South Washington Watershed District

Standards Guidance Manual

Prepared for
South Washington Watershed District

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SWWD

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1 Introduction

1.1 Scope and Purpose

This document – the South Washington Watershed District (SWWD) Standards Guidance Manual (Manual) – is intended to **promote consistency, efficiency, and understanding in regard to meeting SWWD stormwater management performance standards** applicable to development and redevelopment projects within the watershed. This Manual is written for a variety of audiences including land developers and their engineers, city staff, and other technical professionals working within the watershed. This Manual was developed with input from staff of cities located within the SWWD.

This document is a supplement to the SWWD Watershed Management Plan (2016, as amended) and SWWD Rules (2022, as amended). Through its Watershed Management Plan and Rules, the SWWD has established and periodically updates stormwater management performance standards to protect the public health, welfare, and natural resources of the District. Municipalities within the District are required to adopt controls to enforce those standards. Proposers of development and redevelopment projects that trigger SWWD Rules must demonstrate compliance with these performance standards through the design, analysis, and documentation of best management practices (BMPs).

Primary responsibility for management of water quality and stormwater runoff lies with the District. However, the District recognizes that the primary control and determination of appropriate land uses is the responsibility of its municipalities and that the permitting process is best performed at the municipal level. Generally, District review and permitting will not be required for projects in Municipalities where a District-approved municipal local water management plan (LWMP) is adopted and local controls are up to date. In those Municipalities, District requirements shall be deemed satisfied upon issuance of the appropriate Municipal permit and submission of final plans to the District. Projects will be subject to District review and permitting under the following circumstances:

- when the project is located outside the jurisdiction of a District-approved LWMP,
- when required under the municipal LWMP,
- when the project proposer is seeking a variance to LMWP and/or District requirements,
- when a new connection to the District's MS4 is proposed, or
- when the SWWD Board of Managers deems a District permit necessary.

While the District recognizes the value of uniformity in performance standards throughout the watershed, the District believes that standards based on local resource goals and that consider variability in soil and land cover conditions are best. Because resources and site conditions vary throughout the watershed, the analysis of applicable performance standards for projects is nuanced. This Manual provides **guidance on practices, tools, and methods** to achieve and demonstrate compliance with SWWD stormwater management performance standards. The BMP and modeling tool guidance included in this manual is generally presented at a summary level when additional detailed references exist (e.g., Minnesota Stormwater Manual); further detail is provided for those topics of particular importance within the District. Additional references and resources are included, where applicable.

1.2 SWWD Rules and Stormwater Standards

This Manual is intended to address only those performance standards established by the SWWD and directly applicable to stormwater management. These are detailed in SWWD Rule 7 – Stormwater Management and Water Quality. Additional stormwater management standards may apply to projects in areas draining to landlocked basins (see SWWD Rule 6) and projects on sites with known karst features (see SWWD Rule 8).

Unless otherwise noted, the District standards apply to all land alterations (projects) which remove cover or disturb a surface area of one acre or more (regardless of impervious area). Standards also apply to projects that result in the augmentation or diversion of stormwater to a receiving water body. Generally, these standards address:

- **Stormwater discharge rate** – The on-site rate of stormwater runoff for all proposed projects must not exceed the pre-project runoff rates for the 2, 10, and 100 year 24-hour duration rainfall events as estimated by NOAA Atlas 14.
- **Stormwater volume**
    - All projects must treat the water quality volume on any project where the sum of new impervious surface and fully reconstructed impervious surface equals one or more acres.
        - For non-linear projects, the water quality volume is equal to one (1) inch times the sum of the new and the fully reconstructed impervious surface.
        - For linear projects, the water quality volume is equal to the larger of one (1) inch times the new impervious surface or one-half (0.5) inch times the sum of the new and the fully reconstructed impervious surface. Additional considerations for linear projects are described in Rule 7.3.3.
        - Volume reduction practices (e.g., infiltration) to retain the water quality volume on-site must be considered first when designing the permanent stormwater treatment system. Where infiltration is not feasible or is prohibited, alternative compliance sequencing is required (see Section 3.4).
    - For projects draining to landlocked basins, stormwater runoff volume must not exceed the pre-project runoff volume for the 2, 10, and 100 year 24-hour duration rainfall event.
- **Stormwater quality**
    - All projects must provide treatment necessary to meet applicable annual total phosphorus (TP) loading rates specific to the downstream resources (see SWWD Rules) or maintain existing loading rates, whichever is less.
    - All projects must provide treatment necessary to achieve a net reduction of annual off-site Total Suspended Solids (TSS) loading rates relative to existing conditions.
    - For projects draining to a designated trout stream or its tributaries, treatment must be designed to minimize any increase in the temperature of the trout streams resulting from the one (1) or two (2) year 24-hour precipitation events. Treatment should be provided in a manner consistent with Rule 7.3.3.D.

- For project draining to wetlands, treatment must be designed to maintain existing annual TP loading rates for wetlands classified as "Protect" or reduce annual TP loading by 60% for wetlands classified as "Manage 1" and "Manage 2".,

The above standards are summarized for brevity. The project proposer should review the SWWD Rules document for the full requirements. The SWWD volume control standard generally ensures that projects are not required to do more than their "fair share" to address water resource issues. At the same time, there are specific resources where additional protection is required via the stormwater quality treatment standard. The District may also apply more stringent performance standards for projects located upstream of critical resources (i.e., **Regional Assessment Locations**, see Section 5).

Other procedural requirements, such as submittal deadlines, are established for projects proposed in the watershed. These requirements can be found in the SWWD Rules on the District website.

1.2.1 Other SWWD Rules

This Manual does not supersede the SWWD Rules or Watershed Management Plan – users of this guide should refer to the SWWD Rules to ensure they are using the most current performance standards. The SWWD Rules establish additional performance standards regarding floodplain management, wetland protection, groundwater management, and other topics. These performance standards are not addressed in this Manual – refer to the SWWD Rules for additional detail regarding these and other standards.

1.3 Regulatory Scope

This Manual does not address additional performance standards imposed by local and/or state regulatory authorities (e.g., Minnesota Pollution Control Agency's Construction Stormwater Permit) that may be applicable to a project. Proposers of development and redevelopment projects are responsible for ensuring that all applicable regulatory standards are satisfied.

Additional information about stormwater regulations at the state and regional level is available from the Minnesota Pollution Control Agency (MPCA) at: Regulatory information - Minnesota Stormwater Manual (state.mn.us).

1.4 How to Use this Manual

This Manual should be used as a guide for understanding design constraints, project location and site considerations, available datasets, and analysis/modeling tools to ensure that project designs meet SWWD stormwater management performance standards. The primary audience includes developers, their consultants, and member city staff involved in development review, public works, planning, and related activities.

Most often, a "project" means a land disturbing activity related to development or redevelopment. However, a project can also include studies or analyses performed by member cities or other SWWD partners. This Manual may also be used by those seeking guidance on appropriate tools and modeling parameters to achieve consistency in watershed analyses.

This Manual is not intended to replace or supersede the currently adopted SWWD Rules or Watershed Management Plan. The SWWD Rules are only generally referenced within this document to prevent the content from becoming obsolete as District Rules are updated. Project proposers should review the most current version of the SWWD Rules for complete details on regulatory requirements.

To most effectively use this Manual, individuals should begin by reviewing the project location relative to the spatial data described in Section 2 and presented in the SWWD webmap. This data is relevant to understanding applicable water quality performance standards, site characteristics of constraints affecting BMP selection and design, the presence of protected features (e.g., wetlands), and unique considerations such as regional assessment locations. Once site characteristics and considerations are known and understood, the user should refer to Section 3 for BMP selection and design guidance. Following the selection and design of BMPs, they should reference Manual Section 4.4, and the associated appendices to understand the relevant analytical and modeling methods and tools.

This Manual is not intended to be a comprehensive reference for all of the datasets, BMPs, modeling tools, or analytical methods described herein. References to the Minnesota Stormwater Manual and other resources are included, where appropriate.

1.4.1 Manual Updates

BMPs, tools, and methods summarized in this Manual may evolve over time and new approaches may emerge. The District may periodically update this document and its appendices as needed. Updates to the Manual will be reflected by the publication date and tabular version history. The most current version of this Manual will be made available at the SWWD website: South Washington Watershed District | South Washington Watershed District (swwdmn.org)

2 Spatial Data for Site Design

Geospatial data is a key resource in selecting and designing BMPs necessary to meet SWWD stormwater management performance standards. SWWD water quality performance standards vary according to location within the watershed. In addition, spatially variable watershed characteristics such as soil type, runoff coefficients, land use, and others can impact which BMPs are appropriate for a particular project site. Geospatial data is intended to be actively used by project proponents when evaluating site design constraints. This section of the Manual describes data sets impacting performance standards, BMP selection, and site design.

2.1 SWWD Webmap

SWWD has developed and maintains a web-based map (webmap) located at: South Washington Watershed District (swwdmn.org)

SWWD has compiled the webmap using publicly available geospatial data layers and data layers developed by SWWD for use within the watershed. The data layers described in this manual are included in the SWWD webmap (unless noted otherwise). Note that other data layers not included in the SWWD webmap may be necessary or helpful in evaluating compliance with performance standards beyond those of SWWD. Many data layers are publicly available from the "Minnesota Geospatial Commons" maintained by the Minnesota Department of Natural Resources (MnDNR) at: Welcome - Minnesota Geospatial Commons (mn.gov)

Users of the SWWD webmap may navigate the map using the curser or by looking up an address or parcel ID number. Individual layers applicable to stormwater management planning and design may be turned on or off from the layer list. Clicking on individual feature will open an attribute window listing relevant information. Parcel data is cross-referenced to geospatial layers applicable to stormwater management for quick reference (e.g., applicable TP reduction requirement).

2.2 Geospatial Data for Regulatory Considerations

Resources, land characteristics, and stormwater quality performance standards vary across the watershed. Proposers of projects triggering SWWD stormwater management performance standards are expected to evaluate those regulatory requirements that apply to their project location and understand the applicable stormwater treatment options (see Section 1.2 and SWWD Rules).

The location of a project within the watershed can impact project stormwater management in a variety of ways. For some project locations, meeting the applicable annual total phosphorus load requirement may be the most challenging. In other project locations, meeting the volume control standard may be the limiting factor. For projects located upstream of regional assessment locations additional coordination with SWWD to determine any additional stormwater treatment may be required (see Section 5). Project proposers are also responsible for evaluating site characteristics that impact the selection and design of

BMPs. In some locations, the presence of karst geology or other factors may prohibit infiltration practices. The presence of wetlands (and associated buffers) on a project site may limit where BMPs can be placed.

Project proposers are responsible for demonstrating compliance with applicable stormwater management standards through the use of appropriately-designed BMPs.

The geospatial data layers presented in the webmap are intended to assist project proposers in understand stormwater requirements and associated BMP design considerations applicable to their projects. Geospatial data layers included in the webmap and relevant to stormwater design and permitting are described in the following sections. Note that the webmap contains additional data layers not described in this section.

2.2.1 Drainage Patterns

SWWD has subdivided the watershed into **watersheds** and **subwatersheds** according to topography and drainage networks both natural and constructed. **Flow paths** within each major watershed are also delineated. Users of this Manual should use these layers to identify the affected resource(s) located downstream of a proposed project.

Some projects may drain to landlocked basins (i.e., basins that do not discharge under typical hydrologic conditions). Projects draining to landlocked basins are subject to volume control standards as specified in SWWD Rule 6. There are very few landlocked basins within the watershed; the District addresses these situations on a case-by-case basis. Project proposers should coordinate with municipal staff to confirm if the project site drains to a land-locked basin.

2.2.1.1 Subwatershed Total Phosphorus Load Requirements

SWWD has adopted maximum annual total phosphorus loading standards for projects located upstream of the following resources:

- Armstrong Lake
- Colby Lake
- La Lake
- Markgrafs Lake
- Mississippi River
- Powers Lake
- Ravine Lake
- Wilmes Lake

These standards were developed based on the needs of the downstream receiving waterbody. Projects located within these areas must provide treatment to achieve annual total phosphorus loads below maximum rates published in the SWWD Rules or maintain existing (pre-project) loads, whichever is less. The **TP loading standard** webmap layer identifies where resource-specific maximum TP loading rates apply. Note that in all cases, projects must also be evaluated against existing TP loading rates to determine if existing conditions are more limiting.

2.2.1.2 Regional Assessment Locations

Regional assessment locations (RALs) are points at which SWWD has identified a need for additional management of stormwater beyond the on-site performance standards applicable across the watershed (see Section 5). Proposers of projects are expected to use the SWWD webmap to identify whether their project is located immediately upstream of a RAL and, if so, coordinate with SWWD staff to determine if regional assessment analyses (typically performed by SWWD) are required. See Section 5 for more information about RALs.

2.2.2 Wetlands and Buffers

Wetlands are subject to protections outlined in SWWD Rule 3. With respect to stormwater management (the focus of this Manual), the SWWD Rules generally prohibit development and redevelopment from encroaching on existing wetlands or **wetland buffers** (vegetated areas surrounding wetlands). Appendix A of the SWWD Rules also requires water quality treatment (i.e., TP load reduction) for projects drainage to wetlands (see Section 1.2) The SWWD webmap presents wetlands included in the **National Wetland Inventory (NWI)** and those subject to SWWD **wetland management classes**. The webmap also presents **wetland management buffers** applicable to District-classified wetlands and based on wetland classification. The wetland management buffer layer was developed for screening purposes, does not include additional buffer width corrections required in areas of steep slopes, and is not comprehensive to all wetlands.

Project proposers should use the SWWD webmap to make a *preliminary* determination of the location (or absence) of wetlands and associated buffers on a proposed project site. Note that a site-specific wetland delineation is required to determine the areas of a project site subject to wetland-related land development restrictions.

2.2.3 Public Waters Lakes, Streams and Ditches

Lakes, streams, ditches, and adjacent riparian areas are subject to SWWD Rules that may limit site development. The SWWD webmap presents lakes and streams that are included in the Public Waters Inventory as two separate layers (**PWI Lakes**, **PWI Streams**). Projects impacting PWI lakes and streams are subject to State performance standards and the jurisdiction of the MnDNR. Some streams and ditches are also subject to the State buffer law that requires perennial vegetative buffers of up to 50 feet along lakes, rivers, and streams and buffers of 16.5 feet along ditches. There are no public waters ditches in SWWD that are subject to the 16.5-foot buffer requirement. PWI watercourses in SWWD are subject to the 50-foot buffer requirement consistent with Minnesota Statutes 103F.48. The SWWD webmap presents the limit of the 50-foot buffer adjacent to PWI lakes and streams (**Public Waters Buffer**).

Project proposers should use the SWWD webmap to make a *preliminary* determination of the location (or absence) of public waters watercourses relative to the project site. If public waters are present, site-specific survey data is required to determine the areas of a project site subject to associated land development restrictions.

2.2.4 Floodplains

Floodplains are areas that are estimated to be inundated during storm events of a particular likelihood (e.g., a 100-year floodplain is the area estimated to be inundated during an event with a 1% annual chance of occurrence). The Federal Emergency Management Agency (FEMA) maps 100-year floodplains adjacent to larger water bodies, including waterbodies within the District. The SWWD webmap includes information on **FEMA Floodplains**. Local jurisdictions (e.g., cities) often map additional floodplain areas adjacent to lakes, ponds, and other hydrologic features.

The SWWD Rules regulate development within floodplain areas and minimum building elevations for structures located adjacent to hydrologic features. Project proposers should use the SWWD webmap to determine the location (or absence) of FEMA floodplains relative to the project site. Project proposers should also confirm with local jurisdictions whether local floodplains are located on or adjacent to their project site.

FEMA floodplains are periodically updated. Project proposers can find additional information on FEMA floodplains at: FEMA Flood Map Service Center | Welcome!

2.2.5 Receiving Water Considerations

The SWWD Rules are broadly intended to protect the quality of waterbodies within and downstream of the watershed. While most rules are applicable watershed-wide, additional considerations apply upstream of particular waterbodies, including waterbodies listed in Minnesota's Impaired Waters (303(d)) List and designated trout streams.

2.2.5.1 Impaired Waters

Impaired waters are those waterbodies listed on the Minnesota Impaired Waters (303(d)) List as determined by the MPCA and approved by the US Environmental Protection Agency. Impaired waters are those identified as not meeting their intended uses due to excessive concentrations of pollutants (e.g., phosphorus, bacteria) or other stressors. The SWWD webmap presents **Impaired Lakes** and **Impaired Streams** within and adjacent to the watershed. Impaired waters within the District are further described in the SWWD Plan. The Impaired Waters List is updated biannually. More information is available at: Minnesota's impaired waters list | Minnesota Pollution Control Agency (state.mn.us)

The presence or absence of impaired waters downstream of a proposed project does not change the application of District Rules. However, project proposers should be aware of their presence.

2.2.5.2 Trout Streams

The State of Minnesota has identified trout lakes and streams (per Minnesota Rules 6264) that are subject to special protections. Locally, the SWWD enforces these protections through additional stormwater management criteria included in the SWWD Rules applicable to projects discharging to trout streams. The SWWD webmap presents DNR-identified **Trout Streams**. Trout Brook and several tributaries, located in the northeast portion of the watershed, are classified as trout streams.

Project proposers are expected to confirm the presence or absence of trout streams located downstream of their projects and design stormwater BMPs accordingly, as needed. Additional information regarding the location of trout streams subject to additional regulations is available at: Trout fishing streams & lakes | Minnesota DNR (state.mn.us)

2.2.6 Soils, Infiltration and Groundwater

Infiltration of stormwater is the preferred practice to meet SWWD stormwater management performance standards. However, the characteristics of each potential project site may impact the suitability of infiltration as a practice and/or impact site-specific BMP design. This section details some of the geospatial characteristics that affect infiltration. Ultimately, project proposers are responsible for determining the suitability of potential project sites for infiltration BMPs and designing BMPs appropriate to specific site conditions.

The Minnesota Stormwater Manual contains extensive information regarding infiltration practices: Infiltration – Minnesota Stormwater Manual (state.mn.us)

2.2.6.1 Hydrologic Soil Group

The Natural Resource Conservation Service (NRCS) classifies soils into four different **Hydrologic Soil Groups** (HSGs) based on the soil's infiltration and runoff potential. The SWWD webmap presents these classifications within the watershed; some areas of the watershed are unclassified with respect to HSG. HSG categories include:

- **Group A:** sand, loamy sand or sandy loam types of soils. Soils characterized by low runoff potential and high infiltration rates even when thoroughly wetted. They consist mostly of deep, well to excessively drained sands or gravels and have a high rate of water transmission.
- **Group B:** silt loam or loam. Soils characterized by moderate infiltration rates when thoroughly wetted and consist mostly of moderately deep to deep, moderately well to well drained soils with moderately fine to moderately coarse textures.
- **Group C:** sandy clay loam. Soils characterized by low infiltration rates when thoroughly wetted and consist mostly of soils with a layer that impedes downward movement of water and soils with moderately fine to fine structure.
- **Group D:** clay loam, silty clay loam, sandy clay, silty clay or clay. This HSG has the highest runoff potential. They have very low infiltration rates when thoroughly wetted and consist mostly of clay soils with a high swelling potential, soils with a permanent high water table, soils with a clay layer at or near the surface and shallow soils over nearly impervious material.

Generally, project sites with group A and B soils are suitable locations for infiltration BMPs while sites with group C and D soils are not (soils may also be amended to adjust infiltration rates, see Section 3.2.4). The HSG data layer is intended to be used as a screening tool for project proposers for determining the potential for infiltration BMPs. Project proposers must perform soil borings or perform infiltration tests to determine site-specific infiltration rates, as described in Section 4.2.1.5.

The Minnesota Stormwater Manual presents estimated infiltration rates based on unified soil classification: Design infiltration rates – Minnesota Stormwater Manual (state.mn.us)

2.2.6.2 Saturated Hydraulic Conductivity

The SWWD webmap presents the **saturated hydraulic conductivity** (K_{sat}) of soils within the District. Conductivity values approximate infiltration rate (inches/hour) and are based on the SSURGO database. The District recommends that project proposers review this layer as a screening tool to evaluate the use of infiltration features to assist in addressing SWWD stormwater management performance standards. District rules prohibit the use of infiltration for stormwater management when field-measured infiltration rates exceed 8.3 inches/hour (unless the soils are amended to slow the infiltration rate to less than 8.3 inches/hour) (see Section 2.2.6.7).

2.2.6.3 Karst Inventory

Karst geologic features such as sinkholes, springs, stream sinks, and others occur throughout the watershed. These features are pathways for groundwater-surface water interactions and create the potential for groundwater contamination from surface pollutants. The SWWD webmap presents known **Karst features** in the watershed. Infiltration BMPs are prohibited within specified distances of active karst features (see Section 2.2.6.7). The karst feature layer should be used as a screening tool to help guide the location of infiltration practices. Karst features may exist beyond those included in the SWWD webmap data layer.

2.2.6.4 Surface Carbonate Karst and Sandstone

The SWWD webmap presents areas where karst conditions are likely to exist due to the presence of carbonate bedrock (e.g., limestone) or sandstone bedrock within 50 feet of the ground surface. These areas are prone to karst conditions that can increase groundwater-surface water interactions and create the potential for groundwater contamination from surface pollutants. District rules prohibit or limit the use of infiltration BMPs depending on the proximity to karst features (see Section 2.2.6.7). The District recommends that project proposers consider this layer as an initial screening tool to evaluate the feasibility of infiltration BMPs. Infiltration BMPs may be feasible in areas of carbonate or sandstone bedrock depending on other site-scale considerations.

2.2.6.5 Depth to Water Table

The SWWD webmap presents the estimated **depth to the water table**. This data was developed as part of the Washington County Geologic Atlas (Part B) and is based on groundwater elevation and topography. Estimated depth to the water table is not precise and is estimated as a range. The District recommends that project proposers consider this layer as an initial screening tool to evaluate the feasibility of infiltration BMPs. District rules prohibit the use of infiltration BMPs in areas with less than three feet of separation between the bottom of the infiltration system and seasonally saturated soils (see Section 2.2.6.7).

2.2.6.6 Drinking Water Supply Management Areas (DWSMAs)

The SWWD webmap presents **Drinking Water Supply Management Areas** (DWSMAs). DWSMAs are defined as the surface and subsurface area surrounding a public water supply well that must be managed for protection of the drinking water resources. DWSMAs are classified based on their relative vulnerability to contamination and are managed by the entity (often a municipality) identified in a wellhead protection plan (WHPP). Portions of each DWSMA are classified as Emergency Response Areas (ERAs) and are subject to more stringent management protections. ERAs are not presented in the SWWD webmap.

District rules restrict or prohibit the use of infiltration BMPs within vulnerable DWSMAs and ERAs (see Section 2.2.6.7). The District recommends that project proposers review the DWSMA layer as an initial screening tool to determine if DWSMA and ERA infiltration restrictions may apply. For projects located within a DWSMA, project proposers should consult the WHPP of the managing entity and/or contact staff at their permitting city to determine if additional ERA infiltration restrictions apply.

2.2.6.7 Infiltration Prohibitions

Infiltration is the preferred method to achieve SWWD stormwater performance standards. However, throughout the watershed certain land use, soil, and groundwater characteristics create site conditions not appropriate for infiltration. The MPCA has identified conditions under which infiltration is prohibited as detailed in its National Pollutant Discharge Elimination System (NPDES) Construction Stormwater General Permit (CSW Permit) and Municipal Separate Storm Sewer System (MS4) General Permit.

The SWWD Rules include infiltration prohibitions consistent with MPCA guidance. The SWWD prohibits infiltration in the following:

- Areas that that receive runoff from vehicle fueling and maintenance areas;
- Areas where infiltrating stormwater may mobilize high levels of contaminants in soil or groundwater;
- Areas where soil infiltration rates are field measured at more than 8.3 inches per hour (unless the soils are amended to slow the infiltration rate below 8.3 inches per hour);
- Areas with less than three (3) feet of separation distance from the bottom of the infiltration system to the elevation of the seasonally saturated soils or the top of bedrock;
- Areas of predominately **Hydrologic Soil Group** type D soils (clay);
- Within a Drinking Water Supply Management Area (DWSMA) or DWSMA Emergency Response Area (ERA) as follows:
    - In an ERA within a DWSMA classified as having high or very high vulnerability;
    - In an ERA within a DWSMA classified as moderate vulnerability (unless a higher level of engineering review has been approved by the affected City); or
    - Outside an ERA within a DWSMA classified as having high or very high vulnerability (unless a higher level of engineering has been approved by the affected City).
- Areas within 1,000 feet upgradient or 100 feet downgradient of **active karst features**; and
- Areas that receive runoff from specific industrial facilities (see SWWD Rules).

The SWWD webmap contains several data layers related to infiltration. The District recommends that project proposers consider the following layers as screening tools in evaluating the use of infiltration BMPs:

- **Hydrologic Soil Group** (see Section 2.2.6.1)
- **Saturated Hydraulic Conductivity** (see Section 2.2.6.2)
- **Active Karst Features** (see Section 2.2.6.3)
- **Areas Prone to Karst Conditions** (see Section 2.2.6.4)
- **Depth to Water Table** (see Section 2.2.6.5**)**

2.3 Additional Geospatial Data of Land Features

Many of the geospatial layers presented in the SWWD webmap are useful for evaluating compliance with District rules (see Section 2.2). The webmap also contains data layers that characterize political boundaries and landscape conditions present within the watershed. Additional data presented in the webmap may include, but is not limited to:

- Watershed management organization boundaries
- Washington County parcel data
- Municipal boundaries
- County boundaries
- Soil type
- Surficial geology
- Depth to bedrock
- Bedrock faults
- Groundwater sensitivity to pollution

3 Selecting and Incorporating BMPs

This section provides guidance regarding the selection and design of best management practices (BMPs) to meet applicable SWWD stormwater management performance standards including volume control, rate control, and water quality treatment (see Section 1.2). This section also describes general considerations for site design to minimize negative project impacts and promote BMP performance.

The section includes summary information about structural and non-structural stormwater BMPs. The information in this section is not comprehensive; additional detail and references are available from the Minnesota Stormwater Manual. Users of this design manual are directed to the Minnesota Stormwater Manual as BMP selection and design considerations require.

3.1 BMP Decision Analysis

The District recognizes that there are a variety of BMPs that may be used to meet District stormwater management standards applicable to development and redevelopment projects. Not all BMPs are appropriate for all areas of the District or performance standards. Variations in land use, physical considerations at each site, receiving surface water and groundwater resource vulnerability, the presence of or proximity to unique habitats and high-value natural resource areas, and other environmental concerns require that BMP selection and design be factored into each individual project. In addition, different types of stormwater BMPs require different levels of maintenance to sustain performance. With this manual, the District seeks to provide a framework for site design that can limit negative stormwater impacts and achieve applicable standards.

Project proposers are ultimately responsible to ensure that site design elements are engineered and incorporated in a manner consistent with applicable regulations and standard practices.

Projects proposed for development and/or redevelopment within the District should consider the following factors in site design and BMP selection (adapted from the Minnesota Stormwater Manual):

1. Investigate **pollution prevention** opportunities. Evaluate the site to look for opportunities to prevent pollution sources on the land from becoming mobilized by runoff (see Section 3.2).
2. Design the site to **minimize runoff**. Assess whether any better site design techniques can be applied at the site to minimize runoff and therefore reduce the size of structural BMPs (see Section 3.2).
3. Consider **temporary construction erosion and sediment control techniques**. Identify what sediment control techniques will prevent erosion and minimize disturbance during construction.
4. Evaluate BMP stormwater treatment suitability relative to applicable **performance standards**. Not all BMP types will provide the treatment necessary to meet District standards, so designers need to choose the type or combination of BMPs that will provide the desired level of treatment.
    a. Determine the applicable **total phosphorus** reduction requirement based on receiving water.

b. Determine the required **volume control** based on project type, impervious area, and site considerations.

c. Identify applicable **rate control** requirements and where they will be assessed.

d. Volume reduction practices should be prioritized / considered first when considering BMP options.

5. Identify **downstream resources**. Determine which receiving waters are located downstream of the project and identify if special considerations such as trout streams or District Regional Assessment Locations (RALs) apply (see Section 2.2.1.2).

   Assess BMP feasibility relative to the **site characteristics and landscape**. Landscape characteristics such as topography, soils, groundwater, and geology vary across the watershed and impact the performance and suitability of BMPs. The Minnesota Stormwater Manual includes guidance about the suitability of BMPs in areas of shallow soils and shallow depth to bedrock: BMP use in settings with shallow soils and shallow depth to bedrock – Minnesota Stormwater Manual (state.mn.us)

6. Consider BMP **maintenance and long-term performance.** Consider requirements for BMP maintenance, the method by which the BMP will be maintained, and how BMP performance may change over its lifecycle (with consideration for changes in climate).

7. Investigate **community and environmental factors**. Different types of BMPs provide different economic, community, and environmental benefits and drawbacks. Designers should carefully weigh these factors when choosing BMPs for the site.

8. Determine any **site restrictions and setback requirements**. Check to see if any environmental resources (e.g., wetlands, public waters) or infrastructure (e.g., roads, trails and utilities) are present that will influence where a BMP can be located at the development site.

> ***SWWD's Rules require project proposers to consider volume reduction practices first to meet the District's stormwater management requirements.*** *The preferred method for treating stormwater runoff is infiltration in areas where infiltration is not restricted due to site considerations.*
>
> *Project proposers should review geospatial data related to infiltration as an initial screening when considering BMPs appropriate for a site. The collection of site specific data may also be required to demonstrate feasible BMP design.*

The Minnesota Stormwater Manual discusses stormwater treatment concepts and contains detailed tables that compare the suitability of different BMPs to the factors and considerations listed above: Process for selecting Best Management Practices – Minnesota Stormwater Manual (state.mn.us)

3.2 Best Practices in Site Design

While many different types of BMPs may be designed to achieve the District's stormwater management standards, thoughtful site design can help to minimize the need (and associated costs) for post construction stormwater treatment through pollution prevention, reducing runoff, and other means. This section summarizes select site design and BMP considerations that developers should consider to reduce project impacts.

The Minnesota Stormwater Manual also lists site design techniques to reduce runoff by various land use types: [Techniques to reduce runoff during site design and layout – Minnesota Stormwater Manual (state.mn.us)]

3.2.1 Impervious Surface Reduction

Impervious surfaces (e.g., roofs, parking lots, sidewalks) generate a significant volume of stormwater runoff and carry sediment and other pollutants to downstream resources. The impervious area of a project site is directly linked to the District's stormwater volume control requirements and is a primary factor in meeting District performance standards related to phosphorus loading and rate control (see Section 1.2). Project proposers may be able to reduce the scope and cost of stormwater management infrastructure necessary to meet District (and other) regulatory requirements by reducing the amount of impervious surface on a project site. Strategies to reduce impervious surface during site design may include:

- Disconnecting impervious surfaces from draining directly into the storm sewer system
- Using pervious pavement materials
- Locating structures to minimize driveways and other impervious connections
- Minimizing parking areas or developing shared parking
- Reducing street and trail widths

Strategies to reduce impervious area on a site are often generally considered elements of "Low Impact Development" or "Green Infrastructure." Additional information is available from the Minnesota Stormwater Manual at: Overview of Green Infrastructure and Low Impact Development – Minnesota Stormwater Manual (state.mn.us)

The District recognizes that impervious reduction strategies may not be feasible for all proposed projects. The District strongly encourages project proposers to consider opportunities for impervious surface reduction during the early stages of site design.

3.2.2 Tree and Native Vegetation Preservation

Forested areas and minimally disturbed native plant communities provide more stormwater retention and less pollutant loading than areas developed with impervious surfaces and maintained in turf. Native trees, shrubs, and herbaceous vegetation, intercept precipitation, evapotranspirate soil moisture, and mitigate impervious area heat island effects. Native trees, shrubs, and herbaceous vegetation also promote healthy soil structure that acts as a sponge, trapping runoff and facilitating infiltration, and promote increased organic content. While site development may incorporate planting of native trees and other vegetation, the benefits lost by the removal of existing mature trees, shrubs, and herbaceous vegetation during development may not be recovered for decades, if at all.

Low-impact development (LID) and green infrastructure strategies call for the preservation of the natural landscape features, such as native trees, shrubs, and herbaceous vegetation, to minimize potential stormwater impacts. The District encourages project proposers to consider and avoid impacts to mature trees as part of site design and BMP selection. The District recommends that project proposers conduct an assessment of existing vegetation and assess existing trees before design begins. Formal tree surveys may be performed by licensed professionals. Site designs should prioritize preservation of trees notable for their species, size, condition, age, longevity, durability, crown development, visual quality, location, or other beneficial functions (e.g., canopy extending over impervious areas).

SWWD recommends project designs generally prioritize trees of the following size for protection (excluding ash and elm):

- Hardwood deciduous trees >6” diameter (at 4.5 foot height)
- Softwood deciduous trees >8” diameter (at 4.5 foot height)
- Coniferous trees >10 feet in height

SWWD also recommends prioritizing protection of trees and native vegetation that are:

- Located within contiguous stands, groups of high structural diversity, or habitat corridors
- Located within floodplains or adjacent to wetlands, streams, and other water resources

Several cities within SWWD have adopted tree preservation requirements that limit or require mitigation for impacts to existing trees meeting qualifying criteria. Project proposers should check local ordinances (e.g., City codes) to determine if a project requires mitigation for impacted trees or other areas of disturbed vegetation (e.g., wetland buffers). Project proposers can also review the MDNR’s sites of biodiversity to confirm proposed project activities do not disturb high-value areas: MBS Site Biodiversity Significance Ranks | Minnesota DNR (state.mn.us)

The Minnesota Department of Transportation maintains specifications for the protection and restoration of vegetation as part of its standard specifications at: Standard Specifications for Construction – MnDOT (state.mn.us)

The Minnesota Stormwater Manual includes best practices for tree protection and a checklist for preserving natural areas as part of site design: Conservation of natural areas checklist – Minnesota Stormwater Manual (state.mn.us)

3.2.3 Vegetation in BMP Design

The presence of existing vegetation and the establishment and maintenance of new vegetation significantly impact the accumulation, routing, and management of stormwater runoff of a developed site. The presence of healthy vegetation can reduce the overall volume of stormwater generated. Thoughtful site design will consider how existing trees and other native vegetation impact and benefit other elements of the site, including visibility, access, shading, and other factors in addition to stormwater treatment.

Vegetation is also an essential component of many stormwater management BMPs (e.g., biofiltration basins, vegetated swales, buffers). As with any designed feature, vegetation must be well-designed, properly established, and maintained to allow the associated BMP to operate and perform as intended.

Conducting a site assessment and inventory of existing conditions related to vegetation on a proposed project where stormwater best management practices BMPs will be implemented is an essential step in designing BMPs incorporating vegetation. Site characteristics such as soil type and chemistry, sun exposure, and others have a significant impact on the long-term success of installed vegetation. During the BMP design phase, project designers should review the Minnesota Stormwater Manual's resources for properly selecting plants and seed mixes for stormwater management applications to confirm selection of the best plants for the design conditions: Plants for Stormwater Design – Minnesota Stormwater Manual (state.mn.us).

The Minnesota Stormwater Manual provides additional details regarding how site conditions may affect the use of vegetation in stormwater management: Site assessment, preparation, design considerations and recommendations for vegetation in stormwater management – Minnesota Stormwater Manual (state.mn.us)

3.2.3.1 Vegetation Establishment

The vegetation establishment phase refers to the period immediately following plant installation when plants are developing roots and leaves. This is a critical period when plants are susceptible to drought, flooding, erosion, and physical disturbance (foot traffic, animal or insect browse, etc.). A plant's establishment period varies in length depending on the type and size of vegetation planted (seed, containerized plant, tree, etc.). For BMPs planted with seed, it can typically take two to three years for the plants to fully establish; while live containerized or plug plantings may have an establishment period as short as one year (depending on the size of container).

Best practices to be followed during the vegetation establishment phase include but are not limited to:

- **Regular inspection of BMP and site erosion control features during the growing season.** Plantings are especially susceptible to erosion caused by rain during the first month following planting. Re-seeding is strongly recommended in areas where significant erosion occurs. Frequent inspection and maintenance of erosion control practices throughout the establishment period is necessary to ensure their effective operation. Refer to the project SWPPP and erosion control plan for specific stabilization requirements. Additional stabilization measures may be required, as unexpected weather or site conditions can arise.

- **Plan for one or two watering and weeding visits each month during the growing season** to promote desirable plant growth.
    - Hand-weed mulched and formal plantings.
    - Plan for at least one mowing during the first year to knock back annual weeds and get sunlight down to young native perennials.
    - Avoid using herbicide during the first year; overspray is devastating for seedlings
- **Consult a plant specialist to confirm young seedlings are establishing.** While it can take up to three years for native plants to mature, confirmation of a successful seeding can often be determined after the full first growing season. Early inspection allows corrections to be made earlier in the process.
- **Plantings should typically be warrantied through the extent of the anticipated establishment period** as some die-off should always be expected. In addition, this typically motivates the contractor to take better care of the plants while they fully establish.

The Minnesota Board of Water and Soil Resources (BSWR) provides additional technical resources to guide the successful planting and management of vegetation restoration projects: Native Vegetation Establishment and Enhancement Guidelines | MN Board of Water, Soil Resources (state.mn.us)

3.2.3.2 Vegetation Maintenance

Long term maintenance (also referred to as long term management) typically begins 1-3 years following the establishment period and should extend for the design life of the BMP. Expectations for long term maintenance should be budgeted for and clearly defined at the start of the project by the project owner within a detailed vegetation maintenance plan (required by SWWD for all stormwater BMPs). Typical maintenance tasks include mowing, hand weeding, spot spraying with herbicide, mulching, and adding or replacement of plants.

Maintenance activities and frequency can vary depending on the type of BMP, site conditions, vegetation species, age of vegetation, and project goals. Maintenance should utilize an adaptive management approach where site managers implement an iterative process of decision making to adjust management tasks based on the needs of the site. For complex sites, an annual inspection by a trained landscape professional such as a landscape architect, restoration specialist, ecologist, or an arborist is recommended to confirm vegetation is being properly maintained. For well-established plantings, more periodic inspections every 3-5 years may be more appropriate based on consultation with a landscape professional.

The Minnesota Stormwater Manual contains guidance on operations and maintenance considerations for vegetation in stormwater management: Operation and maintenance considerations for vegetation in stormwater management – Minnesota Stormwater Manual (state.mn.us). In addition, the Minnesota Board of Water and Soil Resources (BWSR) has developed more detailed guidelines for specifically establishing native plants (not limited to BMP plantings) at a site: Native Vegetation Establishment and Enhancement Guidelines.

Both construction and operation and maintenance inspection checklists can help inspectors know what to look for and expect when in the field. The MPCA has developed BMP specific inspection forms: Forms - Minnesota Stormwater Manual (state.mn.us)

3.2.4 Soil Protection, Decompaction, and Amendments

Maintaining soil permeability throughout the landscape is important in promoting infiltration and reducing stormwater runoff volume. In addition, achieving and maintaining soil permeability of designed infiltration BMPs is critical to maintaining long-term performance. The District therefore requires soil decompaction within infiltration BMPs; soil protection and decompaction practices are encouraged throughout a project site.

Soils at construction sites are often unintentionally impacted as a result of excavation, mixing, and storing and moving equipment. Soil compaction may be avoided through careful sequencing and locating of construction activities. During construction the project engineer, landscape architect, and/or project site inspector should confirm that contractor soil preparation conforms to the specifications of the project contract. When taking action to alleviate soil compaction, heavy equipment should be positioned to remain outside the area of decompaction work.

Ideal bulk densities for drainage and healthy vegetation vary according to soil type. Where applicable, MnDOT 2020 Standard Specifications section 2571.3.D.7 (Weed Control and Soil Cultivation) requires compaction of no more than 200 pounds per square inch (psi) to a depth of 16 inches for plantings to promote the best long-term success of the project plantings. The Minnesota Stormwater Manual also references guidance of 200 psi to a depth of 20 inches.

The Minnesota Stormwater Manual provides guidance on minimizing soil compaction and practices for alleviating compaction: Alleviating compaction from construction activities – Minnesota Stormwater Manual (state.mn.us)

3.2.5 Chloride Smart Site Design

Chloride loading to lakes, streams, and groundwater has a negative impact on water quality and the intended uses of these resources. Once dissolved in water, chloride is difficult to remove and accumulates in the environment. Therefore, chloride reduction at the source is necessary to restore impacted waterbodies and protect all waters. Deicing salt is a primary source of chloride in the environment.

The MPCA and its partners have developed guidance to assist road authorities, local governments, developers, and managers of public and private properties in minimizing the use and impact of deicing salt through site design and infrastructure maintenance.

The District encourages project proposers to consider future winter maintenance needs and potential salt use during site and BMP design. “Salt-smart design” includes considering how and where snow and ice will accumulate, and where it must be cleared, relative to engineered and natural site features. Considerations for site design include, but are not limited to:

- Elevating impervious features to limit water collection during mid-winter thaws
- Siting impervious surfaces away from areas where blowing snow will accumulate
- Siting sidewalks and other impervious areas to maximize sun exposure

The District also encourages project proposers to develop winter maintenance plans to be implemented by property managers following project completion.

The Minnesota Stormwater Manual includes the Smart Salting Assessment tool (SSAt) to assist public and private maintenance organizations in identifying opportunities to reduce salt use and tracking reductions over time: Smart Salting Assessment tool (SSAt) – Minnesota Stormwater Manual (state.mn.us)

Other potential resources for property managers include:

- Smart Salting training | Minnesota Pollution Control Agency (state.mn.us)Using Sidewalk Salt Responsibly – Clean Water Minnesota (cleanwatermn.org)

3.2.6 BMP Maintenance and Long-term Performance

BMPs constructed for stormwater management must be properly maintained in order to perform as intended throughout their design life. With respect to BMP maintenance, SWWD Rules generally require the following:

- Stormwater management easements shall be provided by the applicant for access for facility inspections and maintenance and preservation of stormwater runoff conveyance, infiltration, and detention areas and facilities, including the overflow route.
- Land used for stormwater management facilities which lie below the 100-year flood elevation shall be preserved by dedication and or perpetual easement to the LGU.
- A maintenance agreement shall be recorded with the County as part of the LGU development approval process. Minimum requirements for the maintenance agreement include:
    - A list of the responsible party(s) (LGU and facility owner/manager)
    - Contact information
    - A formalized maintenance schedule, with scheduled activities
    - A "Failure to Perform" provision laying out remedial actions if the responsible party does not perform as expected
    - Maintenance debris handling plans
    - Emergency response

Within the SWWD, local governments will determine responsibility for maintenance of stormwater management facilities within municipal easements. The District requires maintenance or retrofitting of facilities when it can demonstrate failure of the facility to meet approved design specifications or standards. The District encourages municipalities to collect sureties from developers to be held in escrow for future stormwater maintenance or retrofitting or otherwise take steps to ensure maintenance.

Maintenance needs (and expenses) vary according to BMP type, location, and design. Project proposers must consider inspection and maintenance factors in the selection and design of stormwater BMPs. Factors that may affect maintenance feasibility include (but are not limited to):

- Distance from vehicle access/roads
- Proximity to trees and other vegetation
- Opportunity for unauthorized access/vandalism
- Surface vs. underground construction
- Frequency of inspection and routine cleaning
- Need for specialized maintenance equipment or services

The Minnesota Stormwater Manual includes resources regarding maintenance of several green infrastructure BMPs: Operation and maintenance of green stormwater infrastructure best management practices – Minnesota Stormwater Manual (state.mn.us)

The Minnesota Stormwater Manual also includes maintenance information for more traditional stormwater BMPs, including wet ponds. Maintenance resources for specific BMPs are provided in the BMP summaries included in Section 3.3.

3.2.6.1 Pretreatment

Pretreatment is a general term to describe practices used to reduce or remove pollutants in stormwater, primarily sediment, before they enter structural stormwater BMPs. Pretreatment practices typically include settling devices, screens, and vegetated filter strips.

SWWD requires pretreatment upstream of filtration and infiltration stormwater BMPs.

Pretreatment techniques are necessary to prevent structural stormwater BMPs from being overloaded by pollutants, especially sediment. Installing pretreatment upstream of stormwater BMP(s) reduces maintenance needs and maximizes the lifespan of structural stormwater BMPs by removing trash, debris, organic materials, coarse sediments, and associated pollutants prior to entering structural stormwater BMPs. Implementing pretreatment devices also improves aesthetics by capturing debris in focused or hidden areas. Pretreatment can also be used to dampen the effects of high or rapid inflow, dissipate energy, and provide additional storage.

The District requires pretreatment practices be implemented upstream of infiltration and filtration BMPs consistent with the MPCA’s Construction Stormwater General permit. The District encourages pretreatment upstream of all structural stormwater BMPs. Selecting and sizing appropriate pretreatment practices depends on the characteristics of the upstream drainage area, available space, primary pollutants, and downstream structural BMPs. The Minnesota Stormwater Manual recommends that pretreatment practices be designed for easy maintenance and removal of 25% or more of sediment from runoff.

The Minnesota Stormwater Manual includes additional information about pretreatment practices: Pretreatment – Minnesota Stormwater Manual (state.mn.us)

The Minnesota Stormwater Manual also includes a tool to assist developers in selecting pretreatment practices appropriate to specific project sites: MPCA Pretreatment Practice Selection Tool (igeowater.com)

3.3 BMP Summaries – Structural Practices

This section summarizes types of BMPs commonly used to manage stormwater runoff to achieve the performance standards established by the District (see Section 1.2). The following subsections provide high level summaries and links to more specific guidance, where appropriate. Omission of a BMP type from this section does not prohibit its use in projects within the watershed. In such cases, however, the District recommends developers proactively coordinate with the District and/or City in which the project is located.

3.3.1 On-Site Infiltration

Infiltration BMPs treat urban stormwater runoff as it flows through filtering media and into underlying soil, where it may eventually percolate into groundwater. The filtering media is typically coarse-textured and may contain organic material (e.g., bio-infiltration BMPs such as rainwater gardens); engineered media for these types of BMPs is typically designed to both promote infiltration and support the growth of plants. Infiltration BMPs are effective at reducing stormwater volume during smaller precipitation events and removing pollutants such as TSS, particulate phosphorus, metals, bacteria, nitrogen, and most organics. Soluble pollutants such as chloride and nitrate typically pass through these BMPs.

3.3.1.1 Design Considerations

Infiltration BMPs may only be used in areas with favorable soils and geologic conditions, including moderate to high infiltration potential and limited risk for groundwater contamination.

The District prohibits infiltration in areas where specific criteria are met (see Section 2.2.6.3). Project proposers must provide site-specific data to demonstrate whether infiltration is or is not appropriate for a particular project site.

Vegetation may be used as an integral component in the design of infiltration BMPs; Section 3.2.3 presents information about the use of vegetation in BMP design including selection, establishment, and maintenance. The District requires decompaction of soils underlying infiltration BMPs; Section 3.2.4 includes more information about decompaction practices. Infiltration BMPs must be designed consistent with the requirements of the Minnesota Construction Stormwater General Permit and guidance referenced by the Minnesota Stormwater Manual at: Design criteria for bioretention – Minnesota Stormwater Manual (state.mn.us)

The District requires the use of pre-treatment in BMP design (see Section 3.2.6.1). The Minnesota Stormwater Manual summarizes pretreatment methods: Overview and methods of pretreatment – Minnesota Stormwater Manual (state.mn.us)

3.3.1.2 Maintenance Considerations

The Minnesota Stormwater Manual summarizes operation and maintenance issues and considerations applicable to infiltration BMPs: Operation and maintenance of bioretention and other stormwater infiltration practices – Minnesota Stormwater Manual (state.mn.us)

3.3.1.3 Performance Estimates

Infiltration practices, specifically bioretention, have one of the highest nutrient and pollutant removal efficiencies of any stormwater BMP. Bioretention provides pollutant removal and volume reduction through filtration, evaporation, infiltration, transpiration, biological and microbiological uptake, and soil adsorption; the extent of these benefits is highly dependent on site specific conditions and design. Infiltration BMPs are typically not effective for rate control due to small BMP volumes relative to runoff generated from larger storm events.

The MIDS calculator (see Section 4.4.1) incorporates multiple types of infiltration BMPs. The Minnesota Stormwater Manual provides guidance for calculating volume and pollutant removals from bioretention: Calculating credits for bioretention – Minnesota Stormwater Manual (state.mn.us)

3.3.2 Filtration

Filtration BMPs treat stormwater runoff as it flows through filtering media that removes sediment, nutrients, and other pollutants. Filtration BMPs differ from infiltration BMPs (see Section 3.3.1) by capturing the filtered runoff and routing it downstream before it reaches the underlying soils. Filtration is often used as pretreatment upstream of other stormwater management BMPs. Filtration BMPs are effective at reducing pollutants such as TSS, particulate phosphorus, metals, bacteria, nitrogen, and most organics. Soluble pollutants such as chloride and nitrate typically pass through these BMPs. Increased treatment of soluble pollutants may be possible through the use of "enhanced" media (see Section 3.3.2.2). Filtration BMPs typically provide little or no volume reduction benefit.

Filtration is described in the Minnesota Stormwater Manual: Overview for filtration – Minnesota Stormwater Manual (state.mn.us)

Several types of filtration BMPs are described specifically in the Minnesota Stormwater Manual, including:

- Sand filters
    - Surface sand filters
    - Iron-enhanced sand filters
    - Underground sand filters
- Biofiltration basins
- Swales
    - Wet Swales
    - Dry Swales

3.3.2.1 Design Considerations

Filtration BMPs are often used to achieve pollutant reduction when site conditions prohibit or restrict infiltration practices (see Section 2.2.6.7). Filtration BMPs may be installed on the surface or underground when land space is limited (often an important retrofit or redevelopment consideration). Depending on the filtration media, vegetated filters may also be incorporated into landscaped areas, providing additional aesthetic and habitat benefits. Section 3.2.3 presents information about the use of vegetation in BMP design including selection, establishment, and maintenance.

Design considerations will vary according to the specific type of filtration BMP. Filtration BMPs must be designed in a manner consistent with the requirements of the Minnesota Construction Stormwater General Permit and guidance contained within the Minnesota Stormwater Manual at: Design criteria for filtration – Minnesota Stormwater Manual (state.mn.us)

3.3.2.2 Filter Media

Filtration achieves pollutant removal by passing stormwater through a filter media. The media type may vary according to the specific filtration BMP type or other design considerations. With any type of filter media, careful consideration of the water quality of inflowing water, as well as the potential water quality of outflowing water, should be taken into consideration when choosing the appropriate filter media. Some filtration media, for example, have the potential to export nutrients under certain conditions, while other may affect pH or other parameters. Filtration media selection should be tailored to each individual site's characteristics and water quality treatment goals.

- **Biofiltration** media – for biofiltration systems (e.g., bioretention basins with an underdrain), the Minnesota Stormwater Manual recommends a filter depth of 2.5 feet or more to allow adequate filtration. Generally, media mixes are primarily sand with smaller amounts of fine soils and organics. Example media mixes for biofiltration systems are described in the Minnesota Stormwater Manual: Design criteria for bioretention – Minnesota Stormwater Manual (state.mn.us)
- **Sand filter** media – filtration BMPs that do not include vegetation (e.g., underground filtration) typically include a sand bed approximately 1.5 feet deep (as recommended in the Minnesota Stormwater Manual). The Minnesota Stormwater Manual contains additional information about sand filters: Types of sand (media) filters – Minnesota Stormwater Manual (state.mn.us)
- **Iron-enhanced sand** – sand filter media may be amended with iron to enhance the removal of dissolved phosphorus. The Minnesota Stormwater Manual recommends iron content in the media (by weight) between 5% and 8%. Additionally, the design should specify the type of iron used as zero valent iron filings, which show the most consistency in phosphorus removals. Iron-enhanced sand filters are best implemented on sites where inflows are intermittent and the media has time to dry out between storm events to reoxygenate the iron. Other iron types should be reviewed and laboratory tested for their removal efficiencies: Iron enhanced sand filter (Minnesota Filter) – Minnesota Stormwater Manual (state.mn.us)

- **Spent lime (calcium residual) –** residual calcium byproduct from water treatment processes may be used as filtration media for treatment of phosphorus and other pollutants. Research on the use of spent lime in stormwater applications is ongoing. Designs should consider potential impacts of increases in effluent pH and long-term breakdown of the compound. Additionally, the hydraulic capacity of the spent lime should be periodically evaluated to ensure the media is not clogging. Spent lime filters are best implemented on sites where inflows are intermittent the media has time to dry out between storm events to maintain good flow through the media. Spent lime, calcium water treatment residuals and application in stormwater – Minnesota Stormwater Manual (state.mn.us)
- **Crushed limestone –** crushed limestone media (commonly referred to as CC17) has a high hydraulic capacity and has similar treatment efficiencies to a sand filter. CC17 may be used under continuous or high-frequency inundation flow regimes without negative impacts to treatment efficiency. When designing a filtration BMP using CC17, additional hydraulic control systems (i.e., proper drain tile sizing) are typically needed to provide the proper contact time because of CC17's high rates of hydraulic conductivity.
- **Biochar –** although less commonly used in stormwater filters, biochar is applicable for removal of E. *coli* in influent water. Biochar provides minimal removal of nutrients and suspended solids. There is an evolving body of research about how to best source and implement biochar for best results. As such, it is best to review up to date information when considering a biochar filter design. https://pubs.rsc.org/en/content/articlehtml/2020/ew/d0ew00027b
- **Proprietary media –** proprietary stormwater treatment systems typically offer an enhanced filtration media for use with the proprietary system. These systems often publish high removal efficiencies on the manufacturers websites, but peer reviewed sources should be used to evaluate in-situ removal efficiencies. Some states agencies and/or watershed districts have begun publishing guidance documents regarding use of proprietary media: https://ecology.wa.gov/Regulations-Permits/Guidance-technical-assistance/Stormwater-permittee-guidance-resources/Emerging-stormwater-treatment-technologies

3.3.2.3 Liners

Liners are designed to limit infiltration of water from a stormwater BMP into underlying and adjacent soil. The Minnesota Construction Stormwater Permit requires that BMPs incorporate liners when:

- There is less than three feet of separation between the BMP and seasonally saturated soils or bedrock, or
- The BMP is located within active karst terrain.

The Minnesota Stormwater Manual describes additional circumstances when liners are not required but are recommended. The use of geomembrane liners is generally recommended and preferred over the use of clay liners for sites where infiltration is prohibited. If used, clay liners should be protected to avoid periods of extended drying and protected from freeze / thaw cycles. The Minnesota Stormwater Manual provides guidance on liner specifications and selection: Liners for stormwater management – Minnesota Stormwater Manual (state.mn.us)

3.3.2.4 Maintenance Considerations

The Minnesota Stormwater Manual summarizes operation and maintenance issues and considerations applicable to filtration BMPs: [Operation and maintenance of filtration – Minnesota Stormwater Manual (state.mn.us)]

3.3.2.5 Performance Estimates

Filtration BMPs generally have high nutrient and pollutant removal efficiencies but provide little or no volume reduction. The degree of pollutant removal is dependent on site specific conditions and design. Increased pollutant removal can be achieved through the use of enhanced filter media (Section 3.3.2.2). Filtration BMPs typically are not effective rate control BMPs due to small BMP volumes relative to runoff generated from larger storm events.

The MIDS calculator incorporates multiple types of filtration BMPs. The Minnesota Stormwater Manual provides guidance for calculating volume and pollutant removals from sand filters and swales:

Calculating credits for sand filter – Minnesota Stormwater Manual (state.mn.us)

Calculating credits for dry swale (grass swale) – Minnesota Stormwater Manual (state.mn.us)

3.3.3 Stormwater Ponds

Constructed stormwater basins or ponds are a common BMP to manage stormwater runoff. Water is retained in the pond for a period of time, allowing sediment and particulate pollutants to settle out and releasing the water over days instead of hours. Ponds are effective at removing TSS and particulate pollutants over a range of storm events. Properly designed ponds are also very effective at reducing peak runoff rate.

3.3.3.1 Design Considerations

The size and layout of a stormwater pond will vary according to the design objectives and level of stormwater treatment desired. When designed in series or parallel with other stormwater BMPs (e.g., treatment network approach), ponds are typically included at the downstream end of the BMP sequence. Stormwater ponds must incorporate an impermeable liner if constructed in areas with active karst terrain.

Stormwater ponds must be designed consistent with the guidance and requirements referenced in the Minnesota Stormwater Manual at: Design criteria for stormwater ponds – Minnesota Stormwater Manual (state.mn.us)

Stormwater pond design should also consider relevant aspects of incorporating vegetation in BMP design, including selection, establishment, and maintenance (see Section 3.2.3).

3.3.3.2 Maintenance Considerations

The Minnesota Stormwater Manual summarizes operation and maintenance issues and considerations applicable to stormwater ponds: Operation and maintenance of stormwater ponds – Minnesota Stormwater Manual (state.mn.us)

3.3.3.3 Performance Estimates

Properly sized ponds can capture significant amounts of sediment and particulate phosphorus (i.e., phosphorus bound to sediment particles). Very fine particles (e.g., clay particles) and phosphorus not attached to sediment will typically not be captured within a stormwater pond and will be discharged through the effluent. The water quality treatment efficiency of any particular pond depends on the ultimate characteristics of the pond design.

The MIDS calculator includes stormwater ponds as a BMP. The Minnesota Stormwater Manual includes methodology for calculating pollutant removals from ponds: Calculating credits for stormwater ponds – Minnesota Stormwater Manual (state.mn.us)

3.3.4 Stormwater Reuse

Stormwater reuse is the practice of collecting stormwater and using it to meet water demands at another location and/or time. Rainwater harvesting is a subset of stormwater reuse, associated with the collection of runoff from roof surfaces, which tend to have lower levels of pollution than other urban impervious surfaces. Reuses of collected stormwater and rainwater commonly include, but are not limited to, landscape irrigation and toilet flushing. Stormwater can also be reused for industrial purposes. As a stormwater treatment BMP, reuse is effective at reducing volume and pollutants carried in the retained and reused volume. Reuse BMPs typically provide little or no rate control benefit due to their limited volume.

3.3.4.1 Design Considerations

Stormwater reuse is often considered as a practical volume reduction BMP when site conditions prohibit or limit the feasibility of on-site infiltration (see Section 2.2.6.7). A stormwater reuse system has four components:

- Collection system
- Storage unit (e.g., cistern or pond)
- Treatment system (if needed)
- Distribution system

The specific components and design of each reuse system will vary according to the source of stormwater runoff (e.g., rooftops, parking lots) as well as the intended use (e.g., in-building uses vs. on-site irrigation). A primary consideration in any stormwater reuse system is matching the water quality of the collected stormwater with the requirements of the intended reuse. Water quality requirements for beneficial uses of stormwater are often context-specific and required treatment will vary depending on source water quality. Depending on the project specifics, harvested rainwater may require less treatment than harvested stormwater. State plumbing code requirements come into play for certain aspects of some types of stormwater reuse projects.

The stormwater reuse system must also be sized such that the supply of runoff is appropriately matched to the consumptive use. Project proposers must clearly document calculations and assumptions used in designing and estimating performance of stormwater reuse systems.

The Minnesota Stormwater Manual includes guidance for the selection and design of stormwater reuse systems: Overview for stormwater and rainwater harvest and use/reuse – Minnesota Stormwater Manual (state.mn.us)

The Minnesota Stormwater Manual also summarizes site constraints that can affect the feasibility and design or reuse systems: Water re-use key site considerations – Minnesota Stormwater Manual (state.mn.us)

3.3.4.2 Operation and Maintenance Considerations

Operations and maintenance considerations for stormwater reuse will vary according to the design of individual systems. Information must be documented in a formal operations and maintenance plan that includes the information listed in Section 3.2.6, in addition to the following unique stormwater reuse system considerations:

- Site plans and as-built drawings showing the location of all system components, operational controls (e.g., pumps, valves, sensors), and areas designated for irrigation/application
- A formalized maintenance schedule, with scheduled activities for all system components including:
    - Spring start-up and winter decommissioning
    - Regular inspections – annual, seasonal, monthly, etc.
    - Inspection guidelines for special circumstances (e.g., large storms, electrical outages)
- Component specific O&M plan details addressing (as applicable):
    - Runoff collection surfaces
    - Collection and pretreatment system
    - Storage system
    - Treatment system
    - Distribution system
    - Irrigation system
- Monitoring Plans
- Inspection forms and/or maintenance logs
- Documentation of roles and responsibilities including follow-up for special circumstances

Because of the different system components involved, stormwater reuse systems may require unique maintenance skillsets and/or equipment (e.g., exchanging filters, winterizing equipment). Operations and maintenance agreements should identify non-standard maintenance items to ensure the responsible parties are capable of performing assigned tasks.

The Minnesota Stormwater Manual contains more detailed operation and maintenance information applicable to stormwater reuse, including component-specific maintenance considerations: Operation and maintenance for stormwater and rainwater harvest and use/reuse – Minnesota Stormwater Manual (state.mn.us)

3.3.4.3 Performance Estimates

Volume reduction and pollutant removal performance of stormwater reuse BMPs are dependent upon the volume of captured water that is used and the volume of excess collected water that must be routed downstream. Typically, the volume reduction and pollutant removal of the reused water is assumed to be 100%. Stormwater reuse BMPs typically are not effective rate control BMPs due to small BMP volume relative to runoff generated from larger storm events.

The MIDS calculator incorporates stormwater reuse as a BMP type. The Minnesota Stormwater Manual provides guidance for calculating volume and pollutant removals from bioretention: Calculating credits for stormwater and rainwater harvest and use/reuse – Minnesota Stormwater Manual (state.mn.us)

3.3.5 Hydrodynamic Devices

Hydrodynamic devices (or hydrodynamic separators) are structural devices designed to remove suspended solids, nutrients bound to the solids, and other pollutants from stormwater runoff through gravitational trapping. The devices often also capture oil, grease, and other floatable debris through the use of baffles or skimmers. Hydrodynamic devices are often relatively compact in size and are designed to achieve higher pollutant removals for smaller, more frequent storm events than for larger events.

The Minnesota Stormwater Manual contains general information about hydrodynamic devices: Hydrodynamic devices – Minnesota Stormwater Manual (state.mn.us)

3.3.5.1 Design Considerations

Hydrodynamic devices are proprietary and designed by the manufacturer. Use and design of hydrodynamic separators must consider expected flow rates, removal efficiencies for pollutants of concern, site/size constraints, and maintenance needs. Some devices must be installed by the manufacturer. Some hydrodynamic devices may be designed with filtration media (often in interchangeable cartridges) to achieve higher removal of dissolved pollutants like phosphorus. Performance data is typically unit-specific, provided by the manufacturer, and should be reviewed by the project designer to ensure performance estimates are supported by independent testing.

3.3.5.2 Maintenance Considerations

Hydrodynamic devices require regular maintenance to remove accumulated sediment and floatables. Devices containing filtration media require regular replacement of media to ensure that expected pollutant removal efficiencies are achieved.

3.3.5.3 Performance Estimates

Performance data on hydrodynamic devices is typically unit-specific and provided by the manufacturer. Manufacturer's claims may be high and should be reviewed by the project designer to ensure performance estimates are supported by independent testing. Hydrodynamic devices are effective for reducing sediment and sediment-bound pollutants from stormwater. Additional filtration media may be required to effectively remove nutrients. Hydrodynamic devices provide no volume reduction benefit.

Some organizations (e.g., Washington State) have begun publishing guidance regarding use of proprietary devices including results of performance testing: Emerging stormwater treatment technologies (TAPE) – Washington State Department of Ecology

3.4 Alternative Compliance Sequencing

Infiltration of stormwater is the District's preferred method to satisfy applicable stormwater management requirements. The District recognizes, however, that many sites within the watershed are not suitable for stormwater infiltration due to the presence of one or more limiting site conditions. Consistent with the MPCA's Construction Stormwater General Permit, the SWWD prohibits infiltration in the following:

- Areas that receive runoff from vehicle fueling and maintenance areas;
- Areas where infiltrating stormwater may mobilize high levels of contaminants in soil or groundwater;
- Areas where soil infiltration rates are field measured at more than 8.3 inches per hour (unless the soils are amended to slow the infiltration rate below 8.3 inches per hour);
- Areas with less than three (3) feet of separation distance from the bottom of the infiltration system to the elevation of the seasonally saturated soils or the top of bedrock;
- Areas of predominately **Hydrologic Soil Group** type D soils (clay);
- Within a Drinking Water Supply Management Area (DWSMA) or DWSMA Emergency Response Area (ERA) as follows:
    - In an ERA within a DWSMA classified as having high or very high vulnerability;
    - In an ERA within a DWSMA classified as moderate vulnerability (unless a higher level of engineering review has been approved by the affected City); or
    - Outside an ERA within a DWSMA classified as having high or very high vulnerability (unless a higher level of engineering has been approved by the affected City).
- Areas within 1,000 feet upgradient or 100 feet downgradient of **active karst features**; and
- Areas that receive runoff from specific industrial facilities (see SWWD Rules).

The BMP screening and selection process (see Section 3.1) should consider the above areas and other site conditions that may limit the effectiveness of infiltration even where it is not prohibited. The District recognizes there will be situations where a proposed project may not be able to fully attain compliance with volume control requirements via infiltration, including linear projects with limited right-of-way (see SWWD Rules Section 7.3.3).

If a project proposer believes that infiltration sufficient to meet SWWD performance standards is not feasible or is prohibited for their project, they should contact staff at their permitting city or the District prior to submitting project review materials. Project proposers must provide data to demonstrate that infiltration is not feasible or is prohibited to the satisfaction of city permitting and/or District staff. After staff has confirmed that infiltration is not appropriate for a site, project proposers must pursue "alternative compliance sequencing" in the following progression:

1. Use of alternative (i.e., non-infiltration) volume control practices (e.g., stormwater reuse) as described in the Minnesota Stormwater Manual, sized to treat the water quality volume required by SWWD Rules.
2. Use of on-site filtration practices and biofiltration using an impermeable liner and under drain, sized to treat the water quality volume required by SWWD Rules (see Section 3.3.2).
3. Use of off-site volume control BMPs sized to treat the water quality volume required by SWWD Rules. Off-site BMPs must be:
    a. Constructed within the same drainage area or subwatershed as the project site, as defined by SWWD.
    b. Constructed and operational prior to constructing impervious area within the contributing drainage area.
    c. Constructed consistent with the applicable guidance of this Manual and Minnesota Stormwater Manual.
4. Use of wet sediment basins sized per the guidance described within the MPCA General Construction Stormwater Permit, as amended, and Minnesota Stormwater Manual.

Project proposers must document in the project stormwater pollution prevention plan (SWPPP) why each alternative compliance sequence step is not feasible before proceeding to the next step.

3.5 Stormwater Credit Banking

The SWWD does not currently administer a stormwater credit banking program.

Stormwater crediting (or stormwater banking) is an approach where pollutant or volume reductions in excess of the minimum performance standards are approved, tracked, and may be considered for use in evaluating compliance of a future project unable to meet performance standards on that project's site. Stormwater credit programs are useful to allow development or redevelopment projects to occur on difficult sites while still achieving an overall level of stormwater treatment that is acceptable. However, stormwater credit programs pose administrative challenges due to the degree of record keeping that is required and coordination of responsible parties.

The District has not established a stormwater banking program at this time but does not prohibit its member cities from implementing local stormwater banking programs. Stormwater banking programs developed by member cities must be submitted to the District for review and approval prior to implementation. Cities shall be responsible for the administration of such programs.

4 Calculation Methods for Site Design Analysis

This section provides guidance on the objectives and methods of hydrologic, hydraulic, and water quality analyses to demonstrate compliance of proposed projects with District rules. The information presented in this section focuses on aspects most relevant to proposers of development and redevelopment projects within the District. The Minnesota Stormwater Manual also presents an introduction to stormwater modeling that addresses many of the topics included in this section: [Introduction to stormwater modeling – Minnesota Stormwater Manual (state.mn.us)]

4.1 Compliance with District Rules

For proposers of development or redevelopment projects within the watershed, a primary objective of hydrologic, hydraulic, and water quality analyses is to demonstrate compliance with District Rules regarding stormwater rate control, pollutant loading, and volume retention (for both hydraulic and water quality functions). Note that not all District Rules apply to all projects (see Section 1.2). As applicable, hydrologic, hydraulic, and water quality analyses submitted for District review **must include** the following quantitative outputs:

- **Rate Control Outputs**:
  - Pre-project peak stormwater discharge rates for the 2, 10, and 100 year 24-hour duration rainfall events using District-approved design storms
  - Post-project peak stormwater discharge rates for the 2, 10, and 100 year 24-hour duration rainfall events using District-approved design storms
- **Total Phosphorus Loading Outputs**:
  - Pre-project average annual total phosphorus loading
  - Post-project average annual total phosphorus loading
- **Total Suspended Sediment Loading Outputs**:
  - Pre-project average annual total suspended sediment loading
  - Post-project average annual total suspended sediment loading
- **Volume Retention Outputs** (for water quality considerations)
  - Treatment volume of post-project BMPs including retention, filtration, or other practices

For projects draining to wetlands classified by the District as **Protect**, **Manage 1**, or **Manage 2**, analyses submitted for District review must include the following outputs to assess potential hydrologic, hydraulic, and/or water quality impacts:

- **Wetland Hydrology Outputs:**
  - Storm bounce generated from the 10 year 24-hour duration rainfall events using the District-approved design storm; bounce is the difference between the peak and normal water level
  - Peak inflow rate generated from the 2 and 100 year 24-hour duration rainfall events using District-approved design storms

- Inundation period resulting from the 1 and 2 year 24-hour duration rainfall events using District-approved design storms; inundation period is the time flood waters stored in the wetland exceed the normal water level

- **Wetland Water Quality Outputs:**
  - Pre-project average annual total phosphorus loading to each wetland
  - Post-project average annual total phosphorus loading to each wetland

Additionally, for projects located in landlocked basins or as necessary due to a downstream RAL (see Section 5), analyses submitted for District review must also include the following volume control outputs:

- **Volume Control Outputs** *(for hydrologic and hydraulic considerations)***:**
  - Pre-project stormwater volume generated from the 2, 10, and 100 year 24-hour duration rainfall events using District-approved design storms
  - Post-project stormwater volume generated from the 2, 10, and 100 year 24-hour duration rainfall events using District-approved design storms

The quantitative outputs listed above are necessary to demonstrate compliance with District rules watershed wide. Additional modeling outputs may be required based on project location immediately upstream of RALs (see Section 5) or other sensitive features (e.g., trout streams) downstream of the proposed project. In such cases, project proposers should confirm modeling output needs with District staff.

4.1.1 Allowable Total Phosphorus Loading

The District has established maximum allowable total phosphorus loading limits for areas across their jurisdiction, according to downstream receiving waterbody (see Section 1.2). The maximum allowable load is applicable to development, redevelopment, and public improvement projects. The District established these maximum allowable loads in order to meet District water quality goals for waterbody protection and improvement.

The allowable load applicable to an individual project is that of the nearest downstream resource. The District webmap presents the allowable load applicable to each subwatershed (see Section 2.2.1.1). For wetlands where there is no current BMP between the project and the wetland, the following allowable total phosphorus loads apply based on wetland classification:

- Protect Classification – Maintain pre-project average annual phosphorus loading
- Manage 1 Classification – Reduce post-project average annual phosphorus loading by 60%
- Manage 2 Classification – Reduce post-project average annual phosphorus loading by 60%

4.2 Analysis Input Parameters – Landscape Factors

Hydrologic, hydraulic, and water quality models estimate the response of natural and engineered systems (e.g., conveyance systems, BMPs) to precipitation. These models are dependent on landscape variables including land use and land cover, soils, topography/slope, and more. This section summarizes landscape inputs relevant to hydrologic and hydraulic modeling as well as water quality modeling. Note that not all inputs discussed may be relevant to all analytical methods, models, and tools.

Additional model and calculation inputs specific to hydrologic and hydraulic analysis or water quality analysis are described in Section 4.3.2 or Section 4.4.2, respectively.

4.2.1.1 Drainage Patterns and Subwatersheds

Accurately identifying the area that will contribute runoff to a location is critical in estimating stormwater runoff volume, peak flow, and pollutant load to downstream BMPs and conveyances. The District webmap presents watershed boundaries at multiple levels of detail for areas across the District.

As part of their permit application package, proposers of development and redevelopment projects must create and submit information on both existing and proposed drainage patterns and boundaries at their project site. Drainage boundaries shall be delineated at a level of detail necessary to support BMP design and evaluation.

Drainage boundaries shall be digitized, either in ESRI or GIS-compatible format. Hydrologic analysis efforts shall account for all areas contributing drainage to the project area, including those outside the project property boundary. These “off-site” drainage areas shall be included in the delineation of drainage boundaries for the project area and noted.

4.2.1.2 Hydrologic Soil Group

The ability of soils to infiltrate runoff is characterized by hydrologic soil group (HSG). Project proposers should select the HSG based on soil classifications from soil boring information collected on the site. The District webmap presents HSG data based on the Soil Survey Geographic (SSURGO) database for Washington County, Minnesota. The SSURGO database may be used as a reference, but calculations should be based on field classifications from soil borings.

4.2.1.3 Land Cover, Land Use, and Impervious Area

Land use and land cover data are relevant to hydrologic, hydraulic, and water quality analyses due to their impact on impervious area, curve number (see Section 4.2.1.4), and pollutant loading. The District webmap presents land use and land cover data in the watershed. Project proposers may reference these datasets to obtain a general understanding of land cover and impervious percentage in their project area. Land use, land cover and percent impervious coverage for the purposes of project design and permitting should be defined by site-specific information.

Project proposers must also determine the portion of impervious area that is directly connected to the drainage system versus impervious area that is not directly connected; these inputs are used in some of the tools to assess compliance with District rules.

4.2.1.4 Curve Number

Project proposers shall use runoff curve numbers (CN) based on land cover and HSG as published in the Minnesota Stormwater Manual: Stormwater runoff coefficients/curve numbers for different land uses – Minnesota Stormwater Manual (state.mn.us)

If applicable, antecedent moisture condition II shall be assumed for all event-based design storm modeling when selecting an appropriate CN. Composite, or area-weighted, CNs (i.e., those that take into account pervious and impervious areas and associated CNs) may be used when evaluating conditions related to flood hydrology (2-inch precipitation or greater).

4.2.1.5 Infiltration Rates

Event-based hydrologic and hydraulic models may use constant infiltration rates. Some modeling tools and methods use variable infiltration rates for greater accuracy for continuous modeling. The Minnesota Stormwater Manual includes estimated infiltration rates by soil type: Design infiltration rate as a function of soil texture for bioretention in Minnesota – Minnesota Stormwater Manual (state.mn.us)

Selection of appropriate infiltration rates for modeling is the responsibility of the designer, based on knowledge of existing and proposed site conditions (e.g., soil boring data, field tests). Design infiltration rates should be based on information within the Minnesota Stormwater Manual and hydrologic soil classification at the BMP location as determined by soil borings. The District allows a maximum infiltration rate of 0.8 inches per hour for modeling and site evaluation purposes. This maximum value is recommended by the Minnesota Stormwater Manual for poorly graded sands (SP). Project proposers may also perform field infiltration tests to confirm estimated infiltration rates. The District may consider a variance to the maximum acceptable infiltration rate on a case-by-case basis. In such cases, field documentation is required and the guidance from the Minnesota Stormwater Manual for determining infiltration rates should be used: Infiltration design guideline - determining site infiltration rates - Minnesota Stormwater Manual (state.mn.us)).

4.3 Hydrologic and Hydraulic Analysis of Site Design

4.3.1 Hydrologic and Hydraulic Analytical Tools and Models

Several tools and models are capable of producing the analysis and documentation project proposers need in order to demonstrate compliance with District Rules. Commonly used modeling tools are listed and linked below:

HydroCAD – tool used by civil engineers to complete hydrology and hydraulics modeling and analyses; it incorporates several commonly used methodologies to simulate runoff.

EPA-**SWMM** – free windows-based desktop program from United States Environmental Protection Agency. This modeling tool is used for planning, analysis, and design related to stormwater runoff, combined and sanitary sewers, and other drainage systems. SWMM stands for Storm Water Management Model. Several companies have either updated the EPA-SWMM program or developed proprietary graphical user interfaces for the EPA-SWMM software (e.g., XPSWMM, PCSWMM).

Project proposers should contact District staff regarding the use of other hydrologic and hydraulic modeling tools to demonstrate compliance with District rules. The Minnesota Stormwater Manual also presents a summary of available modeling tools and considerations for selecting a model: Available stormwater models and selecting a model – Minnesota Stormwater Manual (state.mn.us)

4.3.2 Hydrologic and Hydraulic Analysis Input Parameters

Model inputs relevant to hydrologic and hydraulic analyses are described in the following sections and summarized in Table 1.

4.3.2.1 Design Storms

A design storm is a precipitation event of defined characteristics including:

- **Frequency** – the likelihood the storm will occur in a given year presented as a percent chance or recurrence interval (e.g., a 1% chance of annual occurrence = 100-year event).
- **Duration** – the amount of time that precipitation falls.
- **Intensity** – the rate at which precipitation falls throughout the event duration.
- **Depth** – the total depth of precipitation that falls during the event duration.

Design storms are intended to provide a common frame of reference when designing and assessing the performance of stormwater management facilities. Design storms, though hypothetical, are based on historical precipitation data and published in reference documents that are periodically updated. Current design storms adopted by the District for the purposes of hydrologic and hydraulic analysis include combinations of frequency, duration, and depth published in Atlas 14 by the National Oceanic and Atmospheric Administration (NOAA) and the MSE3 rainfall intensity distribution as specified in the District Rules:

- 2 year (50% annual chance of occurrence), 24-hour event, MSE3 distribution
- 10 year (10% annual chance of occurrence), 24-hour event, MSE3 distribution
- 100 year (1% annual chance of occurrence), 24-hour event, MSE3 distribution

Precipitation depths published in Atlas 14 vary by location. Project proposers must identify the appropriate precipitation depth for each applicable storm event based on NOAA's map-based tool: PF Map: Contiguous US (noaa.gov).

4.3.2.2 Critical Duration Analysis

Hydrologic and hydraulic design and analysis often references design storms of a 24-hour duration. Shorter- or longer-duration events, however, can result in higher peak runoff values or runoff volumes than the 24-hour event depending on watershed size, storage, and other factors. The critical duration event is the event that results in the highest peak discharge at a location of concern (e.g., RAL).

Projects located upstream of RALs (see Section 5) may require a critical duration analysis to address regional concerns. In some areas (e.g., the Wilmes Lake watershed), the timing and magnitude of peak inflows is of particular concern. The District webmap identifies RALs. Project proposers for sites that are located immediately upstream of RALs are encouraged to coordinate with District staff early in the project review process to confirm of this type of analysis might be needed.

NOAA's map-based Atlas 14 data presents 2-year, 10-year, and 100-year precipitation events for several durations other than 24-hours. The MSE3 rainfall distribution should be assumed for the critical duration analysis. More information on the MSE3 rainfall distribution can be found in the National Engineering Handbook MN650.290 Purpose of Minnesota Supplement.

4.3.2.3 Time of Concentration

Time of concentration (Tc) is the time required for runoff to travel from the most hydraulically distant point in the watershed to the outlet. Tc should be explicitly calculated for each subwatershed evaluated by adding the time for each type of flow along the flow path (i.e., travel time, or Tt) from the watershed boundary to the outlet.

4.4 Water Quality Analysis of Site Design

This section provides guidance on the objectives and methods of water quality analysis to demonstrate compliance of proposed projects with District Rules. The information presented in this section focuses on aspects most relevant to proposers of development and redevelopment projects within the District. The Minnesota Stormwater Manual also presents an introduction to stormwater modeling that addresses many of the topics included in this section: Introduction to stormwater modeling – Minnesota Stormwater Manual (state.mn.us).

4.4.1 Water Quality Analytical Tools and Models

Several tools and models are capable of producing the analysis and documentation project proposers need to demonstrate compliance with District Rules. The District does not require specific tools be used for this purpose. Commonly used software tools are listed and linked below:

> **MIDS Calculator** – tool available through the MPCA for estimating stormwater runoff volume reductions and annual pollutant load reductions for total phosphorus and total suspended solids of various BMPs. MIDS stands for Minimal Impact Design Standards.
>
> **P8** – model developed by William W. Walker, Jr., Ph.D. and Jeffrey D. Walker, Ph.D. (originally for USEPA, MPCA and Wisconsin Department of Natural Resources) for estimating the generation and transport of stormwater runoff pollutants in urban watersheds and predicting runoff and pollutant removal at user defined stormwater BMPs through processes of sedimentation, filtration, and infiltration. P8 stands for Program for Predicting Pollution Particle Passage through Pits, Puddles, and Ponds.

Examples of select BMP analyses using the MIDS calculator and P8 software are included in **Appendix A.**

Project proposers should contact District staff regarding the use of other water quality modeling tools to demonstrate compliance with District rules. The Minnesota Stormwater Manual also presents a summary of available modeling tools and considerations for selecting a model: Available stormwater models and selecting a model – Minnesota Stormwater Manual (state.mn.us)

At minimum, water quality analysis tools must be able to quantify average annual total phosphorus load and treatment volume (for retention BMPs). If using other District-approved continuous modeling tools, project proposers must demonstrate that model outputs of pollutant concentrations in unmitigated runoff are consistent with values in the Minnesota Stormwater Manual: Event mean concentrations of total and dissolved phosphorus in stormwater runoff – Minnesota Stormwater Manual (state.mn.us)

4.4.2 Water Quality Analysis Input Parameters

Model inputs relevant to water quality analyses are described in the following sections and summarized in Table 2.

4.4.2.1 Climate Input Data

District water quality performance standards are based on average annual loading. To calculate average annual loads, model/tool inputs must incorporate continuous climate input data to calculate time-averages of pollutant loading. The MIDS calculator includes built-in climate data based on project zip code entered by the user. For analysis with P8, the District has developed the necessary precipitation and temperature files for annual loading analysis. Project proposers should use these files when creating P8 models and can access them on the District's webpage: Information for Developers | South Washington Watershed District (swwdmn.org). The number of passes through the storm file should be set to 5 to allow the model to purge the initial conditions before recording results.

When using other tools (see Section 4.4.1), the District requires that simulations use precipitation and temperature records based on a 30-year climate normal from January 1, 1971 – December 31, 2000 to reflect the climate record from the Climatology Working Group used to develop pollutant removals for BMPs in the MIDS Calculator. For more information on the climate data used to develop the MIDS Calculator, visit: MIDS calculator – Minnesota Stormwater Manual (state.mn.us).

4.4.2.2 Pollutant Loading Input Data

Estimated pollutant reductions from properly designed and maintained BMPs vary according to pollutant concentrations in incoming stormwater runoff. The MIDS calculator includes default values for total phosphorus and total suspended sediment. The District has determined that a total phosphorus event mean concentration (EMC) of 0.31 mg/L is most reflective of phosphorus loading in stormwater runoff within the District based on past modeling and monitoring data. Therefore, the default total phosphorus EMC value within the MIDS calculator should be changed from 0.3 mg/L to 0.31 mg/L to reflect these conditions. Project proposers must note and explain all other deviations from default values for their analysis.

The P8 model allows the user to specify the sediment grain size distribution and associated total phosphorus concentrations of incoming runoff. P8 models should be developed using the default nurp50 particle file for these inputs. Model inputs for impervious depression storage and impervious runoff coefficients should be adjusted to values of 0.1 and 0.9, respectively, to reflect expected runoff conditions based on prior District analysis. For P8 models that contain filtration BMPs, the guidance on particle filtration efficiencies described in the Minnesota Stormwater Manual should be used: Recommend filtration efficiency for P8 – Minnesota Stormwater Manual (state.mn.us). All other P8 model parameters should be left as the default values.

Project proposers should contact District staff regarding pollutant input concentrations for tools other than the MIDS calculator and P8.

Table 1 Summary of Recommended Model Input Parameters for Hydrologic and Hydraulic Analyses

Parameter	SWMM Horton Inputs	SWMM NRCS Inputs	HydroCAD NRCS Inputs
Precipitation Amount	NOAA Atlas 14	NOAA Atlas 14	NOAA Atlas 14
Precipitation Distribution	MSE3, 24-hour	MSE3, 24-hour	MSE3, 24-hour
Runoff Method	SWMM Runoff	SCS TR-20	SCS TR-20
Evaporation	Default 0.1 inches/day	Default 0.1 inches/day	NA
Impervious Depression Storage/Initial Abstraction	0.1 inches	0.2 x Potential Maximum Retention, *S*	0.2 x Potential Maximum Retention, *S*
Pervious Depression Storage/Initial Abstraction	0.17 inches	0.2 x Potential Maximum Retention, *S*	0.2 x Potential Maximum Retention, *S*
Impervious Overland Roughness	0.015	NA	NA
Pervious Overland Roughness	0.20	NA	NA
Timestep	60 seconds	60 seconds	60 seconds
Pervious Curve Number	NA	Minnesota Stormwater Manual	Minnesota Stormwater Manual
Infiltration Method	Horton	NA	NA
Hydrologic Infiltration Rates	See Table 3	NA	NA
BMP Design Infiltration Rate	Minnesota Stormwater Manual (maximum of 0.8 inches/hour)	Minnesota Stormwater Manual (maximum of 0.8 inches/hour)	Minnesota Stormwater Manual (maximum of 0.8 inches/hour)

Table 2 Summary of Recommended Model Input Parameters for Water Quality Analyses

Parameter	MIDS Calculator	P8
Precipitation Record (1/1/1971 – 12/31/2000)	Enter project zip code	.pcp file on District website
Temperature Record (1/1/1971 – 12/31/2000)	Enter project zip code	.tmp file on District website
Impervious Depression Storage	NA	0.1
Timestep	NA	Default of 4 timesteps per hour
Number of Passes through Storm File	NA	5
Impervious Runoff Coefficient	NA	0.9
Pervious Curve Number	Predefined by soil type and land cover	Minnesota Stormwater Manual
BMP Design Infiltration Rate	Minnesota Stormwater Manual (maximum of 0.8 inches/hour)	Minnesota Stormwater Manual (maximum of 0.8 inches/hour)
Phosphorus Event Mean Concentration	0.31 mg/L	nurp50 particle file
Total Suspended Solids Event Mean Concentration	54.5 mg/L	nurp50 particle file

Table 3 Horton Infiltration Parameters

Hydrologic Soil Group	Initial Infiltration, f_o (in/hr)	Saturated Hydraulic Conductivity, f_c (in/hr)	Decay Constant, k (1/sec)
A	5	0.38	0.00115
B	3	0.23	0.00115
C	2	0.10	0.00115
D	1	0.03	0.00115

5 Regional Assessment Locations

To promote consistency and transparency, the District has adopted rules and performance standards that are generally consistent throughout the watershed. In some locations, however, the District has determined that additional stormwater management may be required beyond that which is necessary to meet on-site performance standards to protect or safely manage downstream resources. The District has identified these locations as **Regional Assessment Locations** (RALs). These locations are shown on the District webmap.

RALs reflect points along District waterways where the District has identified potential water quality or flood risk concerns based on available monitoring and/or modeling data. To mitigate potential adverse impacts from development or redevelopment, the District may require additional stormwater management (e.g., rate control, volume control, pollutant reduction) for projects located upstream of RALs pending the outcome of a regional assessment performed by the District.

Project proposers should contact District staff if their site is located immediately upstream of a RAL in order to identify if additional analyses may be required. RALs are shown on the District webmap so that project proposers may be aware that their project may require additional design coordination with the District. The District will identify the need for additional project impact analyses on a case-by-case basis.

Appendices

Appendix A

P8 and MIDS Modeling Example Scenarios

Appendix A

P8 and MIDS Modeling Example Scenarios

A.1 Example A: Infiltration & Disconnected Impervious Project Example Using P8

For this modeling example, the hypothetical project is a new 80-acre single family residential development located in the southeastern portion of the District. The existing site is a mix of forest / open space and will be converted to a development consisting of 30.4 acres of impervious area (38% impervious).

The process to determine what standards apply to this development scenario follows the steps described in Section 3.1 of the Standards Guidance Manual.

In this case, the example site drains to the Mississippi River which requires a maximum total phosphorus (TP) loading of 0.22 lbs/acre/year or that existing TP loading rates be maintained, whichever is less. The water quality standard for total suspended solids (TSS) is to provide a net reduction in average annual loading from the site. In addition, a water quality volume of one (1) inch times the sum of new and fully reconstructed impervious surfaces is required to be captured and treated. Infiltration practices will be used to manage the stormwater runoff.

A.1.1 Modeling Example Scenario (P8)

Water quality modeling is performed to determine the impact of the example project on stormwater runoff and pollutant loadings prior to the implementation of any BMPs. P8 (version 3.5) was used in this example to determine the untreated runoff volume and pollutant loading for both pre- and post-development conditions. A series of screen captures from the P8 model have been provided to illustrate how the P8 model was set up for the pre-and post-development conditions.

A.1.2 Modeling Prior to BMP Analysis

Figure A.1 is the *General Case* specifications screen of both the pre- and post-development site. This is where the P8 precipitation and temperature files are specified. The specified inputs in this example reflect conditions for a 30-year simulation using the default nurp50 particle file (as described in Section 4.4.2.2 of the Standards Manual). The modeling 'start', 'keep' and 'stop' dates must be referenced as circled. The number of 'passes through the storm file' have been set to 5 to purge the initial conditions. Standardized temperature and precipitation input files can be found on the SWWD website at: [Information for Developers | South Washington Watershed District (swwdmn.org)].

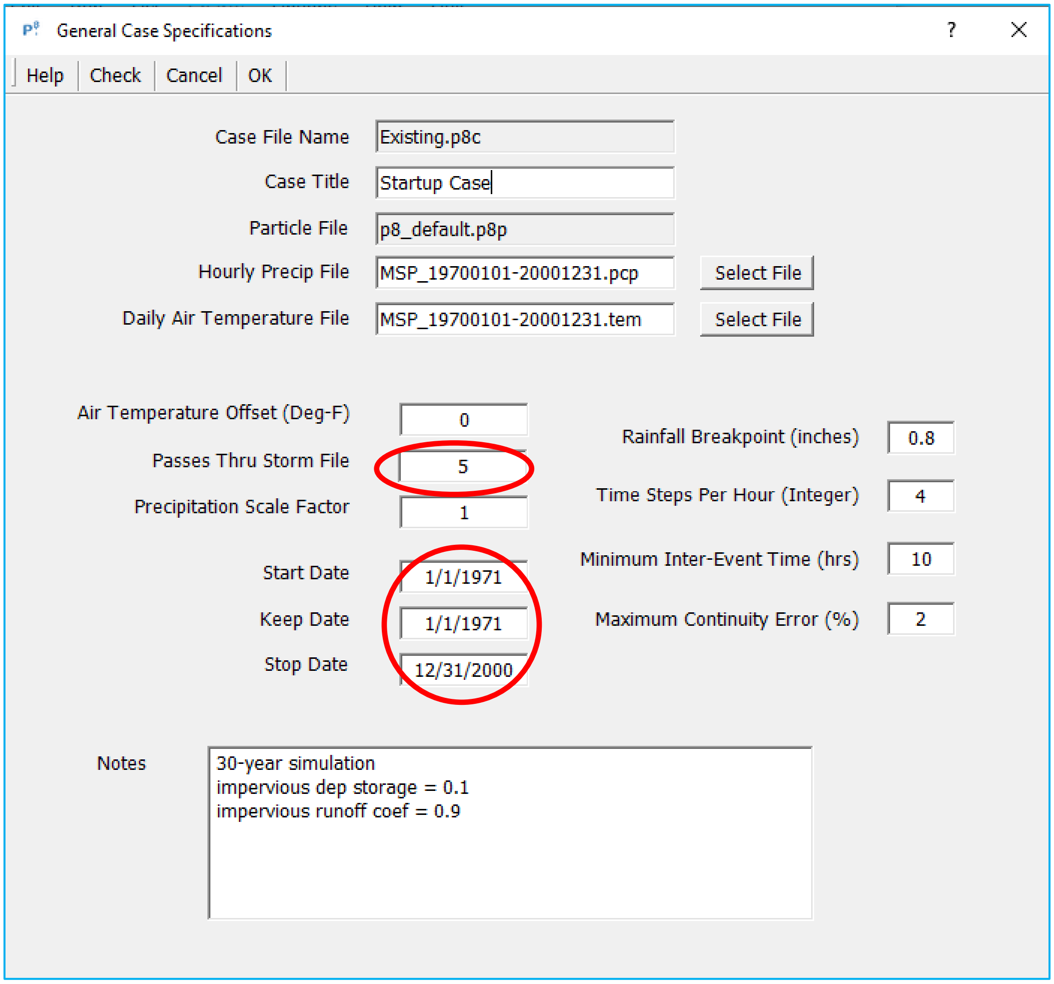


Figure A.1 P8 General Case (Pre-development)

Figure A.2 is the *Watersheds* specification screen under pre-development conditions. This is where parameters describing the site's pre-development subwatersheds are entered, such as area, curve number, and depression storage. In this example, eight (8) subwatersheds were used to represent various areas of the overall 80-acre development area. Because no BMPs exist under existing conditions, these subwatersheds were routed to a pipe device called "UNTREATED". The depression storage and impervious runoff coefficients were adjusted in both the pre- and post-development models to reflect calibrated P8 model conditions as described in Section 4.4.2.2 of the Manual. The pervious curve number was established as 65 using guidance from the Minnesota Stormwater Manual for Type B soils.

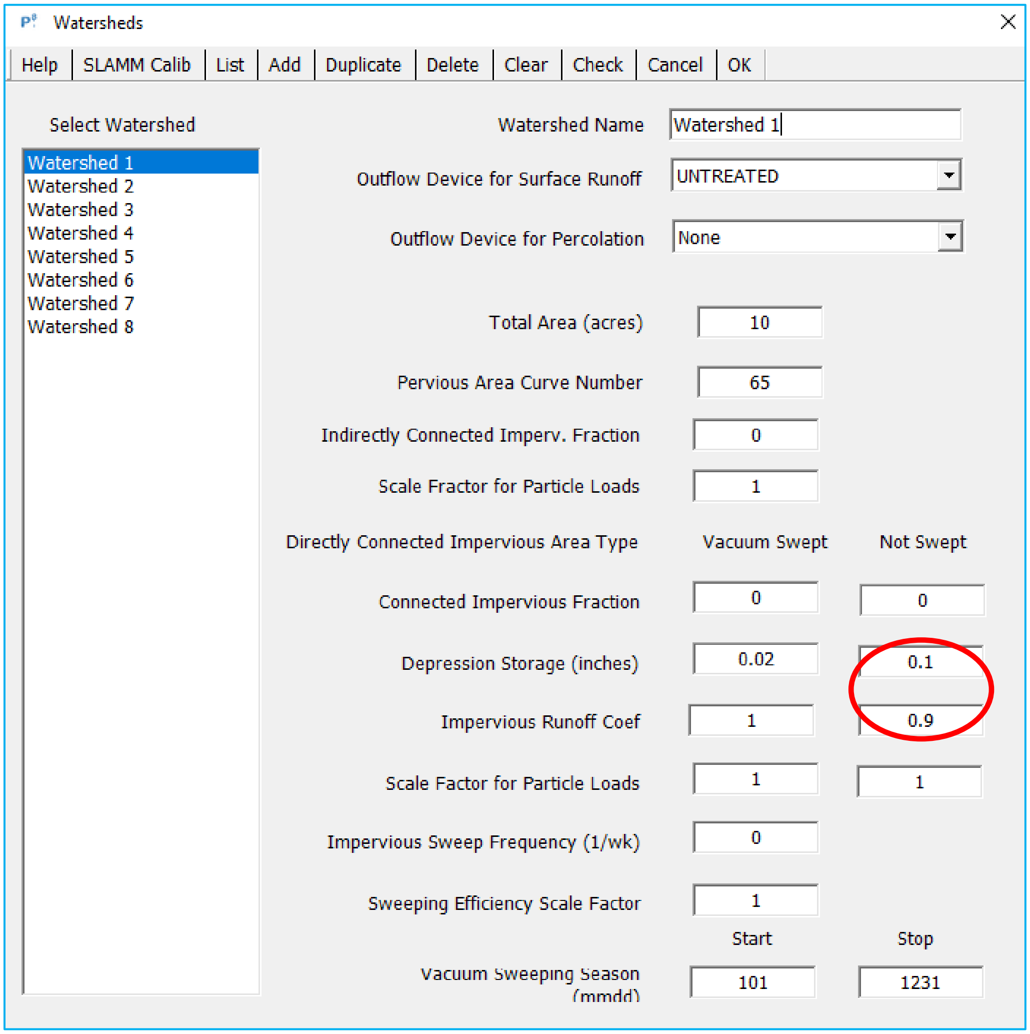


Figure A.2 P8 Example Watersheds Specification (Pre-development)

Figure A.3 is the *Watersheds* specification screen under post-development conditions. A total of 30.4 acres of impervious area are proposed, modeled within the eight subwatersheds. Fifty percent of the impervious area is directly connected (0.19 directly connected impervious fraction); whereas the remaining 50% is indirectly connected (0.19 indirectly connected impervious fraction).

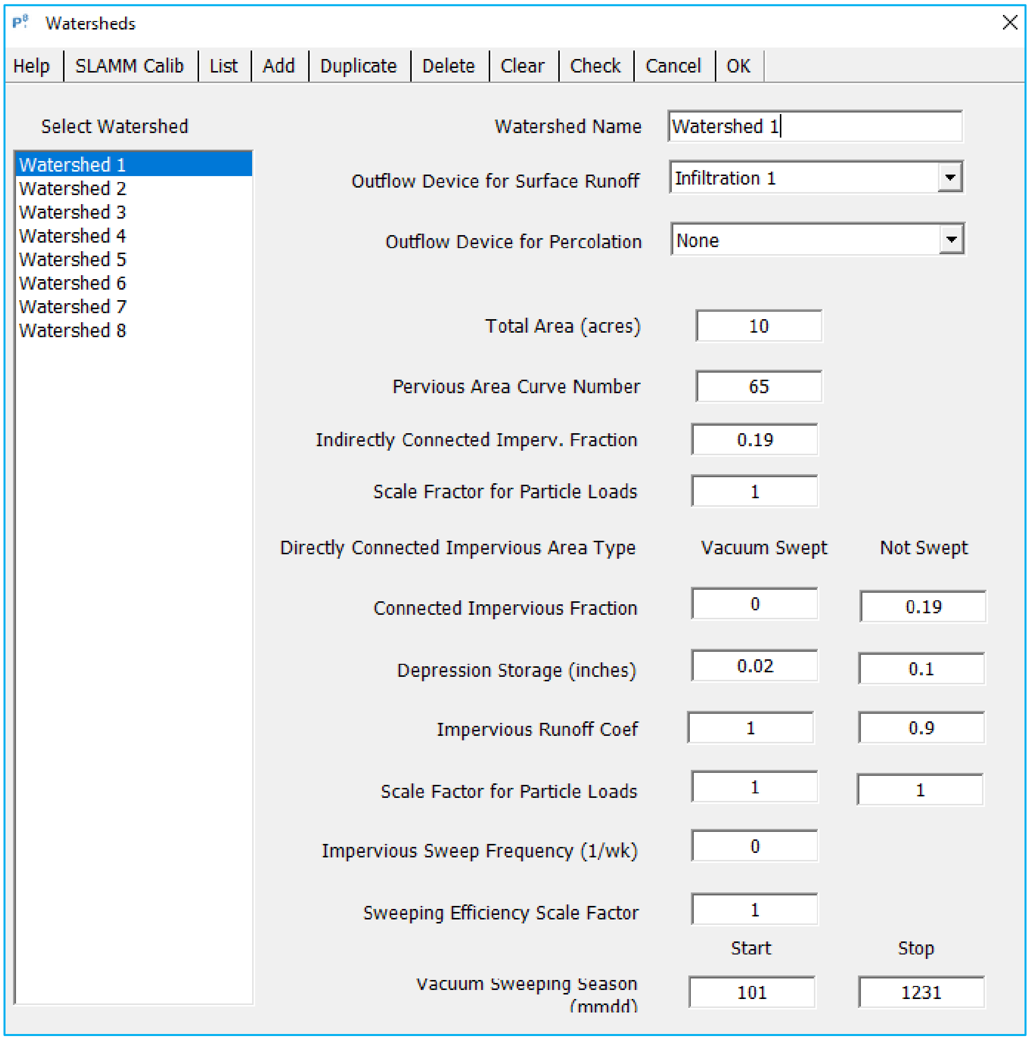
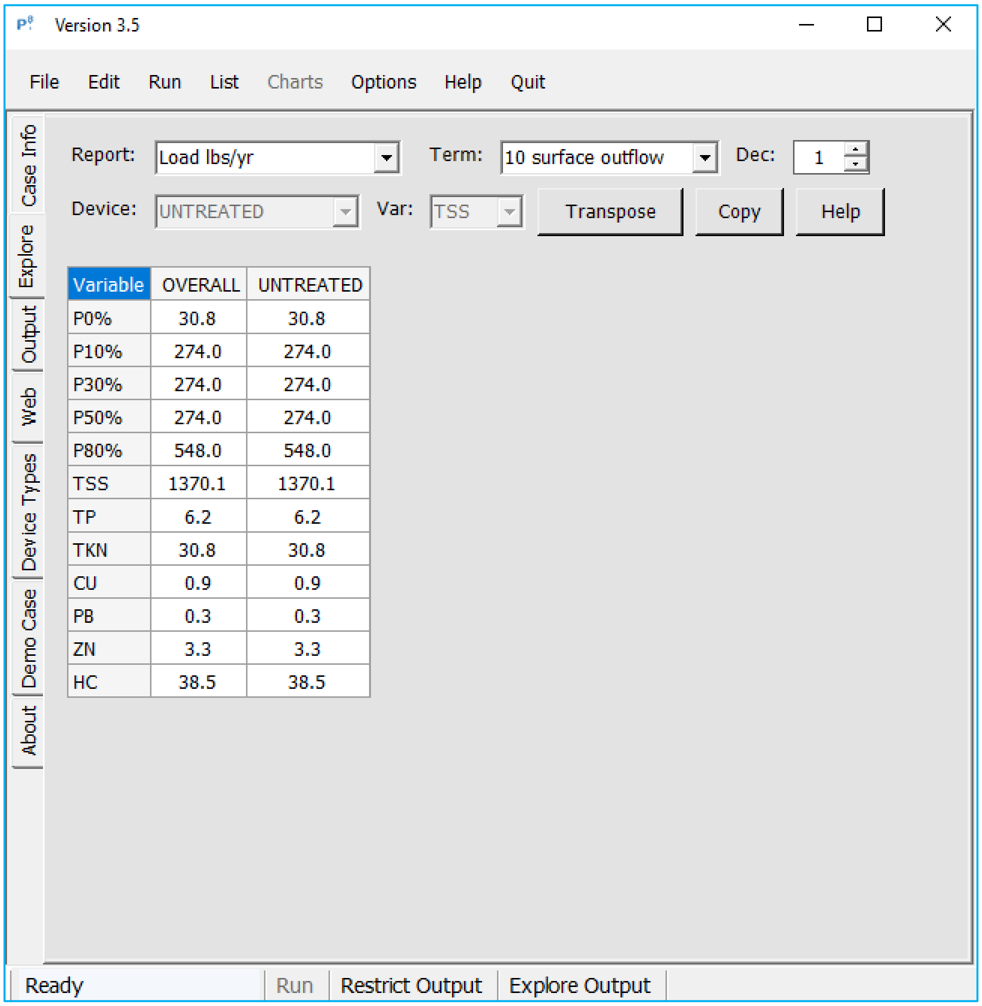


Figure A.3 P8 Example Watersheds Specification (Post-development)

The next step is to confirm the maximum amount of TP and TSS loading that is allowed from the site.

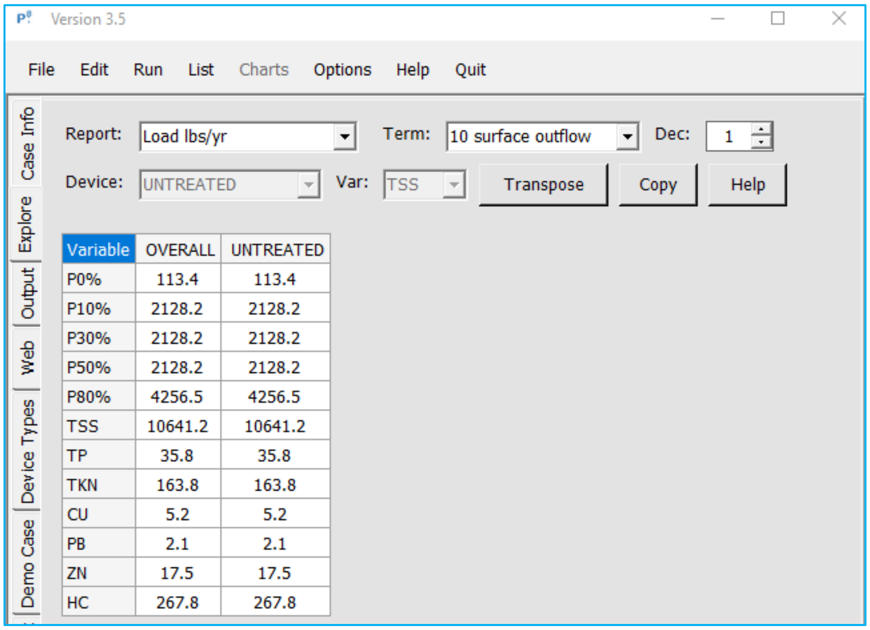
The pre-development pollutant loads are determined from the pre-development model. As shown in Figure A.4, the 30-year average annual TP and TSS loads from the site are 6.2 lbs/year and 1,370 lbs/year, respectively.



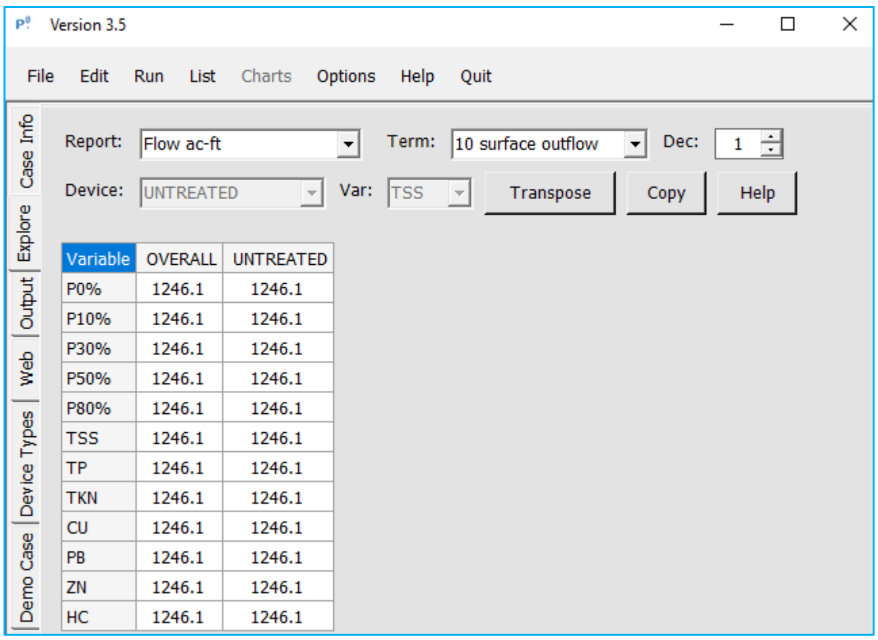
Variable	OVERALL	UNTREATED
P0%	30.8	30.8
P10%	274.0	274.0
P30%	274.0	274.0
P50%	274.0	274.0
P80%	548.0	548.0
TSS	1370.1	1370.1
TP	6.2	6.2
TKN	30.8	30.8
CU	0.9	0.9
PB	0.3	0.3
ZN	3.3	3.3
HC	38.5	38.5

Figure A.4 P8 Unmitigated Site Loading Results (Pre-development)

As shown in Figure A.5, the unmitigated average annual pollutant loading from the site post-development is estimated as 35.8 lbs/year of TP and 10,641 lbs/year of TSS. The average annual runoff volume from the site is estimated at 1,246 acre-feet or 41.7 acre-feet/year.



Variable	OVERALL	UNTREATED
P0%	113.4	113.4
P10%	2128.2	2128.2
P30%	2128.2	2128.2
P50%	2128.2	2128.2
P80%	4256.5	4256.5
TSS	10641.2	10641.2
TP	35.8	35.8
TKN	163.8	163.8
CU	5.2	5.2
PB	2.1	2.1
ZN	17.5	17.5
HC	267.8	267.8



Variable	OVERALL	UNTREATED
P0%	1246.1	1246.1
P10%	1246.1	1246.1
P30%	1246.1	1246.1
P50%	1246.1	1246.1
P80%	1246.1	1246.1
TSS	1246.1	1246.1
TP	1246.1	1246.1
TKN	1246.1	1246.1
CU	1246.1	1246.1
PB	1246.1	1246.1
ZN	1246.1	1246.1
HC	1246.1	1246.1

Figure A.5 P8 Unmitigated Site Loading Results (Post-development, no BMPs)

As indicated in the rules, the post-development pollutant loads from this example site must:

1. be less than or equal to the maximum allowable TP loading for areas draining to the Mississippi River (0.22 lbs/acre/year or 17.6 lbs/year) or maintain the pre-development TP loading rate of 6.2 lbs/year, whichever is less,
2. be less than the pre-development average annual TSS loading of 1,370 lbs/year,
3. capture and treat at least one (1) inch of runoff over the 30.4 acres of total impervious area (110,350 cubic feet).

A.1.3 Scenario 1 – Modeling Structural BMPs and Evaluating Compliance

As a next step, we will model the stormwater BMPs for this site. Figure A.6 is the *Devices* screen. This is where parameters for treatment devices are specified. In this example, two different management practice scenarios were used to illustrate the effect of using structural and/or non-structural practices for managing the site's stormwater runoff.

The first scenario involves using only structural management practices consisting of on-site infiltration basins. The on-site stormwater drainage and infiltration basins are designed to capture and treat stormwater runoff from each of the site's post-development subwatersheds. To comply with the SWWD's stormwater rules, the infiltration basins must be sized to retain and treat a total volume of 1.0 inch of runoff from the post-development impervious area (110,350 cubic-feet). In this case, we assume an infiltration rate of 0.45 inches/hour for the basins as defined in the Minnesota Stormwater Manual for Type B silty sand (SM).

In this example, the stormwater runoff generated from a 5-acre portion of the site (Subwatershed 8) has proven difficult to capture and route into an infiltration basin. Therefore, this subwatershed is modeled as being directed to the pipe device "UNTREATED". Runoff from the remaining seven subwatersheds is routed into infiltration basins (one basin located within each of the subwatersheds). Because Subwatershed 8 contains 1.9 acres of impervious area that is not being treated within this scenario, the site's seven infiltration basins were upsized to accommodate 1.07 inches of runoff from their contributing impervious area to provide a total retention volume of 110,350 cubic-feet.

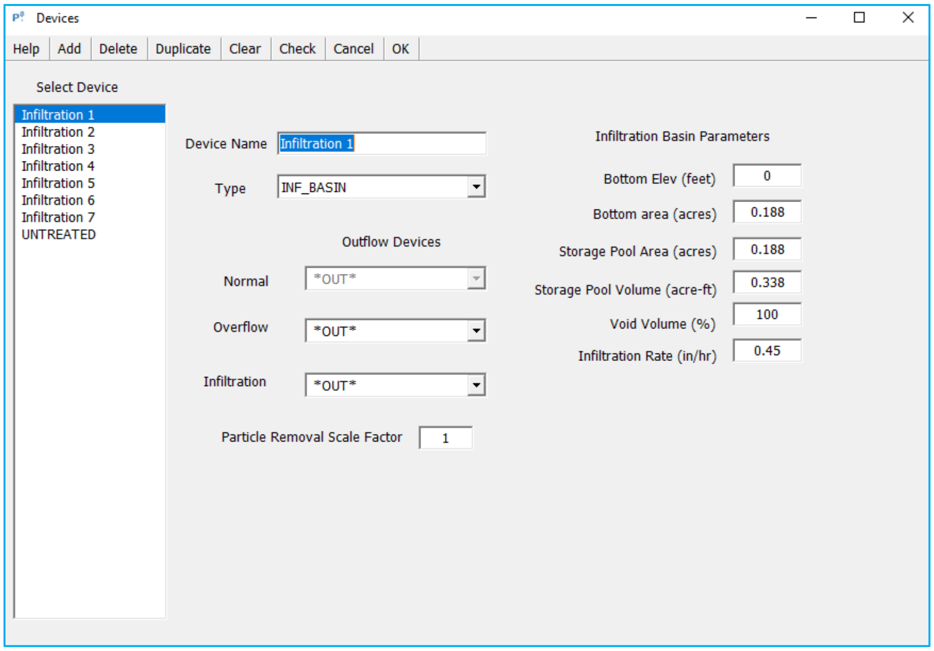


Figure A.6 P8 Example Devices Screen (Structural Treatment Method)

The results from this simulation are summarized in Table A.1. As shown, the proposed design does not meet the stormwater requirements for TSS and TP for the site. This is due to the 5-acre Subwatershed 8 not being directed to a treatment BMP.

Table A.1 P8 Scenario 1 Results Summary

Offsite Discharge Parameter	Existing	Requirement	Proposed
Total Phosphorus Loading (lbs/yr)	6.2	6.2	6.5
Total Suspended Solids Loading (lbs/yr)	1,370	<1,370	1,514
Volume Retention (cu-ft)	-	110,350	110,350

A.1.4 Scenario 2 – Modeling Structural & Non-Structural BMPs and Evaluating Compliance

Because the stormwater requirements were not achieved using only the structural BMPs, the second scenario involves incorporating a non-structural management practice of impervious surface disconnection to provide additional treatment for Subwatershed 8. This stormwater management approach is best applied in small, more challenging areas to treat. The same structural BMPs described in the previous scenario were used for the remainder of the site.

For this example, a 50% reduction in connected impervious area was assumed for Subwatershed 8. This accounts for the portion of impervious areas within the subwatershed that drain directly onto pervious areas with a width of at least 100 feet at less than a 5 percent slope, consistent with design guidance in the Minnesota Stormwater Manual (Turf - Minnesota Stormwater Manual (state.mn.us). The impervious disconnection was modeled in P8 by revising the directly connected impervious area fraction from 0.19 to 0.10 (0.19 x 50% = 0.10) and increasing the indirectly connected impervious fraction from 0.19 to 0.28 (0.19 x 150% = 0.28) as shown in Figure A.7.

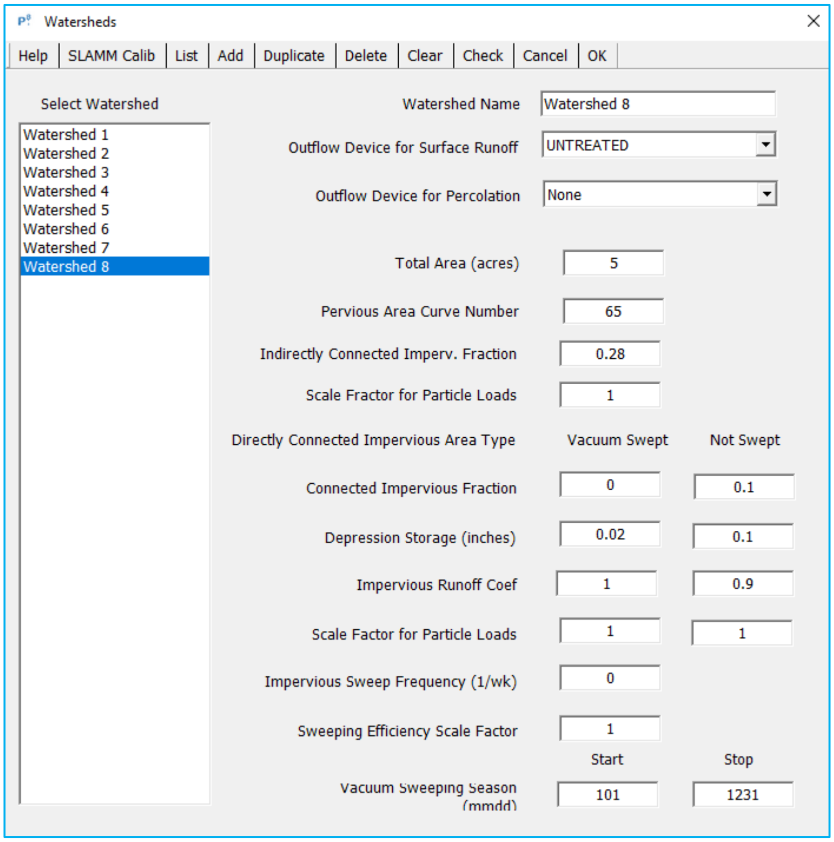
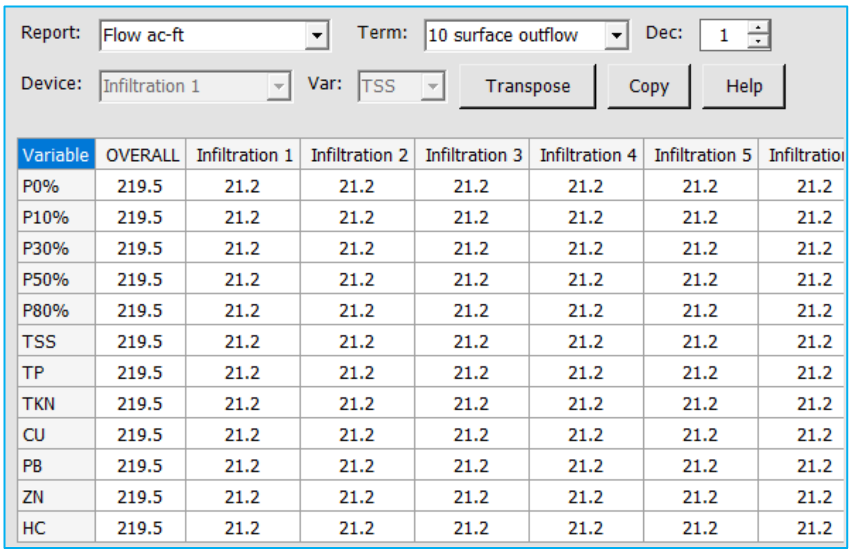


Figure A.7 P8 Watershed 8 Screen (Non-Structural Treatment Method)

P8 summarizes results on an average annual basis. After incorporating the structural and non-structural BMPs, the P8 model reports a total 30-year runoff volume from the site of 219.5 acre-feet (or 7.4 acre-feet/year, see Figure A.8). To demonstrate compliance with the District's rules, this average annual outflow must be converted to the equivalent retention volume that is provided from a 1.0-inch runoff event over the BMP's contributing impervious surfaces. The volume retention provided by the structural BMPs was noted in Scenario 1. The volume retention provided by the disconnected impervious BMP was determined by first modeling an equivalent infiltration BMP within Subwatershed 8 that achieves the estimated outflow volume of 219.5 acre-feet from the site. For this example, an infiltration BMP sized to retain and infiltrate 566 cubic-feet from Subwatershed 8 will achieve the same average annual outflow volume from the entire site computed after accounting for the disconnected impervious area. This means the additional retention volume provided by the impervious disconnection is 566 cubic-feet for a total of 110,916 cubic-feet from the entire site.



Variable	OVERALL	Infiltration 1	Infiltration 2	Infiltration 3	Infiltration 4	Infiltration 5	Infiltratio
P0%	219.5	21.2	21.2	21.2	21.2	21.2	21.2
P10%	219.5	21.2	21.2	21.2	21.2	21.2	21.2
P30%	219.5	21.2	21.2	21.2	21.2	21.2	21.2
P50%	219.5	21.2	21.2	21.2	21.2	21.2	21.2
P80%	219.5	21.2	21.2	21.2	21.2	21.2	21.2
TSS	219.5	21.2	21.2	21.2	21.2	21.2	21.2
TP	219.5	21.2	21.2	21.2	21.2	21.2	21.2
TKN	219.5	21.2	21.2	21.2	21.2	21.2	21.2
CU	219.5	21.2	21.2	21.2	21.2	21.2	21.2
PB	219.5	21.2	21.2	21.2	21.2	21.2	21.2
ZN	219.5	21.2	21.2	21.2	21.2	21.2	21.2
HC	219.5	21.2	21.2	21.2	21.2	21.2	21.2

Figure A.8 Scenario 2 P8 Site Loading Results (Post-development, with BMPs)

With this additional BMP, the proposed design meets the stormwater requirements for the site (Table A.2).

Table A.2 P8 Scenario 2 Results Summary

Offsite Discharge Parameter	Existing	Requirement	Proposed
Total Phosphorus Loading (lbs/yr)	6.2	6.2	5.9
Total Suspended Solids Loading (lbs/yr)	1,370	<1,370	1,319
Volume Retention (cu-ft)	-	110,350	110,916

A.2 Example A: Infiltration & Disconnected Impervious Project Example Using MIDS

A.2.1 Modeling Example Scenario (MIDS)

The MPCA's MIDS calculator is another commonly used tool for demonstrating compliance with stormwater management requirements. The following sections demonstrate the process to apply the MIDS calculator to the same 80-acre development described above. A series of screen captures from within the MIDS calculator have been provided to illustrate how the calculator was set up for the pre- and post-development conditions.

A.2.2 Modeling Prior to BMP Analysis

Figure A.9 is the *Site Information* screen of the pre-development site. Within this screen, the user inputs the project zip code, and information on the amount of site area contained within each land cover and hydrologic soil group combination. The user also denotes event mean concentration (EMC) values for total phosphorus and total suspended sediments from the site's stormwater runoff. Within this example, there are 80 acres of pervious area within Type B soils. Sixty (60) acres consist of undisturbed forested/open space, and 20 acres are more actively managed. The values circled in red have been changed from the original default MIDS values to reflect SWWD modeling guidance.

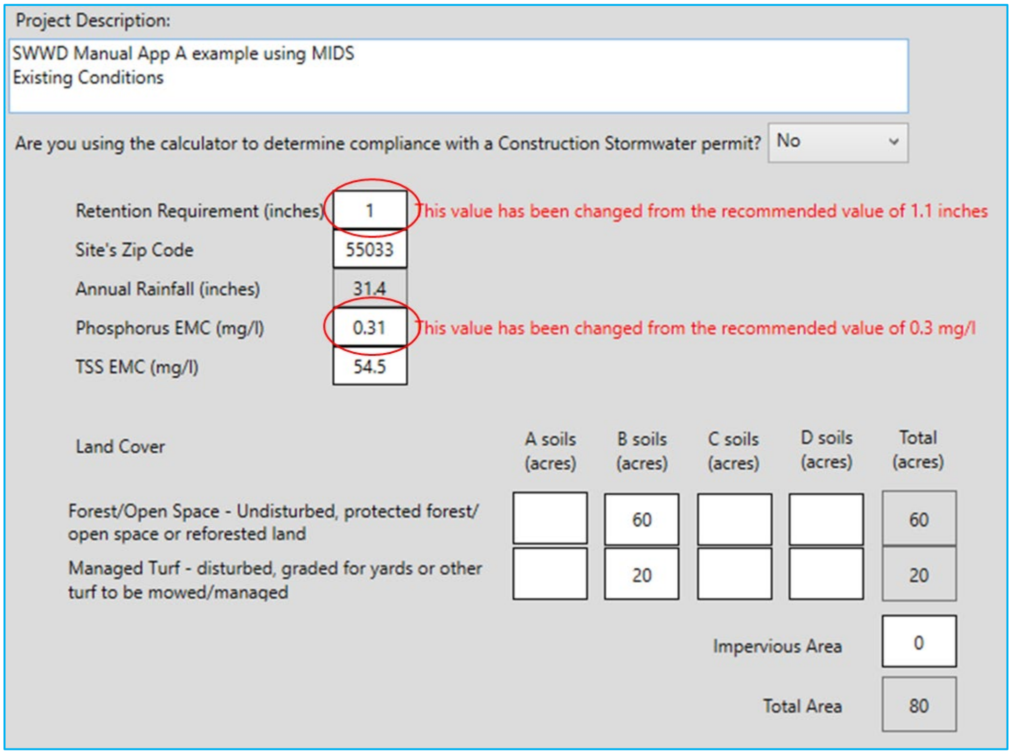


Figure A.9 MIDS Site Information Screen (Pre-development)

Figure A.10 is the *Site Information* screen of the post-development site. The total impervious area is 30.4 acres. The remainder of the site will be converted to and managed as residential yards, denoted as managed turf within the calculator.

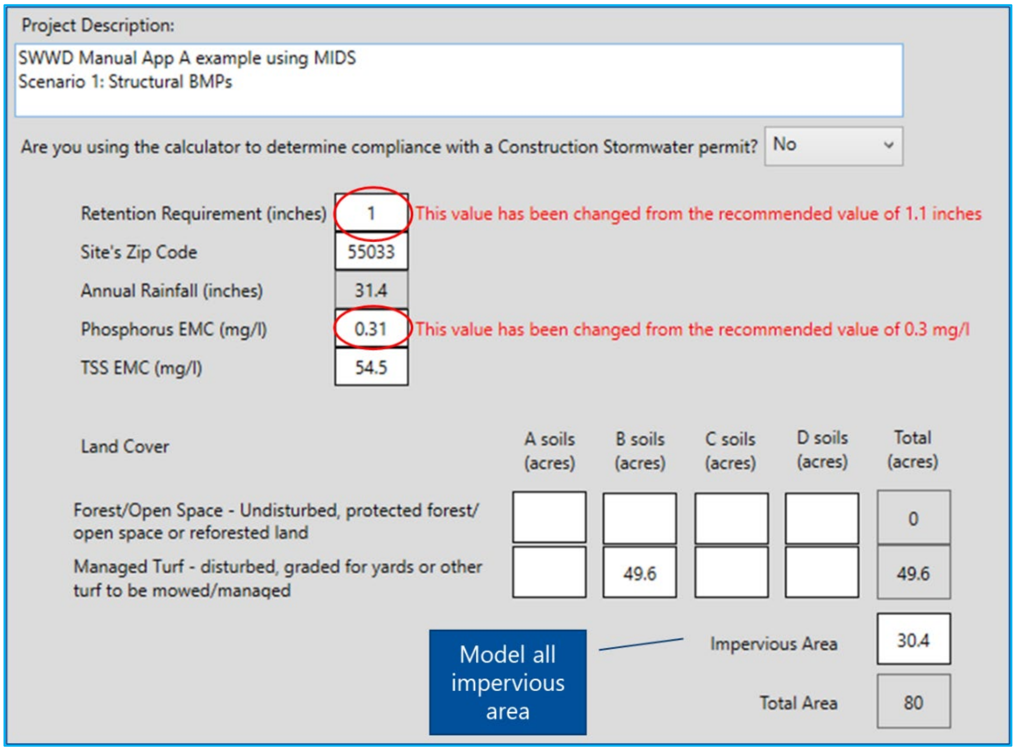


Figure A.10 MIDS Site Information Screen (Post-development)

The next step is to confirm the maximum amount of TP and TSS loading that is allowed from the site. The pre-development pollutant loads are determined from the pre-development calculator results. As shown in Figure A.11, the average annual TP and TSS loads are 11.5 lbs/year and 2,025 lbs/year, respectively.

Summary Information

Performance Goal Requirement

Performance goal volume retention requirement:		ft3
Volume removed by BMPs towards performance goal:		ft^3
Percent volume removed towards performance goal		**%**

Annual Volume and Pollutant Load Reductions

Post development annual runoff volume	13.659	acre-ft
Annual runoff volume removed by BMPs:		acre-ft
Percent annual runoff volume removed:		**%**
Post development annual particulate P load:	6.3345	lbs
Annual particulate P removed by BMPs:		lbs
Post development annual dissolved P load:	5.183	lbs
Annual dissolved P removed by BMPs:	0	lbs
Total P removed by BMPs	0	lbs
Percent annual total phosphorus removed:		**%**
Post development annual TSS load:	2024.8	lbs
Annual TSS removed by BMPs:		lbs
Percent annual TSS removed:		**%**

Figure A.11 MIDS Unmitigated Site Loading Results (Pre-development)

As shown in Figure A.12, the unmitigated average annual pollutant loading from the site post-development is estimated as 77.0 lbs/year of TP and 13,545 lbs/year of TSS. The average annual runoff volume from the site is estimated at 91.4 acre-feet/year.

Summary Information

Performance Goal Requirement

Performance goal volume retention requirement:	110352	ft3
Volume removed by BMPs towards performance goal:		ft^3
Percent volume removed towards performance goal		**%**

Annual Volume and Pollutant Load Reductions

Post development annual runoff volume	91.374	acre-ft
Annual runoff volume removed by BMPs:		acre-ft
Percent annual runoff volume removed:		**%**
Post development annual particulate P load:	42.3756	lbs
Annual particulate P removed by BMPs:		lbs
Post development annual dissolved P load:	34.671	lbs
Annual dissolved P removed by BMPs:	0	lbs
Total P removed by BMPs	0	lbs
Percent annual total phosphorus removed:		**%**
Post development annual TSS load:	13545.3	lbs
Annual TSS removed by BMPs:		lbs
Percent annual TSS removed:		**%**

Figure A.12 MIDS Unmitigated Site Loading Results (Post-development, no BMPs)

As indicated in the rules, the post-development outflow loads at this example site must:

1. be less than or equal to the maximum allowable TP loading for areas draining to the Mississippi River (0.22 lbs/acre/year or 17.6 lbs/year) or maintain the pre-development TP loading rate of 11.5 lbs/year, whichever is less,
2. be less than the pre-development average annual TSS loading of 2,025 lbs/year, and
3. capture and treat at least one (1) inch of runoff over the 30.4 acres of total impervious area (110,350 cubic feet).

A.2.3 Scenario 1 – Modeling Structural BMPs and Evaluating Compliance

Figure A.13 is the *Schematic* screen. This is where parameters for treatment devices are specified. In this example, seven infiltration basins were used. As previously discussed, two different management practice scenarios were used to illustrate the effect of using structural and/or non-structural practices. The first scenario involves using only structural management practices consisting of on-site infiltration basins with an infiltration rate of 0.45 inches/hour as defined in the Minnesota Stormwater Manual for Type B silty sand (SM). To comply with the stormwater requirements, the infiltration basins must be sized to retain and treat a total volume of 1.0 inch of runoff from the post-development impervious area (110,350 cubic-feet).

In this example, the stormwater runoff generated from a 5-acre portion of the site (Subwatershed 8) has proven difficult to capture and route into an infiltration basin. Runoff from the remaining seven subwatersheds is routed into infiltration basins (one basin located within each of the subwatersheds). Because Subwatershed 8 contains 1.9 acres of impervious area that is not being treated within this scenario, the site's seven infiltration basins were upsized to accommodate 1.07 inches of runoff from their contributing impervious area to provide a total retention volume of 110,350 cubic-feet.

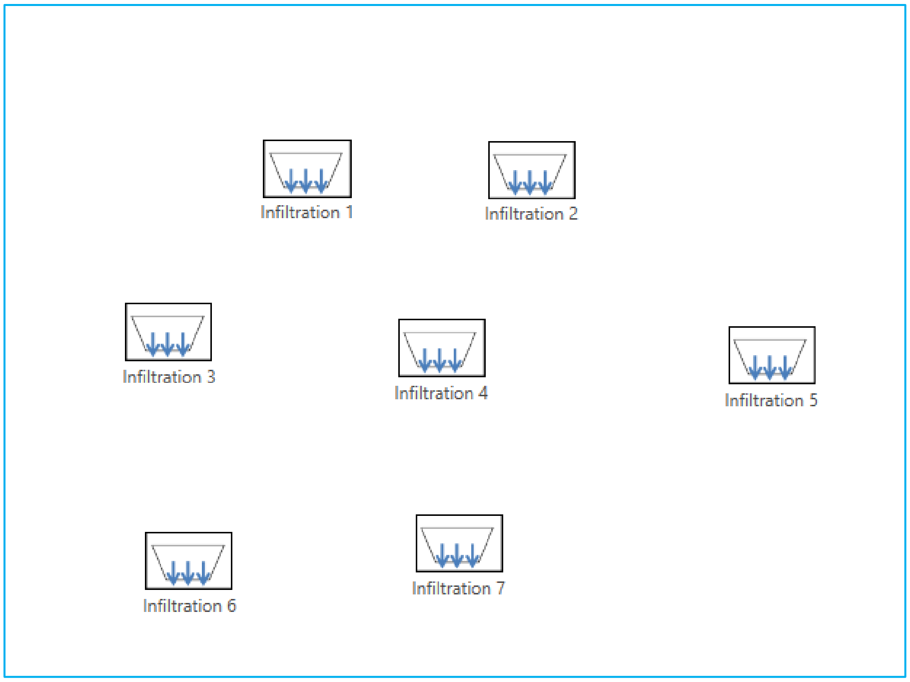


Figure A.13 MIDS Scenario 1 Schematic Screen (Structural Treatment Method)

The results from this simulation are presented in Figure A.14 and summarized in Table A.3. The values in Table A.3 are a subtraction of the 'annual pollutant removed by BMPs' from the 'post-development annual pollutant loads' summarized in the MIDS calculator output. As shown, the proposed design does not meet the stormwater requirements for TSS and TP for the site. This is due to the 5-acre portion of the site not being directed to a treatment BMP.

The 'Volume removed by BMPs towards performance goal' is based on the 'Retention Requirement (inches)' specified in the *Site Information* screen. Because this input was set to 1.0 inches to match the

District's requirements, the MIDS calculator caps the reported performance of each BMP to 1.0 inches of runoff from the contributing impervious area, thus corresponding to the 103,455 cubic-feet of volume retention listed under the 'Performance Goal Requirement' heading. If this input is changed to 1.07 inches (which was used to size each BMP), the reported 'Volume removed by BMPs towards performance goal' would increase to reflect the 110,350 cubic foot retention volume listed in Table A.3.

Summary Information

Performance Goal Requirement

Performance goal volume retention requirement:	110352	ft3
Volume removed by BMPs towards performance goal:	103455	ft^3
Percent volume removed towards performance goal	**94**	**%**

Annual Volume and Pollutant Load Reductions

Post development annual runoff volume	91.374	acre-ft
Annual runoff volume removed by BMPs:	76.7626	acre-ft
Percent annual runoff volume removed:	**84**	**%**
Post development annual particulate P load:	42.3756	lbs
Annual particulate P removed by BMPs:	35.6	lbs
Post development annual dissolved P load:	34.671	lbs
Annual dissolved P removed by BMPs:	29.127	lbs
Total P removed by BMPs	64.727	lbs
Percent annual total phosphorus removed:	**84**	**%**
Post development annual TSS load:	13545.3	lbs
Annual TSS removed by BMPs:	11379.3	lbs
Percent annual TSS removed:	**84**	**%**

Figure A.14 MIDS Scenario 1 Site Loading Results (Post-development)

Table A.3 MIDS Scenario 1 Results Summary

Offsite Discharge Parameter	Existing	Requirement	Proposed
Total Phosphorus Loading (lbs/yr)	11.5	11.5	12.3[1]
Total Suspended Solids Loading (lbs/yr)	2,025	<2,025	2,166[2]
Volume Retention (cu-ft)	-	110,350	110,350

1- (42.4 lbs/yr particulate phosphorus + 34.7 lbs/yr dissolved phosphorus) – 64.7 lbs/yr TP

2- 13,545 lbs/yr TSS – 11,379 lbs/yr TSS

A.2.4 Scenario 2 – Modeling Structural & Non-Structural BMPs and Evaluating Compliance

Because the stormwater requirements were not achieved using only the structural BMPs, the second scenario involves incorporating a non-structural management practice of impervious surface disconnection to provide additional treatment for Subwatershed 8. This stormwater management approach is best applied in small, more challenging areas to treat. The same structural BMPs described in the previous scenario were used for the remainder of the site.

Similar to the P8 example, a 50% reduction in connected impervious area was assumed for the 5-acre Subwatershed 8. This accounts for the portion of impervious areas within this subwatershed that drain directly onto pervious areas with a width of at least 100 feet at less than a 5 percent slope. This 50% reduction results in approximately 1.0 acre of impervious area being disconnected. The impervious disconnection was modeled using the *Stormwater disconnection* BMP as shown in Figure A.15.

The volume retention provided by the disconnected impervious BMP is shown in the *Stormwater disconnection* input screen as a value of 2,375 cubic-feet. This additional retention volume provided by the impervious disconnection results in a total retention volume of 112,725 cubic-feet from the entire site.

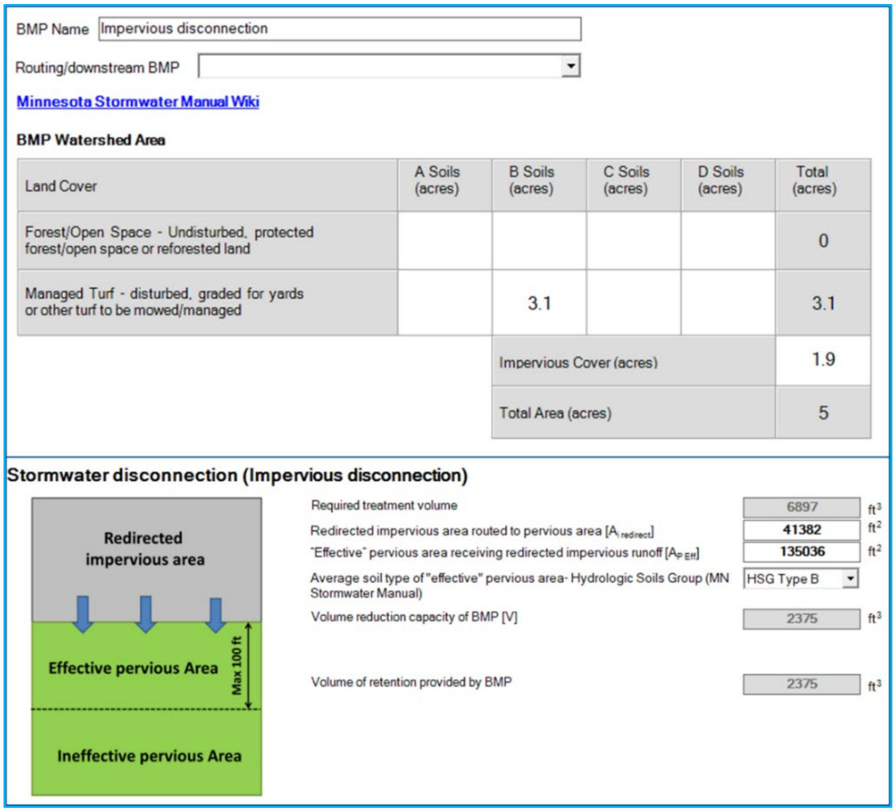


Figure A.15 MIDS Scenario 2 Impervious Disconnection Screen (Non-Structural Treatment Method)

The results from this simulation are presented in Figure A.16 and summarized in Table A.4. Again, the reported ‘Volume removed by BMPs towards performance goal’ is capped based on the ‘Retention Requirement (inches)’ specified in the *Site Information* screen. Adjusting this input to 1.07 inches (which was used to size the structural BMPs), the reported ‘Volume removed by BMPs towards performance goal’ equals 112,725 cubic feet. As shown in Table A.4, the proposed design meets the stormwater requirements for the site.

Summary Information

Performance Goal Requirement

Performance goal volume retention requirement:	110352	ft3
Volume removed by BMPs towards performance goal:	105830	ft^3
Percent volume removed towards performance goal	**96**	**%**

Annual Volume and Pollutant Load Reductions

Post development annual runoff volume	91.374	acre-ft
Annual runoff volume removed by BMPs:	80.0941	acre-ft
Percent annual runoff volume removed:	**88**	**%**
Post development annual particulate P load:	42.3756	lbs
Annual particulate P removed by BMPs:	37.145	lbs
Post development annual dissolved P load:	34.671	lbs
Annual dissolved P removed by BMPs:	30.391	lbs
Total P removed by BMPs	67.536	lbs
Percent annual total phosphorus removed:	**88**	**%**
Post development annual TSS load:	13545.3	lbs
Annual TSS removed by BMPs:	12113	lbs
Percent annual TSS removed:	**89**	**%**

Figure A.16 MIDS Scenario 2 Site Loading Results (Post-development)

Table A.4 MIDS Scenario 2 Results Summary

Offsite Discharge Parameter	Existing	Requirement	Proposed
Total Phosphorus Loading (lbs/yr)	11.5	11.5	9.5[1]
Total Suspended Solids Loading (lbs/yr)	2,025	<2,025	1,432[2]
Volume Retention (cu-ft)	-	110,350	112,725

1- (42.4 lbs/yr particulate phosphorus + 34.7 lbs/yr dissolved phosphorus) – 67.5 lbs/yr TP

2- 13,545 lbs/yr TSS – 12,113 lbs/yr TSS

A.3 Example B: Stormwater Reuse Modeling Example Scenario Using MIDS

For this modeling example, the hypothetical project is a 9-acre redevelopment site located in the northern portion of the District. The existing site is a commercial development and will be converted to a multi-family residential development with associated driveways, parking, and turf areas. The existing site contains 3 acres of impervious surfaces that will be reconstructed as part of the project. One (1) acre of new impervious surface will be added for a total post-development impervious area of 4 acres.

The process to determine what standards apply to this redevelopment scenario follows the steps described in Section 3.1 of the Standards Guidance Manual.

In this case, the example site drains to Colby Lake which requires a maximum total phosphorus loading of 0.34 lbs/acre/year. The water quality standard for total suspended solids is to provide a net reduction in average annual loading from the site. In addition, a water quality volume of one (1) inch times the sum of new and fully reconstructed impervious surfaces is required to be captured and treated.

The site is located within an area where the infiltration of stormwater is prohibited. The project proposer worked with SWWD staff to consider alternative compliance measures at the site, as described in Section 3.4 of the manual. It was determined that a stormwater reuse system would be installed to provide irrigation for a portion of the site. A filtration BMP would be used to treat the remainder of the required water quality treatment volume.

A.3.1 Modeling Example Scenario (MIDS)

Water quality modeling is performed to determine the pre- and post-development impact of the example project prior to implementation of any BMPs. The MIDS calculator was used in this example to determine the untreated runoff volume and nutrient load for both pre- and post-development conditions. A series of screen captures from the MIDS calculator have been provided to illustrate how the calculator was set up for the pre-development condition.

A.3.2 Modeling Prior to BMP Analysis

Figure A.17 is the *Site Information* screen of the pre-development site. Within this screen, the user inputs the project zip code, and information on the amount of site area contained within each land cover and hydrologic soil group combination. The user also denotes event mean concentration (EMC) values for total phosphorus and total suspended sediments from the site's stormwater runoff. Within this example, there are three (3) acres of existing impervious area on the project site. The values circled in red have been changed from the original default MIDS values to reflect SWWD modeling guidance.

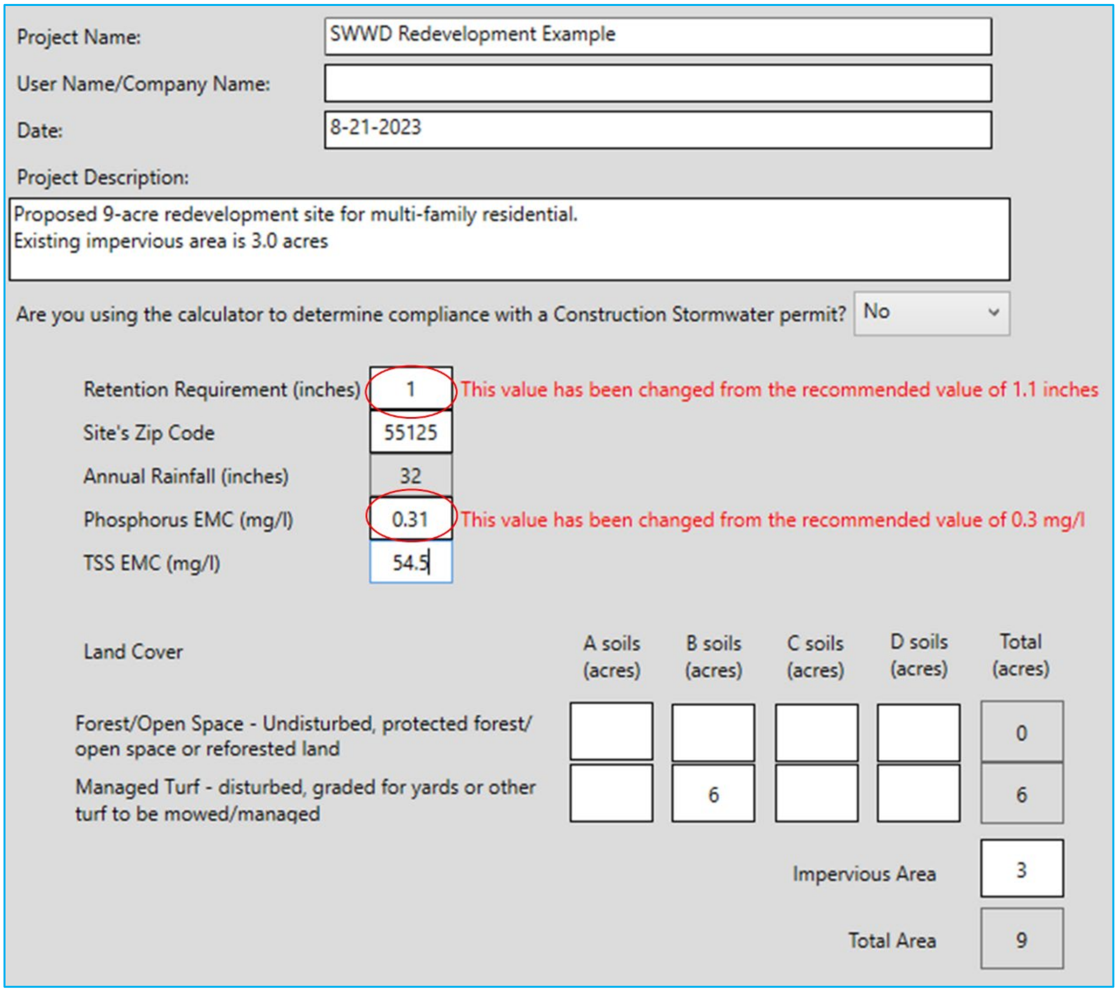


Figure A.17 MIDS Site Information Screen (Pre-development)

Figure A.18 is the *Site Information* screen of the post-development site. The total impervious area is 4 acres, 3 acres of which are reconstructed. The remainder of the site is planned as residential yard space, denoted as managed turf within the calculator.

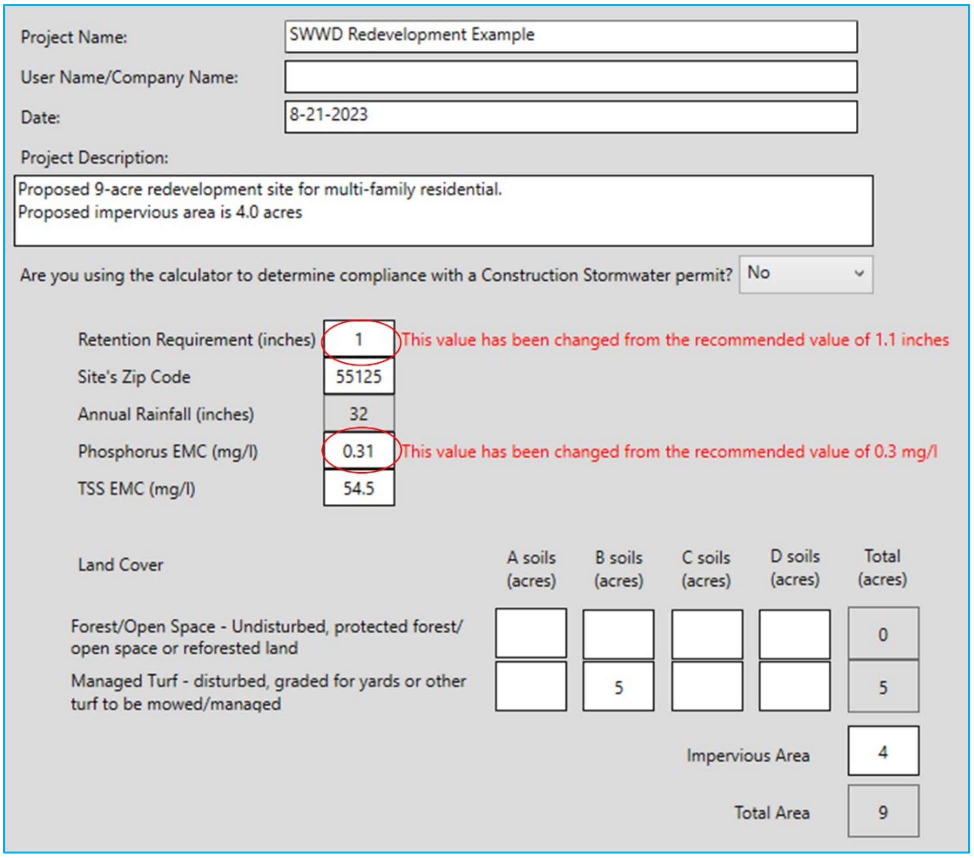


Figure A.18 MIDS Site Information Screen (Post-construction)

The next step is to confirm the maximum amount of total phosphorus loading that is allowed from the site. The pre-development pollutant loads are determined from the pre-development calculator results. As shown in Figure A.19, the 30-year average TSS and TP loads are 1,441 lbs/year and 8.2 lbs/year, respectively.

Summary Information

Performance Goal Requirement

Performance goal volume retention requirement:	10890	ft3
Volume removed by BMPs towards performance goal:		ft^3
Percent volume removed towards performance goal		**%**

Annual Volume and Pollutant Load Reductions

Post development annual runoff volume	9.72	acre-ft
Annual runoff volume removed by BMPs:		acre-ft
Percent annual runoff volume removed:		**%**
Post development annual particulate P load:	4.5077	lbs
Annual particulate P removed by BMPs:		lbs
Post development annual dissolved P load:	3.688	lbs
Annual dissolved P removed by BMPs:	0	lbs
Total P removed by BMPs	0	lbs
Percent annual total phosphorus removed:		**%**
Post development annual TSS load:	1440.9	lbs
Annual TSS removed by BMPs:		lbs
Percent annual TSS removed:		**%**

Figure A.19 MIDS Unmitigated Site Loading Results (Pre-development)

As shown in Figure A.20, the unmitigated average annual pollutant loading from the site post-development is estimated as 1,708 lbs/year of total suspended solids and 9.7 lbs/year of total phosphorus. The average annual runoff volume from the site is estimated at 11.5 acre-feet/year.

Summary Information

Performance Goal Requirement

Performance goal volume retention requirement:	14520	ft3
Volume removed by BMPs towards performance goal:		ft^3
Percent volume removed towards performance goal		**%**

Annual Volume and Pollutant Load Reductions

Post development annual runoff volume	11.52	acre-ft
Annual runoff volume removed by BMPs:		acre-ft
Percent annual runoff volume removed:		**%**
Post development annual particulate P load:	5.3425	lbs
Annual particulate P removed by BMPs:		lbs
Post development annual dissolved P load:	4.371	lbs
Annual dissolved P removed by BMPs:	0	lbs
Total P removed by BMPs	0	lbs
Percent annual total phosphorus removed:		**%**
Post development annual TSS load:	1707.7	lbs
Annual TSS removed by BMPs:		lbs
Percent annual TSS removed:		**%**

Figure A.20 MIDS Unmitigated Site Loading Results (Post-development, no BMPs)

As indicated in the rules, the post-development outflow loads at this example site must:

1. be less than or equal to the maximum allowable TP loading for areas draining to Colby Lake (0.34 lbs/acre/year or 3.1 lbs/year) or maintain the pre-development TP loading rate of 8.2 lbs/year, whichever is less,
2. be less than the pre-development average annual TSS loading of 1,708 lbs/year, and
3. capture and treat at least one (1) inch of runoff over the 30.4 acres of total impervious area (14,520 cubic feet).

A.3.3 Modeling Structural BMPs and Evaluating Compliance

In this example, the site is located within an area where infiltration of stormwater is prohibited. Therefore, through the use of *Alternative Compliance Sequencing* (Section 3.4) the applicant will use alternatives to infiltration practices sized to treat the required water quality volume (14,520 cubic feet). A stormwater reuse system will be used to treat the site's impervious areas to the maximum extent practicable. The system will be sized to capture and reuse the first one (1) inch of stormwater runoff from 2.5 acres of the post-development impervious surfaces (9,075 cubic feet). The irrigation application area for the development is the 5.0 acres of turf grass surrounding the proposed buildings. The irrigation area soil type is Type B.

The reuse system is operational for only 5 months out of the year (May – September) and is limited by the irrigation application rate and application area. Therefore, the reuse system alone is not expected to meet the water quality loading requirements for the site. A lined iron-enhanced sand bioretention basin will receive all runoff exceeding the capacity of the reuse system (either when it is full or offline) in addition to its own direct subwatershed runoff. In total, the BMPs are sized to treat the first one (1) inch of runoff from the site's post-development impervious area.

Figure A.21 is the *Schematic* screen for the MIDS calculator. This is where parameters for treatment devices are specified. In this example, stormwater reuse and the lined iron-enhanced sand bioretention basin were used.

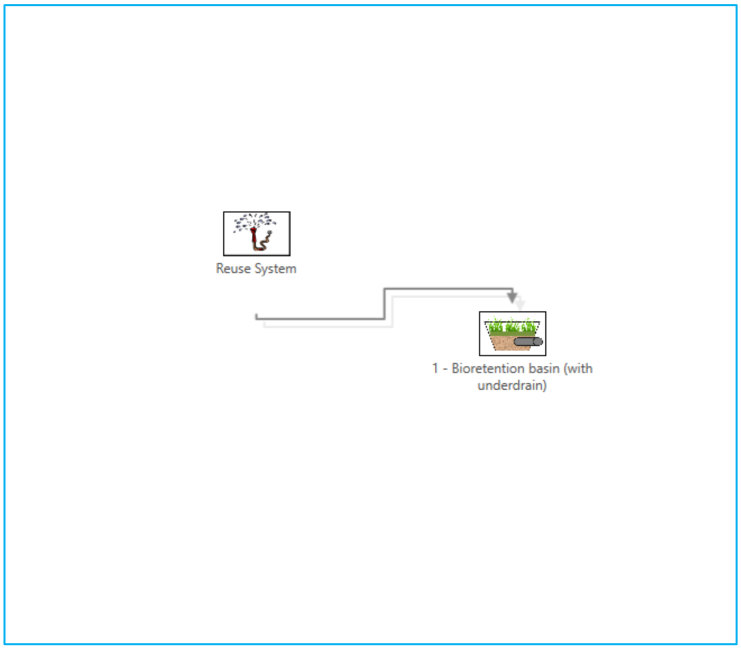


Figure A.21 Schematic Screen

Figure A.22 shows the BMP inputs for the stormwater reuse system. When the reuse system is off-line or when the reuse tank is full, flows bypass the system and discharge into the bioretention basin. Therefore, the bioretention basin is specified as the "downstream BMP" in this case. The pervious and impervious areas that drain to the reuse system are also specified.

The storage volume of the reuse system is sized to contain the first one (1) inch of runoff from the 2.5-acres of impervious surface contributing to the BMP (9,075 cf). The 5.0 acres of turf area to be irrigated by the system are input as the irrigation application area. The default input of 'no' is selected for providing a user-defined maximum weekly irrigation rate. This allows the MIDS calculator to determine the irrigation rate based on potential evapotranspiration from the irrigated areas.

The Minnesota Stormwater Manual recommends the irrigation application season start in May and end in September unless the applicant can provide supporting information to show the irrigation season is longer. By default, the applicant should also assume the system goes offline during the off-season and that water is not retained for on-site use unless supporting information suggests otherwise. Additional information on design criteria for stormwater reuse can be found in the Minnesota Stormwater Manual (Design criteria for stormwater and rainwater harvest and use/reuse - Minnesota Stormwater Manual (state.mn.us)).

As shown in the Reuse System *Input* screen, the retention volume provided by the reuse system (8,664 cubic feet) is less than the reuse storage volume (9,075 cubic feet). This is because the credited volume is not only a function of the reuse storage volume, but also of the irrigation rate, and irrigation application area. In this case, these inputs result in a system that does not achieve credit for the full available storage volume.

BMP Name: Reuse System

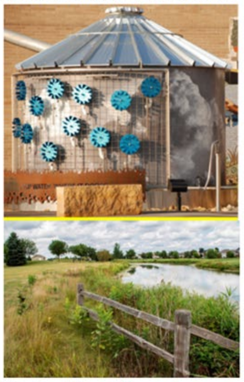
Routing/downstream BMP: Bioretention basin (with underdrain)

Minnesota Stormwater Manual Wiki

BMP Watershed Area

Land Cover	A Soils (acres)	B Soils (acres)	C Soils (acres)	D Soils (acres)	Total (acres)
Forest/Open Space - Undisturbed, protected forest/open space or reforested land					0
Managed Turf - disturbed, graded for yards or other turf to be mowed/managed		0			0
		Impervious Cover (acres)			2.5
		Total Area (acres)			2.5

Harvest and re-use/Cistern



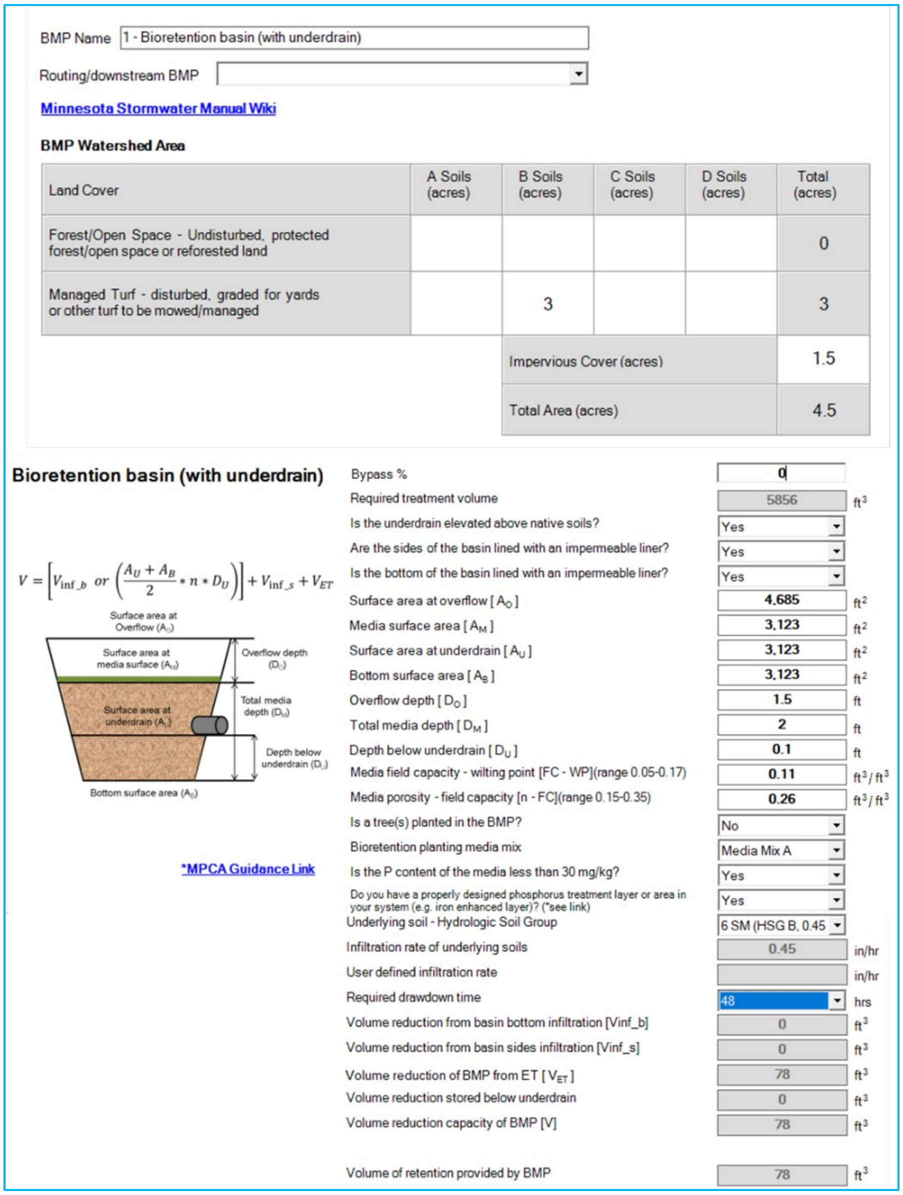
Note: Credit toward the performance goal is only achieved during the time when the system is operational

Required treatment volume	9075	ft^3
Reuse storage volume (pond/cistern)	9075	ft^3
Irrigation application area	5	acres
Provide user defined maximum weekly irrigation rate?	No	
User defined maximum irrigation application rate		in/week
Soil type of irrigated area - Hydrologic Soils Group	HSG Type B	
Irrigated vegetation type	Turf	
Irrigation season start month	May	
Irrigation season end month	September	
Does the system go offline during off season?	Yes	
Is water retained on-site for non-irrigation uses?	No	
Weekly water volume retained for non-irrigation uses		ft^3/week
Average achieved irrigation application rate	1.11	in/week
Volume reduction capacity of BMP [V]	8664	ft^3
Volume of retention provided by BMP	8664	ft^3

Figure A.22 Reuse System Input Screen

Figure A.23 shows the BMP inputs for the lined iron-enhanced sand bioretention basin with underdrain. Because the configuration of the reuse system does not achieve the full volume retention credit, the bioretention basin is sized to retain and treat the first one (1) inch of runoff from its contributing impervious area of 1.5-acres (5,445 cf) plus the additional retention volume not obtained with the reuse system (9,075 cubic feet – 8,664 cubic feet = 411 cubic feet). The basin is lined due to the prohibition of infiltration at the site. Media field capacity, porosity, and wilting point are based on the sand filter media water storage properties. Guidance for selecting these values is provided in the Minnesota Stormwater Manual (Soil water storage properties - Minnesota Stormwater Manual (state.mn.us).

In this case, additional phosphorus treatment will be required to meet the water quality requirement. The enhanced media layer was designed to meet criteria for iron-enhanced sand filters outlined in the Minnesota Stormwater Manual. To simulate this within the MIDS calculator, "Yes" is indicated to the prompted question "Do you have a properly designed phosphorus treatment layer or areas in your system?". This results in the calculator applying additional phosphorus reduction aligning with removal efficiencies for iron-enhanced sand filters (Calculating credits for iron enhanced sand filter - Minnesota Stormwater Manual (state.mn.us)). The guidance provided in the Minnesota Stormwater Manual for iron-enhanced media is used to determine the other inputs for the media-enhanced bioretention BMP (Design criteria for bioretention - Minnesota Stormwater Manual (state.mn.us)).


BMP Name: 1 - Bioretention basin (with underdrain)

Routing/downstream BMP:

Minnesota Stormwater Manual Wiki

BMP Watershed Area

Land Cover	A Soils (acres)	B Soils (acres)	C Soils (acres)	D Soils (acres)	Total (acres)
Forest/Open Space - Undisturbed, protected forest/open space or reforested land					0
Managed Turf - disturbed, graded for yards or other turf to be mowed/managed		3			3
			Impervious Cover (acres)		1.5
			Total Area (acres)		4.5

Bioretention basin (with underdrain)

$$V = \left[V_{\inf\_b}\ or\ \left(\frac{A_U + A_B}{2} * n * D_U\right)\right] + V_{\inf\_s} + V_{ET}$$

*MPCA Guidance Link

Bypass %	0	
Required treatment volume	5856	ft³
Is the underdrain elevated above native soils?	Yes	
Are the sides of the basin lined with an impermeable liner?	Yes	
Is the bottom of the basin lined with an impermeable liner?	Yes	
Surface area at overflow [A_O]	4,685	ft²
Media surface area [A_M]	3,123	ft²
Surface area at underdrain [A_U]	3,123	ft²
Bottom surface area [A_B]	3,123	ft²
Overflow depth [D_O]	1.5	ft
Total media depth [D_M]	2	ft
Depth below underdrain [D_U]	0.1	ft
Media field capacity - wilting point [FC - WP](range 0.05-0.17)	0.11	ft³ / ft³
Media porosity - field capacity [n - FC](range 0.15-0.35)	0.26	ft³ / ft³
Is a tree(s) planted in the BMP?	No	
Bioretention planting media mix	Media Mix A	
Is the P content of the media less than 30 mg/kg?	Yes	
Do you have a properly designed phosphorus treatment layer or area in your system (e.g. iron enhanced layer)? (*see link)	Yes	
Underlying soil - Hydrologic Soil Group	6 SM (HSG B, 0.45	
Infiltration rate of underlying soils	0.45	in/hr
User defined infiltration rate		in/hr
Required drawdown time	48	hrs
Volume reduction from basin bottom infiltration [Vinf_b]	0	ft³
Volume reduction from basin sides infiltration [Vinf_s]	0	ft³
Volume reduction of BMP from ET [V_{ET}]	78	ft³
Volume reduction stored below underdrain	0	ft³
Volume reduction capacity of BMP [V]	78	ft³
Volume of retention provided by BMP	78	ft³

Figure A.23 Bioretention Basin with Underdrain Input Screen

The results from this simulation are presented in Figure A.24 and summarized in Table A.5. In order to compute the post-development loading from the site, after accounting for BMPs, the 'annual pollutant removed by BMPs' is subtracted from the 'post-development annual pollutant loads'. Results are reported in Table A.5. As shown, the proposed design meets the stormwater requirements for TSS and TP for the site.

Summary Information

Performance Goal Requirement

Performance goal volume retention requirement:	14520	ft3
Volume removed by BMPs towards performance goal:	8742	ft^3
Percent volume removed towards performance goal	**60**	**%**

Annual Volume and Pollutant Load Reductions

Post development annual runoff volume	11.52	acre-ft
Annual runoff volume removed by BMPs:	2.7661	acre-ft
Percent annual runoff volume removed:	**24**	**%**
Post development annual particulate P load:	5.3425	lbs
Annual particulate P removed by BMPs:	4.531	lbs
Post development annual dissolved P load:	4.371	lbs
Annual dissolved P removed by BMPs:	3.009	lbs
Total P removed by BMPs	7.54	lbs
Percent annual total phosphorus removed:	**78**	**%**
Post development annual TSS load:	1707.7	lbs
Annual TSS removed by BMPs:	1448.2	lbs
Percent annual TSS removed:	**85**	**%**

Figure A.24 MIDS Site Loading Results (Post-development)

Table A.5 Results Summary

Offsite Discharge Parameter	Existing	Requirement	Proposed
Total Phosphorus Loading (lbs/ac/yr)	0.91	0.34	0.24[1]
Total Suspended Solids Loading (lbs/yr)	1,441	<1,441	260[2]

1- [(5.3 lbs/yr particulate phosphorus + 4.4 lbs/yr dissolved phosphorus) – 7.5 lbs/yr TP] / 9 acres

2- 1,708 lbs/yr TSS – 1,448 lbs/yr TSS

Appendix B

Floodplains, Storage, and Hydraulics

Appendix B

Floodplains, Storage, and Hydraulics

This appendix addresses project design and management considerations relative to District floodplain management requirements. Hydrologic and hydraulic considerations for site design and assessment as they relate to District stormwater volume and rate requirements are described in Section 4 of this manual.

This appendix does not address guidance or requirements of member cities applicable to the design of stormwater conveyance or storage infrastructure. The District defers guidance on specific hydraulic design elements such as catch basin spacing, trunk storm sewer sizing, and similar elements to member communities.

B.1 Floodplains and Minimum Building Elevations

Floodplains are defined in District Rules as the area along channels and waterways, including the area around lakes, marshes, lowlands, and ponding areas that is inundated as the result of a flood event with a 1% chance of occurring in any year (i.e., 100-year event). These areas are also known as “critical storage areas.” The watershed-wide XPSWMM modeling completed by the District evaluated the extent of 100-year water levels for flood storage and conveyance areas; additional information about specific areas is available from the District.

Note that areas defined as floodplain within the District includes area that are outside the floodplain as mapped by the Federal Emergency Management Agency (FEMA) (i.e., FEMA floodplain). Additional information on FEMA floodplains is available at: FEMA Flood Map Service Center | Welcome!

Proposers of development and redevelopment activity must delineate the elevation and extent of the floodplain within the project site through use of a model (see Section 4) or other methods acceptable to the District. Generally, the District prohibits filling or development/redevelopment activity with the floodplain. Some activities may be allowed if equivalent storage is provided (i.e., 1:1 mitigation of critical storage volume that does not adversely affect flow rate, volume, or other hydrologic characteristics). Allowable alterations and land uses within the floodplain are defined in Rule 5 of the District Rules. Additional requirements specific to landlocked basins are detailed in Rule 6 of the District Rules.

The District requires that floodplains adjacent to existing and future waters and waterways be preserved by dedication and/or perpetual easement to the community in which they are located. These easements shall cover those portions of the property which are adjacent to the water or waterway and are less than one foot above the 100-year flood elevation. The local governing unit shall be responsible for all necessary stormwater facility maintenance within the drainage easement.

To minimize the risk of flood damage to structures, the District requires the minimum low opening elevation on all buildings will be at least two feet above the 100-year flood elevation or one foot above the emergency overflow of the adjacent basin, or natural overflow of a landlocked basin (see District Rules). Project proposers must note the applicable minimum building elevation of each lot on grading plans.

B.2 Open Channel Considerations

Natural open channels generally have two hydraulic benefits: they serve to convey water within the channel bank and provide storage capacity in the form of a floodplain. Engineered channels, often in the form of swales or ditches, generally are intended to convey water to a known storage location. The District generally defers specific design criteria for open channels to their member cities. For new channel systems, the District prefers the use of biodegradable or synthetic blankets (liners) instead of riprap or other hard armoring techniques to strengthen channel banks, where appropriate.

Per District Rules, the District requires the following where new or increased discharges to open channels are proposed:

1) It must be demonstrated that design velocities will not cause channel instability during the 100 year event.
2) Appropriate energy dissipation at the outfall is required.
3) A maintenance plan should be developed to illustrate how accumulated sediment will be handled or how channel failures will be remediated.
4) Where possible, open channels should include buffers of herbaceous vegetation and should provide connectivity with adjacent upland habitat.
5) For channels three feet or less in depth, one half foot of freeboard shall be provided.
6) For channels deeper than three feet and up to five feet in depth, one foot of freeboard shall be provided.

Ensuring the stability of open channels, either natural or engineered, is important for preventing erosion or channel failure. This may be done by comparing a modeled or calculated velocity to the critical velocity (i.e., the maximum allowable velocity before sediment particles are suspended in the flow). Several engineering methods can be used to evaluate channel stability. The District's preferred method is the allowable velocity approach, described in Section 654.0803 of the USDA's National Engineering Handbook: Chapter 8--Threshold Channel Design (usda.gov)

Additional considerations to allowable velocities may be appropriate for channels designed with reinforcing materials or products. The allowable velocity may be increased based on vendor performance specifications for a product, such as permanent blankets, or turf reinforcement mats.

Appendix C

Stormwater Utility Fee and Credits

Appendix C

Stormwater Utility Fee and Credits

This appendix explains the Stormwater Utility Fee (SUF) established by the District and generally discusses how the SUF is calculated. This appendix describes the mechanism and application process for property owners who implement runoff volume control practices on their site to reduce their SUF.

A stormwater utility fee (SUF) is a fee applied to each property based on stormwater runoff characteristics generally applicable to that land use. The basis of the current SUF methodology is described in the "Stormwater Utility Update" final report (EOR, 2004) – specific values have been updated to reflect the time value of money. The SUF is collected by Washington County and is labeled as "SWWatershed" under special assessment on property tax statements.

The District has established rules addressing the volume of stormwater runoff from development and redevelopment activities. The District supports voluntary efforts to reduce stormwater runoff volume by providing a reduction in SUF for property owners further reducing stormwater runoff volume.

C.1 SUF Calculation

The District currently calculates the SUF based on a calculated design storm runoff volume for a typical single family residential parcel. This computed runoff volume defines a unitless Residential Equivalency Factor (REF) with a value equal to one.

This method assumes the following in calculating runoff volume and the associated REF:

- 3.6-inch rainfall in 24 hours (approximately a 5-year return interval)
- 0.38 acre lot size
- 27.5% imperviousness

Stormwater runoff volumes increase as percent impervious cover increases, and as parcel size increases. An REF for an individual parcel is based on the REF for a typical residential lot and scaled up or down according to the percent impervious area compared to the typical residential lot. An individual parcel's REF is then multiplied by the acreage of the parcel to calculate a Residential Equivalent Unit (REU) value. The REU value of a parcel is the number of typical single family residential parcels that would generate an equivalent amount of stormwater runoff.

As part of its annual budgeting process, the District evaluates the dollar amount that must be collected per REU each year to responsibly fund District operations. The dollar amount assigned to each REU may change but the REU value of an individual parcel is generally constant.

C.2 SUF Reduction Methods

The purpose of the SUF reduction methods is to provide a financial incentive for property owners to implement volume control BMPs. Volume control BMPs (e.g., rainwater gardens) are typically designed for smaller runoff events and result in a significant cumulative benefit over time.

The District has established two ways for owners to reduce a property's SUF. The first is through an abatement of the fee in which the District will reassess the parcel impervious percentage. The second method is through implementation of BMPs to reduce stormwater runoff volume.

The District initially considered several methods for calculating a financial discount based on BMP implementation and ultimately selected the following method:

> The property owner determines the annual stormwater runoff reduction achieved. The property owner then identifies the percent reduction in overall site impervious area that would result in the same volume reduction. For example, a BMP may reduce runoff volume by 15 percent while the same volume reduction could be achieved by reducing impervious area by 21 percent. The SUF fee reduction is calculated in direct proportion to the effective percent reduction in impervious area (e.g., a 21 percent discount).

The District may reevaluate the method used to calculate SUF fee reduction based as a function of volume reduction in the future.

C.3 Applying for SUF Reduction

C.3.1 Applying for Impervious Redetermination

Prior to June 1st, owners of non-residential properties may submit a written request for re-determination of impervious cover to the SWWD Board. Requests after June 1st will be considered for the following payable year. The parcel owner must submit a written request to the SWWD stating the desire for a redetermination. The request will be included in a regular meeting of the Board. The SWWD will perform at its own expense the necessary efforts to evaluate the impervious percentage of a site which at times may involve the need to access the parcel.

Upon completion of the re-determination, reimbursement of the SUF will be evaluated by SWWD staff and results presented to the Board for acceptance. If the re-determination shows that the actual impervious percentage on-site is lower than what is being assessed, the annual SUF will be reduced to reflect the actual amount for future years and the SWWD shall reimburse the property owner the difference between the assessed fee and the re-determined fee for the current payable year. If reimbursement is granted to the parcel, the parcel owner will be notified by letter stating the fee reduction. There shall be no change to the SUF if the reassessment determines that the actual impervious percentage is greater than what is being assessed.

C.3.2 Applying for Volume Control BMP Credit

Non-residential parcel owners may apply for a BMP credit, which is a reduction to the annual SUF based on the implementation of a stormwater volume control practice. Steps in the process include:

1. Non-residential parcel owner or agent completes the application on the SWWD website and submits the form to the District before any site work is performed. Applications may be received at any time.

2. District staff review the application to ensure the proposed BMP is suitable based on site conditions. District staff may request additional information regarding the BMP, as needed.

3. District staff process the application and calculate the estimated credit to the SUF for the parcel based on the application submittal.

4. The District notifies the applicant that the proposed project qualifies for BMP volume control credit and identifies the estimated amount of the credit. If necessary, a pre-project site visit is scheduled to verify site conditions.

5. The applicant implements the volume control BMP on the parcel and notifies the District after the project is complete and functioning. District staff schedule a post-project site visit to confirm the BMP is functioning and to verify site conditions.

6. After finalization of appropriate documentation, the District processes the SUF credit to the parcel.

C.3.3 Volume Control BMP Requirements for SUF Credit

Implementing a volume control BMP for SUF credit is mutually beneficial to the District (i.e., improved water quality) and property owner (i.e., reduced SUF). To continue receiving the SUF credit, the BMP must continue to perform as intended into the future. The District has established the following requirements to promote the success of volume control BMPs:

1. Volume control BMPs should be identified and implemented based on guidance and design criteria identified within this Manual and the Minnesota Stormwater Manual. Volume control benefits will be estimated by the District for an applicant based on methods referenced within this Manual.

2. For structural improvements that affect the existing storm sewer drainage infrastructure, a qualified professional engineering licensed in Minnesota shall perform design work. Appropriate building permits must also be obtained prior to start.

3. A BMP may be implemented for some, or all, of the parcel site. However, if that BMP receives off-site overland drainage from another parcel, the contributing off-site parcel does not receive credit unless it is a joint application.

4. The application must agree to the following:

    a. Developing, submitting, and implementing an on-going maintenance plan for successful functionality of the BMP.

    b. Annual self-reports to document the maintenance activities performed and identified the status of the BMP. Self-reports must be submitted to the SWWD by the last business day of January.

    c. Disclosing this BMP credit during any sale or ownership transfer of the parcel.

    d. Allowing the District access to inspect the BMP, so long as due notice is provided.

5. If disconnection of impervious area is pursued as a BMP, pre-project and post-project inspections of local drainage must be performed with District staff.

6. If the District determines a BMP is no longer adequately functioning, the original SUF for the parcel may be reinstated. Similarly, if a parcel owner is not responsive in timely submitting the annual self-reports the District may reinstate the original SUF for the parcel.