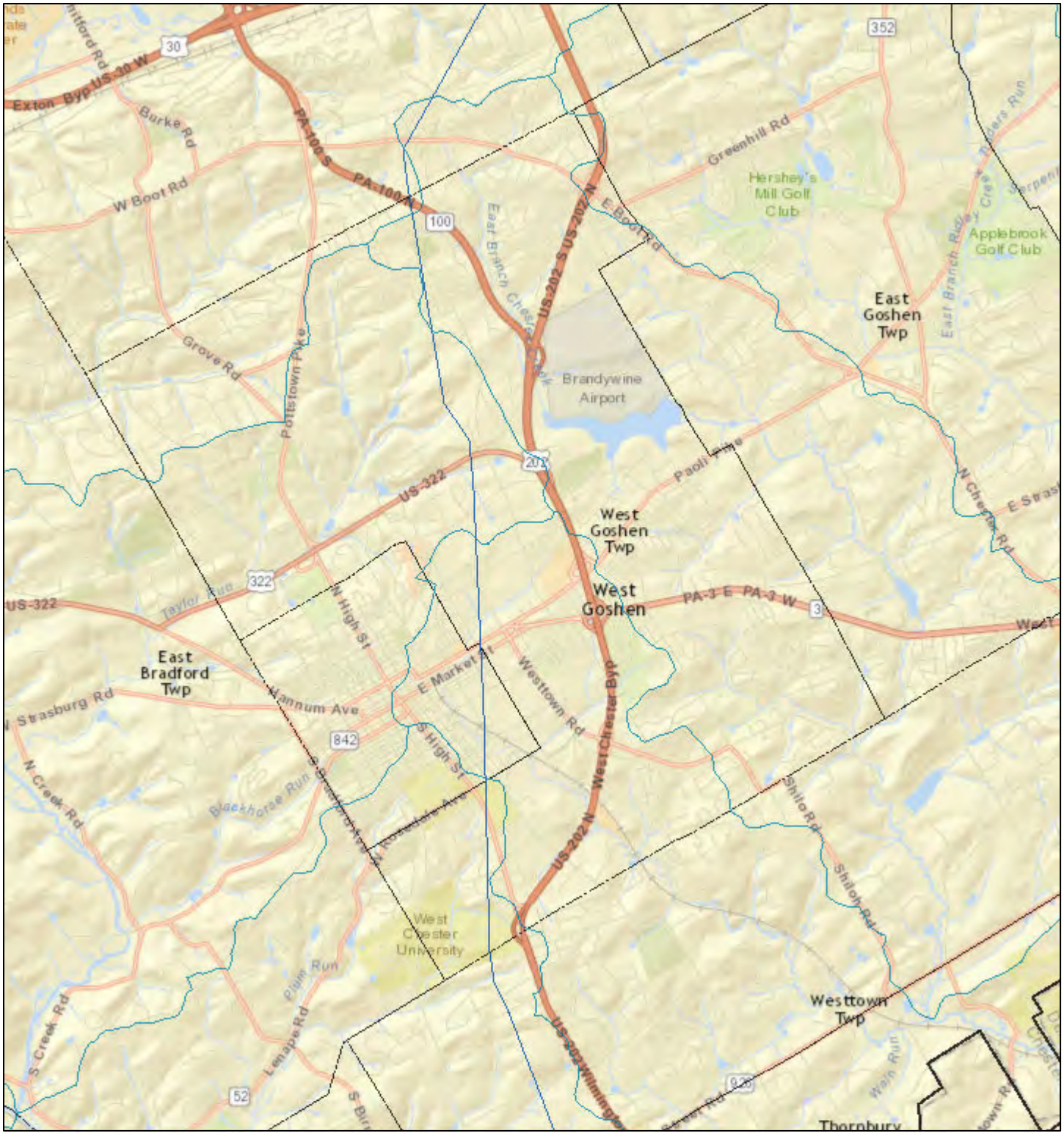

August 21, 2015

1:72,224

0 0.5 1 2 mi

0 1 2 4 km

- Hydrologic Unit Code (HUC) 8
- Hydrologic Unit Code (HUC) 12
- County Boundaries
- Municipalities

West Goshen Township
Hydrologic Unit Code Map

Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), MapmyIndia, © OpenStreetMap contributors, and the GIS User Community
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APPENDIX B

DETENTION BASIN INVENTORY

DETENTION BASIN INVENTORY LIST
FOR
WEST GOSHEN TOWNSHIP

Basins in Brandywine Creek Watershed

Basins in Goose Creek Watershed

***** Identifies basins to be retrofitted

HRG Number	Latitude	Longitude	Area (S.F.)	Berm Condition	Interior Condition	Inspected	Photos Taken
1	39.94718	-75.58759	3204.084		Good	No	
2	39.94782	-75.58113	9135.569			No	
3	39.94792	-75.58828	5439.317		Fair	Yes	No
4	39.99059	-75.61536	9624.964	Good	Good	Yes	Yes
5	39.99080	-75.61641	7807.431	Good	Good	Yes	Yes
6	39.96809	-75.55575	7528.137	Good	Good	No	Yes
7	39.96754	-75.56867	10307.368	Good	Poor	No	Yes
8	39.96736	-75.56716	20967.681	Good	Good	No	Yes
9	39.95406	-75.58659	5126.880	Good	Fair	Yes	Yes
10	39.94684	-75.58067	6864.375	Good	Fair	No	Yes
11	39.97008	-75.56379	2729.372			No	No
12	40.00879	-75.58935	70218.421			Yes	
13	40.00634	-75.59595	10915.284			No	
14	40.00191	-75.60158	5785.645	Good	Good	Yes	
15	39.99987	-75.59750	27703.009			Yes	
16	39.99950	-75.58459	18764.754			No	
17	39.99875	-75.58780	13515.554	Good	Good	No	Yes
18	39.99745	-75.59285	30879.342	Good	Good	No	Yes
19	39.99832	-75.59328	2839.946			No	
20	39.99817	-75.59324	1318.536			No	
21	39.99806	-75.58790	5206.718	Good	Good	No	Yes
22*	39.99808	-75.61215	34774.320			Yes	
23	39.99683	-75.58263	59170.694			No	
24	39.99807	-75.61955	1022.456			No	
25	39.99700	-75.58058	17919.954			No	
26	39.99679	-75.58948	34777.153	Good	Good	No	Yes
27	39.99680	-75.59723	21901.563			Yes	
28	39.99631	-75.58887	25372.668	Good	Good	No	Yes
29	39.99553	-75.59604	116460.082			No	
30*	39.99563	-75.61169	35174.440			Yes	
31	39.99517	-75.59220	10637.778	Good	Good	No	Yes
32	39.99513	-75.59074	6816.425	Good	Good	No	Yes
33	39.99565	-75.62300	26410.181			Yes	
34	39.99558	-75.62493	23230.528			Yes	
35	39.99429	-75.58691	26603.572			No	
36	39.99467	-75.59485	1613.452			No	
37	39.99437	-75.58143	7891.111	Good	Good	No	

Basins in Brandywine Creek Watershed			* Identifies basins to be retrofitted				
Basins in Goose Creek Watershed							
HRG Number	**Latitude**	**Longitude**	**Area (S.F.)**	**Berm Condition**	**Interior Condition**	**Inspected**	**Photos Taken**
38	39.99393	-75.59451	9073.184			No	
39	39.99418	-75.60757	8264.250			Yes	
40	39.99252	-75.57726	82462.901			No	
41	39.99282	-75.59354	8168.940			No	
42	39.99269	-75.58912	12063.819	Good	Good	No	Yes
43	39.99331	-75.63047	5165.890	Good	Good	Yes	Yes
44	39.99213	-75.58769	46065.144	Good	Fair	No	Yes
45	39.99055	-75.59131	33404.976	Good	Good	No	Yes
46	39.99077	-75.62134	15911.426			Yes	
47	39.98976	-75.57535	6732.972			No	
48	39.98973	-75.57633	12258.480			No	
49	39.98962	-75.57713	15774.309			No	
50	39.98927	-75.57454	22810.288			No	
51	39.98921	-75.57811	6938.158			No	
52	39.98909	-75.57668	11234.336			No	
53	39.98861	-75.59041	64962.574	Good	Fair	No	Yes
54	39.98843	-75.57874	33961.044			No	
55	39.98930	-75.62833	6595.738			Yes	
56	39.98827	-75.58227	15835.445			No	
57	39.98840	-75.58717	5598.762	Good	Good	No	Yes
58	39.98824	-75.62017	24901.117			Yes	
59	39.98777	-75.58371	9051.954	Good	Good	No	Yes
60	39.98739	-75.59171	7538.337			No	
61	39.98804	-75.62975	7587.964			Yes	
62	39.98764	-75.62808	7524.782			Yes	
63	39.98675	-75.59501	7083.623			No	
64	39.98584	-75.57864	15809.737			No	
65	39.98667	-75.63051	9280.439			Yes	
66	39.98604	-75.58889	934.602	Good	Good	No	Yes
67	39.98532	-75.59140	4237.641			No	
68	39.98493	-75.59240	13335.506			No	
69	39.98406	-75.58778	7687.108			No	
70	39.98392	-75.58711	14726.615	Good	Good	No	Yes
71	39.98368	-75.58467	12714.325			No	
72	39.98365	-75.59016	7946.313	Good	Good	No	Yes
73	39.98350	-75.58844	17278.098	Good	Good	No	Yes
74	39.98336	-75.59280	6468.740			No	
75	39.98301	-75.58264	7638.695	Good	Good	No	
76	39.98385	-75.62872	2876.687			Yes	
77	39.98255	-75.59183	1273.359			No	
78	39.98174	-75.58519	21284.264			No	
79	39.98174	-75.62478	9533.034			Yes	
80	39.98038	-75.62367	6129.820			Yes	
81	39.97971	-75.59812	28132.995			No	
82	39.97921	-75.58279	11507.000			No	

Basins in Brandywine Creek Watershed			* Identifies basins to be retrofitted				
Basins in Goose Creek Watershed							
HRG Number	**Latitude**	**Longitude**	**Area (S.F.)**	**Berm Condition**	**Interior Condition**	**Inspected**	**Photos Taken**
83	39.97928	-75.58872	3695.027			No	
84	39.97819	-75.57965	37598.203			No	
85	39.97869	-75.61016	10528.974			No	
86	39.97777	-75.61350	2730.520			Yes	
87	39.97697	-75.58918	14517.900			No	
88	39.97686	-75.58723	4287.248	Good	Good	No	
89	39.97722	-75.62954	24535.206			Yes	
90	39.97678	-75.61306	10917.156			Yes	
91	39.97644	-75.59306	4346.412	Good	Good	No	Yes
92	39.97689	-75.62527	10873.347			Yes	
93	39.97678	-75.63053	5996.857			Yes	
94	39.97611	-75.62552	33746.552			Yes	
95	39.97547	-75.58590	7123.508	Good	Good	No	Yes
96	39.97610	-75.63002	2953.574			Yes	
97	39.97547	-75.59102	1128.161			No	
98	39.97472	-75.59991	3399.338			No	
99	39.97480	-75.63045	47881.319			Yes	
100*	39.97468	-75.60933	24609.414			No	
101	39.97453	-75.60062	3552.651			No	
102*	39.97353	-75.60313	44275.346			No	
103	39.97270	-75.59868	13619.808			No	
104	39.97318	-75.62252	24493.351			Yes	
105	39.97152	-75.57222	3443.325			No	
106	39.97156	-75.57359	326.329			No	
107	39.97127	-75.56782	7755.268	Good	Good	No	Yes
108	39.97208	-75.61851	24636.070			Yes	
109	39.97137	-75.58916	6062.319			No	
110	39.97109	-75.61259	12962.971			No	
111	39.97109	-75.61808	9440.801			Yes	
112	39.96959	-75.60071	2834.248			No	
113	39.96860	-75.57195	22246.543	Good	Good	No	Yes
114*	39.96926	-75.62222	19517.261			Yes	
115	39.96803	-75.55746	13833.550			No	
116	39.96831	-75.57373	16927.592	Good	Good	No	Yes
117*	39.96884	-75.62310	22115.639			Yes	
118	39.96717	-75.55447	11160.524			No	
119	39.96737	-75.58644	2795.708			No	
120	39.96768	-75.61812	6862.672			Yes	
121	39.96651	-75.56486	23239.832			No	
122	39.96638	-75.55565	6819.133			No	
123	39.96328	-75.56668	175553.012			Yes	
124	39.96330	-75.57478	13624.568			No	
125	39.96257	-75.58480	12035.107			No	
126	39.96145	-75.56681	16414.984			No	
127	39.96172	-75.58230	247.034			No	
Basins in Brandywine Creek Watershed			* Identifies basins to be retrofitted				

Basins in Goose Creek Watershed

HRG Number	Latitude	Longitude	Area (S.F.)	Berm Condition	Interior Condition	Inspected	Photos Taken
128	39.96136	-75.57029	767.941			No	
129	39.96152	-75.58996	3020.233			No	
130	39.96087	-75.57116	6974.709			No	
131	39.96057	-75.56608	18089.714			No	
132	39.96042	-75.58203	5643.133			No	
133	39.96028	-75.58051	1350.796			No	
134	39.96006	-75.58092	1868.323			No	
135	39.95995	-75.58173	2379.693			No	
136	39.95957	-75.57108	12074.218			No	
137	39.95966	-75.58142	669.789			No	
138	39.95934	-75.59039	15021.347			No	
139	39.95894	-75.58591	1104.636			No	
140*	39.95838	-75.58493	12138.119			No	
141	39.95798	-75.58858	7372.880	Good	Fair	No	Yes
142	39.95724	-75.55564	18617.649	Good	Good	No	Yes
143	39.95764	-75.57956	5691.734			No	
144	39.95707	-75.56567	18918.248	Good	Fair	No	Yes
145	39.95677	-75.55332	21174.628			No	Yes
146	39.95624	-75.55812	19555.993	Good	Good	No	Yes
147	39.95681	-75.58375	3289.101	Good	Good	No	
148	39.95595	-75.56451	22982.825	Good	Good	No	Yes
149	39.95580	-75.57831	4572.443			No	
150	39.95513	-75.56624	31126.045			No	
151	39.95534	-75.58735	45554.691			No	
152	39.95442	-75.57049	7447.597			No	
153	39.95287	-75.58945	26080.100			No	
154	39.95234	-75.57039	28898.629			No	
155	39.95182	-75.59002	36877.949			No	
156*	39.95116	-75.57789	54641.493			No	
157	39.95170	-75.58139	263.627			No	
158	39.95118	-75.58799	837.838			Yes	
159	39.95089	-75.58954	10415.446			Yes	
160	39.95063	-75.59043	4525.520			Yes	
161	39.94872	-75.57306	25972.840			Yes	
162	39.94843	-75.58829	12975.934			Yes	
163	39.94904	-75.58917	9381.842			No	
164	39.94886	-75.59502	3703.182			No	
165	39.94765	-75.57633	8340.843	Good	Poor	No	Yes
166	39.94681	-75.58537	8644.853			No	
167	39.94650	-75.58408	12395.943			No	
168	39.94659	-75.58667	769.841			No	
169	39.94637	#NAME?	5267.717			No	
170	39.94597	-75.58833	20859.852			No	
171	39.94570	-75.58196	17198.874			No	
172	39.94570	-75.57459	7162.569	Good	Good	No	Yes

Basins in Brandywine Creek Watershed

Basins in Goose Creek Watershed

***** Identifies basins to be retrofitted

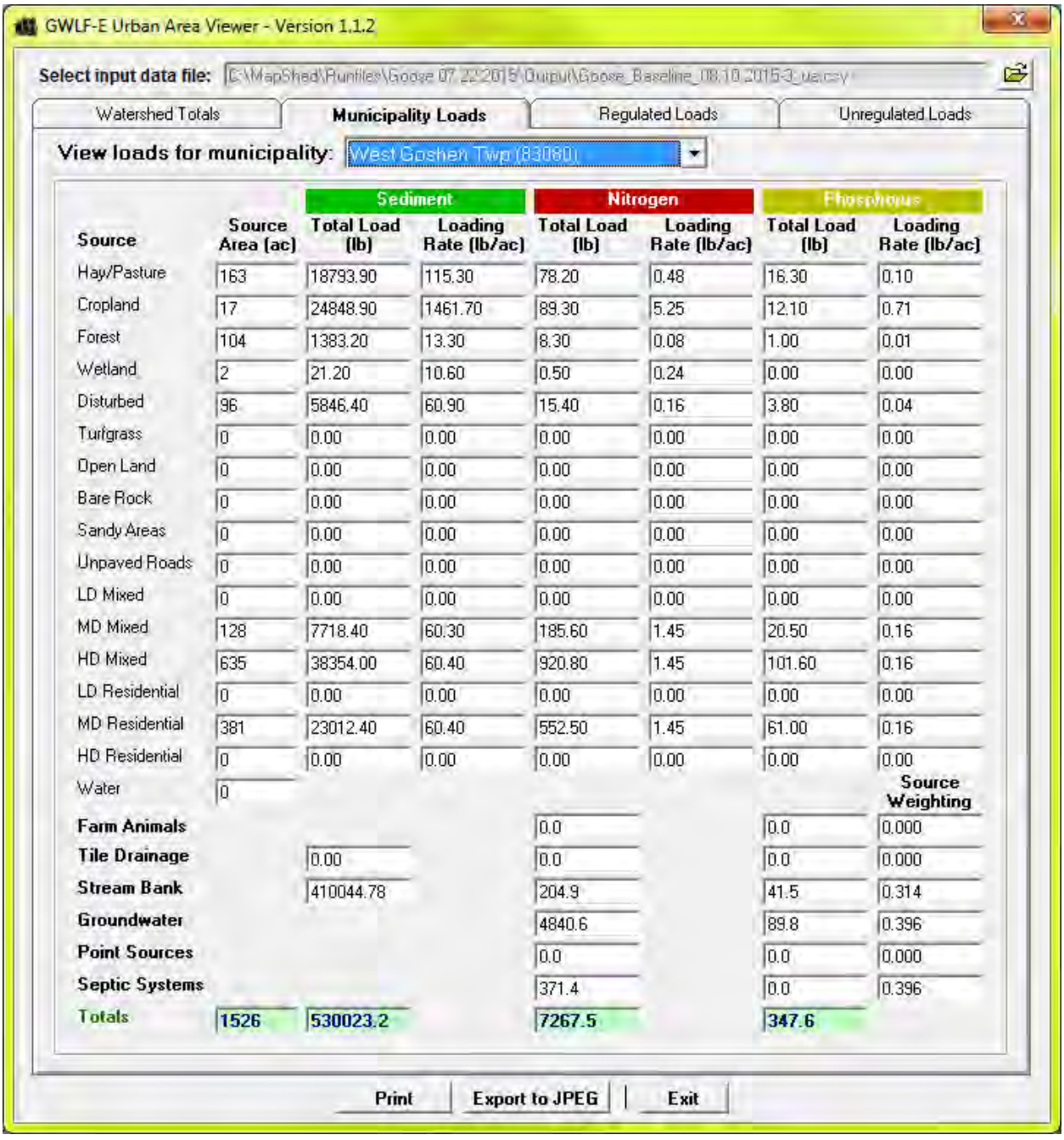
HRG Number	Latitude	Longitude	Area (S.F.)	Berm Condition	Interior Condition	Inspected	Photos Taken
173	39.94568	-75.58104	14094.629			No	
174	39.94580	-75.58979	4874.571			No	
175	39.94511	-75.57737	53110.734	Good	Good	No	
176*	39.94418	-75.58628	48777.126			No	
177	39.94280	-75.59183	2866.032			No	
178	39.94442	-75.57906	16219.248	Poor	Poor	No	No
179	39.98061	-75.58973	10669.160	Fair	Fair	No	No
180	39.99112	-75.62682	14437.636	Good	Good	Yes	Yes
181	39.99501	-75.60442	14087.339	Good	Good	Yes	Yes
182	40.00211	-75.58573	90018.513	Fair	Poor	Yes	Yes
183	39.97923	-75.60644	291.784			No	
184	39.95089	-75.58761	6557.544			No	
190	39.95393	-75.56002	11134.509				
191	39.95426	-75.56077	7385.767				
192	39.98108	-75.59278	41924.252				
193	40.00334	-75.61073	17560.821				
194	39.94573	-75.57596	4501.233				
195	39.94754	-75.57491	1972.853				
196	39.95129	-75.58778	1107.576				
197	39.94995	-75.57939	3545.041				
198	39.95374	-75.58562	7895.605				
199	39.95771	-75.58786	7644.908				
200	39.96044	-75.58986	1224.238				
201	39.96261	-75.59228	4605.205				
202*	39.95879	-75.58469	52375.354				
203	39.97071	-75.57147	6187.142				
204	39.98577	-75.58577	12005.301				
205	39.98637	-75.58464	48817.390				
206	39.98682	-75.58649	3799.707				
207	39.98771	-75.58530	7164.952				
208	39.98652	-75.58339	24242.175				
209	39.98558	-75.58275	8507.324				
210	39.98089	-75.58216	60736.894				

APPENDIX C

MAPSHED INPUT DATA AND RESULTS

Modeled Baseline Total Phosphorus Load for West Goshen Township MS4

- Modeled Baseline MS4 TP Load = 347.6 lb/yr
- Required Reduction = (347.6 lb/yr)(53.9%) = 187.36 lb/yr



GWLF-E Urban Area Viewer - Version 1.1.2

Select input data file: C:\MapShed\Runfiles\Goose 07.22.2015\Output\Goose_Baseline_08.10.2015-3_ua.csv

Watershed Totals | Municipality Loads | Regulated Loads | Unregulated Loads

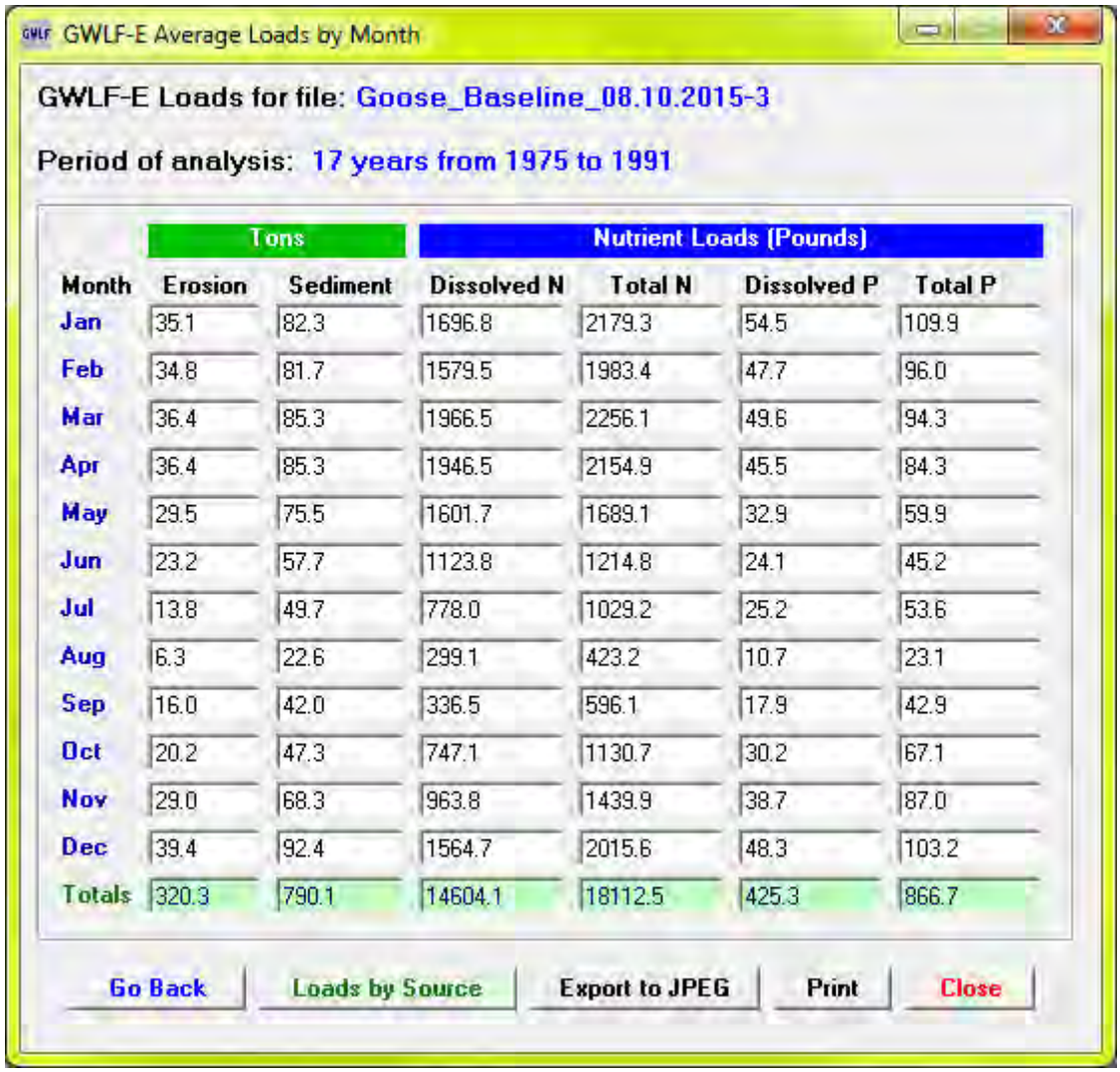
View loads for municipality: West Goshen Twp (83080)

Source	Source Area (ac)	Sediment Total Load (lb)	Sediment Loading Rate (lb/ac)	Nitrogen Total Load (lb)	Nitrogen Loading Rate (lb/ac)	Phosphorus Total Load (lb)	Phosphorus Loading Rate (lb/ac)
Hay/Pasture	163	18793.90	115.30	78.20	0.48	16.30	0.10
Cropland	17	24848.90	1461.70	89.30	5.25	12.10	0.71
Forest	104	1383.20	13.30	8.30	0.08	1.00	0.01
Wetland	2	21.20	10.60	0.50	0.24	0.00	0.00
Disturbed	96	5846.40	60.90	15.40	0.16	3.80	0.04
Turfgrass	0	0.00	0.00	0.00	0.00	0.00	0.00
Open Land	0	0.00	0.00	0.00	0.00	0.00	0.00
Bare Rock	0	0.00	0.00	0.00	0.00	0.00	0.00
Sandy Areas	0	0.00	0.00	0.00	0.00	0.00	0.00
Unpaved Roads	0	0.00	0.00	0.00	0.00	0.00	0.00
LD Mixed	0	0.00	0.00	0.00	0.00	0.00	0.00
MD Mixed	128	7718.40	60.30	185.60	1.45	20.50	0.16
HD Mixed	635	38354.00	60.40	920.80	1.45	101.60	0.16
LD Residential	0	0.00	0.00	0.00	0.00	0.00	0.00
MD Residential	381	23012.40	60.40	552.50	1.45	61.00	0.16
HD Residential	0	0.00	0.00	0.00	0.00	0.00	0.00
Water	0						Source Weighting
Farm Animals				0.0		0.0	0.000
Tile Drainage		0.00		0.0		0.0	0.000
Stream Bank		410044.78		204.9		41.5	0.314
Groundwater				4840.6		89.8	0.396
Point Sources				0.0		0.0	0.000
Septic Systems				371.4		0.0	0.396
Totals	1526	530023.2		7267.5		347.6	

Print | Export to JPEG | Exit

Modeled Baseline Total Phosphorus Load for Goose Creek Watershed

- Current Goose Creek Watershed TP Load = 866.7 lb/yr
- Goose Creek Watershed Target Load = 866.7 lb/yr -187.36 lb/yr = 679.34 lb/yr

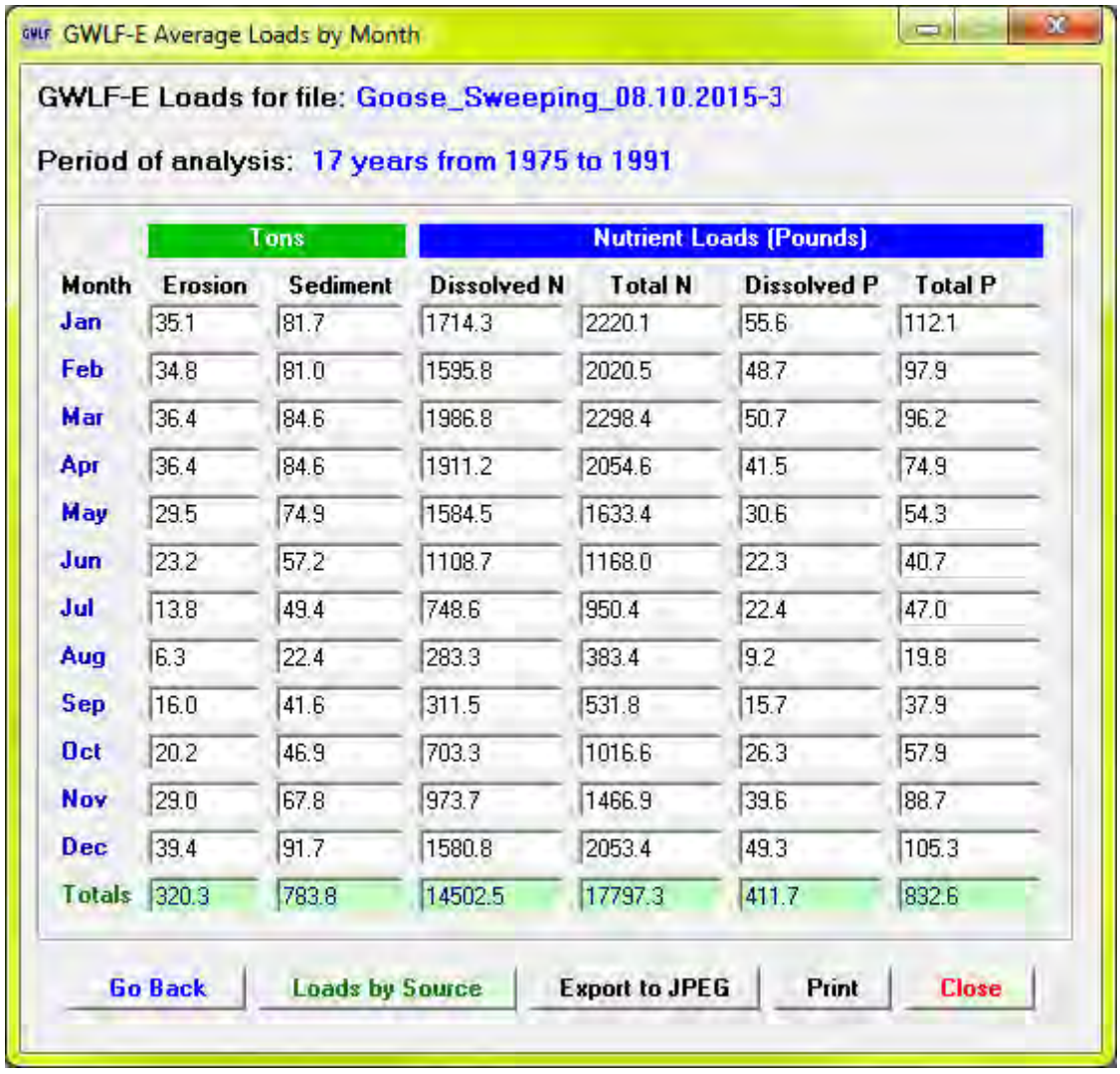


Total Phosphorus Load for Goose Creek Watershed w/ BMPs – Iterative Calculation – Input Data

- Proposed BMP: Street sweeping monthly, April through October

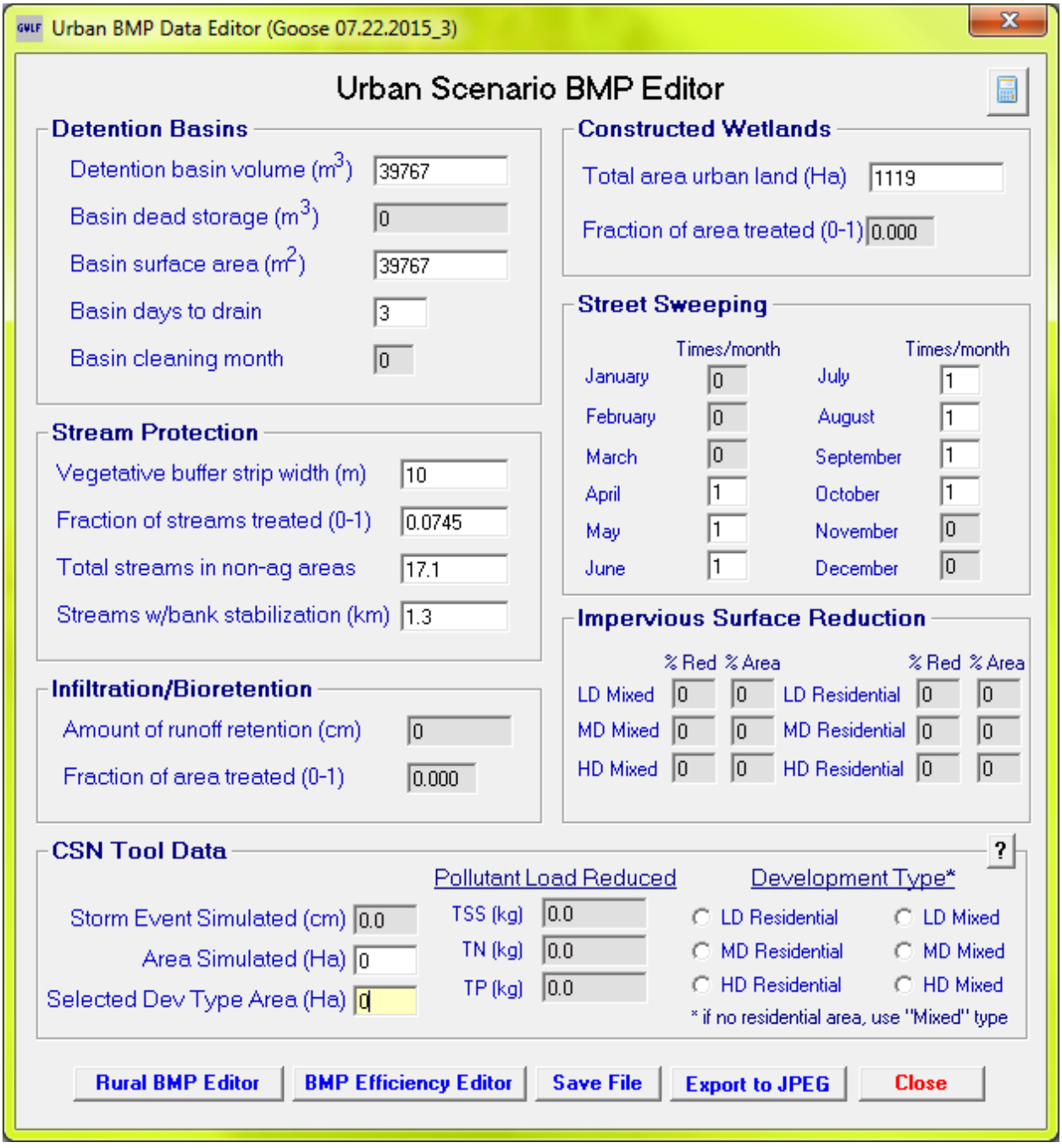
Total Phosphorus Load for Goose Creek Watershed w/ BMPs – Iterative Calculation - Result

- Goose Creek Watershed TP Load w/ Street Sweeping = 832.6 lb/yr
- Reduction = 866.7 lb/yr – 832.6 lb/yr = 34.1 lb/yr



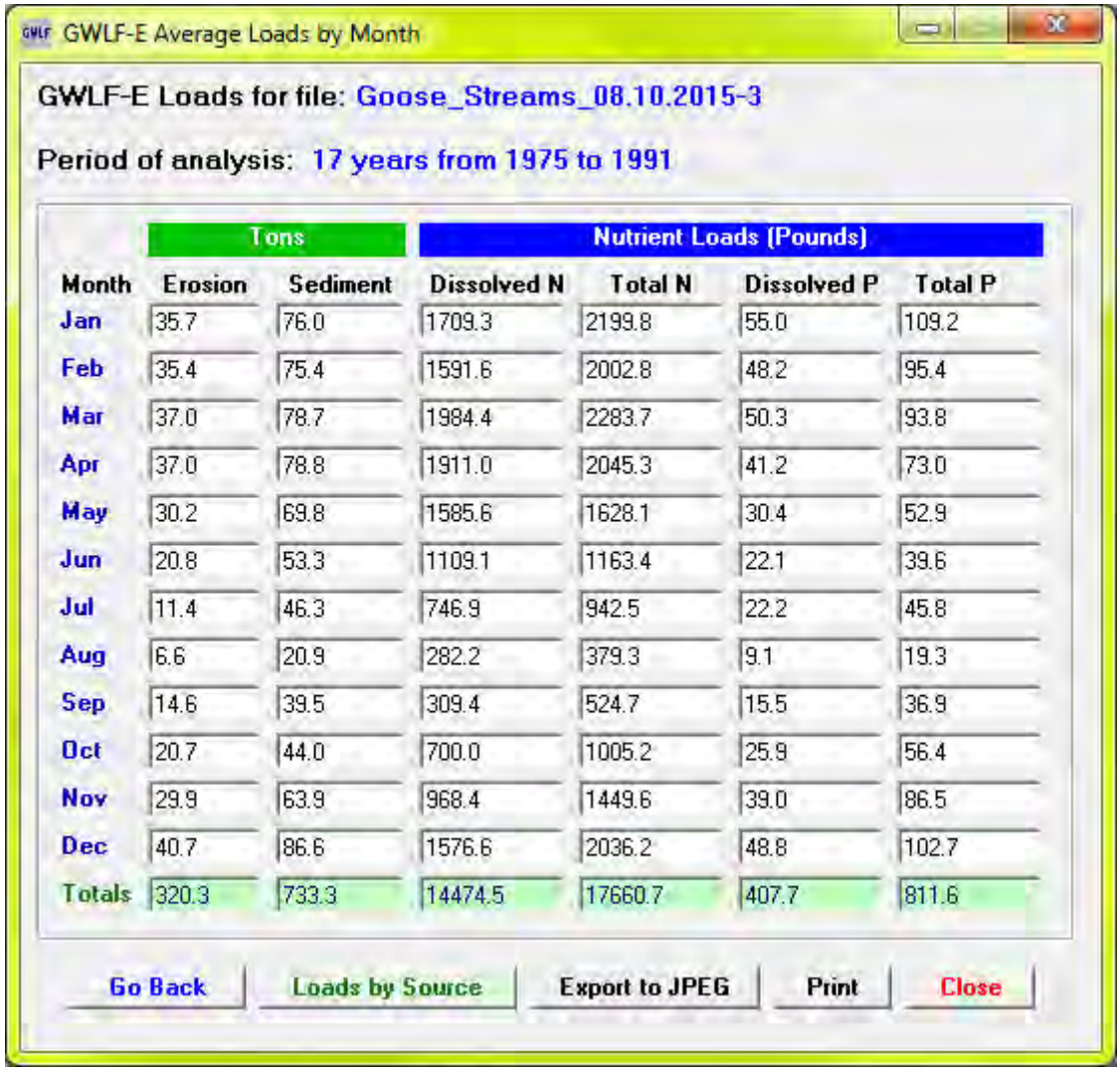
Total Phosphorus Load for Goose Creek Watershed w/ BMPs – Iterative Calculation – Input Data

- Proposed BMP: Streambank stabilization and riparian buffer restoration



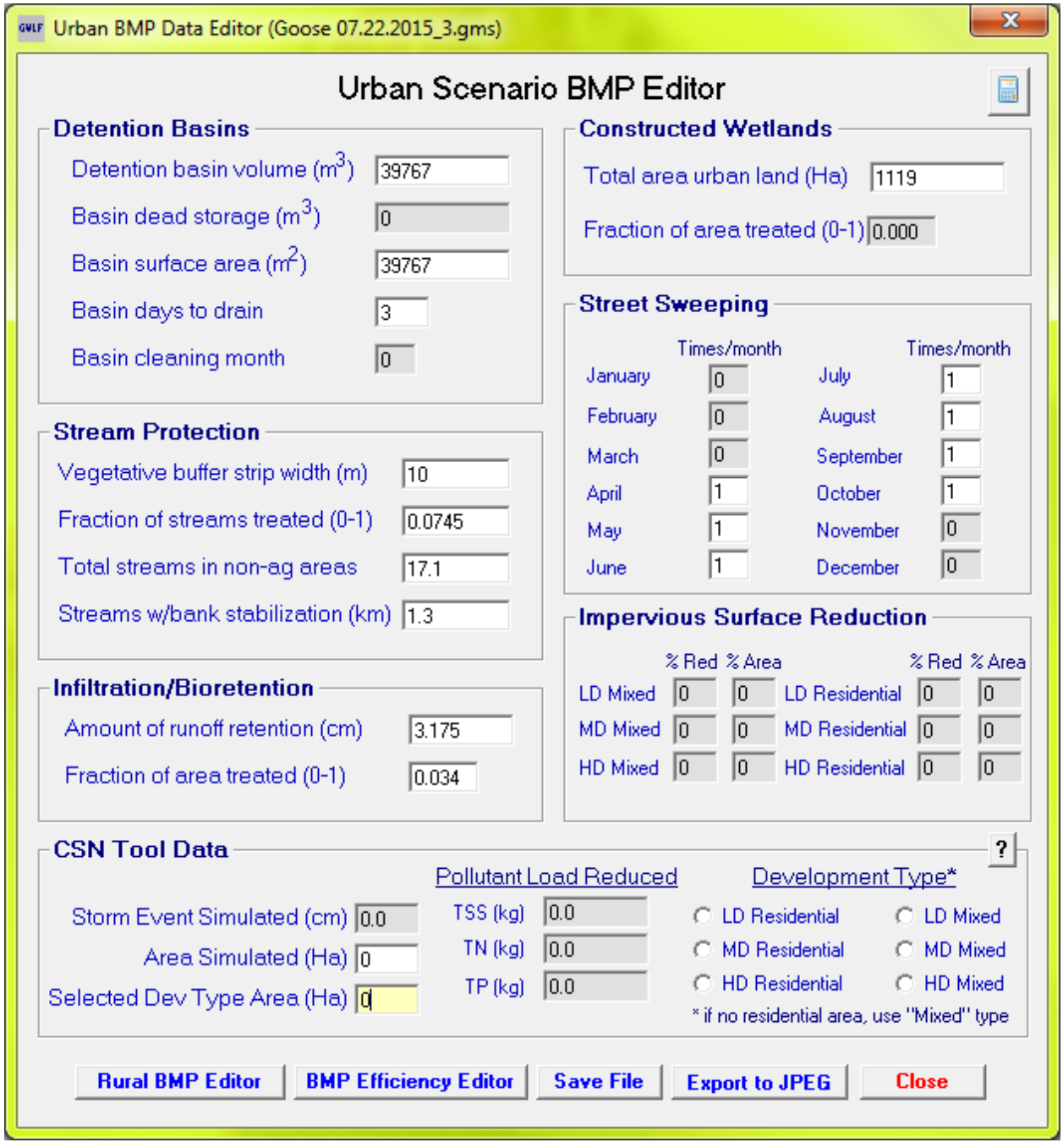
Total Phosphorus Load for Goose Creek Watershed w/ BMPs – Iterative Calculation - Result

- Goose Creek Watershed TP Load w/ Street sweeping, streambank stabilization, & riparian buffer restoration = 811.6 lb/yr
- Reduction = 832.6 lb/yr – 811.6 lb/yr = 21.0 lb/yr



Total Phosphorus Load for Goose Creek Watershed w/ BMPs – Iterative Calculation – Input Data

- Proposed BMP: Basin Retrofit #1



Total Phosphorus Load for Goose Creek Watershed w/ BMPs – Iterative Calculation - Result

- Goose Creek Watershed TP Load w/ Street sweeping, streambank stabilization, riparian buffer restoration, and Retrofit 1 = 714.6 lb/yr
- Reduction = 811.6 lb/yr – 714.6 lb/yr = 97.0 lb/yr

Total Phosphorus Load for Goose Creek Watershed w/ BMPs – Iterative Calculation – Input Data

- Proposed BMP: Basin Retrofit #2

Total Phosphorus Load for Goose Creek Watershed w/ BMPs – Iterative Calculation - Result

- Goose Creek Watershed TP Load w/ Street sweeping, streambank stabilization, riparian buffer restoration, and Retrofits 1, & 2 = 704.8lb/yr
- Reduction = 714.6 lb/yr – 704.8 lb/yr = 9.8 lb/yr

Total Phosphorus Load for Goose Creek Watershed w/ BMPs – Iterative Calculation – Input Data

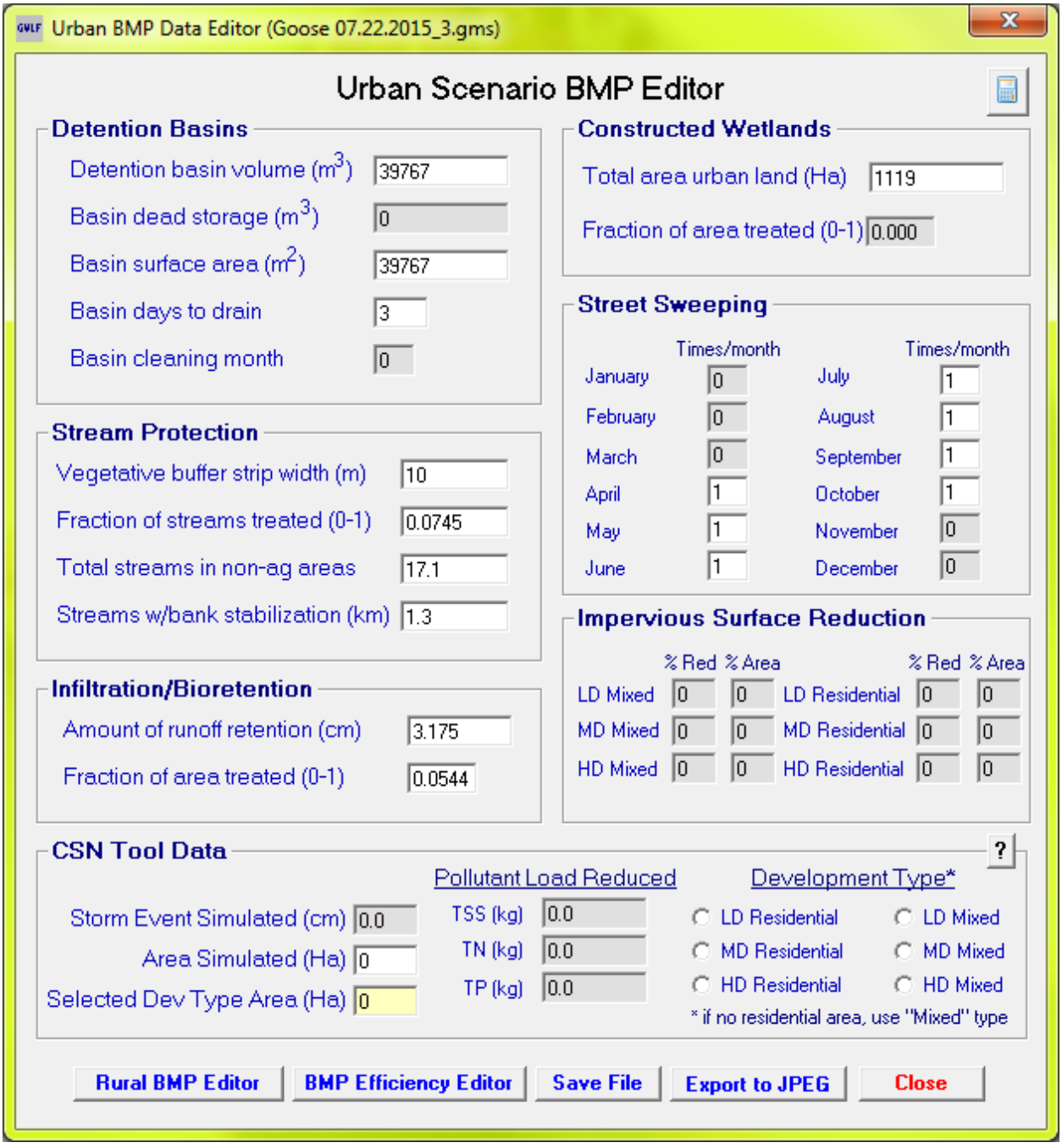
- Proposed BMP: Basin Retrofit #3

Total Phosphorus Load for Goose Creek Watershed w/ BMPs – Iterative Calculation - Result

- Goose Creek Watershed TP Load w/ Street sweeping, streambank stabilization, riparian buffer restoration, and Retrofits 1, 2, & 3 = 692.8lb/yr
- Reduction = 704.8 lb/yr – 692.8 lb/yr = 12.0 lb/yr

Total Phosphorus Load for Goose Creek Watershed w/ BMPs – Iterative Calculation – Input Data

- Proposed BMP: Basin Retrofit #4



Total Phosphorus Load for Goose Creek Watershed w/ BMPs – Iterative Calculation - Result

- Goose Creek Watershed TP Load w/ Street sweeping, streambank stabilization, riparian buffer restoration, and Retrofits 1, 2,3, & 4 = 672.9 lb/yr
- Reduction = 692.8 lb/yr – 672.9 lb/yr = 19.9 lb/yr

Goose Creek Watershed w/ BMPs Modeling Results:

- Goose Creek Watershed Total Phosphorus Reduction = 866.7 lb/yr - 672.9 lb/yr = 193.8 lb/yr
- **Proposed reduction = 194 lb/yr > Required reduction = 187 lb/yr**

MapShed Default BMP Load Reduction Efficiencies

- Default efficiencies used in modeling of Goose Creek Watershed & West Goshen Township MS4
- Default efficiencies assumed acceptable by PADEP

APPENDIX D

STREAM PROJECT LOCATION MAPS

0 400 Feet

Mapping derived from data provided by Chester County, West Goshen Township, and ESRI.

BMP Location

SS 1: Stream Enhancement Project

West Goshen Township
Chester County, Pennsylvania

8/27/2015	PM: MSB	GIS: BLS	QA: HSH	R004194.0430

HRG
Herbert Rowland & Grubic Inc
Engineering & Related Services
An Employee-Owned Company

369 East Park Drive
Harrisburg, PA 17111
717.564.1121 [phone]
717.564.1158 [fax]
www.hrg-inc.com

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0 400 Feet

Mapping derived from data provided by Chester County, West Goshen Township, and ESRI.

BMP Location

SS 2: Stream Enhancement Project

West Goshen Township
Chester County, Pennsylvania

8/27/2015	PM: MSB	GIS: BLS	QA: HSH	R004194.0430

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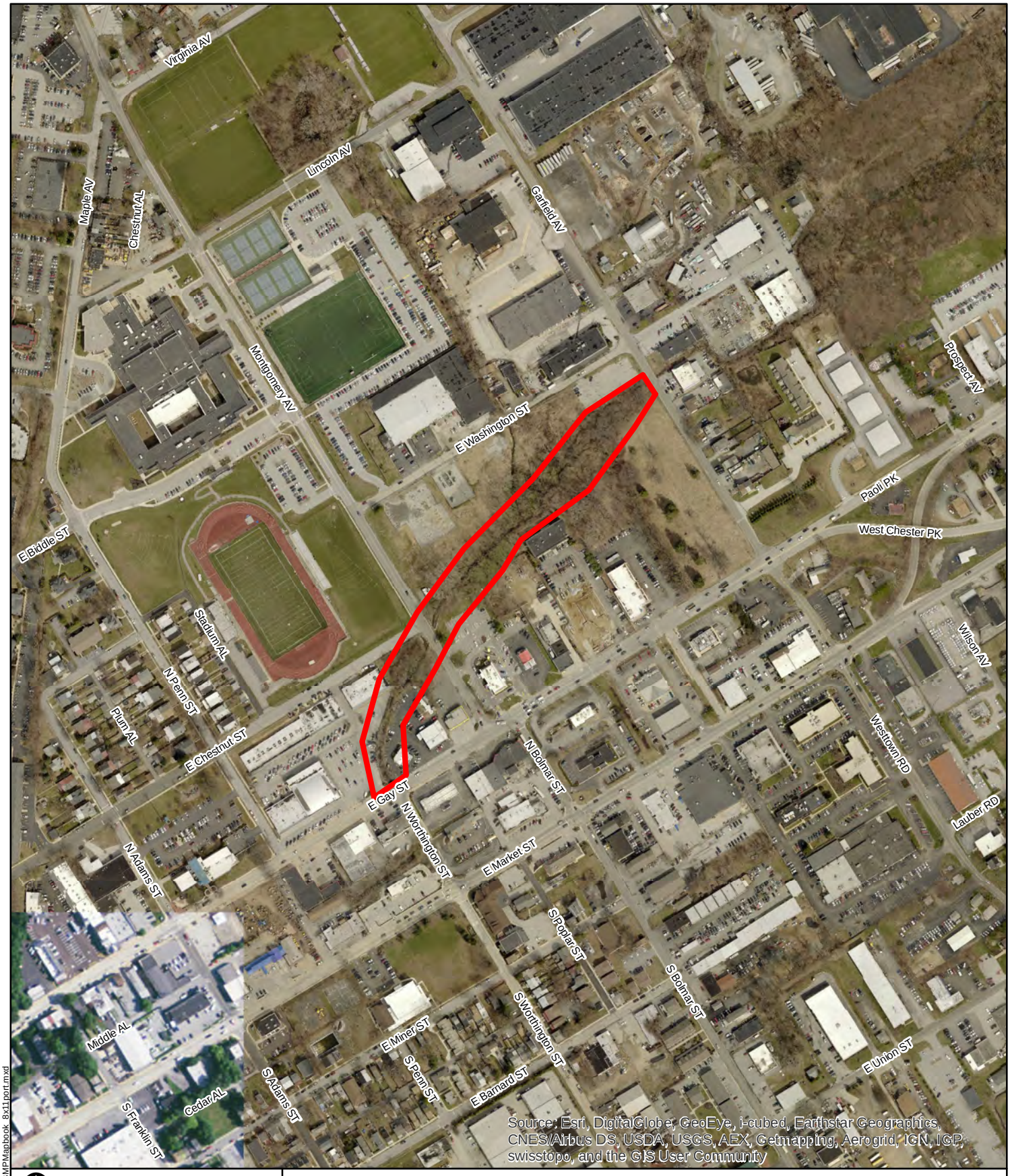

0 400 Feet

Mapping derived from data provided by Chester County, West Goshen Township, and ESRI.

BMP Location

SS 3: Stream Enhancement Project

West Goshen Township
Chester County, Pennsylvania

8/27/2015	PM: MSB	GIS: BLS	QA: HSH	R004194.0430

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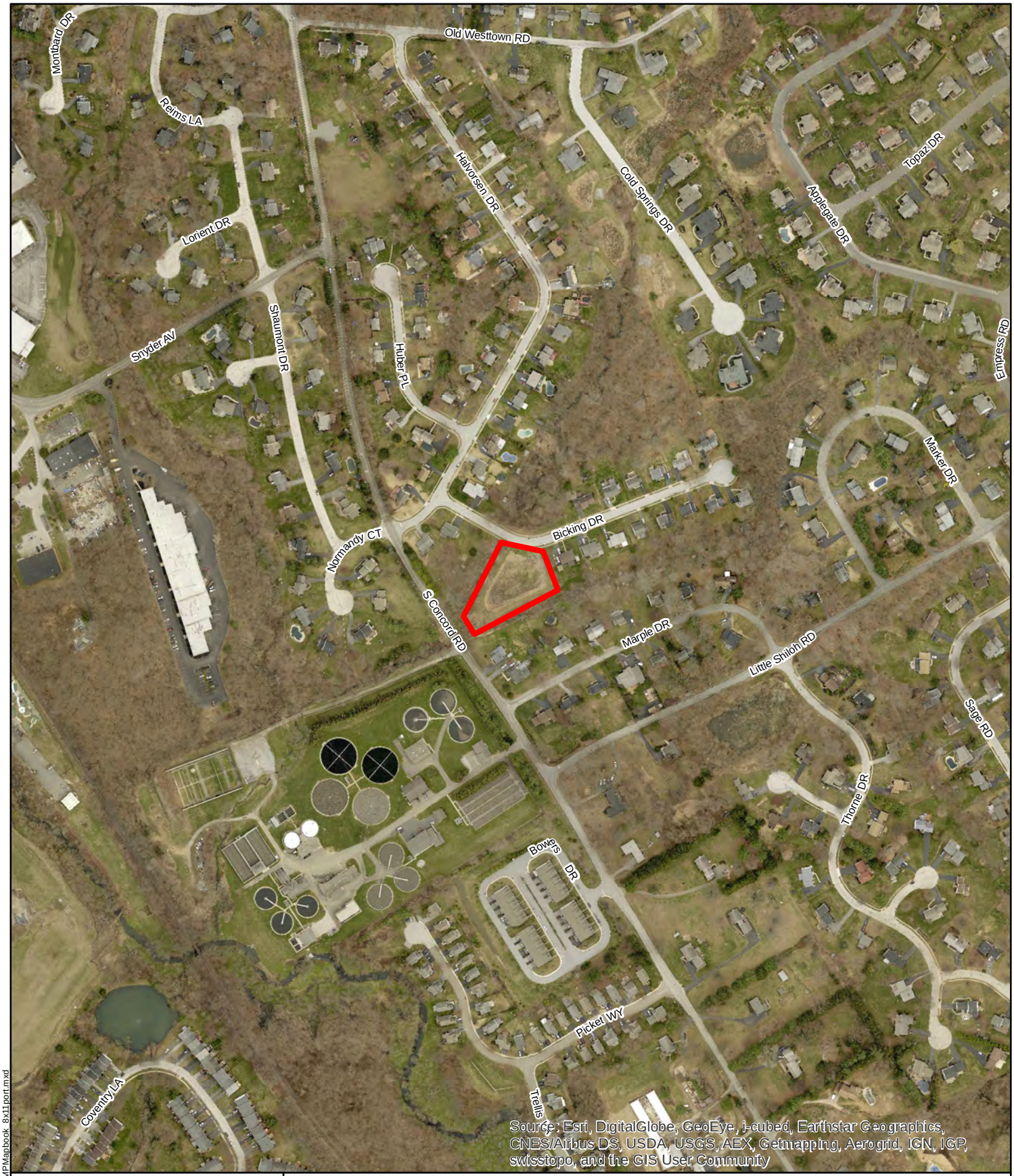
APPENDIX E

DETENTION BASIN RETROFIT
PROJECT LOCATION MAPS



0 400 Feet

Mapping derived from data provided by Chester County, West Goshen Township, and ESRI.

BMP Location

RF 1: Bicking Basin Retrofit

West Goshen Township
Chester County, Pennsylvania

8/27/2015	PM: MSB	GIS: BLS	QA: HSH	R004194.0430

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0 400 Feet

Mapping derived from data provided by Chester County, West Goshen Township, and ESRI.

BMP Location

RF 2: Westtown Road Basin Retrofit

West Goshen Township
Chester County, Pennsylvania

8/27/2015	PM: MSB	GIS: BLS	QA: HSH	R004194.0430

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717.564.1158 [fax]
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0 400 Feet

Mapping derived from data provided by Chester County, West Goshen Township, and ESRI.

BMP Location

RF 3: South Bolmar Street Basin Retrofit

West Goshen Township
Chester County, Pennsylvania

8/27/2015	PM: MSB	GIS: BLS	QA: HSH	R004194.0430

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717.564.1158 [fax]
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0 400 Feet

Mapping derived from data provided by Chester County, West Goshen Township, and ESRI.

BMP Location

RF 4: Willowbrook Lane Basin Retrofit

West Goshen Township
Chester County, Pennsylvania

8/27/2015	PM: MSB	GIS: BLS	QA: HSH	R004194.0430

HRG Herbert Rowland & Grubic Inc
Engineering & Related Services
An Employee-Owned Company

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Harrisburg, PA 17111
717.564.1121 [phone]
717.564.1158 [fax]
www.hrg-inc.com

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APPENDIX F

WEST GOSHEN TOWNSHIP MS4
STORMWATER FACILITY MAPS

Stormwater Map and BMP's

West Goshen Township
Chester County, Pennsylvania

600 0 600 Feet

Mapping derived from data provided by Chester County, USGS, and West Goshen Township.

8/28/2015	PM: MSB	GIS: BLS	QA: HSH	R004194.0430

HRG
Herbert, Rowland & Grubic, Inc.
Engineering & Related Services
An Employee-Owned Company

369 East Park Drive
Harrisburg, PA 17111
717.564.1121 [phone]
717.564.1158 [fax]
www.hrg-inc.com

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- Inlet
- Outfall
- Basin Outlet
- Storm Pipe
- Retention / Detention Basin
- BMP
- Road
- Stream
- Water Body
- Municipal Boundary