BETHLEHEM TOWNSHIP

Northampton County, Pennsylvania

Pollutant Reduction Plan Amendments

December 2022

Revised September 2023

HRG Project No. R008488.0428

HRG
Herbert, Rowland & Grubic, Inc.
Engineering & Related Services
AN EMPLOYEE-OWNED COMPANY

Pollution Reduction Plan Amendments

BETHLEHEM TOWNSHIP

NORTHAMPTON COUNTY, PENNSYLVANIA

TABLE OF CONTENTS

INTRODUCTION

HRG was recently retained by Bethlehem Township as its stormwater engineer. Once retained, HRG performed a full review of the Township's stormwater program, including its Pollutant Reduction Plan (PRP). It was determined via this review that multiple BMPs within the originally-proposed projects list were either not feasible for implementation or were less efficient at achieving sediment reduction than other available BMPs in the Township. To correct this, HRG evaluated multiple alternative projects, and those that better matched the Township's municipal capabilities or achieved a superior level of sediment reduction were selected.

We have collected the above and any carryover projects into this PRP amendment for PADEP review. Due to other developments in the Township, such as the implementation of a stormwater fee, we have also provided minor updates to other PRP sections within.

SUMMARY OF PROPOSED AMENDMENTS

All proposed amendments are included below. Unamended sections from the original PRP are included in this document in order to provide a complete standalone PRP; however, no other changes other than the following amendments are proposed:

Foreword
No amendments proposed.

Section A: Public Participation
Amended to meet the requirements for public comment on the amended portions of the Pollutant Reduction Plan.

Section B: Map
No amendments proposed.

Section C: Pollutants of Concern
No amendments proposed.

Section D: Determine Existing Loading for Pollutants of Concern
For consistency and clarity, removed Operation and Maintenance information and relocated it to Section G.

Section E: Select BMPs to Achieve the Minimum Required Reductions in Pollutant Loading
Amended to show the updated proposed BMPs and describe methodologies used in their design/selection.

Section F: Identify Funding Mechanisms
Amended to account for the Stormwater Utility Fee Program that Bethlehem Township implemented in 2022.

Section G: Identify Responsible Parties for Operation and Maintenance (O&M) of BMPs
Amended to include the Operation and Maintenance of the new proposed BMPs.

Figure 1: Land Cover and Planning Areas
No amendments proposed.

Figure 2: Existing Stormwater BMPs and Planning Area
No amendments proposed.

Figure 3: Proposed Stormwater BMPs and Planning Area
Amended mapping to display proposed BMP locations.

Table 1: Northampton County Pollutant Loading Rates
No amendments proposed.

Table 2: Assignment of Land Covers as Impervious or Pervious
No amendments proposed.

Table 3: Land Cover within the Planning Area
No amendments proposed.

Table 4: Existing Pollutant Loading of TSS
No amendments proposed.

Table 5: PA DEP MS4 Requirements Table
No amendments proposed.

Table 6: Existing Structural BMPs
No amendments proposed.

Table 7: Proposed BMPs
Amended to display updated proposed BMPs. Two versions of Table 7 are provided for clarity depending on desired information.

Table 8: Added/Removed Proposed BMPs
Amended to display additions and removals of proposed BMPs.

Sculac Stream Restoration – Reach 2 & Reach 3 Location Map
Added to show proposed project reaches for Sculac Stream Restoration Project.

Typical BMP Design Details
Added to provide typical design details for proposed BMPs.

Foreward

This Pollutant Reduction Plan (PRP) serves to fulfill the requirements of Appendix D of NPDES PAI-132214 for Bethlehem Township.

This plan has been completed using publicly available data and data supplied by Bethlehem Township.

While this plan aims to provide guidance towards the construction and implementation of stormwater quality Best Management Practices (BMPs) to provide pollutant loading reductions, it should be noted that this is a fluid document that will be evaluated and updated yearly as specific proposed locations and types of BMPs are analyzed and designed, as new opportunities for partnerships are realized, and as revised regulations and BMPs are developed and implemented.

Some examples of common BMPs are extended dry detention basins, raingardens, infiltration trenches, bioretention basins, and stream restoration. Only the latter two were utilized in the amendment of this PRP.

Section A – Public Participation

PA DEP Requirement: "*The applicant shall make a complete copy of the PRP available for public review.*"

A complete copy of the PRP is available for review by the public at the following locations:

- On the Bethlehem Township website at http://www.bethlehemtownship.org.
- At the Bethlehem Township offices at 4225 Easton Avenue, Bethlehem Township PA 18020

PA DEP Requirement: "*The applicant shall publish, in a newspaper of general circulation in the area, a public notice containing a statement describing the plan, where it may be reviewed by the public, and the length of time the permittee will provide for the receipt of comments. The public notice must be published at least 45 days prior to the deadline for submission of the PRP to DEP. Attach a copy of the public notice to the PRP*".

The required public notice was printed in the local paper on October 7, 2022. A copy of the public notice and proof of publishing are attached.

PA DEP Requirement: "*The applicant shall accept written comments for a minimum of 30 days from the date of public notice. Attach a copy of all written comments received from the public to the PRP.*"

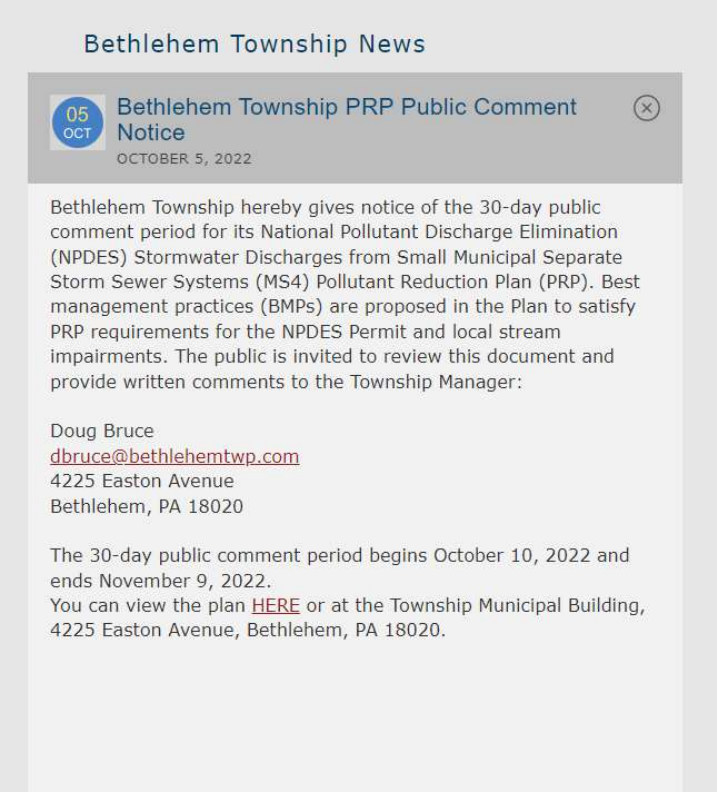
Written comments were accepted from October 10, 2022 to November 9, 2022. The Township received one (1) written comment. All received comments and responses are attached.

PA DEP Requirement: "*The applicant shall accept comments from any interested member of the public at a public meeting or hearing, which may include a regularly scheduled meeting of the governing body of the municipality or municipal authority that is the permittee.*"

Verbal comments were accepted from the public at the regularly scheduled Township Board of Commissioners meeting on December 5, 2022. No verbal comments were received.

PA DEP Requirement: "*The applicant shall consider and make a record of the consideration of each timely comment received from the public during the public comment period concerning the plan, identifying any changes made to the plan in response to the comment. Attach a copy of the permittee's record of consideration of all timely comment received in the public comment period to the PRP.*"

All written and verbal public comments were considered and a written response to each comment is attached.



Bethlehem Township
Public Comment Notice

Bethlehem Township hereby gives notice of the 30-day public comment period for its National Pollutant Discharge Elimination (NPDES) Stormwater Discharges from Small Municipal Separate Storm Sewer Systems (MS4) Pollutant Reduction Plan (PRP). Best management practices (BMPs) are proposed in the Plan to satisfy PRP requirements for the NPDES Permit and local stream impairments.
The public is invited to review this document and provide written comments to the Township Manager:

Doug Bruce
dbruce@bethlehemtwp.com
4225 Easton Avenue
Bethlehem, PA 18020

The 30-day public comment period begins October 10, 2022 and ends November 9, 2022.
The Plan will be available on the Township website https://www.bethlehemtownship.org and at the Township Municipal Building, 4225 Easton Avenue, Bethlehem, PA 18020.

BETHLEHEM TOWNSHIP BOARD OF COMMISSIONERS
REGULAR PUBLIC MEETING
DECEMBER 5, 2022, 7:00 P.M.

AGENDA

1. **CALL TO ORDER**
2. **PLEDGE OF ALLEGIANCE**
3. **ROLL CALL**

4. **COURTESY OF THE FLOOR**

Public comments on non-agenda items should be made during Courtesy of the Floor at the beginning of the meeting. Public comments on agenda items should wait until that specific item is reached on the agenda. A 3-5 minute time limit on each speaker may be considered and voted on by the board at the beginning of meetings with large attendance.

5. **APPROVAL OF MINUTES**

A. Regular Public Meeting – November 21, 2022.

6. **PUBLIC HEARING**

B. Request of Flaming Crab Cajun Seafood, c/o Tian Guizhang, for an Economic Development Liquor License, for their facility located at 3296 Nazareth Pike, Suite 12-14, Bethlehem, PA 18020 pursuant to the Pennsylvania Liquor Code 47 P.S. § 1-101, as amended.

7. **PRESENTATION**

C. Public works master plan – MKSD Architects.

8. **SUBDIVISIONS AND LAND DEVELOPMENT**

D. Bethlehem Area Vocational Technical School – concrete pad waiver request.

9. **MOTIONS OF THE BOARD OF COMMISSIONERS**

E. A motion adopting a revised pollutant reduction plan (PRP).

E1. A motion agreeing with the Pennsylvania Department of Transportation's plan to establish an all-way stop at the intersection of Bethman and Church roads, and additionally agreeing to install the corresponding township-owned signage.

10. **PURCHASE ORDER APPROVAL**

F. Purchase Orders

1. PO 20222679 – Trane USA – PPIS – $8,452.00

11. DISCUSSION ITEM

G. Committee appointments

12. ADJOURNMENT

BOARD OF COMMISSIONERS
REGULAR PUBLIC MEETING
DECEMBER 5, 2022

MEMBERS PRESENT	John J. Merhottein, President John K. Gallagher, Vice President Jan Beatty, Commissioner Dale A. Sourbeck, Commissioner Luke A. Verdes, Commissioner
OTHERS PRESENT	James Broughal, Township Solicitor Doug Bruce, Township Manager Amanda Raudenbush, Planning Director
CALL TO ORDER	Mr. Merhottein called the meeting to order at 7:00 p.m. and led those in attendance in reciting the Pledge of Allegiance.
EXECUTIVE SESSION	Solicitor Broughal announced that on Monday, December 5, 2022, the Board of Commissioners met in executive session at approximately 6:30 p.m. to 6:55 p.m. to discuss personnel issues pursuant to Section 708a of the Pennsylvania Sunshine Act.
COURTESY OF THE FLOOR	
DAVID BUCHERER **4220 NICHOLAS ST.**	Mr. Bucherer said he attended the last Planning Commission meeting but was unable to attend the Zoning Hearing Board meeting. He believes the township is becoming a metropolis: a maximum density transient town. Mr. Bucherer believes a moratorium should be put on new developments. He also believes there is a lack of communication between the Board of Commissioners and other township boards.
ROY ROTH **4323 CHETWIN TERR.**	Mr. Roth commended the construction department for taking care of his concerns about a house under construction without permits, but added it should have never gotten that far. Mr. Roth said the stormwater fee was implemented this year and asked how much work has been done and if there was a plan in place. Mr. Merhottein said they are in the engineering phase right now through 2023. Mr. Gallagher added that the Stormwater Committee gets updates from the stormwater engineer. He said they won't know the exact cost of the repairs until the engineering is done. Mr. Gallagher said he would be willing to sit with Mr. Roth to explain further. Mr. Roth asked how much it cost to run the recycling center. Mr. Bruce said he didn't know.
TOM KEEFER **3803 CARTER RD.**	Mr. Keefer asked the board to figure a way to differentiate the Township of Bethlehem from the City of Bethlehem. He said Kay Builders' commercials refer to the developments in the township as being in Bethlehem, Pennsylvania. Mr. Merhottein said they don't control marketing by developers.
DON WRIGHT **2815 HOPE RIDGE DR.**	Mr. Wright asked if trucks and recreational vehicles were permitted park at Lowes on Southmont. Ms. Raudenbush said notices of violations were sent out to the property owner. Mr. Wright commented that if the Public Works building ever gets developed on Hope Road to keep in mind that there will

be an entrance on the V7 tract and that traffic control would need to be coordinated with the developers.

APPROVAL OF MINUTES

Upon motion (Beatty-Sourbeck), the Board of Commissioners voted unanimously by voice vote to approve the minutes of the November 21, 2022 regular public meeting as presented.

PUBLIC HEARING

REQUEST OF FLAMING CRAB CAJUN SEAFOOD, C/O TIAN GUIZHANG, FOR AN ECONOMIC DEVELOPMENT LIQUOR LICENSE, FOR THEIR FACILITY LOCATED AT 3296 NAZARETH PIKE, SUITE 12-14, BETHLEHEM, PA 18020 PURSUANT TO THE PENNSYLVANIA LIQUOR CODE 47 P.S. § 1-101, AS AMENDED

Solicitor Broughal explained that the Economic Development licenses are typically only issued once an applicant can show that he or she has exhausted all other reasonable means of acquiring a liquor license within the county. Because the state map shows no KOZ/EZ areas in the township, it defaults to township approval. According to the Liquor Code, the following is required:

1. The municipality will hold at least one public hearing on the applicant's request for an economic development license

2. The municipality shall, within 45 days of a request for approval, render a decision by ordinance or resolution to approve or disapprove the applicant's request for an economic development license.

3. If the municipality find that the issuance of the license would promote economic development, it may approve the request. The municipality shall refuse the request if it finds that the approval of the request would adversely affect the welfare, health, peace and morals of the municipality or its residents.

4. If the receiving municipality denies the applicant's request for approval of an economic development license, the applicant may appeal the decision of the municipality to the court of common pleas in the county in which the proposed licensed premises is located.

The hearing and testimony were recorded by Mr. Ted Rewak.

The board will render a decision at the December 19, 2022 meeting.

PRESENTATION

PUBLIC WORKS MASTER PLAN – MKSD ARCHITECTS

Mr. Merhottein said the presentation was postponed until the meeting of January 3, 2023.

SUBDIVISION & LAND DEVELOPMENT

WAIVER REQUEST

BETHLEHEM AREA VOCATIONAL TECHNICAL SCHOOL – CONCRETE PAD WAIVER REQUEST

Ms. Raudenbush said the applicant proposes the installation of a concrete pad for a new exterior walk-in refrigerator/freezer. They are requesting a waiver from the SALDO Section 230-9.D which would allow review and

approval to be handled administratively rather than involving the Planning Commission and the Board of Commissioners for the review and approval processes. Ms. Raudenbush said she had no objections to the request.

Upon motion (Gallagher-Sourbeck), the Board of Commissioners voted unanimously by voice vote to approve the Bethlehem Area Vocational Technical School – concrete pad waiver request.

MOTIONS OF THE BOARD OF COMMISSIONERS

MOTION **A MOTION ADOPTING A REVISED POLLUTANT REDUCTION PLAN (PRP)**

Mr. Bruce said the board had previously voted to advertise the plan, plan was properly advertised, and one public comment was received. The plan was revised to reflect that comment.

Upon motion (Sourbeck-Gallagher), the Board of Commissioners voted unanimously by voice vote to approve a motion adopting a revised pollutant reduction plan (PRP).

MOTION **A MOTION AGREEING WITH THE PENNSYLVANIA DEPARTMENT OF TRANSPORTATION'S PLAN TO ESTABLISH AN ALL-WAY STOP AT THE INTERSECTION OF BETHMAN AND CHURCH ROADS, AND ADDITIONALLY AGREEING TO INSTALL THE CORRESPONDING TOWNSHIP-OWNED SIGNAGE**

Upon motion (Sourbeck-Beatty) the Board of Commissioners voted unanimously by voice vote to approve a motion agreeing with the Pennsylvania Department of Transportation's plan to establish an all-way stop at the intersection of Bethman and Church roads, and additionally agreeing to install the corresponding township-owned signage.

APPROVAL OF PURCHASE ORDERS **PO 20222679 – TRANE USA – PPIS – $8,452.00**

Upon motion (Gallagher-Beatty), the Board of Commissioners voted unanimously by voice to approve Purchase Orders 20222679 as presented.

DISCUSSION ITEM

COMMITTEE APPOINTMENTS

Mr. Gallagher said the late Commissioner Davis served on the Stormwater Committee, the ARCHIE Project, and the Fire Relations Committee. The board needs to appoint someone to fill the vacancies.

Mr. Gallagher nominated Mr. Merhottein to serve on the Fire Relations Committee as he has an established relationship with both fire companies. By consensus, the board appointed Mr. Merhottein to serve on the Fire Relations Committee.

Mr. Gallagher nominated Mr. Verdes to serve on the Stormwater Committee. By consensus, the board appointed Mr. Verdes to serve on the Stormwater Committee.

COMMENT	Mr. Merhottein thanked staff for putting together the Veteran's Day event and Mr. Gallagher for serving as emcee.
ADJOURNMENT	Mr. Sourbeck made a motion to adjourn the meeting at 7:46 p.m.

Respectfully submitted,

Laura G. Zapata
Recording Secretary

12-05-2022

PUBLIC COMMENTS

Written:

1. Comment received regarding the Township's ability to maintain stormwater facilities.
    a. Bethlehem Township recognizes this concern and is confident that the Public Works staff will have the appropriate training and resources to ensure maintenance is completed. The Township will continue to monitor this and make necessary adjustments to ensure proper maintenance of stormwater facilities.

Verbal:

1. No verbal comments were received.

Section B – Map

PA DEP Requirement: "Attach a map that identifies land uses and/or impervious/pervious surfaces and the storm sewershed boundary associated with each MS4 outfall that discharges to impaired surface waters, or surface waters draining to the Chesapeake Bay (see note below), and calculate the storm sewershed area that is subject to Appendix D and/or Appendix E. In addition, the map must identify the proposed location(s) of structural BMP(s) that will be implemented to achieve the required pollutant load reductions."

"The MS4 may display the storm sewershed for each MS4 outfall or just the PRP Planning Area, at its discretion."

> A map showing the PRP planning area and current land covers is included in the Appendix as Figure 1. A map showing the PRP planning area and the location of the existing structural BMPs is provided in the Appendix as Figure 2. A map showing the planning area and the locations of structural BMPs proposed to meet the minimum required reductions in pollutant loading is provided as Figure 3 in the Appendix.

Section C – Pollutants of Concern

PA DEP Requirement: "Identify the pollutants of concern for each storm sewershed or the overall PRP Planning Area (see Section I.B of these instructions)."

Since this PRP is being developed for impaired waters, the pollutants are based on the impairment listing provide in PA DEPs MS4 Requirements Table (included in the Appendix) which references "siltation" for each of the Township's impaired watercourses. The pollutant of concern for siltation is Total Suspended Solids (TSS).

The PA DEP's MS4 Requirements Table also lists Organic Enrichment/Low D.O. for the Lehigh River. However, per Section 1.B of PADEP's "PRP Instructions", permittees that select appropriate BMPs to achieve the 10% sediment loading reduction will (incidentally) achieve the required reductions for the pollutants associated with organic enrichment.

Section D – Determine Existing Pollutant Loading for Pollutants of Concern

PA DEP Requirement: "Identify the date associated with the existing loading estimate (see Section I.C of these instructions)"

> The date of the of the development of this PRP was March 1, 2018; it was amended in September of 2023.

PA DEP Requirement: "Calculate the existing loading, in lbs. per year, for the pollutant(s) of concern in the PRP Planning Area."

> The planning area assessed in this PRP consists of the urbanized area in Bethlehem Township which drains to the impaired watercourses (the Nancy Run, Monocacy Creek and Lehigh River) excluding PennDOT rights-of-way. The loading rates for pervious and impervious cover for Bethlehem Township are provided in the PADEPs "PRP Instructions" in Attachment B, "Developed Land Loading Rates for PA Counties" under the "Other Counties" Section.

Table 1. "Other Counties" Pollutant Loading Rates

Pollutant and Source	Loading Rate (lb/ac/yr)
TSS Impervious Developed	1,839
TSS Pervious Developed	246.96

The impervious and pervious developed areas covered by the planning area were derived using the "High-Resolution Land Cover, Commonwealth of Pennsylvania, Chesapeake Bay Watershed and Delaware River Basin, 2013" provided by the University of Vermont Spatial Analysis Laboratory for land-cover mapping and modeling initiatives in the Chesapeake Bay Watershed and Delaware River Basin.

The land covers within the planning area were compiled into impervious and pervious surfaces as shown in Table 2.

Table 2. Assignment of Land Covers as Impervious or Pervious

Impervious	Pervious
Barren	Low Vegetation
Other Impervious Surfaces	Scrub-Shrub
Roads	Tree Canopy
Structures	Wetlands (emergent)
Tree Canopy Over Other Impervious Surfaces	
Tree Canopy Over Roads	
Tree Canopy Over Structures	

Table 3 shows the breakdown of the different land covers within the PRP planning area, and the sum of the impervious and pervious areas.

Table 3. Land Cover within the Planning Area

Land Cover	Area (ft2)	Area (Ac)
Barren	1188992.3	27.3
Low Vegetation	119621385.0	2746.1
Other Impervious Surfaces	31724399.4	728.3
Roads	12311700.9	282.6
Scrub-Shrub	131975.6	3.0
Structures	21932524.3	503.5
Tree Canopy	48308052.6	1109.0
Tree Canopy Over Other Impervious Surfaces	3215105.5	73.8
Tree Canopy Over Roads	1409311.8	32.4
Tree Canopy Over Structures	439781.2	10.1
Water	210120.4	4.8
Wetlands (emergent)	0	0
TOTAL	240493348.8	5521.0
Total Impervious	72221815.4	1658.0
Total Pervious	168061413.1	3858.2

The existing loading of TSS for the planning area was calculated in Table 4.

Table 4. Existing Pollutant Loading of TSS

Pollutant and Source	Loading Rate (lb/ac/yr)	Area (Ac)	Annual Load (lbs/yr)	Annual Load (Ton/yr)
TSS Impervious developed	1,839	1,658.0	3,049,033.9	1,524.5
TSS Pervious Developed	264.96	3,858.2	1,022,257.9	511.1
		Total TSS Load	4,071,291.8	2,035.6

In accordance with PADEP's "PRP Instructions", the Township may claim 'credit' for existing structural BMPs to reduce the existing sediment load estimate. Please find attached in the Appendix, Figure 2, which shows the location of existing structural BMPs within the PRP planning area. The drainage area treated by each existing BMP was delineated and the amount of pervious and impervious land cover in each drainage area was determined in the same manner as the planning area. Table 6 (attached in the Appendix) provides the required information for existing structural stormwater BMPs within the planning area and the pollutant reduction they provide. The total annual credit generated by the existing BMP's equals 308,788.8 lbs/year (154.4 tons).

Taking the annual credit for existing basins into account, the existing TSS load from the planning area is calculated as:

4,071,291.8 lbs/yr – 308,788.8 lbs/yr = 3,762,503 lbs/yr (1,881.3 tons/yr)

As part of the Township's ongoing MS4 program, inspections of the existing stormwater BMPs will be completed by the Township to verify that each BMP listed in Table 6 continues to serve the function(s) it was

designed for. If it is determined during these inspections that any of the existing BMPs are not functioning properly, maintenance will be performed to correct the problem(s) or this BMP will be removed from the credit calculations and the proposed BMPs and reduction calculations will be revised accordingly.

As part of the Township's ongoing MS4 program, the Township will perform research to determine which existing BMP's were authorized through a permit and the date each BMP was installed. Table 6 will then be updated to include these permit numbers and installation dates.

Section E – Select BMPs to Achieve the Minimum Required Reductions in Pollutant Loading

PA DEP Requirement: "*Identify the minimum required reductions in pollutant loading*" "*If the impairment is based on siltation only, a minimum 10% sediment reduction is required.*"

> PA DEPs MS4 Requirements Table references "siltation" for the Township's impaired watercourses. Therefore, the Township's minimum required sediment reduction is 10%.
>
> Therefore, the Township's minimum required reduction is: 3,762,503 lbs/yr x 0.10 = **376,250.30** lbs/yr (188.1 ton/yr)

Tables 7a and 7b list the BMPs proposed to meet the required reduction. Their locations are shown in Figure 3 attached in the Appendix.

If it is determined during the design process that a project is not feasible and other alternative projects cannot be utilized, the PRP will be updated accordingly to achieve the minimum required TSS reduction. However, a substantial number of alternative (backup) projects have been proposed, and we believe the aforementioned scenario is unlikely.

The simplified method was utilized to calculate total BMP sediment loading. It is anticipated that three joint projects with Bethlehem City will be completed; for these projects, 40% IA was assumed, while all other projects within the Township boundary assumed 34% IA. Both values were obtained from the "*PADEP Statewide MS4 Land Cover Estimates*" document. Based on a combination of PASDA LiDAR and other topographic resources, drainage areas were determined for all proposed BMPs.

The proposed BMP types are as follows:

Vegetated Swale Retrofit/Bioretention Swale

Vegetated swales are simple conveyance features designed primarily to convey water from one point to another without erosion, not to provide enhanced water quality benefits. While infiltration and vegetation do provide some cleaning of runoff, the water quality benefits are limited. Instead, retrofits that convert vegetated swales into bioretention swales focus not just on conveyance of runoff, but providing water capture via check dams, terracing, stilling pools, and other engineered obstructions; infiltration via amended soil installation; and water quality via the aforementioned amended soils as well as establishment of native wetland vegetation. By doing so, swale retrofits will have an increase in sediment-removal efficiency from 50% to 80% TSS removal, as stated within the "*PADEP BMP Effectiveness Values*" guidance. A 20:1 drainage area to swale bottom area loading ratio was then applied to account for hydrodynamic loading efficiency.

Proposed 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 pollutant laden runoff in order to reduce the amount of nutrients and sediment eventually reaching the local waterways. Vegetative stabilization relies on the root structures of established plantings to stabilize the streambank and provide scour protection. In addition, incised streambanks will be regraded at a lesser slope to prevent further incision by allowing the stream to reconnect to the surrounding floodplain. This method offers a relatively inexpensive means of stabilization and provides a naturalized appearance to the rehabilitated streambank.

Velocity reduction, where practical, will be achieved through the use of rock vanes, wing deflectors, and grade controls in combination with streambank stabilization, riparian buffer projects, and floodplain reconnection. These instream structures will direct stream flow away from eroding or newly stabilized streambanks, as well as create stream meanders that will reduce stream velocity, further preventing streambank erosion and scour. The structures will be constructed of natural materials such as rock, root wads, and logs. The exact number and locations for the proposed instream structures will be determined upon completion of the engineered design.

Bethlehem 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, diseased, and/or invasive vegetation; as well as new plantings in areas where buffers have diminished in size. The riparian buffer restoration projects 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 and will incorporated into the engineered design.

A TSS reduction of 44.88 lb/ft is assumed, as stated within the "*PADEP BMP Effectiveness Values*" guidance.

Detention Basin Retrofit/Bioretention BMPs

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 mitigation, 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 with structure modifications, improving soil conditions to allow for greater infiltration rates, and naturalizing the basins with native and/or wetland plant species. Additionally, brand new bioretention basins are also being proposed where no BMP currently exists, and these will follow the same overall philosophy as retrofits.

For basins that *have* had preliminary design completed, the "*Recommendations of the Expert Panel to Define Removal Rates for Urban Stormwater Retrofit Projects*" guidance was utilized. Per expert panel guidance, these BMPs were listed as having a 0% existing sediment-removal efficiency and varied proposed efficiencies depending on the characteristics of each basin. Basin retrofits that *have not* had preliminary design completed have an increase in efficiency from 10% to 80% TSS removal, as stated within the "*PADEP BMP Effectiveness Values*" guidance. Similarly, newly-constructed basins that have not had preliminary design completed have an increase in efficiency from 0% to 80% TSS removal, as stated within the "*PADEP BMP Effectiveness Values*" guidance. For those calculations utilizing the PADEP BMP Effectiveness Values guidance, a 20:1 drainage area to basin bottom area loading ratio was then applied to account for hydrodynamic loading efficiency.

Design and Construction Methodology for Basin Retrofits

All proposed basin retrofits follow a similar four-part design philosophy: 1. increase storage volume via excavation; 2. promote water infiltration and vegetative bioretention via amended soils and wetland plantings; 3. replace outlet structures to create larger treatment volumes and lower outflows; and 4. correct design flaws of the past.

Regarding increased storage volume, each basin will be expanded beyond existing capacity by excavating the basins to their maximum practical extents in both the horizontal and vertical directions. Vertical limits are determined for each basin by analyzing the basin's geology (presence/height of bedrock, karst features, etc.) and surrounding inflow and outflow elevations. Horizontal limits are determined by available property footprint, safe slope criteria, existing basin bottom areas, and surrounding conflicts. Other unique constraints to basin expansion may be considered on a basin-by-basin basis depending on the surrounding area.

Regarding promotion of runoff infiltration and vegetative bioretention, each basin bottom will be outfitted with a layer of amended (engineered) soils designed to both retain and percolate more water than standard soils. These soils will be supported by a geotextile layer to prevent sinkhole development and intermingling of non-engineered soils. High-quality, native wetland plants will then be established via seed and/or planting on the basin bottom to provide further water quality and volume-reduction benefits beyond infiltration.

Regarding outlet structure replacement, each basin will likely have its existing outlet structure replaced, though final decisions on replacement will not be known until final design is complete for each basin. HRG expects that outlet structures will need to be replaced due to chronic oversizing of existing outlet structure orifices in other basins of similar age and region. These existing outlet structure orifices are so large that they do not provide any notable water quality benefits; water enters and leaves the existing basins so quickly that virtually no infiltration nor sediment settling occurs. Replacement allows new outlet structures to be utilized that hold back more water than before; encourage more infiltration, evapotranspiration, and sediment settling than before; and have lesser discharge rates and volumes than before (NOTE: specific emphasis in outlet structure design will be placed on locating the primary outflow orifice at approximately 2' above the basin bottom to maximize the available treatment volume in the retrofit). The aforementioned expanded basin volumes work in conjunction with the replaced outlet structures to make all of this possible.

Regarding correction of past design flaws, unique design elements must be implemented on a basin-by-basin basis to correct improper, past design practices. For example, short circuiting – where inflow structures and outflow structures are positioned directly across from one another and cause water to flow through instead of be stored by an existing basin – is often corrected by relocating said structures or by providing forebays/earthen baffles to redirect flow. Additionally, incorrectly repaired sinkholes (usually grouted) will be remediated with inverted filters per PADEP specifications. Low-flow channels will also be removed where necessary to ensure small storms are detained by the basin for maximum water quality benefit. Other unique design corrections may be required depending on existing basin features.

Calculation Methodology for Basin Retrofits

Per PADEP's PRP instructions (section I.D, document 3800-PM-BCW0100k), municipalities are afforded two options for calculating sediment reduction in a basin retrofit: PADEP's BMP Effectiveness Values document or the Chesapeake Bay expert panel report. An image of this reference is below:

D. **BMP Effectiveness**: All MS4s must use the BMP effectiveness values contained within DEP's BMP Effectiveness Values document (3800-PM-BCW0100m) or Chesapeake Bay Program expert panel reports

Both methods prescribe or include procedures to account for hydrodynamic loading and BMP effectiveness. When utilizing the BMP Effectiveness Values document, PADEP has prescribed a loading ratio cap of 20:1 to account for hydrodynamic loading. This value is based on infiltration BMP loading ratios in Appendix C of the Pennsylvania Stormwater Best Management Practices manual, with additional loading permitted beyond the limits recommended in the BMP manual to take into account two items inherent to retrofitting existing BMPs: 1. retrofits are rarely strict infiltration BMPs, and 2. existing basins in need of retrofit usually have an existing loading ratio in excess of BMP manual limits that retrofit designers cannot avoid.

However, there are inherent problems with the PADEP Effectiveness Tables method in terms of scientific accuracy: 1. it assigns a universal reduction rate to all retrofit practices of a similar nature, 2. the loading ratio cap is ultimately arbitrary and based on (justified) professional judgment rather than evidentiary studies, and 3. infiltration area loading ratios in Appendix C, Protocol 2 of the BMP manual were not developed to account for hydrodynamic loading nor maximum sediment removal efficiency, but instead were created to prevent physical failures of infiltration BMPs (compaction of soils, excessive infiltration creating sinkholes, etc.). The Chesapeake Bay expert panel attempts to solve these issues through sampling and study of real-life BMPs. It then assigns hydrodynamic loading efficiencies to BMPs based on the type of retrofit and a separate

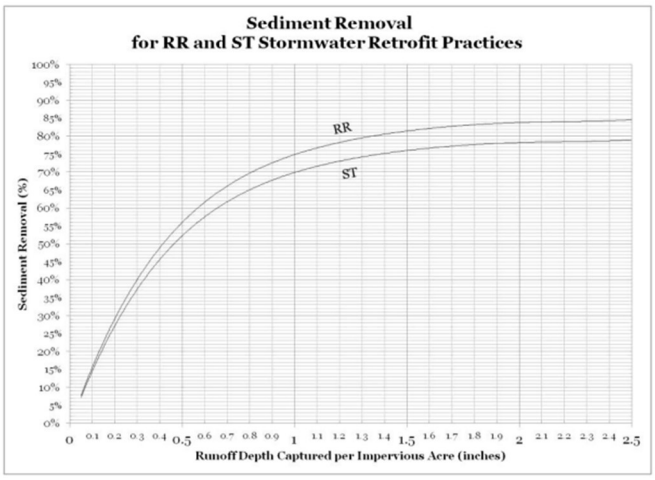
loading ratio that is more reflective of sediment removal efficiency: drainage area versus *treatment volume* (rather than drainage area vs. *infiltration area*).

Through the aforementioned sampling and studies, the panel created two key items that professionals can use to more-accurately determine BMP sediment removal efficiency than the BMP Effectiveness Values. The first is a formula capping the amount of runoff a BMP is capable of treating relative to its volume (measured in inches of runoff depth). The second is an efficiency curve modeling the professional judgment that PADEP and retrofit designers intuitively know: that as BMPs receive more runoff, the amount of sediment they remove begins to decrease (measured in % effectiveness). Images of these items are below:

$$= \frac{(RS)(12)}{IA}$$

Where:

RS = Runoff Storage Volume (acre-feet)
IA = Impervious Area (acres)



As requested by PADEP for BMPs F1 through F5, the results of applying this formula and curve to those basins are provided below:

- F1 – East Blvd Basin (East): 0.33" (runoff depth treated), 47% (sediment removal efficiency)
- F2 – East Blvd Basin (West): 0.83" (runoff depth treated), 66% (sediment removal efficiency)
- F3 - Swale to Santee Basin: N/A (swale)
- F4 – Apartment Basin: 1.62" (runoff depth treated), 81% (sediment removal efficiency)
- F5 – Santee Basin: 0.38" (runoff depth treated), 49% (sediment removal efficiency)

As requested by PADEP, we have also included a comparison of the 2-year storm volume tributary to each of the above basins relative to the treatment volume of each basin in acre-feet:

- F1 – East Blvd Basin (East): 44.998 (2-year total volume), 37.390 (2-year impervious volume), 4.509 (treatment volume)
- F2 – East Blvd Basin (West): 4.347 (2-year total volume), 3.612 (2-year impervious volume), 1.107 (treatment volume)
- F3 - Swale to Santee Basin: N/A (swale)
- F4 – Apartment Basin: 2.104 (2-year total volume), 1.665 (2-year impervious volume), 0.993 (treatment volume)

- F5 – Santee Basin: 1.328 (2-year total volume), 1.051 (2-year impervious volume), 0.147 (treatment volume)

(NOTE: these are preliminary figures assuming 2 feet of treatment storage in each basin as called for in the BMP manual; because the PRP is a planning document, because final retrofit designs are not complete nor required per FAQ #37, and because the proposed basins are going to be far deeper than 2 feet in total depth, we believe this is a reasonable assumption for planning purposes)

As seen above, the tributary 2-year storm volumes to each basin are in excess of the treatment volumes. Since these are basin retrofit projects, this is no surprise, as existing basins most in need of retrofit are usually older and were designed prior to loading ratios (whether area [infiltration] or volume [sediment]) being a constraint of concern. Even accounting for the discrepancy, HRG is comfortable with utilizing the results of the Chesapeake Bay expert panel for the following reasons:

1. The Chesapeake Bay expert panel method is explicitly allowed and arguably even required per PADEP MS4 regulations. This can be seen in the above-mentioned section of the PRP instructions, as well as in PADEP's MS4 NPDES Permits Frequently Asked Questions document (FAQ #32). An image of this reference is below:

FAQ #32: What are the approved methods to calculate load reductions from BMPs?

The efficiency of BMPs must conform to EPA's Chesapeake Bay Model efficiencies (i.e., see Chesapeake Assessment Scenario Tool (CAST)) or Chesapeake Bay expert panel reports except as otherwise approved by DEP. For example, PRPs/TMDL Plans may also apply thoroughly vetted mechanistic models with

The BMP Effectiveness Values document or the Final CBP Approved Expert Panel Report on Stormwater Retrofits can be used to calculate the reductions for retrofit BMPs.

2. In the same FAQ, PADEP actually notes preference for the Chesapeake Bay Model over the BMP Effectiveness Values document due to its deeper basis in science and evidentiary-based study, calling the latter method "outdated." An image of this reference is below:

The BMP effectiveness values (as presented in 3800-PM-BCW0200m) are being phased out by the Chesapeake Bay Program because they are outdated. They are, however, somewhat simpler to use than the expert panel reports, and for that reason DEP permits their use for PRPs and TMDL Plans for the 2018-2023 permit term. Permittees are cautioned that use of the expert panel reports frequently provides a small margin of additional load reduction. MS4s may use the effectiveness values in 3800-PM-BCW0200m for some BMPs and the expert panel reports for others. See the PRP Instructions and TMDL Plan Instructions for further details.

3. As seen in the FAQ #32 reference image in #2 above, PADEP recognizes that utilizing the Chesapeake Bay method usually provides additional sediment load reduction compared to utilizing PADEP's BMP effectiveness values. With this in mind, HRG is not concerned with the calculated sediment reduction values in this PRP. It appears these higher values are expected for basin retrofits.

4. The Chesapeake Bay expert panel method is more scientific and representative of true sediment-removal efficiencies relative to PADEP BMP effectiveness values. An image of the expert panel's introductory statement on this topic is below:

Given the diversity of possible retrofit applications, the Panel decided that assigning a single universal removal rate was not practical or scientifically defensible. Every retrofit is unique, depending on the drainage area it treats, the treatment mechanism employed, its volume or size and the antecedent degree of stormwater treatment, if any.

Instead, the Panel elected to develop a protocol whereby the removal rate for each individual retrofit project is determined based on the amount of runoff it treats and the degree of runoff reduction it provides. The Panel conducted an extensive review of recent BMP performance research and developed a series of retrofit removal adjustor curves to define sediment, nitrogen and phosphorus removal rates. The Panel then developed specific calculation methods tailored for different retrofit categories. To assist users, the Panel has included numerous design examples to illustrate how retrofit removal rates are calculated.

5. The Chesapeake Bay expert panel method accounts for discrepancies in tributary volume and treatment volume via the runoff depth treatment formula. For example, BMPs F1 and F2 only treat depths of 0.33 and 0.83 inches of runoff, respectively.

6. The Chesapeake Bay expert panel method accounts for hydrodynamic loading in the sediment removal curves.

7. Of the two provided sediment removal curves, the Runoff Reduction (RR) curve is applicable to the proposed basin retrofits due to the use of bioretention and infiltration practices as key components in the retrofit design.

8. The Chesapeake Bay expert panel method does not provide for a third sediment reduction factor beyond the runoff depth formula and sediment removal curves. With this in mind, HRG does not believe another should be included based on the tributary volume/treatment volume discrepancy, especially considering that discrepancy is already built into the two previous methods for determining sediment reduction efficiency (runoff depth formula, sediment removal curve).

9. The expert panel requires use of the entire drainage area to the BMP, not impervious area or tributary area ratios relative to tributary volume.

   The removal rates determined from the retrofit removal adjustor curves are applied to the entire drainage area of the retrofit, and not just its impervious acres. Also, the retrofit reporting unit is the entire treated area, regardless of whether it is pervious or impervious.

10. Guidance on how to calculate sediment removal efficiencies for this series of BMPs was given by PADEP in an email dated November 22, 2022 that mirrors HRG's methods. No further reductions in sediment-removal efficiency beyond those in the Chesapeake Bay expert panel were included in this guidance. An image of one of the examples in this email is below:

    BMP 2 – Option 1
    BMP 2 looks to be about twice the size of BMP 1 so I'll assume 2 ac-ft for that basin with the same percentage of impervious in the drainage area
    Runoff Depth Captured per impervious acre (in) = (2 ac-ft*12)/(395 ac *.4) = .15 in
    Using the RR curve you get 20% TSS efficiency
    Load to treat (395*.4*1839)+(395*.6*265) = 353,367 lb/yr *20% = 70,670 lb/yr (load reduction)

11. While *not* a requirement in the Chesapeake Bay expert panel report, HRG has voluntarily limited the proposed basin retrofits to a maximum 2' depth of treatment volume per the PADEP BMP manual in order to ensure long-term function of the basins.

12. HRG has combined both the Chesapeake Bay expert panel method and PADEP BMP effectiveness values for calculating sediment reduction in its PRP. The BMP effectiveness values, with a 20:1 infiltration area loading ratio cap, are only utilized for proposed basin retrofits that do not have preliminary designs available. This is because without at least preliminary designs, it is impossible to utilize the methods in the Chesapeake Bay expert panel to determine anticipated sediment reduction. However, for those proposed retrofits where preliminary and/or final design data is available, we have utilized the Chesapeake Bay expert panel methods. We are comfortable with this approach, as utilizing the 20:1 infiltration area loading ratio cap is very conservative relative to the Chesapeake Bay expert panel method, and once all basins are complete, we are confident that final sediment reduction values for the proposed retrofits will actually increase. Additionally, this approach is specifically allowed per FAQ #32, with an image of the reference below:

a small margin of additional load reduction. MS4s may use the effectiveness values in 3800-PM-BCW0200m for some BMPs and the expert panel reports for others. See the PRP Instructions and TMDL Plan Instructions for further details.

Basin Retrofit Function

Combining the design/construction methods HRG is proposing along with the calculation methods required in the Chesapeake Bay expert panel, the proposed basin retrofits will function as follows: precipitation, including the first flush volume that often contains the majority of suspended particulate in stormwater runoff, will enter the basin through various conveyance mechanisms. Large treatment volumes will be permanently retained in the basins due to new outlet structures being provided with approximately 2' of elevation difference between the basin bottom and primary discharge orifice. These large treatment volumes will permanently retain water, allowing sediment to settle. Further, these permanently-held treatment volumes will enhance water quality due to the encouragement of infiltration and evapotranspiration via amended soils and wetland plantings, respectively. Storage volumes above and beyond the treatment volume will then be held in the basins for extended durations relative to existing basin conditions. This will have the effect of encouraging further sediment reduction, infiltration, and evapotranspiration, as well as lowering rate and volume discharges from the retrofitted basins. Because total basin volumes will be greatly expanded in the retrofit process, all of this is possible with an equal or lower frequency of basin overtopping compared to existing conditions. Finally, O&M will be performed to ensure basin function, mainly consisting of removing accumulated sediment and potential long-term replacement of the amended soils should infiltration potential diminish.

We understand the hesitancy of PADEP in reviewing the proposed basin retrofits and the sediment reduction values being provided. Both the reduction values and the methods used to calculate them are different than the traditional way that PADEP has handled these sorts of calculations. With that in mind, we hope the above explanation has been helpful in assuaging any concerns the Department may have in its review. HRG has determined the sediment reduction values in the PRP in strict accordance with PADEP regulations and the Chesapeake Bay expert panel, and respectfully requests PRP approval as per PADEP's regulatory commitments regarding these methods.

Section F – Identify Funding Mechanisms

PA DEP Requirement: *"Applicants must identify all project sponsors and partners and probable funding sources for each BMP."*

Funding for the design and construction of the BMPs proposed herein will be funded through a variety of sources including the Township's General Fund, available grants, and public donation of materials and manpower. Additionally, the Township adopted a stormwater fee ordinance and credit policy in 2022. The fee is being collected from each developed parcel within Bethlehem Township and will be used to offset the Township's Stormwater Management costs.

Section G – Identify Responsible Parties for Operation and Maintenance (O&M) of BMPs

PA DEP Requirement: "Applicants must identify the following for each selected BMP:

- The party(ies) responsible for ongoing O&M;
- The activities involved with O&M for each BMP; and
- The frequency at which O&M activities will occur."

Once implemented, the BMPs outlined in this plan will be operated and maintained on a case-by case basis. If a property owner or Homeowner's Association (HOA) is responsible for O&M of the basin, the Township will ultimately have the responsibility should the property owner/HOA neglect to maintain the BMP so that it functions as designed. Bethlehem Township Staff will inspect all BMPs regularly to ensure that they continue to provide the expected pollutant reductions. The Operation and Maintenance (O&M) activities will be reported in the Annual MS4 Status Reports submitted in accordance with the Individual Permit. Projects located within private property will obtain an easement, if not already existing.

The Operation and Maintenance activities and schedule for each BMP will be developed during the design phase. A general summary of the O&M activities involved with each BMP type and the frequency at which O&M activities will occur are as follows:

Bioretention BMPs and Retrofits (Bioswales and Basin Retrofits)

Operation and maintenance requirements for the bioretention projects include:

- Ensure disturbed areas are kept free of foot and/or vehicular traffic until full stabilization has occurred. Properly designed and installed Bioretention areas require some regular maintenance.
- While vegetation is being established, pruning and weeding may be required.
- Detritus may also need to be removed every year. Perennial plantings may be cut down at the end of the growing season.
- Mulch should be re-spread when erosion is evident and be replenished as needed. Once every 2 to 3 years the entire area may require mulch replacement.
- Bioretention areas should be inspected at least two times per year for sediment buildup, erosion, vegetative conditions, etc.
- During periods of extended drought, Bioretention areas may require watering.
- Trees and shrubs should be inspected twice per year to evaluate health.

The contractor shall be responsible for the operation and maintenance of the bioretention basin until all features of the project have been successfully constructed to the specifications and design standards set forth by the Stormwater Engineer. The Contractor should provide a one-year 80% care and replacement warranty for all planting beginning after installation and inspection of all plants.

Once construction of the project(s) is complete, the Township shall be responsible for long term implementation of all Operation and Maintenance procedures to ensure the basin remains operationally functional and physically consistent with the original design.

Stream Restorations

Operation and maintenance requirements for the stream restoration projects include:

- Ensure disturbed areas are kept free of foot and/or vehicular traffic until full stabilization has occurred.

- Regular watering of plantings during the first growing season. Planting in the fall may reduce the need for additional watering.
- Conduct monthly site visits to ensure plantings are healthy and sufficiently watered, weeds are properly managed, sufficient mulch is in place until site is stabilized and plantings have become established.
- Conduct monthly site visits to ensure all disturbed earth remains stabilized and erosion or cutting of the streambank has not taken place. Any destabilized earth or active streambank erosion shall be repaired immediately upon discovery.
- 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 promote stabilization of the streambank and surrounding area.
- Replace mulch as needed.
- Remove accumulated trash and debris weekly.
- Remove and replace dead and diseased plantings annually.
- Keep machinery and vehicles away from stabilized areas.

The contractor shall be responsible for the operation and maintenance of the streambank restoration and buffer project(s) until all features of the project have been successfully constructed to the specifications and design standards set forth by the Stormwater Engineer. The Contractor shall remain responsible for operation and maintenance of the streambank restoration and buffer project(s) until 70% permanent stabilization has been achieved.

Once construction of the project(s) is complete and stabilization has occurred, the Township shall be responsible for long term implementation of all Operation and Maintenance procedures to ensure the streambank stabilization and buffer improvements remained operationally functional and physically consistent with the original design.

APPENDIX

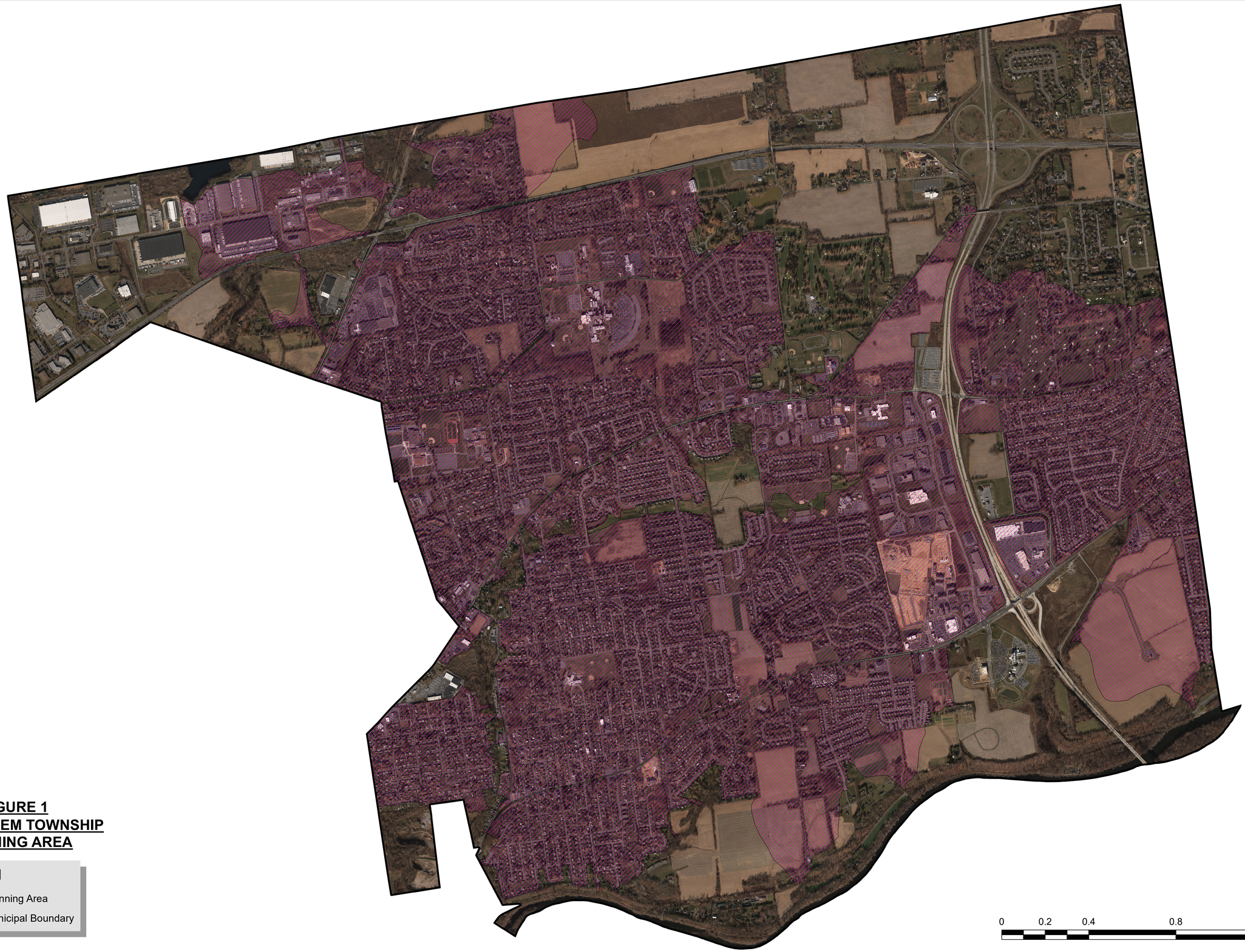


FIGURE 1
BETHLEHEM TOWNSHIP
PLANNING AREA

FIGURE 2
BETHLEHEM TOWNSHIP
EXISTING BMPS

Legend

- Existing BMPs
- Municipal Boundary
- Planning Area

Figure 3
Bethlehem Township
Proposed BMPs

Northampton County, Pennsylvania

F1 - East Blvd (East)
F2 - East Blvd (West)
F3 - East Blvd to Santee Swale
F4 - Apartment Basin
F5 - Santee Basin
F6 - Shelton Basin
F7 - Walnut Street Basin
F8 - Ebenezer Bible Basin
P1 - Bethlehem Municipal Park Bioswale(s)
P2 - Campbell Estates Basin #1
P3- Campbell Estates Basin #2
P4 - Washington St (Nancy Run Estates Ph 1) Basin
P5 - Washington Street (Walnut Hills) Basin
P6 - Long Court Basin
P7 - Country Top Trail Basin
P8 - Vintage Dr (The Vineyard at Wagner Farm) Basin
P9 - Miller Heights Elementary School Basin
P10 - PP&L Basin (Birch Drive)
P11 - Sculac Stream Restoration
P12 - Walnut Street Green Infrastructure Projects
P13 - Hannah's Lane (Hampton Meadows) Basin
P14 - Hannah's Lane (Hampton Meadows) Basin 2

LEHIGH VALLEY THRUWAY
GREEN POND RD
CHURCH RD
NULTON AV
NAZARETH PK
OAKLAND RD
EASTON AV
CHESTER RD
MACADA RD
BUTZTOWN RD
LINDEN ST
NORTH BL
STEFKO BL
PEMBROKE RD
WILLOW PARK RD
FREEMANSBURG AV
HOPE RD
RIVERSIDE DR
Nancy Run
Bull Run
Lehigh River

F1 F2 F3 F4 F5 F6 F7 F8
P1 P2 P3 P4 P5 P6 P7 P8 P9 P10 P11 P12 P13 P14

PRP Projects
Bethlehem Township
State Roads
Waterbody
Planning Area

1,500 0 1,500 Feet

Mapping derived from data provided by PennDOT, PEMA, USGS, and ESRI.

8/23/2022	PM: BRH	GIS: ALV	QA: TE	R008488.0428

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TABLE 5 - PA DEP MS4 REQUIREMENTS TABLE

MS4 Name	NPDES ID	Individual Permit Required?	Reason	Impaired Downstream Waters or Applicable TMDL Name	Requirement(s)	Other Cause(s) of Impairment
Northampton County						
ALLEN TWP	PAI132250	Yes	IP	Hokendauqua Creek	Appendix E-Siltation, Suspended Solids (5)	
				Dry Run	Appendix E-Siltation (5)	Water/Flow Variability (4c)
				Catasauqua Creek	Appendix E-Siltation (5)	
				Lehigh River	Appendix A-Metals (5), Appendix E-Organic Enrichment/Low D.O., Siltation, Suspended Solids (5)	
BANGOR BORO	PAG132249	No		Unnamed Tributaries to Martins Creek	Appendix E-Siltation (5)	Flow Alterations, Other Habitat Alterations (4c)
BATH BORO	PAI132215	Yes	SP, IP	East Branch Monocacy Creek	Appendix E-Siltation (5)	
				Monocacy Creek	Appendix E-Siltation (5)	Other Habitat Alterations (4c)
BETHLEHEM CITY	PAI132210	Yes	SP, IP	East Branch Saucon Creek	Appendix E-Siltation (5)	
				Saucon Creek	Appendix E-Siltation (5)	
				Monocacy Creek	Appendix E-Siltation (5)	Other Habitat Alterations (4c)
				Unnamed Tributaries to Lehigh Coal And Navigation Canal	Appendix E-Siltation (5)	Water/Flow Variability (4c)
				Lehigh River	Appendix C-PCB (5), Appendix E-Siltation, Suspended Solids, Organic Enrichment/Low D.O. (5)	
				Unnamed Tributaries to East Branch Saucon Creek		Other Habitat Alterations, Water/Flow Variability (4c)
BETHLEHEM TWP	PAI132214	Yes	SP, IP	Nancy Run	Appendix E-Siltation (5)	Water/Flow Variability (4c)
				Monocacy Creek	Appendix E-Siltation (5)	Other Habitat Alterations (4c)
				Delaware River		Mercury (5)
				Lehigh River	Appendix C-PCB (5), Appendix E-Organic Enrichment/Low D.O., Siltation, Suspended Solids (5)	
BUSHKILL TWP	PAI132219	Yes	SP, IP	Monocacy Creek	Appendix E-Siltation (5)	Other Habitat Alterations (4c)
				East Branch Monocacy Creek	Appendix E-Siltation (5)	
				Shoeneck Creek	Appendix E-Siltation (5)	Water/Flow Variability (4c)
				Bushkill Creek	Appendix B-Pathogens (5)	
CHAPMAN BORO	PAI132257*	Yes	SP, W-I	Monocacy Creek	Appendix E-Siltation (5)	Other Habitat Alterations (4c)
EAST ALLEN TWP	PAI132212	Yes	SP, IP	Unnamed Tributaries to Shoeneck Creek	Appendix E-Siltation (5)	Water/Flow Variability (4c)
				Monocacy Creek	Appendix E-Siltation (5)	Other Habitat Alterations (4c)
				Lehigh River	Appendix E-Organic Enrichment/Low D.O., Siltation, Suspended Solids (5)	
				East Branch Monocacy Creek	Appendix E-Siltation (5)	
				Catasauqua Creek	Appendix E-Siltation (5)	

TABLE 6 - BETHLEHEM TOWNSHIP - EXISTING STORMWATER MANAGEMENT BMPs

14-Mar-18

Id	Address	Description	Description of the BMP	Lattitue	Longitude	Impervious Area (acres)	Pervious Area (acres)	TSS Impervious Loading rate (lbs/ac/yr)	TSS Pervious Loading rate (lbs/ac/yr)	TSS lbs/year	BMP Effectiveness	Annual Credit (lbs/yr)
B1	4098 Freemansburg Avenue	Arden Courts of Old Orchard	Dry Detention Basin	40.656834	-75.275481	0.4	2.1	1,839.0	264.96	1,353.9	10.00%	135.4
B2	2388 Esquire Drive	Behind 3980 Danberry Drive	Dry Detention Basin	40.656004	-75.27318	18.2	32.9	1,839.0	264.96	42,285.9	10.00%	4,228.6
B3	3950 Danberry Drive	Rau lane and Esquire Drive	Dry Detention Basin	40.656701	-75.272348			1,839.0	264.96	0.0	10.00%	0.0
B4	Farmhouse Court North	Danberry Drive and Farmhouse Court N	Dry Detention Basin	40.658098	-75.271639	1.7	3.4	1,839.0	264.96	4,066.0	10.00%	406.6
B5	4169 Freemansburg Avenue	Behind 2854 Hodle Avenue	Dry Detention Basin	40.658361	-75.278907	98.3	316.1	1,839.0	264.96	264,459.6	10.00%	26,446.0
B6	1001 Illinois Street	next to 1010 Illinois Street	Dry Detention Basin	40.661825	-75.285736	7.6	10.2	1,839.0	264.96	16,678.8	10.00%	1,667.9
B7	4920 Bayard Street	behind 4920 Bayard Street	Dry Detention Basin	40.663835	-75.2874	1.1	1.8	1,839.0	264.96	2,532.7	10.00%	253.3
B8	1610 Sculac Drive	at intersection of Sculac Drive and Lehigh St	Dry Detention Basin	40.638681	-75.32242	1.4	2.1	1,839.0	264.96	3,044.7	10.00%	304.5
B9	2409 Emrick Boulevard	across from 2400 Emrick Boulevard	Wet Detention Basin	40.655117	-75.292257	11.2	21.4	1,839.0	264.96	26,302.3	60.00%	15,781.4
B10	Southmont Way	Between Southmont Way and Panera Br	Dry Detention Basin	40.654199	-75.286665	35.5	7.8	1,839.0	264.96	67,330.2	10.00%	6,733.0
B11	Southmont Way	between 33 and Southmont Way	Dry Detention Basin	40.653741	-75.287269			1,839.0	264.96	0.0	10.00%	0.0
B12	10th Street (3820 Tamarind Drive)	behind 3820 Tamarind Drive	Dry Detention Basin	40.658626	-75.32445	9.0	15.5	1,839.0	264.96	20,643.7	10.00%	2,064.4
B13	2951 10th Street	10th and Emerald Hills Greenway	Dry Detention Basin	40.657716	-75.324127	20.1	56.6	1,839.0	264.96	51,889.0	10.00%	5,188.9
B14	2701 Baglyos Circle	behind 2701 Baglyos Circle	Dry Detention Basin	40.661169	-75.300344	0.1	2.5	1,839.0	264.96	784.6	10.00%	78.5
B15	2978 Emrick Boulevard	btwn 3000 and 2800 Emrick Blvd	Wet Detention Basin	40.663519	-75.293688	16.4	18.9	1,839.0	264.96	35,155.9	60.00%	21,093.5
B16	2781 Baglyos Circle	south of 2801 Baglyos Curcke	Wet Detention Basin	40.662448	-75.299621	48.4	62.6	1,839.0	264.96	105,580.1	60.00%	63,348.0
B17	3158 Meyer Lane	Farmersville Elementary School	Dry Detention Basin	40.664571	-75.300487	2.4	4.7	1,839.0	264.96	5,743.9	10.00%	574.4
B18	Meyer Lane	North Side Athletic Complex	Dry Detention Basin	40.661668	-75.301518	3.9	9.8	1,839.0	264.96	9,776.3	10.00%	977.6
B19	4567 Falmer Drive	Penske Truck Rental	Dry Detention Basin	40.664783	-75.304095	3.8	2.4	1,839.0	264.96	7,624.9	10.00%	762.5
B20	4548 Falmer Drive	Budget Store and Lock	Dry Detention Basin	40.663615	-75.304682	5.1	6.2	1,839.0	264.96	11,044.3	10.00%	1,104.4
B21	2900 Farmersville Road	Bethlehem Twp Community Center	Dry Detention Basin	40.660379	-75.301884	5.4	3.8	1,839.0	264.96	10,854.2	10.00%	1,085.4
B22	4440 Easton Avenue	Sunocoa Gas station	Dry Detention Basin	40.666335	-75.308372	0.5	0.1	1,839.0	264.96	1,038.1	10.00%	103.8
B23	4530 Falmer Drive	Township Yard Waste	Wet Detention Basin	40.664419	-75.30832	2.2	1.2	1,839.0	264.96	4,441.6	60.00%	2,665.0
B24	110 Clubhouse Drive	Campbell Estates	Dry Detention Basin	40.669484	-75.313605	0.9	65.9	1,839.0	264.96	19,115.1	10.00%	1,911.5
B25	4390 Anthony Court	Campbell Estates	Dry Detention Basin	40.672914	-75.309528	20.6	30.2	1,839.0	264.96	45,820.6	10.00%	4,582.1
B26	104 Colonial Court	Farmersville Rd and King Charles Blvd	Dry Detention Basin	40.670793	-75.307566	1.1	3.1	1,839.0	264.96	2,925.0	10.00%	292.5
B27	Bedford Drive	between 4241 and 4227 Bedford Drive	Dry Detention Basin	40.668842	-75.311155	12.1	15.1	1,839.0	264.96	26,236.9	10.00%	2,623.7
B28	Founders Court	center island	Dry Detention Basin	40.66962	-75.309574	1.5	0.9	1,839.0	264.96	2,957.0	10.00%	295.7
B29	2479 Brodhead Road	Rahns Concrete	Underground Dry Detention Basin	40.679569	-75.358335	1.7	0.1	1,839.0	264.96	3,077.8	10.00%	307.8
B30	Preakness Place (Highland Park Ph 1)	between 5012 and 5020 Preakness Place	Dry Detention Basin	40.656693	-75.305136	5.9	8.7	1,839.0	264.96	13,147.3	10.00%	1,314.7
B31	Derby Lane (Highland Park Ph 3)	between 5001 and 5009 Derby Lane	Dry Detention Basin	40.65827	-75.303933	4.0	5.0	1,839.0	264.96	8,601.2	10.00%	860.1
B32	5053 Derby Lane	Highland Park Phase 2	Dry Detention Basin	40.657839	-75.307939	3.2	5.0	1,839.0	264.96	7,176.3	10.00%	717.6
B33	4185 Walter Road	Towns at Highland Park	Dry Detention Basin	40.659039	-75.310591	5.2	7.5	1,839.0	264.96	11,496.6	10.00%	1,149.7
B34	4173 Sapphire Lane	Emerald Hills Phase 10	Dry Detention Basin	40.658697	-75.314369	7.5	10.3	1,839.0	264.96	16,476.8	10.00%	1,647.7
B35	4035 Galway Drive	Emerald Hills Phase 9	Dry Detention Basin	40.659047	-75.319145	5.7	9.3	1,839.0	264.96	12,868.8	10.00%	1,286.9
B36	3535 Orth Street	Bethlehem Twp Physical Plant	Dry Detention Basin	40.656607	-75.32925	0.6	0.5	1,839.0	264.96	1,161.6	10.00%	116.2
B37	Carter Republic Road (Hampton Meadows)	across from 3915 Carter Republic Road	Dry Detention Basin	40.652583	-75.321313	2.2	3.3	1,839.0	264.96	4,963.3	10.00%	496.3
B38	Carter Road and Saphire Lane	next to 2602 Sapphire Lane	Dry Detention Basin	40.65405	-75.31423	12.7	16.3	1,839.0	264.96	27,611.3	10.00%	2,761.1
B39	Washington St (Nancy Run Estates Ph 1)	Washington Street and Oliver Court	Dry Detention Basin	40.651749	-75.314752	19.5	35.2	1,839.0	264.96	45,287.9	10.00%	4,528.8
B40	Fourteenth Street (Hampton Meadows)	between 2180 and 2220 14th Street	Dry Detention Basin	40.649549	-75.31915	4.5	4.4	1,839.0	264.96	9,527.8	10.00%	952.8
B41	Hannah's Lane (Hampton Meadows)	across from 2298 Hannah's Lane	Dry Detention Basin	40.649621	-75.322443	6.9	9.4	1,839.0	264.96	15,186.1	10.00%	1,518.6
B42	Hannah's Lane (Hampton Meadows)	across from 2182 Hannah's Lane	Dry Detention Basin	40.648088	-75.322151	1.8	2.1	1,839.0	264.96	3,830.6	10.00%	383.1
B43	3605 Allen Street	Miller Height Elementary School	Dry Detention Basin	40.647915	-75.32493	0.5	1.3	1,839.0	264.96	1,218.8	10.00%	121.9
B44	Hilltop Circle	behind 4355 Hilltop Circle	Dry Detention Basin	40.645471	-75.310454	2.9	7.3	1,839.0	264.96	7,312.6	10.00%	731.3
B45	Washington Street (Walnut Hills)	Washington St and Freemansburg Ave	Dry Detention Basin	40.646382	-75.314993	32.6	65.8	1,839.0	264.96	77,359.9	10.00%	7,736.0
B46	Vintage Dr (The Vineyard at Wagner Farm)	behind 1827 Chianti Court	Dry Detention Basin	40.646922	-75.305012	15.2	31.3	1,839.0	264.96	36,312.7	10.00%	3,631.3
B47	5050 Freemansburg Avenue	next to CVS	Dry Detention Basin	40.648815	-75.300475	10.1	25.6	1,839.0	264.96	25,265.2	10.00%	2,526.5
B48	5022 fremansburg Avenue	CVS	Underground Dry Detention Basin	40.648572	-75.2996			1,839.0	264.96	0.0	10.00%	0.0
B49	Chateau Place (The Vineyard at Wagner F)	behind 1805 Chateau Place	Dry Detention Basin	40.644515	-75.300049	21.7	31.7	1,839.0	264.96	48,255.5	10.00%	4,825.5
B50	Freemansburg Avenue	behind 5232 Freemansburg Avenue	Dry Detention Basin	40.647604	-75.305842	0.2	0.7	1,839.0	264.96	514.7	10.00%	51.5
B51	Long Drive	Long Drive and Country Top Trail	Dry Detention Basin	40.653913	-75.306232	14.5	21.9	1,839.0	264.96	32,456.6	10.00%	3,245.7
B52	Long Court	between 4820 and 4825 Long Court	Dry Detention Basin	40.653395	-75.303049	23.2	59.8	1,839.0	264.96	58,431.8	10.00%	5,843.2
B53	5284 Freemansburg Avenue	Wolfe Dental Spa	Underground Infiltraton basin	40.647688	-75.307585	0.0	0.8	1,839.0	264.96	295.1	95.00%	280.4
B54	Country Top Trail	next to 5094 Country Top Trail	Dry Detention Basin	40.649345	-75.304605	25.1	52.6	1,839.0	264.96	60,023.2	10.00%	6,002.3
B55	Freemansburg Avenue	behind 2100 Emrick Boulevard	Dry Detention Basin	40.65296	-75.289191	10.8	9.2	1,839.0	264.96	22,335.2	10.00%	2,233.5
B56	3564 Easton Avenue	Nancy Run Fire	Dry Detention Basin	40.658496	-75.329198	0.4	1.1	1,839.0	264.96	1,057.3	10.00%	105.7
B57	Scherman Blvd (Emerald Hills Phase 1)	Scherman Blvd and Tamarind Drive	Dry Detention Basin	40.659731	-75.321742	23.9	34.6	1,839.0	264.96	53,131.8	10.00%	5,313.2
B58	4108 Scherman Blvd	Emerald Hills Phase 7	Dry Detention Basin	40.660287	-75.316227	12.3	23.4	1,839.0	264.96	28,748.0	10.00%	2,874.8
B59	Embur Terrace	behind 4338 Embur Terrace	Dry Detention Basin	40.661164	-75.27554	0.5	1.5	1,839.0	264.96	1,385.0	10.00%	138.5
B60	4500 Falmer Drive	The Goddard School	Dry Detention Basin	40.664218	-75.306944	0.9	0.4	1,839.0	264.96	1,786.7	10.00%	178.7

Id	Address	Description	Description of the BMP	Lattitue	Longitude	Impervious Area (acres)	Pervious Area (acres)	TSS Impervious Loading rate (lbs/ac/yr)	TSS Pervious Loading rate (lbs/ac/yr)	TSS lbs/year	BMP Effectiveness	Annual Credit (lbs/yr)
B61	4470 Easton Avenue	Capis Hand Car Wash	Underground Dry Detention Basin	40.665741	-75.308323	1.1	0.1	1,839.0	264.96	2,109.3	10.00%	210.9
B62	Willow Park Road	next to 2416 Willow Park Road	Dry Detention Basin	40.650831	-75.332354	9.4	17.9	1,839.0	264.96	21,957.9	10.00%	2,195.8
B63	Williams Avenue	between 2116 and 2118 Williams Avenue	Dry Detention Basin	40.646732	-75.334824	0.8	1.4	1,839.0	264.96	1,771.8	10.00%	177.2
B64	3050 Easton Avenue	Aldi (behind the buidling)	Dry Detention Basin	40.650772	-75.335463	0.1	0.0	1,839.0	264.96	253.3	10.00%	25.3
B65	3050 Easton Avenue	Aldi (along Easton Avenue)	Dry Detention Basin	40.651151	-75.33697	3.3	1.0	1,839.0	264.96	6,297.8	10.00%	629.8
B66	4300 William Penn Highway	First Commonwealth Federal Credit Union	Extended Dry Detention Basin	40.668907	-75.275444	1.4	20.9	1,839.0	264.96	8,091.7	60.00%	4,855.0
B67	Farmersville Road	behind 4421 Anthony Drive	Dry Detention Basin	40.676817	-75.308609	1.5	6.3	1,839.0	264.96	4,477.7	10.00%	447.8
B68	4313 Green Pond Road (baseball fields)	Moravian Academy Athletic and Wellness	Extended Dry Detention Basin	40.681342	-75.317213	8.6	24.7	1,839.0	264.96	22,285.7	60.00%	13,371.4
B69	3868 Hecktown Road	NCC	Dry Detention Basin	40.676211	-75.328268	2.6	2.1	1,839.0	264.96	5,359.6	10.00%	536.0
B70	3827 Greenpond Road	NCC	Dry Detention Basin	40.674823	-75.327876	0.9	1.5	1,839.0	264.96	2,070.6	10.00%	207.1
B71	3881 Greenpond Road	NCC	Infiltration Basin	40.675038	-75.327054	0.6	1.1	1,839.0	264.96	1,391.4	95.00%	1,321.8
B72	3997 Greenpond Road	NCC	Dry Detention Basin	40.675776	-75.323588	1.4	3.6	1,839.0	264.96	3,575.6	10.00%	357.6
B73	4017 Greenpond Road	Country Meadows	Dry Detention Basin	40.675451	-75.322371	8.5	18.8	1,839.0	264.96	20,555.6	10.00%	2,055.6
B74	4123 Greenpond Road	Country Meadows	Dry Detention Basin	40.675343	-75.31913	2.3	6.4	1,839.0	264.96	5,832.9	10.00%	583.3
B75	4018 Greenpond Road	NCC	Dry Detention Basin	40.674682	-75.323685	1.4	0.8	1,839.0	264.96	2,739.4	10.00%	273.9
B76	4032 Greenpond Road	NCC	Dry Detention Basin	40.67387	-75.322705	0.0	0.9	1,839.0	264.96	322.5	10.00%	32.2
B77	Greenpond Road (next to College Center)	NCC	Dry Detention Basin	40.672578	-75.325675	4.4	4.9	1,839.0	264.96	9,430.4	10.00%	943.0
B78	Greenpond Road (north end)	NCC	Infiltration Basin	40.670514	-75.320738	0.3	0.2	1,839.0	264.96	648.2	95.00%	615.8
B79	Greenpond Road (north end)	NCC	Infiltration Basin	40.670105	-75.321895	1.3	0.5	1,839.0	264.96	2,449.4	95.00%	2,327.0
B80	Greenpond Road (Commonwealth Hall)	NCC	Dry Detention Basin	40.670413	-75.32393	2.0	12.5	1,839.0	264.96	7,036.8	10.00%	703.7
B81	3839 Easton Avenue	Margle Law Offices	Extended Dry Detention Basin	40.663176	-75.323867	0.3	1.1	1,839.0	264.96	920.4	60.00%	552.2
B82	3439 Shelton Ave	Rolling Greens Subdivision	Dry Detention Basin	40.661605	-75.32789	43.6	76.6	1,839.0	264.96	100,408.7	10.00%	10,040.9
B83	3100 Hecktown Road	Ebenezer Bible Fellowship Church	Dry Detention Basin	40.660434	-75.329439	3.5	2.3	1,839.0	264.96	7,120.8	10.00%	712.1
B84	3301 Easton Avenue	Lafayette Ambassador Bank	Dry Detention Basin	40.655053	-75.33488	0.3	0.7	1,839.0	264.96	703.5	10.00%	70.4
B85	2739 Santee Road	Bethlehem Township Storage	Dry Detention Basin	40.65435	-75.335953	1.6	2.2	1,839.0	264.96	3,489.2	10.00%	348.9
B86	3247 Wimmer Road	Wright Veterinary Medical Center	Underground Extended Dry Detention	40.653814	-75.336731	1.4	1.3	1,839.0	264.96	2,863.8	60.00%	1,718.3
B87	3173 Rachel Drive	Behind Townhomes on Rachel Drive	Dry Detention Basin	40.657064	-75.336657	0.3	0.5	1,839.0	264.96	623.5	10.00%	62.3
B88	3229 Santee Rd	Our Lady Of Perpetual Help RCC	Dry Detention Basin	40.659853	-75.338555	5.4	8.9	1,839.0	264.96	12,342.7	10.00%	1,234.3
B89	3495 Lafayette Drive	College View West Subdivision	Dry Detention Basin	40.667522	-75.332391	6.9	11.6	1,839.0	264.96	15,782.2	10.00%	1,578.2
B90	3224 Oakland Square Drive	Oakland Square Condominiums	Dry Detention Basin	40.667258	-75.333421	3.5	5.0	1,839.0	264.96	7,798.9	10.00%	779.9
B91	3280 Oakland Square Drive	Oakland Square Condominiums	Dry Detention Basin	40.666657	-75.339133	4.6	8.9	1,839.0	264.96	10,805.5	10.00%	1,080.6
B92	3001 Gloucester Drive	At end of Gloucester Drive	Wet Detention Basin	40.675702	-75.340553	0.0	0.6	1,839.0	264.96	162.7	60.00%	97.6
B93	Canterbury Road	Millstone 1 Condominiums	Dry Detention Basin	40.67171	-75.330212	6.6	10.0	1,839.0	264.96	14,827.1	10.00%	1,482.7
B94	3701 Amherst Court	Millstone 1 Condominiums	Dry Detention Basin	40.674118	-75.330492	0.4	0.5	1,839.0	264.96	896.0	10.00%	89.6
B95	3602 Manor Road	Brodhead Manor Subdivision	Dry Detention Basin	40.683268	-75.337055	4.6	10.0	1,839.0	264.96	11,120.5	10.00%	1,112.1
B96	4046 Cottage Lane	Brodhead Manor Subdivision	Dry Detention Basin	40.682193	-75.331965	6.0	15.6	1,839.0	264.96	15,098.1	10.00%	1,509.8
B97	3386 Brodhead Road	Lehigh Valley Church of Christ	Dry Detention Basin	40.679838	-75.336427	0.1	0.9	1,839.0	264.96	422.1	10.00%	42.2
B98	201 Drift Court	Valley Ambulatory Surgical Center	Dry Detention Basin	40.677379	-75.34004	0.5	0.5	1,839.0	264.96	959.5	10.00%	95.9
B99	3926 Linden Street	Bethlehem Square Shopping Center	Dry Detention Basin	40.675668	-75.343757	30.7	4.1	1,839.0	264.96	57,569.0	10.00%	5,756.9
B100	3838 Linden Street	Burger King	Dry Detention Basin	40.673808	-75.345138	1.1	0.4	1,839.0	264.96	2,224.6	10.00%	222.5
B101	3810 Linden Street	Applebee's	Dry Detention Basin	40.673119	-75.345398	1.2	0.3	1,839.0	264.96	2,365.1	10.00%	236.5
B102	3648 Linden Street	Bethlehem Village Shoppes	Dry Detention Basin	40.67009	-75.345955	5.5	16.0	1,839.0	264.96	14,361.3	10.00%	1,436.1
B103	3811 Christian Springs Road	Housenick Park	Infiltraton basin	40.673263	-75.351669	0.1	3.4	1,839.0	264.96	1,158.3	95.00%	1,100.3
B104	2564 Brodhead Road	Behind Leading Edge Martial Arts	Dry Detention Basin	40.676844	-75.356211	36.2	27.9	1,839.0	264.96	74,018.4	10.00%	7,401.8
B105	4016 Christian Springs Road	WoodSpring Suites Allentown	Underground Extended Dry Detention	40.677764	-75.349526	2.9	1.0	1,839.0	264.96	5,571.1	60.00%	3,342.7
B106	2736 Brodhead Road	Versalift	Dry Detention Basin	40.678976	-75.349322	4.2	1.5	1,839.0	264.96	8,100.0	10.00%	810.0
B107	4230 Fritch Drive	Human vs Room Escape Room	Dry Detention Basin	40.682053	-75.343813	2.1	4.1	1,839.0	264.96	4,870.1	10.00%	487.0
B108	4229 Fritch Drive	SiteOne Landscape Supply	Dry Detention Basin	40.681884	-75.345334	0.6	1.6	1,839.0	264.96	1,497.2	10.00%	149.7
B109	4219 Fritch Drive	Roadmasters Driving School	Dry Detention Basin	40.682626	-75.345415	0.6	0.3	1,839.0	264.96	1,117.1	10.00%	111.7
B110	4211 Tracy Lane	JOAO & BRADLEY	Dry Detention Basin	40.681699	-75.348848	0.9	0.0	1,839.0	264.96	1,721.7	10.00%	172.2
B111	2645 Brodhead Road	Bethlehem Crossings 2	Dry Detention Basin	40.680168	-75.353549	23.4	7.4	1,839.0	264.96	44,935.5	10.00%	4,493.5
B112	2617 Brodhead Road	Bethlehem Crossings 1	Dry Detention Basin	40.680029	-75.355464			1,839.0	264.96	0.0	10.00%	0.0
											Total Annual Credit =	**308,788.8**

Sample Calculation for existing basin B2

Impervious Area that drains to existing basin B2 x Impervious Loading rate = 18.2 acres x 1,839.0 lbs/acre/year = 33,560.2 lbs

Pervious Area that drains to existing basin B2 x Pervious Loading rate = 32.9 acres x 264.96 lbs/acre/year = 8,725.7 lbs

Total Sediment Load that drains to existing basin B2 = 33,560.2 + 8,725.7 = 42,285.9 lbs/year of sediment

The amount of sediment that existing basin B2 'captures' per year = total sediment to existing basin B2 x the BMP effectiveness for a 'dry detention basin' (10%) = 42,285.9 lbs/year x 0.10 = 4,228.6 lbs/year

Therefore, the total sediment load credit that existing basin B2 provides per year = 4,228.6 lbs/year

Bethlehem Township - Table 7a. Proposed BMPs (BMP ID order)

BMP ID	BMP	Size (acre - unless noted otherwise)	Drainage Area (acre)	Drainage Area 20/1 Ratio (acre)	Drainage Area Characteristics				Loading Rate TSS (lb/ac/yr)		Total Load TSS (lb/yr)	Load from Previous BMP in Series (lb/yr)	BMP Efficiency (Existing)	BMP Efficiency (Proposed)	BMP Efficiency (Credited)	Load Reduction TSS (lbs/yr)	Load to next BMP in series (lbs/yr)	Notes
					% Imperv.	% Pervious	Imperv. (acres)	Pervious (acres)	Imperv.	Pervious								
F1	East Blvd Basin (East) Assumed Credit	2.0	414.1	N/A	40%	60%	165.64	248.46	1839.00	264.96	370,444	0	0%	47%	47%	87,054	196,335	Joint Project with Bethlehem City; 50% total credit assumed. (See note 3) Expert Panel Guidance Used
F1	East Blvd Basin (East) Potential Additional Credit	2.0	414.1	N/A	40%	60%	165.64	248.46	1839.00	264.96	370,444	0	0%	47%	47%	87,054	196,335	Joint Project with Bethlehem City; remaining 50% total credit to be negotiated. (See note 3) Expert Panel Guidance Used
F2	East Blvd Basin (West) Assumed Credit	1.5	40.0	N/A	40%	60%	16.00	24.01	1839.00	264.96	35,792	0	0%	66%	66%	11,811	12,169	Joint Project with Bethlehem City; 50% total credit assumed. (See note 3) Expert Panel Guidance Used
F2	East Blvd Basin (West) Potential Additional Credit	1.5	40.0	N/A	40%	60%	16.00	24.01	1839.00	264.96	35,792	0	0%	66%	66%	11,811	12,169	Joint Project with Bethlehem City; remaining 50% total credit to be negotiated (See note 3)
F3	Swale to Santee Basin Assumed Credit	1.8	169.1	36.8	40%	60%	14.72	22.08	1839.00	264.96	32,920	0	50%	80%	30%	4,938	6,584	Joint Project with Bethlehem City; 50% total credit assumed. (See note 3)
F3	Swale to Santee Basin Potential Additional Credit	1.8	169.1	36.8	40%	60%	14.72	22.08	1839.00	264.96	32,920	0	50%	80%	30%	4,938	6,584	Joint Project with Bethlehem City; remaining 50% total credit to be negotiated. (See note 3)
F4	Apartment Basin (Johnston Drive)	0.6	21.7	N/A	34%	66%	7.37	14.31	1839.00	264.96	17,347	0	0%	77%	81%	14,051	3,990	Expert Panel Guidance Used
F5	Santee Basin	0.6	13.7	N/A	34%	66%	4.64	9.02	1839.00	264.96	10,930	0	0%	47%	49%	5,356	5,793	Expert Panel Guidance Used
F6	Shelton Basin	2.1	121.2	N/A	34%	66%	41.19	79.97	1839.00	264.96	96,944	0	0%	56%	56%	54,289	42,655	Expert Panel Guidance Used
F7	Walnut Street Basin	2.0	98.3	40.8	34%	66%	13.87	26.93	1839.00	264.96	32,645	0	0%	80%	80%	26,116	6,529	PADEP BMP Effectiveness Values (3800-PM-BCW0100m)
F8	Ebenezer Bible Basin	1.0	4.3	4.3	34%	66%	1.47	2.86	1839.00	264.96	3,462	0	0%	90%	90%	3,116	346	Expert Panel Guidance Used
P1	Bethlehem Municipal Park Bioswale(s)	3.0	112.8	60.0	34%	66%	20.40	39.60	1839.00	264.96	48,008	0	50%	80%	30%	14,402	9,602	PADEP BMP Effectiveness Values (3800-PM-BCW0100m)
P2	Campbell Estates Basin #1	3.6	69.2	69.2	34%	66%	23.53	45.68	1839.00	264.96	55,380	0	10%	80%	70%	38,766	11,076	PADEP BMP Effectiveness Values (3800-PM-BCW0100m)
P3	Campbell Estates Basin #2	1.7	75.2	33.4	34%	66%	11.35	22.03	1839.00	264.96	26,705	0	10%	80%	70%	18,694	5,341	PADEP BMP Effectiveness Values (3800-PM-BCW0100m)
P4	Washington St (Nancy Run Estates Ph 1) Basin	2.2	92.0	N/A	34%	66%	31.29	60.74	1839.00	264.96	73,636	0	0%	63%	66%	48,600	27,245	Expert Panel Guidance Used
P5	Washington Street (Walnut Hills) Basin	2.1	97.8	N/A	34%	66%	33.26	64.57	1839.00	264.96	78,277	27,245	0%	57%	57%	60,148	45,375	Expert Panel Guidance Used
P6	Long Court Basin	2.7	135.2	N/A	34%	66%	45.97	89.23	1839.00	264.96	108,178	0	0%	64%	69%	74,643	38,944	Expert Panel Guidance Used
P7	Country Top Trail Basin	3.5	73.7	69.8	34%	66%	23.74	46.09	1839.00	264.96	55,877	0	10%	80%	70%	39,114	11,175	PADEP BMP Effectiveness Values (3800-PM-BCW0100m)
P8	Vintage Dr (The Vineyard at Wagner Farm) Basin	2.2	43.5	N/A	34%	66%	14.79	28.72	1839.00	264.96	34,814	0	0%	83%	87%	30,288	5,918	Expert Panel Guidance Used
P9	Miller Heights Elementary School Basin	1.0	20.5	20.0	34%	66%	6.97	13.53	1839.00	264.96	16,403	0	0%	80%	80%	13,122	3,281	PADEP BMP Effectiveness Values (3800-PM-BCW0100m)
P10	PP&L Basin (Birch Drive)	0.6	31.7	12.0	34%	66%	10.78	20.94	1839.00	264.96	25,380	0	0%	80%	80%	20,304	5,076	PADEP BMP Effectiveness Values (3800-PM-BCW0100m)
P11	Sculac Stream Restoration	1,700 ft	N/A	N/A	34%	66%	N/A	N/A	1839.00	264.96	N/A	0	N/A	N/A	44.88lbs/ft	76,296	N/A	PADEP BMP Effectiveness Values (3800-PM-BCW0100m)
P12	Green Infrastructure Projects (Walnut St)	0.2	8.38	3.8	34%	66%	2.85	5.53	1839.00	264.96	6,705	0	0%	80%	80%	5,364	1,341	PADEP BMP Effectiveness Values (3800-PM-BCW0100m)
P13	Hannah's Lane (Hampton Meadows) Basin	0.3	13.6	7.0	34%	66%	2.36	4.59	1839.00	264.96	5,566	0	10%	80%	70%	3,896	1,113	PADEP BMP Effectiveness Values (3800-PM-BCW0100m)
P14	Hannah's Lane (Hampton Meadows) Basin 2	0.2	7.1	4.0	34%	66%	1.36	2.64	1839.00	264.96	3,201	0	10%	80%	70%	2,240	640	PADEP BMP Effectiveness Values (3800-PM-BCW0100m)
	Total															**750,276.16**		

Note 1: Not all proposed BMPs will be built this permit cycle to comply with the required TSS Load Reduction. Alternatives have been provided to allow flexibility in BMP selection. Basins were designed in accordance with guidance from the "Expert Panel to Define Removal Rates for Urban Stormwater Retrofit Projects" to be classified as BMP conversions. The retrofits include amended soils, wetland plantings, grading modifications, and modification/replacement of the existing outlet structures. The retrofits designs allow for the projects to be classified as providing Runoff Reduction (RR) and to use the (RR) curve on the "Sediment Removal for RR and ST Stormwater Retrofit Practices" curve.

Note 2: Project values calculated using the PADEP BMP Effectiveness Values have not been designed. Without a design, the Expert Panel Guidance could not be used. A conservative loading ratio was used for these projects to ensure no overprojection of loads. These values will be updated via minor amendment utilizing the Expert Panel Guidance if and when final designs are completed.

Note 3: Projects listed as assumed or potential additional credit show 50% of total calculated sediment reduction. Projects listed as "Potential Additional" to be negotiated with Bethlehem City as part of the collabrative project.

Note 4: Projects labeled with "F" BMP IDs are labeled as such due to being upstream of severe flooding locations; projects labeled with "P" BMP IDs are not. There is no functional or technical difference in design or calculation methodology. Labels differences are for internal identification purposes only.

Required TSS Load Reduction	376,250.30
Total Project List	750,276.16
Difference	374,025.86

Bethlehem Township - Table 7b. Proposed BMPs (priority order)

Priority Ranking	BMP ID	BMP	Size (acre - unless noted otherwise)	Drainage Area (acre)	Drainage Area 20/1 Ratio (acre)	Drainage Area Characteristics				Loading Rate TSS (lb/ac/yr)		Total Load TSS (lb/yr)	Load from Previous BMP in Series (lb/yr)	BMP Efficiency (Existing)	BMP Efficiency (Proposed)	BMP Efficiency (Credited)	Load Reduction TSS (lbs/yr)	Load to next BMP in series (lbs/yr)	Notes
						% Imperv.	% Pervious	Imperv. (acres)	Pervious (acres)	Imperv.	Pervious								
Primary	F1	East Blvd Basin (East) Assumed Credit	2.0	414.1	N/A	40%	60%	165.64	248.46	1839.00	264.96	370,444	0	0%	47%	47%	87,054	196,335	Joint Project with Bethlehem City; 50% total credit assumed. (See note 3) Expert Panel Guidance Used
Primary	F2	East Blvd Basin (West) Assumed Credit	1.5	40.0	N/A	40%	60%	16.00	24.01	1839.00	264.96	35,792	0	0%	66%	66%	11,811	12,169	Joint Project with Bethlehem City; 50% total credit assumed. (See note 3) Expert Panel Guidance Used
Primary	F4	Apartment Basin (Johnston Drive)	0.6	21.7	N/A	34%	66%	7.37	14.31	1839.00	264.96	17,347	0	0%	77%	81%	14,051	3,990	Expert Panel Guidance Used
Primary	F5	Santee Basin	0.6	13.7	N/A	34%	66%	4.64	9.02	1839.00	264.96	10,930	0	0%	47%	49%	5,356	5,793	Expert Panel Guidance Used
Primary	F6	Shelton Basin	2.1	121.2	N/A	34%	66%	41.19	79.97	1839.00	264.96	96,944	0	0%	56%	56%	54,289	42,655	Expert Panel Guidance Used
Primary	P1	Bethlehem Municipal Park Bioswale(s)	3.0	112.8	60.0	34%	66%	20.40	39.60	1839.00	264.96	48,008	0	50%	80%	30%	14,402	9,602	PADEP BMP Effectiveness Values (3800-PM-BCW0100m)
Primary	P4	Washington St (Nancy Run Estates Ph 1) Basin	2.2	92.0	N/A	34%	66%	31.29	60.74	1839.00	264.96	73,636	0	0%	63%	66%	48,600	27,245	Expert Panel Guidance Used
Primary	P5	Washington Street (Walnut Hills) Basin	2.1	97.8	N/A	34%	66%	33.26	64.57	1839.00	264.96	78,277	27,245	0%	57%	57%	60,148	45,375	Expert Panel Guidance Used
Primary	P6	Long Court Basin	2.7	135.2	N/A	34%	66%	45.97	89.23	1839.00	264.96	108,178	0	0%	64%	69%	74,643	38,944	Expert Panel Guidance Used
Primary	P7	Country Top Trail Basin	3.5	73.7	69.8	34%	66%	23.74	46.09	1839.00	264.96	55,877	0	10%	80%	70%	39,114	11,175	PADEP BMP Effectiveness Values (3800-PM-BCW0100m)
Primary	P8	Vintage Dr (The Vineyard at Wagner Farm) Basin	2.2	43.5	N/A	34%	66%	14.79	28.72	1839.00	264.96	34,814	0	0%	83%	87%	30,288	5,918	Expert Panel Guidance Used
Primary	P11	Sculac Stream Restoration	1,700 lf	N/A	N/A	34%	66%	N/A	N/A	1839.00	264.96	N/A	0	N/A	N/A	44.88lbs/ft	76,296	N/A	PADEP BMP Effectiveness Values (3800-PM-BCW0100m)
Secondary	F1	East Blvd Basin (East) Potential Additional Credit	2.0	414.1	N/A	40%	60%	165.64	248.46	1839.00	264.96	370,444	0	0%	47%	47%	87,054	196,335	Joint Project with Bethlehem City; remaining 50% total credit to be negotiated. (See note 3) Expert Panel Guidance Used
Secondary	F2	East Blvd Basin (West) Potential Additional Credit	1.5	40.0	N/A	40%	60%	16.00	24.01	1839.00	264.96	35,792	0	0%	66%	66%	11,811	12,169	Joint Project with Bethlehem City; remaining 50% total credit to be negotiated (See note 3)
Secondary	F3	Swale to Santee Basin Assumed Credit	1.8	169.1	36.8	40%	60%	14.72	22.08	1839.00	264.96	32,920	0	50%	80%	30%	4,938	6,584	Joint Project with Bethlehem City; 50% total credit assumed. (See note 3)
Secondary	F3	Swale to Santee Basin Potential Additional Credit	1.8	169.1	36.8	40%	60%	14.72	22.08	1839.00	264.96	32,920	0	50%	80%	30%	4,938	6,584	Joint Project with Bethlehem City; remaining 50% total credit to be negotiated. (See note 3)
Secondary	F7	Walnut Street Basin	2.0	98.3	40.8	34%	66%	13.87	26.93	1839.00	264.96	32,645	0	0%	80%	80%	26,116	6,529	PADEP BMP Effectiveness Values (3800-PM-BCW0100m)
Secondary	F8	Ebenezer Bible Basin	1.0	4.3	4.3	34%	66%	1.47	2.86	1839.00	264.96	3,462	0	0%	90%	90%	3,116	346	Expert Panel Guidance Used
Secondary	P2	Campbell Estates Basin #1	3.6	69.2	69.2	34%	66%	23.53	45.68	1839.00	264.96	55,380	0	10%	80%	70%	38,766	11,076	PADEP BMP Effectiveness Values (3800-PM-BCW0100m)
Secondary	P3	Campbell Estates Basin #2	1.7	75.2	33.4	34%	66%	11.35	22.03	1839.00	264.96	26,705	0	10%	80%	70%	18,694	5,341	PADEP BMP Effectiveness Values (3800-PM-BCW0100m)
Secondary	P9	Miller Heights Elementary School Basin	1.0	20.5	20.0	34%	66%	6.97	13.53	1839.00	264.96	16,403	0	0%	80%	80%	13,122	3,281	PADEP BMP Effectiveness Values (3800-PM-BCW0100m)
Secondary	P10	PP&L Basin (Birch Drive)	0.6	31.7	12.0	34%	66%	10.78	20.94	1839.00	264.96	25,380	0	0%	80%	80%	20,304	5,076	PADEP BMP Effectiveness Values (3800-PM-BCW0100m)
Secondary	P12	Green Infrastructure Projects (Walnut St)	0.2	8.38	3.8	34%	66%	2.85	5.53	1839.00	264.96	6,705	0	0%	80%	80%	5,364	1,341	PADEP BMP Effectiveness Values (3800-PM-BCW0100m)
Secondary	P13	Hannah's Lane (Hampton Meadows) Basin	0.3	13.6	7.0	34%	66%	2.36	4.59	1839.00	264.96	5,566	0	10%	80%	70%	3,896	1,113	PADEP BMP Effectiveness Values (3800-PM-BCW0100m)
Secondary	P14	Hannah's Lane (Hampton Meadows) Basin 2	0.2	7.1	4.0	34%	66%	1.36	2.64	1839.00	264.96	3,201	0	10%	80%	70%	2,240	640	PADEP BMP Effectiveness Values (3800-PM-BCW0100m)
		Total															**750,276.16**		

Note 1: Not all proposed BMPs will be built this permit cycle to comply with the required TSS Load Reduction. Alternatives have been provided to allow flexibility in BMP selection. Basins were designed in accordance with guidance from the “Expert Panel to Define Removal Rates for Urban Stormwater Retrofit Projects” to be classified as BMP conversions. The retrofits include amended soils, wetland plantings, grading modifications, and modification/replacement of the existing outlet structures. The retrofits designs allow for the projects to be classified as providing Runoff Reduction (RR) and to use the (RR) curve on the “Sediment Removal for RR and ST Stormwater Retrofit Practices” curve.

Note 2: Project values calculated using the PADEP BMP Effectiveness Values have not been designed. Without a design, the Expert Panel Guidance could not be used. A conservative loading ratio was used for these projects to ensure no overprojection of loads. These values will be updated via minor amendment utilizing the Expert Panel Guidance if and when final designs are completed.

Note 3: Projects listed as assumed or potential additional credit show 50% of total calculated sediment reduction. Projects listed as "Potential Additional" to be negotiated with Bethlehem City as part of the collabrative project.

Note 4: Projects labeled with "F" BMP IDs are labeled as such due to being upstream of severe flooding locations; projects labeled with "P" BMP IDs are not. There is no functional or technical difference in design or calculation methodology. Labels differences are for internal identification purposes only.

Required TSS Load Reduction	376,250.30
Total Project List	750,276.16
Difference	374,025.86

Bethlehem Township - Table 8. Added/Removed/Retained Proposed BMPs

Oringinal PRP BMP ID	Amended PRP BMP ID	BMP	Added/Removed	Reason for Removal From PRP	Primary / Secondary*	Retrofit / New BMP
N/A	F1	East Blvd Basin (East) Assumed Credit	Added	N/A	Primary	Retrofit
N/A	F1	East Blvd Basin (East) Potential Credit	Added	N/A	Secondary	Retrofit
N/A	F2	East Blvd Basin (West) Assumed Credit	Added	N/A	Primary	Retrofit
N/A	F2	East Blvd Basin (West) Potential Credit	Added	N/A	Secondary	Retrofit
N/A	F3	Swale to Santee Basin Assumed Credit	Added	N/A	Secondary	Retrofit
N/A	F3	Swale to Santee Basin Potential Credit	Added	N/A	Secondary	Retrofit
N/A	F4	Apartment Basin (Johnston Drive)	Added	N/A	Primary	New BMP
N/A	F5	Santee Basin	Added	N/A	Primary	Retrofit
N/A	F6	Shelton Basin	Added	N/A	Primary	Retrofit
N/A	F7	Walnut Street Basin	Added	N/A	Secondary	New BMP
N/A	F8	Ebenezer Bible Basin	Added	N/A	Secondary	Retrofit
N/A	P1	Bethlehem Municipal Park Bioswale(s)	Added	N/A	Primary	Retrofit
P5	P2	Campbell Estates Basin #1	Carryover	N/A	Secondary	Retrofit
P6	P3	Campbell Estates Basin #2	Carryover	N/A	Secondary	Retrofit
P13	P4	Washington St (Nancy Run Estates Ph 1) Basin	Carryover	N/A	Primary	Retrofit
P17	P5	Washington Street (Walnut Hills) Basin	Carryover	N/A	Primary	Retrofit
P19	P6	Long Court Basin	Carryover	N/A	Primary	Retrofit
N/A	P7	Country Top Trail Basin	Added	N/A	Primary	Retrofit
P18	P8	Vintage Dr (The Vineyard at Wagner Farm) Basin	Carryover	N/A	Primary	Retrofit
N/A	P9	Miller Heights Elementary School Basin	Added	N/A	Secondary	New BMP
N/A	P10	PP&L Basin (Birch Drive)	Added	N/A	Secondary	New BMP
N/A	P11	Sculac Stream Restoration	Added	N/A	Primary	N/A
N/A	P12	Green Infrastructure Projects (Walnut St)	Added	N/A	Secondary	New BMP
P15	P13	Hannah's Lane (Hampton Meadows) Basin	Carryover	N/A	Secondary	Retrofit
P16	P14	Hannah's Lane (Hampton Meadows) Basin 2	Carryover	N/A	Secondary	Retrofit
P1	N/A	Vacuum 340 existing inlets (avg DA = .5 ac/inlet)	Removed	Concerns with realized sediment removal amounts	N/A	N/A
P2	N/A	B2 New Orchard Estates Basin	Removed	Retaining walls around basin edges - constructability concerns	N/A	N/A
P3	N/A	B3 New Orchard Estates Basin	Removed	Retaining walls around basin edges - constructability concerns	N/A	N/A
P4	N/A	B21 BTCC Basin	Removed	$/lb of sediment removal concerns	N/A	N/A
P7	N/A	B30 Highland Park Phase 1 Basin	Removed	$/lb of sediment removal concerns	N/A	N/A
P8	N/A	B31 Highland Park Phase 3 Basin	Removed	$/lb of sediment removal concerns	N/A	N/A
P9	N/A	B32 Highland Park Phase 2 Basin	Removed	$/lb of sediment removal concerns	N/A	N/A
P10	N/A	B34 Emerald Hills Phase 10 Basin	Removed	$/lb of sediment removal concerns	N/A	N/A
P11	N/A	B35 Emerald Hills Phase 9 Basin	Removed	$/lb of sediment removal concerns	N/A	N/A
P12	N/A	B37 Hampton Meadows Basin	Removed	$/lb of sediment removal concerns	N/A	N/A
P14	N/A	B40 Fourteenth Street (Hampton Meadows) Basin	Removed	$/lb of sediment removal concerns	N/A	N/A

*Primary Projects are anticipated to be completed by Summer 2024

Southern Drainage Area Existing Conditions

Bethlehem Township
Northampton County, PA

- Watershed Boundary
- Bethlehem Twp Parcels
- Stormwater Gravity Mains
- Sculac Study Channel
- Open Channels
- Existing Basins
- Sanitary Sewers
- Township Boundary

Karst Features

- Sinkhole
- Surface Depression

N

0 140 280 560 US Feet

Mapping derived from data provided by ESRI, PennDOT, and USGS.

5/21/2023	PM: XXX	GIS: XXX	QA: XXX	R002309.0477

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

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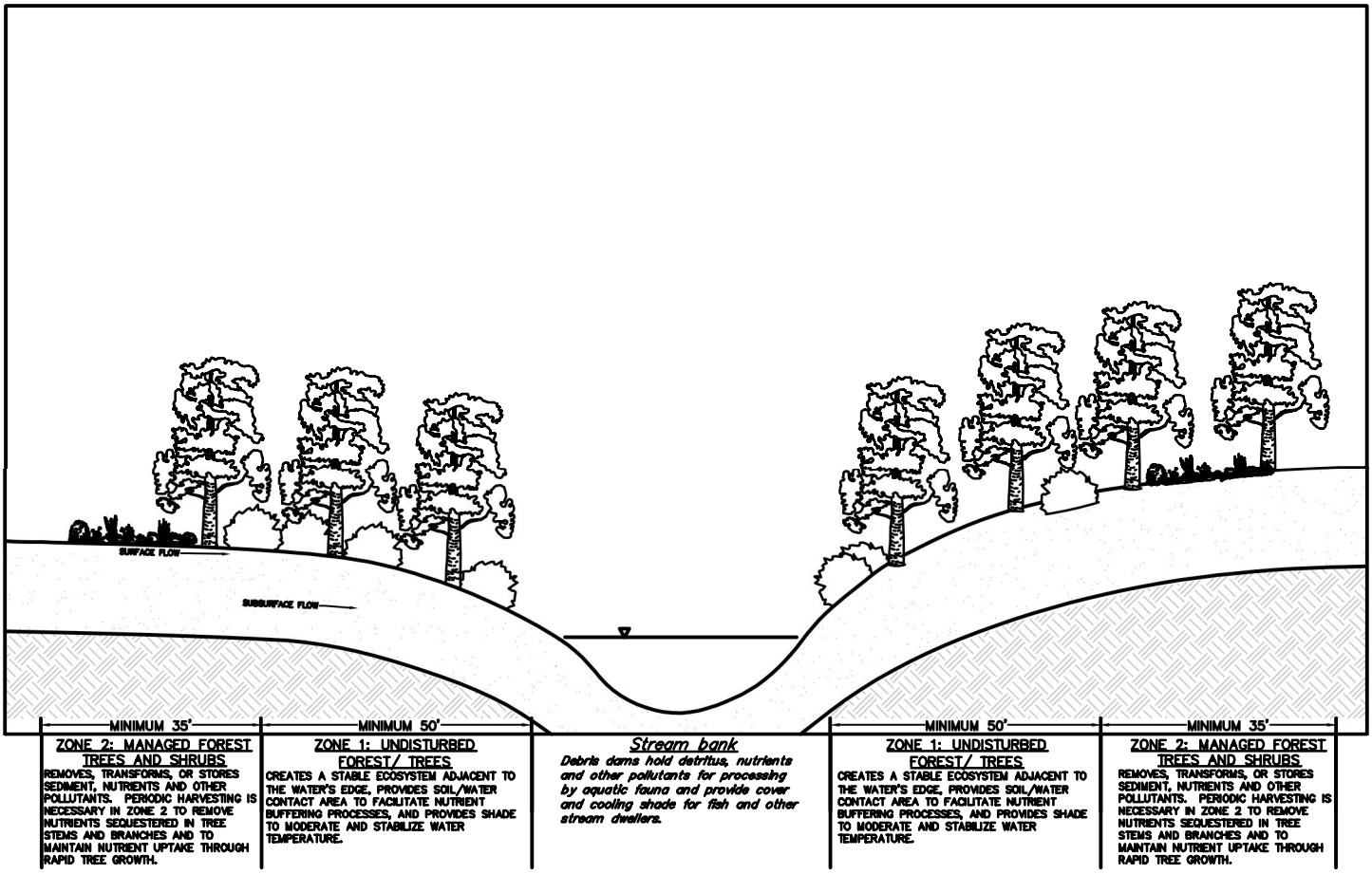

TYPICAL RIPARIAN BUFFER DETAIL

NOT TO SCALE

NOTES:

1. THE AVERAGE MINIMUM RIPERIAN FOREST BUFFER WIDTH RECOMMENDED BY PADEP IS TO BE 100 FEET (50 FEET ZONE 1 AND 50 FEET ZONE 2). ACCORDING TO THE MOST RECENT CHESAPEAKE BAY EXPERT REVIEW PANEL (RECOMMENDATION OF THE EXPERT PANEL TO REASSESS REMOVAL RATES FOR RIPARIAN FOREST AND GRASS BUFFER BET MANAGEMENT PRACTICES, OCTOBER 2014), THE BUFFER WIDTH REQUIRED TO RECEIVE CREDIT IS 35 FEET.
2. THE RIPERIAN FOREST BUFFER MANAGEMENT PLAN SHALL CONSIST OF THE FOLLOWING:
   - 2.A. A PLANTING PLAN FOR CONVERTED OR NEWLY ESTABLISHED RIPARIAN FOREST BUFFERS THAT IDENTIFIES THE NUMBER, DENSITY AND SPECIES OF NATIVE TREES AND SHRUBS APPROPRIATE TO A GEOGRAPHIC LOCATION THAT WILL ACHIEVE 60% UNIFORM CANOPY COVER.
   - 2.B. A MAINTENANCE SCHEDULE AND MEASURES FOR CONVERTED OR NEWLY ESTABLISHED RIPARIAN FOREST BUFFERS TO ENSURE SURVIVAL AND GROWTH OF PLANTINGS AND PROTECTION FROM COMPETING PLANTS AND ANIMALS INCLUDING NOXIOUS WEEDS AND INVASIVE SPECIES OVER A FIVE YEAR ESTABLISHMENT PERIOD INCLUDING ACTIVITIES OR PRACTICES USED TO MAINTAIN THE RIPARIAN FOREST BUFFER INCLUDING THE DISTURBANCE OF EXISTING VEGETATION, TREE REMOVAL, SHRUB REMOVAL, CLEARING, MOWING, BURNING OR SPRAYING IN ACCORDANCE WITH LONG TERM OPERATION AND MAINTENANCE.
   - 2.C. AN INSPECTION SCHEDULE AND MEASURES TO ENSURE LONG TERM MAINTENANCE AND PROPER FUNCTIONING OF RIPARIAN FOREST BUFFERS INCLUDING MEASURES TO REPAIR DAMAGE TO THE BUFFER FROM STORM EVENTS GREATER THAN THE 2 YEAR/ 24 HOUR STORM.

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hrg@hrg-inc.com
www.hrg-inc.com

RIPARIAN BUFFER DETAIL FOR

COST ESTIMATION

XX TOWNSHIP XX COUNTY PENNSYLVANIA

PROJ. MGR. – ***	DRAWING NO. DT
DESIGN– ***	
CADD– ***	
CHECKED– ***	SHEET NO. 1 OF 1
SCALE– NOT TO SCALE	
DATE– XX–XX–2017	PROJECT ***

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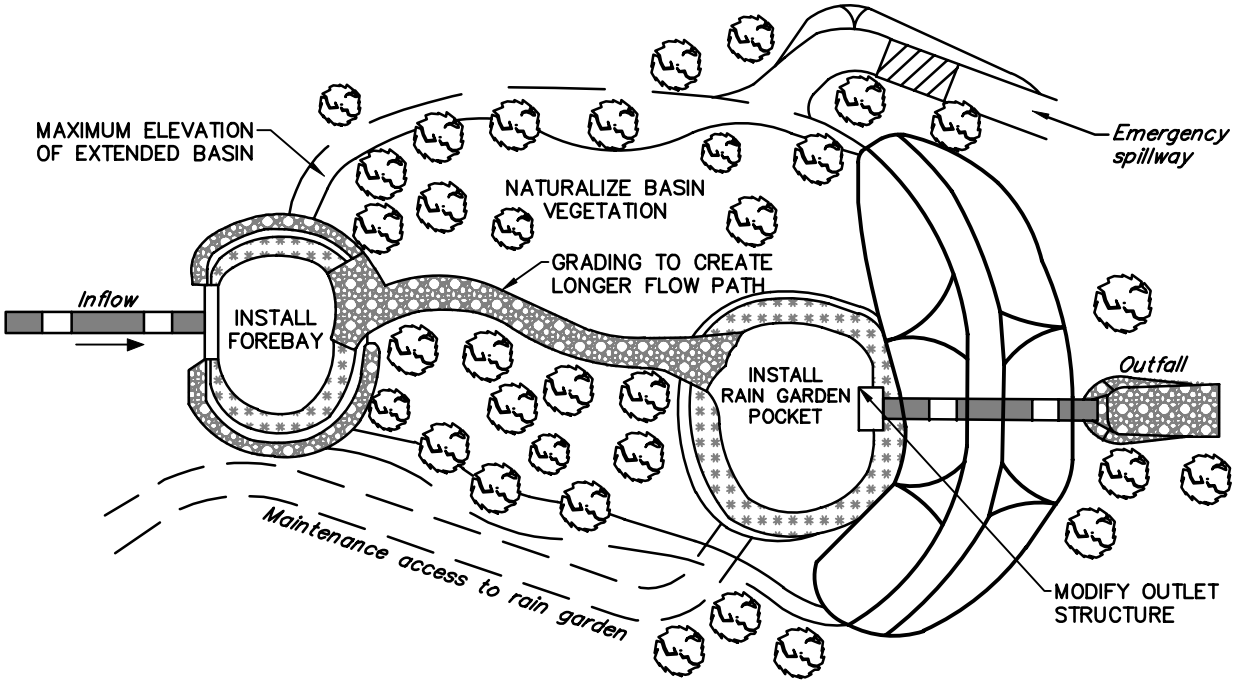

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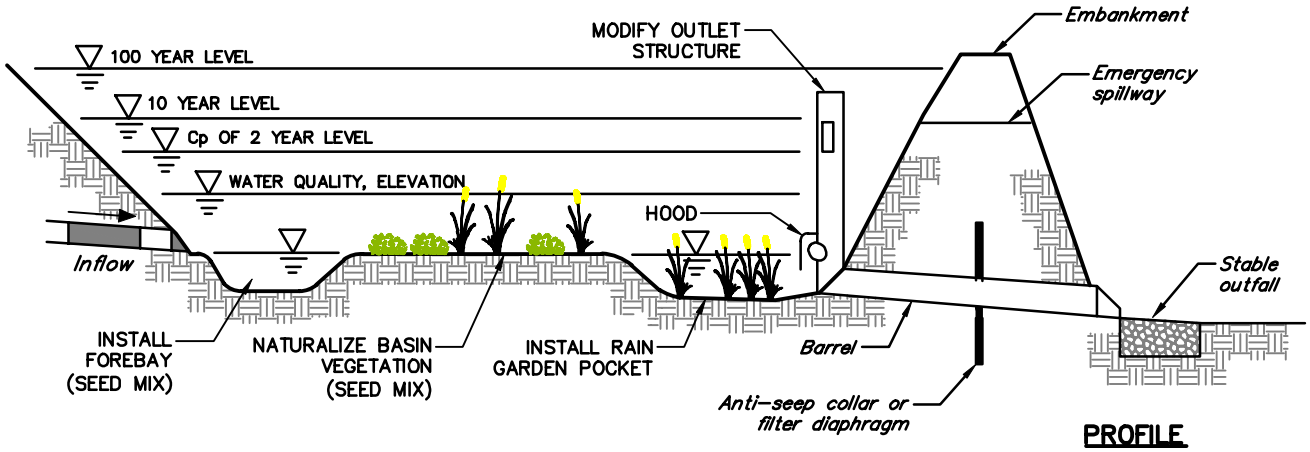

PROFILE

TYPICAL BASIN RETROFIT DETAIL

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BASIN RETROFIT DETAIL
FOR

COST ESTIMATION

XX TOWNSHIP XX COUNTY PENNSYLVANIA

PROJ. MGR. – ***	
DESIGN– ***	
CADD– ***	
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SCALE– NOT TO SCALE	
DATE– XX–XX–2017	

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SHEET NO. 1 OF 1

PROJECT ***

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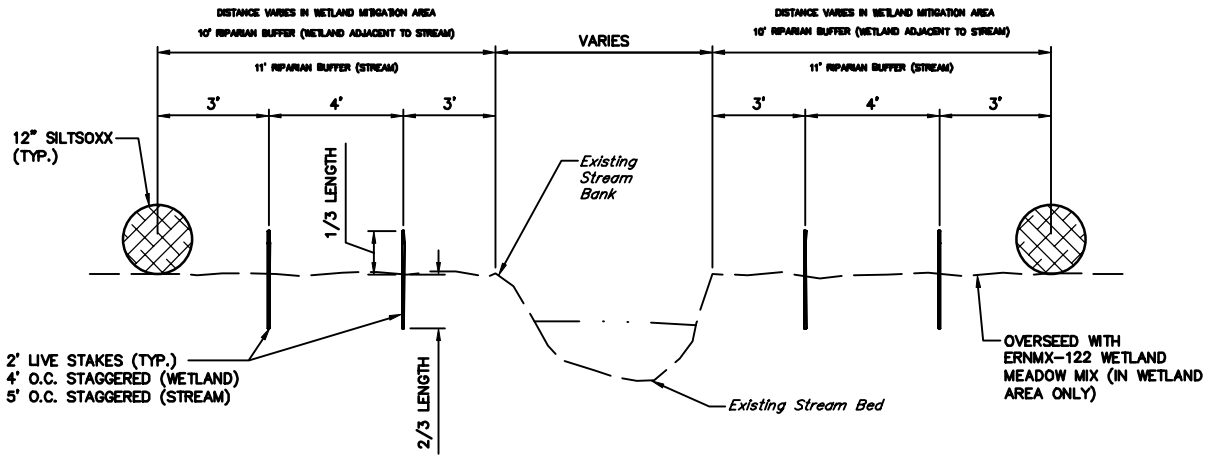

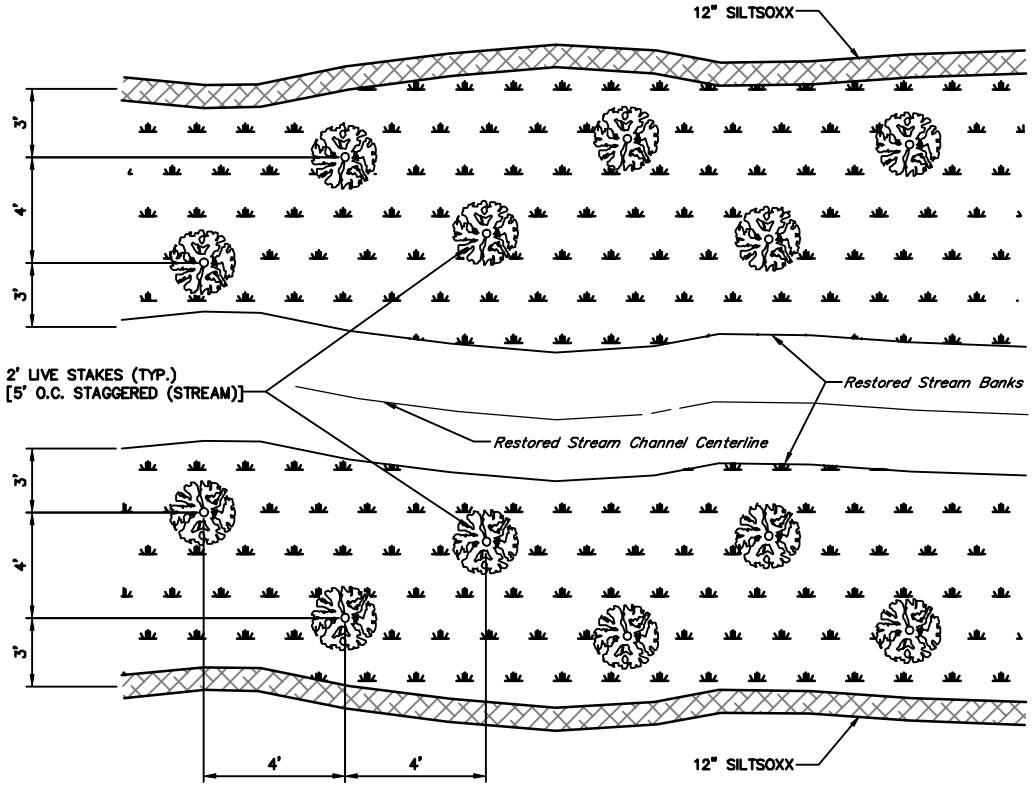

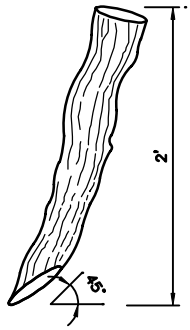

WETLAND AND STREAM LIVE STAKE SIZE AND SHAPE

TYPICAL STREAMSIDE WETLAND RESTORATION

NOT TO SCALE

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WETLAND RESTORATION DETAIL
FOR

COST ESTIMATION

XX TOWNSHIP XX COUNTY PENNSYLVANIA

PROJ. MGR. – ***	
DESIGN– ***	
CADD– ***	
CHECKED– ***	
SCALE– NOT TO SCALE	
DATE– XX-XX-2017	

DRAWING NO. DT-1

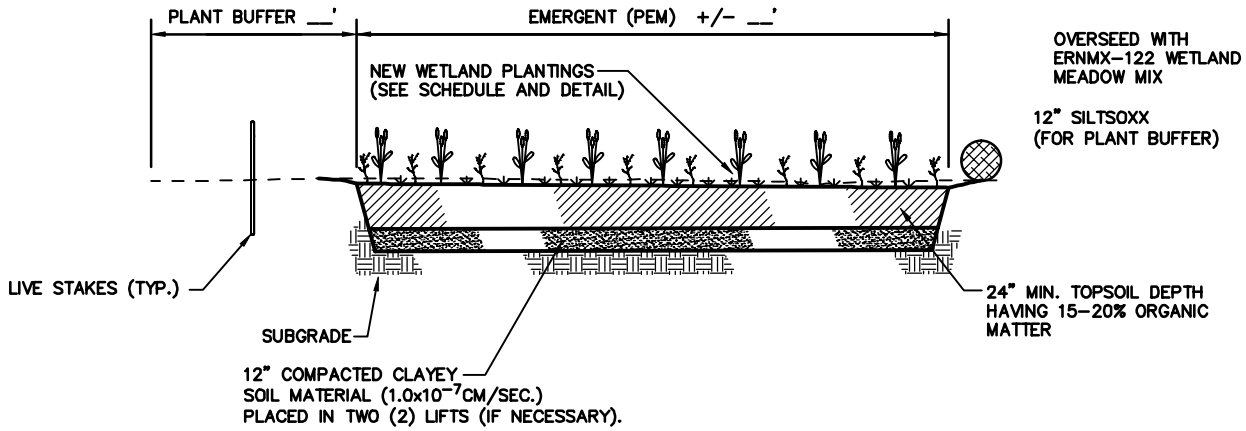
SHEET NO. 1 OF 2

PROJECT ***

SHRUBS					
QTY. (WETLAND)	QTY. (STREAM)	BOTANICAL NAME	COMMON NAME	PLANTING INTERVAL (WETLAND)	PLANTING INTERVAL (STREAM)
XX	XX	Cephalanthus occidentalis	BUTTONBUSH	4 FT. O/C, STAGGERED	5 FT. O/C, STAGGERED
XX	XX	Cornus stolonifera	RED OSIER DOGWOOD	4 FT. O/C, STAGGERED	5 FT. O/C, STAGGERED
XX	XX	Viburnum dentatum	ARROW-WOOD	4 FT. O/C, STAGGERED	5 FT. O/C, STAGGERED
XX	XX	Sambucus canadensis	ELDERBERRY	4 FT. O/C, STAGGERED	5 FT. O/C, STAGGERED
XX	XX	Cornus amomum	SILKY DOGWOOD	4 FT. O/C, STAGGERED	5 FT. O/C, STAGGERED
XX	XX	Salix purpurea	STREAMCO WILLOW	4 FT. O/C, STAGGERED	5 FT. O/C, STAGGERED
TOTAL=XXX	TOTAL=XXX	*SCHEDULE DOES NOT INCLUDE LIVE STAKES FOR COIR ROLL			

WETLAND AND STREAM SHRUB PLANTING SCHEDULE FOR LIVE STAKES*

FACW WETLAND MEADOW MIX (ERNMX-122)		
20.00%	Carex vulpinoidea	Fox Sedge
20.00%	Elymus virginicus	Virginia Wild Rye
6.00%	Verbena hastata	Blue Vervain
5.00%	Carex lurida	Lurid (Shallow) Sedge
5.00%	Carex scoparia	Blunt Broom Sedge
5.00%	Scirpus atrovirens	Green Bulrush
4.00%	Helliopsis helianthoides	Ox Eye Sunflower/False
3.00%	Eupatorium fistulosum	Joe Pye Weed
3.00%	Eupatorium perfoliatum	Boneset
3.00%	Glyceria grandis	American Mannagrass
3.00%	Juncus effusus	Soft Rush
3.00%	Onoclea sensibilis	Sensitive Fern
2.00%	Carex comosa	Cosmos (Bristly) Sedge
2.00%	Carex lupulina	Hop Sedge
2.00%	Eupatorium maculatum	Spotted Joe Pye Weed
2.00%	Juncus tenuis, PA Ecotype	Path Rush, PA Ecotype
2.00%	Mimulus ringens	Square Stemmed Monkey Flower
2.00%	Scirpus polyphyllus	Many Leaved Bulrush
2.00%	Vernonia gigantea	Giant Ironweed
1.00%	Carex stipata	Awl Sedge
1.00%	Carex tribuloides	Bristlebract Sedge
1.00%	Euthamia graminifolia	Grass Leaved Goldenrod
1.00%	Geum laciniatum	Rough Avens
1.00%	Glyceria canadensis	Rattlesnake Grass
1.00%	Ludwigia alternifolia	Seedbox
SEEDING RATE: 15 LB PER ACRE, OR 1/3 - 1/2 LB PER 1,000 SQ. FT.		



TYPICAL WETLAND CROSS SECTION

NOT TO SCALE

HRG
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www.hrg-inc.com

WETLAND RESTORATION DETAIL
FOR

COST ESTIMATION

XX TOWNSHIP XX COUNTY PENNSYLVANIA

PROJ. MGR. - ***	
DESIGN- ***	
CADD- ***	
CHECKED- ***	
SCALE- NOT TO SCALE	
DATE- XX-XX-2017	

DRAWING NO.
DT-2

SHEET NO.
2 OF 2

PROJECT ***

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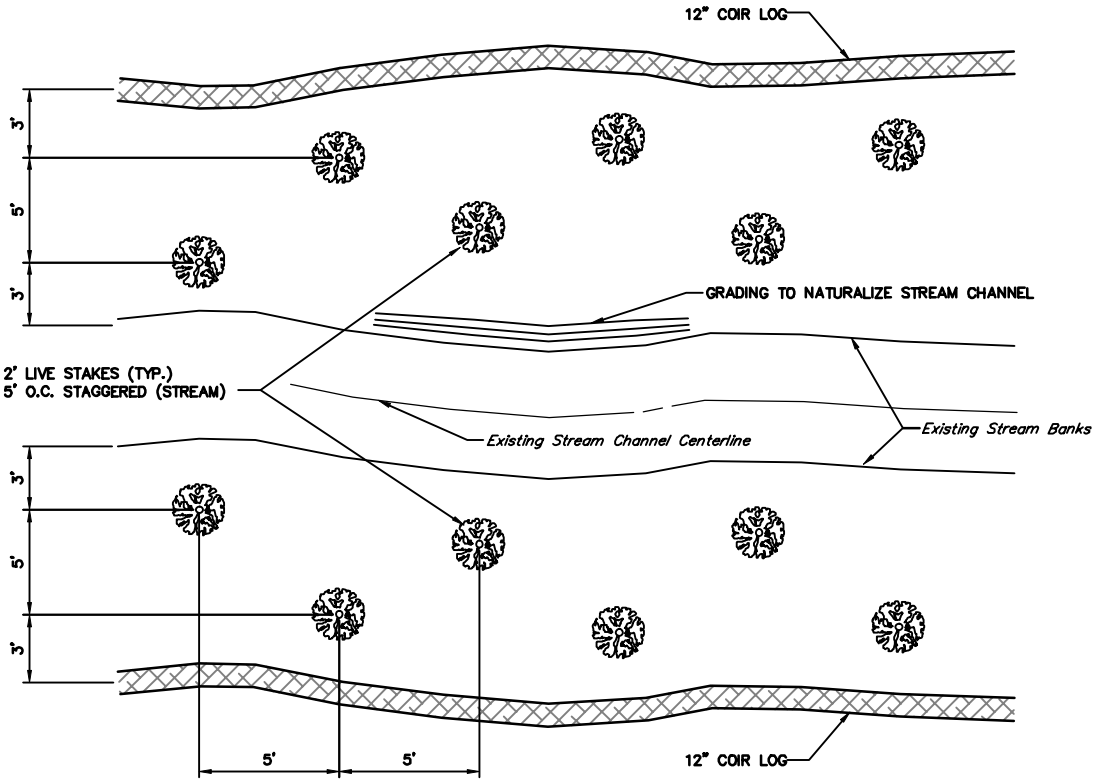
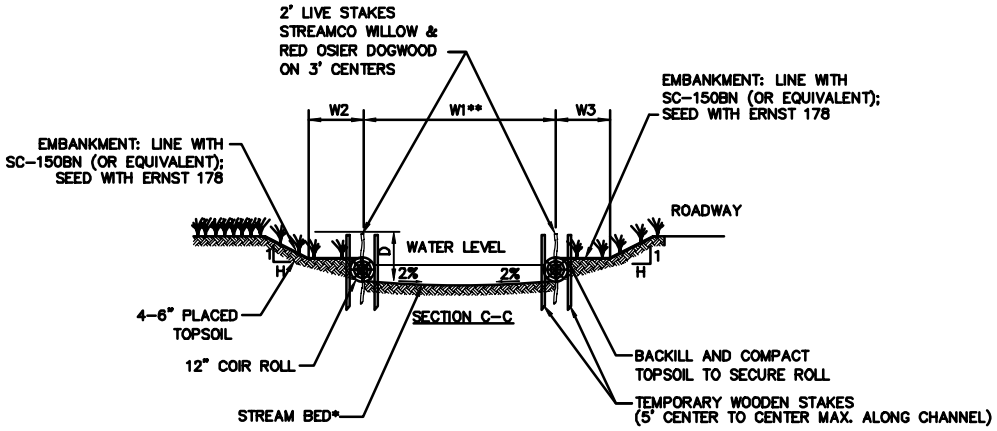


TYPICAL STREAM RESTORATION CONFIGURATION DETAIL

NOT TO SCALE



SWALE NO.	WIDTH W1**	WIDTH W2	WIDTH W3	DEPTH D	LONGITUDINAL SLOPE (%)	SIDE SLOPE H
STREAM	5	3	4	VARIES	VARIES (SEE DR-03)	VARIES (SEE DR-04)

*STREAM BED TO BE EXCAVATED TO PROPOSED GRADE. DO NOT OVER EXCAVATE. IF ANY GRADE ADJUSTMENT IS NEEDED, USE ONLY NATIVE TOPSOIL AND R-4 EQUIVALENT NATIVE COBBLES) MIXTURE.

**INSTALL COIR ROLL AT 5' WIDTH CENTER TO CENTER, RESULTING IN AN APPROXIMATE 4' NORMAL WIDTH CHANNEL

TYPICAL STREAM SECTION (LOOKING DOWNSTREAM)

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STREAM RESTORATION DETAIL
FOR

COST ESTIMATION

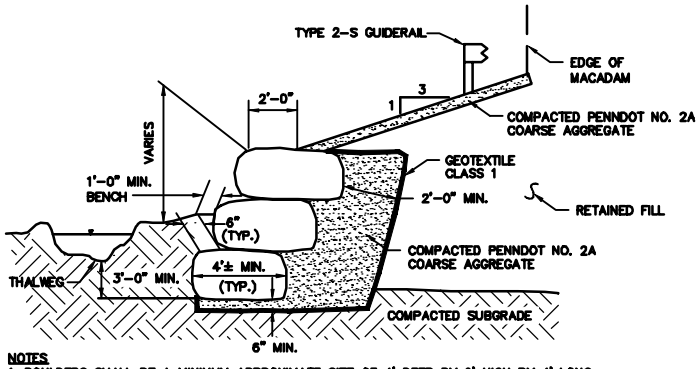
XX TOWNSHIP XX COUNTY PENNSYLVANIA

PROJ. MGR. - ***	
DESIGN- ***	
CADD- ***	
CHECKED- ***	
SCALE- NOT TO SCALE	
DATE- XX-XX-2017	

DRAWING NO.
DT

SHEET NO.
1 OF 1

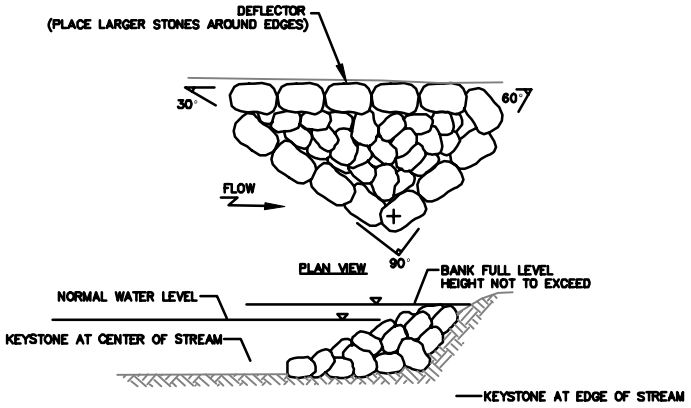
PROJECT ***



NOTES:
1. BOULDERS SHALL BE A MINIMUM APPROXIMATE SIZE OF 4' DEEP BY 2' HIGH BY 4' LONG.
2. STAGGER JOINTS BETWEEN BOULDERS IN SUCCESSIVE ROWS.
3. GEOTEXTILE SHALL CONFORM TO PENNDOT PUB. 408, SECTIONS 212 AND 735.
4. WALL FACE BATTER SLOPE SHOULD BE A MAXIMUM OF 1H:4V. HOWEVER IF FIELD CONDITIONS DO NOT ALLOW FOR MINIMUM SPACING REQUIREMENTS FOR TYPE 2-S GUIDERAIL AND EDGE OF MACADAM PER PENNDOT AND BETWEEN EDGE OF STREAM AND WALL BENCH, SLOPES CAN BE MODIFIED AT THE DISCRETION OF THE ENGINEER.

TYPICAL SECTION ROCK WALL

NOT TO SCALE

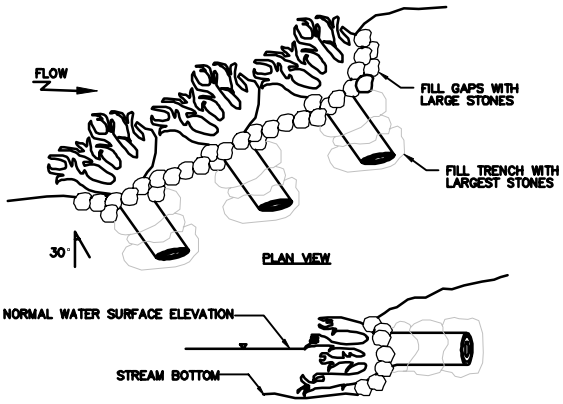


SECTION VIEW

NOTES:
1. SUBMERGE KEYSTONES (R-4) IN CENTER OF STREAM, LEAVING APPROXIMATELY 6" EXPOSED. USE LARGER STONES AS KEYSTONES.
2. SUBMERGE KETSTONES AT EDGE OF STREAM, LEAVING APPROXIMATELY 10" EXPOSED. USE LARGER STONES AS KEYSTONES.
3. DEFLECTORS SHALL BE CONSTRUCTED DURING NORMAL LOW FLOW CONDITIONS TYPICALLY ENCOUNTERED IN EARLY SUMMER THROUGH MID-FALL.
4. THE DISTANCE FROM THE STREAM BANK TO THE TIP OF THE STRUCTURE SHOULD TYPICALLY EQUAL A THIRD OF THE CHANNEL WIDTH AND NEVER EXCEED HALF THE CHANNEL WIDTH.
5. ONLY CLEAN STONE SHALL BE USED TO CONSTRUCT DEFLECTORS.
6. " + " DENOTES STATION LOCATION OF DEFLECTOR;
7. SEE "STREAM FEATURE LOCATIONS" TABLE FOR STATIONING.

STONE DEFLECTORS DETAIL

NOT TO SCALE



SECTION VIEW

NOTES:
1. ROOT WADS CAN BE PLACED AS A SINGLE DEFLECTOR OR OVERLAPPING AS SHOWN.
2. TREE STEM SHOULD BE A MINIMUM OF 8' IN LENGTH AND A MINIMUM OF 6" DIAMETER WITH THE ROOT BALL STILL ATTACHED AND TRENCHED INTO THE BANK A MINIMUM OF 4 FEET.
3. TO INSTALL DEFLECTOR, DIG A TRENCH UPSTREAM AT A 30 DEGREE ANGLE THEN PLACE THE ROOT WAD INTO THE TRENCH WITH THE ROOT BALL EXTENDING INTO THE CHANNEL BEFORE BACKFILLING THE TRENCH AND AREA BETWEEN THE ROOT BALL AND STREAM BANK WITH LARGE STONES.
4. WHEN LAID IN THE TRENCH, THE ROOT BALL SHOULD REST ON THE STREAM BOTTOM OR IT SHOULD BE ONE-THIRD TO ONE-HALF SUBMERGED IN DEEPER WATER. THE UPSTREAM SIDE OF THE ROOT BALL SHOULD BE TIGHT AGAINST THE TRENCH.
5. DEFLECTORS SHOULD BE CONSTRUCTED DURING NORMAL LOW-FLOW CONDITIONS, TYPICALLY ENCOUNTERED IN EARLY SUMMER THROUGH MID-FALL.
6. SEE "STREAM FEATURE LOCATIONS" TABLE FOR STATIONING.

ROOT WAD DEFLECTORS DETAIL

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IN-STREAM RESTORATION DETAIL FOR

COST ESTIMATION

XX TOWNSHIP XX COUNTY PENNSYLVANIA

PROJ. MGR. - ***	DRAWING NO. DT-1
DESIGN- ***	
CADD- ***	
CHECKED- ***	SHEET NO. 1 OF 2
SCALE- NOT TO SCALE	
DATE- XX-XX-2017	PROJECT ***

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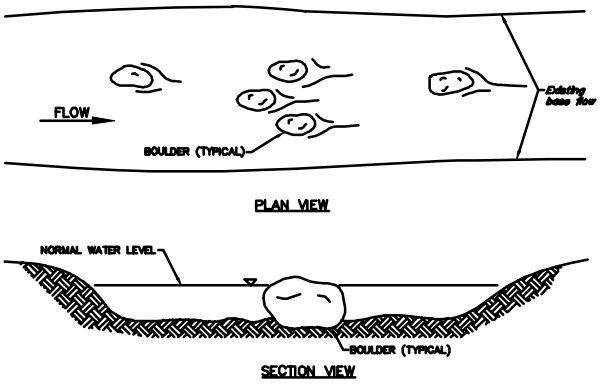
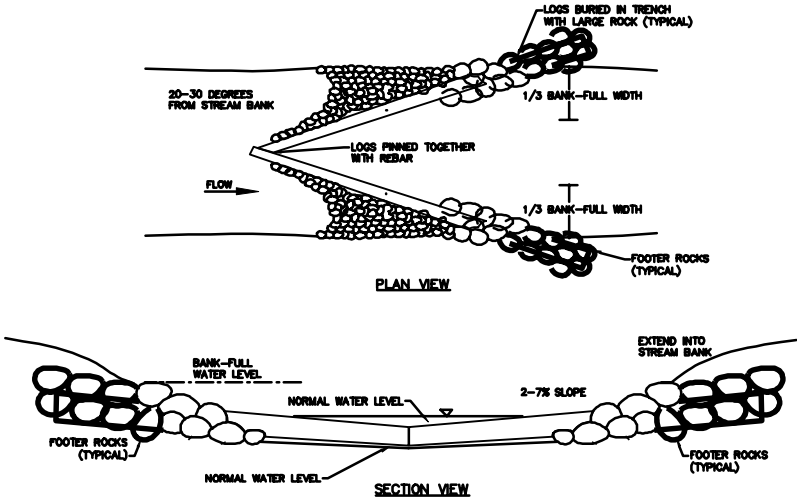


NOTES:
1. PLACE BOULDERS IN THE MIDDLE THIRD OF THE WETTED WIDTH OF THE STREAM TO PREVENT FLOW DEFLECTION INTO THE STREAM BANKS.
2. BOULDER SHOULD BE LARGE ENOUGH NOT TO BE DISPLACED DURING HIGH FLOW PERIODS.
3. DRAWING IN REFERENCE TO PA FISH AND BOAT COMMISSION STANDARD DRAWINGS OF HABITAT STRUCTURES.

RANDOM BOULDER PLACEMENT DETAIL

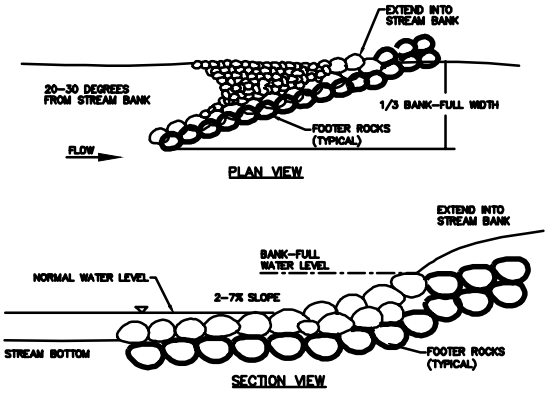
NOT TO SCALE



NOTES:
1. DRAWING IN REFERENCE TO PA FISH AND BOAT COMMISSION STANDARD DRAWINGS OF HABITAT STRUCTURES.

LOG CROSS VANE DETAIL

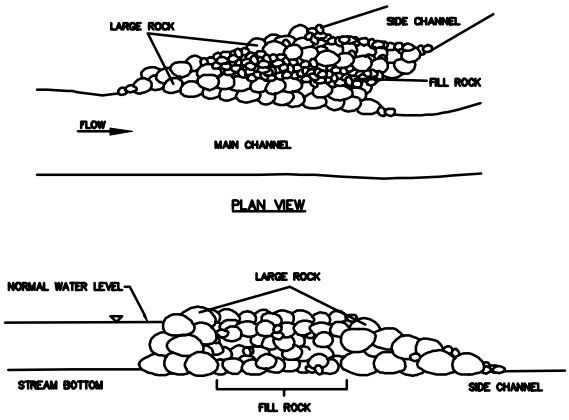
NOT TO SCALE



NOTES:
1. DRAWING IN REFERENCE TO PA FISH AND BOAT COMMISSION STANDARD DRAWINGS OF HABITAT STRUCTURES.

ROCK VANE DEFLECTOR DETAIL

NOT TO SCALE



NOTES:
1. CHANNEL BLOCK BUILT LOWER THAN SURROUNDING STREAM BANKS.
2. DRAWING IN REFERENCE TO PA FISH AND BOAT COMMISSION STANDARD DRAWINGS OF HABITAT STRUCTURES.

STONE CHANNEL BLOCK DETAIL

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IN-STREAM RESTORATION DETAIL FOR

COST ESTIMATION

XX TOWNSHIP XX COUNTY PENNSYLVANIA

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DRAWING NO. DT-2

SHEET NO. 2 OF 2

PROJECT ***