THE CITY OF

HOBART

STORMWATER TECHNICAL STANDARDS MANUAL

2025

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CHAPTER 1 APPLICABLE POLICIES

I. Introduction

a. The City of Hobart Stormwater Technical Standards Manual provides guidance for design and construction for anyone creating a land disturbance within the City of Hobart, Indiana.

b. The purpose of this Stormwater Technical Standards Manual is to establish design standards for stormwater management within a single document that can be easily referenced and to ensure quality design in order to minimize the impacts of development projects on the City's stormwater facilities. Refer to City of Hobart Municipal Code: Chapter 152 for additional Stormwater Management requirements.

II. Compliance Requirements

a. The City of Hobart Stormwater Technical Standards Manual applies to new development or redevelopment activities within the City of Hobart. Follow the applicability section of the City of Hobart Stormwater Management Ordinance, Chapter 152.

   i. Land disturbing activity means any manmade change of the land surface including, but not limited to removing vegetative cover that exposes the underlying soil, excavating, filling, and grading.

   ii. The following activities shall be considered land disturbances:

      1. Changing the contour of the land.
      2. Increasing the runoff rate or volume from the project site.
      3. Increasing the percentage of impervious area of the project site.
      4. Changing the project site's drainage pattern.
      5. Creating a new stormwater facility or modifying an existing stormwater facility (even if under an acre).
      6. Creating an impoundment (even if under an acre).
      7. Restricting or potentially restricting pass-through flows from off-site (even if under an acre).
      8. Adding stormwater infrastructure including, but not limited to, culverts, catch basins, storm sewers, etc., which are to be maintained by the City of Hobart (even if under an acre).

III. Plan Submittal

a. All project plans, specifications, and calculations shall be certified by a Professional Engineer or Land Surveyor registered in the State of Indiana.

b. All project plans, specifications and calculations shall be completed in accordance with the Hobart, Indiana City Standards.

c. Plan Submittal and Review Process

   i. Required Submissions

      1. It is the responsibility of the project site owner to complete a Stormwater Permit (STWP) Application for submission to the City for review for each site with land disturbing activity according to the City of Hobart Stormwater Management Ordinance, Chapter 152. Components of the STWP Application shall include items as required by the IDEM Construction Stormwater General Permit, including an NOI letter with proof of public notice, construction plans, a stormwater pollution prevention plan (SWPPP), environmental investigation reports, drainage report, post-construction SWPPP, and any other necessary information or documentation requested by the City.

2. The project site owner shall submit an Operations and Maintenance (O&M) Manual per Chapter 2 requirements.
3. The project site owner shall complete a Long-Term Maintenance Agreement (LTMA) with the City.
4. The project site owner shall submit supporting calculations and documentation demonstrating the adequacy of the selected post-construction stormwater management measures.
5. Site Plan Review in front of the Plan Commission is required and is normally performed concurrently with the STWP Review.
6. Pay permit application, review and inspection fees according to the City of Hobart Stormwater Management Ordinance, Chapter 152.

IV. Inspection Requirements

a. Owner/Developer/Representative performed inspections (project self-monitoring) must be performed by a qualified professional according to City of Hobart Municipal Code: Chapter 152. Inspections shall be performed at all control measures every 7 days and within 24 hours of a ½-inch rain event.
   i. Project self-monitoring shall be documented in written form and be submitted weekly to the City of Hobart MS4 Coordinator.
b. Documentation of permittee performed inspections and inspection findings shall be kept on site.
c. Documentation of permittee performed inspections and inspection findings shall be made available within 48 hours of a request by the City or designated representative. If inspections are not posted or submitted in a timely manner, as requested, it will be assumed to indicate inspections were not performed and may result in corresponding enforcement procedures.

V. Maintenance Requirements

a. Maintenance must be performed under the direction and/or supervision of a qualified professional.
b. Maintenance of erosion and sediment control, and pollution prevention practices shall be performed according to the construction plan, Stormwater Pollution Prevention Plan (SWPPP), LTMA, and O&M Manual.
c. Maintenance activities shall be performed in accordance with action plans developed through the course of permittee-performed inspections and O&M Manuals.
   i. Corrective actions shall be tracked in the construction site inspection project management log with dates the corrective action was complete. If steps were taken to address the deficiency the log should be detailed to provide the steps taken.
   ii. Ensure the SWPPP is updated to include any changes and reflect field conditions.

VI. Communication

a. Owner/Developer/Representative must send SWPPP updates to the City.
b. Completed self-monitoring reports must be submitted weekly to the City.

VII. Drainage Easements

a. Drainage easements must be provided for maintenance of publicly-owned stormwater management systems. Privately-owned ponds, detention/retention basins, water quality BMPs, and LID practices must be contained within easements. Easements are not required for private systems which are temporary and permanent infrastructure, such as permeable pavement, green roof, rain barrels, and other BMPs and LID practices as approved by the City Engineer.

b. Access easements must be provided from a public roadway to the drainage easement, for access to stormwater management facilities.
c. Structures, fences, obstructions, or landscaping may not be placed in an easement in a way that will impede the free flow of stormwater.
d. Drainage easements shall be maintained by the property owner.
e. The following table includes easement width requirements for applicable situations as defined by this section
f. Additional easement requirements and alternative requirements may be requested by the City Engineer.

AREA OR SITUATION	MINIMUM DRAINAGE EASEMENT WIDTH
Storm sewer (smaller than 24-in.)	20 feet, centered over sewer
Storm sewer (24-in. and larger)	25 feet, centered over sewer
Grassed waterways (including equivalent sized-lined channels)	Width of channel plus 15 feet, centered over waterway
Subsurface drain	20 feet, centered over drain
Open outlet channel (including equivalent sized-lined channels)	20 feet from top of each bank
Retention pond, detention basin, and/or permanent sediment basin	Elevation of the emergency spillway design flow, plus 20 feet (horizontally)
Underground detention facility	Detention facility footprint plus 15 feet in every direction (horizontally)
Permanent Stormwater BMP (above or below grade)	BMP footprint plus 15 feet in every direction (horizontally)
Flood routing path/ponding area	Width of flood path/ponding area
Access easement	10 feet wide from a public right-of-way to the stormwater infrastructure

VIII. Enforcement

a. If the City or its designated representative finds the permittee to be out of compliance with the inspections, maintenance requirements, or provisions of the Stormwater Management Chapter 152, the City, or its designated representative, or his or her designee may give notice to the permittee. The following tiered approach will be applied:
   i. Significant deficiencies, classified as Tier 1: 3 days to correct deficiency
   ii. Significant deficiencies, classified as Tier 2: 5 days to correct deficiency.
   iii. Significant deficiencies, classified as Tier 3: Up to 7 days to correct deficiency.

CHAPTER 2 OPERATION AND MAINTENANCE MANUAL REQUIREMENTS

I. Introduction

a. The Operation and Maintenance (O&M) Manual shall be prepared by the design engineer and be submitted for review with the STW Permit. An O&M Manual shall be provided for all ponds, stormwater components (pipes, swales, structures, etc.), stormwater quantity and quality Best Management Practices (BMPs), and low-impact development facilities/BMPs to facilitate their proper long-term function.
b. Refer to the City of Hobart Municipal Code: Chapter 152 for the Long-Term Maintenance Agreement requirements.

II. O&M Manual Requirements

a. It is the designer's responsibility to determine which additional operation and maintenance measures are necessary to prolong the optimal function of the facility.
b. An O&M Manual shall includes a description of the maintenance guidelines for all post-construction stormwater measures to facilitate their proper long-term function.
c. The O&M Manual must be signed by the owner and provided to future parties who will assume responsibility for the operation and long-term maintenance of the post-construction stormwater management system.
d. When known at the time of plan submittal, the entity that will be responsible for operation and maintenance of the system must be provided a copy of the O&M Manual and Long-term Maintenance Agreement to ensure they understand the requirements.

III. O&M Manual Content

a. Owner Information
    i. The first section of the manual shall contain information about all people involved with the operation and maintenance of the facility. This section shall list the names and contact information of all responsible parties, including property owner(s), maintenance staff, and person(s) responsible for performing inspections. The responsibilities of each individual shall be clearly defined. Contact information shall include business or mobile phone number, mailing address for giving notice, and email address (if available).
b. An acknowledgement statement signed by the owner and notarized. The signed and approved O&M Manual shall be recorded with the property by the County Recorder's office. A copy of the O&M Manual shall be provided to each new owner before the transfer of ownership. The O&M Manual shall be signed by the new owner, notarized, and submitted to the City to be kept on record.
c. The O&M Manual shall include a site map and exhibits drawn to a legible scale on 8.5-inches by 11-inches or 11-inches by 17-inches sized paper that clearly indicates the following:
    i. The location of the stormwater management facilities and BMPs.
    ii. Plan and cross-section details, showing applicable features.
    iii. The flow of stormwater through the site, including an overview of the stormwater's path through the onsite stormwater facilities and BMPs.
    iv. Dimensions, easements, outlets/discharge points and outfall locations, drainage patterns, stormwater runoff flow directions, the extent and depth (elevation) of high water levels, flood routing path, signage, connecting structures, weirs, invert elevations, structural controls used to control stormwater flows, and other relevant features.

IV. O&M Practices

a. Each stormwater management facility and BMP shall require specific inspection and maintenance procedures. Guidance shall be written in simple, layman's terms, including:

   i. Guidance on owner-required periodic inspections and inspections to be performed by the City.

   ii. Guidance on routine maintenance including vegetation maintenance, mowing, litter removal, woody growth removal, etc. to be performed by the owner.

   iii. Guidance on remedial maintenance such as inlet replacement, outlet work, etc. to be performed by the owner.

   iv. Guidance on sediment removal, both narrative and graphical, describing when sediment removal shall occur in order to ensure that the stormwater management facility or BMP remains effective as a stormwater management device. Guidance shall include instructions as to how the depth of sediment shall be measured and at what measurement removal will be required.

   v. Instructions on inspection and clean-out of BMPs, sumps, trash screens, settling pits, and oil/grease collection chambers.

   vi. Instructions on proper disposal of removed sediments, trash, debris, and other substances.

   vii. Guidance and methods for preventing water stagnation and all recommended maintenance.

V. O&M Inspection & Maintenance

a. The minimum requirements below shall also be incorporated into the inspection and maintenance regimen and clearly documented in the O&M Manual.
   i. Operation and maintenance procedures and practices shall be reviewed and assessed annually.
   ii. Access routes, including roadways and sidewalks, shall be inspected annually and maintained as needed.
b. Drainage structures and flow restrictors shall be inspected and cleaned semi-annually or per the manufacturer's recommendations, whichever is more stringent.
c. Volume control facilities and BMPs shall be inspected semi-annually and after significant rainfall events exceeding 1.5-inches, or per the manufacturer's recommendations, whichever is more stringent.
d. The owner shall keep an updated log or inspection worksheets documenting the performance of the required operation and maintenance activities for perpetuity. Note inspection dates, facility components inspected, facility condition, and any maintenance performed, or repairs made. Documentation must be produced upon the request of the City within 48-hours of the request.
e. Vegetation shall be maintained on a regular basis per design specifications.
f. Pest control measures shall be implemented to address insects, rodents, and other pests. Natural pest control is preferred over chemical treatments.
g. Mechanical measures shall be maintained on a regular basis per the manufacturer's recommendations.
h. Native vegetation plantings shall have "No Mow" or other additional signage as directed by the City Engineer.
i. Underground vaults and structures shall include design measures to facilitate regular cleaning and maintenance. Confined space entry procedures shall be followed.

VI. Right-of-Entry Statement

a. The O&M Manual shall include a statement that the City has the right to enter the property to inspect the stormwater management facility or BMP. The statement shall be signed by the Owner and notarized.

VII. Implementation Schedule

a. An inspection and maintenance schedule shall be prepared in a tabular format and included in the O&M Manual. This schedule shall provide for routine examination of all stormwater management facilities and stormwater quality BMPs.

VIII. Drainage Easement(s) Documentation

a. The O&M Manual shall include graphic documentation of drainage easement(s) around the stormwater management facilities and BMPs and access to those that do not adjoin a public right-of-way.

CHAPTER 3 RUNOFF RATE DETERMINATION

I. Introduction

a. This Chapter, “Runoff Rate Determination”, outlines the process for determining release rates for a site under development.

II. Compliance Requirements

a. Development sites less than or equal to 5 acres with a contributing drainage area of 50 acres or less may utilize the rational method to determine runoff rates. Computer models which can generate hydrographs based on the time of concentration calculated using the TR-55 method and curve number calculation may also be used with a 24-hour duration SCS Type 2 storm.

b. Development sites greater than 5 acres and/or with a contributing drainage area of over 50 acres shall utilize a computer model that can generate hydrographs based on the time of concentration calculated using the TR-55 method and curve number calculations based on a 24-hour duration SCS Type 2 rain event.

c. Development sites that drain into the watershed downstream of the Lake George Dam shall meet an allowable release rate of 0.4 cubic feet per second (cfs) per acre. Developments that drain into the watershed upstream of the Lake George Dam shall meet an allowable release rate of 0.2 cubic feet per second (cfs) per acre. Additionally, the 2-year post development release rate cannot exceed the 2-year predevelopment release rate.

III. Runoff Rate Determination Calculations

a. The peak release rate (Q) as determined utilizing the rational method is computed as follows:

$$Q = (C)(I)(A)$$

Where:

Q = peak release rate in cubic feet per second

C = runoff coefficient

I = average rainfall intensity in inches per hour

A = drainage area in acres

CHAPTER 4 FLOOD ROUTING

I. Introduction

a. This Chapter, “Flood Routing” outlines requirements for designing flood routing within the City of Hobart to ensure the safe routing of flood waters through the subject development. Flood routing is important in the design of flood protection measures, to estimate how the proposed measures will affect the behavior of flood waves in rivers, so that adequate protection and economic solutions may be found.

II. Compliance Requirements

a. Stormwater ponding and overflow path routing throughout a site or development shall be evaluated for the peak 100-year storm event.

b. Peak runoff flow shall be estimated for all contributing drainage areas, on-site and off-site, in their proposed (developed) land use.

c. The stormwater collection system (storm lines, open channels, etc.) shall be assumed full (at capacity) from a previous storm event at the beginning of the flood routing analysis.

d. The overflow path/ponding resulting from the flood routing event shall be clearly shown as a hatch area on the plans. Plans shall include cross sections along the flood route path. Cross sections shall include the existing surface, proposed grading, and the maximum water elevation for the peak 100-year storm event. The flood routing path and ponding areas shall be placed in a right-of-way or drainage easement in accordance with Chapter 1 of this manual. The flood routing path must flow to a conveyance or receiving stream.

   i. The flood route path shall be included in the O&M Manual in accordance with Chapter 2 of this manual.

e. If an emergency spillway is not available, the storm line system shall be designed for the 10-year storm event within the system and all inlets must pass the 100-year with less than 6 inches of ponding at 50% clogged inlets.

CHAPTER 5 DETENTION STORAGE VOLUMES

I. Introduction

a. This Chapter, "Detention Storage Volumes", outlines the process for determining required detention volumes for a site under development.

II. Compliance Requirements

a. Development sites less than or equal to 5 acres with a contributing drainage area of 50 acres or less may utilize the rational method to determine runoff rates. Computer models which can generate hydrographs based on the time of concentration calculated using the TR-55 method and curve number calculation can also be used with a 24-hour duration SCS Type 2 storm.

b. Development sites greater than 5 acres and/or with a contributing drainage area of over 50 acres shall utilize a computer model that can generate hydrographs based on the time of concentration calculated using the TR-55 method and curve number calculation can also be used with a 24-hour duration SCS Type 2 storm.

c. The allowable release rate from any development site shall meet the requirements set forth in Chapter 3.

III. Runoff Rate Determination Calculations

a. The required storage volume (S_R) as determined by utilizing the rational method can be computed with the following procedure:

   i. Determine the site drainage area (A_d).

   ii. Determine the 100-year release rate (Q_u) based on the allowable release rates stated in Chapter 3.

   iii. Determine the composite runoff coefficient (C_d) based on developed conditions and a 100-year return period.

   iv. Determine the 100-year return rainfall intensity (I_d) for various appropriate storm durations (t_d) from zero to 24 hours.

   v. Determine developed inflow rates (Q_d) for various t_d values utilizing the following equation:

$$Q_d = (C_d)(I_d)(A_d)$$

   vi. Determine storage rates (S_{td}) for various t_d values utilizing the following equation:

$$S_{td} = Q_d - Q_u$$

   vii. Select the largest required storage volume (S_R) in acre-feet determined for the various t_d values utilizing the following equation:

$$S_R = \frac{(S_{td})(t_d)}{12}$$

CHAPTER 6 STORM SEWER DESIGN

I. Introduction

a. This Chapter, “Storm Sewer Design”, outlines the design standards and other requirements for storm sewers within the City of Hobart.

II. Compliance Requirements

a. All elements of storm sewers (pipe, inlets, catch basins, curb and gutters, etc.) shall be in accordance with the Hobart, Indiana City Standards.

b. Storm sewers, inlets, catch basins, and curb and gutters shall be sized for, at a minimum, the peak runoff from a 24-hour, 10-year frequency storm.

c. Culverts shall be sized for the peak runoff from a 24-hour, 100-year frequency storm.

d. For minor drainage systems the allowable spread of water is limited to maintaining at least two, 10- foot moving lanes of traffic on Collector Streets and one, 10-foot lane on Local Roads. Other access lanes such as subdivision cul-de-sacs can have a water spread of one-half their total width.

e. Storm sewers shall be sized at a minimum of 12 inches in diameter. An orifice plate or other device will be required if the minimum pipe size cannot limit the release rate to the required amount. A minimum of a 4” orifice for maintenance purposes is required. Every reasonable effort shall be made to comply with the release rate requirements identified in Chapter 3.

f. Pipe slopes shall be designed to produce velocities of a minimum of 2.5 feet per second and a maximum of 10 feet per second and energy dissipaters are required on outlet structures.

g. Storm sewers shall be run straight between structures (manholes, inlets, etc.).

h. Manholes on 12-inch through 42-inch storm sewer runs shall be spaced a maximum distance of 400 feet apart. Manholes on 48-inch and larger storm sewer runs shall be spaced a maximum distance of 600 feet apart.

i. A minimum drop of 0.1 feet through manhole and inlet structures is required to reduce the effect of head loss through storm structures.

III. Storm Sewer Design Calculations

a. The determination of the hydraulic capacity for storm sewers is based on the Manning’s open-channel flow equation:

$$V = \frac{1.49}{n} * R^{\frac{2}{3}}\sqrt{s}$$

where:

V = velocity of flow in feet per second n = Manning’s roughness coefficient

R = hydraulic radius in feet

S = slope of hydraulic gradeline in feet per foot

b. The hydraulic radius (R) can be calculated utilizing the following equation:

$$R = \frac{A}{P^1}$$

Where:

A = cross sectional water area in feet squared

P’ = wetted perimeter in feet.

c. The hydraulic capacity (Q) can be calculated utilizing the following equation:

$$Q = (A)(v)$$

Where:

A = cross sectional area of flow in feet squared

V = velocity of flow in feet per second

CHAPTER 7 OPEN CHANNEL DESIGN

I. Introduction

a. This Chapter, “Open Channel Design”, outlines the design standards and other requirements for open channels within the City of Hobart.

II. Compliance Requirements

a. Channels and swales shall be designed to accommodate a 10-year, 24-hour rain event based on Chapter 2 of this manual.

b. Channels with a capacity of more than 30 cubic feet per second shall be capable of accommodating a 24-hour, 50-year rain event based on Chapter 2 of this manual.

c. All elements of the drainage system shall be checked to ensure that all buildings are located outside of the 100-year flood boundary and that 100-year flow paths are confined to areas with sufficient easement.

d. Open channel velocities based upon the design storm shall not be less than 2 feet per second to avoid siltation.

e. If velocities of 5 feet per second or greater are anticipated, utilize alternative measures to riprap, such as hybrid-turf mat and tied concrete block. Approval must be obtained from the City Engineer if alternatives cannot be implemented.

f. The bottom of open channels along streets and roads shall be low enough to install driveway culverts without causing speed bumps.

g. Swales and vegetated channels shall have side slopes no steeper than 3:1.

h. Riprap, concrete or other lined channels shall have side slopes no steeper than 2:1. If a lined channel is steeper than 2:1 the walls must be designed and constructed as structural retaining walls.

i. The minimum slope of a drainage swale is 0.5%. Vegetated swales with slopes less than 1% shall have tile under-drains unless the swale is to act as a Best Management Practice (BMP).

j. Acceptable channel linings include: grass, native plantings, revetment riprap, concrete, riprap, gabions, hybrid turf mat, and tied concrete block. Straw or coconut mattings may be used on a temporary basis until grass is established.

k. Two-stage ditches may be utilized where a single-stage ditch is unable to accommodate the design flow. Two-stage ditches shall be designed so that the upper stage is of adequate size to prevent design flows from overtopping the ditch banks.

III. Open Channel Waterway Area Calculations

a. Velocity (V) of an open channel waterway shall be based on Manning’s Equation:

$$V = \frac{1.49}{n} * R^{\frac{2}{3}}\sqrt{S}$$

Where:
V = velocity of flow in feet per second

n = Manning’s roughness coefficient

R = hydraulic radius in feet

S = slope of hydraulic gradeline in feet per foot

b. Open channel waterway area (A) shall be determined based on the following equation:

$$A = \frac{Q}{v}$$

Where:

A = cross sectional area of flow in feet squared

Q = discharge in cubic feet per second

V = velocity of flow in feet per second

CHAPTER 8 DETENTION, RETENTION, AND INFILTRATION DESIGN STANDARDS

I. Introduction

a. This Chapter, "Detention, Retention, Infiltration Design Standards", outlines the design of improvements that deal with stormwater detention within the City of Hobart.

II. Compliance Requirements

a. Development sites that drain into the watershed downstream of the Lake George Dam shall meet an allowable release rate of 0.4 cubic feet per second (cfs) per acre. Developments that drain into the watershed upstream of the Lake George Dam shall meet an allowable release rate of 0.2 cubic feet per second (cfs) per acre. Additionally, the 2-year post development release rate cannot exceed the 2-year predevelopment release rate.

b. The primary outlet structure and overflow weir invert elevation shall be sized according to onsite runoff only. The minimum orifice size shall be no less than 4-inches diameter. Runoff from offsite land areas may be bypassed around the detention facility or routed through the detention facility provided that a separate outlet system is incorporated for this flow. The 100-year pond elevation shall be determined by routing the entire flow, onsite and offsite, through the detention facility.

c. The design of the detention facility shall ensure that a minimum of 90% of its capacity is restored within 48 hours of the start of the design 100-year storm.

d. The 100-year elevation of stormwater detention facilities shall be at least 25 feet away from any building. The lowest adjacent grade for all buildings shall be a minimum of 2 feet above the 100-year pond elevation or emergency overflow weir elevation, whichever is higher. Any basement floor must be at least one foot above the normal water level of any stormwater detention facility.

e. No stormwater detention facility shall be located within twenty feet of any pole or high voltage electrical line.

f. Stormwater detention facilities shall be located a minimum of 50 feet from any road right of way. Guard rails, berms, or other measures may be considered as acceptable alternatives to this setback.

g. Stormwater detention facilities may not have slopes steeper than 3:1.

h. Animal guards are required on all pipes or openings leaving the stormwater detention facility.

i. Emergency overflow facilities shall be able to handle one and one quarter the peak inflow discharge and peak flow velocity of a 100-year rain event from the entire contributing watershed. The emergency overflow facilities shall be indicated on the plan set.

j. The minimum freeboard provided shall be 1.5 feet.

k. All detention/retention facilities, including underground facilities, shall have an upstream BMP designed in accordance with Chapter 9.

III. Wet-Bottom Requirements

a. Facilities with permanent pools must have a water area of at least 0.5 acres. A minimum depth of 10 feet over 25% of the permanent pool is required if fish are to be used.

b. A minimum 10-foot wide flat safety ledge at a maximum depth of 30 inches is required. There shall be a minimum side slope of 4:1 between the edge of water and safety ledge and a minimum slope of 3:1 beyond the safety ledge.

c. A safety ramp exit with a minimum width of 20 feet and a slope of 6:1 is required for all wet-bottom stormwater detention facilities.

d. Pond stagnation prevention measures, including aeration, are required for all wet-bottom stormwater detention facilities.

e. Refer to Hobart, Indiana City Standards for Standard Details.

IV. Dry Bottom Requirements

a. The maximum planned depth for stored stormwater in a dry-bottom stormwater detention facility is 4 feet.

b. A minimum side slope of 3:1 is required except in the case of valley storage where natural slopes are considered stable.

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CHAPTER 9 POST-CONSTRUCTION BMP DESIGN

I. Introduction

a. This Section, "Post-Construction BMP Design", provides minimum design criteria and standards for post-construction stormwater best management practices.

II. Compliance Requirements

a. Pollutants must not directly infiltrate into the ground. Prior to utilizing infiltration practices, it is important to consider the feasibility of using such a device. Utilizing infiltration practices where infiltrating stormwater may mobilize high levels of contaminants in soil or groundwater is prohibited.

   i. Upstream BMP shall be provided for all infiltration practices.

   ii. Infiltration practices require prior approval from the City Engineer.

b. Control of stormwater quality within the City of Hobart is based upon the management of Total Suspended Solids (TSS) and the control of floatables.

   i. TSS

      1. Post-Construction BMPs shall be designed to treat the water quality volume (W_{Qv}) for detention-based BMPs or the water quality discharge flow rate (Q_{wq}), for flow-through BMPs.

      2. BMPs, individually or in combination, must meet or exceed an 80% TSS removal rate of particles 125 microns or larger in diameter without re-entrainment. Testing to establish the TSS removal rate of a BMP must be conducted by an independent testing facility.

   ii. Floatables

      1. Floatable controls shall be incorporated to capture floating debris and remove them during routine maintenance of the BMP.

      2. Standalone BMPs must include floatable control.

      3. BMP Treatment Trains are required to include at least one floatable containment component located between the last inflow point to the system and the outlet.

c. BMPs utilized in the City of Hobart are required to be certified by a Professional Engineer licensed in the State of Indiana and approved by the Hobart City Engineer.

d. If velocities of 5.0 feet per second or greater are anticipated, utilize alternative measures to riprap, such as hybrid-turf mat and tied concrete block. Approval must be obtained from the City Engineer if alternatives cannot be implemented.

e. BMP Treatment Trains, a number of BMPs in series, may be utilized where a single BMP measure is not adequate to achieve the project's water quality goals.

f. New retail gasoline outlets and fueling areas are required to install appropriate measures (Refer to the City of Hobart Municipal Code: Chapter 152 for stormwater quality treatment requirements) to reduce lead, copper, zinc, and polyaromatic hydrocarbons in stormwater run-off.

III. Sizing Methodology for BMPs

a. Detention BMP sizing is based upon water quality volume (W_{Qv}) of a project site.

i. Detention BMPs pond and store the W_{Qv} to be treated.

ii. W_{Qv} is equivalent to one inch of rainfall multiplied by the volumetric runoff coefficient (R_v) multiplied by the site area:

$$W_{QV} = \frac{(P)(R_v)(A)}{12}$$

Where:

W_{Qv} = water quality volume in acre-feet

P = 1 inch of rainfall

R_v = volumetric runoff coefficient

A = area in acres

iii. The volumetric runoff coefficient (R_v) is a measure of imperviousness for the contributing areas:

$$Rv = 0.05 + 0.009(I)$$

Where:

I = percent impervious cover

b. Flow through BMP sizing is based upon water quality discharge (Q_{wq}), which is a peak design flow rate through the BMP of a project site.

   i. Flow through BMPs treat the Q_{wq} through some form of a filtration process. Flow through BMPs include catch basin inserts, sand filters, grassed channels, and hydrodynamic separators.

   ii. Hydrodynamic separators are required to be listed on the most current version of the City of Indianapolis Stormwater Quality Unit (SQU) Selection Guide.

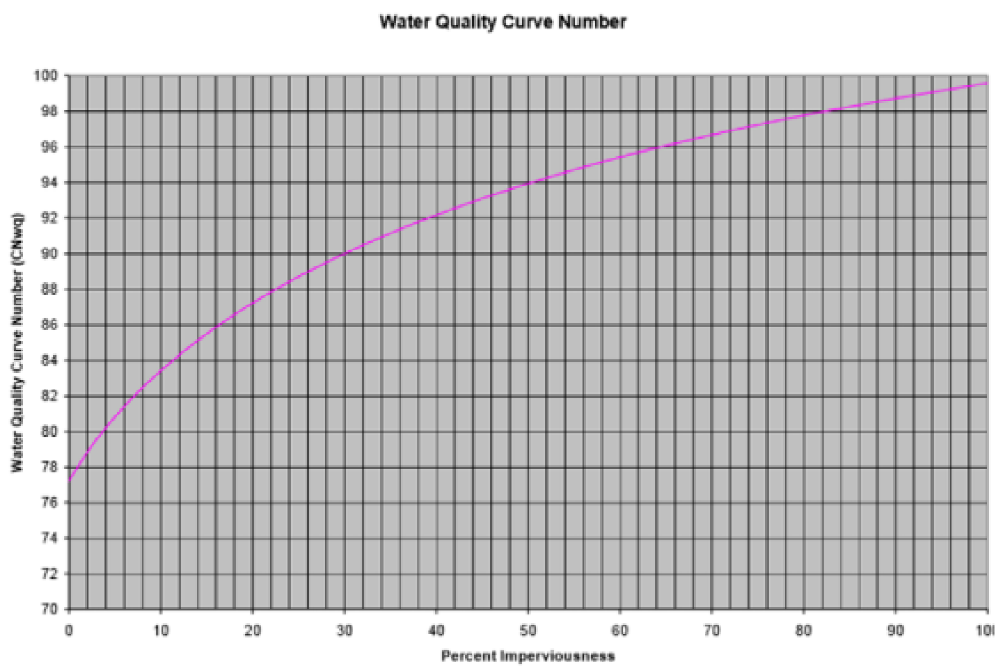
   iii. Using the WQv methodology, a corresponding Curve Number (CNwq) is computed utilizing the following equation:

$$CN\omega q = \frac{100}{10 + 5P + 10Qa - 10\sqrt{Qa^2 + 1.25QaP}}$$

Where:

P = 1 inch of rainfall

   iv. Due to the complexity of the above equation, the water quality curve number can be determined from the chart below as a function of imperviousness.



   v. CNwq is then used in conjunction with the standard calculated time of concentration and drainage area as the basis for input for TR-55 calculations. Using the appropriate 1-inch Huff rainfall distribution, the Q_{wq} can then be calculated.

TABLE 1 URBAN RUNOFF COEFFICIENTS

SURFACE TYPE	RUNOFF COEFFICIENT "C"
Hard Surfaces	
Asphalt	0.82
Concrete	0.85
Roof	0.85
Sandy Lawns	
Flat (0-2% slope)	0.07
Rolling (2-7% slope)	0.12
Steep (greater than 7% slope)	0.17
Clay Lawns	
Flat (0-2% slope)	0.16
Rolling (2-7% slope)	0.21
Steep (Greater than 7% slope)	0.30

Source: HERPICC Stormwater Drainage Manual

TABLE 2 RURAL RUNOFF COEFFICIENTS

SURFACE TYPE	RUNOFF COEFFICIENT "C"
Sandy Woodland	
Flat (0-5% slope)	0.10
Rolling (5-10% slope)	0.25
Steep (greater than 10% slope)	0.30
Clay Woodland	
Flat (0-5% slope)	0.30
Rolling (5-10% slope)	0.35
Steep (greater than 10% slope)	0.50
Sandy Pasture	
Flat (0-5% slope)	0.10
Rolling (5-10% slope)	0.16
Steep (greater than 10% slope)	0.22
Clay pasture	
Flat (0-5% slope)	0.30
Rolling (5-10% slope)	0.36
Steep (greater than 10% slope)	0.42
Sandy Cultivated	
Flat (0-5% slope)	0.30
Rolling (5-10% slope)	0.40
Steep (greater than 10% slope)	0.52
Clay Cultivated	
Flat (0-5% slope)	0.50
Rolling (5-10% slope)	0.60
Steep (greater than 10% slope)	0.72

Source: HERPICC Stormwater Drainage Manual

TABLE 3 RAINFALL INTENSITIES (INCHES PER HOUR) FOR HOBART, INDIANA

DURATION	RETURN PERIOD (YEARS)					
	2	5	10	25	50	100
5-min	5.38	6.36	7.26	8.32	9.20	10.0
10-min	4.20	4.94	5.60	6.35	6.97	7.55
15-min	3.42	4.05	4.60	5.24	5.75	6.26
30-min	2.29	2.77	3.19	3.70	4.11	4.52
60-min	1.41	1.74	2.03	2.40	2.71	3.02
2-hr	0.82	1.03	1.22	1.47	1.68	1.89
3-hr	0.59	0.74	0.88	1.07	1.22	1.38
6-hr	0.35	0.45	0.54	0.66	0.77	0.89
12-hr	0.20	0.26	0.31	0.38	0.44	0.50
24-hr	0.12	0.16	0.19	0.23	0.26	0.30

Source: NOAA National Weather Service

TABLE 4 RAINFALL DEPTHS (INCHES)
HOBART, INDIANA

DURATION	RETURN PERIOD (YEARS)					
	2	5	10	25	50	100
5-min	0.45	0.53	0.61	0.69	0.78	0.84
10-min	0.70	0.82	0.93	1.06	1.16	1.26
15-min	0.86	1.01	1.15	1.31	1.44	1.56
30-min	1.15	1.39	1.60	1.85	2.06	2.26
60-min	1.41	1.74	2.03	2.40	2.71	3.02
2-hr	1.64	2.06	2.44	2.93	3.36	3.78
3-hr	1.76	2.23	2.65	3.20	3.67	4.16
6-hr	2.10	2.68	3.23	3.96	4.62	5.31
12-hr	2.44	3.09	3.70	4.52	5.25	6.01
24-hr	2.91	3.76	4.46	5.47	6.32	7.25

Source: NOAA National Weather Service

CITY OF HOBART

THE CITY OF
HOBART

APPENDIX A

BEST MANAGEMENT PRACTICES (BMP) MANUAL

2025

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BMP1 SILT FENCE

CONSTRUCTION PHASE BMP

Significantly Targeted Pollutants: Sediment

Partially Targeted Pollutants: None

Purpose: Silt fence is utilized as a means to trap sediment from small, disturbed areas by reducing the velocity of sheet flow. Silt fences capture sediment by ponding water to allow deposition, not by filtration.

Silt fence is not recommended for use as a diversion and should never be used across a stream, channel, ditch, swale, or anywhere that concentrated flow is anticipated.

Specifications: Limited to one quarter acre of drainage area per 100 linear feet of fence.

Silt fence has a six-month maximum effective service life and must be replaced if the project is not completed.

Silt fence shall be a minimum height of 18 inches and a maximum height of 30 inches above ground level.

Support posts shall be spaced 8 feet maximum if fence is supported by wire mesh fencing and 6 feet maximum for extra-strength fabric without wire backing.

Spacing between rows of silt fence shall be per the slope steepness restriction table below:

Percent Slope		Maximum Distance
< 2%	< 50:1	100 feet
2% - 5%	50:1 - 20:1	75 feet
5% - 10%	20:1 - 10:1	50 feet
10% - 20%	10:1 - 5:1	25 feet
> 20%	> 5:1	15 feet

TSS removal rates per USEPA:

Average TSS removed	Soil classification
80-90%	Sand
50-80%	Silt-loam
0-20%	Silt-clay-loam

Refer to the Hobart, Indiana, standards and ordinances.

Materials: Support posts shall be 2-by-2-inch hardwood or steel posts.

Fabric shall be woven or non-woven geotextile fabric meeting the specified minimums as outlined in the table below:

Physical Property	Woven Geotextile Fabric	Non-Woven Geotextile Fabric
Filtering efficiency	85%	85%
Standard textile strength at 20% elongation	30 lbs per linear inch	50 lbs per linear inch
Extra textile strength at 20% elongation	50 lbs per linear inch	70 lbs per linear inch
Slurry flow rate	0.3 gal/min/square feet	4.5 gal/min/square feet
Water Flow Rate	15 gal/min/square feet	220 gal/min/square feet
UV resistance	70%	85%
Post spacing	7 feet	5 feet

Installation: The location of the silt fence shall be parallel to the contour of the slope and at least 10 feet beyond the toe of the slope in order to provide a sediment storage area. The ends of the silt fence shall be turned up slope such that the point of contact between the ground and the bottom of the fence end terminates at a higher elevation than the top of the fence at its lowest point.

Silt fence shall be installed per the manufacturer’s instructions and recommendations. At a minimum, silt fence shall be trenched into the soil a minimum of 8 inches deep in a v-shaped or flat bottom trench and secured by filling the trench with soil along the entire fence line.

Maintenance: The silt fence shall be inspected after every rain event or every 7 days at a minimum.

Any fabric tears, decomposition or inefficiencies in the silt fence shall be replaced immediately.

Deposited sediment shall be removed when it reaches half the height of the silt fence at the silt fence’s lowest point or is causing the fabric to bulge.

Take care to avoid undermining the silt fence during clean out.

After the contributing drainage area has been stabilized, remove the fence and sediment deposits, bring the disturbed area to grade, and stabilize the area.

BMP2 ROCK CHECK DAM

CONSTRUCTION PHASE BMP

Significantly Targeted Pollutants: Sediment

Partially Targeted Pollutants: None

Purpose: Rock check dams are utilized to reduce erosion in a drainage channel by slowing the velocity of flow.

Specifications: Two-acre maximum contributing drainage area per check dam. Rock check dams shall have a 2 feet maximum dam height with the center of the dam at least 9 inches lower than the points of contact between the uppermost points of the dam and channel banks.

Rock check dams have an 80% design removal efficiency goal for TSS in the inflow.

Alternatively, filter socks stacked in a pyramid, can be used instead of rock. See the BMP5 Filter Tube/Filter Sock for details.

Refer to the Hobart, Indiana, standards and ordinances.

Materials: Utilize an 8-ounce or heavier nonwoven geotextile fabric.

INDOT revetment riprap shall be used for the check dam and well-graded INDOT CA No. 5 aggregate shall be used as filter medium.

Installation: Excavate a cutoff trench into the swale banks and extend it to a minimum of 18 inches beyond the top of bank. Place the rock in the cutoff trench and channel to the limits described above.

Extend the rock a minimum of 18 inches beyond the top of bank to keep overflow water from undercutting the dam as it re-enters the channel.

Dams shall be placed so that the upstream dam toe elevation and the overflow weir of the downstream dam top elevation are the same.

Stabilize the channel above the uppermost check dam.

Erosion resistant lining shall extend at least 6 feet below the lowest check dam.

Maintenance: Inspect check dams and the channel after each rain event and repair any damage immediately. If significant erosion occurs between the check dams, install a riprap liner in that portion of the channel.

Remove sediment accumulated behind each check dam as needed to maintain channel capacity, to allow drainage through the dam, and to prevent large flows from displacing sediment.

Add aggregate to the dams as needed to maintain design height and cross section.

When the dams are no longer needed, remove the aggregate and stabilize the channel using an erosion resistant lining if necessary.

BMP3 TEMPORARY SEDIMENT TRAP

CONSTRUCTION PHASE BMP

Significantly Targeted Pollutants: Sediment, Floatable Materials

Partially Targeted Pollutants: None

Purpose: Temporary sediment traps are utilized to minimize release from construction areas by pooling stormwater runoff, allowing sufficient retention time for settling of suspended soil particles, and to minimize offsite sedimentation by trapping sediment at designated locations accessible for cleanout.

Specifications: Five-acre maximum drainage area per sediment trap. Typically, a two-year structure life. Proper maintenance will extend the life of the measure. On average, 60% TSS reduction can be obtained through the use of a temporary sediment trap.

The pool area shall be a minimum of 1,800 cubic feet per acre of the watershed's total contributing area with side slopes at 2:1 or flatter and a length to width ratio of 2:1 or greater in line with the flow.

The sediment trap pond should completely drain within 48 hours to 72 hours of a rain event. The outlet

should have a capacity designed for a 2-year frequency, 24-hour rain event.

Temporary sediment trap spillway shall be in accordance with the following table:

Drainage Area (acres)	Minimum Bottom Width (feet)
1	4
2	6
3	8
4	10
5	12

Refer to the Hobart, Indiana, standards and ordinances.

Materials: Temporary sediment traps shall be constructed utilizing INDOT revetment riprap, INDOT CA No. 5 aggregate, and geotextile fabric.

Installation: Clear, grub, and strip all vegetation and root mat from the embankment area.

Create embankment using compacted material free of roots, brush, and debris. Overfill the embankment 6 inches to allow for settling.

Excavate a trapezoidal stone outlet section from the compacted embankment.

Install geotextile and place specified stone to the lines and grades shown in the Construction Details.

Stabilize the embankment and other disturbed areas with seed and mulch or another suitable erosion resistant cover.

Maintenance: Sediment traps shall be inspected weekly and following each rain event and immediately repaired if damaged. Check embankment for any erosion and holes and repair.

Remove sediment when it has accumulated to one half the design depth. Check sediment trap pool area side slopes for erosion and repair.

Replace spillway gravel facing if clogged with INDOT CA No. 5 aggregate. Inspect vegetation and seed

again, if necessary.

Check the spillway depth periodically to ensure a minimum 18-inch depth from the lowest point of the settled embankment to the highest point of the spillway crest. Fill any low areas to maintain the design elevation.

BMP4 CONCRETE WASHOUT

CONSTRUCTION PHASE BMP

Significantly Targeted Pollutants: Illicit discharge

Partially Targeted Pollutants: Construction Waste

Purpose: Concrete washout systems are implemented to reduce the discharge of pollutants associated with concrete washout waste. Performing concrete washout in designated areas and into specifically designed systems reduces the impact concrete washout can have on the environment.

Specifications: Install concrete washout prior to delivery of concrete.

Do not wash out concrete trucks or equipment into the storm sewer system, storm drains, wetlands, streams, rivers, creeks, ditches, or streets.

Install systems at strategic locations that are convenient and in close proximity to work areas and in sufficient number to accommodate the demand for disposal. On average 7 gallons of water is used per chute washout. Calculate the daily needs by multiplying the number of concrete loads which will be needed in one day by 7 gallons to determine the volume of washout needed.

Locate concrete washout systems at least 50 feet away from bodies of water or conveyance systems.

Refer to the Hobart, Indiana, standards and ordinances.

Materials: Utilize a minimum of 10-mil polyethylene sheeting that is free of holes, tears, and other defects. Sheeting shall be of an appropriate size to fit the washout system without seams or overlap of lining.

The washout system shall be constructed of sandbags, soil material, or other appropriate materials.

Metal pins or staples with a minimum of 6 inches in length, sandbags or alternative fasteners shall be used to secure the polyethylene lining to the containment system.

Installation: Construct a washout base or excavate an earthen pit that is free of rocks and other debris that may cause tears or punctures in the polyethylene lining.

Install the polyethylene lining and secure it with pins, staples, or other fasteners.

Place flags, safety fencing, or equivalent warning to provide a barrier to construction equipment and other traffic.

Install signage that indicates concrete washout areas.

Maintenance: Inspect daily and after each rain event.

Excess concrete shall be removed when the washout system reaches 50% of its capacity. Dispose of all concrete in a legal manner.

Inspect construction activities on a regular basis to ensure suppliers, contractors, and others are utilizing the designated washout areas.

When concrete washout areas are no longer required, they shall be closed. All hardened concrete and other materials shall be properly disposed of, and holes, depressions, and other land disturbances associated with the system shall be backfilled, graded, and stabilized.

BMP5 FILTER TUBE/FILTER SOCK

CONSTRUCTION PHASE BMP

Significantly Targeted Pollutants: Sediment

Partially Targeted Pollutants: None

Purpose: To trap sediment by intercepting runoff and reducing the velocity of sheet flow or concentrated flow (limited application). Filter socks capture sediment by ponding water to allow settling and deposition. Filter socks can be used as a filter berm, perimeter protection, or in a pyramid configuration as an alternative to utilizing rock in check dams.

Specifications: Limited to one-quarter acre per 100 linear feet of barrier. Further restricted by slope steepness.

For slope application, filter sock is to be installed parallel to the contour 10 feet horizontally past the toe of slope. Filter socks can be placed horizontally across a slope to shorten a slope's length and prevent rill and gully erosion. Additionally, filter socks can be used on the edge of pavement to slow or divert water.

For channel/swale application, filter sock is to be installed perpendicular to channel flow. Channel/swale applications are limited to less than one acre of drainage area and a larger product is to be utilized, typically 18 or more inches in diameter.

Filter tube may be utilized as drop inlet protection. Locate filter tube where accessible for maintenance.

Filter tubes average 90% oil and TSS removal.

Refer to the Hobart, Indiana, standards and ordinances.

Materials: Filter socks are mesh tubes, at least 8' in diameter and include a geotextile fabric sock or a non-biodegradable netting matrix and typically are filled with organic material, such as 2" wood chips. Specifications for fill materials are as follows:

1. Compost/Mulch Specifications:
   - Feedstock's may include, but are not limited to, well-composted vegetable matter, leaves, yard trimmings, food scraps, composted manures, paper fiber, wood bark, Class A bio solids (as defined in federal regulations 40 CFR Part 503), or any combination thereof.

   - Compost shall be produced using an aerobic composting process meeting CFR 503 regulations, including time and temperature data indicating effective weed seed, pathogen and insect larvae kill.

   - Compost shall be well decomposed, stable, and weed free with variable particle size with maximum dimensions of two inches in length, one-half inch in width, and one-half inch in depth. It shall be refuse free (less than one percent by weight), free of any contaminants and materials toxic to plant growth, inert materials not to exceed one percent by dry weight, with a pH of 5.5 to 8.0 a carbon-nitrogen ratio which does not exceed 100, and moisture content not to exceed 45 percent by dry weight.

2. Aggregate Specifications:
   - INDOT CA No. 5 or No. 8 aggregate.

3. Straw, Excelsior, etc. are to be pre-manufactured.

2 x 2-inch hardwood or steel posts are to be utilized for anchoring.

Bonding agents are optional. Tackifiers, flocculants, or microbial additives may be used to remove sediment and/or additional pollutants from stormwater runoff. (All additives combined with compost materials should be tested for physical results at a certified erosion and sediment control laboratory and biologically tested for elevated beneficial microorganisms at a United States Compost Council, Seal of Testing Assurance approved testing laboratory.)

Installation:

Instructions for various application are as follows:

1. Filter berm:
   - Lay out the location of the filter tube barrier so that it is parallel to the contour of the slope and at least 10 feet beyond the toe of the slope to provide a sediment storage area.
   - Turn the ends of the filter tube barrier up slope such that the point of contact between the ground and the bottom of the filter tube barrier end terminates at a higher elevation than the top of the filter sock barrier at its lowest point.
   - Excavate a trench with a depth and width equal to at least one-fourth the diameter of the filter tube or follow the manufacturer's recommendations. Where applicable, the trench may also be excavated upslope of a curb or sidewalk.
   - Placing the product against the curb or sidewalk will provide additional stability and resistance to surface flow.
   - Filter socks can be placed at the top of slopes to reduce runoff velocity and help vegetation establishment.

2. Check dam:
   - Install three horizontal rows to form a pyramid and secure with wooden stakes.
   - Install geotextile fabric below the socks and extend the fabric downstream to prevent scour.
   - When used with a ditch line, shaped with a lower center and sides tied into the slopes.
   - Adding a filter stone wedge to face will increase efficacy in filter sock check dams.

Construct the filter tube or utilize a pre-manufactured product. For compost use a pneumatic blower or similar device to provide adequate and consistent fill in the tube (seed or sod may be applied at the time of installation for permanent applications).

If more than one tube is placed in a row, the tube should be overlapped with both ends of the overlapping tube on the ground; not abutted or stacked.

Anchor the filter tube barrier in place by driving posts immediately downstream of the barrier and into the underlying soil material. Posts should be spaced no more than five feet apart and driven a minimum of 18 inches deep into the soil. The stake should be flush with the top of the tube. Wedge the stake when possible.

Backfill the trench with excavated soil placed against the filter tube barrier to ground level on the down-slope side and to two inches above ground level on the up-slope side of the filter tube barrier. Compact the fill material to keep it in place.

Maintenance: Inspect once every 7 days and after each rain event. Secure and replace damaged filter socks. Replace with a stronger measure, such as rock, if damage is severe or reoccurring.

Remove accumulated sediment when it reaches one-quarter the height of the filter tube. Inspect to ensure that the tube is maintaining its integrity and producing adequate flow. Repair eroded and damaged areas within 24 hours.

If ponding becomes excessive, tube should be removed and either reconstructed or new product installed. Traffic shall not be permitted to cross the filter tube.

After the contributing drainage area has been stabilized, remove the filter tube and sediment deposits, bring the disturbed area to grade, and stabilize the area.

BMP6 TEMPORARY DIVERSION

CONSTRUCTION PHASE BMP

Significantly Targeted Pollutants: Sediment

Partially Targeted Pollutants: None

Purpose: Temporary diversions are used to temporarily direct stormwater runoff in a controlled manner to a desired location; especially to protect work areas and to manipulate watershed areas for sizing of sediment control measures.

Specifications: The maximum contributing drainage area for temporary diversions is 3 acres.

Temporary diversions shall be designed for a peak runoff from a 2-year frequency, 24-hour duration rain event.

Side slopes shall be a ratio of 2:1 or flatter with a minimum top width of 2 feet.

Refer to the Hobart, Indiana, standards and ordinances.

Installation: Lay out the diversion by setting grade and alignment to fit site needs and topography maintaining a stable, positive channel grade towards the outlet.

Remove and properly dispose of brush, trees, and other debris from the foundation area. Construct the diversion to dimensions and grades shown in the construction plans.

Construct the diversion ridge in 6-inch to 8-inch lifts. Compact each lift by driving wheels of construction equipment along the ridge. Overfill and compact the ridge to design height plus 1% to allow for settlement.

Stabilize outlets prior to or during construction of the diversion and divert sediment-laden stormwater flow to a temporary sediment trap or a temporary dry sediment basin.

Maintenance: Inspect within 24 hours of each rain event and at least once every seven calendar days. Remove sediment from the channel to maintain positive grade.

Check outlets and make necessary repairs immediately. Adjust ridge height to prevent overtopping.

After the contributing drainage area has been stabilized, remove the temporary diversion, bring the disturbed area to grade, and stabilize the area.

BMP7 TEMPORARY SLOPE DRAIN

CONSTRUCTION PHASE BMP

Significantly Targeted Pollutants: Sediment

Partially Targeted Pollutants: None

Purpose: Temporary slope drains are utilized to temporarily convey stormwater runoff down the face of a slope without causing erosion. Use in combination with drainage channel or swale at the top of the slope to direct water to the pipe or culvert used to convey water down a slope where there is a high potential for erosion.

Specifications: Temporary slope drains shall be designed for peak runoff from a 2-year frequency, 24-hour duration rain event.

Typically, this measure is used for less than 2 years during grading operations until permanent drainage structures are installed or slopes are permanently stabilized.

The area that a temporary slope drain shall not exceed 5 acres.

The outlet pipe shall extend beyond the toe of slope and terminate on a stable, minimum 4-foot long level section.

Fill shall be used and compacted over the pipe to a minimum of a depth of one foot to 1.5 feet, width of 4 feet, and a height that is 6 inches higher than the diversion ridge to divert runoff to the temporary slope drain.

Pipe selection shall be in accordance with the following table:

Maximum Drainage Area Per Pipe (acres)	Minimum Pipe Diameter (inch)
0.50	8
0.75	10
1.00	12
> 1.00	Individually designed

When water reaches the temporary slope drain, with proper installation and maintenance, the measure will be 100% effective at not adding TSS to the discharge.

Refer to the Hobart, Indiana, standards and ordinances.

Materials: Pipe shall be strong and flexible, such as heavy duty, non-perforated, corrugated plastic. A flared-end or "T" type end section shall be utilized for the inlet.

Wooden stakes or rebar shall be utilized to anchor the slope drain.

Installation: Temporary slope drains shall be placed on undisturbed soil or well compacted fill. The slope drain inlet shall be at the bottom of the diversion channels. Connect the pipe to the inlet section.

Construct the diversion ridge by placing fill over the pipe in 6-inch lifts. Compact each lift by hand tamping under and around the inlet and along the pipe.

The top of fill shall be 6 inches higher than the adjoining diversion.

All pipe connections shall be watertight and secure so that joints will not separate in use.

Anchor the pipe to the face of the slope with stakes spaced no more than 10 feet apart. Extend the pipe beyond the toe of slope to a stable grade. Protect the outlet from erosion.

Grade the diversion channel at the top of the slope toward the temporary slope drain (slope < 2%).

Stabilize all disturbed areas following installation.

Maintenance: Inspect weekly and following each rain event. Remove sediment from the channel and reinforce the ridge as needed.

Check the inlet for sediment and trash accumulation.

Check the fill over the pipe for settlement, cracking, or piping holes and repair any problems immediately.

Check for holes where the pipe emerges from the dike and repair any problems immediately.

Check the conduit for evidence of leaks or inadequate anchoring and repair any problems immediately.

Check the outlet for erosion or sedimentation and clean and repair or extend if necessary.

After the contributing drainage area has been stabilized, remove the slope drain and sediment deposits, bring the disturbed area to grade, and stabilize the area.

BMP8 BASKET CURB INLET PROTECTION

CONSTRUCTION PHASE BMP

Significantly Targeted Pollutants: Sediment

Partially Targeted Pollutants: Floatable Materials

Purpose: Basket curb inlet protection is utilized to minimize sediment from entering the storm system while still allowing runoff to enter the storm sewer system.

Specifications: Basket curb inlet protection shall be limited to a one quarter of an acre maximum contributing drainage area.

Basket curb inlet protection shall be designed to handle the runoff from a 2-year, 24-hour duration rain event entering a storm drain without bypass flow.

Filter sock inlet protection is preferred to basket curb inlet protection in already developed areas. It is the site owner and contractor's responsibility to prevent flooding that may be caused by restricting inlet intake capacity. A representative from the site owner or contractor shall be onsite during any storm in excess of the 2-year 24-hour duration rain event.

Refer to the Hobart, Indiana, standards and ordinances.

Materials: Basket curb inlet protection shall be constructed of a metal frame or basket with a top width and length such that the frame fits into the inlet.

Geotextile fabric shall be in accordance with the following table:

Physical Property	Woven Geotextile Fabric	Non-Woven Geotextile Fabric
Filtering efficiency	85%	85%
UV resistance	70%	85%
Standard tensile strength at 20% elongation	30 lbs per linear inch	50 lbs per linear inch
Extra tensile strength at 20% elongation	50 lbs per linear inch	70 lbs per linear inch
Slurry flow rate	0.3 gal/min/square feet	4.5 gal/min/square feet
Water flow rate	15 gal/min/square feet	220 gal/min/square feet

Installation: Install basket curb inlet protection as soon as inlet boxes are installed or prior to land disturbing activities for existing inlets.

If necessary, adapt basket dimensions to fit inlet box dimensions.

Remove the grate and install the frame into the grate opening. Cut and install geotextile fabric according to the manufacturer's recommendations. Replace the grate.

Maintenance: Inspect daily and after each rain event and remove sediment.

Replace or clean geotextile fabric as needed and following any rain event.

Remove tracked on sediment from the street, without flushing with water, to reduce the sediment load on the curb inlet.


BMP9 GRAVEL DONUT DROP INLET PROTECTION

CONSTRUCTION PHASE BMP

Significantly Targeted Pollutants: Sediment

Partially Targeted Pollutants: Floatable Materials

Purpose: Gravel donut drop inlet protection is utilized to capture sediment at the approach to a storm drain inlet allowing full use of the storm drain system during construction.

Specifications: Gravel donut drop inlet protection is limited to a maximum of one acre of contributing drainage area.

Gravel donut drop inlet protection shall be designed to handle runoff from a 2-year frequency, 24-hour duration rain event entering a storm drain without bypass flow.

The outside side slopes of the aggregate donut shall be at a 2:1 ratio or flatter. The inside side slopes of the aggregate donut shall be at a 3:1 ratio or flatter.

The height of the aggregate donut shall be 12 inches to 24 inches above the top of the inlet.

Keep the minimum volume of excavated area around the drop inlet at approximately 1800 ft^3/acre disturbed.

Refer to the Hobart, Indiana, standards and ordinances.

Materials: Gravel donut drop inlet protection shall be constructed of INDOT uniform B riprap and INDOT CA No. 5 aggregate.

Installation: Excavate an area a minimum of 8 inches deep and 12 inches wide immediately out from the storm drain.

Around the excavated area, lay a ring of INDOT Uniform B Riprap to a height of 9 inches to 21 inches above the top of the inlet.

Cover the outside face of the ring with at least 12 inches of INDOT CA No. 5 aggregate, maintaining the slopes listed above.

Place INDOT CA No. 5 aggregate in the 12 inchwide excavation, from the toe of the inside slope to the inlet structure.

Maintenance: Inspect the structure daily and after each storm event. Remove sediment and make necessary repairs immediately.

When the contributing drainage area has been stabilized, remove, and properly dispose of any unstable sediment and construction material and restabilize.

BMP10 WELDED WIRE INLET PROTECTION

CONSTRUCTION PHASE BMP

Significantly Targeted Pollutants: Sediment

Partially Targeted Pollutants: Floatable Materials

Purpose: Welded wire inlet protection is utilized to capture sediment at the approach to a storm drain inlet allowing full use of the storm drain system during construction.

Specifications: Welded wire inlet protection is limited to a maximum of one acre of contributing drainage area.

Welded wire inlet protection shall be designed to handle runoff from a 2-year frequency, 24-hour duration rain event entering a storm drain without bypass flow.

Refer to the Hobart, Indiana, standards and ordinances.

Materials: Welded wire inlet protection shall be constructed of 6 inch by 6 inch welded wire mesh formed of 10 gauge steel conforming to ASTM A-185 with geotextile fabric fastened by rings constructed of wire conforming to ASTM A-641, A-809, and A-938.

Installation: Geotextile shall be wrapped 3 inches over the top member of the 6 inch by 6 inch welded wire mesh and shall be secured with fastening rings through both geotextile layers and close around a steel member at 6 inches on center.

Geotextile shall be secured to the sides of the welded wire mesh with fastening rings at a spacing of one per square foot except for the bottom 2 inches, which shall extend past the welded wire and be left unsecured for entrenchment.

Welded wire assembly shall be formed into a minimum 42-inch diameter circle or 42-inch by 42-inch square with a minimum of 3 inches of overlap on the ends secured by wire or zip ties.

Welded wire assembly shall be placed in a 6-inch-deep trench and backfilled and compacted over the geotextile flap.

Maintenance: Inspect the welded wire inlet protector weekly and after each rain event.

If geotextile tears, starts to decompose, or in any way become ineffective, replace the affected portion immediately. Replace welded wire inlet protector at least every 6 months.

Remove the deposited sediment when it reaches half the height of the assembly at its lowest point or it is causing the structure to shift. Take care to avoid undermining the assembly during clean out.

After the contributing drainage area has been stabilized, remove the assembly and sediment deposits, bring the disturbed area to grade, and stabilize.

BMP11 TEMPORARY CONSTRUCTION ENTRANCE

CONSTRUCTION PHASE BMP

Significantly Targeted Pollutants: None

Partially Targeted Pollutants: Sediment, Nutrients, Toxic Materials, Oil & Grease

Purpose: The purpose of the temporary gravel construction entrance is to provide ingress and egress to a construction site and minimize tracking of mud and sediment onto public roadways.

Specifications: The entrance shall be placed to avoid steep slopes, blind spots, or curves on public roads.

The temporary gravel construction entrance should be the full width of the roadway entrance/exit or a minimum of 20 feet wide and a minimum of 50 feet in length. If the site is 2-acres or larger, the construction entrance should be a minimum length of 150 feet. A modification to the construction entrance length can be submitted for acceptance by the City Engineer and shall include justification for such a reduction based on site conditions. Additionally, the construction entrance length shall not be less than 50 ft.

If installing a temporary rock construction entrance, the entrance shall be a minimum of 6 inches thick. Rock shall be underlain with nonwoven geotextile fabric.

The overall effectiveness in percentage of soil removal from vehicles, preventing tracking sediment, can range from less than 30%, and up to 60%, but is highly dependent on design, installation, frequency of use, and maintenance.

In certain situations, construction entrances other than stone may be preferred and may reduce cost. Alternatives include: timber mats, reusable rubber mats or rumble plates, and wheel wash systems or other manufactured systems with City Engineer's approval. When utilizing a manufactured product, follow the manufacturer's specifications.

Refer to the Hobart, Indiana, standards and ordinances.

Materials: Utilize INDOT CA No. 2 aggregate for the base. Utilize INDOT CA No. 53 washed aggregate to top-dress.

Geotextile fabric shall be used as a separation layer to prevent intermixing of aggregate and the underlying soil material.

Manufactured products may be used in lieu of aggregate and must be approved by the City Engineer prior to use.

Installation: Remove all vegetation and other objectionable material from the foundation area and grade the foundation and crown for positive drainage.

If longitudinal slope is in excess of 2%, construct a water bar (ridge) approximately 15 feet from the entrance to divert runoff away from the road.

Install pipe under the pad to maintain proper public road drainage if necessary.

If wet conditions are anticipated place geotextile fabric on the graded foundation to improve stability.

Place aggregate to proper dimensions and grade as shown on the erosion control plan. Leave the surface smooth and sloped for drainage.

Top-dress the drive with INDOT CA No. 53 washed aggregate.

Divert all surface runoff and drainage from the stone pad to a sediment trap or basin.

Maintenance: Inspect daily and after each storm event or heavy use. Reshape the pad and top-dress as needed for drainage and runoff control.

Immediately remove mud and sediment tracked or washed onto public roads by brushing or sweeping. Flushing should only be used if the water is conveyed to a sediment trap or basin or vacuumed up.

BMP12 RIPRAP

CONSTRUCTION PHASE AND POST-CONSTRUCTION PHASE BMP

Significantly Targeted Pollutants: Sediment

Partially Targeted Pollutants: None

Purpose: Riprap is a permanent layer of large, angular stone, utilized to protect and stabilize slopes or areas of concentrated flow and subject to erosion by water.

Specifications: Riprap shall be placed at a slope with a ratio of 2:1 or flatter.

The minimum thickness of riprap shall be two times the designed stone diameter plus the depth of the bedding material.

When used around waterways, additional permits may be needed, and site design must take into consideration the normal wildlife movement and not be a hazard to wildlife or to vehicle traffic.

Riprap Maximum Size Based on Velocity of Flow	
Velocity (feet per second)	Dmax (inches)
Less than 5.0	6
5.0 or greater	BMP24 Hybrid Turf Mat or BMP25 Tied Concrete Block

Refer to the Hobart, Indiana, standards and ordinances.

Materials: Riprap shall be hard, angular, and weather resistant. Riprap shall have a specific gravity of at least 2.5.

Riprap shall be of a size and gradation that will withstand velocities of stormwater discharge flow design. Riprap size will increase with velocity.

Riprap shall be a well-graded mixture of stone with 50% of the stone pieces by weight larger than the designed size. No more than 15% of the pieces by weight should be less than 3 inches.

Riprap should always be underlain by a non-woven geotextile fabric.

Installation: Excavate only deep enough for both filter and riprap. Compact any fill material to the density of the surrounding undisturbed soil.

Cut a keyway into stable material at the base of the slope to reinforce the toe. Keyway depth shall be one and a half times the design thickness of the riprap (minimum 2 feet) and should extend a horizontal distance equal to the design thickness (minimum 1 feet 6 inches). Request inspection from the City of Hobart Engineering Department prior to placing geotextile and riprap.

Place geotextile fabric on the smoothed foundation, overlapping the edges a minimum of 12 inches. Secure with anchor pins spaced every 3 feet along the overlap.

Immediately after installing the geotextile fabric add the riprap to full thickness in one operation. Do not dump through chutes or use any method that causes segregation of rock sizes or that will dislodge or damage the underlying geotextile fabric.

If fabric is damaged, remove the riprap and repair by adding another layer of fabric overlapping the damaged area by a minimum of 12 inches.

Place similar aggregate in voids to form a dense, uniform, well graded mass. Blend the riprap surface smoothly with the surrounding area to eliminate protrusions or over falls.

Maintenance: During construction, inspect periodically for displaced aggregate material, slumping, and erosion at edges, especially downstream or downslope, after rain events, and at a minimum every 7 days.

Replace rock or other components that have become dislodged.

Immediately repair damages to geotextile fabric.

Inspect riprap for signs of erosion and scour or sediment accumulation.

Remove accumulated material including sediment, trash, and woody debris from riprap.

If riprap stones continue to wash away, replace them with larger stones.

For permanent installations, inspect riprap every 6 months.

BMP13 ENERGY DISSIPATOR (OUTLET PROTECTION)

CONSTRUCTION PHASE AND POST-CONSTRUCTION PHASE BMP

Significantly Targeted Pollutants: Sediment

Partially Targeted Pollutants: None

Purpose: To prevent erosion at the outlet of a channel or conduit by reducing the velocity of stormwater flow and dissipating its energy.

Specifications: Outlet protection shall be designed for the peak runoff from a 10-year, 24-hour storm event or the design discharge of the water conveyance structure, whichever is greater.

Maximum velocity through the outlet protection shall be 10 feet per second.

The tailwater depth shall be determined immediately below the structure outlet and based on design discharge plus other contributing flows. Apron length and width shall be determined based upon tailwater conditions.

Outlet protection shall be aligned straight with channel flow. If a curve is necessary to align the apron with the receiving stream, locate the curve in the upstream section of the apron.

Plunge pools, stilling basin, or impact basins, may be necessary with higher velocities.

When using riprap, outlet protection thickness shall be 1.2 times the maximum stone diameter for a d50 stone size of 15 inches or larger and 1.5 times the maximum stone diameter for a d50 stone size of 15 inches or less.

Pipe Size (in)	Average Riprap Diameter (in)	Apron Width (ft)	Apron Length (ft)
8	3	2 to 3	5 to 7
12	5	3 to 4	6 to 12
18	8	4 to 6	8 to 18

Pipe diameters greater than 18” must utilize alternative measures to riprap, such as hybrid- turf mat and tied concrete block or receive approval from the City Engineer for larger diameter riprap if alternatives cannot be implemented. Follow manufacturer’s guidance for apron sizing.

Place energy dissipation for temporary and permanent outlets within 24 hours after connection to a surface water or permanent stormwater treatment system.

Refer to the Hobart, Indiana, standards and ordinances.

Materials: For short term application, temporary energy dissipators at construction sites, often include riprap aprons. Permanent dissipators will be decided on during the design phase of the project and based on erosive force estimates and the final aesthetics desired. When using riprap, it will be hard and angular, highly weather resistant, with a specific gravity of at least 2.5, and size and gradation that will withstand velocities of stormwater discharge design flow.

Riprap shall be a well-graded mixture of stone with 50 percent of the stone pieces, by weight, larger than the d50 size and the diameter of the largest stone equal to 1.5 times the d50 size.

Turf reinforcement products, hybrid turf mat, tied concrete blocks, gabion baskets, grouted riprap, interlocking concrete blocks, drop structures, and cabled concrete are alternative options to riprap.

Installation: Divert surface water runoff around the structure during construction so that the site can be properly dewatered for foundation preparation.

For installation of riprap aprons, excavate foundation and apron area subgrades below design elevation to allow for thickness of the filter medium and riprap. Compact any fill used in subgrade preparation to the density of surrounding undisturbed soil material. Remove roots and debris then smooth subgrade enough to protect geotextile fabric from tearing. Place geotextile fabric or aggregate bedding material (for stabilization and filtration) on the compacted and smoothed foundation. Install riprap to the lines and elevations shown in the construction plans. Blend riprap smoothly to surrounding grade. If the channel is well defined, extend the apron across the channel bottom and up the channel banks to an elevation of six inches above the maximum tailwater depth or to the top of the bank, whichever is less. If geotextile fabric tears when placing riprap, repair immediately by laying and stapling a piece of fabric over damaged area, overlapping the undamaged areas by at least 12 inches.

When using a manufactured product, such as turf reinforcement mats or tied concrete block, the manufacturer’s specifications for installation and design standards must be followed. All permanent dissipators will be identified within the design of the project.

Maintenance: Inspect within 24 hours of a rain event and at least once every 7 calendar days during construction.

Inspect for stone displacement; replace stones ensuring placement at finished grade. Check for erosion

or scouring around sides of the apron; repair immediately.

Check for piping or undercutting; repair immediately.

BMP14 EROSION CONTROL BLANKET

CONSTRUCTION PHASE AND POST-CONSTRUCTION PHASE BMP

Significantly Targeted Pollutants: Sediment

Partially Targeted Pollutants: None

Purpose: Erosion control blankets are utilized to prevent erosion by protecting the soil from rainfall impact, overland water flow, concentrated runoff, and wind. They are also used to provide temporary surface stabilization, to anchor mulch in critical areas, to reduce soil crusting, and to conserve soil moisture and increase seed germination and seedling growth.

Specifications: The effective service life of an erosion control blanket is dependent upon the material used; follow manufacturer's recommendations.

Erosion control blankets shall be used on all slopes steeper than 3:1. Staples, pins or stakes shall be used to prevent movement or displacement of the blanket. Erosion control blankets must be installed within 24 hours of seeding.

Erosion control blankets typically can reduce erosion potential by 90%.

Refer to the Hobart, Indiana, standards and ordinances.

Materials: Erosion control blankets shall be made of organic mulch incorporated with a natural fiber or similar netting material. Six to twelve inch non-metallic staples, pins or stakes shall be utilized to secure the blanket.

Utilizing wildlife friendly materials, such as plastic free jute nets and straw is preferred, especially near and around waterways and within ditches.

Installation (Flowline Application): Prepare soil before installing blankets including any necessary application of lime, fertilizer, or seed.

Begin at the top of the channel by anchoring the blanket in a 6 inch deep by 6 inch wide trench with approximately 12 inches of blanket extended beyond the upslope portion of the trench. Anchor the blanket with a row of staples/stakes approximately 12 inches apart in the bottom of the trench. Backfill and compact the trench after stapling. Apply seed to compacted soil and fold remaining 12-inch portion of blanket back over seed and compacted soil. Secure blanket over compacted soil with a row of staples or stakes spaced approximately 12 inches apart across the width of the blanket.

Roll center blanket in direction of water flow in the bottom of the channel. Blankets will unroll with appropriate side against the soil surface. All blankets must be securely fastened to soil surface by placing staples or stakes in appropriate locations as recommended by the manufacturer.

Place consecutive blankets end over end (shingle style) with a 4 inch to 6-inch overlap. Use a double row of staples staggered 4 inches apart and 4 inches on center to secure blankets. Joints are to be staggered in subsequent rows.

Full length edge of blankets at top of side slopes shall be anchored with a row of staples or stakes approximately 12 inches apart in a 6 inch deep by 6-inch-wide trench. Backfill and compact the trench after stapling.

Adjacent blankets shall be overlapped approximately 4 inches to 6 inches and stapled. To ensure proper seam alignment, place the edge of the overlapping blanket even with the colored seam-stitch on the blanket being overlapped.

In high flow channel applications, a staple check slot is recommended at 30-foot to 40-foot intervals. Use a double row of staples staggered 4 inches apart and 4 inches on center over entire width of the channel.

The terminal end of the blankets must be anchored with a row of staples or stakes approximately 12 inches apart in a 6 inch deep by 6-inch-wide trench. Backfill and compact the trench after stapling.

Installation (Slope Application): Prepare soil before installing blankets, including any necessary application of lime, fertilizer, or seed.

Begin at the top of the channel by anchoring the blanket in a 6 inch deep by 6 inch wide trench with approximately 12 inches of blanket extended beyond the upslope portion of the trench. Anchor the blanket with a row of staples or stakes approximately 12 inches apart in the bottom of the trench. Backfill and compact the trench after stapling. Apply seed to compacted soil and fold remaining 12-inch portion of blanket back over seed and compacted soil. Secure blanket over compacted soil with a row of staples or stakes across the width of the blanket spaced approximately 12 inches apart.

Roll the blankets either down or horizontally across the slope. Blankets will unroll with appropriate side against the soil surface. All blankets must be securely fastened to soil surface by placing staples/stakes in appropriate locations as recommended by the manufacturer.

The edges of parallel blankets shall be stapled with approximately 2 inches to 5 inches overlap depending on the blanket type. To ensure proper seam alignment, place the edge of the overlapping blanket even with the colored seam stitch on the previously installed blanket.

Consecutive blankets spliced down the slope must be placed end over end with an approximate 3-inch overlap. Staple through overlapped area, approximately 12 inches apart across entire blanket width.

Maintenance: Inspect the erosion control blanket installation site immediately after seeding to verify seed coverage. Inspect within 24 hours of each rain event and at least once every seven calendar days.

Check for erosion or displacement of the blanket. If any area shows erosion, pull back that portion of the blanket covering the eroded area, add soil and tamp, reseed the area, then replace and staple the blanket.

BMP15 VEGETATED SWALE

POST-CONSTRUCTION PHASE BMP

Significantly Targeted Pollutants: Sediment

Partially Targeted Pollutants: Floatables, Nutrients

Purpose: Vegetated swales are utilized to convey stormwater runoff through and from the site. While moving through the swale, runoff velocity is greatly reduced allowing biofiltration, infiltration, and settling of larger suspended particles.

Specifications: Given adequate subsurface soil infiltration properties, the design of vegetated swales is centered around two parameters: establishing low flow velocities and maximizing surface area for infiltration. Velocities below 1.5 feet per second promote deposition of suspended sediments and increase hydraulic residence time, maximizing treatment time within the swale. Swales designed with cross sections that maximize ground to water contact have increased infiltration and reduced runoff volume.

Siting, design, installation, and maintenance are critical to the performance of swales as a water quality measure. These systems should be designed by a professional proficient in hydrology and stormwater design and in accordance with Chapter 7 of the City of Hobart Stormwater Technical Standards Manual.

Typical storm intensities should be calculated for each specific site location.

Swale design should be based on flow rate, not volume. Runoff should pass from the upstream end to the downstream end of the swale in ten minutes.

Swale should be designed to effectively handle runoff from a one-inch, 24-hour storm event and efficiently pass excess runoff from larger storms (e.g., 10-year storm events).

Perforated pipe underdrains are required if the slope is less than 1 percent.

Materials: Soil infiltration rates between 0.5 and 3.0 inches per hour are preferred.

Ideally, the clay content of the soil should be less than 20 percent, the silt/clay content should be less than 40 percent, and both should be in the U.S. Department of Agriculture Natural Resources Conservation Service hydrologic groups A or B.

Coarse, highly permeable soils should be avoided because they have shorter infiltration times and are less conducive to supporting growth of vegetation.

Impermeable soils facilitate ponding and should be avoided.

The bottom of the swale should be at a minimum of two feet above the seasonal water table or bedrock.

Less desirable soils can be amended to improve infiltration characteristics.

Vegetation should be limited to perennial grasses, grass-legume mixes, and prairie mixes.

Species of vegetation chosen should have a dense growth habit and be able to tolerate extended periods of flooding (up to 48 hours).

Vegetative species can be selected to target different types of pollutants. Vegetation height should be maintained at a minimum height of three to four inches.

Installation: Parabolic or trapezoidal cross sections maximize infiltration.

Triangular cross sections should be avoided as they concentrate flow and promote channel erosion.

Side slopes should be relatively flat (3:1 or flatter).

Channel bottom width should be between two feet and eight feet (based on cross-sectional area required channel flow).

Swale gradients (slopes) of one to two percent are recommended. Swale length should be a minimum of

200 feet to encourage deposition.

Maintenance: Mowing (minimum height of 3 to 4 inches) is required as needed during growing season depending upon vegetation planted.

Inspect for and correct erosion problems twice during the first year and annually thereafter. Remove sediment, trash, and debris from the annually or more frequently if needed.

Remove sediment from the swale when sediment reaches 25 percent or more of swale volume.

Monitor vegetative growth annually to determine if an alternative grass species is more conducive to site conditions.

Remove woody vegetation annually to maintain flow.

BMP16 DRY DETENTION BASIN

POST-CONSTRUCTION PHASE BMP

Significantly Targeted Pollutants: Sediment

Partially Targeted Pollutants: Floatables

Purpose: Dry detention basins are constructed basins that collect, temporarily hold, and gradually release excess stormwater from storm events. Detention is achieved through the use of an outlet control structure that regulates the rate of stormwater outflow. Unlike wet ponds, dry detention basins are designed to drain completely between storm events, thereby attenuating peak flows associated with storm events.

Specifications: Proper design, siting, installation, and maintenance of dry detention and extended dry detention basins are critical if they are to function properly and efficiently. Therefore, these measures should be designed by a professional proficient in hydrology and stormwater design.

Refer to Chapter 8 of the City of Hobart Stormwater Technical Standards Manual for design parameters. The design of a dry extended detention basin may still require stormwater quality measures for pretreatment above the basin but also incorporates several design modifications that may address water quality objectives. These design specifications and modifications are listed below.

Low flow channels should be incorporated into the design of dry detention basins to reduce erosion as runoff enters the pond and to route storm events to the outlet, thereby reducing ponding and providing adequate drainage of the basin. These channels shall be permeable. Channels constructed of impermeable concrete is not allowed.

Extended dry basins should be limited to drainage areas of ten acres or more in order to maintain an orifice opening at the outlet that is sufficiently large to prevent clogging. Basins can be constructed on sites with slopes up to 15 percent, provided the slope within the basin can be made relatively flat to ensure proper design flow. Soils are rarely a limiting factor. Ideally, the basin should be sited on soils with infiltration rates of less than three inches per hour. Sites with highly permeable soils or in a karst landscape may require an impermeable liner or other modification to protect ground water, especially if the basin is being constructed for treatment of runoff from a “hotspot” area. In all cases, the ground water level should remain below the base of the pond at all times to allow the pond to dry out. Site selection should be chosen to maximize flow path length between the inlet and outlet and allow for maximum stormwater detention and release capability of the basin.

A pretreatment BMP is required at the basin inlet to treat the water quality volume or flowrate. Forebays are not an approved measure.

Dry extended detention basins should have a shape with a length to width ratio of at least 3:1 in order to maximize retention time and maximize the length of the flow path between the inlet and outlet. In the event that this shape is not feasible, engineered structures (baffles and internal grading) which convey the water through the basin with the desired flow rate and residence time may be incorporated into the basin design.

All basin side slopes should be limited to a ratio of 3:1. The side slopes of vegetated embankments should be designed at 3:1 (horizontal to vertical). Riprap protected embankments should be no steeper than 2:1. A minimum of one foot of freeboard is recommended above the 100-year storm volume. A geotechnical engineer should evaluate slope stability on sites where the embankment berm is in excess of ten feet. Slopes should be planted immediately with a quick rooting annual as well as long term perennials in order to stabilize slopes and prevent erosion. Basin bottom slopes should be on the order of two percent to achieve complete drainage, but site-specific design criteria may be required to establish appropriate grade.

The basin's drawdown time should be regulated by a stand pipe, gate valve, orifice plate, or notched weir. Outlet structures should be designed to allow the controlled release of detained stormwater runoff and should include measures to deter clogging by debris (e.g., trash racks, skimmers, etc.). Outlet structures should be designed with stability in mind and should be resistant to frost heaving and failure under saturated conditions. All outlet structures must include a stable nonerosive spillway on their downstream side to prevent scour associated with the discharge from the basin.

Basins shall incorporate an emergency spillway capable of safely passing a minimum of a 100-year flow event efficiently through the basin. These spillways should be reinforced and capable of withstanding significant flood conditions. Measures should be taken to stabilize an outlet apron on the downstream side of the emergency spillway so as to reduce the risk of berm failure from scour in a high flow situation. A stabilized outlet apron must be located on the downstream side of the emergency spillway to reduce the risk of embankment failure as a result of scour in a high-flow situation.

Refer to the Hobart, Indiana, standards and ordinances.

Maintenance: Inspect for erosion along pond surfaces two times per year.

Annually inspect for embankment damage, monitor sediment accumulation in the upstream BMP.

Restore dead or damaged ground cover via sodding or seeding as needed.

Remove litter and debris from basin inlet and outlet monthly.

BMP17 WET DETENTION POND

POST-CONSTRUCTION PHASE BMP

Significantly Targeted Pollutants: Sediment

Partially Targeted Pollutants: Nutrients

Purpose: Wet detention ponds, including stormwater ponds, retention ponds, and wet extended detention ponds, are constructed basins that contain a permanent pool of water and treat polluted stormwater runoff. The purpose of a wet detention pond is to detain stormwater runoff long enough for contaminated sediments to settle and remain in the pond and allow the water in the pond to be displaced by the next rain event. This sedimentation process removes particulates, organic matter, and metals from the water while nutrients are removed through biological uptake. By capturing and retaining runoff, wet ponds control both stormwater quantity and quality.

Specifications: Proper design, siting, installation, and maintenance of wet detention ponds are critical if they are to function properly and efficiently. Therefore, these measures should be designed by a professional proficient in hydrology and stormwater design.

Site shall be selected with adequate base-flow to maintain a permanent pool. Underlying soils within hydrologic soil groups C and D are typically adequate to maintain a permanent pool.

The contributing drainage area should be adequate to maintain the minimum water level in the permanent pool. Typically, the drainage area will be a minimum of 25 acres. However, this may need to be adjusted based on design and site characteristics.

Wet detention ponds are to be designed to control multiple types of storm events (e.g., two- and/or 10-year storms) and safely pass the 100-year storm event.

The depth of the permanent pool is typically between three to eight feet. If the pond is too deep, thermal stratification and anoxic conditions may develop. If it is too shallow, trapped sediments could become resuspended. Deeper depths near the outlet may yield cooler temperatures and mitigate downstream thermal impacts. A minimum depth of 10 feet is required if the pond is to contain fish.

A 3:1 length-to-width ratio is used when water quality is of concern. Higher ratios will decrease the potential of short-circuiting and will increase sedimentation within the permanent pool.

Shoreline slopes between 5:1 and 10:1 allow for easy access for maintenance.

The side slopes of the permanent pool should be no steeper than 4:1 and shall include a 10-foot safety ledge.

Ponds are to be wedge-shaped to allow flow to enter the pond and gradually spread out, thereby minimizing potential of little or no-flow zones.

The layout of the pond should provide access areas to conduct maintenance.

The pond should contain a discharge riser and low-flow drain with adjustable gate valve allowing for gradual discharge.

An upstream stormwater quality BMP is required to treat the water quality volume or flowrate. Forebays are not approved.

Emergency spillways are to be sized to safely convey large flood events that exceed a 100-year rain event.

A vegetative buffer around the pond will protect banks from erosion and remove pollutants from overland flow.

Alternative designs for traditional wet detention ponds include wet extended detention ponds, micropool extended detention ponds, and multiple pond systems.

Refer to the Hobart, Indiana, standards and ordinances.

Maintenance: If wetland components are present, inspect for invasive vegetation and remove twice per year.

Inspect for damage and monitor for sediment accumulation in the wet detention pond and upstream BMP annually and after large storm events.

Repair undercut and eroded areas as needed.

Clear debris from the inlet and outlet structures and ensure they are operational monthly.

Remove sediment from the permanent pool when volumes are reduced by 25 percent or the pond is eutrophic every 20 to 25 year.

BMP18 SUBSURFACE DETENTION

POST-CONSTRUCTION PHASE BMP

Significantly Targeted Pollutants: None

Partially Targeted Pollutants: Sediment

Purpose: Subsurface detention systems are designed to store stormwater runoff and release the stormwater to a receiving water. Retention systems are designed to provide infiltration, stormwater storage, and ground water recharge where it would otherwise be impossible due to extensive impervious surfaces.

Specifications: Siting, design, installation, and maintenance of subsurface detention/retention systems are critical if they are to function properly and efficiently. Therefore, these systems, and especially the stormwater component, should be designed by a professional proficient in hydrology and stormwater design.

Refer to Chapter 8 of the City of Hobart Stormwater Technical Standards Manual for design parameters.

Retention systems designed to provide infiltration must consider the soil properties where the system will be installed. They are best suited to well-drained soils with a seasonal water table well below the structure to allow for infiltration. Typical soil infiltration rates should range from .5 to 3.0 inches per hour.

To achieve a water quality benefit, pretreatment of stormwater is required. Stormwater may be pretreated by incorporating an oil-grit separator, hydrodynamic separator, grass swales, wetland/pond system, or other measures into the design of the storage system.

Areas should be as level as possible in order to maximize infiltration rates across the entire structure.

Both grids and pipe systems have backfill requirements (which must be adhered to) specific to the device.

Outflow locations (if used) must prevent concentrated flow conditions from developing within the subsurface storage unit.

Maintenance “ports” should be installed at strategic points to allow for easy inspection and maintenance of the structures.

Maintenance: In high sediment flow conditions, pretreatment is necessary to reduce accumulation in the subsurface detention system. Maintenance of these pretreatment structures can be frequent. The structures themselves should remain relatively maintenance free if proper precautions are taken to limit the amount of sediment and debris that is allowed to accumulate inside the grid or pipe system.

BMP19 GRAVITY OIL-GRIT SEPARATOR

POST-CONSTRUCTION PHASE BMP

Significantly Targeted Pollutants: Sediment, Floatable Materials, Oil & Grease

Partially Targeted Pollutants: Phosphorous, Nitrogen

Purpose: Gravity oil-grit separators are primarily intended as pretreatment for other structural stormwater quality measures for stormwater runoff from high-density sites.

Specifications: Contributing area to each unit shall be determined based on manufacturer's recommendations.

Total wet storage area shall be at least 400 cubic feet per acre of contributing area. The following rates can be used conservatively for design purposes:

Substance	Percent Removed
Total Suspended Solids	40
Total Phosphorous	5
Total Nitrogen	5

Installation shall be per manufacturer's recommendations

Maintenance: The frequency of inspection is dependent upon land use, climate conditions and design. At a minimum, the unit shall be inspected quarterly.

Follow manufacturer's maintenance instructions.

BMP20 HYDRODYNAMIC SEPARATOR

POST-CONSTRUCTION PHASE BMP

Significantly Targeted Pollutants: Sediment, Floatable Materials

Partially Targeted Pollutants: Oil & Grease

Purpose: Hydrodynamic separators are modifications of traditional oil/grit separators that commonly rely on vortex-enhanced treatment of stormwater runoff for pollutant removal.

Specifications: Hydrodynamic separators, individually or in combination, must meet or exceed an 80% TSS removal rate of particles smaller than 125 microns in diameter without re-entrainment. Testing to establish the TSS removal rate of a BMP shall be conducted by an independent testing facility.

Floatable controls shall be incorporated in order to capture and remove floating debris during routine maintenance.

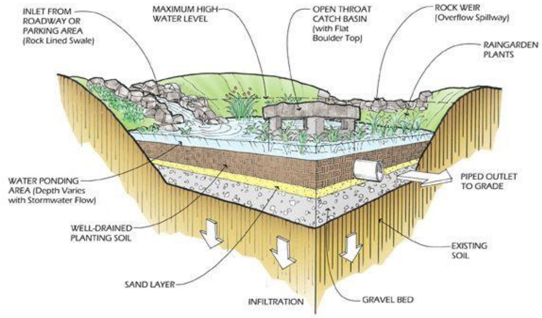
There are a number of different structures on the market that utilize hydrodynamic separation. Hydrodynamic separators utilized in the City of Hobart are required to be certified by a Professional Engineer licensed in the State of Indiana and approved by the Hobart City Engineer.

Hydrodynamic separators shall be installed per manufacturers' recommendations.

Maintenance: Frequent inspection and cleanout are critical for proper operation. Follow manufacturer's recommendations for inspection and maintenance schedules.

Hydrodynamic separators shall have easy, unobstructed access from the top of the unit to allow for inspection, cleanout, and maintenance. The access point shall be located such that is easily and safely accessible with a vacuum truck.

Maintenance typically involves utilizing a vacuum truck to remove accumulated oil, floatables, and sediment.



BMP21 BIORETENTION

POST-CONSTRUCTION PHASE BMP

Significantly Targeted Pollutants: Phosphorous, Metals, TSS, Organics, Bacteria

Partially Targeted Pollutants: Nitrogen

Purpose: Bioretention systems are shallow, landscaped depressions that are designed to treat stormwater runoff from impervious surfaces.

Specifications: Siting, design, installation, and maintenance of bioretention systems are critical elements to consider if they are to function properly and efficiently.

The drainage area is not to exceed 5 acres. The ideal drainage area is one-quarter acre to two acres. Multiple bioretention areas may be required for larger drainage areas.

The bioretention area should be 5 to 10 percent of the imperious surfaces within the drainage area. Bioretention areas are to be a minimum of 10 feet wide by 20 feet long.

A ponding depth of 6 to 9 inches is recommended to provide adequate storage. Slopes shall be 5 percent or flatter.

The bottom of the bioretention system is to be 3 feet or more above the high-water table to minimize the potential for groundwater contamination.

Elements of a bioretention system include a pretreatment area (typically a vegetative filter strip), sand/gravel substrate, organic mulch area, planting soil bed, under drain, overflow structure, and native plants.

A licensed Landscape Architect and/or licensed Professional Engineer should handle specific design of the rain garden as well as specific types of plants, which would be unique for each site.

The licensed Landscape Architect and/or licensed Professional Engineer's specific design must be acceptable by the City and the plan must include supporting sample results, which show the soils are suitable. Soil characteristics must meet suitable ranges to support the biotic community above and below the ground.

The planting plan shall include sequence of construction; a description of the contractor's responsibilities; a planting schedule and installation specifications; initial maintenance requirements; and a warranty period stipulating requirements for plant survival.

Maintenance: Frequent inspection and cleanout is critical for proper operation. Water plants as necessary.

Add mulch once per year and replace the entire mulch area once every two to three years.

Annually test soil pH. Replace soil when levels of pollutants reach toxic levels that decrease the effectiveness of the system.

Inspect inflow points for sediment accumulation and possible clogging twice per year. Remove litter and debris at least monthly.

BMP22 CONSTRUCTED WETLANDS

POST-CONSTRUCTION PHASE BMP

Significantly Targeted Pollutants: TSS, Hydrocarbons, Bacteria

Partially Targeted Pollutants: Phosphorous, Nitrogen, Carbon, Metals

Purpose: Constructed wetlands are man-made systems that utilize wetland plantings and permanent pools of varying depths to control the quantity and quality of stormwater runoff.

Specifications: Constructed wetlands are to be designed by a professional proficient in hydrology and stormwater design.

There must be a minimum contributing drainage area of 10 acres. Pocket wetlands, as little as one acre, can be constructed to contribute to the drainage area.

A minimum dry weather flow path ratio of 2:1 to 3:1 is preferred from inflow to outflow.

Pretreatment of runoff should be provided by incorporating an upstream measure.

Permeable soils are not well suited for constructed wetlands. Soils within the hydrologic soil groups B, C, and D are usually best suited.

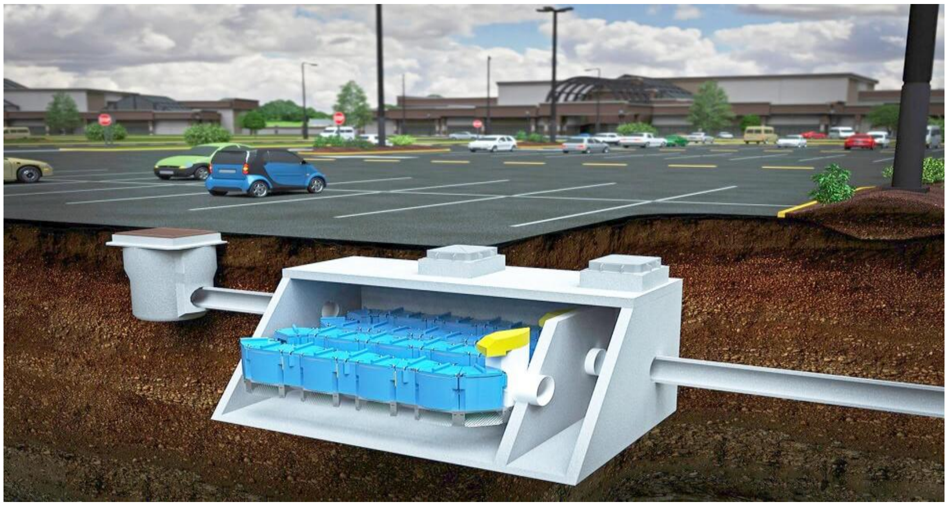
Maintenance: Frequent inspection and cleanout is critical for proper operation.

Replace wetland vegetation to maintain 50 percent coverage for wetland plants one time after the second growing season.

Clean and remove debris from inlet and outlet structures at least quarterly.

Monitor wetland vegetation and perform replacement plantings as necessary semi-annually.

Annually inspect for the stability of the original depth zones and micro-topographic features, invasive vegetation, and damage to the embankment and inlet/outlet structures, repair as necessary.



BMP23 HYDROCARBON FILTERS

POST-CONSTRUCTION PHASE BMP

Significantly Targeted Pollutants: TSS, Hydrocarbons, Coolant and Oil Fluids

Partially Targeted Pollutants: Phosphorous, Lead, Zinc, Copper

Purpose: Hydrocarbon Filters are used to reduce oil, grease, debris, and suspended solids through gravity, centrifugal force, or other methods. BMP's such as these can be useful in areas susceptible to spills or petroleum products, such as fueling stations.

Specifications: Hydrocarbon Filters, individually or in combination, must meet or exceed an 80% TSS removal rate of particles smaller than 125 microns in diameter without re-entrainment. Testing to establish the TSS removal rate of a BMP shall be conducted by an independent testing facility.

Floatable controls shall be incorporated in order to capture and remove floating debris during routine maintenance.

There are a number of different structures on the market that utilize hydrocarbon filters. Hydrocarbon filters utilized in the City of Hobart are required to be certified by a Professional Engineer licensed in the State of Indiana and approved by the Hobart City Engineer.

Hydrocarbon filters shall be installed per manufacturer's recommendations.

Maintenance: Frequent inspection and cleanout is critical for proper operation. Follow manufacturer's recommendations for inspection and maintenance schedules.

Hydrocarbon filters shall have easy, unobstructed access from the top of the unit to allow for inspection, cleanout, and maintenance. The access point shall be located such that is easily and safely accessible with a vacuum truck.

Maintenance typically involves utilizing a vacuum truck to remove accumulated petroleum, floatables, and sediment.

BMP24 HYBRID-TURF MAT

POST-CONSTRUCTION PHASE BMP

Significantly Targeted Pollutants: Sediment

Partially Targeted Pollutants: None

Purpose: Hybrid erosion control methods are a combination of synthetic control method with the benefits of natural vegetation to create a high strength matting or cover for soil surfaces.

Specifications: Typically, the hybrid turf mat is woven or stitched into patterns or extruded in random patterns to create a porous mat, with varied thicknesses and heights. The mat will provide rigid framework for holding seeds in place longer and establishing consistent vegetative stands and promoting a solid base for plant root protection from all types of erosion.

The effective service life of a hybrid-turf mat is dependent upon the material used; follow manufacturer's recommendations.

The mat can be used on 1:1 slopes or shorelines with a wave height up to 1.5 feet. Ensure staking is completed to secure the mat in place and obtain maximum product potential.

Performance Properties		
Velocity	Shear Stress	Tensile Strength
20 ft/s	10 lbs/sf	363 lbs/ft

Refer to the Hobart, Indiana, standards and ordinances.

Materials: Products come in rolls and mats which conform to ASTM D6460.

Installation: Hybrid turf mats shall be placed on seeded soil.

Prepare the seedbed, ensuring the surface is smooth, eliminating all existing rills, soil clods, sticks and rocks larger than 2 inches in diameter. Ensure all soil that is used to fill rills is adequately compacted before seedbed preparation.

Apply seed, fertilizer, and other soil amendments at the specified rates, either by broadcasting, drilling or hydro-seeding.

Select appropriate anchors based on soil type and consistency. Anchor each section per the manufacturer's specifications.

To use on slopes: Anchor the top of the mat, either by installing a 6-inch covered anchor trench or double row anchor check. Unroll the mat, ensuring the simulated turf is on tip and fabric backing is against the soil surface. Ensure the mat is not stretched to tight and it maintains continuous fabric contact with the underlying soil surface.

Ensure the material is overlapped at the seams (2-inch overlap), or as manufacturer recommends.

Anchor the mat to the soil. If there are areas where some wrinkles remain, additional anchors may be necessary to ensure good fabric-to-soil contact.

To use in channels: Position and anchor the mats at the culvert outfall and/or in-flow end of channel, securing with a single row of anchors spaced 1-foot apart. Seam any adjacent mats by butting mat edges together an anchor on a 1.5-foot center, along 3.0foot mat edges, or 2.0-foot centers along 4-foot mat edges. Anchor mats at top of side-slopes with a single row of anchors spaced 1-foot apart.

To use in shorelines: Position and anchor the leading edges of mats at the top of, or over the shoulder of shoreline slope and secure with a single row of anchors spaced 1-foot apart. Seam adjacent mats by butting edges together and anchor on a 1.5-foot center along 30foot mat edges or 2.0-foot centers along 4-foot mat edges. Secure mat body with anchors.

Maintenance: Inspect weekly and following each rain event.

Restore dead or damaged ground cover via seeding as needed.

BMP25 TIED CONCRETE BLOCK MAT

POST-CONSTRUCTION PHASE BMP

Significantly Targeted Pollutants: Sediment

Partially Targeted Pollutants: None

Purpose: Tied concrete block mat is utilized for stabilizing slopes, channels, low water crossings, inlet/outlet protection and shorelines. It consists of concrete blocks locked together and embedded into a high-strength geo-grid and capable of being vegetated.

Specifications: Concrete blocks, consisting of 6.5" x 6.5" with a 2.25" profile, locked together and embedded into a high-strength geo-grid. The blocks have 1.5" spacing between the blocks to allow optional vegetation and give the mat flexibility.

When installed in a stream channel, ensure native vegetation approved by the Indiana Department of Natural Resources or per waterway permits. Perennial vegetation will add to the benefits of tied concrete block mat in areas where vegetation is not needing mowed or kept low near roadway clear zones.

When installing on steep slopes, channels, or stream banks engineered with live staking or native vegetation, the anchors shall exhibit an engineered downward force over the polypropylene grid between the tied concrete blocks.

Standard anchors used are #3 Rebar bent into a "U" shaped 18" in length or percussion anchors with designed cross plates.

Key areas for considering anchoring are the leading edges, seams, and overlaps. The engineer shall design, with assistance from the manufacturer, the spacing layout of the anchored system.

Vegetative support will assist in maintaining and preserving the life span of the geogrid.

Tied concrete block mat is capable of handling 30 ft./sec. and 24 PSF.

Performance Standards			
Bed Slope:	Tested Value:	Test:	Limiting Value30%:
30%	Shear Stress	ASTM 6460	1149 Pa
20%	Velocity	ASTM 6460	9.1 m/s

Refer to the Hobart, Indiana, standards and ordinances.

Materials: Tied concrete block mat is a manufactured product comprised of tied concrete blocks with a double layered underlayment, which is comprised of high-strength biaxial geogrid, 5-pick leno weave, and erosion control blanket.

Installation: Provide the proper equipment to place the mat that will not damage the mat material or disturb the topsoil subgrade and seed bed.

Prepare the subgrade as detailed in the plans. Ensure all subgrade surfaces are free of all rocks, stones, sticks, roots, and other protrusions or debris of any kind that would result in an individual block being raised more than ¾" above the adjoining blocks. When seeding is shown on the plans, provide subgrade material that can sustain growth.

The subgrade should be graded into a parabolic or trapezoidal shape to concentrate flow to middle of mat(s).

Spread seed on the prepared topsoil before placing the concrete mats.

Install mats to the line and grade, as shown on the plans and per the manufacturer's guidelines.

Provide a minimum 18" deep concrete mat embedment toe trench at all edges exposed to concentrated flows, or per plans. Recess exterior edges subject of sheet flow a minimum of 12" or greater if shown on plans.

Anchor or fasten the mats as recommended by the manufacturer or engineer to meet site conditions.

In ditch or channel applications, if the seams run parallel to the flow line in the ditch or channel, an extension of geogrid and specified underlayment shall be provided at a length recommended by the manufacturer or engineer for the site conditions. This extension shall be placed entirely beneath the adjacent upstream mats and anchored using U-anchors or zip ties at manufacturer's or engineer's recommended spacing. If zip ties are used, they shall encompass three cords of geogrid of either adjacent mat. Parallel seams in the center of the ditch shall be avoided when possible.

Seams perpendicular to the flow line shall utilize extensions of geogrid and underlayment executed as in parallel seams or shall be shingled at the manufacturer's or engineer's recommendation. If shingled, seams shall be completed with the downstream mat recessed a minimum of 3 blocks under the upstream mat and fastened together along the seam at 2 ft. maximum spacing if required by manufacturer or engineer.

Maintenance: Routine maintenance can include mowing on stabilized areas and weed eating around wet areas.

The vegetated concrete block mat can be mowed over with commercial mowing equipment.

Do not spray with weed or grass killers, instead use a selective herbicide to control invasive plants.

Maintain adjacent vegetation. Exposed soil above and along the sides of Flexamat should be seeded or covered.

Repair any rills or gullies that can affect upstream/downstream or top of slope terminations.

Check panel seams for any separation.

Inspect outlets that enter the concrete block mat or abutment failure or loss of stabilization.

BMP26 GABION BASKETS

POST-CONSTRUCTION PHASE BMP

Significantly Targeted Pollutants: Sediment

Partially Targeted Pollutants: None

Purpose: Gabion baskets are large rectangular wire mesh boxes that are filled with large stone or riprap. Gabions can be used in drainage channels, low retaining walls, bridge abutments and approaches, culvert headwalls, flow aprons, or drop structures.

Specifications: A gabion wall is the equivalent of a gravity-design retaining wall. Analysis for a gabion wall should include basic computation for structural failure such as sliding, overturning, and settlement.

Walls over 4 feet require the design of a Professional Engineer.

Place geotextile fabric beneath gabions to maintain separation from underlying soils.

Filter fabric must be used in stream channels to avoid loss of fine-grained soils. Ensure the filter fabric is anchored securely using anchor trenches, stakes, staples sewing or a combination of methods.

The wire mesh must be galvanized to resist rust. In addition to being galvanized, the wire mesh can be coated with PVC to further resist deterioration.

Refer to the Hobart, Indiana, standards and ordinances.

Materials: Thin wire mesh, typically galvanized to resist rust.

Riprap is used for filling the gabion baskets.

Tools to secure the tops of the baskets after filled.

Additional materials for anchoring as specified by the Engineer.

Installation: Installation of gabions must be in accordance with the manufacturer's instructions and according to the design documents. Installation should be accomplished within 1 to 2 days. Clear and grade the area of trees, brush, vegetation, and unsuitable soils. Provide equipment access as necessary for earthwork and handling of large rocks.

Prepare the subgrade to the specified depth necessary for installation of gabions.

Compact subgrade to firmly to prevent slumping or undercutting.

Excavate anchor trenches as necessary for installation of geotextile filter fabric.

Install geotextile filter fabric. Be sure the geotextile filter fabric is placed so it isn't stretched too tight and makes continuous contact with the ground. Secure the fabric by using anchor trenches, stakes, staples, sewing, or as approved by the engineer and supported by the manufacturer.

Place a layer or aggregate or sand as a bedding layer (4 inches thick for bedding).

Fold each gabion panel to the proper shape, using heavy gauge wire as recommended by the manufacturer. Lace all contact edges for adjacent gabions as construction proceeds. Stagger and interlock joints for gabion walls.

Ensure the gabions are properly squared and vertical.

Place stone in lifts of 12" thick.

Ensure stone surfaces bear against each other for structural integrity.

Close lids securely using lace or other fasteners as recommended by the manufacturer. If the wire mesh has been cut, then securely fasten to other parts of the gabion structure.

Maintenance: Inspect gabion installation regularly for settlement, scour, damaged wire mesh, or wire corrosion.

Periodically check for excessive growth of bushes, trees, weeks, and other vegetation.

Remove vegetation as needed to maintain channel flow capacity and prevent damage to gabions.

BMP27 BAFFLE SYSTEMS

CONSTRUCTION PHASE BMP

Significantly Targeted Pollutants: Sediment

Partially Targeted Pollutants: Floatables

Purpose: Temporary sediment traps and basins are designed to temporarily pool runoff water to allow sediment to settle before the water is discharged. Porous Baffle systems can be used inside a temporary sediment basin to reduce the velocity and turbulence of water flowing through the structure by spreading the flow across the entire width of the basin. The reduction of turbulent flow facilitates the settling of sediment and improves sediment retention efficiency for sediment detainment structures. Baffles can increase the sediment trapping efficiency by increasing the residency time for sediment to settle out.

Specifications: Access is needed for sediment removal and must be maintained to ensure the baffles continue to function as designed.

Baffles should be at least as tall as the overflow of the basin.

Spacing between baffles shall be determined by the designer and shall allow at least three rows of baffles, with a minimum space of ten feet between each baffle.

Refer to the Hobart, Indiana, standards and ordinances.

Materials: Porous baffle system material consisting of either Turf Reinforcement Matting (TRM) or coconut erosion control blanket, or excelsior erosion control blanket.

The TRM must be composed of non-degradable synthetic fibers, filaments, nets, processed into a permanent, three-dimensional matrix. The non-degradable three-dimensional matrix may be infilled with coconut or excelsior materials. Do not use TRMs infilled with straw.

When using coconut erosion control blanket, or excelsior blanket material, ensure the blankets are made of undyed and unbleached 100% natural fibers that are biodegradable. Do not use erosion control blankets made of straw.

Stake the porous baffle equipment with steel posts. Do not use wood posts. Minimum length of posts must be 5 feet, with minimum yield strength of 50,000 psi, painted with a water based baked enamel paint, and has a soil stabilization plate made of 15-gauge steel with a minimum cross section area of 17 square inches. Add soil stabilization plates every 6 inches of post length past 5.0 feet.

Installation: Ensure the basin is debris free, smooth and level and dry enough to install. Ensure porous baffle systems are installed perpendicular to flow within the sediment control structure. Install porous baffle systems across the entire width of the sediment basin/dam. Ensure the basin is at least 25 feet in length and install the baffles equal distance apart to ensure proper flow mixing.

Porous Baffle Row	Installation Location
1	¼ Length of Basin
2	½ Length of Basin
3	¾ Length of Basin

Install posts on 4-foot centers across the basin. Ensure the posts are driven at least 2 feet depth. Attach the porous baffle system material to the upstream side of the steel posts by using heavy-duty plastic ties, or wire ties that are evenly spaced and placed in a manner to prevent sagging or tearing of the fabric. Attach ties spaced at 6-inch intervals.

Use 12-inch anchors (stakes, pins, or staples) spaced on 1-foot intervals to secure the porous baffle system material to the bottom and up the sediment basin/dam embankments.

Avoid utilizing joints to adhere pieces of porous baffle material together to meet the required length. Consider the length needed and purchase a roll of material and cut to fit in place.

Maintenance: Inspect weekly and following each rain event. Remove sediment when it reaches 50% of the height of the first baffle row.

Check where runoff has eroded a channel beneath the porous baffle, or where the porous baffle has sagged or collapsed. Ensure the porous baffle material stays securely installed along the basin sides and in the bottom. Ensure the porous baffle system does not sag across the top of the porous baffle system. Replace the material if torn or if evidence of deterioration is noted.

Replace the porous baffle material whenever it has deteriorated to the extent that it reduces the effectiveness of the porous baffle system. Maintain access to the porous baffles and replace immediately if the baffle collapses, tears, decomposes or becomes ineffective.

BMP28 DEWATERING FILTER BAG

CONSTRUCTION PHASE BMP

Significantly Targeted Pollutants: Sediment

Partially Targeted Pollutants: None

Purpose: Filter bags are used to prevent water pollution from the discharge of sediment during dewatering of construction site. The filter bag collects sediment and debris from water that is pumped through the geotextile material the bag is constructed out of. out of ditches, runoff collection ponds, drilling, and construction sites. Filter bags are not suggested to be used on clean water that is being pumped around or diverted from a construction activity.

Specifications: Select and design the dewatering practices that are appropriate for the pumping or discharge rate and the removal of the target soil particle.

Locate and install dewatering practices so that discharges from the practice will not come in contact with or flow across exposed soil. Discharge to a stable surface.

Avoid discharging to steep slopes.

When discharging to a waterway or wetlands, do not discharge at a rate that will increase erosion or flood elevations in the receiving water.

Do not discharge at a rate that increases erosion or flooding on off-site properties.

Do not discharge to Karst features or other direct groundwater connections.

Ensure the dewatering filter bag is placed on a level flat surface, with secondary containment on the down gradient side of the level pad.

Refer to the Hobart, Indiana, standards and ordinances.

Materials: Use a UV resistant, non-woven geotextile fabric bag that is sewn into a completely enclosed bag. Ensure the dewatering bag is sewn with high strength double stitched seams. Use a dewatering bag that have a sewn in sleeve to receive the pump discharge hose.

Geotextile Filter Bag Minimum Properties		
Property	**Test Method**	**Value**
Mass Per Unit Area	ASTM D-5261	8 oz/yd^2
Grab Tensile Strength	ASTM D-4632	180 lbs
Grab Elongation	ASTM D-4632	50%
Trapezoid Tear Strength	ASTM D-4533	80 lbs
CBR Puncture Strength	ASTM D-6241	475 lbs
Water Flow Rate	ASTM D-4491	70 gal/min/ft^2
Apparent Opening Size	ASTM D-4751	80 U.S. Sieve
UV Resistance (500 hours)	ASTM D-4355	70%

Level flat surface should be layered with geotextile fabric and riprap.

Secondary containment can be comprised of materials such as a riprap check dam, or filter sock.

Installation: Dewatering filter bags shall not be placed, whole or partially, within waterways or wetlands.

Elevate filter bags to allow water to flow out of the bottom of the bag. Install the filter bag on a level surface to prevent it from rolling into the waterway and for the area to temporarily become saturated.

Ensure the hose is connected to the filter bag securely before turning on the pump. Install a secondary containment on the down-gradient side of the filter bag to assist in sediment removal and slowing down the discharge prior to entering the waterway.

Maintenance: Dewatering filter bags should be removed and replaced once they are half full.

Frequently inspect the filter bag when in operation.

Inspect bags for holes, rips, and tears.

If the receiving waters show any signs of turbid water, erosion, or sediment accumulation, discharges shall be stopped immediately once safety and property damage concerns have been addressed.

Store additional bags out of direct sunlight and in a way to reduce the potential for bags to get punctured by equipment, traffic, or other sharp objects.

BMP29 ROCK FILTER BERM

CONSTRUCTION PHASE BMP

Significantly Targeted Pollutants: Sediment

Partially Targeted Pollutants: None

Purpose: Rock filter berms are a perimeter control of aggregate used to intercept stormwater runoff from a disturbed area and allow the temporary pooling and deposition of sediment prior to discharging off-site or to a waterbody. The rock filter berm is not intended to impound the water.

Specifications: Rock filter berms should be at least ten feet from the base of a slope, installed on a flat surface prior to the waterbody or perimeter of the project, not impeding on the natural riparian buffer or existing natural vegetation.

The maximum height of the rock filter berms should be 2.0 feet and 2:1 side slopes.

The table below provides the limitations for use of the rock filter berm:

Slope Steepness Restrictions		
Percent Slope		Maximum Distance
< 2%	< 50:1	400 feet
2%-5%	50:1 to 20:1	300 feet
5%-10%	20:1 to 10:1	200 feet
10%-20%	10:1 to 5:1	100 feet
> 20%	> 5:1	60 feet

Do not install multiple rows of rock filter berms.

Control the watershed to the rock filter berm by installing J-hooks to maximize water storage within each section of rock filter berm. Each section of rock filter berm separated by J-hooks must not exceed 1 acre. J-hooks must be a minimum of 6 inches higher than the top elevation of the perimeter rock berm.

Design Limitations	
Berm height:	2 to 3 feet
Top width:	1 foot
Front slope:	2:1 or flatter
Back slope:	2:1 or flatter
Pooling side face of berm:	Filter stone (compacted INDOT #5 or #8 stone) 1 foot high X 4 inches wide
Geotextile:	Located under the total width of the berm and extending 3.0 feet downstream of berm

Refer to the Hobart, Indiana, standards and ordinances.

Materials: Use geotextile fabric, revetment riprap or class 1 or 2 riprap, and filter stone.

Level flat surface should be layered with geotextile fabric and riprap.

Installation: The drainage areas should not exceed 50 acres.

Install the rock filter berm on the contour, with the ends turned upslope to prevent discharges from bypassing the measure.

Install measures upslope of the rock filter berm to lessen the amount of sediment in the runoff.

Maintenance: Initial inspections should ensure the rock filter berm is intercepting all upslope runoff from disturbed areas.

Inspect weekly and after rain events.

Check for #5 or #8 filter stone on front face of dam.

Geotextile under dam should extend 3 feet downstream of the berm.

Inspect for channel erosion.

Remove sediment once it reaches one-half the height of the berm.

Ensure the rock filter berm maintains the initial configuration and ponding/filtration/flow function are maintained. Check berm for scouring, where overflows of the berm may occur. Check the berms and note any areas where runoff has blown out or bypassed the bermed areas. Look for washouts, undercutting and end bypasses along berms.

Repair or replace rock filter berms found to be non-functional, due to severe weather conditions, age, extended use, damage, or other causes.

If the rock filter berm is frequently overloaded, based on frequent maintenance, install additional upgradient erosion prevention and/or sediment control practices or redundant measures to eliminate the overloading and amend the stormwater pollution prevention plan to identify the additional measures.

When all areas above the rock filter berm have been stabilized, the temporary rock filter berm must be removed. After removing the temporary rock filter berm, collect and dispose of the accumulated sediment, and fill and compact holes, trenches, depressions, or any other ground disturbance to blend with the surrounding landscape. Stabilize the area with seed, mulch, or sod per the final stabilization plans.

BMP30 ROCK HORSESHOE

CONSTRUCTION PHASE BMP

Significantly Targeted Pollutants: Sediment

Partially Targeted Pollutants: None

Purpose: Rock horseshoe is a sediment control measure that is utilized as an outlet protection device in a sediment pond to minimize sediment leaving a construction site via a sediment basin or outlet connected to a direct conveyance channel. The rock horseshoe, or arc, is constructed out of geotextile fabric, INDOT Revetment Riprap, and #5 or #8 filter stone.

Specifications: Drainage area should not exceed 5 acres.

Rock horseshoe can be used in front of an inlet to a culvert, pipe, stormwater inlet, and sediment basin inlet or outlet.

Ensure there is enough area for sufficient pooling of run-off prior to the rock horseshoe.

Rock horseshoes are not allowed to be placed in a jurisdictional waterway.

For culverts, pipes, or inlet applications the rock horseshoe shall be designed for a 2-year frequency, 24-hour duration storm event.

For use with a sediment basin the rock horseshoe shall meet discharge requirements for sediment basins.

The crest elevation should be the same as the top elevation of the dewatering zone. The weir length/flow depth: flow over the weir for a 2-year frequency, 24-hour duration storm event should be below the emergency spillway and at a velocity that will not displace the riprap. Minimum height is to be 2 feet above the bottom orifice or outlet structure elevation.

Spillway spacing from inlet: 1 foot minimum from toe of the berm back slope to inlet or culvert invert (sufficient distance to minimize horseshoe aggregate from entering into inlet).

Front slope of horseshoe (pooling side): 2:1 or flatter.

Back slope of horseshoe (inlet side): 2:1 or flatter.

Pooling side face of horseshoe: Is covered with facing stone 1 foot thick of INDOT #8 filter stone.

Horseshoe termination ends: Extend aggregate horseshoe up the embankment to prevent flow around end points. The horseshoe ends need to be a minimum of 6 inches higher than the spillway crest.

Embankment side protection: Where embankment slope is to grade stabilize with seeding and mulching and prevent or divert sediment-laden run-off from entering the backside of the horseshoe from the embankment area.

For unstabilized (rough and not to final grade) embankment situations: To prevent inflows of sediment-laden run-off from entry behind the rock horseshoe utilize control options such as: diversion berms, filter sock/filter tube, riprap stabilization, or other methods of stabilization.

Outlet apron to culvert or structure inlet: Stabilize the flow path from the toe of the horseshoe to the inlet with riprap 1 foot thick (minimum) with the top of riprap being flush with the invert/opening.

Ensure the outlet is stabilized with stone, vegetation, geotextile, or other approved material.

Refer to the Hobart, Indiana, standards and ordinances.

Materials: Use geotextile fabric, revetment riprap, and filter stone.

Level flat surface should be layered with geotextile fabric and riprap. Add the filter stone to the upstream or front face of the rock horseshoe.

Installation: Install the rock horseshoe in front of the outlet, arcing towards the stabilized armor surrounding the outlet structure, to prevent erosion at the structure.

Install additional erosion and sediment control measures within the watershed of the disturbed area.

Maintenance: Initial inspections should ensure the rock horseshoe is intercepting discharges from the basin, and flow is passing through the measure.

Inspect every seven days, and within 24 hours of a rain event. Ensure water is passing through the measure and conduct maintenance on the face of the measure if the water is no longer passing through. Redressing the filter stone as needed.

Remove sediment once it reaches one-half the height of the rock horseshoe.

Ensure the rock horseshoe maintains the initial configuration and ponding/filtration/flow function are maintained. Check rock horseshoe for scouring, where overflows of the rock horseshoe may occur. Check the rock horseshoe and note any areas where runoff has blown out or bypassed the rock horseshoe. Look for washouts, undercutting and end bypasses along rock horseshoe.

Repair or replace rock horseshoe found to be non-functional, due to severe weather conditions, age, extended use, damage, or other causes.

If the rock horseshoe is frequently overloaded, based on frequent maintenance, install additional upgradient erosion prevention and/or sediment control practices or redundant measures to eliminate the overloading and amend the stormwater pollution prevention plan to identify the additional measures.

When all areas above the rock horseshoe have been stabilized, the temporary rock horseshoe must be removed. After removing the temporary rock horseshoe, collect and dispose of the accumulated sediment, and fill and compact holes, trenches, depressions, or any other ground disturbance to meet final grade. Stabilize the area with seed and mulch, or per the final stabilization plans.

BMP31 FLOATING SKIMMER

CONSTRUCTION PHASE BMP

Significantly Targeted Pollutants: Sediment

Partially Targeted Pollutants: None

Purpose: Floating skimmer is a sediment control measure which draws the water from just below the water surface, allowing clarified water to release from a basin. When the water level in the basin is down, the skimmer rests on a rock dam to prevent muddy water from discharging and the outlet from clogging with sediment.

Specifications: Floating skimmers shall be designed to dewater sediment basin from the top of the riser within 48 hours.

A portion of the floating skimmer must be visible above the water surface at all times.

Inlets to the floating skimmer must not be submerged more than six inches below the water surface.

All floating skimmers should include a floatable maintenance rope and trash guard.

Include a shallow pit, with minimum dimensions of 4 feet by 4 feet with a minimum depth of 2 feet. Install revetment riprap to the top elevation of the skimmer pit.

Ensure the top elevation of the skimmer pit is lower than the invert of the outlet barrel from the riser.

Ensure a rock dam is constructed for the skimmer to rest when the water level is low so that the skimmer doesn't get buried in the sediment.

Ensure the outlet of the basin is stabilized with stone, vegetation, geotextile, or other approved material.

Refer to the Hobart, Indiana, standards and ordinances.

Materials: Components of the floating skimmer varies based on device type and design. Floating skimmers shall have a flexible joint at the connection with the riser pipe.

Installation: All floating outlet device joints or connections shall be securely fastened. Ensure they are watertight. The skimmer shall be connected to the outlet by a flexible pipe to the outlet structure.

Secure the floating outlet to prevent excessive side to side movement.

Install a rock dam for the floating skimmer to rest on when the water level is down.

Install additional erosion and sediment control measures within the watershed of the disturbed area.

Maintenance: Initial inspections should ensure the floating skimmer is intercepting discharges from the basin, and flow is passing through the measure.

Inspect every seven days, and within 24 hours of a rain event.

Ensure the basin is draining within 48 hours. If flow is restricted, conduct maintenance on the floating outlet to remove debris, trash, or clogged materials.

Replace any buoys which are no longer floating.

Repair or replace floating skimmer found to be non-functional, due to severe weather conditions, age, extended use, damage, or other causes.

Do not use floating skimmers during cold weather periods where freezing conditions could potentially occur.

Once the contributing drainage area has been stabilized, the floating skimmer can be removed.

BMP32 PERFORATED RISER INLET

CONSTRUCTION PHASE BMP

Significantly Targeted Pollutants: Sediment

Partially Targeted Pollutants: None

Purpose: A perforated riser is a vertical standpipe, that has been drilled with regularly spaced holes, designed to control the dewatering time of a sedimentation basin. The openings in the standpipe will allow water to enter the outlet from the water storage zone and extract water from low in the water column of a sediment basin.

Specifications: The number of columns of holes within the perforated riser pipe, the vertical spacing between the holes, and the diameter of the holes must be selected carefully. The perforated riser shall be designed to allow the water to be released within a 24-48 hour period.

Ensure the holes in the riser pipe are at least a ½" and the diameter of the pipe is at least 8".

The lifetime of this temporary structure is 2 years.

The height of the perforated riser shall be at least two-feet and shall be the top elevation of the dewatering zone.

A filter stone cone will be placed surrounding the riser pipe and be a minimum of 1 foot thick.

Wire mesh with 1/4 to 3/8 inch square openings shall wrap the perforated riser pipe at least to the height of the filter stone cone located at the base.

A trash guard shall be installed at the top of the riser standpipe.

An anti-floatation block shall be implemented.

Ensure the outlet of the basin is stabilized with stone, vegetation, geotextile, or other approved material.

The perforated riser can remove up to 80% of the fines suspended in the detained water.

Refer to the Hobart, Indiana, standards and ordinances.

Materials: Components of the perforated riser include PVC pipe, corrugated metal pipe, dual wall drain tile, or similar pipe.

A tee connector between the riser and outlet pipe.

Trash guard, INDOT #8 filter stone, concrete anti-floatation block, and square wire mesh.

Installation: Install riser on a firm, even foundation.

Perforate the riser pipe with ½" holes spaced 3 inches apart vertically and horizontally. Perforations shall extend from the top elevation to the bottom elevation of the dewatering zone.

Attach the riser pipe to the outlet pip with a watertight connector.

Install the trash guard to the riser pipe.

If an antivortex device is required, install.

Embed the riser pipe in a least 1 foot of concrete and a minimum of 6 inches beyond the perimeter of the pipe.

Wrap the perforated riser with wire mesh.

Place an aggregate cone around the perforated riser consisting of #8 filter stone.

Install additional erosion and sediment control measures within the watershed of the disturbed area.

Maintenance: Initial inspections should ensure the perforated riser is intercepting discharges from the basin, and flow is passing through the measure.

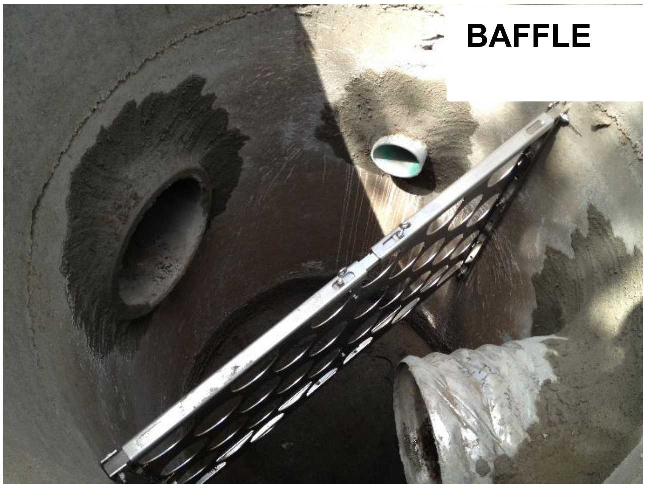
Inspect every seven days, and within 24 hours of a rain event.

Ensure the basin is draining within 72 hours. If flow is restricted, conduct maintenance on the perforated riser pipe to remove debris, trash, or clogged materials.

Replace filter stone around the base of the perforated riser pipe if the basin is not draining within the 72 hour time period.

Remove trash/debris from the top of the riser.

Once the contributing drainage area has been stabilized, the perforated riser can be removed.



BMP33 SUMP MANHOLE WITH BAFFLE

POST CONSTRUCTION PHASE BMP

Significantly Targeted Pollutants: Sediment

Partially Targeted Pollutants: Floatables

Purpose: A modified sump manhole with baffle is a baffle installed in a concrete structure to enhance capture of sediment from stormwater runoff by means of flow redirection and velocity reduction. It fits into a new or existing sump manhole to reduce sediment in stormwater runoff. The targeted pollutant will need to be verified with independent testing to show TSS removal and floatable control.

Specifications: Utilization of sump manholes with baffles, individually or in combination, must meet or exceed an 80% TSS removal rate of particles smaller than 125 microns in diameter without re-entrainment.

Testing to establish the TSS removal rate of a BMP shall be conducted by an independent testing facility.

Floatable controls shall be incorporated in order to capture and remove floating debris during routine maintenance.

The use of modified sump manholes with baffles utilized in the City of Hobart are required to be certified by a Professional Engineer licensed in the State of Indiana and prior to install, the proposed design must be approved by the Hobart City Engineer.

Sump manholes with baffles shall be installed per manufacturers' recommendations.

Refer to the Hobart, Indiana, standards and ordinances.

Materials: The baffle is made of a reinforced sheet of stainless steel with strategically placed holes, designed to effectively capture and retain sediment from stormwater runoff.

Installation: Installation of the modified sump manhole baffle should follow the manufacturer's instructions. Installation guidance can be found within the operation and maintenance manual of the manufacturer's representative and documents available through the manufacturer's website.

Install additional erosion and sediment control measures within the watershed of the disturbed area to provide adequate TSS and floatable removal. Note, additional measures may be necessary to address floatables.

Maintenance: Conduct inspection and maintenance as described within the manufacturers' operation and maintenance manual.

The following tools may be needed:

1. Vacuum truck with jet power washer
2. Measuring tape with attached flat disk
3. Rake or broom

Generally, during the inspection, assess to ensure there is access to the structure and remove any obstruction. Once access is obtained, evaluate the debris within the structure. If the structure is full, sump cleaning will be required. Once clear of debris, evaluate the structural integrity by pulling and pushing on the baffle to assure it is securely anchored to the walls. If the holes of the baffle are clogged, clear the materials and debris from the holes by using a rake or broom. Check the level of sediment accumulated in the sump. Sump depth is measured from the pipe invert to the sump floor. If average sediment depth is more than 18 inches above the sump floor, then the sump needs to be cleaned out.

Sump cleaning shall be completed at a minimum one time a year. If sediment is accumulating more than 18 inches between evaluations, then more frequent cleaning is necessary to ensure maximum capture of sediment and proper maintenance.

Sump cleaning steps:

1. Vacuum water, debris, and sediment
2. Jet wash debris from baffle
3. Jet wash any remaining debris and sediment towards vacuum hose

BMP34 DUST CONTROL

CONSTRUCTION PHASE BMP

Significantly Targeted Pollutants: Sediment

Partially Targeted Pollutants: None

Purpose: Dust control, especially during hot and dry conditions, helps reduce sediment being mobilized by wind.

Specifications: Dust generation will vary on construction sites and is dependent on the amount of exposed soil. Vegetative cover is the most effective way to prevent dust from exposed soil. Straw mulch and temporary erosion control and stabilization practices will provide a fast and effective means of controlling dust. Sequencing activities to limit the amount of exposed or disturbed soil reduces dust generation. A pro-active approach should be used for effective dust control. Alternate measures may be proposed to the City Engineer for approval. All requests must include justification for the alternative measure.

Mechanical methods such as the use of a leaf blower that may result in the mobilization of dust off a construction site is prohibited.

Refer to the Hobart, Indiana, standards and ordinances.

Materials: Methods can include watering, resin/polymer application (with approval by the City of Hobart), mulching, street sweeping, and temporary vegetative covers.

Mechanical methods will require equipment, such as a sweeper and vacuum truck, water truck, application tools for wetting agents, and broom attachment.

Installation: Location of haul and access roads and a method for dust control must be identified and discussed prior to the start of construction. If possible, locate haul roads away from residential, commercial or other public areas.

Apply water at a rate to keep soil wet/moist, but not saturated or muddy.

If brooming is a chosen method, wet the area with water prior to the brooming operation to aid in dust suppression.

Sweeping is generally more efficient for cleaning large areas in less time and generates less dust than brooming.

Maintenance: Most dust control measures, such as application of water or road treatments, will require monitoring and repeat applications as needed to accomplish good control.

Apply additional water or mulch as needed to control dust.

Repetition is required to be effective. Keep construction equipment speeds appropriate for the conditions.

Stabilize disturbed areas with vegetation and mulch as much as possible.

CITY OF HOBART

APPENDIX B

LOW IMPACT DESIGN (LID)MANUAL

2025

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LID1 RAIN GARDEN

Purpose: Rain gardens are shallow depressions with engineered soils and specific plants to help in the infiltration of water and breakdown of pollutants, oils, metals, and others through microorganisms on plant roots from run-off of buildings, roads and/or parking lots. They additionally provide habitat and help with reducing stormwater runoff and flooding.

Recommended Applications: Recommended applications include, but are not limited to, parking lot islands, commercial developments, campus developments, residential developments and other areas that have significant area for water absorption. A minimum of 10 feet away from buildings is recommended for the installation of a rain garden so moisture does not penetrate the foundation. Rain gardens cannot be located over a septic field and will be most effective in a full to partial sun site.

Benefits: Benefits include Pollutant Treatment (solids, nutrients, metals, oils, etc.), reduction of velocity and volume of stormwater run-off, groundwater recharge, micro habitat, aesthetic improvement (compared to lawn or hardscape), minimal maintenance (if installed correctly), and an education opportunity for the public.

Design Criteria: It is best for run-off into a rain garden to be pretreated through a swale or other method to reduce the volume of sediments entering into (or clogging) the rain garden.

Plants should be native and selected based on their tolerance to harsh conditions, including long dry periods, long wet periods, winter snow storage, salt, and sand.

Soil compaction rates should be checked following construction to be sure there isn't a high compaction rate. Compaction is one of the leading causes of a failed rain garden. Subsoil tests should be done before construction to check if the water is percolating through at appropriate rates (1 inch per hour). If the subsoil has poor percolation rates and amending the soil does not help, an underdrain must be used to provide an outlet from the rain garden, to avoid standing water and mosquito problems. If the depth to groundwater is less than two feet, the site shall not be used or considered for a rain garden.

A minimum of 18 inches of uncompacted, engineered and permeable soil shall be placed in, at least, the base of the rain garden. The engineered soil should have an infiltration rate of at least 1 inch per hour. If high water volumes are expected or existing soil has a percolation rate less than 1 inch per hour, also include an underdrain or other overflow structure. If existing soil is desired to be used, but does not pass a percolation test, an on-site mixture of compost and/or sand (or any other addition that will increase the percolation of stormwater) can be done with equipment, like a tiller, that will sufficiently mix without compacting the soil. An additional percolation test shall be done after mixing the soil to ensure proper drainage before planting the rain garden.

The rain garden needs to be designed for a minimum of a 2-year storm event (sizing and treating). The area of coverage, or contributing area, for a rain garden can vary from 2,000 square feet (residential) to 10,000 square feet (commercial or other) depending on the application. This area should be designed as deemed appropriate based on the site amenities and functions.

Construction shall be by low contact pressure equipment, excavators and/or backhoes and shall operate from adjacent ground.

If there is existing desirable vegetation, measures should be taken to have the least amount of impact/removal of this vegetation.

A licensed Landscape Architect and/or licensed Professional Engineer should handle specific design of the rain garden as well as specific types of plants, which would be unique for each site.

The licensed Landscape Architect and/or licensed Professional Engineer's specific design must be acceptable by the City and the plan must include supporting sample results, which show the soils are suitable. Soil characteristics must meet suitable ranges to support the biotic community above and below the ground.

The planting plan shall include sequence of construction; a description of the contractor's responsibilities; a planting schedule and installation specifications; initial maintenance requirements; and a warranty period stipulating requirements for plant survival.

Maintenance: Quarterly inspection to confirm the rain garden system is working correctly and proper disposal of any sediments that are clogging the system.

Vegetation management is needed to reduce weeds and reestablish any plants that do not survive. This can include mowing, spot spraying, controlled burning, and/or re-planting.

If compaction occurs for any reason, measures shall be taken to mitigate the compaction. Compaction can be mitigated in a variety of ways, one of which could be tilling the soil from a location outside of the rain garden.

Inspect rain garden after a large storm event where water is sitting. Water should drain within 48 hours, and if it doesn't, some modifications to the system may be necessary (check compaction rates of soil, add an inlet, or add an underdrain).

Examples: For a list of specific plant types, see your local native plant nursery which specializes in ecological and native plant services or see www.indiananativeplants.org for a list of native plant resources.

For rain gardens that are going to be visible to the public eye, a more aesthetic look may be desirable, and therefore a higher count of wildflowers and shrubs could be used. This type will likely be in residential and commercial settings.

For rain gardens that are not visible to the public eye and are serving more as a functional piece of stormwater management, less wildflowers and shrubs could be used and more grasses/sedges could be used. This type will likely be in an industrial setting

A typical stormwater seed mix will include seven sedges, two rushes, four grasses, and twelve wildflowers/shrubs. Also included in that is a temporary cover crop, including both Common Oat and Annual Rye.

Some situations may benefit from utilizing plugs rather than seeding for aesthetics, soil stabilization, etc. The wetland indicator status states the following:

1) Seven sedges:
    a. Four should be of an obligate wetland status (almost always wet, rarely found in uplands)
    b. Two should be of a facultative wetland status (usually wet, but occasionally found in uplands)
    c. One should be of a facultative status (either wet or dry)
2) Two rushes
    a. One should be of an obligate wetland status (almost always wet, rarely found in uplands)
    b. One should be of a facultative wetland status (usually wet, but occasionally found in uplands)
3) Four grasses
    a. One should be of a facultative status (either wet or dry)
    b. Two should be of an obligate wetland status (almost always wet, rarely found in uplands)
    c. One should be of an obligate upland status (rarely wet, almost always found in uplands)
4) Twelve Wildflowers/Shrubs
    a. Five should be of an obligate wetland status (almost always wet, rarely found in uplands)
    b. Four should be of a facultative wetland status (usually wet, but occasionally found in uplands)

Three should be of a facultative or facultative upland status (occasionally wet, but usually found in uplands)

LID2 NATIVE PLANTS

Purpose: Native plants are used for many reasons, one of which is the grass or wildflowers (prairie environment) deep root system. This root system, as opposed to a typical turf grass whose roots are only a few inches deep, can stretch up to 8 feet deep and beyond. Because of this expansive root system, native plants reduce the amount of run-off by a higher absorption rate, filter pollutants, and prevent erosion. A few other reasons native plants are used are their higher survivability (than non-native), their ability to adapt to our climate and soils, and less required irrigation.

Recommended Applications: Native plants can and should be used in every application. There is a wide range of color, texture, seasonal interest, and sizes that can be utilized in an interesting and beautiful landscape design, avoiding any use of non-native or invasive species. Using “non-native plants” can cause potential risk of disease and/or invasion of insects harmful to plants, especially when coming from another country, and can risk introducing invasive species, choking out many native plants that are not highly established.

Benefits: Benefits include less invasive plants (which can cause disease and a monoculture), pollutant treatment (solids, metals, oils, etc.), reduction of erosion, reduction in velocity and volume of stormwater run-off, groundwater recharge, micro habitat, aesthetic improvement (compared to lawn or hardscape), minimal maintenance (if installed correctly), cost savings due to less maintenance (mowing, irrigation, pesticides, fertilizer), and education opportunity for the public. Native plants also create natural habitats for wildlife and reduce the likelihood of disease and pests of plants, which come from non-native/invasive species.

Design Criteria: A licensed Landscape Architect or licensed Professional Engineer should handle the specific design of native plants to ensure the correct use and application of native plants, including soil types, moisture requirements, lighting, and correct size for location. The planting plan shall include sequence of construction; a description of the contractor’s responsibilities; a planting schedule and installation specifications; initial maintenance requirements; and a warranty period stipulating requirements for plant survival.

Reference Indiana Native Plant Society (INPS) at www.indiananativeplants.org, Invasive Plant Species Assessment Working Group (IPSAWG) at www.invasivespecies.in.gov, and/or “101 Trees of Indiana” by Marion T. Jackson, to know what plants are native and what are invasive to be sure no invasive plants are planted.

Maintenance: Vegetation management is needed to reduce weeds and reestablish any plants that do not survive. This can include annual mowing, spot spraying for weeds, or re-planting.

There may be some initial watering needed to establish the plants, but once the plants are established, minimal to no watering should be necessary.

Examples: Native plant choices are dependent on-site conditions and the client's preference. The above references give a great start on what plant choices to make. Depending on the site, it may need an aesthetic look, where many wildflowers could be chosen with a touch of native grasses. Some wildflowers commonly used are Black-Eyed Susan (Rudbeckia), Purple Coneflower (Echinacea), Wild Bergamont (Monarda), Aster Varieties, and Coreopsis Varieties.

Native grass varieties include Sedge Varieties (Carex), Rush Varieties (Scirpus), Big Bluestem (Andropogon), Little Bluestem (Schizachyrium), Side-Oats Grama (Bouteloua), Switch Grass (Panicum), Indian Grass (Sorghastrum), and many others. See above resources for additional native plant choices, including trees and shrubs.

LID3 RAIN BARREL

Purpose: Rain barrels are typically used in unison with downspouts of buildings. They provide storage of stormwater and can be used for grey water irrigation of plants. Rain barrels are typically used in a smaller setting. Another type of stormwater storage is a cistern, which is usually a bigger system for larger areas of roof runoff.

Recommended Applications: Rain barrels can be used on most residential, commercial and institutional properties. Proper means must be taken to ensure that any overflow of water can go into open green spaces to infiltrate, instead of going back into storm sewers or foundations of buildings.

Benefits: Benefits include reduction in the volume of stormwater runoff, reduction in the amount of water consumption for non-potable uses, reduction in utility costs (if a lot of water is used), groundwater recharge, minimal maintenance (if installed correctly), and an education opportunity for the public.

Design Criteria: It is best if water is being discharged from the rain barrel regularly, to provide enough capacity for storm events. However, discharging too often could lead to the need for supplemental irrigation sources. Care should be taken in choosing the correct rain barrel size to properly hold and discharge stormwater after rain events.

Place a screen at the bottom of the downspout to minimize the volume of leaves and other debris entering the rain barrel.

The rain barrel should be screened with plants or other landscape features to avoid tampering problems and to also make a more aesthetic treatment.

Overflow from the rain barrels should be directed towards another low impact development, including but not limited to, a rain garden, infiltration basin, bioswale, filter strip, or another form of filtering/infiltration system.

Maintenance: The rain barrel must be sealed during warm months to avoid mosquitos and other bugs or pests and be drained prior to winter, to avoid freezing.

Periodically inspect, clean, and dispose of any particles or debris in the rain barrel and downspout.

LID4 PERMEABLE PAVEMENT

Purpose: Permeable pavement is used to infiltrate stormwater runoff from roads, sidewalks and parking lots, reducing the amount of storm runoff, oils, and other sediments into storm systems, decreasing the amount of flooding, and overall reducing pollution to receiving waters.

Recommended Applications: Permeable paving can be applied in many low-volume, low-speed situations, including parking lots, driveways, sidewalks, utility and access roads, emergency access lanes, fire lanes, and alleys.

Benefits: Benefits include reduction in the volume of stormwater runoff, pollutant treatment (solids, metals, oils, etc.), groundwater recharge, reduced heat island effect, minimal maintenance (if installed correctly) and education opportunity for the public.

Design Criteria: It is only appropriate to use this type of pavement for low-volume, low-speed traffic, or parking areas because it has a lower load-bearing capacity than traditional pavement.

It is highly recommended that care be taken when placing permeable pavement of any kind, especially when in close proximity or downstream of a high pollutant level area, as this could cause groundwater contamination. If the project site is near a high pollutant area, the user should consider using a different low impact development treatment to better treat the pollutants and not cause groundwater contamination, such as a bioswale or rain garden.

If a post treatment option is considered for stormwater overflow from the permeable pavement, the plant selection shall be drought tolerant. Drought tolerance is necessary in this treatment because the amount of water is less since it will mostly be permeating into the pavement before overflowing into the post treatment option. Such post treatment options could be a rain garden or bioswale.

Typically, it is recommended that lawn areas should not drain into a permeable pavement site because of the extra sediment running off from the lawn. This can cause problems with the sediment soaking into the voids of the pavement, reducing the effectiveness of the permeable pavement. If soil impediment cannot be avoided, use curbs to redirect the flow of stormwater off of the lawn area.

Design and installation should follow the concrete industry standards and specifications.

Pavement design should allow for water to completely drain, from 12 hours minimum to 72 hours maximum. Soil should be uncompacted, engineered, and permeable for quick percolation. If it seems that water does not infiltrate quickly, consider using an underdrain in addition to the permeable paving.

There are several different types of permeable paving options, some of which include the standard pour of permeable concrete (or asphalt), eco-pavers, or grid systems. There are several different types of eco-pavers and these typically use a system that has small or large openings between pavers. These openings can be filled with a fine stone or a soil & seed mix, depending on the desired function and look. Grid systems are typically used with gravel or seeding and are structurally sound for the same applications as permeable pavement and eco-pavers.

A typical cross section of porous pavement should include porous concrete (or asphalt) that is 4 to 6 inches thick with 15 to 25% void space for high percolation, a stone subsurface that contains 1.5-inch to 2.5-inch aggregate which is typically 6 inches thick and has geotextile nonwoven fabric to allow water to drain but limit particles to flow into soil around it, and an uncompacted, engineered and permeable soil subgrade to avoid stress on subgrade.

A typical cross section of eco-pavers should include the paver which would be filled with either a fine stone or a soil & seed mix that is a varying depth depending on the thickness of the paver. Below the paver should be a 1” depth of a sand setting bed on top of a 3-4” depth of compacted subbase (or aggregate). Below the compacted subbase should be a geotextile fabric on top of existing subgrade.

A typical cross section of a gravel grid system should include the grid or ring system with geotextile fabric attached, on top of compacted sandy gravel base to a depth determined by an engineer based on load requirements (typically anywhere from 6 to 12 inches). The base material would then be on top of compacted subgrade. This ring system should then be filled with 3/16” to 3/8” angular, uniform size and washed gravel.

A typical cross section of a grass grid system should include the grid or ring system on top a hydrogrow mix to help the grass grow quickly. This will then be on top of compacted sandy gravel base to a depth determined by an engineer based on load requirements (typically anywhere from 6 to 12 inches). The base material would then be on top of compacted subgrade. This ring system should then be filled with clean and sharp concrete sand and then topped with a thin-cut sod, washed sod or hydroseeding.

A professional with expertise in hydrology and stormwater design, including a licensed engineer and/or licensed/certified permeable pavement company, should be consulted to determine the appropriate application, design, and options of this pavement. The manufacturer’s recommendations on these products must be followed, as each specific type of product may vary in requirements and/or restrictions.

Maintenance: Periodic inspection and proper disposal of any particles or debris.

With pavers, special care needs to be taken with snowplows, like any paver, so that they aren’t uprooted by the plow being too low and knocking the paver out of place. In addition to snowplows, it is also recommended as a preventative measure to use a street sweeper or vacuum truck a couple times a year to clean out any unnecessary clogging of the pavers. Choosing the correct and best sweeper is essential in caring for the pavers.

LID5 VEGETATED FILTER STRIP

Purpose: Vegetated Filter Strips help to slow down and reduce run-off of impervious surfaces by retaining a pervious surface with vegetated cover. Filter strips also serve as a treatment system for run-off, reducing pollutants such as solids, metals, and oils. Ideally, the vegetative cover will be well established and deep-rooted native plants.

Recommended Applications: Filter strips can be used for residential developments, commercial developments, along roadsides, along parking lots, and in any other situation where there is opportunity for green space between impervious surfaces. Filter strips can also serve as a buffer between an impervious surface and a stream, wetland, or other body of water.

Benefits: Benefits include pollutant treatment (solids, nutrients, metals, oils, etc.), reduced flow (cubic feet per second) in pipe, groundwater recharge, micro habitat, aesthetic improvement (compared to hardscape), minimal maintenance (if installed correctly), and protection of wet habitat (stream or wetland).

Design Criteria: Minimum recommended length is 25 feet. Filter strips less than 25 feet are acceptable but are less effective.

If the filter strip is serving as a buffer for a stream or wetland, it should be as close to the same width as the impervious surface as possible.

Filter Strips should have a gentle to flat slope. However, the slope is dependent on the conditions of the site and the existing watershed slope. A good range is from 1% to 3%. If existing conditions restrict this, the absolute maximum is 8% slope, although all measures should be taken to make this as flat as possible. Cross slope should be 1% or less if possible.

A filter strip is to be designed for a minimum 10-year storm event.

Soil investigation and percolation testing is necessary to be sure the site is appropriate, and if the soils are not appropriate, an amendment to increase permeability would be necessary.

A minimum of 18 inches of uncompacted, engineered, and permeable soil shall be placed in the filter strip. The engineered soil should have an infiltration rate of at least 1 inch per hour will infiltrate. If high water volumes are expected, or less than 1 inch per hour, consider also including an underdrain or other overflow structure. If existing soil is to be used, but does not pass a percolation test, an on-site mixture of compost and/or sand (or any other addition that will increase the percolation of stormwater) can be performed with equipment, such as a tiller, that will sufficiently mix without compacting the soil. An additional percolation test shall be done after mixing the soil to ensure proper drainage before planting the filter strip.

If there is existing desirable vegetation, measures should be taken to have the least amount of impact/removal of this vegetation.

Ideally, only native plants which can tolerate salt, long periods of wet weather, and long periods of drought should be used. There should be 80% vegetative cover. See “Native Plants” section for typical plant varieties.

A licensed Professional Engineer or licensed Landscape Architect should handle specific design of the filter strip. The licensed Landscape Architect and/or Licensed Professional Engineer’s specific design must be acceptable by the City and the plan must include supporting sample results, which show the soils are suitable. Soil characteristics must meet suitable ranges to support the biotic community above and below the ground.

The planting plan shall include sequence of construction; a description of the contractor’s responsibilities; a planting schedule and installation specifications; initial maintenance requirements; and a warranty period stipulating requirements for plant survival.

Maintenance: Periodic inspection and proper disposal of any sediments, trash or large debris. If the site allows for a trash receptacle or other container, it should be highly considered for proper disposal of trash or cigarette butts.

Vegetation management is needed to reduce weeds and reestablish any plants that do not survive. This can include mowing, trimming, removal of invasive species, and/or replanting.

LID6 BIOSWALE

Purpose: Bioswales can serve as a more environmentally sound alternate to, or in conjunction with, storm sewers or concrete ditches. Bioswales slow the flow of stormwater runoff (sometimes significantly more than that of a pipe or a paved ditch), absorb some of that flow, and filter out pollutants.

Recommended Applications: Bioswales can be used in a variety of applications, including but not limited to roadside drainage, parking lots, commercial developments, campus developments, and residential developments.

Benefits: Benefits include reduced erosion and channel flow on open land, reduced flow (cubic feet per second) in pipe, pollutant treatment (solids, nutrients, metals, oils, etc.), groundwater recharge, micro habitat, aesthetic improvement (compared to paved ditch), minimal maintenance (if installed correctly), and education opportunity for the public.

Design Criteria: Bioswales need to be designed to a 10-year storm event, minimum.

Soil investigation and percolation testing is necessary to be sure the site is appropriate, and if the soils are not appropriate, an amendment with more sand would be necessary.

A minimum of 18 inches of uncompacted, engineered, and permeable soil shall be placed at the bottom of the bioswale, with a typical width of 2 feet to 6 feet. The engineered soil should have an infiltration rate of at least 1 inch per hour. If high water volumes are expected or existing soil has a percolation rate less than 1 inch per hour, also include an underdrain or other overflow structure. If existing soil is desired to be used, but does not pass a percolation test, an on-site mixture of compost and/or sand (or any other addition that will increase the percolation of stormwater) can be done with equipment, such as a tiller, that will sufficiently mix without compacting the soil. An additional percolation test shall be done after mixing the soil to ensure proper drainage before planting the bioswale.

Check-dams, turf reinforcement mats, erosion control blankets, or other erosion control measures should be considered depending on the velocity of flow to ensure that flows do not become erosive.

Plants should be native and selected based on their tolerance to harsh conditions, including long dry periods, long wet periods, winter snow storage, salt, and sand. See below as well as “Native Plants” section for typical plant varieties.

Longitudinal slope should not exceed 3%, preferable 1% or less, and side slopes should not exceed 2:1 (3:1 preferable, or whatever mower specifications require).

If there is desirable existing vegetation, measures should be taken to have the least amount of impact/removal of this vegetation.

A licensed Landscape Architect and/or licensed Professional Engineer should handle specific design of the bioswale. The licensed Landscape Architect and/or licensed Professional Engineer’s specific design must be acceptable by the City and the plan must include supporting sample results, which show the soils are suitable. Soil characteristics must meet suitable ranges to support the biotic community above and below the ground.

The planting plan shall include sequence of construction; a description of the contractor’s responsibilities; a planting schedule and installation specifications; initial maintenance requirements; and a warranty period stipulating requirements for plant survival.

Maintenance: Periodic inspection and proper disposal of any sediment, trash or large debris.

Vegetation management is needed to reduce weeds and reestablish any plants that do not survive. This can include mowing, controlled burn, and/or re-planting.

Examples: For a list of specific plant types, consult a local native plant nursery which specializes in ecological and native plant services or see www.indiananativeplants.org for a list of native plant resources.

For bioswales that are going to be visible to the public eye, a more aesthetic look would be desirable, and therefore a higher count of wildflowers and shrubs could be used. This type will likely be in residential and commercial settings.

For bioswales that are not visible to the public eye and are serving more as a functional piece of stormwater management, less wildflowers and shrubs could be used and more grasses/sedges could be used. This type will likely be in an industrial setting.

For all bioswale plants, a typical swale seed mix will include seven sedges, five grasses, and fourteen wildflowers/shrubs. Also included in that is a temporary cover crop, including both Common Oat and Annual Rye. This temporary cover crop is used because it will take time for the native grasses and wildflowers to establish fully, whereas the temporary will pop up almost immediately.

Some situations may benefit from utilizing plant plugs instead of seeding for aesthetics, soil stability the wetland indicator status states the following:

1) Seven sedges:
    a. Six should be of an obligate wetland status (almost always wet, rarely found in uplands)
2) One should be of a facultative wetland status (usually wet, but occasionally found in uplands)Five grasses
    a. One should be of an obligate wetland status (almost always wet, rarely found in uplands)
    b. Two should be of a facultative wetland status (usually wet, but occasionally found in uplands)
    c. Two should be of a Facultative status (either wet or dry)
3) Fourteen Wildflowers/Shrubs
    a. Seven should be of an obligate wetland status (almost always wet, rarely found in uplands)
    b. Three should be of a facultative wetland status (usually wet, but occasionally found in uplands)
    c. Three should be of a facultative status (either wet or dry)
    d. One should be of a facultative upland status (occasionally wet, but usually found in uplands)

LID7 INFILTRATION BASIN

Purpose: Infiltration basins help reduce erosion from high velocity stormwater runoff by holding water in its basin as it slowly percolates underground, infiltrating, purifying, and recharging the groundwater.

Recommended Applications: Infiltration basins can be used in most developed or developable areas where there is open land for the holding basin.

Infiltration basins are to be located a minimum of 10 feet from any building to protect the buildings foundation.

Benefits: Benefits include groundwater recharge, micro habitat, aesthetic improvement (compared to lawn or hardscape), minimal maintenance (if installed correctly), and education opportunity for the public.

Design Criteria: Infiltration basins need to be designed for a minimum of a 2-year storm event.

If the basin is off of a parking lot or roadway, pretreatment measures should be taken to minimize sediment that comes into the basin, including a swale, rain garden or another system that would filter out pollutants. If large amounts of contaminants enter the basin it can cause groundwater contamination.

There should be one or several overflow structures (with erosion control measures) included for the possibility of a storm event exceeding the design capacity; this can be an inlet, catch basin, underdrain, or another form of overflow structure.

Soil investigation and percolation testing is necessary to ensure the site is appropriate, and if the soils are not appropriate, an amendment with more sand or other approved material would be necessary.

The area for the basin should be a level (less than 1%), uncompacted site, with little to no disturbance of vegetation. If excavation must happen to accomplish the design, extra care shall be taken in order to cause minimal compacting.

A minimum of 18 inches of uncompacted, engineered, and permeable soil shall be placed in the infiltration basin. The engineered soil should have an infiltration rate of at least 1 inch per hour. If high water volumes are expected or existing soil has a percolation rate less than 1 inch per hour, also include an underdrain or other overflow structure. If existing soil is desired to be used, but does not pass a percolation test, an onsite mixture of compost and/or sand (or any other addition that will increase the percolation of stormwater) can be done with equipment, such as a tiller, that will sufficiently mix without compacting the soil. An additional percolation test shall be done after mixing the soil to ensure proper drainage before planting the infiltration basin.

Berms can be used as a way to reduce the amount of excavation.

If there is existing desirable vegetation, measures should be taken to have the least amount of impact/removal of this vegetation.

A licensed Landscape Architect and/or licensed Professional Engineer should handle specific design of the bioswale. The licensed Landscape Architect and/or licensed Professional Engineer's specific design must be acceptable by the City and the plan must include supporting sample results, which show the soils are suitable. Soil characteristics must meet suitable ranges to support the biotic community above and below the ground.

The planting plan shall include sequence of construction; a description of the contractor's responsibilities; a planting schedule and installation specifications; initial maintenance requirements; and a warranty period stipulating requirements for plant survival.

Maintenance: Periodic inspection of inlet or catch basin to confirm the system is working correctly, properly disposing of any sediment that is clogging the system.

Vegetation management is needed to reduce weeds and reestablish any plants that do not survive.

Sediment removal and proper disposal, as needed.

If compaction happens from mowers or vehicles driving over the basin, measures shall be taken to reduce and mitigate compaction, including limiting all traffic on and around the rain garden.

Inspect basins after large storm events. Water should drain within 48 hours, and if it doesn't, some modifications to the system may be necessary (check compaction rates on soil, add an inlet, or add an underdrain). Water pooled over 48 hours could cause a mosquito problem.

LID8 HYBRID DITCH

Purpose: Hybrid ditches look like a typical open ditch on the surface, however underneath there is a perforated pipe surrounded by pervious stone and sand that operates similar to a French drain to provide storage and filtration of stormwater runoff.

Recommended Applications: Hybrid ditches are able to utilize where traditional ditches have been installed in the past. Hybrid ditches are especially helpful when dealing with flatter slopes.

Benefits: Benefits include a smaller footprint than deeper ditches when dealing with flatter slopes, reduction of stormwater flow rate, lowers the water table when it is high, can recharge the water table when it is low, and filters sediments and pollutants from surface runoff.

Design Criteria: Side slopes of hybrid ditch shall be 3:1 or flatter.

A typical hybrid ditch cross section will include plantings, topsoil, a 50/50 mix of topsoil and sand, filter fabric, No. 8 washed stone backfill around a perforated HDPE pipe, and No.8 washed stone bedding.

Maintenance: Periodic inspection of inlets or catch basins to confirm the system is working correctly, properly disposing of any sediment that is clogging the system.

Vegetation management is needed to reduce weeds and reestablish any plants that do not survive.

Sediment removal and proper disposal, as needed.

LID9 PRESERVING EXISTING RIPARIAN BUFFER

Purpose: Natural buffers are complex ecosystems that help provide food and habitat for stream communities. Buffers comprised of mature trees provide shading to the aquatic resource lowering the water temperature, providing bank stability and improving habitat. Preserving existing natural buffers that are adjacent to waterways to promote water quality. and planning around the existing vegetation promotes stream

Recommended Applications: Buffers that exist prior to development should be evaluated in the planning stage. Buffers can be used to enhance a development to create areas that are aesthetically pleasing and benefit both people and wildlife. Preserving existing natural buffers that are adjacent to waterways (riparian buffers), promote infiltration and provide protection of the water resource.

Benefits: Benefits include Pollutant Treatment (solids, nutrients, metals, oils, etc.), reduction of velocity and volume of stormwater run-off, groundwater recharge, micro habitat, aesthetic improvement (compared to lawn or hardscape), minimal maintenance (if installed correctly), and an education opportunity for the public.

Design Criteria: Natural riparian buffers bordering and/or surrounding a water resource that are 50 feet or more in width must be preserved to a minimum of 50 feet. Less than 50 feet in width must be preserved in their entirety. The natural riparian buffer may be enhanced with vegetation that is native and promotes ecological improvement and sustainability.

All run-off directed to the natural buffer must be treated with appropriate erosion and sediment control measures prior to discharging to the buffer.

Run-off must be managed with an energy dissipator, or like, to prevent erosion from occurring within the buffer area.

Discharges to the buffer after the completion of the project should include pretreatment through an appropriate post-construction stormwater measure prior to discharging to the buffer.

Maintenance: Limit disturbances to the existing buffer during the construction phase and ensure only treated stormwater run-off reaches the buffer.

Sediment control measures must be installed in locations between a disturbed area and the buffer. If sediment control measures fail and sediment is discharged into the preserved buffer area, the sediment discharge should be removed with minimal impact to the buffer, and the sediment control measure should be repaired and-or replaced.



LID10 OPEN CHANNEL /TWO STAGE DITCH

Purpose: A two-stage ditch is a modified in channel design to account for a vegetated bench within the ditch, as well as the normal low-flow channel. The bench is an area that is planned for flooding during higher flows.

Recommended Applications: Use for agricultural ditches, which experience bank erosion or for undersized ditches. Use on ditches with a grade of less than 2%.

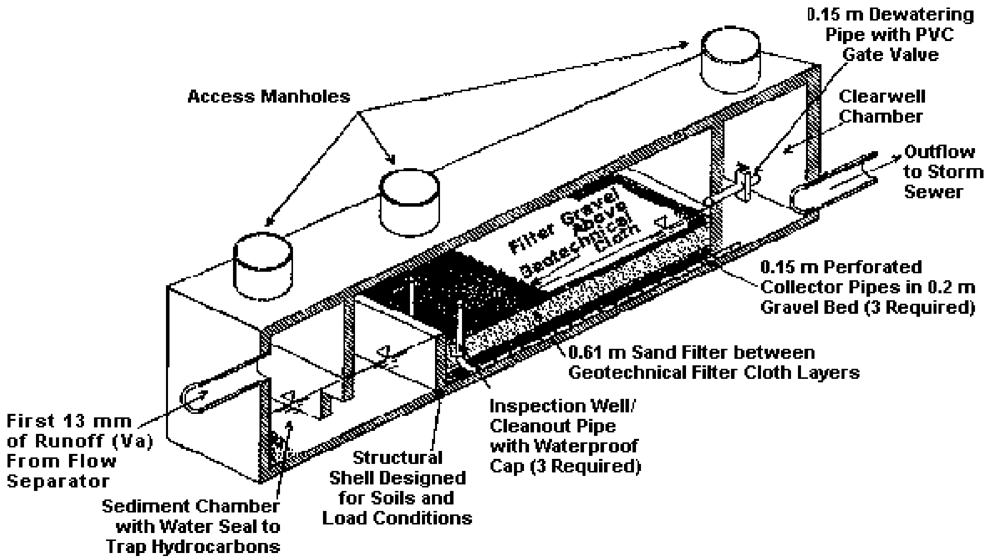
Benefits: After installation of the two-stage ditch, the channel is less prone to accumulate sediment and need less maintenance over the lifetime of the ditch. The low flow will stay within the banks and the flood flows stay within the second stage. The wider ditch will slow down the speed of the flood waters and reduce the height of the water in the ditch. The banks are likely to be more stable, and tile outlets will be submerged less often and will not be clogged by sediment deposits.

Design Criteria: Determine the capacity for open channels according to procedures applicable to the purposes of the channel and according to related engineering standards and guidelines in approved references. Design must consider low flow, average flows, frequent storm flows, and high (infrequent) storm flows.

Determine the water surface profile r hydraulic grade line for design flow using guidelines for hydraulic design in NRCS TR-210-25 and/or NRCS NEH, Par 654. Select a Manning's n value for the condition representing an aged channel. Base the selection on the expected vegetation and other factors such as the level of maintenance prescribed in the operation and maintenance plan. Establish the required flow capacity by considering volume-duration removal rates, peak flow, or a combination of the two, as determined by the topography, purpose of the channel, desired level of protection and economic feasibility. Design conditions cannot result in flood impacts to adjacent properties without addressing through the appropriate authorities.

Creating a low bench will likely require the top width of the ditch to be greater than what would be required for a traditional trapezoidal channel. This would result in ROW costs and surrendering of surrounding agricultural production land. The landowner could offset the costs by getting the lower bench considered for buffer conservation programs. Designers can verify the applicability of the buffer conservation program by looking into the drainage easement standards.

Maintenance: After construction of the two-stage ditch and final establishment of vegetation the ditch is likely to require less maintenance as well as the system will have improved conveyance capacity, be more self-sustaining, and create and maintain improved aquatic habitat.



LID11 SAND FILTER

Purpose: A sand filter can be utilized to capture and treat stormwater runoff which is expected to contain high levels of pollutants. The sand filter will act as a pretreatment and temporarily storing the runoff to remove the large particle sediment and allowing the runoff to percolate through the filter's sand media. As a result, the water quality improves.

Recommended Applications: Sand Filters are primarily used as water quality BMPs; however, the water quality volume entering the filter is detained and released at a rate potentially capable of providing downstream channel erosion control.

Peak rate control of the 10-year and greater storm events is typically beyond the capacity of the stormwater filtering systems and may require the use of a separate structural peak rate reduction facility.

Sand filters are most commonly used in urbanized settings where runoff is generated from areas with imperviousness from 67-100%.

Sand filters are best suited for small drainage areas.

The three most common sand filters are the D.C Underground Vault, Delaware, and Austin Surface.

Maximum Drainage Area:

Filter type	Appropriate Drainage Shed
D.C. Underground Vault	.25-1.25
Delaware	1.25 Maximum
Austin Surface	Greater than 1.25

Benefits: A 75% - 90% TSS removal rate is estimated with the use of a sand filter.

Design Criteria: Stormwater filtering systems should be designed to operate exclusively by gravity flow.

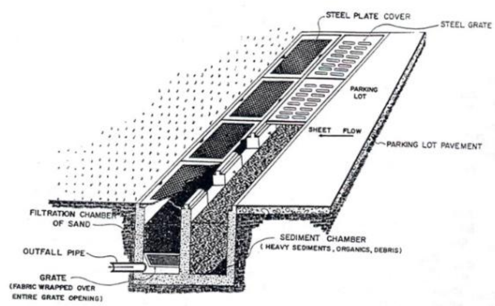
Surface sand filter: The surface sand filter uses a flow splitter to divert runoff into an off-line sedimentation chamber. The chamber may be either wet or dry and is generally used for pre-treatment. Runoff is then distributed into the second chamber, which consists of a sand filter bed (around 18 inches) and temporary runoff storage above the bed. Pollutants are trapped or strained out at the surface of the filter bed. The filter bed surface may have a sand or grass cover. A series of perforated pipes located in a gravel bed collect the runoff passing through the filter bed and return it to the stream or channel at a downstream point. If underlying soils are permeable, and groundwater contamination unlikely, the bottom of the filter bed may have no lining, and the filtered runoff may be allowed to infiltrate.

Underground sand filter: The underground sand filter was designed for sites where space is at a premium. The underground sand filter is a three-chamber underground vault with accessible manholes or grate openings. The vault can be either on-line or off-line in the storm drain system. The first chamber is used for pre-treatment and relied on a wet pool as well as temporary runoff storage. It is connected to the second sand filter chamber by an inverted elbow, which keeps the filter surface free from trash and oil. The filter bed is 18 inches in depth and may have a protective screen of gravel or permeable geotextile to limit clogging. During a storm, the water quality volume is temporarily stored in both the first and second chambers. Flows in excess of the filter's capacity are diverted through an overflow weir. Filtered runoff is collected, using perforated underdrains that extend into the third overflow chamber.

Pollutant removal effectiveness for underground sand filters (%):

Study	TSS	TP	TKN	NO_3	Metals	Bacteria	Comments
Bell et. Al., 1995	79	65	NA	(-53)	25-91	NA	Delaware sand filter
Horner and Horner, 1995	<81	43-60	NA	NA	22-66	NA	Delaware sand filter, oil and grease removal at >80%

Perimeter sand filter: The perimeter sand filter consists of two parallel trench-like chambers, installed along the perimeter (Delaware Sand Filter). Parking lot runoff enters the first chamber, which has a shallow permanent pool of water. The first trench provides pre-treatment before the runoff spills into the second trench, which consists of a sand layer (12-18 inches). During a storm event, runoff is temporarily ponded above the normal pool and sand layer. When both chambers fill up to capacity, excess parking lot runoff is routed to a bypass drop inlet. The remaining runoff is filtered through the sand, collected by underdrains, and delivered to a protected outflow point.



The liner should be located 2-4 feet above the high-water table. A high-water table could flood the filter system. Additionally, buoyancy calculations must be performed, and additional weight provided within the filter as necessary to prevent floatation.

Ensure there is easy site access and adequate pre-treatment.

Ensure the drainage area is fully stabilized prior to bringing the practice online.

Maintenance: More frequent maintenance will be required if the sand filters are planned for receiving flows with hydrocarbons.

The most frequent maintenance concern for filters is surface and underdrain clogging. Clogging occurs at the inlets and outlets and the filter surface. Materials that are collected by the system, consisting of fines, hydrocarbons, algal matter, and organic matter can clog the filter surface, inlet, and outlets. Inspect the inlets, outlets and contributing drainage area monthly and remove any trash and debris.

Ensure sediment is cleaned out of chamber when it accumulates to a depth equal to ½ the total depth to the outlet, or when greater than 1.5 feet, whichever is less. Clean the sediment chamber outlet when drawdown times exceed 36 hours. Remove trash and debris routinely.

Remove silt and sediment from the filter bed when the accumulation exceeds one inch.

When water ponds on the surface of the filter bed for more than 48 hours, the top few inches of discolored filter bed material should be removed and replaced with fresh material. Removed sediments should be disposed of in a landfill.

Replace any filter fabric that has become clogged.

Annually inspect the filter bed to ensure it is clean of sediment and the sediment chamber is not more than 6 inches of sediment. Make sure there is no evidence of spalling, or cracking of concrete, which would be signs of deterioration of the concrete. Inspect grates and inlets and outlets, to ensure there is no evidence of erosion and repair or replace any damaged structural parts. Stabilize any erosion that is observed. Ensure the flow is not bypassing the system and there are no odors detected outside the system.

Replace the top 2-5 inches of sand filter media every 3 to 5 years. More often replacement is necessary for areas with higher sediment yield or high oil and grease.

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APPENDIX A

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