ENVIRONMENT, HEALTH & SAFETY
UNIVERSITY OF MICHIGAN

Stormwater Management - Post-Construction Requirements (EP3-001)

Guideline

Issue Date: 07/28/2009
Revision Date: 06/03/2025

Applies To: As required by the National Pollutant Discharge Elimination System (NPDES) permit for University of Michigan (U-M), the scope of this Guideline includes all construction and renovation projects on U-M properties that involve either:

a. Earth disturbance of one (1) acre or greater,

OR

b. Earth disturbance of less than one (1) acre, but which are part of a larger common plan of development or sale that would disturb one (1) acre or more.

Notes: *i. "Regulated site ", "Project site" and "Site" in this guideline refers to individual project construction sites meeting a. or b. above. Note – per previous discussion with EGLE staff, if a project site only exceeds one (1) acre due to the installation of elective stormwater best management practices (such as adding a bioswale around the perimeter of a parking lot), that project is not considered to have exceeded one (1) acre, and thus post-construction stormwater controls are not required, and remain elective. An SESC plan would, however, be required.*

ii. Per previous discussion with EGLE, if UM does not own/operate the MS4 first receiving the discharge, then that area is not subject to UM's post-construction requirements. This typically applies to ROW areas. These areas do not need to be accounted for in the stormwater management calculations, but should be noted for reference and be part of the site SESC plan.

iii. Common Plan of Development: The University treats each project with a different project number as a separate development. Projects that take place in the same area may be funded differently, have different approvals from the Regents, and additional site-specific requirements. Thus, they are stand-alone projects, not a common plan of development. Generally, a common plan of development is not applicable to U-M, since common plan developments, such as sub-divisions, do not occur on campus. If this type of development occurs, the requirements and procedures of this guideline will be met.

iv. Laydown and staging areas where topsoil/grass is not removed are not considered as earth disturbances as they will be returned to grass.

v. Projects that are part of a Planned Unit Development (PUD) meeting the local entities post-construction stormwater management requirements, or projects that follow the local entities post-construction stormwater management requirements are deemed to be within compliance of the UMs NPDES post-construction permit requirements.

Acronyms

AEC – Architecture, Engineering and Construction Department
BMPs – Best Management Practices
DEQ – Michigan Department of Environment (now EGLE)
EGLE – Michigan Department of Environment, Great Lakes, and Energy

EHS – Environment, Health & Safety
GI – Green Infrastructure
HUC – Hydrologic Unit Code
LID – Low Impact Development
MDNRE – Michigan Department of Natural Resources and Environment (now EGLE)
MS4 – Municipal Separate Storm Sewer System
NOAA – National Oceanic & Atmospheric Administration
NPDES – National Pollutant Discharge Elimination System
O&M – Operation & Maintenance
PCSM – Post-Construction Stormwater Management
SCMs – Stormwater control measures
TSS – Total Suspended Solids
UAs – Urbanized Areas
U-M – The University of Michigan

Post-Construction Requirements Policy Statement

U-M construction and redevelopment projects on U-M property are regulated under and **must** comply with the U-M NPDES permit for stormwater discharges, as issued by the Michigan Department of Environment, Great Lakes, and Energy (EGLE). The Stormwater Management Post-Construction Requirements Guideline has been developed to provide guidance regarding responsibilities and actions to meet the NPDES permit conditions for construction and renovation projects on U-M properties, which include but are not limited to, the Ann Arbor, Dearborn and Flint campuses.

Post-Construction Plan for Stormwater Management

The post-construction plan for stormwater management on regulated sites **must** include:

- A minimum treatment volume standard to address water quality impacts.
- Channel protection criteria to address resource impairment resulting from flow volumes and rates.
- Drawings showing the location of stormwater control measures (SCMs) and the storm system.
- Details on the proposed SCMs.
- Operation & Maintenance (O&M) requirements.
- Supporting information
    - Calculations used for designing all components of the stormwater management systems.
    - Total suspended Solids (TSS) design removal rates and supporting manufacturer documentation, if applicable.
    - Geotechnical report including soil boring and infiltration test data.

Refer to U-M Stormwater Management Program Plan and the Post-Construction Stormwater Worksheet for additional details on these requirements.

The project team [Architecture, Engineering & Construction (AEC), Other Project Managers, Project Developer and/or Contractors] shall develop the post-construction stormwater management plan in accordance with this guideline and the NPDES permit. Preferred design elements are identified in the Post-Construction Stormwater Worksheet.

Minimum Treatment Volume Standard

The minimum treatment volume standard **must** be either:

a. One (1) inch of runoff from the entire site.

OR

b. The calculated runoff for the entire site from the 90 Percent Annual Non-Exceedance Storm, as summarized in DEQ's memo dated March 24, 2006.

Total Suspended Solids Removal

The treatment methods **must** be designed on a site-specific basis to achieve the following:

a. A minimum of 80 percent removal of TSS, as compared with uncontrolled runoff.

OR

b. Discharge concentrations of TSS not to exceed 80 milligrams per liter (mg/l).

NOTES:

i. A minimum treatment volume standard is not required where site conditions are such that TSS concentrations in stormwater discharges will not exceed 80 mg/l.
ii. 80mg/L will be determined by a mathematical calculation by land use and TSS values provided by EGLE or other reputable source. Site specific testing will not be performed (see text below from 2008 permit compliance assistance document)

The intent is not for permittees to monitor sites to determine compliance with this permit requirement. Instead, the expected reduction of suspended solids by BMPs is obtained from the literature.

The following table shall be used to determine post-construction TSS discharges from the project sites. If determined through calculation based on TSS load for a land use, that the land use alone or through a combination of land uses, the mean TSS from the project site will be less than 80 mg/l, no additional structural controls will be required.

Mean TSS Loading Rates by Land Use

Land Use Category	*Percent Imperviousness*	*Mean TSS (mg/l)*	*Mean TSS loading rate lbs/ft^3*
Forest/Rural Open	*2*	*51*	*0.0032*
Urban Open	*11*	*51*	*0.0032*
Agricultural/Pature	*2*	*145*	*0.0091*
Low-Density Residential	*19*	*70*	*0.0044*
Medium-Density Residential	*38*	*70*	*0.0044*
High-Density Residential	*51*	*97*	*0.0061*
Commercial	*56*	*77*	*0.0048*
Industrial	*76*	*149*	*0.0093*
Highways	*53*	*141*	*0.0088*

Adapted from "Rouge River Wet Weather demonstration Project, Selection of Stormwater Pollutant Loading Factors" RPO-MOD-TM34.00, October 1994, Table 3-13 (To convert mg/l to lbs/ft^3, multiply by 6.243 X 10^{-5})

Channel Protection Criteria

The channel protection criteria **must** maintain post-development site runoff volume and peak flow rate at or below existing levels for all storms up to the 2-year, 24-hour event. "Existing levels" means the runoff volume and peak flow rate for the last land use prior to the planned new development or redevelopment. More restrictive channel protection criteria may be utilized by U-M on a case-by-case basis, as appropriate.

Rainfall data

The rainfall data for calculating runoff volume and peak flow rate shall be the NOAA Atlas 14 Point Precipitation Frequency Estimates. Projects can electively opt to use larger storm events as an elective BMP.

Methods for estimating pre- and post-development runoff

The methods used for estimating pre- and post-development runoff shall follow curve number evaluations as described in MDNRE's (now EGLE) document Computing Flood Discharges for Small Ungaged Watersheds, June 2010, which notes other SCS (curve number) methods such as to TR-55 and TR-20 as acceptable methods for calculating runoff. In addition, other computer modeling, such as HydroCAD and SWMM are also acceptable to calculate pre and post runoff conditions. Section 6.1 of this referenced document indicates to see TR-55 Tables 2-2a through 2-2d for the complete list of curve numbers. Utilize this more comprehensive list of curve numbers for completing the channel protection calculations. As noted in section 6.2 of the above referenced document, a composite curve number approach is acceptable to calculate site runoff.

Alternative Approaches

Detention in Lieu

On-site extended detention may be utilized on project sites where retention (infiltration) is not feasible due to:

a. High water table present on-site, where adequate separation between the bottom of the infiltration bed and the groundwater is not feasible;
b. Site specific infiltration testing or geotechnical data determine that on-site soils are not suitable for infiltration (little to no infiltration capability);
c. There is known contamination or hotspots present that could be exacerbated by infiltration;
d. Infiltration would cause harm to building infrastructure or may cause harm to property adjacent to the project;
e. Soil instability as documented by a thorough geotechnical analysis;
f. Case by case conditions not covered by items a. though e. above, with prior EGLE approval.

In situations where detention in lieu is to be utilized, the U-M will detain a minimum of 120% of the required channel protection volume as described above. This is applicable to both on-site and off-site detention facilities. Detention facilities shall be designed to release required management volume within 36 hours (+/- 12 hrs), at a velocity at or below the existing 2yr/24hr storm peak flow rate and are encouraged to reduce peak flow rate through the 100yr/24hr event. The following considerations shall be made:

a. When feasible and prudent, a minimum of 10% of the total required channel protection volume shall be managed on-site as the first tier. This involves the use of LID and GI approaches. Each project shall document how this has been accomplished, or if it is not possible due to site constraints.
b. An offset ration of 1:1.2 shall be applied to volume above the first-tier volume that is to be managed through the use of extended detention.

If it is not feasible to infiltrate (though the use of GI or LID) the first tier volume (or any portion thereof), the offset ratio for the first tier volume (or portion thereof) for management by extended detention shall be 1:1.2.

Off-Site Mitigation in Lieu (Retention and Detention)

Off-site mitigation shall be permitted when any of the following conditions are present at the proposed development site:

a. High water table present on-site, where adequate separation between bottom of infiltration bed and groundwater is not feasible, or where the retention and/or detention system would be within the anticipated high water table level.
b. Site specific infiltration testing or geotechnical data determines that on-site soils are not suitable for infiltration (little to no infiltration capability).
c. There is known contamination or hotspots present that could be exacerbated by infiltration.
d. Infiltration would cause harm to building infrastructure or may cause harm to property adjacent to the project.
e. Insufficient space outside of the building footprint to create the necessary infiltrative and/or storage capacity even with amended soils.
f. Soil instability as documented by a thorough geotechnical analysis.
g. Site use is inconsistent with the capture and retention/detention of stormwater.
h. Site use will be land consumptive, preventing future development needs required to meet the University's mission
i. Too much shade or other physical conditions that preclude adequate use of plants.
j. Regional BMPs are preferred when build-out land use density does not allow for multiple future BMP locations, when several agencies or municipalities are contributing to one treatment system, or when budgetary constraints align with the construction of a regional BMP. (Regional BMPs treat runoff from multiple projects or site locations using one designed BMP system. Such BMPs minimize overall land impacts and costs, as one large BMP is constructed in lieu of several smaller BMPs. A few examples of regional BMPs on U-M campus include the Palmer Drive Cistern, Museum of Art underground infiltration system, and the wetland detention basin system at the Art and Architecture Building). It is anticipated that regional systems previously installed and with available capacity shall be used as needed to meet U-M's post-construction stormwater management requirements.

   The use of existing regional stormwater management facilities with adequate capacity may be permitted with prior approval from AEC. The facility must have available capacity to control the increased runoff as determined by section 2.2 outlined above. The regional stormwater management facility must be within the same 10-digit hydrologic unit code (HUC), and preferably within the same creekshed as the project requiring post-construction stormwater management.

Off-site mitigation sites shall meet the following minimum requirements

a. When feasible and prudent, a minimum of 10% of the total required channel protection volume shall be managed on-site as the first tier. This involves the use of LID and GI approaches. Each project shall document how this has been accomplished.
b. An offset ratio of 1:1.2 shall be applied to the volume above the first-tier volume that is to be managed at the off-site mitigation area.
c. If it is not feasible to manage the first-tier volume (or any portion thereof) on-site, the offset ratio for the first-tier volume (or portion thereof) for management in the off-site mitigation area shall be 1:1.2.
d. Offset ratio can be waived for off-site infiltration practices if the project site stormwater enters the infiltration feature through storm pipe or constructed stormwater conveyance (such as a swale or ditch) prior to discharge to surface waters of the State. Because there are no impacts to receiving waters, the use of an offset protection factor is not required.

Off-site stormwater banks and banking:

a. It is acceptable to create a stormwater bank for use by projects owned by the U-M.
b. In order for a project to utilize a bank, it must be within the same 10-digit HUC and preferably within the same creekshed as the project.

c. A bank can be created as a stand-alone project for future use by future development and redevelopment.
d. Projects installing a system to meet post-construction stormwater management (PCSM) requirements can over-design to create a bank for future use by another project.
    1. Clearly document the volume of water retained or detained at the bank site
    2. Deduct the initial project's PCSW needs from the calculated storage volume
    3. Document the volume available for use as a bank by other projects
    4. Perform calculations for individual sites, and apply to the bank
e. Water managed by the off-site mitigation does not have to come specifically from the new development/redevelopment project location, rather, it must be of equal volume (plus offset ratio).
f. Consideration shall also be made of the stream order and location within the watershed/creekshed/sewershed as it relates to the water quality impacts from the original project site *(e.g., the water quality impact from a site with a discharge to a small-sized stream would be greater than a site on a large river and an offset downstream of the project site may provide less water quality benefit.*)

Note: If the off-site mitigation bank does not already exist, it shall be constructed and completed within 24 months from the start of construction for the project requiring the off-site mitigation. If more time is needed, prior approval from EGLE is required. There is no time limit for use of a created mitigation bank, as it pertains to future projects that wish to utilize credits from a previously constructed mitigation bank. If a created bank can take stormwater off-line in advance of a project, and chooses to do so, it shall be clearly tracked as to the volume being taken off-line, and that volume (including the required offset ratios) shall be applied to future development (i.e., a bank can be used now to help improve a receiving water, but that volume shall be available for credit to a future construction project).

Off-site mitigation long-term operation and maintenance & tracking

a. Any control that is installed to meet requirements of this permit shall remain in-place and be properly maintained in perpetuity. If a required stormwater control needs to be removed and relocated off-site due to, for example, future development needs, the replacement controls shall follow the above off-site mitigation strategy. If a control is being replaced as maintenance, relocated on-site, or the control is being changed to a different style (for example, an infiltration basin becomes in-ground retention, or porous pavement is replace by standard pavement, but the volume mitigated by porous is properly managed on-site by an alternate control), then it shall meet the original channel protection requirements for that project.
b. Documentation of allocations will be kept in a database, and copies attached to the PCSM file for each project using the bank. A spreadsheet and/or a database shall be maintained by EHS to track all required stormwater controls, both off-site, and on-site.

Use of reduction in impervious as a bank

This option has limited use at the U-M as the campus is generally growing. There are some instances when a significant amount of impervious is removed. In those cases (usually for sites >1acre), the U-M plans to track these reductions for use as an offset for future build-out (either at the same location, or within the 10 digit HUC, and preferably within the same creekshed).

a. The volume and rate of stormwater banking shall be calculated by using an approved curve number method as described above to determine the reduction in runoff volume and rate.
b. This volume and rate will be available for use by future projects, with the appropriate offset of 1:1.2 applied (if credit to be taken at a different location than the reduction in impervious occurred).
c. There will be no offset required if the bank is used to meet future needs at the same location that caused the banking.

Operation & Maintenance Plans

All structural and vegetative BMPs/SCMs installed as a requirement under this section of the permit shall include a plan for maintaining maximum design performance through long-term operation and maintenance.

Environment, Health & Safety department at each campus will facilitate inspections (as needed) of the BMPs/SCMs, and report the findings to the facility manager(s) for remedy.

More frequent inspections of SCMs may be required, based on the O&M plan. All inspections, other than annual inspections, shall be the responsibility of the facility manager. A copy of all inspection reports shall be forwarded to the appropriate campus EHS department, as applicable, for recordkeeping.

Project Submittals

Development of the Post-Construction Plan for Stormwater Management is part of the formal U-M project review process. For each of the major phases of design (i.e. Schematic Phase, Design Development Phase, and Construction Document Phase), the Project Team (AEC, developer, and/or contractor) shall follow the stormwater management procedures as indicated in the Design Deliverables document and Stormwater Management Procedure document. The Project Team, with assistance by the Stormwater Management Team (representatives from EHS and AEC), sets the stormwater management requirements and goals at the pre-design phase to ensure that stormwater management is incorporated early into the planning process.

The Project Team shall submit the Post-Construction Plan for Stormwater Management to EHS-Ann Arbor for review and comment and ensure that the plan and all supporting information are deemed acceptable prior (preferably) to beginning any earth disturbance. The post-construction stormwater management plan shall include all calculations, BMP/SCM details, stormwater system details, site plan, TSS designed removal rates, and the O&M plan

It is required that a Professional Engineer familiar with the project certifies that the design meets the minimum treatment volume standard and channel protection criteria required by the NPDES permit.

A second certification from the engineer is required after construction has been completed, stating that the as-built conditions meet the minimum treatment volume standard and channel protection criteria required by the NPDES permit, and outlined in the approved stormwater management plan.

Enforcement

EHS-Ann Arbor will administer and enforce the stormwater management program for U-M, including developing and maintaining procedures, guidance, information, etc. to aid U-M staff and contractors in complying with the post-construction requirements for stormwater management on regulated sites. Enforcement may include, but is not limited to: letters of warning, stop work orders, withholding Soil Erosion and Sedimentation Control permits, withholding payment to the contractor, etc. and shall be implemented with the participation of respective EHS departments, AEC, and other Project Managers at U-M.

Technical Support

All referenced regulations and other documents are available through the EHS – Ann Arbor Environmental Protection Permitting Program (734-647-1143) or email stormwater@umich.edu.

Referenced Documents

U-M, EP3

- Attachment A – U-M Stormwater Discharge Permit (NPDES)
- Attachment B – 90 Percent Annual Non-Exceedance Storms, March 2006 – MDEQ
- Attachment C – NOAA Atlas 14 Point Precipitation Frequency Estimates – NOAA
- Attachment D – Computing Flood Discharges for Small Ungaged Watersheds, June 2010 - MDNRE
- Attachment E – Post-Construction Stormwater Worksheet
- Attachment F – TR-55 CN Tables 2-2a through 2-2d
- Attachment G – Detention in Lieu Flowchart
- Attachment H – Ann Arbor 10 Digit HUC Map

U-M, AEC

- Design Deliverables
- Stormwater Management Procedure

Federal Regulations

- Federal Water Pollution Control Act, as amended (33 U.S.C. 1251 et seq.)

Michigan Regulations

- Michigan Act 451, Public Acts 1994, as amended, Part 31.
- Michigan Executive Orders 1991-31, 1995-4, and 1995-18.

Revision History

REVISION #	DATE	REVISION #	DATE	REVISION #	DATE	REVISION #	DATE
1	1/5/2014	3	03/08/2021				
2	4/16/18	4	06/03/2025				

Attachment A

U-M NPDES Stormwater Permit

PERMIT NO. MI0053902

STATE OF MICHIGAN
DEPARTMENT OF ENVIRONMENT, GREAT LAKES, AND ENERGY

AUTHORIZATION TO DISCHARGE UNDER THE NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM

In compliance with the provisions of the federal Clean Water Act (federal Water Pollution Control Act, 33 U.S.C., Section 1251 *et seq*., as amended); Part 31, Water Resources Protection, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended (NREPA); Part 41, Sewerage Systems, of the NREPA; and Michigan Executive Order 2019-06,

The Regents of the University of Michigan
Environmental Health and Safety
1239 Kipke Drive
Ann Arbor, MI 48109

is authorized to discharge from the Municipal Separate Storm Sewer System (MS4)

designated as **UM MS4-Washtenaw**

to surface waters of the state of Michigan in accordance with effluent limitations, monitoring requirements, and other conditions set forth in this permit.

This permit takes effect on October 1, 2025. This permit is based on a complete application submitted on December 26, 2006, as amended through June 6, 2025.

The provisions of this permit are severable. After notice and opportunity for a hearing, this permit may be modified, suspended, or revoked in whole or in part during its term in accordance with applicable laws and rules. On its effective date this permit shall supersede National Pollutant Discharge Elimination System (NPDES) Permit No. MI0053902 (expiring October 1, 2006).

This permit and the authorization to discharge shall expire at midnight, **October 1, 2028**. In order to receive authorization to discharge beyond the date of expiration, the permittee shall submit an application which contains such information, forms, and fees as are required by the Department of Environment, Great Lakes, and Energy (Department) by **April 4, 2028**.

Issued: September 28, 2025.

Original signed by Christine Alexander
Christine Alexander, Manager
Permits Section
Water Resources Division

PERMIT FEE REQUIREMENTS

In accordance with Section 324.3118 of the NREPA, the permittee shall make payment of an annual stormwater fee to the Department for each January 1 the permit is in effect regardless of occurrence of discharge. The permittee shall submit the fee in response to the Department's annual notice. Payment may be made electronically via the Department's MiEnviro Portal system. The MiEnviro Portal website is located at https://mienviro.michigan.gov/ncore/. Payment shall be submitted or postmarked by March 15 for notices mailed by February 1. Payment shall be submitted or postmarked no later than 45 days after receiving the notice for notices mailed after February 1.

Annual Permit Fee Classification: Municipal Stormwater – Institution

CONTACT INFORMATION

Unless specified otherwise, all contact with the Department required by this permit shall be made to the Jackson District Office of the Water Resources Division. The Jackson District Office is located at 301 East Louis Glick Highway, Jackson, MI 49201-1535, Telephone: 517-780-7690, Fax: 517-780-7855.

CONTESTED CASE INFORMATION

Any person who is aggrieved by this permit may file a sworn petition with the Michigan Administrative Hearing System within the Michigan Department of Licensing and Regulatory Affairs, c/o the Michigan Department of Environment, Great Lakes, and Energy, setting forth the conditions of the permit which are being challenged and specifying the grounds for the challenge. The Department of Licensing and Regulatory Affairs may reject any petition filed more than 60 days after issuance as being untimely.

PART I

Section A. Limitations and Monitoring Requirements

1. Authorized Discharges

a. Authorized Outfalls and Points of Discharge
This permit authorizes the discharge of stormwater from the permittee's MS4 to the surface waters of the state via the outfalls and points of discharge identified in the permittee's application and as modified in accordance with this permit. Such discharges shall be controlled and monitored by the permittee in accordance with this permit.

b. Nested MS4 Discharges
This permit authorizes the discharge of stormwater to surface waters of the state from a nested MS4 owned or operated by public bodies that include, but are not limited to, public school districts; public universities; airports; or county, state, or federal agencies. The permittee may request to modify permit coverage to add or remove a nested MS4 by submitting a request to the Department for approval. Modifications to the permit coverage may result in a permit modification, after opportunity for public comment.

c. Discharges Authorized Under Other National Pollutant Discharge Elimination System (NPDES) Permits
This permit does not prohibit the use of an MS4 for other discharges authorized under other NPDES permits, or equivalent Department approval under the NREPA or the Federal Act.

d. Water Quality Requirements
Discharges from the permittee's MS4 shall not cause or contribute to an exceedance of water quality standards in the receiving waters. This includes, but is not limited to, the requirement set forth in R 323.1050 of the Water Quality Standards stating that the receiving waters shall not have any of the following unnatural physical properties as a result of the discharge, in quantities which are or may become injurious to any designated use: turbidity, color, oil films, floating solids, foams, settleable solids, suspended solids, or deposits.

2. Outfall or Point of Discharge Identified, Constructed, or Installed After Permit Issuance

a. Outfall or Point of Discharge Within the Permittee's Regulated Area
Authorization from the Department is required to discharge stormwater to a surface water of the state from a permittee owned or operated outfall or point of discharge identified, constructed, or installed after issuance but during the term of this permit and located within the permittee's regulated area as identified in the application. For each outfall or point of discharge identified, constructed, or installed after issuance but during the term of this permit, the permittee shall request authorization to discharge stormwater by providing the following to the Department in a written request:

1) whether the discharge is from an outfall or point of discharge;

2) the outfall or point of discharge identification number assigned by the permittee;

3) the surface water of the state receiving the discharge from the outfall or point of discharge;

4) a certification statement that the outfall or point of discharge is within the permittee's regulated area as identified in the application;

5) a certification statement that the previously approved Stormwater Management Program (Part I.A.3. of this permit) includes best management practices (BMPs) to comply with the minimum requirements of the permit for the outfall or point of discharge; and

PART I

Section A. Limitations and Monitoring Requirements

6) a certification statement that the previously approved Stormwater Management Program (Part I.A.3. of this permit) is being implemented in the regulated area served by the outfall or point of discharge, including having available an up-to-date storm sewer system map required in Part I.A.3.d.1) of this permit.

b. Outfall or Point of Discharge Outside the Permittee's Regulated Area
Authorization from the Department is required to discharge stormwater to a surface water of the state from a permittee owned or operated outfall or point of discharge identified, constructed, or installed after issuance but during the term of this permit and located outside the permittee's regulated area as identified in the application (e.g., area served by an expanded MS4 or area previously served by a combined sewer system that is now separated). For each outfall or point of discharge identified, constructed, or installed after issuance but during the term of this permit, the permittee shall request authorization to discharge stormwater by providing the following to the Department in a written request:

1) whether the discharge is from an outfall or point of discharge;

2) the outfall or point of discharge identification number assigned by the permittee;

3) the surface water of the state receiving the discharge from the outfall or point of discharge;

4) a map identifying the expanded regulated area served by the permittee's MS4;

5) a certification statement that the previously approved Stormwater Management Program (Part I.A.3. of this permit) includes BMPs to comply with the minimum requirements of the permit for the outfall or point of discharge and expanded regulated area; and

6) a certification statement that the previously approved Stormwater Management Program (Part I.A.3. of this permit) is being implemented in the expanded regulated area served by the outfall or point of discharge, including having available an up-to-date storm sewer system map as required in Part I.A.3.d.1) of this permit.

c. Upon review of the request to authorize the discharge from an outfall or point of discharge identified, constructed, or installed after issuance but during the term of this permit in accordance with Part I.A.2.a. or Part I.A.2.b. of this permit, the Department may determine that a permit modification is required, after opportunity for public comment. The Department will notify the permittee if a modification is required.

3. Stormwater Management Program (SWMP)

The permittee submitted a SWMP with its application for an NPDES permit. The SWMP is approved as submitted. The permittee shall implement the approved SWMP to comply with the minimum requirements identified in this permit. The SWMP shall cover the regulated area served by, or otherwise contributing to discharges from, the MS4 owned or operated by the permittee identified in the application. The permittee shall implement and enforce the SWMP to reduce the discharge of pollutants from the MS4 to the maximum extent practicable, to protect water quality, and to satisfy the appropriate water quality requirements of the NREPA and the Federal Act. The approved SWMP is an enforceable part of this permit and any Department approved modifications made to the SWMP shall also become enforceable parts of this permit.

a. Enforcement Response Procedure (ERP)
The permittee shall implement the ERP for violations of the permittee's ordinances or regulatory mechanisms identified in the SWMP to the maximum extent practicable. The ERP shall be implemented to compel compliance with the permittee's ordinances and/or regulatory mechanisms and to deter continuing violations.

PART I

Section A. Limitations and Monitoring Requirements

The permittee shall track and document all enforcement conducted pursuant to the permittee's ERP. At a minimum, the permittee shall track and document the following: the name of the person responsible for violating the permittee's ordinance or regulatory mechanism; the date and location of the violation; a description of the violation; a description of the enforcement response used; a schedule for returning to compliance; and the date the violation was resolved.

b. Public Participation/Involvement Program (PPP)
The permittee shall implement the PPP to encourage public participation/involvement in the implementation and periodic review of the SWMP to the maximum extent practicable. The permittee shall implement the PPP as part of the SWMP. The permittee has chosen to work collaboratively with watershed or regional partners to implement the PPP or part of the PPP, therefore each permittee working collaboratively is responsible for complying with the PPP as described in the SWMP.

The PPP requires implementation of the following minimum requirements:

1) The procedure for making the SWMP available for public inspection and comment, including complying with local public notice requirements, as appropriate; and

2) The procedure for inviting public participation and involvement in the implementation and periodic review of the SWMP.

c. Public Education Program (PEP)
The permittee shall implement the PEP as part of the SWMP to the maximum extent practicable. At the minimum, the PEP shall promote, publicize, and facilitate education for the purpose of encouraging the public to reduce the discharge of pollutants in stormwater runoff. The PEP shall be implemented to achieve measurable improvements in the public's understanding of stormwater pollution and efforts to reduce the impacts of stormwater pollution. The permittee has chosen to work collaboratively with watershed or regional partners to implement the PEP or part of the PEP, therefore each permittee working collaboratively is responsible for complying with the PEP as described in the SWMP.

The permittee shall implement the PEP in accordance with the procedure for prioritizing the following PEP topics based on high-priority, community-wide issues and targeted issues to reduce pollutant loads to stormwater to the maximum extent practicable.

The PEP requires implementation of the following minimum requirements:

1) BMPs to address the following PEP topics:

(a) Promote public responsibility and stewardship in the permittee's watershed.

(b) Inform and educate the public about the connection of the MS4 to area waterbodies and the potential impacts discharges can have on surface waters of the state.

(c) Educate the public on illicit discharges and promote public reporting on illicit discharges and improper disposal of materials into the MS4.

(d) Promote preferred cleaning materials and procedures for car, pavement, and power washing.

(e) Inform and educate the public on proper application and disposal of pesticides, herbicides, and fertilizers.

(f) Promote proper disposal practices for grass clippings, leaf litter, and animal wastes that may enter into the MS4.

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(g) Identify and promote the availability, location, and requirements of facilities for collection or disposal of household hazardous wastes, travel trailer sanitary wastes, chemicals, and motor vehicle fluids.

(h) Educate the public on, and promote the benefits of, green infrastructure and Low Impact Development.

(i) Identify and educate commercial, industrial, and institutional entities likely to contribute pollutants to stormwater runoff.

2) The procedure for determining the overall effectiveness of implementation and the process for modifying the PEP to address ineffective implementation. The Department may determine that a permit modification is required, after opportunity for public comment, based on modifications to the PEP. The Department will notify the permittee if a modification is required.

d. Illicit Discharge Elimination Program (IDEP)
The permittee shall implement and enforce the IDEP to detect and eliminate illicit discharges and connections to the permittee's MS4. The permittee shall implement the IDEP as part of the SWMP to the maximum extent practicable. The permittee has chosen to work collaboratively with watershed or regional partners to implement the IDEP or part of the IDEP, therefore each permittee working collaboratively is responsible for complying with the IDEP as described in the SWMP.

The IDEP requires implementation of the following minimum requirements:

1) An available, up-to-date storm sewer system map identifying the following: the storm sewer system, location of all outfalls and points of discharge the permittee owns or operates in the regulated area, and the names and location of all surface waters of the state that receive discharges from the permittee's MS4. The map shall be retained by the permittee and made available to the Department upon request. The map shall be maintained and updated as outfalls and points of discharge are identified, constructed, and installed in accordance with Part I.A.2. of this permit.

2) The plan to detect and eliminate non-stormwater discharges to the permittee's MS4, including illegal dumping/spills. The plan includes the following:

a) A procedure for identifying priority areas for field observations. The permittee shall conduct field observations in accordance with the procedure identifying the priority area(s) developed as part of the IDEP.

b) A procedure for conducting field observations, field screening, and source investigations. The permittee shall conduct a field observation in accordance with the procedure during dry-weather at least once during the term of the permit. Field screening and source investigation shall be conducted in accordance with the schedule in the procedure.

Field observations, field screening, and source investigations shall include the following:

(1) Field Observation – The permittee shall observe the outfall or point of discharge for the following during dry-weather in accordance with the procedure: presence/absence of flow, water clarity, color, odor, floatable materials, deposits/stains on the discharge structure and bank, vegetation condition, structural condition, and biology (e.g. bacterial sheens, algae, and slimes).

(2) Field Screening – If flow is observed at an outfall or point of discharge, the permittee shall analyze the flow for the indicator parameters identified in the procedure. If the source of an illicit discharge is identified during the field observation, field screening may not be necessary.

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(3) Source Investigation – If the source of the illicit discharge was not identified by the field screening, the permittee shall conduct an investigation to identify the source in accordance with the procedure. If the permittee opts to use tracer dyes, the discharge of the dyes shall be authorized in accordance with Part I.A.6. of this permit.

If the permittee is made aware of non-stormwater discharges outside the priority areas, illegal dumping/spills, or complaints received, the permittee shall conduct field observations and follow-up field screening and source investigations as appropriate in accordance with the procedure, including the schedule, in the IDEP. The permittee shall immediately report any release of any polluting material which occurs to the surface waters or groundwaters of the state in accordance with Part II.C.7. of this permit.

c) A procedure for responding to illicit discharges and pursuing enforcement action. The permittee shall implement the procedure to respond and pursue enforcement action once the source of the illicit discharge is identified, including the corrective action required to eliminate the illicit discharge. The permittee shall also implement the procedure to respond to illegal spills/dumping. For each illicit discharge not eliminated within 90 days of its discovery, the permittee shall provide, with the next progress report due, a written certification that the illicit discharge was eliminated or a description of how the illicit discharge will be eliminated.

3) The employee training program, which includes the following:

a) Training on techniques for identifying illicit discharges and connections, including field observations, field screening, and source investigations;

b) Training on procedures for reporting, responding to, and eliminating an illicit discharge or connection and the proper enforcement response; and

c) A schedule and requirement for training at least once during the term of the permit for existing staff and **within the first year** of hire for new staff.

4) The procedure for IDEP evaluation and determining the overall effectiveness of the IDEP.

e. Construction Stormwater Runoff Control Program

The permittee shall implement the construction stormwater runoff control program to address areas of construction activity that disturb one (1) or more acres, including projects less than one (1) acre that are part of a larger common plan of development or sale. The permittee shall implement the construction stormwater runoff control program as part of the SWMP to the maximum extent practicable.

The construction stormwater runoff control program requires implementation of the following minimum requirements:

1) The procedure to notify the Part 91 Agency, or appropriate staff (if the permittee is a Part 91 Agency), when soil or sediment is discharged to the permittee's MS4 from a construction activity.

2) The procedure to notify the Department when soil, sediment, or other pollutants are discharged to the permittee's MS4 from a construction activity.

3) The procedure for ensuring that construction activity one (1) acre or greater in total earth disturbance with the potential to discharge to the permittee's MS4 obtains a Part 91 permit or is conducted by an approved Authorized Public Agency, as appropriate.

4) The procedure to advise the landowner or recorded easement holder of the State of Michigan Permit by Rule (R 323.2190 of the Part 21 Rules promulgated pursuant to Part 31 of the NREPA).

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f. Post-Construction Stormwater Runoff Program

The permittee shall implement and enforce the program to address post-construction stormwater runoff from new development and redevelopment projects that disturb one (1) or more acres, including projects less than one (1) acre that are part of a larger common plan of development or sale, and that discharge into the permittee's MS4. The permittee shall implement and enforce the post-construction stormwater control program as part of the SWMP, to the maximum extent practicable and in accordance with the approved ordinance or regulatory mechanism.

1) The permittee shall implement and enforce the ordinance or regulatory mechanism requiring implementation of BMPs to achieve to the maximum extent practicable the following post-construction stormwater runoff performance standards at the project site, including projects where the permittee is the project developer:

a) Water Quality Treatment Performance Standard
Treat the first one (1) inch of runoff from the entire site or treat the runoff generated from 90 percent of all runoff-producing storms. BMPs shall be designed on a site-specific basis to achieve a minimum of 80 percent removal of total suspended solids (TSS) as compared with uncontrolled runoff or a discharge concentration of TSS not to exceed 80 milligrams per liter (mg/l).

b) Channel Protection Performance Standard
The post-construction runoff rate and volume of discharges shall not exceed the pre-development rate and volume for the project site for all storms up to the two-year, 24-hour storm.

2) The permittee shall implement and enforce the following site-specific requirements as part of meeting the post-construction stormwater runoff performance standards set forth in a) and b), above:

a) The procedure for reviewing the use of infiltration BMPs to achieve the performance standards in areas of soil or groundwater contamination in a manner that does not exacerbate existing conditions.

b) The ordinance or regulatory mechanism requiring BMPs to address the associated pollutants in potential hot spots as part of meeting the performance standards. Hot spots include areas with the potential for significant pollutant loading including, but not limited to, the following: gas stations; vehicle maintenance and repair; auto recyclers; recycling centers and scrap yards; landfills; solid waste facilities; and railroads. Hot spots also include areas with the potential for contaminating public water supply intakes.

3) For projects that cannot meet 100 percent of the performance standards on site, the permittee is allowed to implement and enforce the ordinance approving the following alternative: off-site mitigation to allow for BMPs to be implemented at another location within the same jurisdiction and watershed as the original project site. The permittee shall implement a tracking system to track the alternative.

4) All structural and vegetative BMPs installed and implemented to meet the performance standards shall be operated and maintained in perpetuity. The permittee shall implement and enforce the ordinance or regulatory mechanism program to ensure long-term operation and maintenance of BMPs.

5) The ordinance or regulatory mechanism and procedures for site plan review and approval for projects that disturb one (1) or more acres, including projects less than one (1) acre that are part of a larger common plan of development or sale, and discharge to the permittee's MS4, including projects where the permittee is the developer. The site plan review and approval shall demonstrate compliance with the performance standards and long-term operation and maintenance requirements of this permit.

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g. Pollution Prevention and Good Housekeeping Activities for Municipal Operations
The permittee shall implement the pollution prevention and good housekeeping program with the goal of preventing or reducing pollutant runoff from municipal facilities and operations that discharge stormwater to surface waters of the state. The permittee shall implement the program as part of the SWMP to the maximum extent practicable.

1) Municipal Facility and Structural Stormwater Control Inventory
The permittee shall make available to the Department upon request an up-to-date map or maps of the facilities and structural stormwater controls owned or operated by the permittee with a discharge to surface waters of the state in the regulated area. In accordance with the procedure for updating and revising the permittee's facility inventory and map(s), the permittee shall submit to the Department the type and location for any new facility obtained or constructed during this permit term with a discharge of stormwater to surface waters of the state and the information requested in Part I.A.2. of the permit.

2) Facility-Specific Stormwater Management
The permittee shall implement the facility-specific standard operating procedure (SOP) for each facility the permittee identified as having the high potential to discharge pollutants to surface waters of the state. The permittee shall implement the BMPs identified in the procedure to prevent or reduce pollutant runoff at each facility the permittee identified as having the medium or low potential to discharge pollutants to surface waters of the state. The permittee shall assess new facilities for the potential to discharge pollutants to surface waters of the state in accordance with the procedure to determine a priority level. High-priority facilities shall include permittee-owned or operated fleet maintenance and storage yards unless a demonstration is submitted and approved by the Department demonstrating how the permittee's fleet maintenance or storage yard has the low potential to discharge pollutants to surface waters of the state. The assessment shall be submitted in writing to the Department for approval **within 30 days** of ownership or operation of the new facility. The permittee shall certify in writing to the Department that a facility-specific SOP is being implemented **within 90 days** of ownership or operation of a new high-priority facility. **Within 90 days** of ownership or operation, the permittee shall certify in writing to the Department that BMPs are being implemented in accordance with the procedure developed to prevent or reduce pollutant runoff at each new medium- or low-priority facility. For new facilities, the Department may determine that a permit modification is required, after opportunity for public comment. The Department will notify the permittee if a modification is required. The permittee shall document all other changes to the facility assessment as part of the progress report and as an update to the procedure.

The facility-specific SOP shall be kept at the site described in the SOP and made available upon request by the Department. The facility-specific SOP for each high-priority facility shall include implementation of the following.

a) Structural and non-structural stormwater controls to prevent or reduce the discharge of pollutants to surface waters of the state.

b) Up-to-date list of significant materials stored on-site that could pollute stormwater with a description of the handling and storage requirements and potential to discharge for each significant material.

c) Good housekeeping practices including, but not limited to, maintaining a clean and orderly facility, properly storing and covering materials, and minimizing pollutant sources to prevent or reduce pollutant runoff.

d) Routine maintenance and inspections of stormwater management and control devices to ensure materials and equipment are clean and orderly and prevent or reduce pollutant runoff. The written report of the inspection and corrective actions shall be retained in accordance with Part II.B.5. of this permit.

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Section A. Limitations and Monitoring Requirements

e) Comprehensive site inspections at least once **every six (6) months**. The comprehensive site inspection shall include an inspection of all structural stormwater controls and a review of non-structural stormwater controls to prevent or reduce pollutant runoff. A written report of the inspection and corrective actions shall be retained in accordance with Part II.B.5. of this permit.

3) Structural Stormwater Control Operation and Maintenance Activities

a) The permittee shall implement the procedures for inspecting, cleaning, and maintaining permittee-owned or operated catch basins in the regulated area using the priority level assigned to each catch basin. The permittee shall document changes to the priority level for a catch basin as part of the progress report and as an update to the procedure.

The permittee shall also implement the procedure for dewatering and disposal of materials extracted from the catch basins in accordance with Part 111 (Hazardous Waste), Part 115 (Solid Waste), and Part 121 (Liquid Industrial Waste) of the NREPA.

b) The permittee shall implement the procedure for inspecting and maintaining permittee-owned or operated structural stormwater controls other than catch basins in the regulated area. The permittee shall document changes to the procedure as part of the progress report and as an update to the procedure.

c) The permittee shall implement the procedure requiring that new permittee-owned or operated facilities or structural stormwater controls to address water quantity be designed and implemented in accordance with the post-construction stormwater runoff performance standards and long-term operation and maintenance requirements in Part I.A.3.f. of this permit.

4) Municipal Operations and Maintenance Activities

a) The permittee shall implement the procedure, including the BMPs identified, to prevent or reduce pollutant runoff from the permittee's operation and maintenance activities identified in the SWMP. The permittee shall document changes to the assessment of operation and maintenance activities for the potential to discharge pollutants to surface waters of the state as part of the progress report and as an update to the procedure.

b) The permittee shall implement the procedure for the street sweeping program for permittee-owned or operated streets, parking lots, or other impervious infrastructure in the regulated area using the sweeping methods and assigned priority levels identified in the procedure. The permittee shall document changes to the priority level for a street, parking lot, or other impervious infrastructure as part of the progress report and as an update to the procedure.

The permittee shall also implement the procedure for dewatering and disposal of street sweeper waste material.

5) Managing Vegetated Properties

The permittee shall implement the procedure requiring the permittee's pesticide applicator to be certified by the State of Michigan as an applicator in the applicable category, to prevent or reduce pollutant runoff from vegetated land.

6) Employee Training

The permittee shall implement the employee training program to train employees involved in implementing pollution prevention and good housekeeping activities. At a minimum, existing staff shall be trained once during the permit cycle and new hire employees **within the first year** of their hire date.

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Section A. Limitations and Monitoring Requirements

7) Contractor Requirements and Oversight
The permittee shall implement the procedure requiring contractors hired by the permittee to perform municipal operation and maintenance activities that comply with the permittee's pollution prevention and good housekeeping program and contractor oversight to ensure compliance.

h. Total Maximum Daily Load (TMDL) Implementation Plan
The permittee shall implement the TMDL Implementation Plan to reduce the discharge of pollutants from the permittee's MS4 to make progress in meeting Water Quality Standards. The permittee shall implement the TMDL Implementation Plan as part of the SWMP. The permittee has chosen to work collaboratively with watershed or regional partners to implement this plan or part of the plan, therefore each permittee is responsible for complying with the plan as described in the SWMP.

The following TMDL is applicable to the discharge from the permittee's MS4:

Name of TMDL	**Pollutant of Concern**
Ford Lake and Belleville Lake	Phosphorus
Geddes Pond	*E. coli*
Malletts Creek	Biota (sediment)
Statewide *E. coli*	*E. coli*

The permittee shall implement the prioritized BMPs included in the TMDL Implementation Plan during the permit cycle to make progress in achieving the pollutant load reduction requirement in the TMDL. The permittee shall review, update, and revise the list of BMPs implemented as part of the TMDL Implementation Plan in accordance with the procedure included in the SWMP. The Department may determine that a permit modification is required, after opportunity for public comment, based on modifications to the TMDL Implementation Plan. The Department will notify the permittee if a modification is required.

The permittee shall implement the monitoring plan included in the TMDL Implementation Plan for assessing the effectiveness of the BMPs implemented in making progress toward achieving the TMDL pollutant load reduction. Available monitoring data shall be submitted with each progress report.

4. SWMP Modifications

a. SWMP Modifications Requested by the Permittee
Modifications to the previously approved SWMP may be requested by the permittee as follows:

1) Modifications adding BMPs (but not replacing, subtracting, or affecting the level of implementation of any other BMP) to the previously approved SWMP may be made by the permittee at any time upon written notification to the Department. Notification shall include a description of the modification, which may include a description of a new BMP with a corresponding measurable goal. Upon notification to the Department, the modification is considered an enforceable part of the approved SWMP.

2) Modifications replacing an ineffective or unfeasible BMP identified in the previously approved SWMP with an alternative BMP may be requested at any time by written notification to the Department. The ineffective or unfeasible BMP identified shall not be replaced in the previously approved SWMP unless the replacement is approved by the Department. Modifications to the previously approved SWMP may result in a permit modification after opportunity for public comment. Such requests shall include the following:

a) an analysis of why the BMP is ineffective or unfeasible (including cost-prohibitive);

b) a measurable goal for the replacement BMP; and

c) an analysis of why the replacement BMP is expected to achieve the intent of the BMP to be replaced.

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Section A. Limitations and Monitoring Requirements

3) Modifications subtracting an ineffective or unfeasible BMP identified in the previously approved SWMP may be requested by written notification to the Department. The identified BMP shall not be subtracted from the previously approved SWMP unless the subtraction is approved by the Department. Modifications to the previously approved SWMP may result in a permit modification after opportunity for public comment. Such requests shall include the following:

a) an analysis of why the BMP is ineffective or unfeasible (including cost prohibitive); and

b) a determination of why the removal of the BMP will not change the permittee's ability to comply with the permit requirements.

b. Modifications Required by the Department
The Department may require the permittee to modify the SWMP as needed to:

1) address contributions from the permittee's MS4 discharge that impair receiving water quality;

2) include more stringent requirements necessary to comply with new state or federal statutory or regulatory requirements; and/or

3) include such other conditions deemed necessary by the Department to comply with the goals and requirements of the Federal Act or the NREPA, including the requirement to reduce the discharge of pollutants from the MS4 to the maximum extent practicable.

5. Request for Approval to Use Water Treatment Additives

This permit does not authorize the use of any water treatment additive without prior written approval from the Department. Such approval is authorized under separate correspondence. Water treatment additives include any materials that are added to water used at the facility, or to wastewater generated by the facility, to condition or treat the water. Permittees proposing to use water treatment additives, including a proposed increased concentration of a previously approved water treatment additive, shall submit a request for approval via the Department's MiEnviro Portal system. The MiEnviro Portal website is located at https://mienviro.michigan.gov/ncore/. Instructions for submitting such a request may be obtained at https://www.michigan.gov/eglenpdes (near the center of that page, click on one or both links). Additional monitoring and reporting may be required as a condition of approval to use the water treatment additive.

A request for approval to use water treatment additives shall include all of the following usage and discharge information for each water treatment additive proposed to be used:

a. The Safety Data Sheet (SDS);

b. Ingredient information, including the name of each ingredient, CAS number for each ingredient, and fractional content by weight for each ingredient;

c. The proposed water treatment additive discharge concentration with supporting calculations;

d. The discharge frequency (i.e., number of hours per day and number of days per year);

e. The outfall(s) and monitoring point(s) from which the water treatment additive is to be discharged;

f. The type of removal treatment, if any, that the water treatment additive receives prior to discharge;

g. The water treatment additive's function (i.e., microbiocide, flocculant, etc.);

h. The SDS shall include a 48-hour LC50 or EC50 for a North American freshwater planktonic crustacean (either *Ceriodaphnia sp*., *Daphnia sp*., or *Simocephalus sp*.). The results shall be based on the whole water treatment additive, shall not be results based on a similar product, and shall not be estimated; and

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Section A. Limitations and Monitoring Requirements

i. The SDS shall include the results of a toxicity test for one (1) other North American freshwater aquatic species (other than a planktonic crustacean) that meets a minimum requirement of R 323.1057(2) of the Water Quality Standards. The results shall be based on the whole water treatment additive, shall not be results based on a similar product, and shall not be estimated. Examples of tests that would meet this requirement include a 96-hour LC50 for rainbow trout, bluegill, or fathead minnow.

6. Tracer Dye Discharges

This permit does not authorize the discharge of tracer dyes without approval from the Department. Requests to discharge tracer dyes shall be submitted to the Department in accordance with Rule 1097 (R 323.1097 of the Michigan Administrative Code).

7. Stormwater Program Manager (Facility Contact)

The "Facility Contact" was specified in the application. The permittee may replace the facility contact at any time, and shall notify the Department in writing **within 10 days** after replacement (including the name, address and telephone number of the new facility contact).

a. The facility contact shall be (or a duly authorized representative of this person):
- for a corporation, a principal executive officer of at least the level of vice president; or a designated representative if the representative is responsible for the overall operation of the facility from which the discharge originates, as described in the permit application or other NPDES form,
- for a partnership, a general partner,
- for a sole proprietorship, the proprietor, or
- for a municipal, state, or other public facility, either a principal executive officer, the mayor, village president, city or village manager or other duly authorized employee.

b. A person is a duly authorized representative only if:
- the authorization is made in writing to the Department by a person described in paragraph a. of this section; and
- the authorization specifies either an individual or a position having responsibility for the overall operation of the regulated facility or activity such as the position of plant manager, operator of a well or a well field, superintendent, position of equivalent responsibility, or an individual or position having overall responsibility for environmental matters for the facility (a duly authorized representative may thus be either a named individual or any individual occupying a named position).

Nothing in this section obviates the permittee from properly submitting reports and forms as required by law.

PART I

Section B: Program Assessment and Reporting

1. Progress Reports

Progress reports shall be submitted **on or before March 1, 2026, and on or before March 1 every year following**. The Department may approve alternate dates for progress report submittal if requested and adequately justified by the permittee. Each progress report shall contain the following information for the entire period that has elapsed since the last progress report submittal (i.e., the reporting cycle):

a. Compliance Assessment
The permittee shall describe the status of compliance with the approved SWMP identified in Part I.A.3 of this permit. The permittee shall assess and describe the appropriateness of the BMPs identified in the SWMP. The report shall describe the progress made towards achieving the identified measurable goals for each of the BMPs, and specific evaluation criteria as follows:

1) For the PEP, provide a summary of the evaluation of the overall effectiveness of the PEP, using the evaluation methods described in the PEP.

2) For the IDEP, provide a summary of the evaluation and determination of the overall effectiveness of the IDEP, using the evaluation methods described in the IDEP. For each illicit discharge that was not eliminated within 90 days of its discovery the permittee shall provide a written certification that the illicit discharge was eliminated or a description of how the illicit discharge will be eliminated.

3) If applicable, the permittee shall submit to the Department any new outfall or point of discharge information as required in Part I.A.2. of this permit.

4) For the TMDL Implementation Plan, if monitoring data is available in accordance with the monitoring plan, provide an assessment of progress made toward achieving the TMDL pollutant load reduction requirement.

b. Data and Results
The permittee shall provide a summary of all of the information collected and analyzed, including monitoring data, if any, during the reporting cycle.

c. Upcoming Activities
The permittee shall provide a summary of the BMPs to be implemented during the next reporting cycle.

d. Changes to BMPs and Measurable Goals
The permittee shall describe any changes to BMPs or measurable goals in the approved SWMP. In accordance with the permit, these changes will be reviewed to determine if a permit modification is necessary. The Department will notify the permittee if a permit modification is required.

e. Notice of Changes in Nested Jurisdiction Agreements
The permittee shall identify any nested jurisdictions that enter into or terminate permit agreements with the permittee which were not identified in the SWMP. The permittee may request to modify the permit coverage to add or remove a nested MS4 by submitting a request to the Department for approval in accordance with Part I.A.1.b. of this permit. Modifications to the permit coverage may result in a permit modification, after opportunity for public comment.

f. Required Signatures
All reports required by this permit, and other information requested by the Department, shall be signed by either a principal executive officer or ranking elected official, or by a duly authorized representative of that person in accordance with 40 CFR 122.22(b).

PART II

Part II may include terms and /or conditions not applicable to discharges covered under this permit.

Section A. Definitions

Acute toxic unit (TUA) means 100/LC50 where the LC50 is determined from a whole effluent toxicity (WET) test which produces a result that is statistically or graphically estimated to be lethal to 50% of the test organisms.

Annual monitoring frequency refers to a calendar year beginning on January 1 and ending on December 31. When required by this permit, an analytical result, reading, value or observation shall be reported for that period if a discharge occurs during that period.

Authorized public agency means a state, local, or county agency that is designated pursuant to the provisions of Section 9110 of Part 91, Soil and Sedimentation Control, of the NREPA, to implement soil erosion and sedimentation control requirements with regard to construction activities undertaken by that agency.

Best management practices (BMPs) means structural devices or nonstructural practices that are designed to prevent pollutants from entering into stormwater, to direct the flow of stormwater, or to treat polluted stormwater.

Bioaccumulative chemical of concern (BCC) means a chemical which, upon entering the surface waters, by itself or as its toxic transformation product, accumulates in aquatic organisms by a human health bioaccumulation factor of more than 1000 after considering metabolism and other physiochemical properties that might enhance or inhibit bioaccumulation. The human health bioaccumulation factor shall be derived according to R 323.1057(5). Chemicals with half-lives of less than 8 weeks in the water column, sediment, and biota are not BCCs. The minimum bioaccumulation concentration factor (BAF) information needed to define an organic chemical as a BCC is either a field-measured BAF or a BAF derived using the biota-sediment accumulation factor (BSAF) methodology. The minimum BAF information needed to define an inorganic chemical as a BCC, including an organometal, is either a field-measured BAF or a laboratory-measured bioconcentration factor (BCF). The BCCs to which these rules apply are identified in Table 5 of R 323.1057 of the Water Quality Standards.

Biosolids are the solid, semisolid, or liquid residues generated during the treatment of sanitary sewage or domestic sewage in a treatment works. This includes, but is not limited to, scum or solids removed in primary, secondary, or advanced wastewater treatment processes and a derivative of the removed scum or solids.

Bulk biosolids means biosolids that are not sold or given away in a bag or other container for application to a lawn or home garden.

CAFO means concentrated animal feeding operation.

Certificate of Coverage (COC) is a document, issued by the Department, which authorizes a discharge under a general permit.

Chronic toxic unit (TUC) means 100/MATC or 100/IC25, where the maximum acceptable toxicant concentration (MATC) and IC25 are expressed as a percent effluent in the test medium.

Class B biosolids refers to material that has met the Class B pathogen reduction requirements or equivalent treatment by a Process to Significantly Reduce Pathogens (PSRP) in accordance with the Part 24 Rules, Land Application of Biosolids, promulgated under Part 31 of the NREPA. Processes include aerobic digestion, composting, anaerobic digestion, lime stabilization and air drying.

Combined sewer system is a sewer system in which stormwater runoff is combined with sanitary wastes.

Composite sample is a sample collected over time, either by continuous sampling or by mixing discrete samples. A composite sample represents the average wastewater characteristics present during the compositing period. Various methods for compositing are available and are based on either time or flow-proportioning, the choice of which will depend on the permit requirements.

PART II

Section A. Definitions

Continuous monitoring refers to sampling/readings that occur at regular and consistent intervals throughout a 24-hour period and at a frequency sufficient to capture data that are representative of the discharge. The maximum acceptable interval between samples/readings shall be one (1) hour.

Daily concentration
FOR PARAMETERS OTHER THAN pH, DISSOLVED OXYGEN, TEMPERATURE, AND CONDUCTIVITY – Daily concentration is the sum of the concentrations of the individual samples of a parameter taken within a calendar day divided by the number of samples taken within that calendar day. The daily concentration will be used to determine compliance with any maximum and minimum daily concentration limitations. For guidance and examples showing how to report and perform calculations using results below quantification levels, see the document entitled "Reporting Results Below Quantification," available at https://www.Michigan.gov/-/Media/Project/Websites/EGLE/Documents/Programs/WRD/MiEnviro/Results-Below-Quantification.pdf.

FOR pH, DISSOLVED OXYGEN, TEMPERATURE, AND CONDUCTIVITY – The daily concentration used to determine compliance with maximum daily pH, temperature, and conductivity limitations is the highest pH, temperature, and conductivity readings obtained within a calendar day. The daily concentration used to determine compliance with minimum daily pH and dissolved oxygen limitations is the lowest pH and dissolved oxygen readings obtained within a calendar day.

Daily loading is the total discharge by weight of a parameter discharged during any calendar day. This value is calculated by multiplying the daily concentration by the total daily flow and by the appropriate conversion factor. The daily loading will be used to determine compliance with any maximum daily loading limitations. When required by the permit, report the maximum calculated daily loading for the month in the "MAXIMUM" column under "QUANTITY OR LOADING" on the DMRs.

Daily monitoring frequency refers to a 24-hour day. When required by this permit, an analytical result, reading, value or observation shall be reported for that period if a discharge occurs during that period.

Department means the Michigan Department of Environment, Great Lakes, and Energy.

Detection level means the lowest concentration or amount of the target analyte that can be determined to be different from zero by a single measurement at a stated level of probability.

Discharge means the addition of any waste, waste effluent, wastewater, pollutant, or any combination thereof to any surface water of the state.

EC_{50} means a statistically or graphically estimated concentration that is expected to cause 1 or more specified effects in 50% of a group of organisms under specified conditions.

Fecal coliform bacteria monthly
FOR WWSLs THAT COLLECT AND STORE WASTEWATER AND ARE AUTHORIZED TO DISCHARGE ONLY IN THE SPRING AND/OR FALL ON AN INTERMITTENT BASIS – Fecal coliform bacteria monthly is the geometric mean of all daily concentrations determined during a discharge event. Days on which no daily concentration is determined shall not be used to determine the calculated monthly value. The calculated monthly value will be used to determine compliance with the maximum monthly fecal coliform bacteria limitations. When required by the permit, report the calculated monthly value in the "AVERAGE" column under "QUALITY OR CONCENTRATION" on the DMR. If the period in which the discharge event occurred was partially in each of two months, the calculated monthly value shall be reported on the DMR of the month in which the last day of discharge occurred.

FOR ALL OTHER DISCHARGES – Fecal coliform bacteria monthly is the geometric mean of all daily concentrations determined during a reporting month. Days on which no daily concentration is determined shall not be used to determine the calculated monthly value. The calculated monthly value will be used to determine compliance with the maximum monthly fecal coliform bacteria limitations. When required by the permit, report the calculated monthly value in the "AVERAGE" column under "QUALITY OR CONCENTRATION" on the DMR.

PART II

Section A. Definitions

Fecal coliform bacteria 7-day
FOR WWSLs THAT COLLECT AND STORE WASTEWATER AND ARE AUTHORIZED TO DISCHARGE ONLY IN THE SPRING AND/OR FALL ON AN INTERMITTENT BASIS – Fecal coliform bacteria 7-day is the geometric mean of the daily concentrations determined during any 7 consecutive days of discharge during a discharge event. If the number of daily concentrations determined during the discharge event is less than 7 days, the number of actual daily concentrations determined shall be used for the calculation. Days on which no daily concentration is determined shall not be used to determine the value. The calculated 7-day value will be used to determine compliance with the maximum 7-day fecal coliform bacteria limitations. When required by the permit, report the maximum calculated 7-day geometric mean value for the month in the "MAXIMUM" column under "QUALITY OR CONCENTRATION" on the DMRs. If the 7-day period was partially in each of two months, the value shall be reported on the DMR of the month in which the last day of discharge occurred.

FOR ALL OTHER DISCHARGES – Fecal coliform bacteria 7-day is the geometric mean of the daily concentrations determined during any 7 consecutive days in a reporting month. If the number of daily concentrations determined is less than 7, the actual number of daily concentrations determined shall be used for the calculation. Days on which no daily concentration is determined shall not be used to determine the value. The calculated 7-day value will be used to determine compliance with the maximum 7-day fecal coliform bacteria limitations. When required by the permit, report the maximum calculated 7-day geometric mean for the month in the "MAXIMUM" column under "QUALITY OR CONCENTRATION" on the DMRs. The first calculation shall be made on day 7 of the reporting month, and the last calculation shall be made on the last day of the reporting month.

Flow-proportioned composite sample is a composite sample in which either a) the volume of each portion of the composite is proportional to the effluent flow rate at the time that portion is obtained; or b) a constant sample volume is obtained at varying time intervals proportional to the effluent flow rate.

General permit means an NPDES permit authorizing a category of similar discharges.

Geometric mean is the average of the logarithmic values of a base 10 data set, converted back to a base 10 number.

Grab sample is a single sample taken at neither a set time nor flow.

IC_{25} means the toxicant concentration that would cause a 25% reduction in a nonquantal biological measurement for the test population.

Illicit connection means a physical connection to a municipal separate storm sewer system that primarily conveys non-stormwater discharges other than uncontaminated groundwater into the storm sewer; or a physical connection not authorized or permitted by the local authority, where a local authority requires authorization or a permit for physical connections.

Illicit discharge means any discharge to, or seepage into, a municipal separate storm sewer system that is not composed entirely of stormwater or uncontaminated groundwater. Illicit discharges include non-stormwater discharges through pipes or other physical connections; dumping of motor vehicle fluids, household hazardous wastes, domestic animal wastes, or litter; collection and intentional dumping of grass clippings or leaf litter; or unauthorized discharges of sewage, industrial waste, restaurant wastes, or any other non-stormwater waste directly into a separate storm sewer.

Individual permit means a site-specific NPDES permit.

Inlet means a catch basin, roof drain, conduit, drain tile, retention pond riser pipe, sump pump, or other point where stormwater or wastewater enters into a closed conveyance system prior to discharge off site or into waters of the state.

PART II

Section A. Definitions

Interference is a discharge which, alone or in conjunction with a discharge or discharges from other sources, both: 1) inhibits or disrupts a POTW, its treatment processes or operations, or its sludge processes, use or disposal; and 2) therefore, is a cause of a violation of any requirement of the POTW's NPDES permit (including an increase in the magnitude or duration of a violation) or, of the prevention of sewage sludge use or disposal in compliance with the following statutory provisions and regulations or permits issued thereunder (or more stringent state or local regulations): Section 405 of the Clean Water Act, the Solid Waste Disposal Act (SWDA) (including Title II, more commonly referred to as the Resource Conservation and Recovery Act (RCRA), and including state regulations contained in any state sludge management plan prepared pursuant to Subtitle D of the SWDA), the Clean Air Act, the Toxic Substances Control Act, and the Marine Protection, Research and Sanctuaries Act. [This definition does not apply to sample matrix interference].

Land application means spraying or spreading biosolids or a biosolids derivative onto the land surface, injecting below the land surface, or incorporating into the soil so that the biosolids or biosolids derivative can either condition the soil or fertilize crops or vegetation grown in the soil.

LC_{50} means a statistically or graphically estimated concentration that is expected to be lethal to 50% of a group of organisms under specified conditions.

Maximum acceptable toxicant concentration (MATC) means the concentration obtained by calculating the geometric mean of the lower and upper chronic limits from a chronic test. A lower chronic limit is the highest tested concentration that did not cause the occurrence of a specific adverse effect. An upper chronic limit is the lowest tested concentration which did cause the occurrence of a specific adverse effect and above which all tested concentrations caused such an occurrence.

Maximum extent practicable means implementation of best management practices by a public body to comply with an approved stormwater management program as required by a national permit for a municipal separate storm sewer system, in a manner that is environmentally beneficial, technically feasible, and within the public body's legal authority.

MBTU/hr means million British Thermal Units per hour.

MGD means million gallons per day.

Monthly concentration is the sum of the daily concentrations determined during a reporting period divided by the number of daily concentrations determined. The calculated monthly concentration will be used to determine compliance with any maximum monthly concentration limitations. Days with no discharge shall not be used to determine the value. When required by the permit, report the calculated monthly concentration in the "AVERAGE" column under "QUALITY OR CONCENTRATION" on the DMR. For guidance and examples showing how to report and perform calculations using results below quantification levels, see the document entitled "Reporting Results Below Quantification," available at https://www.Michigan.gov/-/Media/Project/Websites/EGLE/Documents/Programs/WRD/MiEnviro/Results-Below-Quantification.pdf.

For minimum percent removal requirements, the monthly influent concentration and the monthly effluent concentration shall be determined. The calculated monthly percent removal, which is equal to 100 times the quantity [1 minus the quantity (monthly effluent concentration divided by the monthly influent concentration)], shall be reported in the "MINIMUM" column under "QUALITY OR CONCENTRATION" on the DMRs.

Monthly loading is the sum of the daily loadings of a parameter divided by the number of daily loadings determined during a reporting period. The calculated monthly loading will be used to determine compliance with any maximum monthly loading limitations. Days with no discharge shall not be used to determine the value. When required by the permit, report the calculated monthly loading in the "AVERAGE" column under "QUANTITY OR LOADING" on the DMR.

Monthly monitoring frequency refers to a calendar month. When required by this permit, an analytical result, reading, value or observation shall be reported for that period if a discharge occurs during that period.

PART II

Section A. Definitions

Municipal separate storm sewer means a conveyance or system of conveyances designed or used for collecting or conveying stormwater which is not a combined sewer and which is not part of a POTW as defined in the Code of Federal Regulations at 40 CFR 122.2.

Municipal separate storm sewer system (MS4) means all separate storm sewers that are owned or operated by the United States, a state, city, village, township, county, district, association, or other public body created by or pursuant to state law, having jurisdiction over disposal of sewage, industrial wastes, stormwater, or other wastes, including special districts under state law, such as a sewer district, flood control district, or drainage district, or similar entity, or a designated or approved management agency under Section 208 of the Clean Water Act that discharges to the waters of the state. This term includes systems similar to separate storm sewer systems in municipalities, such as systems at military bases, large hospital or prison complexes, and highways and other thoroughfares. The term does not include separate storm sewers in very discrete areas, such as individual buildings.

National Pretreatment Standards are the regulations promulgated by or to be promulgated by the Federal Environmental Protection Agency pursuant to Section 307(b) and (c) of the Clean Water Act. The standards establish nationwide limits for specific industrial categories for discharge to a POTW.

No observed adverse effect level (NOAEL) means the highest tested dose or concentration of a substance which results in no observed adverse effect in exposed test organisms where higher doses or concentrations result in an adverse effect.

Noncontact cooling water is water used for cooling which does not come into direct contact with any raw material, intermediate product, by-product, waste product or finished product.

Nondomestic user means an industry, commercial establishment, or other entity that discharges wastewater to a POTW other than, or in addition to, sanitary sewage.

Nonstructural controls are practices or procedures implemented by employees at a facility to manage stormwater or to prevent contamination of stormwater.

NPDES means National Pollutant Discharge Elimination System.

Outfall is the location at which a point source discharge first enters a surface water of the state.

Part 91 agency means an agency that is designated by a county board of commissioners pursuant to the provisions of Section 9105 of Part 91 of the NREPA; an agency that is designated by a city, village, or township in accordance with the provisions of Section 9106 of Part 91 of the NREPA; or the Department for soil erosion and sedimentation control activities under Part 615, Supervisor of Wells; Part 631, Reclamation of Mining Lands; or Part 632, Nonferrous Metallic Mineral Mining, of the NREPA, pursuant to the provisions of Section 9115 of Part 91 of the NREPA.

Part 91 permit means a soil erosion and sedimentation control permit issued by a Part 91 agency pursuant to the provisions of Part 91 of the NREPA.

Partially treated sewage is any sewage, sewage and stormwater, or sewage and wastewater, from domestic or industrial sources that is treated to a level less than that required by the permittee's NPDES permit, or that is not treated to national secondary treatment standards for wastewater, including discharges to surface waters from retention treatment facilities.

PFAS means perfluoroalkyl and polyfluoroalkyl substances.

Point of discharge is the location of a point source discharge where stormwater is discharged directly into a separate storm sewer system.

PART II

Section A. Definitions

Point source discharge means a discharge from any discernible, confined, discrete conveyance, including but not limited to any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, or rolling stock. Changing the surface of land or establishing grading patterns on land will result in a point source discharge where the runoff from the site is ultimately discharged to waters of the state.

Polluting material means any material, in solid or liquid form, identified as a polluting material under the Part 5 Rules, Spillage of Oil and Polluting Materials, promulgated under Part 31 of the NREPA (R 324.2001 through R 324.2009 of the Michigan Administrative Code).

POTW is a publicly owned treatment work.

Predevelopment is the last land use prior to the planned new development or redevelopment.

Pretreatment is reducing the amount of pollutants, eliminating pollutants, or altering the nature of pollutant properties to a less harmful state prior to discharge into a public sewer. The reduction or alteration can be by physical, chemical, or biological processes, process changes, or by other means. Dilution is not considered pretreatment unless expressly authorized by an applicable National Pretreatment Standard for a particular industrial category.

Public (as used in the MS4 individual permit) means all persons who potentially could affect the authorized stormwater discharges, including, but not limited to, residents, visitors to the area, public employees, businesses, industries, and construction contractors and developers.

Public body means the United States; the state of Michigan; a city, village, township, county, school district, public college or university, or single-purpose governmental agency; or any other body which is created by federal or state statute or law.

Qualified Personnel means an individual who meets qualifications acceptable to the Department and who is authorized by an Industrial Stormwater Certified Operator to collect the stormwater sample.

Qualifying storm event means a precipitation event that results in a measurable amount of precipitation (i.e., a storm event that results in an actual discharge), and that follows the preceding storm event by at least 72 hours (i.e., three days). The 72-hour storm interval does not apply if documentation is provided showing that less than a 72-hour interval is representative for local storm events.

Quantification level means the measurement of the concentration of a contaminant obtained by using a specified laboratory procedure calculated at a specified concentration above the detection level. It is considered the lowest concentration at which a particular contaminant can be quantitatively measured using a specified laboratory procedure for monitoring of the contaminant.

Quarterly monitoring frequency refers to a three-month period, defined as January through March, April through June, July through September, and October through December (or otherwise defined in the permit). When required by this permit, an analytical result, reading, value or observation shall be reported for that period if a discharge occurs during that period.

Regional Administrator is the Region 5 Administrator, U.S. EPA, located at R-19J, 77 W. Jackson Blvd., Chicago, Illinois 60604.

Regulated area means the permittee's urbanized area, where urbanized area is defined as a place and its adjacent densely populated territory that together have a minimum population of 50,000 people as defined by the United States Bureau of the Census and as determined by the latest available decennial census.

Sanitary sewage means water-carried wastes from toilet, kitchen, laundry, bathing, or other facilities used for household purposes.

PART II

Section A. Definitions

Secondary containment structure means a unit, other than the primary container, in which significant materials are packaged or held, which is required by state or federal law to prevent the escape of significant materials by gravity into sewers, drains, or otherwise directly or indirectly into any sewer system or to the surface waters or groundwaters of the state.

Separate storm sewer system means a system of drainage, including, but not limited to, roads, catch basins, curbs, gutters, parking lots, ditches, conduits, pumping devices, or man-made channels, which is not a combined sewer where stormwater mixes with sanitary wastes, and is not part of a POTW.

Significant industrial user is a nondomestic user that: 1) is subject to Categorical Pretreatment Standards under 40 CFR 403.6 and 40 CFR Chapter I, Subchapter N; or 2) discharges an average of 25,000 gallons per day or more of process wastewater to a POTW (excluding sanitary, noncontact cooling and boiler blowdown wastewater); contributes a process waste stream which makes up five (5) percent or more of the average dry weather hydraulic or organic capacity of the POTW treatment plant; or is designated as such by the permittee as defined in 40 CFR 403.12(a) on the basis that the industrial user has a reasonable potential for adversely affecting the POTW's treatment plant operation or violating any pretreatment standard or requirement (in accordance with 40 CFR 403.8(f)(6)).

Significant materials means any material which could degrade or impair water quality, including but not limited to: raw materials; fuels; solvents, detergents, and plastic pellets; finished materials such as metallic products; raw materials used in food processing or production; hazardous substances designated under Section 101(14) of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) (see 40 CFR 372.65); any chemical the facility is required to report pursuant to Section 313 of Emergency Planning and Community Right-to-Know Act (EPCRA); polluting materials as identified under the Part 5 Rules (R 324.2001 through R 324.2009 of the Michigan Administrative Code); Hazardous Wastes as defined in Part 111, Hazardous Waste Management, of the NREPA; fertilizers; pesticides; and waste products such as ashes, slag, and sludge that have the potential to be released with stormwater discharges.

Significant spills and significant leaks means any release of a polluting material reportable under the Part 5 Rules (R 324.2001 through R 324.2009 of the Michigan Administrative Code).

Special-use area means stormwater discharges for which the Department has determined that additional monitoring is needed from: secondary containment structures required by state or federal law; lands on Michigan's List of Sites of Environmental Contamination pursuant to Part 201, Environmental Remediation, of the NREPA; and/or areas with other activities that may contribute pollutants to the stormwater.

Stoichiometric means the quantity of a reagent calculated to be necessary and sufficient for a given chemical reaction.

Stormwater means stormwater runoff, snowmelt runoff, surface runoff and drainage, and non-stormwater included under the conditions of this permit.

Stormwater discharge point is the location where the point source discharge of stormwater is directed to surface waters of the state or to a separate storm sewer. It includes the location of all point source discharges where stormwater exits the facility, including outfalls which discharge directly to surface waters of the state, and points of discharge which discharge directly into separate storm sewer systems.

Structural controls are physical features or structures used at a facility to manage or treat stormwater.

SWPPP means the Stormwater Pollution Prevention Plan prepared in accordance with this permit.

Tier I value means a value for aquatic life, human health or wildlife calculated under R 323.1057 of the Water Quality Standards using a tier I toxicity database.

Tier II value means a value for aquatic life, human health or wildlife calculated under R 323.1057 of the Water Quality Standards using a tier II toxicity database.

PART II

Section A. Definitions

Total maximum daily loads (TMDLs) are required by the Clean Water Act for waterbodies that do not meet water quality standards. TMDLs represent the maximum daily load of a pollutant that a waterbody can assimilate and meet water quality standards, and an allocation of that load among point sources, nonpoint sources, and a margin of safety.

Toxicity reduction evaluation (TRE) means a site-specific study conducted in a stepwise process designed to identify the causative agents of effluent toxicity, isolate the sources of toxicity, evaluate the effectiveness of toxicity control options, and then confirm the reduction in effluent toxicity.

Water Quality Standards means the Part 4 Water Quality Standards promulgated pursuant to Part 31 of the NREPA, being R 323.1041 through R 323.1117 of the Michigan Administrative Code.

Weekly monitoring frequency refers to a calendar week which begins on Sunday and ends on Saturday. When required by this permit, an analytical result, reading, value, or observation shall be reported for that period if a discharge occurs during that period. If the calendar week begins in one month and ends in the following month, the analytical result, reading, value, or observation shall be reported in the month in which monitoring was conducted.

WWSL is a wastewater stabilization lagoon.

WWSL discharge event is a discrete occurrence during which effluent is discharged to the surface water up to 10 days of a consecutive 14-day period.

3-portion composite sample is a sample consisting of three equal-volume grab samples collected at equal intervals over an 8-hour period.

7-day concentration
FOR WWSLs THAT COLLECT AND STORE WASTEWATER AND ARE AUTHORIZED TO DISCHARGE ONLY IN THE SPRING AND/OR FALL ON AN INTERMITTENT BASIS – The 7-day concentration is the sum of the daily concentrations determined during any 7 consecutive days of discharge during a WWSL discharge event divided by the number of daily concentrations determined. If the number of daily concentrations determined during the WWSL discharge event is less than 7 days, the number of actual daily concentrations determined shall be used for the calculation. The calculated 7-day concentration will be used to determine compliance with any maximum 7-day concentration limitations. When required by the permit, report the maximum calculated 7-day concentration for the WWSL discharge event in the “MAXIMUM” column under “QUALITY OR CONCENTRATION” on the DMR. If the WWSL discharge event was partially in each of two months, the value shall be reported on the DMR of the month in which the last day of discharge occurred.

FOR ALL OTHER DISCHARGES – The 7-day concentration is the sum of the daily concentrations determined during any 7 consecutive days in a reporting month divided by the number of daily concentrations determined. If the number of daily concentrations determined is less than 7, the actual number of daily concentrations determined shall be used for the calculation. The calculated 7-day concentration will be used to determine compliance with any maximum 7-day concentration limitations in the reporting month. When required by the permit, report the maximum calculated 7-day concentration for the month in the “MAXIMUM” column under “QUALITY OR CONCENTRATION” on the DMR. The first 7-day calculation shall be made on day 7 of the reporting month, and the last calculation shall be made on the last day of the reporting month.

PART II

Section A. Definitions

7-day loading
FOR WWSLs THAT COLLECT AND STORE WASTEWATER AND ARE AUTHORIZED TO DISCHARGE ONLY IN THE SPRING AND/OR FALL ON AN INTERMITTENT BASIS – The 7-day loading is the sum of the daily loadings determined during any 7 consecutive days of discharge during a WWSL discharge event divided by the number of daily loadings determined. If the number of daily loadings determined during the WWSL discharge event is less than 7 days, the number of actual daily loadings determined shall be used for the calculation. The calculated 7-day loading will be used to determine compliance with any maximum 7-day loading limitations. When required by the permit, report the maximum calculated 7-day loading for the WWSL discharge event in the "MAXIMUM" column under "QUANTITY OR LOADING" on the DMR. If the WWSL discharge event was partially in each of two months, the value shall be reported on the DMR of the month in which the last day of discharge occurred.

FOR ALL OTHER DISCHARGES – The 7-day loading is the sum of the daily loadings determined during any 7 consecutive days in a reporting month divided by the number of daily loadings determined. If the number of daily loadings determined is less than 7, the actual number of daily loadings determined shall be used for the calculation. The calculated 7-day loading will be used to determine compliance with any maximum 7-day loading limitations in the reporting month. When required by the permit, report the maximum calculated 7-day loading for the month in the "MAXIMUM" column under "QUANTITY OR LOADING" on the DMR. The first 7-day calculation shall be made on day 7 of the reporting month, and the last calculation shall be made on the last day of the reporting month.

12-month rolling average
When required by the permit, the 12-month rolling average is determined by adding the present monthly average result to the preceding 11 monthly average results and dividing the sum by 12. If sufficient data needed to calculate the 12-month rolling average is not yet available, enter **"*E"** on the monthly DMR until 12 months, or the equivalent of 12 months, of monthly monitoring data have been obtained, then begin reporting the calculated 12-month rolling average as required. If quarterly monitoring requirements apply, quarterly monitoring shall be equivalent to three (3) months of monitoring in calculating the 12-month rolling average. If monitoring more frequent than monthly applies, determine the monthly average result by summing the results of all data obtained in a given month and dividing that sum by the total number of samples taken in that month.

24-hour composite sample is a flow-proportioned composite sample consisting of hourly or more frequent portions that are taken over a 24-hour period and in which the volume of each portion is proportional to the discharge flow rate at the time that portion is taken. A time-proportioned composite sample may be used upon approval from the Department if the permittee demonstrates it is representative of the discharge.

PART II

Section B. Monitoring Procedures

1. Representative Samples

Samples and measurements taken as required herein shall be representative of the volume and nature of the monitored discharge.

2. Test Procedures

Test procedures for the analysis of pollutants shall conform to regulations promulgated pursuant to Section 304(h) of the Clean Water Act (40 CFR Part 136 – Guidelines Establishing Test Procedures for the Analysis of Pollutants), unless specified otherwise in this permit. **Test procedures used shall be sufficiently sensitive to determine compliance with applicable effluent limitations**. For lists of approved test methods, go to https://www.EPA.gov/CWA-Methods. Requests to use test procedures not promulgated under 40 CFR Part 136 for pollutant monitoring required by this permit shall be made in accordance with the Alternate Test Procedures regulations specified in 40 CFR Part 136.4. These requests shall be submitted to the Manager of the Permits Section, Water Resources Division, Michigan Department of Environment, Great Lakes, and Energy, P.O. Box 30458, Lansing, Michigan, 48909-7958. The permittee may use such procedures upon approval.

The permittee shall periodically calibrate and perform maintenance procedures on all analytical instrumentation at intervals to ensure accuracy of measurements. The calibration and maintenance shall be performed as part of the permittee's laboratory Quality Assurance/Quality Control program.

3. Instrumentation

The permittee shall periodically calibrate and perform maintenance procedures on all monitoring instrumentation at intervals to ensure accuracy of measurements.

4. Recording Results

For each measurement or sample taken pursuant to the requirements of this permit, the permittee shall record the following information: 1) the exact place, date, and time of measurement or sampling; 2) the person(s) who performed the measurement or sample collection; 3) the dates the analyses were performed; 4) the person(s) who performed the analyses; 5) the analytical techniques or methods used; 6) the date of and person responsible for equipment calibration; and 7) the results of all required analyses.

5. Records Retention

All records and information resulting from the monitoring activities required by this permit, including all records of analyses performed, calibration and maintenance of instrumentation, and recordings from continuous monitoring instrumentation, shall be retained for a minimum of three (3) years, or longer if requested by the Regional Administrator or the Department.

PART II

Section C. Reporting Requirements

1. Start-Up Notification

The permittee shall notify the Department of start-up if one of the following conditions applies and in accordance with the applicable condition:

a. Non-CAFOs

1) **If this is an individual permit** and the permittee will not discharge during the first 60 days following the effective date of this permit, the permittee shall notify the Department via MiEnviro Portal **within 14 days** following the effective date of this permit, and then again **60 days prior** to commencement of the discharge.

2) **If this is a general permit** and the permittee will not discharge during the first 60 days following the effective date of the Certificate of Coverage (COC) issued under this general permit, the permittee shall notify the Department via MiEnviro Portal **within 14 days** following the effective date of the COC, and then again **60 days prior** to commencement of the discharge.

b. CAFOs

1) **If this is an individual permit** and the permittee will not populate with animals during the first 60 days following the effective date of this permit, the permittee shall notify the Department via MiEnviro Portal **within 14 days** following the effective date of this permit, and then again **60 days prior** to populating with animals.

2) **If this is a general permit** and the permittee will not populate with animals during 60 days following the effective date of the Certificate of Coverage (COC) issued under this general permit, the permittee shall notify the Department via MiEnviro Portal **within 14 days** following the effective date of the COC, and then again **60 days prior** to populating with animals.

2. Submittal Requirements for Self-Monitoring Data

Part 31 of the NREPA (specifically Section 324.3110(7)); and R 323.2155(2) of Part 21, Wastewater Discharge Permits, promulgated under Part 31 of the NREPA, allow the Department to specify the forms to be utilized for reporting the required self-monitoring data. Unless instructed on the effluent limitations page to conduct "Retained Self-Monitoring," the permittee shall submit self-monitoring data via the Department's MiEnviro Portal system.

The permittee shall utilize the information provided on the MiEnviro Portal website, located at https://mienviro.michigan.gov/ncore/, to access and submit the electronic forms. Both monthly summary and daily data shall be submitted to the Department no later than the **20th day of the month** following each month of the authorized discharge period(s). The permittee may be allowed to submit the electronic forms after this date if the Department has granted an extension to the submittal date.

3. Retained Self-Monitoring Requirements

If instructed on the effluent limits page (or otherwise authorized by the Department in accordance with the provisions of this permit) to conduct retained self-monitoring, the permittee shall maintain a year-to-date log of retained self-monitoring results and, upon request, provide such log for inspection to the staff of the Department. Retained self-monitoring results are public information and shall be promptly provided to the public upon request.

The permittee shall certify, in writing, to the Department, on or before **January 10 (April 1 for animal feeding operation facilities) of each year**, that: 1) all retained self-monitoring requirements have been complied with and a year-to-date log has been maintained; and 2) the application on which this permit is based still accurately describes the discharge. With this annual certification, the permittee shall submit a summary of the previous year's monitoring data. The summary shall include maximum values for samples to be reported as daily maximums and/or monthly maximums and minimum values for any daily minimum samples.

PART II

Section C. Reporting Requirements

Retained self-monitoring may be denied to a permittee by notification in writing from the Department. In such cases, the permittee shall submit self-monitoring data in accordance with Part II.C.2., above. Such a denial may be rescinded by the Department upon written notification to the permittee. Reissuance or modification of this permit or reissuance or modification of an individual permittee's authorization to discharge shall not affect previous approval or denial for retained self-monitoring unless the Department provides notification in writing to the permittee.

4. Additional Monitoring by Permittee

If the permittee monitors any pollutant at the location(s) designated herein more frequently than required by this permit, using approved analytical methods as specified above, the results of such monitoring shall be included in the calculation and reporting of the values required in the Discharge Monitoring Report. Such increased frequency shall also be indicated.

Monitoring required pursuant to Part 41 of the NREPA or Rule 35 of the Mobile Home Park Commission Act, 1987 PA 96, as amended, for assurance of proper facility operation, shall be submitted as required by the Department.

5. Compliance Dates Notification

Within 14 days of every compliance date specified in this permit, the permittee shall submit a written notification to the Department via MiEnviro Portal (https://mienviro.michigan.gov/ncore/) indicating whether or not the particular requirement was accomplished. If the requirement was not accomplished, the notification shall include an explanation of the failure to accomplish the requirement, actions taken or planned by the permittee to correct the situation, and an estimate of when the requirement will be accomplished. If a written report is required to be submitted by a specified date and the permittee accomplishes this, a separate written notification is not required.

6. Noncompliance Notification

Compliance with all applicable requirements set forth in the Clean Water Act, Parts 31 and 41 of the NREPA, and related regulations and rules is required. All instances of noncompliance shall be reported as follows:

a. 24-Hour Reporting
Any noncompliance which may endanger health or the environment (including maximum and/or minimum daily concentration discharge limitation exceedances) shall be reported, verbally, **within 24 hours** from the time the permittee becomes aware of the noncompliance by calling the Department at the number indicated on the second page of this permit (or, if this is a general permit, on the COC). A written submission shall also be provided via MiEnviro Portal (https://mienviro.michigan.gov/ncore/) **within five (5) days**.

b. Other Reporting
The permittee shall report, in writing via MiEnviro Portal (https://mienviro.michigan.gov/ncore/), all other instances of noncompliance not described in a. above **at the time monitoring reports are submitted**; or, in the case of retained self-monitoring, **within five (5) days** from the time the permittee becomes aware of the noncompliance.

Reporting shall include: 1) a description of the discharge and cause of noncompliance; and 2) the period of noncompliance, including exact dates and times, or, if not yet corrected, the anticipated time the noncompliance is expected to continue, and the steps taken to reduce, eliminate and prevent recurrence of the noncomplying discharge.

PART II

Section C. Reporting Requirements

7. Spill Notification

The permittee shall immediately report any release of any polluting material which occurs to the surface waters or groundwaters of the state, unless the permittee has determined that the release is not in excess of the threshold reporting quantities specified in the Part 5 Rules (R 324.2001 through R 324.2009 of the Michigan Administrative Code), by calling the Department at the number indicated on the second page of this permit (or, if this is a general permit, on the COC); or, if the notice is provided after regular working hours, by calling the Department's 24-hour Pollution Emergency Alerting System telephone number, 1-800-292-4706.

Within 10 days of the release, the permittee shall submit to the Department via MiEnviro Portal (https://mienviro.michigan.gov/ncore/) a full written explanation as to the cause of the release, the discovery of the release, response measures (clean-up and/or recovery) taken, and preventive measures taken or a schedule for completion of measures to be taken to prevent reoccurrence of similar releases.

8. Upset Noncompliance Notification

If a process "upset" (defined as an exceptional incident in which there is unintentional and temporary noncompliance with technology-based permit effluent limitations because of factors beyond the reasonable control of the permittee) has occurred, the permittee who wishes to establish the affirmative defense of upset shall notify the Department by telephone **within 24 hours** of becoming aware of such conditions; and **within five (5) days**, provide in writing, the following information:

a. that an upset occurred and that the permittee can identify the specific cause(s) of the upset;

b. that the permitted wastewater treatment facility was, at the time, being properly operated and maintained (note that an upset does not include noncompliance to the extent caused by operational error, improperly designed treatment facilities, inadequate treatment facilities, lack of preventive maintenance, or careless or improper operation); and

c. that the permittee has specified and taken action on all responsible steps to minimize or correct any adverse impact in the environment resulting from noncompliance with this permit.

No determination made during administrative review of claims that noncompliance was caused by upset, and before an action for noncompliance, is final administrative action subject to judicial review.

In any enforcement proceedings, the permittee, seeking to establish the occurrence of an upset, has the burden of proof.

9. Bypass Prohibition and Notification

a. Bypass Prohibition
Bypass is prohibited, and the Department may take an enforcement action, unless:

1) bypass was unavoidable to prevent loss of life, personal injury, or severe property damage;

2) there were no feasible alternatives to the bypass, such as the use of auxiliary treatment facilities, retention of untreated wastes, or maintenance during normal periods of equipment downtime. This condition is not satisfied if adequate backup equipment should have been installed in the exercise of reasonable engineering judgment to prevent a bypass; and

3) the permittee submitted notices as required under 9.b. or 9.c. below.

PART II

Section C. Reporting Requirements

b. Notice of Anticipated Bypass
If the permittee knows in advance of the need for a bypass, the permittee shall submit written notification to the Department before the anticipated date of the bypass. This notification shall be submitted **at least 10 days before** the date of the bypass; however, the Department will accept fewer than 10 days advance notice if adequate explanation for this is provided. The notification shall provide information about the anticipated bypass as required by the Department. The Department may approve an anticipated bypass, after considering its adverse effects, if it will meet the three (3) conditions specified in a. above.

c. Notice of Unanticipated Bypass
As soon as possible but no later than 24 hours from the time the permittee becomes aware of the unanticipated bypass, the permittee shall notify the Department by calling the number indicated on the second page of this permit (or, if this is a general permit, on the COC); or, if notification is provided after regular working hours, call the Department's 24-hour Pollution Emergency Alerting System telephone number, 1-800-292-4706.

d. Written Report of Bypass
A written submission shall be provided within five (5) working days of commencing any bypass to the Department, and at additional times as directed by the Department. The written submission shall contain a description of the bypass and its cause; the period of bypass, including exact dates and times, and if the bypass has not been corrected, the anticipated time it is expected to continue; steps taken or planned to reduce, eliminate, and prevent reoccurrence of the bypass; and other information as required by the Department.

e. Bypass Not Exceeding Limitations
The permittee may allow any bypass to occur which does not cause effluent limitations to be exceeded, but only if it also is for essential maintenance to ensure efficient operation. These bypasses are not subject to the provisions of 9.a., 9.b., 9.c., and 9.d., above. This provision does not relieve the permittee of any notification responsibilities under Part II.C.11. of this permit.

f. Definitions

1) Bypass means the intentional diversion of waste streams from any portion of a treatment facility.

2) Severe property damage means substantial physical damage to property, damage to the treatment facilities which causes them to become inoperable, or substantial and permanent loss of natural resources which can reasonably be expected to occur in the absence of a bypass. Severe property damage does not mean economic loss caused by delays in production.

10. Bioaccumulative Chemicals of Concern (BCC)

Consistent with the requirements of R 323.1098 and R 323.1215 of the Michigan Administrative Code, the permittee is prohibited from undertaking any action that would result in a lowering of water quality from an increased loading of a BCC unless an increased use request and antidegradation demonstration have been submitted and approved by the Department.

PART II

Section C. Reporting Requirements

11. Notification of Changes in Discharge

The permittee shall notify the Department via MiEnviro Portal (https://mienviro.michigan.gov/ncore/), as soon as possible but **within no more than 10 days** of knowing, or having reason to believe, that any activity or change has occurred or will occur which would result in the discharge of: 1) detectable levels of chemicals on the current Michigan Critical Materials Register, priority pollutants or hazardous substances set forth in 40 CFR 122.21, Appendix D, or the Pollutants of Initial Focus in the Great Lakes Water Quality Initiative specified in 40 CFR 132.6, Table 6, which were not acknowledged in the application or listed in the application at less than detectable levels; 2) detectable levels of any other chemical not listed in the application or listed at less than detection, for which the application specifically requested information; or 3) any chemical at levels greater than five times the average level reported in the complete application (see the first page of this permit, for the date(s) the complete application was submitted). Any other monitoring results obtained as a requirement of this permit shall be reported in accordance with the compliance schedules.

12. Changes in Facility Operations

Any anticipated action or activity, including but not limited to facility expansion, production increases, or process modification, which will result in new or increased loadings of pollutants to the receiving waters must be reported to the Department a) by submission of an increased use request (application) and all information required under R 323.1098 (Antidegradation) of the Water Quality Standards or b) by written notice if the following conditions are met: 1) the action or activity will not result in a change in the types of wastewater discharged or result in a greater quantity of wastewater than currently authorized by this permit; 2) the action or activity will not result in violations of the effluent limitations specified in this permit; 3) the action or activity is not prohibited by the requirements of Part II.C.10.; and 4) the action or activity will not require notification pursuant to Part II.C.11. Following such written notice, the permit or, if applicable, the facility's COC, may be modified according to applicable laws and rules to specify and limit any pollutant not previously limited.

13. Transfer of Ownership or Control

In the event of any change in ownership or control of facilities from which the authorized discharge emanates, the following requirements apply: Not less than **30 days prior** to the actual transfer of ownership or control – for non-CAFOs, or **within 30 days** of the actual transfer of ownership or control – for CAFOs, the permittee shall submit to the Department via MiEnviro Portal (https://mienviro.michigan.gov/ncore/) a written agreement between the current permittee and the new permittee containing: 1) the legal name and address of the new owner; 2) a specific date for the effective transfer of permit responsibility, coverage and liability; and 3) a certification of the continuity of or any changes in operations, wastewater discharge, or wastewater treatment.

If the new permittee is proposing changes in operations, wastewater discharge, or wastewater treatment, the Department may propose modification of this permit in accordance with applicable laws and rules.

14. Operations and Maintenance Manual

For wastewater treatment facilities that serve the public (and are thus subject to Part 41 of the NREPA), Section 4104 of Part 41 and associated Rule 2957 of the Michigan Administrative Code allow the Department to require an Operations and Maintenance (O&M) Manual from the facility. An up-to-date copy of the O&M Manual shall be kept at the facility and shall be provided to the Department upon request. The Department may review the O&M Manual in whole or in part at its discretion and require modifications to it if portions are determined to be inadequate.

At a minimum, the O&M Manual shall include the following information: permit standards; descriptions and operation information for all equipment; staffing information; laboratory requirements; record keeping requirements; a maintenance plan for equipment; an emergency operating plan; safety program information; and copies of all pertinent forms, as-built plans, and manufacturer's manuals.

PART II

Section C. Reporting Requirements

Certification of the existence and accuracy of the O&M Manual shall be submitted to the Department at least 60 days prior to start-up of a new wastewater treatment facility. Recertification shall be submitted **60 days prior to start-up** of any substantial improvements or modifications made to an existing wastewater treatment facility.

15. Signatory Requirements

All applications, reports, or information submitted to the Department in accordance with the conditions of this permit and that require a signature shall be signed and certified as described in the Clean Water Act and the NREPA.

The Clean Water Act provides that any person who knowingly makes any false statement, representation, or certification in any record or other document submitted or required to be maintained under this permit, including monitoring reports or reports of compliance or noncompliance, shall, upon conviction, be punished by a fine of not more than $10,000 per violation, or by imprisonment for not more than six (6) months per violation, or by both.

The NREPA (Section 3115(2)) provides that a person who at the time of the violation knew or should have known that he or she discharged a substance contrary to this part, or contrary to a permit, COC, or order issued or rule promulgated under this part, or who intentionally makes a false statement, representation, or certification in an application for or form pertaining to a permit or COC or in a notice or report required by the terms and conditions of an issued permit or COC, or who intentionally renders inaccurate a monitoring device or record required to be maintained by the Department, is guilty of a felony and shall be fined not less than $2,500.00 or more than $25,000.00 for each violation. The court may impose an additional fine of not more than $25,000.00 for each day during which the unlawful discharge occurred. If the conviction is for a violation committed after a first conviction of the person under this subsection, the court shall impose a fine of not less than $25,000.00 per day and not more than $50,000.00 per day of violation. Upon conviction, in addition to a fine, the court in its discretion may sentence the defendant to imprisonment for not more than two (2) years or impose probation upon a person for a violation of this part. With the exception of the issuance of criminal complaints, issuance of warrants, and the holding of an arraignment, the circuit court for the county in which the violation occurred has exclusive jurisdiction. However, the person shall not be subject to the penalties of this subsection if the discharge of the effluent is in conformance with and obedient to a rule, order, permit, or COC of the Department. In addition to a fine, the attorney general may file a civil suit in a court of competent jurisdiction to recover the full value of the injuries done to the natural resources of the state and the costs of surveillance and enforcement by the state resulting from the violation.

16. Electronic Reporting

Upon notice by the Department that electronic reporting tools are available for specific reports or notifications, the permittee shall submit electronically via MiEnviro Portal (https://mienviro.michigan.gov/ncore/) all such reports or notifications as required by this permit, on forms provided by the Department.

PART II

Section D. Management Responsibilities

1. Duty to Comply

All discharges authorized herein shall be consistent with the terms and conditions of this permit. The discharge of any pollutant identified in this permit, more frequently than, or at a level in excess of, that authorized, shall constitute a violation of the permit.

It is the duty of the permittee to comply with all the terms and conditions of this permit. Any noncompliance with the Effluent Limitations, Special Conditions, or terms of this permit constitutes a violation of the NREPA and/or the Clean Water Act and constitutes grounds for enforcement action; for permit or COC termination, revocation and reissuance, or modification; or denial of an application for permit or COC renewal.

It shall not be a defense for a permittee in an enforcement action that it would have been necessary to halt or reduce the permitted activity in order to maintain compliance with the conditions of this permit.

2. Operator Certification

The permittee shall have the waste treatment facilities under direct supervision of an operator certified at the appropriate level for the facility certification by the Department, as required by Sections 3110 and 4104 of the NREPA. Permittees authorized to discharge stormwater shall have the stormwater treatment and/or control measures under direct supervision of a stormwater operator certified by the Department, as required by Section 3110 of the NREPA.

3. Facilities Operation

The permittee shall, at all times, properly operate and maintain all treatment or control facilities or systems installed or used by the permittee to achieve compliance with the terms and conditions of this permit. Proper operation and maintenance includes adequate laboratory controls and appropriate quality assurance procedures.

4. Power Failures

In order to maintain compliance with the effluent limitations of this permit and prevent unauthorized discharges, the permittee shall either:

a. provide an alternative power source sufficient to operate facilities utilized by the permittee to maintain compliance with the effluent limitations and conditions of this permit; or

b. upon the reduction, loss, or failure of one or more of the primary sources of power to facilities utilized by the permittee to maintain compliance with the effluent limitations and conditions of this permit, the permittee shall halt, reduce or otherwise control production and/or all discharge in order to maintain compliance with the effluent limitations and conditions of this permit.

5. Adverse Impact

The permittee shall take all reasonable steps to minimize or prevent any adverse impact to the surface waters or groundwaters of the state resulting from noncompliance with any effluent limitation specified in this permit including, but not limited to, such accelerated or additional monitoring as necessary to determine the nature and impact of the discharge in noncompliance.

6. Containment Facilities

The permittee shall provide facilities for containment of any accidental losses of polluting materials in accordance with the requirements of the Part 5 Rules (R 324.2001 through R 324.2009 of the Michigan Administrative Code). For a POTW, these facilities shall be approved under Part 41 of the NREPA.

PART II

Section D. Management Responsibilities

7. Waste Treatment Residues

Residuals (i.e., solids, sludges, biosolids, filter backwash, scrubber water, ash, grit, or other pollutants or wastes) removed from or resulting from treatment or control of wastewaters, including those that are generated during treatment or left over after treatment or control has ceased, shall be disposed of in an environmentally compatible manner and according to applicable laws and rules. These laws may include, but are not limited to, the NREPA, Part 31 for protection of water resources, Part 55 for air pollution control, Part 111 for hazardous waste management, Part 115 for solid waste management, Part 121 for liquid industrial wastes, Part 301 for protection of inland lakes and streams, and Part 303 for wetlands protection. Such disposal shall not result in any unlawful pollution of the air, surface waters or groundwaters of the state.

8. Right of Entry

The permittee shall allow the Department, any agent appointed by the Department, or the Regional Administrator, upon the presentation of credentials and, for animal feeding operation facilities, following appropriate biosecurity protocols:

a. to enter upon the permittee's premises where an effluent source is located or any place in which records are required to be kept under the terms and conditions of this permit; and

b. at reasonable times to have access to and copy any records required to be kept under the terms and conditions of this permit; to inspect process facilities, treatment works, monitoring methods and equipment regulated or required under this permit; and to sample any discharge of pollutants.

9. Availability of Reports

Except for data determined to be confidential under Section 308 of the Clean Water Act and Rule 2128 (R 323.2128 of the Michigan Administrative Code), all reports prepared in accordance with the terms of this permit and required to be submitted to the Department shall be available for public inspection via MiEnviro Portal (https://mienviro.michigan.gov/ncore/). As required by the Clean Water Act, effluent data shall not be considered confidential. Knowingly making any false statement on any such report may result in the imposition of criminal penalties as provided for in Section 309 of the Clean Water Act and Sections 3112, 3115, 4106 and 4110 of the NREPA.

10. Duty to Provide Information

The permittee shall furnish to the Department via MiEnviro Portal (https://mienviro.michigan.gov/ncore/), **within a reasonable time**, any information which the Department may request to determine whether cause exists for modifying, revoking and reissuing, or terminating this permit or the facility's COC, or to determine compliance with this permit. The permittee shall also furnish to the Department, upon request, copies of records required to be kept by this permit.

Where the permittee becomes aware that it failed to submit any relevant facts in a permit application or submitted incorrect information in a permit application or in any report to the Department, it shall promptly submit such facts or information.

PART II

Section E. Activities Not Authorized by This Permit

1. Discharge to the Groundwaters

This permit does not authorize any discharge to the groundwaters. Such discharge may be authorized by a groundwater discharge permit issued pursuant to the NREPA.

2. POTW Construction

This permit does not authorize or approve the construction or modification of any physical structures or facilities at a POTW. Approval for the construction or modification of any physical structures or facilities at a POTW shall be by permit issued under Part 41 of the NREPA.

3. Civil and Criminal Liability

Except as provided in permit conditions on "Bypass" (Part II.C.9. pursuant to 40 CFR 122.41(m)), nothing in this permit shall be construed to relieve the permittee from civil or criminal penalties for noncompliance, whether or not such noncompliance is due to factors beyond the permittee's control, such as accidents, equipment breakdowns, or labor disputes.

4. Oil and Hazardous Substance Liability

Nothing in this permit shall be construed to preclude the institution of any legal action or relieve the permittee from any responsibilities, liabilities, or penalties to which the permittee may be subject under Section 311 of the Clean Water Act except as are exempted by federal regulations.

5. State Laws

Nothing in this permit shall be construed to preclude the institution of any legal action or relieve the permittee from any responsibilities, liabilities, or penalties established pursuant to any applicable state law or regulation under authority preserved by Section 510 of the Clean Water Act.

6. Property Rights

The issuance of this permit does not convey any property rights in either real or personal property, or any exclusive privileges, nor does it authorize violation of any federal, state or local laws or regulations, nor does it obviate the necessity of obtaining such permits, including any other Department of Environment, Great Lakes, and Energy permits, or approvals from other units of government as may be required by law.

Attachment B

90 Percent Annual Non-Exceedance
Storms, March 2006 - MDEQ

STATE OF MICHIGAN
DEPARTMENT OF ENVIRONMENTAL QUALITY
LANSING

JENNIFER M. GRANHOLM
GOVERNOR

STEVEN E. CHESTER
DIRECTOR

March 24, 2006

TO: Ralph Reznick, Nonpoint Source Unit
Water Bureau

FROM: Dave Fongers, Hydrologic Studies Unit
Land and Water Management Division

SUBJECT: 90-Percent Annual Non-Exceedance Storms

Michigan Department of Environmental Quality (MDEQ) Best Management Practice (BMP) guidelines recommend capture and treatment of 0.5 inches of runoff from a single site. The runoff is then released over 24 to 48 hours or is allowed to infiltrate into the ground within 72 hours. However, this is only applicable to a single site. Runoff from multiple or large sites may exhibit elevated pollutant concentrations longer, because the first flush runoff from some portions of the drainage area will take longer to reach the outlet. For multiple sites or watershed wide design, it is better to capture and treat 90 percent of the runoff producing storms (Claytor, 1996, pages 2-22 through 2-23, attached). This "90 percent rule" effectively treats storm runoff that could be reaching the treatment at different times during the storm event. It was designed to provide the greatest amount of treatment that is economically feasible. This criterion is being considered for inclusion in the MDEQ's BMP guidebook.

As requested, the Hydrologic Studies Unit of the Land and Water Management Division has completed an analysis of January 1948 through March 2005, National Oceanic and Atmospheric Administration climatological data, in order to statistically define 90-percent non-exceedance storms statewide. The 90-percent non-exceedance storm is the storm where 90 percent of the runoff-producing storm rainfalls are equal to or less than the specified value. The Center for Watershed Protection recommends using a runoff threshold of 0.10 inches, because impervious areas of the watershed are assumed to generate runoff beginning at approximately 0.10 inches of rainfall.

Data from 13 weather stations were evaluated, as shown in Figure 1. The selected weather stations include at least one station from within each of the ten Michigan climatic divisions, plus three additional stations to improve statewide coverage and comparability. Statistics for this analysis are shown in Table 1.

The limitations of this technique and methods to calculate water quality volumes and peak flows are further discussed by Claytor and Schueler in the attached reference. Although the goal of this memo is simply to statistically define the 90-percent non-exceedance storms statewide, the attached information, or an adaptation of it, will need to be combined with the 90-percent non-exceedance storm information if it is to be meaningful in the BMP manual.

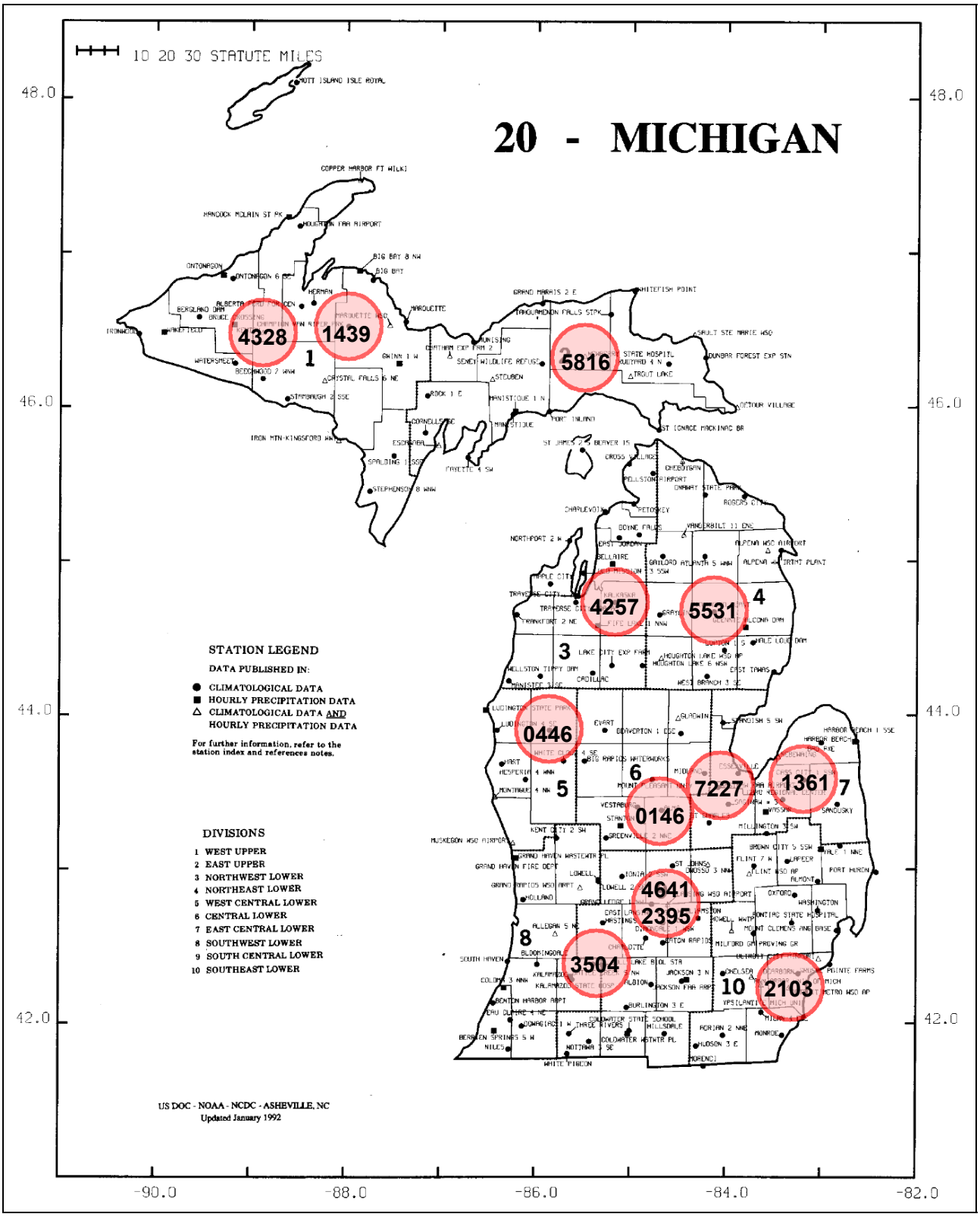

Figure 1: Selected Weather Stations

Table 1: Statistics for storms with more than 0.10" of rainfall at selected weather stations

Weather Station	Kenton	Champion Van Riper	Newberry	Kalkaska	Mio	Baldwin	Alma	Saginaw Airport	Cass City	Gull Lake	Lansing	East Lansing	Detroit Metro
Station Number	4328	1439	5816	4257	5531	0446	0146	7227	1361	3504	4641	2395	2103
Climatic Section	1		2	3	4	5	6	7		8	9		10
90-Percent Non-exceedance Storm	**0.95**	**0.87**	**0.84**	**0.77**	**0.78**	**0.93**	**0.93**	**0.92**	**0.87**	**1.00**	**0.90**	**0.91**	**0.90**
Period of Record	5/48-12/99	12/49-3/05	1/48-12/99	5/48-12/99	5/48-12/99	6/48-12/99	5/48-12/99	1/48-12/99	7/76-3/05	5/48-12/99	5/48-12/99	1/57-12/99	12/58-12/99
Number of Storms	3151	3943	3772	4219	3564	4007	3602	3453	1957	4071	3395	2939	3191
Minimum	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11
Median	0.30	0.29	0.29	0.26	0.27	0.30	0.30	0.31	0.30	0.32	0.29	0.30	0.30
Mean	0.44	0.41	0.41	0.39	0.38	0.43	0.45	0.44	0.43	0.46	0.42	0.44	0.43
Maximum	5.45	4.41	4.18	3.26	3.13	4.21	9.33	5.51	9.01	3.95	4.95	4.18	4.34

If you have any questions regarding our evaluation, please contact me at 517-373-0210.

Attachment: Claytor, R.A., and T.R. Schueler. 1996. *Design of Stormwater Filtering Systems*. The Center for Watershed Protection, Silver Spring, MD, pages 2-16 through 2-29.

cc: Steve Holden, WB
Ric Sorrell, LWMD

Design of Stormwater Filtering Systems

Prepared by

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PARTICLE SIZE DISTRIBUTION

One additional important aspect of stormwater runoff from different source areas is the relationship of particle size to pollutant load. Work done by Sartor and Boyd (1974) and Pitt (1987) starting in the early 1970's suggests that most of the total particulate load from urban runoff is made up by the coarser fractions, consisting of sand/gravel particle sizes greater than approximately 40 microns. Shaver and Baldwin (1991) reported that while nearly 94% of the urban runoff particulate load is from these coarser grained fractions, more than half of the phosphorus load and significant percentages of other pollutants are associated with fine grained silts and clays.

Particle size distribution is an important consideration for sizing the sedimentation chamber of a filter system. Shaver and Baldwin (1991) and Bell et al. (1995) specify that sand filters should only be used to treat runoff from impervious, or nearly-impervious surfaces. They argue that the larger percentage of particulates from impervious surfaces are in the coarser fractions, and therefore, filtering systems will be less prone to clogging. The logic follows that the sedimentation chamber will capture the coarser grained material, and the filter chamber will capture and treat the relatively small amount of finer grained material. Therefore, filters designed to treat runoff from purely impervious surfaces require less sedimentation area and volume than those designed to treat runoff from more pervious surfaces.

The City of Austin (1988) allows the use of sand filters for a range of land uses and drainage areas. They use a smaller, silt size particle (20 microns) as the target for sizing the sedimentation chamber, probably recognizing that more pervious areas are likely to contribute more fine grained particles In order to quantify and resolve the apparent discrepancy between the above criteria, this manual recommends that for drainage areas less than 75% impervious, the target particle size for designing the sedimentation chamber be set at 20 microns. For drainage areas with imperviousness greater than 75%, the target particle size should be set at 40 microns. See Chapter 5 for discussion and application of these sizing principles.

2.3 SMALL STORM HYDROLOGY

Small storms are responsible for most annual urban runoff and likewise are responsible for most pollutant washoff from urban surfaces. Therefore, the small storms are of most concern for water quality resource protection.

Large storms occur infrequently, and although they may contain significant pollutant loads (Chang, G., et al., 1990), their contribution to the annual average pollutant load is really quite small (due to the infrequency of their occurrence). In addition, there are longer periods of recovery available to receiving waters between larger storm events

allowing systems to flush themselves and the aquatic environment to recover.

The runoff **volume** is the most important hydrologic variable for water quality protection and design because water quality is a function of the capture and treatment of the mass load of pollutants. The runoff **peak rate** is the most important hydrologic variable for drainage system design and flooding analysis. Water quality facilities are designed to treat a specified quantity or volume of runoff for the full duration of a storm event as opposed to accommodating only an instantaneous peak at the most severe portion of a storm event.

To design effective BMPs and evaluate water quality impacts in urban watersheds, it is necessary to predict the amount of rainfall converted to runoff. The amount of rainfall which is converted to runoff is a function of storm characteristics such as rainfall amount, storm duration, rainfall intensity, and the urban land surface. These surfaces can be broken down into two main categories, pervious and impervious surfaces.

Impervious surfaces are traditionally thought to convert almost all rainfall into runoff, with pervious surfaces contributing much less runoff. In urban areas, particularly for small storms, this is not necessarily the case. Pervious surfaces can be heavily compacted and can have a surprisingly high runoff potential. Impervious surfaces, with minor cracks and expansion joints can have a remarkably high infiltration capability.

Impervious surfaces have five main components which contribute to rainfall losses:

- Interception of rainfall by over-hanging vegetation
- Flash evaporation
- Depression storage
- Sorption by dirt particles
- Infiltration through cracks and seams

The first four processes predominately occur immediately after the start of a rainfall event and dissipate within a relatively short time period and are therefore often referred to as initial abstractions. Infiltration through cracks and seams continues throughout the storm event and depending on the amount of rainfall, can account for significant losses. Many runoff models incorrectly estimate initial abstractions by holding them constant, and few consider infiltration through impervious surfaces for the duration of the storm event (Pitt, 1994).

The amount of runoff generated by pervious surfaces is related to the size of the pervious area, the relationship to impervious surfaces, the permeability of the underlying soils and the condition and type of vegetative cover.

The primary hydrologic methods to estimate storm runoff peak discharges in the Chesapeake Bay Watershed are the Rational Formula and SCS Methods, particularly, TR-55, "Urban Hydrology for Small Watersheds" (USDA, 1986). Several computer models, including SCS, TR-20, "Project Formulation, Hydrology" (USDA, 1982) and the U.S. Army Corps of Engineers', HEC-1 (U.S. Army, COE 1982) also utilize SCS methods to compute discharge rates. These methods are valuable for estimating peak discharge rates for large storms (i.e., >2") and larger drainage areas (> 10 to 25 acres), but can significantly underestimate the runoff from small storm events.

The limiting factors for the Rational Formula are in the computation of the time of concentration (usually set at a minimum of 5 minutes, which is hard to achieve on many small sites), the selection of "C" values for urban developments which do not address soil infiltration capability, and the equal weight placed on drainage area. The rational method is ideally suited for drainage design where peak rates of runoff are required, but does not estimate storm volume and therefore should not be used for water quality design.

Urban Hydrology For Small Watersheds (TR-55), as the title suggests, is recommended for urban watersheds with small drainage basins. This methodology has been used extensively for stormwater management design for quantity control (i.e., 2, 10, and 100 year management). TR-55 relies on a Curve Number (CN) instead of the "C" to reflect the percentage of rainfall converted to runoff. The TR-55 methodology also has the same limitations associated with computing the time of concentration for extremely small drainage areas.

One of the principal short comings of TR-55 is that the methodology assumes a constant CN for a large range of rainfall events. While this assumption does not significantly affect the accuracy of the model for larger storm events (> 2"), smaller rainfall events produce more runoff than are predicted by the SCS procedure (Pitt, 1994). This chapter presents a method for estimating the volume of runoff and peak discharge from small storms. Standard SCS methods should be used by designers for computing volumes and peak discharges for larger storm events (i.e., 2, 10 and 100 year storms).

Dr. Robert Pitt and his colleagues, have conducted several years of research on small storm hydrology, in several diverse geographic regions, over a wide range of land uses with remarkable consistency between simulated and observed results. The results of Pitt's research are described in Table 2.10.

TABLE 2.10: PRINCIPLES OF SMALL STORM HYDROLOGY (ADAPTED FROM PITT, 1994)

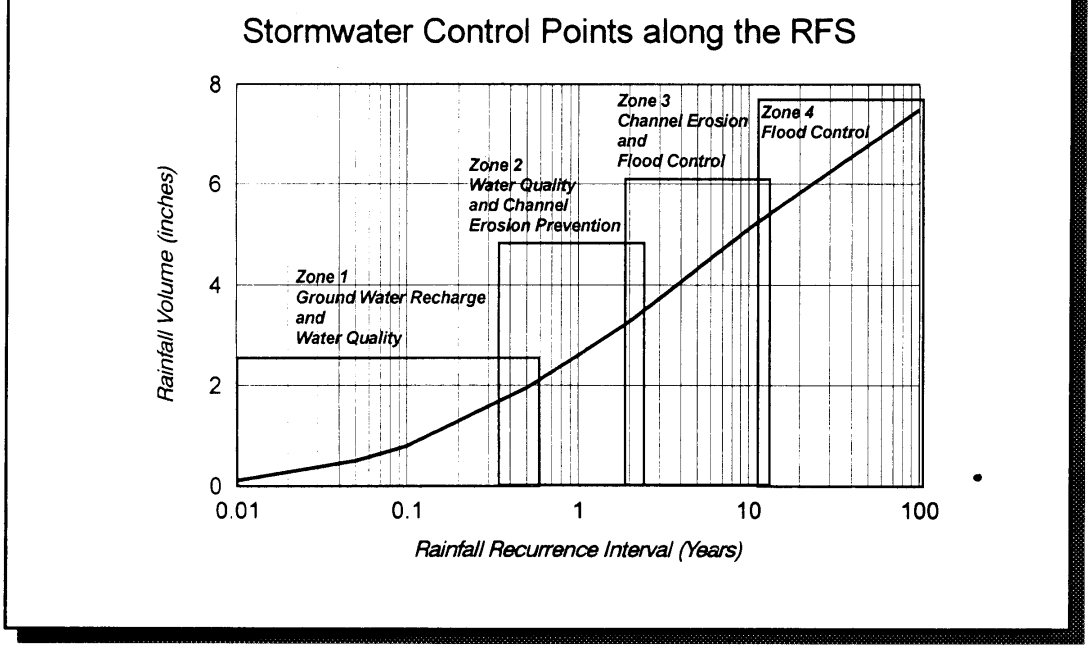
Larger rainfall events correspond reasonably well with SCS CN procedures.
Smaller rainfall events produce more runoff than is predicted by SCS CN procedures.
For strictly pervious surfaces, published CN's are much lower than observed CN's for small storm events. Therefore, less runoff is predicted from pervious areas during small storm events and SCS methodology incorrectly attributes more flow to impervious surfaces. This translates into inaccurate pollutant loading estimates from both pervious and impervious surfaces.
For impervious surfaces, the type of surface (i.e., rooftop, large paved surface, narrow street) has a significant impact on the amount of runoff for small storm events. The infiltration characteristics of these surfaces vary greatly. Remarkably, narrow streets can have a higher infiltration capability than some compacted urban pervious surfaces (such as ballfields).
Disconnecting impervious surfaces can significantly reduce the volume of runoff. The relative amount of reduction is a function of the pervious area flow path, the amount of impervious area draining to pervious areas, and the infiltration capacity of the pervious surfaces. Substantial reductions in runoff are observed for a wide range of land uses when impervious surfaces are disconnected and drained through permeable soils (SCS, Hydrologic Soil Groups (A and B). Reductions are only slight for relatively low density land uses when impervious surfaces are disconnected and drained through relatively impermeable soils (HSG's - C and D). Not surprisingly, disconnecting paved surfaces and rooftops for commercial areas does not result in significant reductions in runoff.

2.4 RAINFALL FREQUENCY SPECTRUM (RFS)

The effectiveness of any stormwater water quality treatment practice is a function of how much stormwater runoff is treated by the system and how much bypasses the practice. Since storms vary dramatically in magnitude, stormwater best management practices must be sized to capture a reasonable percentage of all runoff but bypass excessively large events. The rainfall frequency spectrum or RFS, which is defined as the distribution of all rainfall events, is a useful tool for establishing water quality treatment volume sizing criteria. This distribution is the cumulative volume from all storm events ranging from the smallest most frequent events in any given year to the largest most extreme events over a long duration, say, the 100 year frequency event.

The RFS consists of classes of frequencies often broken down by return interval, such as the two year storm return interval. Four principle classes are typically targeted for control by stormwater management practices. The two smallest, most frequent, classes are often referred to as water quality storms, where the control objectives are groundwater recharge, pollutant load reduction, and to some extent, control of channel erosion producing events. The two larger classes are typically referred to as quantity storms, where the control objectives are channel erosion control, overbank control, and flood control. Figure 2.5 illustrates a theoretical representation of these four classes.

FIGURE 2.5: FOUR CLASSES OF RAINFALL DISTRIBUTION



The distribution and magnitude of the RFS varies from region to region and to some extent, from year to year. Therefore, in order to establish a reasonable water quality treatment design volume for stormwater filtering practices it is necessary to define the RFS for the region of application. Within the Chesapeake Bay Watershed the average precipitation characteristics vary somewhat. This manual presents a sizing criteria based on an in-depth analysis conducted for the Washington, DC metropolitan area, compared with three other locations within the Bay and makes

recommendations for establishing the RFS for other locations within the Bay Watershed.

Schueler (1987 and 1992), conducted a detailed evaluation of 50 years of hourly rainfall data in the Washington D.C. area. The recorded precipitation data from Washington National Airport consisted of all storm events separated by at least 3 hours from the next event. The base data collected at National Airport included minor storm events which normally do not produce measurable runoff. These minor events make up approximately 10% of all annual rainfall, are usually less than 0.1 inches, and are therefore excluded from the RFS analysis.

Table 2.11 outlines the RFS for the Washington D.C. metropolitan area and illustrates that the vast majority of all annual runoff is produced from the small frequent storm events.

TABLE 2.11: RAINFALL FREQUENCY SPECTRUM WASHINGTON, DC AREA[a]
SOURCE: DESIGN OF STORWATER WETLAND SYSTEMS (SCHUELER, 1992)

Percent of All Storm Events [b]	*Return Interval*	*Rainfall*[c] *Volume*
30	7 days	0.25
50	14 days	0.40
70	Monthly	0.75
85	Bi-monthly	1.05
90	Quarterly	1.25
95	Semi-annually	1.65
98	Annually	2.40
99	Two-year	2.90

a. 50 year analysis of hourly rainfall record at Washington National Airport, excluding all storms less than 0.10 inches that were separated by three consecutive hours from the next storm. These small storms seldom produce measurable stormwater runoff, yet are numerically the most common rainfall event.

b. Equal to or less than given rainfall volume

c. Watershed inches

2.5 THE 90% RULE-CUMULATIVE RAINFALL VOLUME FOR WATER QUALITY TREATMENT

A careful examination of Table 2.11 suggests that a BMP which is sized to capture and treat the three month storm frequency storm (or 1.25" rainfall) will effectively treat 90% of the annual average rainfall. While this is true, such a practice will also capture and at least partially treat the first 1.25" of larger rainfall events. Therefore treating the 1.25" rainfall will result in a capture efficiency of greater than 90%.

Given the economic considerations of capturing and storing a reasonably large water quality volume, and the realization that stormwater filters tend to lose efficiency as pollutant load input concentrations decrease (Bell, et. al, 1995), a smaller storm event was investigated to evaluate the effectiveness of an alternative treatment criteria. Many jurisdictions require storage of the first one-half inch of runoff from impervious surfaces. While this volume appears to have gained widespread acceptance, there has been little research on the cumulative pollutant load bypassing facilities sized on this principle. One notable exception, is a study conducted in Texas by Chang and his colleagues (1990), where the annual total solids load captured using the half-inch rule showed significant drop-off when imperviousness approached 70%.

To balance the desire to capture and treat as much cumulative rainfall as possible while avoiding an overly burdensome sizing criteria, additional rainfall data was evaluated throughout Chesapeake Bay watershed. In addition to Washington, DC, Three other locations were selected to evaluate longer term rainfall characteristics.

Daily precipitation data was analyzed for an 11 year period (January 1980 through December 1990) at four locations within the Chesapeake Bay Watershed. Norfolk VA, Washington, DC, Frederick MD, and Harrisburg, PA were selected as representative of the bay-wide watershed where new development activity is occurring. In addition locations are separated by 100 to 150 miles and represent a distribution from coastal to inland, and south to north.

The one-inch rainfall was evaluated to assess whether this value could be used to effectively capture 90% of the annual runoff. The average capture percentage using the 1.0" rainfall ranges from approximately 85% to 91% for the four locations. The analysis included the first one-inch of larger rainfall events which will be captured, but probably not completely treated. It is recognized that during these large events treatment conditions may be less than ideal. But it is safe to say that approximately 90% of the annual average rainfall events will be captured and treated using a **one-inch rainfall criteria**.

The results presented in Table 2.12 provide justification for using the 1.0" rainfall event for sizing stormwater filtering practices throughout the Chesapeake Bay Watershed. It must be emphasized that regional rainfall characteristics will differ from specific location to location. Additional rainfall frequency analysis is required for more complete reliance on this value. If a particular jurisdiction has the resources and long term data, a complete RFS should be conducted and the 90% rule applied to establish a local water quality precipitation value. In addition a longer data-set (say 50 years) will make some of the extreme rainfall events or drought periods less statistically significant and may have a minor effect on the capture value derived herein.

TABLE 2.12: COMPARISON OF PRECIPITATION DATA FOR FOUR LOCATIONS WITHIN THE CHESAPEAKE BAY WATERSHED 1980 - 1991 (DAILY ANALYSIS)

	Norfolk, VA	*Washington, DC*	*Harrisburg, PA*	*Frederick, MD*
Annual average precipitation	43.4 inches	37.9 inches	39.6 inches	37.0 inches
Annual average snowfall	7.7 inches	17.2 inches	31.3 inches	Not Obtained
Annual average # of precipitation days *	76 days	67 days	71 days	68 days
Annual average # of precipitation days more than 1.0"	10.5 days	9.5 days	9.5 days	7.7 Days
Annual average # of precipitation days less than 0.1"	39.0 days	45.4 days	55.1 days	Not Obtained
Percent of annual average rainfall ≤ 1.0" *	85.3%	91.4%	86.8%	89.9%
Percent of annual precipitation days ≤ 1.0" *	86.2%	85.9%	86.7%	88.6%
* adjusted to exclude rainfall events ≤ 0.1 (assumed to produce no runoff)				

2.6 STORMWATER FILTERING SYSTEMS - SIZING CONSIDERATIONS

In general, stormwater filtering systems should be sized based on the **volume** of runoff to be filtered. All practices identified in this manual utilize the volume based sizing criteria, except for the grass channel practice, where a peak rate is utilized. It is necessary, however, to utilize a peak rate of discharge for sizing off-line flow diversion structures.

As presented earlier in this chapter, the target rainfall event for estimating the Water Quality Volume (WQV) for sizing all filtering devices is based on the **90% Rule** for capturing annual runoff volume. For the Mid-Atlantic region and much of the Chesapeake Bay Watershed, a rainfall value of **1.0 inches** is suggested.

Some jurisdictions may elect to use other sizing guidelines, such as the ½ inch rule (measured in watershed inches). This criteria may be acceptable for lower imperviousness but will have decreased pollutant capture efficiencies for a higher imperviousness and a lower capture percentage of the annual runoff volume. The individual practice sizing principles contained in this manual are applicable for alternative treatment volumes so a reliance on the 90% Rule is not mandatory. In addition, several filtering practices are ideally suited for retrofit applications where full storage is often constrained. Designers and regulators should recognize that the 90% Rule is targeted mainly at new construction and is based on maximizing pollutant load capture. Practices sized for smaller treatment volumes are certainly acceptable in many situations.

2.7 ESTIMATING WATER QUALITY VOLUME (WQV)

Two methods can be utilized to estimate the Water Quality Volume (WQV). Both rely on computing a volumetric runoff coefficient (R_v) and multiplying this by the rainfall volume to obtain a runoff volume in watershed inches.

The first method, or what we call the **Short Cut Method,** utilizes equation 2.1 to estimate the volumetric runoff coefficient R_v, (Schueler, 1987). It is recommended that the Short Cut Method be utilized where the site consists of predominately one type of land surface or for quick calculations to obtain a reasonably accurate estimate of treatment volume.

$$R_v = 0.05 + 0.009(I)$$ **Equation 2.1**

where I = site percent impervious

Therefore, the required treatment volume for a site will be equal to:

$$WQV = P * R_v \qquad \text{Equation 2.2}$$

P = rainfall, in inches
and WQV = Water Quality Volume, in watershed inches

EXAMPLE CALCULATION

Assume a 3.0 acre shopping center which is 87% impervious, for a 1.0 inch rainfall event.

$R_v = 0.05 + 0.009(87\%)$
$R_v = 0.83$

for P = 1.0 inches
WQV = (1.0")(.83) = .83 watershed inches
WQV = .83"(1/12 "/ft)(3.0 ac)(43,560 ft^2/ac) = 9,039 ft^3

The second method, or **Small Storm Hydrology Method** utilizes the work done by Pitt and others, to compute a volumetric runoff coefficient (R_v) based on the specific characteristics of the pervious and impervious surfaces of the drainage catchment. This method presents a relatively simple relationship between rainfall amount, land surface, and runoff volume. The R_vs used to compute the volume of runoff are identified in Table 2.13. The small storm hydrology model involves the following:

- For a given rainfall depth, the runoff coefficients for land surfaces present on the subject site are selected.
- A weighted runoff coefficient for the entire site is computed.
- If a portion of the site has disconnected impervious surfaces, reduction factors are applied to R_v. The reduction factors (from Table 2.14) are multiplied by the computed R_v for connected impervious areas to obtain the corrected value.
- For the given rainfall, the runoff volume (in watershed inches) is computed. WQV is equal to the rainfall times the R_v (same as equation 2.2 above).

TABLE 2.13: VOLUMETRIC COEFFICIENTS FOR URBAN RUNOFF
(DIRECTLY CONNECTED IMPERVIOUS AREAS, ADAPTED FROM PITT, 1994)

Rainfall (inches)	Flat roofs and large unpaved parking lots	Pitched roofs and large impervious areas (large parking lots)	Small impervious areas and narrow streets	Sandy soils HSG-A	Silty soils HSG-B	Clayey soils HSG-C & D
0.75	.82	.97	.66	.02	.11	.20
1.00	.84	.97	.70	.02	.11	.21
1.25	.86	.98	.74	.03	.13	.22
1.50	.88	.99	.77	.05	.15	.24

TABLE 2.14: REDUCTION FACTORS TO VOLUMETRIC RUNOFF COEFFICIENTS FOR DISCONNECTED IMPERVIOUS SURFACES (ADAPTED FROM PITT, 1994)

Rainfall (inches)	Strip commercial and shopping center	Medium to high density residential with paved alleys	Medium to high density residential without alleys	Low density residential
0.75	.99	.27	.21	.20
1.00	.99	.38	.22	.21
1.25	.99	.48	.22	.22
1.50	.99	.59	.24	.24

In order to use the reduction factors for disconnected impervious surfaces, as general guidance, the impervious area above the pervious surface area should be less than one-half of the pervious surface and the flowpath through the pervious area should be at least twice the impervious surface flowpath.

The Small Storm Hydrology method has the advantage of evaluating the precise elements of a particular site and should be utilized for most design applications to estimate accurate runoff volumes. The method requires somewhat more effort to identify the

specific land surface area ratios and additional effort is needed to assess the disconnections of impervious areas. The method rewards site designs which utilize disconnections of impervious surfaces by lowering the computed R_v and the required WQV.

EXAMPLE CALCULATION

Assume a 3.0 acre small shopping center having a 1.0 acre flat roof, 1.6 acres of parking and a 0.4 acre open space (sandy soil), for a 1.0 inch rainfall event and no disconnection of impervious surfaces. The weighted volumetric runoff coefficient is:

flat roof:	1.0 acre x .84 = 0.84
parking:	1.6 acres x .97 = 1.55
open space:	0.4 acre x .02 = 0.01
total:	3.0 acres = 2.40

weighted volumetric runoff coefficient R_v = 2.40/3.0 = .80

for P = 1.0 inches
Water Quality Volume (WQV) = (1.0")(.80) = .80 watershed inches
= (.80") (1 ft/12") (3.0 ac) (43,560 ft^2/ac)
= 8,712 ft^3

2.8 ESTIMATING PEAK DISCHARGE FOR THE WATER QUALITY STORM (Q_p)

The peak rate of discharge is needed for the sizing of off-line diversion structures and to design grass channels. As discussed earlier in this chapter, conventional SCS methods underestimate the volume and rate of runoff for rainfall events less than 2". This discrepancy in estimating runoff and discharge rates can lead to situations where a significant amount of runoff by-passes the filtering treatment practice due to an inadequately sized diversion structure or leads to the design of undersized grass channels.

The following procedure can be used to estimate peak discharges for small storm events. It relies on the volume of runoff computed using the Small Storm Hydrology Method and utilizes SCS, TR-55 Graphical Peak Discharge Method.

- Using the water quality volume (WQV), computed using the methods previously presented, a corresponding Curve Number (CN) is computed utilizing equation 2.3.

$$CN = 1000/[10 + 5P + 10Q - 10(Q^2 + 1.25\,QP)^{1/2}]$$ **Equation 2.3**

where P = rainfall, in inches (use 1.0" for the Water Quality Storm)
and Q = runoff volume, in inches (equal to WQV)

Note: Equation 2.3 above, is derived from the SCS Runoff Curve Number method described in detail in NEH-4, Hydrology (SCS 1985) and SCS TR-55 Chapter 2: Estimating Runoff. The CN can also be obtained graphically (also from TR-55).

- Once a CN is computed, the time of concentration (t_c) is computed (based on the methods identified in TR-55, Chapter 3: "Time of concentration and travel time"). The t_c for small sites is often small based on relatively short flow paths; however, a minimum value of 0.1 hours should be used.

- Using the computed CN, t_c and drainage area (A), in acres; the peak discharge (Q_p) for the Water Quality Storm is computed (based on the procedures identified in TR-55, Chapter 4: "Graphical Peak Discharge Method"). For the Chesapeake Bay Watershed use Rainfall distribution type II.

  - Read initial abstraction (I_a), compute I_a/P
  - Read the unit peak discharge (q_u) from Exhibit 4-II for appropriate t_c
  - Using the water quality volume (WQV), compute the peak discharge (Q_p)

$$Q_p = q_u * A * WQV$$ **Equation 2.4**

where Q_p = the peak discharge, in cfs
q_u = the unit peak discharge, in cfs/mi²/inch
A = drainage area, in square miles
and WQV = Water Quality Volume, in watershed inches

EXAMPLE CALCULATION

Using the previous example:

where WQV = .80"

$CN = 1000/[10+5*1.0"+10*.80"-10((0.80")^2+1.25*.80"*1.0")^{½}]$

CN = 98

assume t_c = 10 minutes = .17 hours

I_a = 0.041 for CN = 98, I_a/P = 0.041/1.25" = .03

read q_u = 950 csm/in (TR-55 Exhibit 4-II)

A = 3.0 acres/640ac/mi² = .0047mi²

Q_p = 950 csm/in * .0047mi² * .80" =3.6 cfs

For computing runoff volume and peak rate for storms larger than the Water Quality Storm (i.e., 2, 10 and 100 year storms), use the published CN's from TR-55 and follow the prescribed procedure in TR-55.

In some cases the Rational Formula may be used to compute peak discharges associated with the Water Quality Storm. The designer must have available reliable intensity, duration, frequency (IDF) tables or curves for the storm and region of interest. This information may not be available for many locations and therefore the TR-55 method described above is recommended.

Attachment C

NOAA Atlas 14 Point Precipitation
Frequency Estimates - NOAA (excerpts)

NOAA Atlas 14, Volume 8, Version 2
Location name: Ann Arbor, Michigan, USA*
Latitude: 42.2885°, Longitude: -83.7259°
Elevation: 756.5 ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Deborah Martin, Sandra Pavlovic, Ishani Roy, Michael St. Laurent, Carl Trypaluk, Dale Unruh, Michael Yekta, Geoffery Bonnin

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	**0.321** (0.282-0.370)	**0.378** (0.331-0.436)	**0.473** (0.413-0.546)	**0.553** (0.481-0.642)	**0.666** (0.561-0.795)	**0.755** (0.621-0.911)	**0.845** (0.673-1.04)	**0.939** (0.718-1.18)	**1.07** (0.784-1.37)	**1.16** (0.833-1.52)
10-min	**0.470** (0.412-0.541)	**0.553** (0.485-0.638)	**0.692** (0.605-0.800)	**0.810** (0.704-0.939)	**0.975** (0.821-1.16)	**1.11** (0.910-1.34)	**1.24** (0.985-1.53)	**1.38** (1.05-1.73)	**1.56** (1.15-2.01)	**1.70** (1.22-2.22)
15-min	**0.573** (0.503-0.660)	**0.675** (0.592-0.778)	**0.844** (0.738-0.976)	**0.988** (0.859-1.15)	**1.19** (1.00-1.42)	**1.35** (1.11-1.63)	**1.51** (1.20-1.86)	**1.68** (1.28-2.11)	**1.90** (1.40-2.45)	**2.08** (1.49-2.71)
30-min	**0.767** (0.674-0.884)	**0.906** (0.795-1.04)	**1.14** (0.994-1.31)	**1.33** (1.16-1.55)	**1.61** (1.36-1.92)	**1.83** (1.51-2.21)	**2.05** (1.64-2.53)	**2.29** (1.75-2.88)	**2.60** (1.91-3.36)	**2.84** (2.04-3.72)
60-min	**0.969** (0.851-1.12)	**1.14** (1.00-1.32)	**1.44** (1.26-1.67)	**1.70** (1.48-1.97)	**2.08** (1.75-2.49)	**2.38** (1.96-2.88)	**2.69** (2.15-3.33)	**3.02** (2.32-3.83)	**3.48** (2.57-4.51)	**3.84** (2.76-5.02)
2-hr	**1.17** (1.03-1.34)	**1.38** (1.22-1.58)	**1.75** (1.54-2.00)	**2.07** (1.81-2.38)	**2.54** (2.16-3.04)	**2.93** (2.43-3.53)	**3.33** (2.68-4.10)	**3.76** (2.90-4.74)	**4.37** (3.24-5.62)	**4.84** (3.50-6.29)
3-hr	**1.30** (1.15-1.48)	**1.53** (1.35-1.74)	**1.93** (1.70-2.20)	**2.29** (2.01-2.63)	**2.82** (2.42-3.37)	**3.27** (2.73-3.94)	**3.74** (3.02-4.60)	**4.25** (3.30-5.34)	**4.97** (3.71-6.38)	**5.55** (4.02-7.17)
6-hr	**1.55** (1.38-1.75)	**1.79** (1.59-2.03)	**2.22** (1.97-2.52)	**2.62** (2.32-2.99)	**3.23** (2.80-3.85)	**3.75** (3.16-4.50)	**4.32** (3.51-5.28)	**4.93** (3.85-6.16)	**5.80** (4.37-7.42)	**6.51** (4.76-8.36)
12-hr	**1.82** (1.64-2.05)	**2.06** (1.84-2.32)	**2.49** (2.23-2.81)	**2.90** (2.58-3.29)	**3.54** (3.09-4.19)	**4.09** (3.47-4.87)	**4.68** (3.84-5.70)	**5.34** (4.21-6.64)	**6.29** (4.77-7.98)	**7.06** (5.19-9.00)
24-hr	**2.10** (1.89-2.34)	**2.35** (2.12-2.63)	**2.82** (2.54-3.16)	**3.26** (2.91-3.66)	**3.93** (3.44-4.60)	**4.50** (3.83-5.31)	**5.11** (4.22-6.16)	**5.78** (4.58-7.12)	**6.74** (5.15-8.49)	**7.53** (5.57-9.53)
2-day	**2.37** (2.15-2.63)	**2.69** (2.44-2.99)	**3.26** (2.94-3.62)	**3.76** (3.38-4.20)	**4.50** (3.95-5.21)	**5.12** (4.38-5.97)	**5.76** (4.77-6.87)	**6.46** (5.14-7.87)	**7.42** (5.69-9.26)	**8.20** (6.11-10.3)
3-day	**2.59** (2.36-2.86)	**2.93** (2.67-3.24)	**3.52** (3.19-3.90)	**4.04** (3.65-4.49)	**4.81** (4.23-5.54)	**5.44** (4.67-6.32)	**6.11** (5.08-7.24)	**6.82** (5.45-8.27)	**7.81** (6.01-9.69)	**8.59** (6.43-10.8)
4-day	**2.79** (2.55-3.07)	**3.14** (2.86-3.46)	**3.74** (3.40-4.13)	**4.28** (3.87-4.74)	**5.06** (4.46-5.81)	**5.71** (4.92-6.61)	**6.39** (5.32-7.55)	**7.11** (5.70-8.60)	**8.12** (6.27-10.0)	**8.93** (6.70-11.1)
7-day	**3.31** (3.04-3.62)	**3.70** (3.39-4.05)	**4.36** (3.99-4.79)	**4.95** (4.49-5.45)	**5.79** (5.13-6.59)	**6.48** (5.61-7.45)	**7.21** (6.03-8.46)	**7.97** (6.42-9.57)	**9.03** (7.01-11.1)	**9.87** (7.45-12.2)
10-day	**3.77** (3.47-4.11)	**4.20** (3.86-4.58)	**4.92** (4.51-5.38)	**5.54** (5.05-6.09)	**6.45** (5.72-7.29)	**7.17** (6.22-8.21)	**7.93** (6.66-9.26)	**8.73** (7.05-10.4)	**9.82** (7.65-12.0)	**10.7** (8.10-13.2)
20-day	**5.12** (4.74-5.55)	**5.64** (5.22-6.11)	**6.51** (6.00-7.07)	**7.24** (6.64-7.89)	**8.28** (7.37-9.26)	**9.09** (7.93-10.3)	**9.93** (8.38-11.5)	**10.8** (8.76-12.8)	**12.0** (9.36-14.5)	**12.8** (9.81-15.8)
30-day	**6.29** (5.85-6.79)	**6.91** (6.42-7.46)	**7.92** (7.33-8.57)	**8.76** (8.06-9.50)	**9.90** (8.84-11.0)	**10.8** (9.43-12.1)	**11.7** (9.88-13.4)	**12.6** (10.2-14.8)	**13.7** (10.8-16.5)	**14.6** (11.2-17.9)
45-day	**7.84** (7.31-8.41)	**8.61** (8.02-9.24)	**9.83** (9.13-10.6)	**10.8** (9.99-11.7)	**12.1** (10.8-13.3)	**13.1** (11.5-14.6)	**14.0** (11.9-16.0)	**14.9** (12.2-17.4)	**16.1** (12.7-19.2)	**16.9** (13.0-20.6)
60-day	**9.19** (8.59-9.84)	**10.1** (9.45-10.8)	**11.5** (10.8-12.4)	**12.7** (11.7-13.6)	**14.1** (12.6-15.5)	**15.2** (13.3-16.8)	**16.1** (13.7-18.3)	**17.0** (13.9-19.8)	**18.1** (14.3-21.6)	**18.9** (14.6-22.9)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

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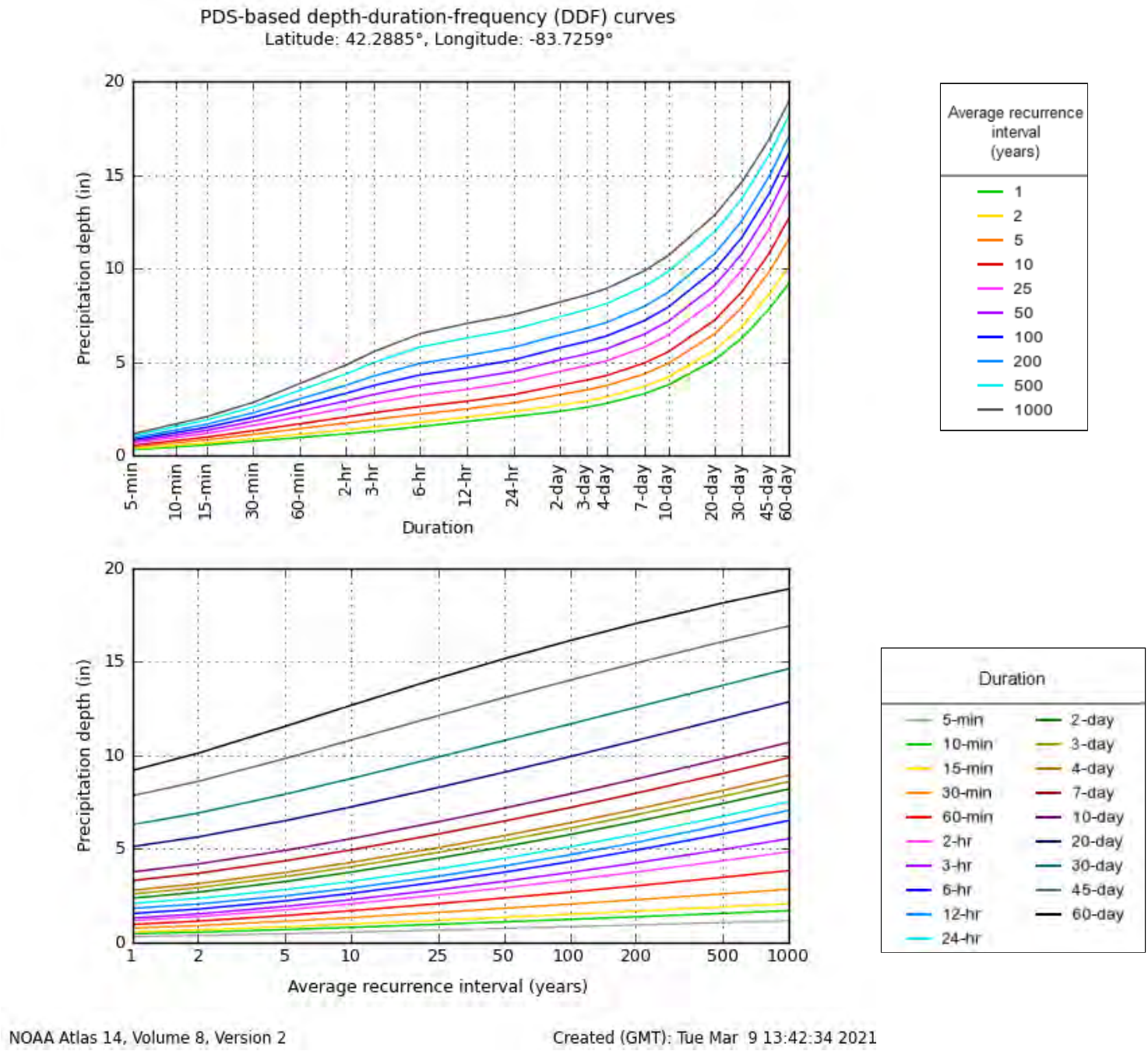
PF graphical



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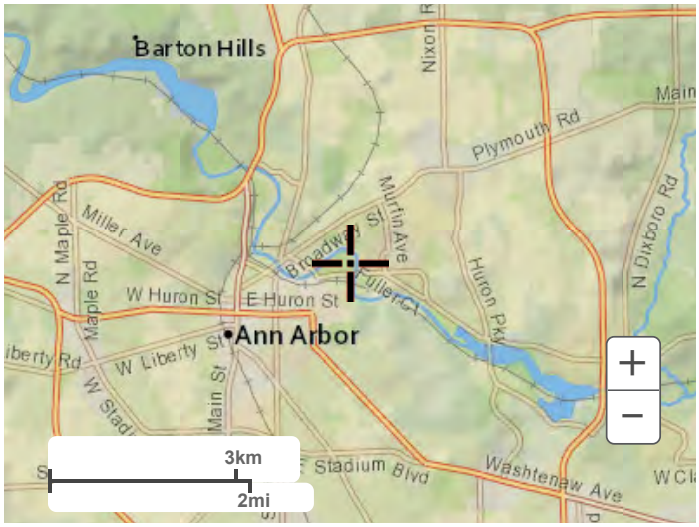
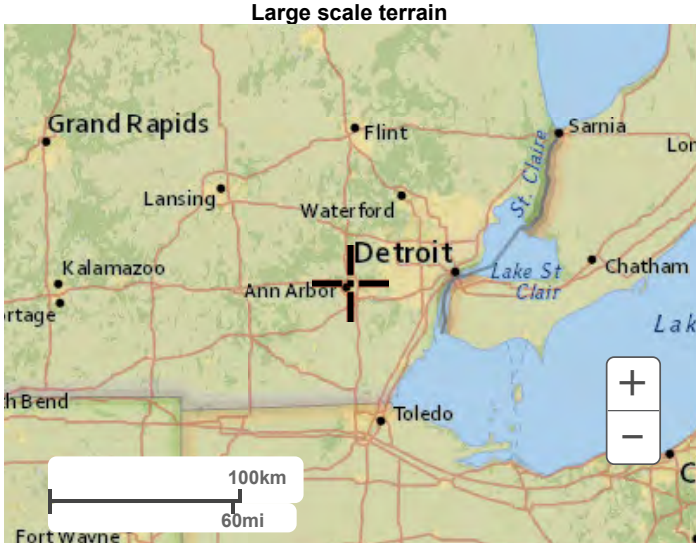
Maps & aerials

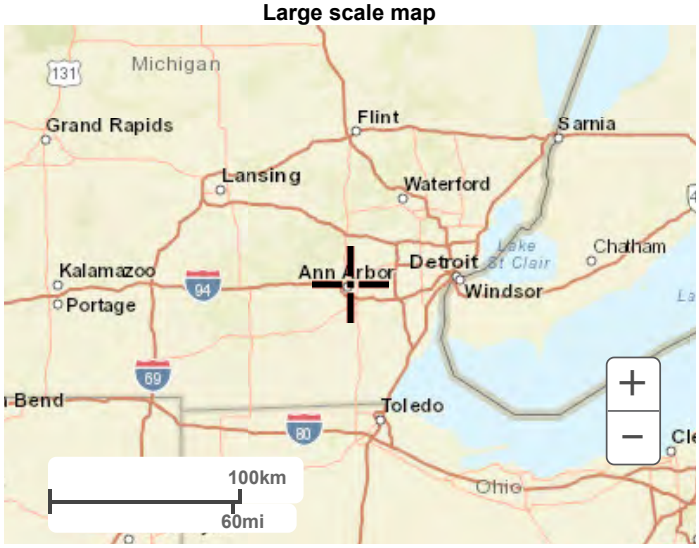
Small scale terrain



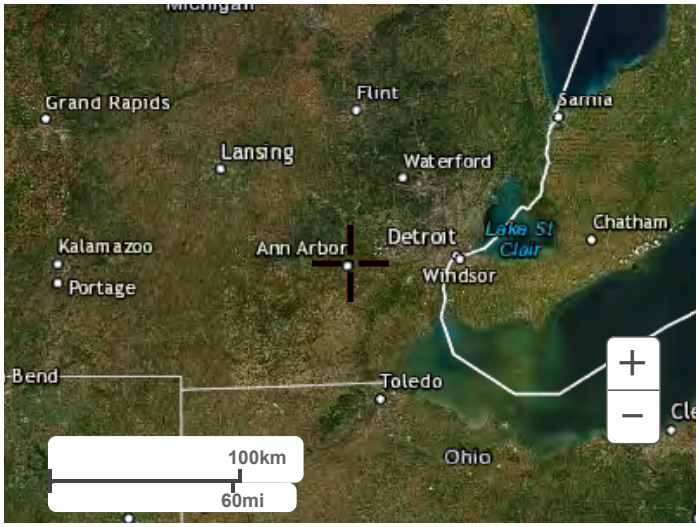
Large scale terrain



Large scale map



Large scale aerial



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Silver Spring, MD 20910
Questions?: HDSC.Questions@noaa.gov

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NOAA Atlas 14, Volume 8, Version 2
Location name: Dearborn, Michigan, USA*
Latitude: 42.3206°, Longitude: -83.2354°
Elevation: 606.57 ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Deborah Martin, Sandra Pavlovic, Ishani Roy, Michael St. Laurent, Carl Trypaluk, Dale Unruh, Michael Yekta, Geoffery Bonnin

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	**0.307** (0.238-0.397)	**0.363** (0.281-0.470)	**0.457** (0.353-0.593)	**0.537** (0.412-0.698)	**0.650** (0.484-0.862)	**0.739** (0.538-0.986)	**0.830** (0.585-1.12)	**0.924** (0.627-1.27)	**1.05** (0.687-1.46)	**1.15** (0.733-1.61)
10-min	**0.449** (0.348-0.582)	**0.532** (0.411-0.689)	**0.670** (0.516-0.868)	**0.787** (0.603-1.02)	**0.952** (0.708-1.26)	**1.08** (0.787-1.44)	**1.22** (0.857-1.64)	**1.35** (0.917-1.86)	**1.54** (1.01-2.14)	**1.68** (1.07-2.36)
15-min	**0.548** (0.424-0.709)	**0.649** (0.502-0.840)	**0.817** (0.630-1.06)	**0.959** (0.736-1.25)	**1.16** (0.864-1.54)	**1.32** (0.960-1.76)	**1.48** (1.05-2.00)	**1.65** (1.12-2.26)	**1.88** (1.23-2.62)	**2.05** (1.31-2.88)
30-min	**0.760** (0.589-0.984)	**0.899** (0.695-1.16)	**1.13** (0.872-1.47)	**1.33** (1.02-1.73)	**1.61** (1.20-2.13)	**1.83** (1.33-2.44)	**2.06** (1.45-2.78)	**2.29** (1.55-3.14)	**2.61** (1.71-3.63)	**2.85** (1.82-4.00)
60-min	**0.971** (0.752-1.26)	**1.15** (0.889-1.49)	**1.45** (1.12-1.88)	**1.71** (1.31-2.22)	**2.08** (1.55-2.76)	**2.37** (1.72-3.16)	**2.67** (1.88-3.61)	**2.98** (2.02-4.09)	**3.41** (2.23-4.75)	**3.74** (2.38-5.24)
2-hr	**1.18** (0.925-1.51)	**1.40** (1.10-1.79)	**1.77** (1.38-2.27)	**2.09** (1.62-2.68)	**2.54** (1.92-3.34)	**2.91** (2.14-3.84)	**3.28** (2.34-4.40)	**3.67** (2.52-4.99)	**4.20** (2.78-5.81)	**4.62** (2.98-6.43)
3-hr	**1.31** (1.03-1.66)	**1.55** (1.22-1.97)	**1.96** (1.54-2.49)	**2.31** (1.80-2.95)	**2.82** (2.14-3.68)	**3.23** (2.39-4.24)	**3.65** (2.62-4.87)	**4.09** (2.83-5.54)	**4.70** (3.13-6.47)	**5.18** (3.36-7.17)
6-hr	**1.54** (1.23-1.94)	**1.80** (1.44-2.26)	**2.26** (1.79-2.83)	**2.65** (2.09-3.34)	**3.23** (2.49-4.19)	**3.71** (2.79-4.83)	**4.21** (3.06-5.56)	**4.74** (3.31-6.36)	**5.47** (3.69-7.47)	**6.06** (3.98-8.31)
12-hr	**1.80** (1.45-2.23)	**2.07** (1.66-2.56)	**2.53** (2.03-3.14)	**2.95** (2.36-3.68)	**3.58** (2.80-4.60)	**4.10** (3.13-5.30)	**4.66** (3.44-6.11)	**5.26** (3.73-7.01)	**6.11** (4.17-8.27)	**6.78** (4.50-9.22)
24-hr	**2.07** (1.69-2.53)	**2.35** (1.92-2.88)	**2.86** (2.32-3.50)	**3.32** (2.68-4.07)	**4.00** (3.15-5.07)	**4.56** (3.51-5.82)	**5.16** (3.85-6.70)	**5.81** (4.17-7.67)	**6.73** (4.65-9.03)	**7.46** (5.01-10.1)
2-day	**2.35** (1.94-2.84)	**2.70** (2.22-3.26)	**3.28** (2.70-3.97)	**3.80** (3.11-4.61)	**4.55** (3.62-5.68)	**5.16** (4.01-6.49)	**5.80** (4.37-7.42)	**6.48** (4.69-8.43)	**7.42** (5.18-9.84)	**8.16** (5.54-10.9)
3-day	**2.58** (2.15-3.10)	**2.94** (2.44-3.53)	**3.56** (2.94-4.27)	**4.09** (3.37-4.93)	**4.86** (3.90-6.02)	**5.49** (4.30-6.85)	**6.14** (4.65-7.79)	**6.82** (4.97-8.82)	**7.76** (5.45-10.2)	**8.51** (5.82-11.3)
4-day	**2.79** (2.33-3.32)	**3.16** (2.63-3.76)	**3.79** (3.15-4.52)	**4.33** (3.58-5.19)	**5.12** (4.12-6.30)	**5.75** (4.52-7.14)	**6.41** (4.88-8.09)	**7.10** (5.20-9.13)	**8.05** (5.68-10.6)	**8.79** (6.04-11.6)
7-day	**3.30** (2.78-3.89)	**3.71** (3.12-4.37)	**4.39** (3.69-5.19)	**4.97** (4.16-5.90)	**5.81** (4.71-7.06)	**6.47** (5.14-7.95)	**7.16** (5.50-8.95)	**7.87** (5.82-10.0)	**8.85** (6.30-11.5)	**9.61** (6.67-12.6)
10-day	**3.76** (3.19-4.40)	**4.19** (3.56-4.91)	**4.92** (4.16-5.78)	**5.54** (4.66-6.53)	**6.42** (5.24-7.75)	**7.11** (5.68-8.67)	**7.82** (6.05-9.71)	**8.56** (6.36-10.8)	**9.56** (6.85-12.4)	**10.3** (7.22-13.5)
20-day	**5.10** (4.38-5.90)	**5.62** (4.82-6.50)	**6.47** (5.54-7.50)	**7.18** (6.11-8.35)	**8.17** (6.74-9.71)	**8.94** (7.22-10.7)	**9.72** (7.60-11.9)	**10.5** (7.90-13.1)	**11.6** (8.38-14.8)	**12.4** (8.74-16.0)
30-day	**6.27** (5.43-7.19)	**6.89** (5.95-7.90)	**7.88** (6.79-9.05)	**8.69** (7.45-10.0)	**9.79** (8.12-11.5)	**10.6** (8.63-12.7)	**11.5** (9.01-13.9)	**12.3** (9.29-15.2)	**13.4** (9.73-16.9)	**14.1** (10.1-18.2)
45-day	**7.81** (6.81-8.88)	**8.58** (7.47-9.76)	**9.80** (8.51-11.2)	**10.8** (9.30-12.3)	**12.0** (10.0-14.0)	**13.0** (10.6-15.3)	**13.9** (11.0-16.7)	**14.7** (11.2-18.1)	**15.8** (11.6-19.9)	**16.5** (11.9-21.2)
60-day	**9.15** (8.02-10.3)	**10.1** (8.83-11.4)	**11.5** (10.1-13.1)	**12.7** (11.0-14.4)	**14.1** (11.8-16.3)	**15.1** (12.4-17.7)	**16.1** (12.8-19.2)	**16.9** (12.9-20.7)	**18.0** (13.2-22.5)	**18.7** (13.4-23.8)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

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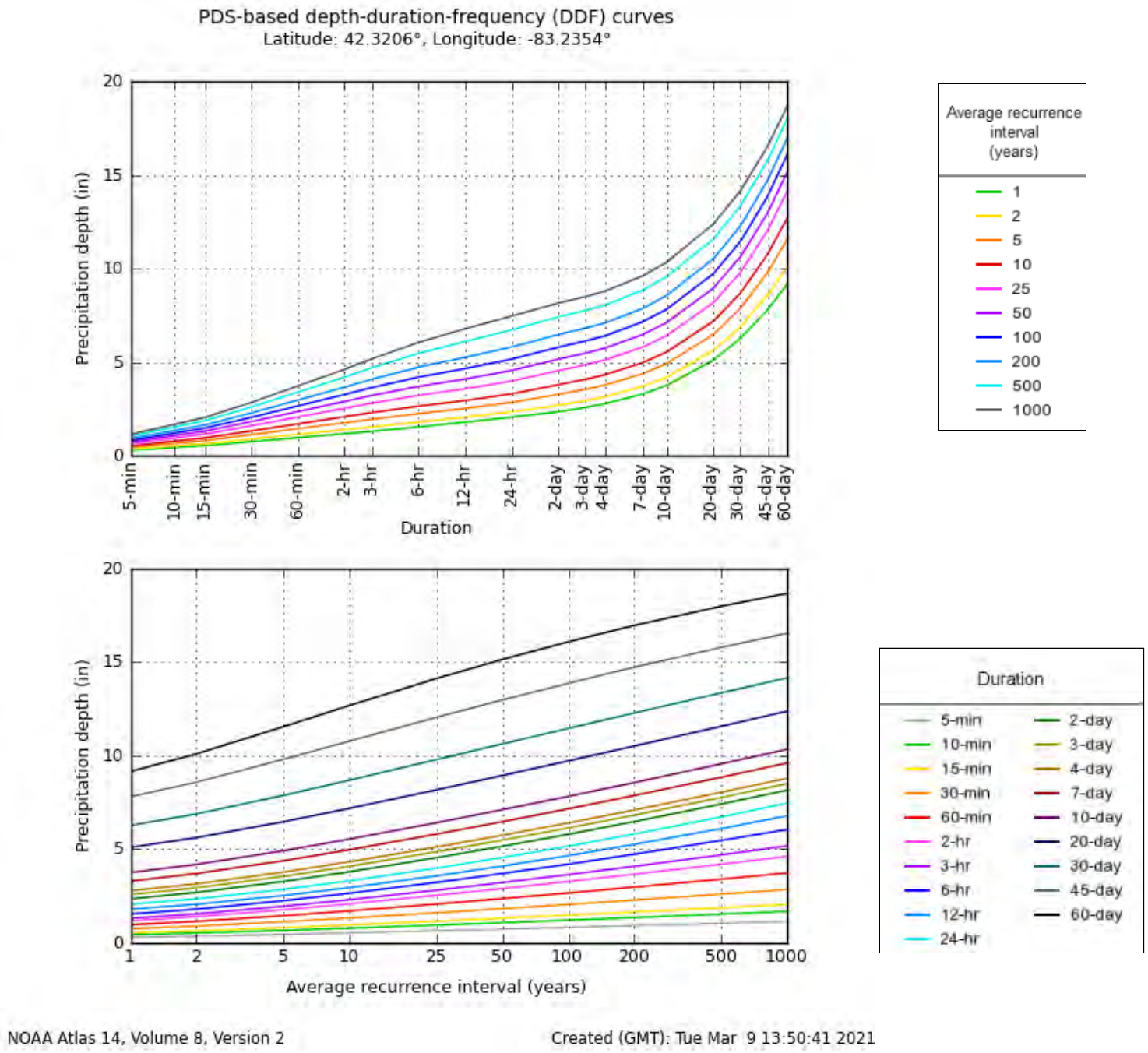
PF graphical



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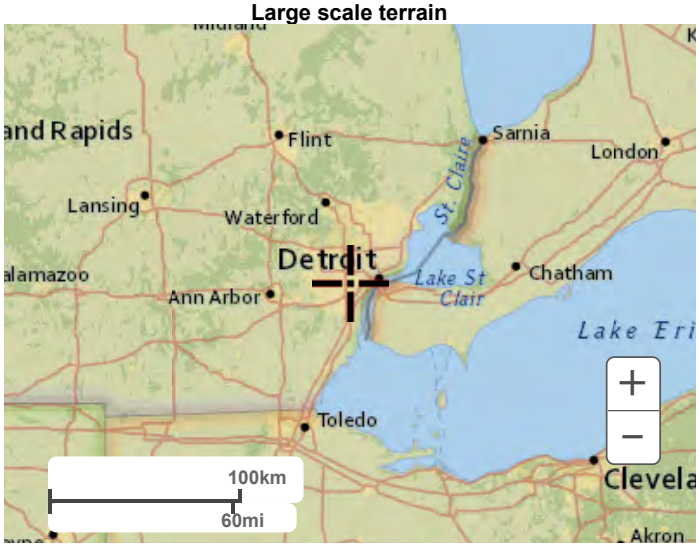
Maps & aerials

Small scale terrain

Large scale terrain



Large scale map

Large scale aerial

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NOAA Atlas 14, Volume 8, Version 2
Location name: Flint, Michigan, USA*
Latitude: 43.0194°, Longitude: -83.688°
Elevation: 717.05 ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Deborah Martin, Sandra Pavlovic, Ishani Roy, Michael St. Laurent, Carl Trypaluk, Dale Unruh, Michael Yekta, Geoffery Bonnin

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	**0.284** (0.234-0.351)	**0.335** (0.276-0.415)	**0.422** (0.346-0.524)	**0.497** (0.405-0.620)	**0.606** (0.475-0.781)	**0.692** (0.528-0.903)	**0.782** (0.573-1.04)	**0.877** (0.611-1.20)	**1.01** (0.671-1.41)	**1.11** (0.716-1.57)
10-min	**0.415** (0.342-0.514)	**0.490** (0.404-0.608)	**0.618** (0.506-0.767)	**0.728** (0.593-0.908)	**0.887** (0.696-1.14)	**1.01** (0.773-1.32)	**1.15** (0.839-1.53)	**1.28** (0.895-1.75)	**1.47** (0.982-2.06)	**1.62** (1.05-2.29)
15-min	**0.506** (0.417-0.627)	**0.598** (0.492-0.741)	**0.754** (0.618-0.936)	**0.888** (0.723-1.11)	**1.08** (0.848-1.40)	**1.24** (0.943-1.61)	**1.40** (1.02-1.86)	**1.57** (1.09-2.14)	**1.80** (1.20-2.51)	**1.98** (1.28-2.80)
30-min	**0.729** (0.601-0.903)	**0.863** (0.710-1.07)	**1.09** (0.893-1.35)	**1.28** (1.05-1.60)	**1.56** (1.23-2.02)	**1.79** (1.36-2.33)	**2.02** (1.48-2.69)	**2.26** (1.57-3.08)	**2.59** (1.72-3.62)	**2.84** (1.84-4.02)
60-min	**0.956** (0.788-1.18)	**1.14** (0.935-1.41)	**1.45** (1.19-1.80)	**1.72** (1.40-2.14)	**2.11** (1.66-2.73)	**2.43** (1.85-3.17)	**2.76** (2.02-3.68)	**3.11** (2.17-4.25)	**3.60** (2.40-5.04)	**3.98** (2.57-5.63)
2-hr	**1.18** (0.982-1.45)	**1.41** (1.17-1.73)	**1.80** (1.49-2.22)	**2.15** (1.76-2.66)	**2.66** (2.11-3.41)	**3.07** (2.36-3.98)	**3.51** (2.59-4.65)	**3.97** (2.79-5.39)	**4.61** (3.10-6.41)	**5.12** (3.33-7.19)
3-hr	**1.32** (1.10-1.62)	**1.57** (1.31-1.92)	**2.01** (1.67-2.46)	**2.40** (1.98-2.96)	**2.99** (2.38-3.84)	**3.48** (2.69-4.50)	**3.99** (2.97-5.28)	**4.55** (3.22-6.16)	**5.32** (3.60-7.39)	**5.95** (3.89-8.32)
6-hr	**1.57** (1.32-1.90)	**1.83** (1.53-2.22)	**2.30** (1.92-2.80)	**2.75** (2.28-3.35)	**3.43** (2.77-4.40)	**4.02** (3.15-5.19)	**4.66** (3.50-6.15)	**5.36** (3.84-7.24)	**6.37** (4.36-8.81)	**7.19** (4.75-9.99)
12-hr	**1.83** (1.55-2.20)	**2.06** (1.74-2.47)	**2.51** (2.12-3.02)	**2.96** (2.48-3.58)	**3.69** (3.03-4.73)	**4.35** (3.44-5.60)	**5.07** (3.86-6.67)	**5.89** (4.26-7.93)	**7.09** (4.90-9.77)	**8.08** (5.38-11.2)
24-hr	**2.07** (1.77-2.47)	**2.31** (1.97-2.75)	**2.79** (2.37-3.33)	**3.27** (2.76-3.92)	**4.07** (3.36-5.17)	**4.78** (3.82-6.11)	**5.58** (4.28-7.30)	**6.49** (4.74-8.69)	**7.83** (5.46-10.7)	**8.94** (6.01-12.3)
2-day	**2.32** (1.99-2.73)	**2.64** (2.26-3.11)	**3.24** (2.77-3.83)	**3.82** (3.24-4.53)	**4.74** (3.93-5.93)	**5.54** (4.45-6.99)	**6.42** (4.95-8.29)	**7.40** (5.44-9.80)	**8.82** (6.20-12.0)	**10.00** (6.78-13.6)
3-day	**2.53** (2.19-2.97)	**2.88** (2.48-3.37)	**3.52** (3.02-4.14)	**4.14** (3.53-4.88)	**5.10** (4.24-6.33)	**5.93** (4.78-7.43)	**6.84** (5.30-8.77)	**7.84** (5.79-10.3)	**9.30** (6.56-12.5)	**10.5** (7.15-14.2)
4-day	**2.73** (2.36-3.18)	**3.08** (2.66-3.60)	**3.74** (3.22-4.38)	**4.36** (3.73-5.13)	**5.34** (4.45-6.60)	**6.18** (5.00-7.71)	**7.10** (5.52-9.07)	**8.11** (6.01-10.6)	**9.58** (6.79-12.9)	**10.8** (7.37-14.6)
7-day	**3.22** (2.80-3.73)	**3.59** (3.12-4.16)	**4.27** (3.70-4.97)	**4.92** (4.23-5.74)	**5.92** (4.96-7.25)	**6.78** (5.51-8.39)	**7.72** (6.03-9.78)	**8.75** (6.52-11.4)	**10.2** (7.30-13.7)	**11.5** (7.89-15.4)
10-day	**3.65** (3.19-4.21)	**4.05** (3.54-4.67)	**4.78** (4.16-5.54)	**5.47** (4.73-6.35)	**6.52** (5.48-7.93)	**7.41** (6.05-9.12)	**8.39** (6.58-10.6)	**9.45** (7.07-12.2)	**11.0** (7.86-14.6)	**12.2** (8.45-16.4)
20-day	**4.90** (4.32-5.60)	**5.45** (4.80-6.23)	**6.42** (5.63-7.35)	**7.28** (6.34-8.38)	**8.55** (7.22-10.2)	**9.60** (7.89-11.7)	**10.7** (8.46-13.3)	**11.9** (8.97-15.2)	**13.6** (9.80-17.9)	**14.9** (10.4-19.9)
30-day	**6.01** (5.32-6.83)	**6.69** (5.92-7.61)	**7.85** (6.92-8.95)	**8.86** (7.76-10.1)	**10.3** (8.72-12.2)	**11.5** (9.44-13.8)	**12.7** (10.0-15.6)	**13.9** (10.5-17.7)	**15.7** (11.3-20.4)	**17.0** (11.9-22.5)
45-day	**7.49** (6.67-8.46)	**8.34** (7.41-9.42)	**9.72** (8.61-11.0)	**10.9** (9.57-12.4)	**12.5** (10.6-14.7)	**13.7** (11.3-16.4)	**15.0** (11.9-18.3)	**16.3** (12.3-20.5)	**18.0** (13.0-23.3)	**19.3** (13.6-25.4)
60-day	**8.82** (7.87-9.92)	**9.78** (8.72-11.0)	**11.3** (10.1-12.8)	**12.6** (11.1-14.3)	**14.3** (12.1-16.6)	**15.6** (12.9-18.4)	**16.8** (13.4-20.4)	**18.1** (13.7-22.6)	**19.6** (14.3-25.3)	**20.8** (14.8-27.4)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

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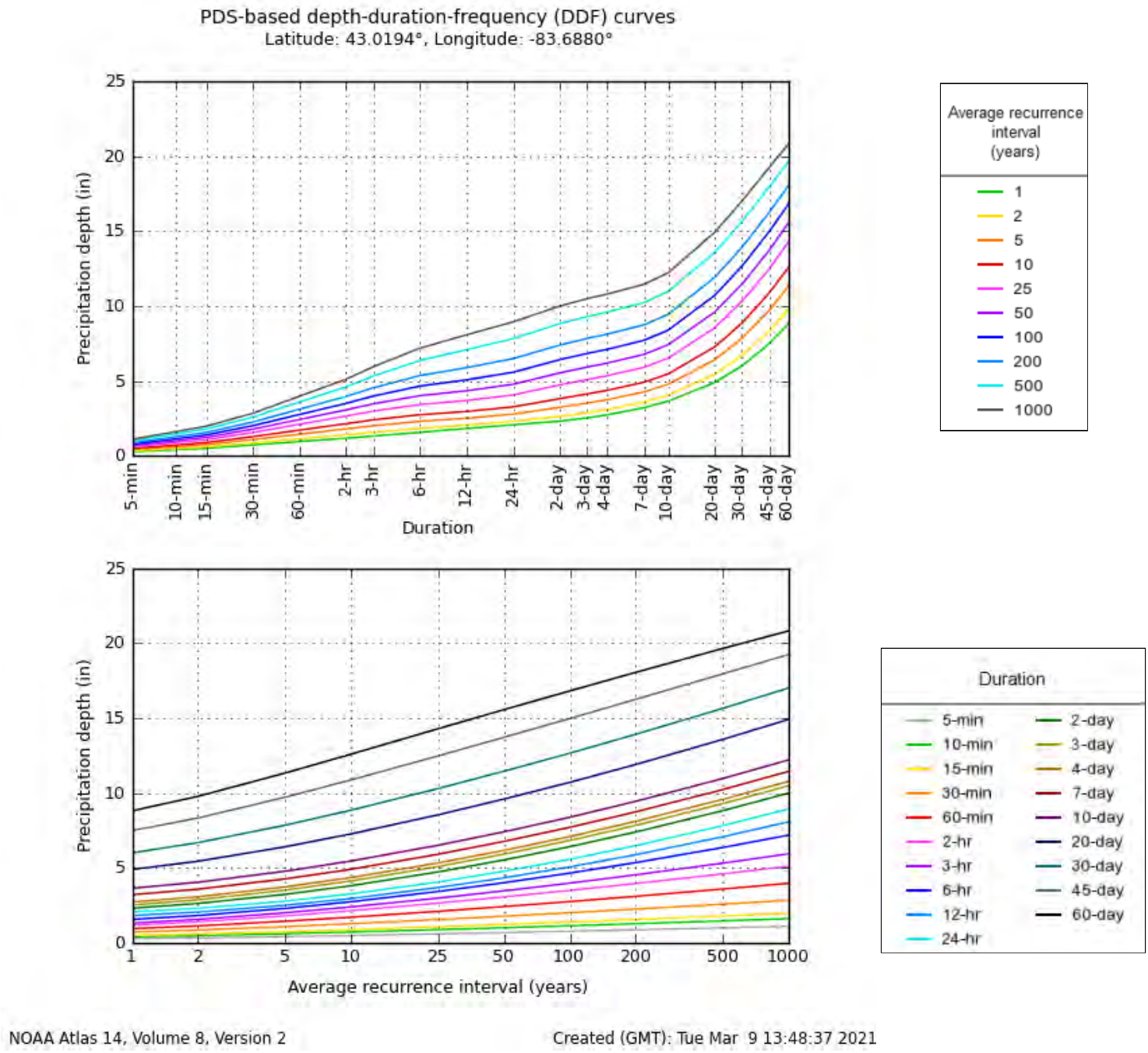
PF graphical



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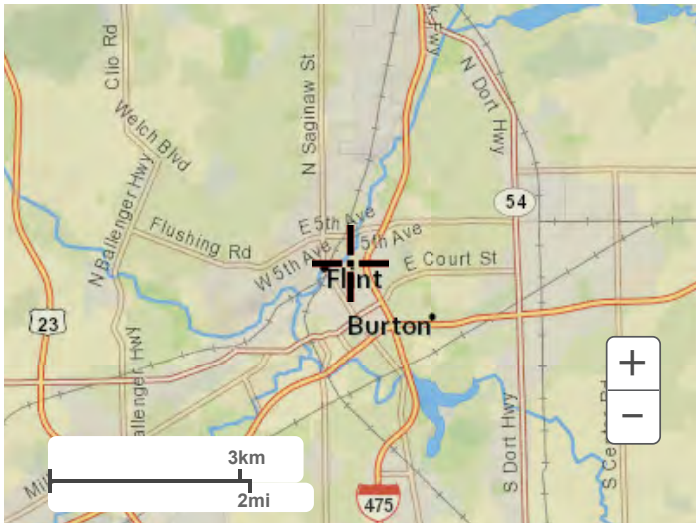
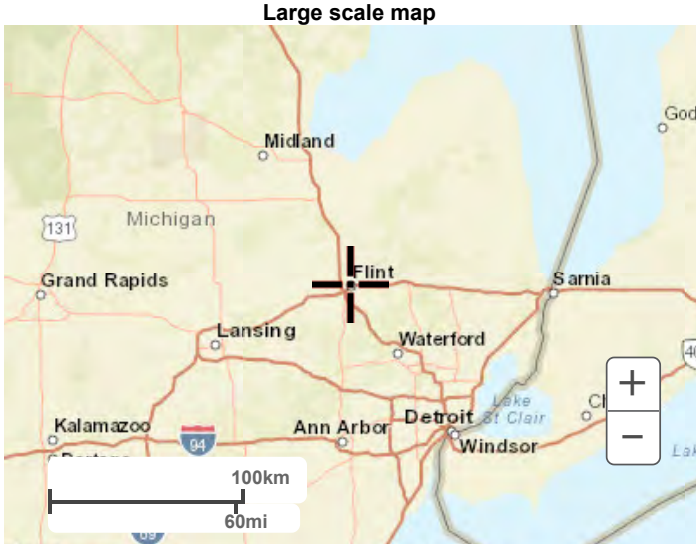
Maps & aerials

Small scale terrain

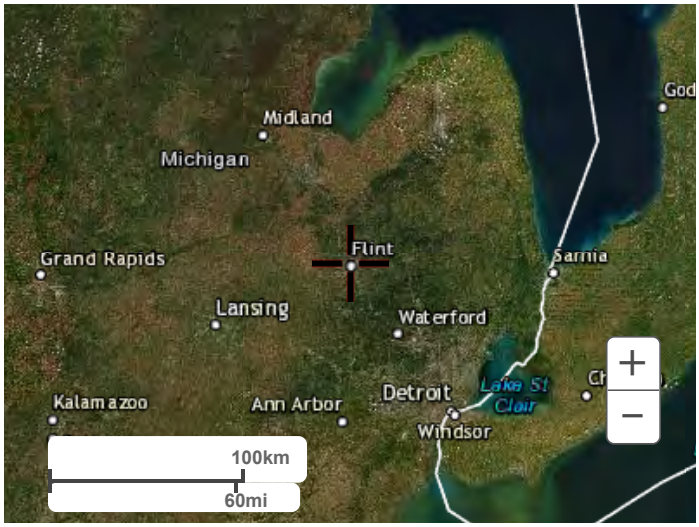


Large scale terrain

Large scale map



Large scale aerial



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Silver Spring, MD 20910
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Attachment D

Computing Flood Discharges for Small Ungaged Watersheds

June 2010 - MDEQ

Computing Flood Discharges

For Small Ungaged Watersheds

Peak Discharge Calculations:

Watercourse	Clear Creek	
Drainage Area	18.23	sq. mile
Cont Drainage Area	16.80	sq. mile
Basin Number	12	
Basin Name	Clinton	
Quad	P23SW	
Section	14	Insert information in
Town/Range	T03NR03E	green cells.
Latitude	42.222222	Place your cursor over
Longitude	-84.111111	the red triangles for
County	Macomb	additional tips.
Township	Ray	
Location	First Street	
Job Number	29990999	
By	Smith	
Date	Jun-04-2010	

Frequency	*50%*	*20%*	*10%*	*4%*	*2%*	*1%*	*0.50%*	*0.20%*
Discharge (cfs)	192	317	415	553	665	786	914	1100
Volume (Acre-ft)	389	644	842	1122	1350	1595	1854	2232
Ponding								
% throughout/mid	*2.1*	2.1	2.1	2.1	2.1	2.1	2.1	2.1
% upper reaches	*0*	0	0	0	0	0	0	0
% design point	*0*	0	0	0	0	0	0	0
Ponding Adjustment	0.77	0.78	0.80	0.82	0.84	0.86	0.88	0.90
Adjusted Flow (cfs)	148	247	332	453	560	679	800	985

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Land and Water Management Division
June 22, 2010
www.michigan.gov/hydrology

This report supersedes and replaces all previous versions that describe this method, including *Computing Flood Discharges For Small Ungaged Watersheds* (Sorrell and Hamilton, September 1991, July 2000, October 2001; *Computing Flood Discharges For Small Ungaged Watersheds* (Sorrell, July 2003 and June 2008), as well as *SCS UD-21 Method* (Sorrell, 1980 and 1985).

Revisions Summary

January 2010: Clarifies that the Appendix B hydrologic soil groups are not current and provides reference for current soils data. Clarifies maximum length for sheet flow and use of ponding adjustment at design point. Presents ordinates of Michigan unit hydrograph for use in WinTR-55. Changes unit hydrograph peak designation from Q_{up} as q_p' to match SCS designation. Contact: Linda Burke, 517-241-3720.

August 2008: Clarifies the minimum T_c applicable to the Michigan Unit hydrograph and designate the unit hydrograph peak as Q_{up} instead of Q_p. Contact: Dave Fongers, 517-373-0210.

June 2008: Revises three curve numbers that were less than 30 up to 30 (on Table 6-1) to reflect revised Natural Resources Conservation Service guidance, http://directives.sc.egov.usda.gov/media/pdf/H_210_630_9.pdf. Contact: Dave Fongers, 517-373-0210.

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Computing Flood Discharges
For Small Ungaged Watersheds

1. Introduction

Concern for potential flooding is a critical factor in the safe design of water-related projects. The magnitudes of floods are described by flood discharge, flood elevation, and flood volume. This report will detail a procedure that can be used to estimate both the discharge and volume of a flood given a design rainfall and a physical description of the watershed.

There are a variety of methods for estimating design floods. They can be grouped into three general categories.

1. Statistical analysis of gage data
   This method is used for streams which have a number of years of recorded flood data. It involves fitting a probability distribution to the data (usually the log-Pearson Type III) and using the parameters of the distribution to estimate large floods. Since this method utilizes actual flood data, it is generally regarded as the best estimator of design floods and should be used whenever possible.

2. Regression analysis
   This method involves correlating watershed characteristics to streamflow using data from a number of gaged streams. The predicting equation derived from this type of analysis usually expresses flood discharge as a function of multiple watershed characteristics. These equations almost always include drainage area as the most significant factor and may also include channel slope, precipitation intensity, and other characteristics related to land uses, soil types, and geologic formations in the watershed. This method can be used for ungaged stream locations.

3. Unit hydrograph techniques
   This method involves determining the peak rate of runoff, q_p', expressed in cubic feet per second (cfs) per inch of runoff from a given drainage area. This factor is primarily a function of the time it takes for runoff to travel through the basin to the design point. Once this rate of runoff is determined, it can be multiplied by the amount of runoff to produce a discharge. The versatility of this method is that it can account for changes in watershed travel time, and subsequently q_p', that are caused by alterations in the hydraulic capacity of the stream, such as channel maintenance operations, flood control structures, etc. The volume of runoff from a given amount of rainfall can also be adjusted to reflect changing land use within a watershed. This method is suitable for ungaged watersheds.

4. Drainage Area Ratio method
   Flows can be estimated if the flows are known at an upstream or downstream location using a drainage area ratio equation. Contact DNRE Hydrologic Studies program staff for more information.

This report presents a method for computing flood discharges using unit hydrograph (UH) techniques. The procedure is similar to that developed by the U.S. Department of Agriculture Soil Conservation Service (SCS), now known as the Natural Resource Conservation Service (NRCS). The "SCS Method" is described in the NRCS National Engineering Handbook (NEH), Part 630: Hydrology (2004).

The advantage of this method is that it is straightforward to apply and the physical parameters are easily determined. The primary disadvantage is that the method presented here is only valid for use with a 24-hour rainfall. For other rainfall durations, one should follow the full procedure in the NRCS reference. This method should also be limited to watersheds with a drainage area of approximately 20 square miles or less. One of the reasons for this limit is that UH theory assumes uniform rainfall and runoff from the entire drainage basin. This assumption is less reliable if the drainage area becomes too large. If a large watershed is being analyzed, it should be divided into subbasins and the flows from the individual sub-areas routed to the design location.

The SCS Method is also less accurate in cases where a large fraction of precipitation infiltrates into the ground, or for small rainfall values. In both cases, runoff is a small fraction of precipitation. Therefore, the SCS Method is not recommended to estimate low flows or small, more frequent flood flows. (See Hawkins, et. al., 1985, for a precise measure of "small".)

The physical description of the watershed includes drainage area, soil types, land uses, and time of concentration. These are discussed in subsequent sections of this report.

A comprehensive application of the SCS Method is presented in Appendix A.

2. The Unit Hydrograph

The unit hydrograph (UH) theory was first proposed by Sherman (1932). It is defined as a surface runoff hydrograph (SRH) resulting from one inch of excess rainfall generated uniformly over the drainage area at a constant rate for an effective unit time duration. Sherman originally used the word "unit" to denote a unit of time, but since then it has often been interpreted as a unit depth of excess rainfall. Sherman classified streamflow into surface runoff and groundwater runoff or baseflow. The UH is defined for use only with surface runoff. When analyzing a recorded flood hydrograph, the baseflow contribution should be subtracted from the total flow before deriving the UH. Likewise, when using a UH to compute a design flow, a baseflow should be added to obtain the total design discharge.

The following basic assumptions are inherent to the UH:

1. The excess rainfall has a constant intensity within the unit duration.

2. The excess rainfall is uniformly distributed throughout the whole drainage area.

3. The base time of the SRH (the duration of surface runoff) resulting from an excess rainfall of a given duration is constant.

4. The ordinates of all SRH of a common base time are directly proportional to the total amount of surface runoff represented by each hydrograph.

5. For a given watershed, the hydrograph resulting from a given excess rainfall reflects the unchanging characteristics of the watershed.

Assumption 3 implies that all 24-hour rainfalls will produce a SRH where the time to peak and base time of the SRH remain constant. Assumption 4 implies that if the ordinates of the UH represent one inch of runoff, then a hydrograph representing two inches of runoff is obtained by simply multiplying each ordinate of the UH by two. If all unit hydrographs conform to a constant shape, that is, a constant amount of volume under the rising limb of the UH, then both the time and discharge ordinates can be normalized to produce a dimensionless UH. The SCS examined many hydrographs nationwide and computed a standard dimensionless UH which has 37.5 percent of the volume under the rising limb. This volume has been known to vary, according to the SCS, in the range of 23 to 45 percent.

Over the years, use of the SCS dimensionless hydrograph consistently overestimates discharges when compared to recorded gage flows for Michigan streams. To partially compensate for this, the SCS Type I rainfall distribution has been used in place of the recommended, but more intense, Type II distribution. A review of hourly rainfall data shows, however, that the Type II distribution is the appropriate one to use. Therefore, a study has been done to evaluate whether the shape of the standard SCS dimensionless UH is applicable to Michigan streams.

This study involved 24 gaged streams with drainage areas less than 50 square miles. Seventy-four different flood events were analyzed. The results from this study demonstrate that the recorded floods are best reproduced if the SCS UH is revised to have 28.5 percent of the volume under the rising limb. This value is within the SCS-acknowledged range for this parameter.

3. Design Rainfall

Atlases are available from various governmental agencies which provide design rainfall amounts for durations from 30 minutes to 24 hours and recurrence intervals from 1 to 100 years. Normal practice in Michigan has been to use 24 hours as the design rainfall duration.

Formerly, rainfall amounts were taken almost exclusively from Hershfield (1961), commonly known as the U.S. Weather Bureau's Technical Paper 40 (TP-40).

However, rainfall amounts well in excess of the frequency predicted by TP-40 have been occurring in Michigan and throughout the country for a number of years. Part of the reason may be that TP-40 utilized a shorter data set ending in 1958. Sorrell and Hamilton (1991) analyzed 24-hour rainfall data through 1986 for Michigan gages in order to update the TP-40 information. Huff and Angel (1992) also analyzed rainfall data for the Midwest, including Michigan, for durations from 5 minutes to 10 days. The 24-hour results from these two studies are similar.

Since the Huff and Angel study cover more durations and frequencies, we recommend its use to obtain design rainfall for the method presented in this report. This study was published as the "Rainfall Frequency Atlas of the Midwest" by the Midwestern Climate Center and the Illinois State Water Survey, and is commonly known as "Bulletin 71".

The Bulletin 71 study divided the state into ten climatic zones that correspond to the weather forecast divisions used by the National Weather Service at that time. These 10 climatic zones are depicted in Figure 3.1. The rainfall frequency data for each climatic zone is presented in Table 3.1. To use this map and table, locate the design point in Figure 3.1 and use the corresponding climatic zone number to obtain the rainfall amounts from the corresponding Section in Table 3.1. If the watershed straddles two or more climatic zones, use the rainfall for the zone that contains the largest percentage of the total drainage area.

The design rainfall data are point estimates and must be adjusted if the drainage area is greater than ten square miles. The adjustment ratio, listed in Table 3.2, accounts for uncertainty in the areal distribution. These adjustment ratios are taken from Figure 21.2 in Chapter 21 of the NRCS National Engineering Handbook. Values for intermediate drainage areas may be interpolated from the table.

4. Soil Type

Soil properties influence the process of generating runoff from rainfall and must be considered in methods of runoff estimation. When runoff from an individual storm is the major concern, the properties can be represented by a hydrologic parameter which reflects the minimum rate of infiltration obtained for a bare soil after prolonged wetting. The influences of both the surface and the horizons of the soil are therefore included.

Four hydrologic soil groups are used. The soils are classified on the basis of water intake at the end of long-duration storms occurring after prior wetting and an opportunity for swelling and without the protective effects of vegetation. In the definitions to follow, the infiltration rate is the rate at which water enters the soil at the surface, which is controlled by surface conditions. The transmission rate is the rate at which the water moves downward

through the soil and is controlled by the horizons. The hydrologic soil groups, as defined by NRCS soil scientists, are:

A. Soils having high infiltration rates even when thoroughly wetted and consisting chiefly of deep, well to excessively drained sands or gravels. These soils have a high rate of water transmission.

B. Soils having moderate infiltration rates when thoroughly wetted and consisting of moderately deep to deep, moderately well to well drained soils with moderately fine to moderately coarse textures. These soils have a moderate rate of water transmission.

C. Soils having slow infiltration rates when thoroughly wetted and consisting chiefly of soils with a layer that impedes the downward movement of water or soils with moderately fine to fine texture. These soils have a slow rate of water transmission.

D. Soils having very slow infiltration rates when thoroughly wetted and consisting chiefly of clay soils with a high swelling potential, soils with a permanent high water table, soils with a claypan or clay layer at or near the surface, and shallow soils over nearly impervious material. These soils have a very slow rate of water transmission.

Figure 3.1 - Climatic Zones for Michigan

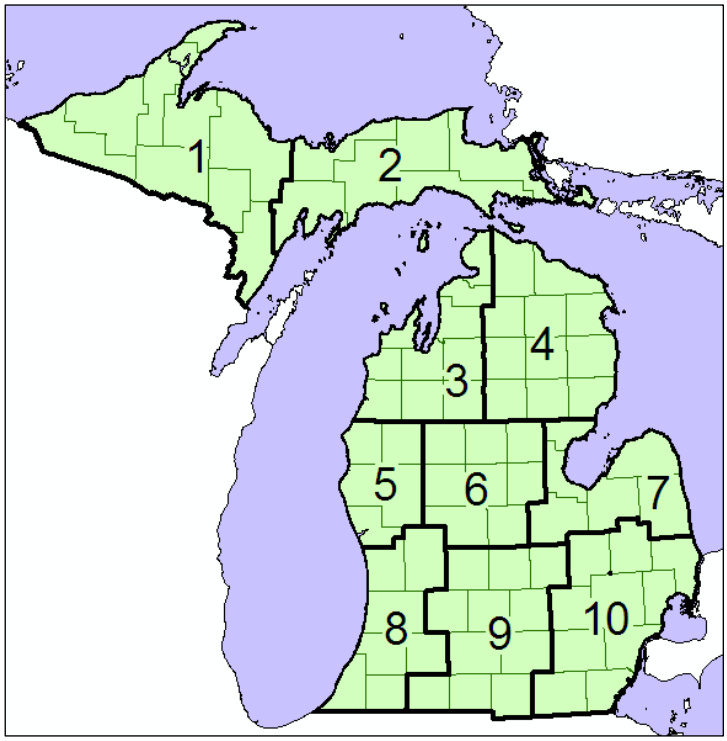

Table 3.1 - Rainfall depths corresponding to the climatic zones in Figure 3.1

Zone	Annual probability storm depth, 24-hour duration (rainfall in inches)					
	50%	20%	10%	4%	2%	1%
1	2.39	3.00	3.48	4.17	4.73	5.32
2	2.09	2.71	3.19	3.87	4.44	5.03
3	2.09	2.70	3.21	3.89	4.47	5.08
4	2.11	2.62	3.04	3.60	4.06	4.53
5	2.28	3.00	3.60	4.48	5.24	6.07
6	2.27	2.85	3.34	4.15	4.84	5.62
7	2.14	2.65	3.05	3.56	3.97	4.40
8	2.37	3.00	3.52	4.45	5.27	6.15
9	2.42	2.98	3.43	4.09	4.63	5.20
10	2.26	2.75	3.13	3.60	3.98	4.36

Table 3.2 - Ratios for areal adjustment of point rainfall

Area (mi^2)	Ratio
10	1.000
15	0.978
20	0.969
25	0.964
30	0.960
35	0.957
40	0.953

Appendix B tabulates the hydrologic soil group for many soil series as of March 1990, and is presented as an example only. See below for information on obtaining current soils data

As shown in Appendix B, in some cases, several possible hydrologic soil groupings may be listed for a soil series. When this occurs, the first hydrologic group shown is the native or natural group under which the soil series is usually classified when its water intake characteristics have not been significantly changed by artificial drainage, land use, or other factors. The second group shown is the probable maximum improvement that can be made through artificial drainage and the maintenance or improvement of soil structure. For example, the Adrian soil series is classified as D/A. This means that the natural hydrologic soil group is D. If a field inspection shows that drains and tiles have been constructed to improve the drainage or a county drain has been installed nearby, then the hydrologic soil group may be lowered to A. In general, those soils having several possible classifications are those with relatively high water tables so that artificial drainage measurably improves their ability to absorb rainfall and thus reduce runoff.

County soil surveys have been performed by the NRCS and were originally published in book form. Surveys published since 1970 show the soil type delineations superimposed on

an aerial photograph. This format allows for determining land use at the same time the soil determinations are made.

A soil's hydrologic classification may occasionally change based upon updated experimental data defining its infiltration and transmission characteristics.

The soils listed in Appendix B were last reviewed and updated in March 1990. To obtain current soils data, visit the NRCS Soil Data Mart at http://soildatamart.nrcs.usda.gov/ (this URL is current as of the date of this report).

Soils data can be downloaded at no cost as GIS shapefiles at this site, or the Web Soil Survey interactive map can be used to generate a soils map and report for any identified project site. The GIS data file must still be downloaded to access the attribute data (file name ending in .dbf) to obtain the hydrologic group for the soils complex. This file can be opened using the Excel spreadsheet program.

5. Land Use

The SCS Method evaluates the effects of the surface conditions of a watershed by means of land use and treatment classes. Land use is a means to estimate the effects of watershed cover on infiltration and runoff, and it includes most kinds of vegetation, litter, and mulch; fallow (bare) soil, as well as nonagricultural uses such as water surfaces (lakes, swamps, etc.) and impervious surfaces, such as roads, roofs, etc. Land treatment applies mainly to agricultural land uses and includes mechanical practices such as contouring and terracing, and management practices like grazing control and crop rotation. The classes consist of land use and treatment combinations likely to be found in watersheds. The following is a brief description of various land uses.

Pasture or range is grassed land that is continuously used for grazing animals. The hydrologic condition is characterized by the degree of grazing and plant cover. Poor condition is heavily grazed with plant cover on less than half of the area. Fair condition has a moderate amount of grazing with plant cover on ½ to ¾ of the area. Good condition refers to light grazing with plant cover on more than ¾ of the area.

Meadow is a field on which grass is continuously grown, protected from grazing, and generally mowed for hay.

Woods or forest are characterized by their vegetative condition and density of the tree canopy. Poor condition refers to those woods which are either heavily grazed, regularly burned, or have had the undergrowth cleared for recreational uses. Litter, small trees, and brush are absent in this condition. Woods in fair condition may still be grazed but have not been burned. In a good condition, the woods are protected from grazing, and litter, small trees, and shrubs cover the soil.

Fallow is the agricultural land use and treatment with the highest runoff potential. The land is kept as bare as possible to conserve moisture for use by a succeeding

crop, the concept being that soil moisture lost to runoff is offset by the gain due to reduced transpiration.

Row crop is any field crop (corn, soybeans, and sugar beets) planted in rows far enough apart that most of the soil surface has no vegetative cover through the growing season.

Small grain (wheat, oats, and barley) is planted in rows close enough that the soil surface is vegetated except during planting and shortly thereafter.

Close-seeded legumes or rotation meadow (alfalfa, sweet clover) are either planted in close rows or broadcast. This cover may be allowed to remain for more than a year so that the soil is vegetated year-round.

The four preceding agricultural land uses are also characterized by the farming practice employed. Straight row fields are those farmed in straight rows either up and down the hill or across the slope. Where land slopes are less than about two percent, farming across the slope in straight rows is equivalent to contouring. Contoured fields are those farmed as nearly as possible to conform to the natural land contours. The hydrologic effect of contouring is due to the surface storage provided by the furrows, because the storage prolongs the time during which infiltration can take place. Terracing refers to systems containing open-end level or graded terraces, grassed waterway outlets, and contour furrows between the terraces. The hydrologic effects are due to the replacement of a low-infiltration land use by grassed waterways and to the increased opportunity for infiltration in the furrows and terraces.

The four agricultural land uses are further characterized by the crop rotation. Hydrologically, rotations range from “poor” to “good” in proportion to the amount of dense vegetation in the rotation. Poor rotations are generally one-crop land uses, such as continuous corn or wheat or combinations of row crops, small grains, and fallow soil. Good rotations generally contain alfalfa or other close-seeded legume or grass to increase infiltration.

6. Runoff Curve Number

6.1 Method

In 1954, the SCS developed a unique procedure for estimating surface runoff from rainfall. This procedure, the Runoff Curve Number (RCN) technique, has proven to be a very useful tool for evaluating effects of changes in land use and treatment on surface runoff. It is the procedure most frequently used within the NRCS and by hydrologists nationwide to estimate surface runoff from ungaged watersheds.

The combination of a hydrologic soil group and a land use and treatment class is a hydrologic soil-cover complex. Each combination is assigned a RCN, which is an index to its runoff potential on soil that is not frozen. A list of these values is shown in Table 6.1. (See TR-55 documentation, Tables 2-2a through 2-2d, for additional curve numbers.)

Table 6.1 – Runoff curve numbers for hydrologic soil-cover complexes (AMC-II conditions)

Land use	Treatment or practice	Hydrologic condition	Hydrologic soil group			
			A	B	C	D
Fallow soil	Straight row		77	86	91	94
Row crops	Straight row	Poor	72	81	88	91
		Good	67	78	85	89
	Contoured	Poor	70	79	84	88
		Good	65	75	82	86
	Contoured and terraced	Poor	66	74	80	82
		Good	62	71	78	81
Small grain	Straight row	Poor	65	76	84	88
		Good	63	75	83	87
	Contoured	Poor	63	74	82	85
		Good	61	73	81	84
	Contoured and terraced	Poor	61	72	79	82
		Good	59	70	78	81
Close-seeded legumes or rotation meadow	Straight row	Poor	66	77	85	89
		Good	58	72	81	85
	Contoured	Poor	64	75	83	85
		Good	55	69	78	83
	Contoured and terraced	Poor	63	73	80	83
		Good	51	67	76	80
Pasture or range		Poor	68	79	86	89
		Fair	49	69	79	84
		Good	39	61	74	80
	Contoured	Poor	47	67	81	88
		Fair	30	59	75	83
		Good	30	35	70	79
Meadow			30	58	71	78
Woods		Poor	45	66	77	83
		Fair	36	60	73	79
		Good	30	55	70	77
Residential	⅛ acre		77	85	90	92
	¼ acre		61	75	83	87
	1/3 acre		57	72	81	86
	½ acre		54	70	80	85
	1 acre		51	68	79	84
Open spaces (parks, golf courses, cemeteries, etc.)	Good condition: Grass cover > 75% of area		39	61	74	80
	Fair condition: Grass cover 50-75% of area		49	69	79	84
Commercial or business area (85% impervious)			89	92	94	95
Industrial district (72% impervious)			81	88	91	93
Farmsteads			59	74	82	86
Paved areas (roads, drive-ways, parking lots, roofs)			98	98	98	98
Water surfaces (lakes, ponds, reservoirs, etc.)			100	100	100	100
Swamp	At least 1/3 is open water		85	85	85	85
	Vegetated		78	78	78	78

RCN values are published for wet, dry, and normal soil moisture conditions. These conditions were referred to as Antecedent Moisture Condition (AMC) I (dry), II (normal), and III (wet). The AMC is related to the amount of rainfall in the five days previous to the design storm.

Note: In the late 1990s and early 2000s it was recognized that the range of RCNs for a soil/ land use condition did not correlate well to the antecedent moisture as defined above. It was determined instead that the RCN for conditions I and III represent the outer confidence limits for RCN values, and the RCN for condition II represents the mean value within the range of accepted values. The term AMC was changed to Antecedent Runoff Condition (ARC) to clarify the change in philosophy.

However, studies in Michigan have shown a strong correlation between antecedent moisture and peak runoff. For this reason, it is recommended to continue to use the antecedent moisture conditions previously recommended by the SCS for studies in Michigan.

AMC-I has the lowest runoff potential and represents dry watershed soils. AMC-III has the highest runoff potential as it represents soils that are practically saturated from antecedent rainfall or snowmelt. The AMC can be estimated from the 5-day antecedent rainfall using Table 6.2. In this table, the "growing" season in Michigan is assumed to be June through September. The limits for "dormant" season apply the remainder of the year, except when the soils are frozen or there is snow cover on the ground.

Table 6.2 – Seasonal Rainfall Limits for AMC

Antecedent Moisture Condition (AMC)	Total 5-day antecedent rainfall (inches)	
	Dormant season	Growing season
I	< 0.5	< 1.4
II	0.5 - 1.1	1.4 - 2.1
III	> 1.1	> 2.1

Although the runoff curve numbers in Table 6.1 are for AMC-II conditions, an analysis of an actual storm event may require an equivalent RCN for AMC-I or AMC-III. They may be computed by the following equations:

$$RCN(I) = \frac{4.2 * RCN(II)}{10 - 0.058 * RCN(II)} \qquad \text{(Eq. 6.1)}$$

and

$$RCN(III) = \frac{23 * RCN(II)}{10 + 0.13 * RCN(II)} \qquad \text{(Eq. 6.2)}$$

When estimating the peak discharge for an annual percent chance storm, such as the 1% annual chance storm, it is standard practice to assume AMC-II conditions. Other AMC conditions may be assumed when estimating the peak flow for an actual event, based on the observed rainfall before the event. When evaluating pre-development and post-development peak discharge rates, it is important to assume a consistent AMC for both existing and proposed conditions.

A typical watershed is comprised of many different combinations of soil types and land uses. In using the method presented here, the runoff characteristic of the watershed is represented using a weighted average or composite RCN for the entire watershed. The most practical way to determine this is to tabulate each of the four hydrologic soil groups as a percentage of the total drainage area. Land uses should then be tabulated as a percentage within each specific hydrologic soil group, along with the appropriate RCN. Multiplying the RCN by the two percentages and summing the partial RCNs over all the different soil-cover complexes yields the average watershed RCN.

An example runoff curve number calculation follows.

6.2 Runoff Curve Number Sample Calculation:

The following table was prepared for a sample watershed. The first and second columns are a summary of soil complex by hydrologic group, presented as a percentage of the drainage area. The land use for each hydrologic group is summarized next, presented as a percentage of the total area for that hydrologic group. These values are obtained by planimetry of county soils and land use maps, or from a Geographic Information System (GIS). See below for documentation on using GIS to calculate runoff curve numbers.

The runoff curve number for each land use / hydrologic soil group combination is obtained from Table 6.1 and added to the table in the column titled “RCN”.

The “Partial RCN” column is the product of the percentage of the drainage area times the percent of the soil hydrologic group, times the runoff curve number. When all the partial RCNs are summed, the result is a composite runoff curve number (also called a “weighted RCN”) for the watershed.

Table 6.3 – Sample RCN Calculation Table

Hydrologic Soil Group	Percent of Total Drainage Area	Land Use	Percent of Soil Group	RCN	Partial RCN
A	30	Meadow	100	30	9.0
B	50	Woods (good cover)	25	55	6.9
		Fallow soil	75	86	32.3
C	10	Pasture (fair condition)	80	79	6.3
		Woods (poor cover)	20	77	1.5
D	10	Meadow	100	78	7.8
		Composite Runoff Curve Number:		**Sum**	**63.8**

In this instance, an average RCN of 64 would be used for this watershed. Tabulating in this manner makes it easier to estimate how a change in land use will alter runoff. Here the bulk of the Partial RCN (and therefore the runoff volume) is contributed by the fallow soil. If all of this land is developed into ¼-acre residential lots (RCN 75), the composite RCN for the watershed would decrease to 60.

On the other hand, if all of the fallow land is developed into an industrial area (RCN 88), the composite RCN would increase to 65, thereby increasing surface runoff volume.

This method of computing a composite RCN works very well if all of the individual RCNs are at least 45 or above, where the correlation between RCN and SRO is virtually linear. This method also works well if all of the individual RCNs are less than 45. But there may be an occasion where the watershed has a significant amount of very low RCNs and a large amount of very high ones. Since the RCN/SRO relationship becomes less linear for the very low RCNs, proportioning the RCN to compute a composite value as described above will produce an RCN which underestimates the correct amount of runoff.

In this instance, a more accurate runoff estimate can be made by computing the incremental surface runoff (see Section 7) for each land use and summing these to obtain the total runoff. Equations 6.1 and 6.2 may then be solved to yield the composite RCN, if desired. This method of weighting the runoff requires more work than simply proportioning the RCNs. It should only be needed if more than 20 percent of the watershed has RCNs less than 45 with most of the remaining RCNs at the higher end of the scale.

This procedure can also be performed with a Geographic Information System (GIS) using land use and soils shape files. Information describing calculation of curve numbers with Geographic Information Systems (GIS) is at www.mi.gov/deqhydrology, GIS category, "Calculating Runoff Curve Numbers with GIS".

7. Surface Runoff

The total precipitation (P) in a storm can be divided into three paths that the water will follow in the hydrologic cycle. There is some initial amount of rainfall for which no runoff will occur. This quantity is the initial abstraction (I_a) and consists of interception, evaporation, and the soil-water storage that must be satisfied before surface runoff will begin. After this initial abstraction is met, the soil has a continuing abstraction capacity (F), depending on the type of soil. A rainfall rate greater than this continuing abstraction is surface runoff (SRO). These quantities can be described by the equation:

$$P = SRO + I_a + F \qquad \text{(Eq. 7.1)}$$

All parameters are as described above, in total inches for the entire storm event.

While F is a continuing abstraction, there is a potential maximum retention S characteristic to each RCN. The hypothesis of the SCS Method is that the ratio of F to S is equal to the ratio of the actual runoff SRO to the potential maximum runoff, P - I_a. This is expressed as:

$$\frac{F}{S} = \frac{SRO}{P - I_a} \qquad \text{(Eq. 7.2)}$$

Combining (7.1) and (7.2) to solve for SRO:

$$SRO = \frac{(P - I_a)^2}{P - I_a + S} \qquad \text{(Eq. 7.3)}$$

An empirical relation was developed by studying many small experimental watersheds:

$$I_a = 0.2 * S \qquad \text{(Eq. 7.4)}$$

Substituting this into (7.3) produces:

$$SRO = \frac{(P - 0.2S)^2}{P + 0.8S} \qquad \text{(Eq. 7.5)}$$

where:

$$S = \frac{1000}{RCN} - 10 \qquad \text{(Eq. 7.6)}$$

where S is in inches. Therefore, for a given 24-hour rainfall depth and watershed RCN, equations (7.5) and (7.6) can be solved to compute the surface runoff volume in inches over the watershed.

8. Time of Concentration

Time of concentration (T_c) is the time it takes for runoff to travel from the hydraulically most distant point in the watershed to the design point. In hydrograph analysis, T_c is the time from the end of rainfall excess to the inflection point on the falling limb of the hydrograph. This point signifies the end of surface runoff and the beginning of baseflow recession. The time of concentration may vary between different storms, especially if the rainfall is non-uniform in either areal coverage or intensity. However, in practice, a watershed's T_c is considered to be constant.

Measuring from a recorded hydrograph provides the most accurate estimate of T_c. For ungaged watersheds, T_c is calculated by estimating the travel time from the most hydraulically distant point in the watershed. Since travel time (T) equals length (L) divided by velocity (V), it is necessary to estimate the velocity through the various components of the stream network.

There are many methods used to estimate the velocity. The method presented in this report expresses velocity in the form:

$$V = K * S^{0.5} \qquad \text{(Eq. 8.1)}$$

where K is a coefficient depending on the type of flow, S is the slope of the flow path in percent, and V is the velocity in feet per second.

Three flow types are used based on their designation on U.S. Geological Survey topographic maps.

Small tributary: Permanent or intermittent streams which appear as a solid or dashed blue line on the topo maps. This also applies to a swamp that has a defined stream channel. Man-made channels and swales as shown on engineering drawings should be considered small tributaries.

Waterway: A travel path as shown by the curves in the elevation contours on a USGS topographic map (such as a valley, swale, or shallow drainage course), but does not have a blue streamline denoting a defined channel. This also applies to a swamp that does not have a defined channel flowing through it.

Sheet Flow: This is any overland flow path which does not conform to the waterway definition. Studies have shown that after approximately 300 feet, sheet flow forms shallow concentrated rivulets that are better defined as “waterway” flow. For this reason, Sheet Flow reach lengths should be terminated at a maximum length of 300 feet. The remaining downstream portion of the reach should be modeled using the “Waterway” velocity equation.

An illustration of each of these flow types is included in the example in Appendix A. The coefficients for each of these in Equation 8.1 are shown in Table 7-1.

Table 7.1 – Velocity Coefficients for Flow Type

Flow type	K
Small tributary	2.1
Waterway	1.2
Sheet flow	0.48

These coefficients were derived by Richardson (1969) as a means of estimating velocities when detailed stream hydraulic data are unavailable.

Once the velocity is determined, the travel time for each flow path can be computed as:

$$Tc = \sum T_i = \sum \frac{L_i}{V_i * 3600} \qquad \text{(Eq. 8.2)}$$

where T_c is time of concentration; T_i is travel time in hours; L_i is the length in feet; and V_i is velocity in feet per second for each individual flow path segment *i*.

In most watersheds, all three flow types will be present. Starting at the basin divide, the runoff may proceed from sheet flow to waterway to small tributary, then waterway again, then small tributary, etc. The T_i for each segment should be computed and then summed to give the total T_c.

It is important that the length used to compute each T_i has a uniform slope. As an example, assume a 5,000-foot length of small tributary has a change in elevation of 10.4 feet. This slope of 0.208% produces a single $T_1 = T_c$ of 1.45 hours. However, if it is known that the upper 1,000 feet of this stream falls 10 feet, and the lower 4,000 feet only falls 0.4 feet, this would produce $T_1 + T_2$ for a total T_c of 5.42 hours. Therefore, it is best to sum T_i over the smallest possible contour interval; which is usually the contour interval given for the topographic map. This interval can be increased if a visual examination of the topographic map shows a uniform spacing between successive elevation contours.

It may be necessary to evaluate several travel paths to determine which one is most hydraulically distant from the design point (has the longest travel time as described above). The longest travel time may not occur along the main channel, if a side tributary has a flatter slope.

The discharge calculation method in this report is not applicable for watersheds with a T_c less than one hour. Another SCS method, such as WinTR-55, is recommended in this case. The Michigan-specific unit hydrograph should be used with WinTR-55 to be compatible with the method presented here. The ordinates of the Michigan-specific unit hydrograph are [0.0, 0.5, 1.0, 0.8, 0.6, 0.4, 0.2, and 0.0]. Contact DNRE Hydrologic Studies Program staff for additional assistance if needed.

9. Unit Hydrograph Peak

The unit hydrograph peak (q_p') is a function of travel time through the stream system or T_c. An expression relating q_p' to T_c was developed in the following manner.

Discharges were computed for a hypothetical watershed having a drainage area of one square mile, a runoff curve number of 75, and a 24-hour design rainfall of 5 inches. The discharges were computed using the SCS TR-20 computer program and the SCS "Type II" rainfall distribution. However, in lieu of using the standard dimensionless unit hydrograph in TR-20, these simulations used the Michigan-specific unit hydrograph determined from the gage analysis discussed in Section 2 of this report.

The T_c for this hypothetical basin was varied from 1 hour to 40 hours. The peak discharge for each different T_c was divided by the volume of surface runoff to obtain q_p' which has the units of cfs per inch of runoff per square mile of drainage area. The data set of q_p' versus T_c was analyzed using a log-linear regression to obtain:

$$q_p' = 238.6 \cdot T_c^{-0.82} \qquad \text{(Eq. 9.1)}$$

This equation is only valid for T_c equal to or greater than one hour.

Q, the peak discharge in cubic feet per second (cfs), is estimated as follows:

$$Q = q_p' \cdot SRO \cdot DA \cdot POND \qquad \text{(Eq. 9.2)}$$

Where q_p' is the unit hydrograph peak in cfs per inch of runoff per square mile of drainage area; SRO is surface runoff volume in inches; DA is contributing drainage area in square miles; and POND is the ponding adjustment factor, unitless, described in the following section.

10. Adjustments for Surface Ponding

Peak flows determined in this method assume that the topography is such that surface flow into ditches, drains, and streams is approximately uniform. In areas where ponding or swampy areas occur in the watershed, a considerable amount of surface runoff may be retained in temporary storage. The peak rate of runoff should be reduced to reflect this condition.

Table 10.1 provides adjustment factors to determine this reduction based on the ratio of ponding or swampy area (as shown by the USGS map symbol for “marsh”) to the total drainage area for a range of flood frequencies. The three sections of this table provide different adjustment factors depending on where the ponding occurs in the watershed. These values were determined by the NRCS (1975) from experimental watersheds of less than 2,000 acres. These factors may still be used for larger basins until newer data become available. For percentages beyond the range in the tables, the data may be extrapolated on semi-log paper with the reduction factor on the log scale.

In some cases, it is appropriate to apply the ponding adjustment more than once. For example, assume a watershed has ponding equal to two percent of the drainage area scattered throughout and a lake that is one percent of the drainage area located in the lower portion of the basin near the design point. If the 100-year frequency flood is being determined, the peak flow should be multiplied by 0.87 for the scattered ponding and further reduced by 0.89 for the lake. This produces a total reduction factor of 0.77.

It is important to note that the ponding adjustment factor is not intended to replace a reservoir routing procedure when such is called for. The ponding adjustment factor should not include a water body immediately upstream of a design point, such as a lake outlet or dam spillway. In this case, only the peak inflow to the water body can be estimated using the method presented here. A reservoir routing model, such as HEC-HMS, must be used to estimate the peak outflow from the water body.

Table 10.1 - Adjustment factors for ponding

Percentage of ponded and swampy area	Annual Storm Probability					
	50%	20%	10%	4%	2%	1%
Ponding occurs in central parts of the watershed or is spread throughout						
0.2	0.94	0.95	0.96	0.97	0.98	0.99
0.5	0.88	0.89	0.90	0.91	0.92	0.94
1.0	0.83	0.84	0.86	0.87	0.88	0.90
2.0	0.78	0.79	0.81	0.83	0.85	0.87
2.5	0.73	0.74	0.76	0.78	0.81	0.84
3.3	0.69	0.70	0.71	0.74	0.77	0.81
5.0	0.65	0.66	0.68	0.72	0.75	0.78
6.7	0.62	0.63	0.65	0.69	0.72	0.75
10	0.58	0.59	0.61	0.65	0.68	0.71
20	0.53	0.54	0.56	0.60	0.63	0.68
Ponding occurs only in upper reaches of watershed						
0.2	0.96	0.97	0.98	0.98	0.99	0.99
0.5	0.93	0.94	0.94	0.95	0.96	0.97
1.0	0.90	0.91	0.92	0.93	0.94	0.95
2.0	0.87	0.88	0.88	0.90	0.91	0.93
2.5	0.85	0.85	0.86	0.88	0.89	0.91
3.3	0.82	0.83	0.84	0.86	0.88	0.89
5.0	0.80	0.81	0.82	0.84	0.86	0.88
6.7	0.78	0.79	0.80	0.82	0.84	0.86
10	0.77	0.77	0.78	0.80	0.82	0.84
20	0.74	0.75	0.76	0.78	0.80	0.82
Ponding occurs only in lower reaches of watershed						
0.2	0.92	0.94	0.95	0.96	0.97	0.98
0.5	0.86	0.87	0.88	0.90	0.92	0.93
1.0	0.80	0.81	0.83	0.85	0.87	0.89
2.0	0.74	0.75	0.76	0.79	0.82	0.86
2.5	0.69	0.70	0.72	0.75	0.78	0.82
3.3	0.64	0.65	0.67	0.71	0.75	0.78
5.0	0.59	0.61	0.63	0.67	0.71	0.75
6.7	0.57	0.58	0.60	0.64	0.67	0.71
10	0.53	0.54	0.56	0.60	0.63	0.68
20	0.48	0.49	0.51	0.55	0.59	0.64

11. Summary of Method

This section summarizes the steps needed to compute discharges using the procedures in this report.

1. Delineate the watershed boundaries on a topographic map and measure the total drainage area. If there are deep depressions within this boundary or other areas that do not contribute to runoff, measure these and subtract them from the total drainage area. The area remaining is termed the 'contributing drainage area' and is the portion of the watershed which will be used in subsequent calculations.

   Note: Some judgment needs to be used when defining noncontributing areas. If a topo map with a five-foot contour interval shows two nested depression contours, we know that portions of the entire depression are at least five feet deep. The volume of the depression can be calculated and compared to the volume of runoff which drains into it. If it can contain all of the runoff, the entire area draining into the depression may be deleted as 'noncontributing area'. However, if the topo map only shows a single depression contour, it could be anywhere from a few inches deep to just under five feet deep. In this case, there is no definitive way to tell how much runoff this depression can store. In this instance, it may be necessary to conduct a field inspection of the watershed to ascertain the storage potential of the depression area.

2. Overlay the boundaries of the contributing drainage area on soil and land use maps and tabulate the hydrologic soil-cover/land use complexes in the watershed. Assign curve numbers using Table 6.1 and calculate the composite RCN as outlined in Section 6.

3. Starting at the design point and working upstream, tabulate incremental travel times using the procedure in section 8. When reaching a junction of two or more streams, follow the one which will result in the longest T_c. After reaching the most upstream point (as defined by a blue line on topo maps), determine any additional contribution to T_c due to overland and sheet flow paths. Add all of the incremental travel times to determine the watershed T_c. Compute q_p' using equation 9.1.

4. Select a design frequency and determine the 24-hour rainfall from Table 3.1. If the contributing drainage area is greater than 10 square miles, adjust the rainfall using Table 3.2.

5. Using the weighted RCN computed in step 2, calculate the surface runoff for the selected design event using equations 7.5 and 7.6.

6. Estimate surface ponding as a percent of the contributing drainage area and determine the ponding adjustment factor from Table 10.1.

7. Compute the peak discharge using Equation 9.2.

12. References

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Appendix A - Sample Application

The bridge at the Brocker Road crossing of the example watershed needs to be replaced. The watershed that contributes runoff to this point, which is depicted in Figure A.1, has a drainage area of 2.43 square miles and is undergoing urbanization. All of the areas which are currently either pasture or meadow will be developed into ¼-acre residential subdivisions. What effect will this have on the design flood produced by the 100-year, 24-hour rainfall?

Figure A.1 is an enlargement of a USGS topographic map. The contour interval for this map is 10 feet. In this figure, a thick black line is used to denote the watershed boundary. The blue lines inside the boundary show the small tributaries in the basin. The irregularly shaped blue areas show the locations of lakes and ponds, while the lighter green patches show the wooded portions of the watershed. The following table shows the different soil groups and associated land uses as they currently exist in the watershed.

Table A.1 – RCN Calculation

Hydrologic Soil Group	Percent of Total Drainage Area	Land Use	Percent of Soil Group	RCN	Partial RCN
A	7	Meadow	25	30	0.5
		Pasture (fair)	15	49	0.5
		Row crop (cont./good)	60	65	2.7
B	84	Small grain (cont./good)	60	73	36.8
		Pasture (fair condition)	25	69	14.5
		Woods (poor cover)	10	66	5.5
		Meadow	5	58	2.4
D	9	Meadow	35	78	2.5
		Woods (good cover)	5	77	0.3
		Lakes and ponds	15	100	1.4
		Swamps (vegetated)	35	78	2.5
		Swamps (open water)	10	85	0.8
				Sum	70.4

Deleting the contribution from meadows and pastures and replacing them with the RCNs for the residential lots changes the composite RCN to 73.4. Common practice is to round off the computed RCN, so this watershed would have curve numbers of 70 and 73 to represent existing and proposed development conditions, respectively.

The time of concentration is computed along the travel path beginning at the headwaters in Section 36 and proceeding in a northeastward direction. The travel path begins with a short section of sheet flow to the area shown as swamp (waterway flow), then continues to the upstream end of the tributary. The small tributary portions were generally divided into lengths which correspond with the contour interval of the topo map. The following table shows the computations:

Table A.2 – Time of Concentration Calculation

Type of flow	Length (ft)	Δ Elevation (ft)	Slope (%)	Velocity (fps)	Incremental T_c (hr)
Small trib.	1640	12	0.73	1.80	0.25
" "	1380	10	0.73	1.79	0.21
" "	1970	10	0.51	1.50	0.37
" "	1520	10	0.66	1.70	0.25
" "	6870	8	0.12	0.72	2.66
Waterway	1840	2	0.11	0.40	1.29
Sheet	150	22	14.67	1.84	0.02
				Sum	**5.05**

Summing the incremental travel times produces a total T_c of 5.05 hours. Substituting this into equation (9.1) produces a peak discharge of 63.24 cfs per square mile per inch of runoff. The table shows that the slope of the small tributary is not uniform over its entire length. If the slope is calculated as a 50-foot drop over the 13,400-foot length, the resulting total T_c is 4.21 hours. This produces a q_p' of 65.79 cfs/square mile-in. Thus, the design discharge would have been 13 percent higher because of an error in calculating T_c. This illustrates the importance of using the most refined data available; in this case, the distance between successive 10-foot contours.

The 100-year, 24-hour rainfall obtained from Table 3.1 is 4.36 inches. Using this value and the previously computed RCNs, the runoff can be determined using equations (7.5) and (7.6). For existing conditions (RCN=70), the runoff is 1.57 inches. The runoff for proposed development conditions (RCN=73) is 1.79 inches.

The design discharge is obtained by simply multiplying the computed q_p' by the drainage area and the computed runoff. These results are:

Existing: Q = 63.24 cfs/square mile-in * 2.43 square mile * 1.57 in
= 241 cfs

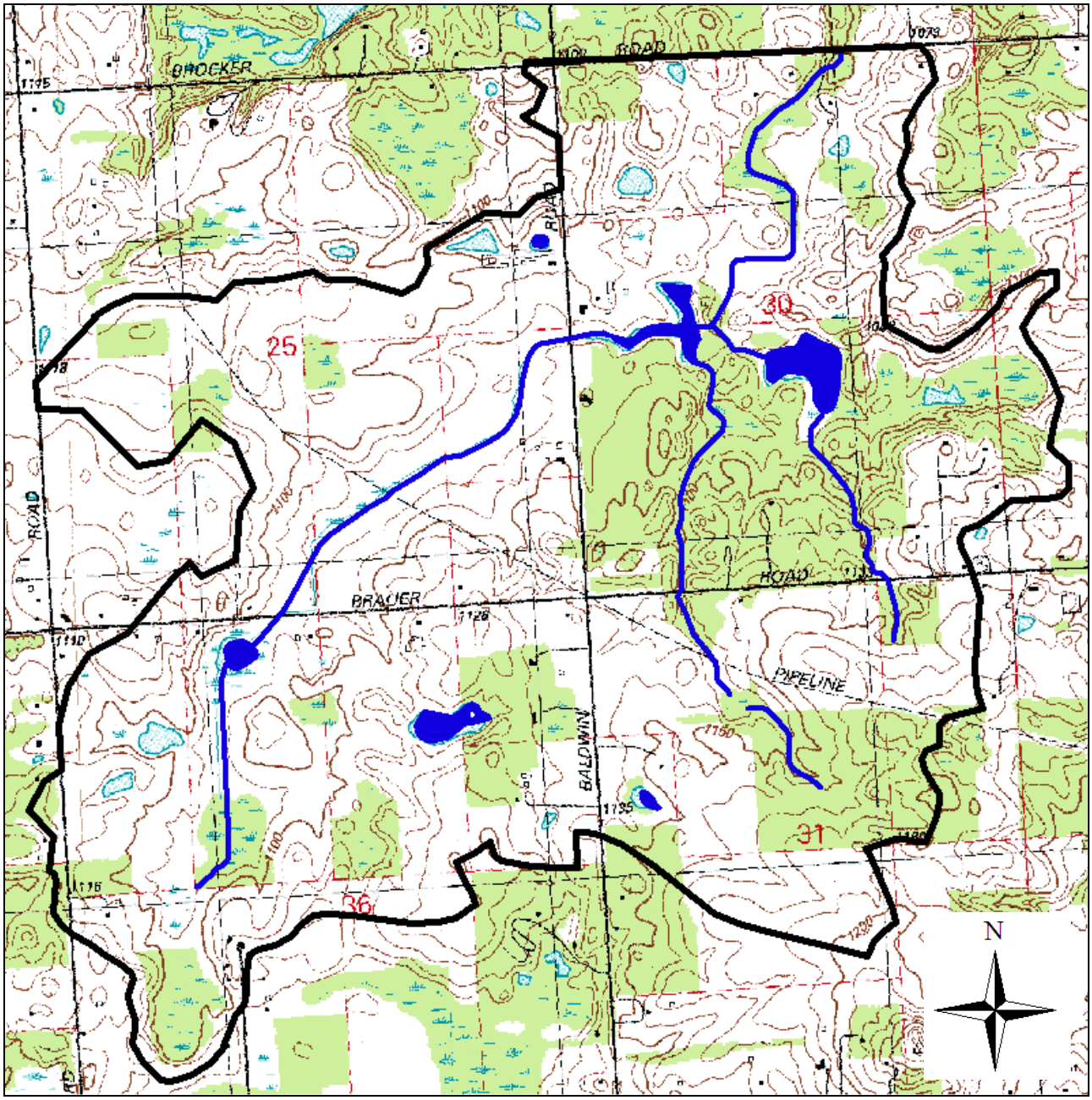
Proposed: Q = 275 cfs

These numbers need to be adjusted for ponding. The land use table shows that 5.4 percent of the watershed is either open water or swamps. These areas are spread uniformly throughout the basin. An adjustment factor of 0.77 can be interpolated from Table (10.1). The final design discharges are:

Existing: Q = 241 * 0.77
= 186 cfs

Proposed: Q = 212 cfs

Figure A.1 – Example watershed



Appendix B – Hydrologic Soil Groups for Michigan Soils

These soils data were last reviewed and updated in March 1990. To obtain current soils data by county, visit the NRCS Soil Data Mart at http://soildatamart.nrcs.usda.gov/ (this URL is current as of the date of this report).

NOTE: When two soil groups are listed (such as D/B), this indicates the hydrologic group for the soil under undrained/drained conditions.

Soil Series	Hydrologic Group	Soil Series	Hydrologic Group	Soil Series	Hydrologic Group
Abbaya	B	Abscota	A	Adrian	D/A
Alcona	B	Algansee	B	Allendale	B
Allouez	B	Alpena	A	Alstad	C
Amasa	B	Angelica	D/B	Arkona	B
Arkport	B	Arnheim	D	Ashkum	D/B
Assinins	B	Au Gres	B	Aubarque	D/C
Aubbeenaubbee	B	Aurelius	D/B	Avoca	B
Bach	D/B	Badaxe	B	Banat	B
Barry	D/B	Battlefield	D/A	Beavertail	D
Beechwood	C	Belding	B	Belleville	D/B
Benona	A	Bergland	D	Berville	D/B
Biscuit	D/B	Bixby	B	Bixler	C
Blount	C	Blue Lake	A	Bohemian	B
Bonduel	C	Bono	D	Boots	D/A
Borski	B	Bowers	C	Bowstring	D/A
Boyer	B	Brady	B	Branch	B
Brassar	C	Breckenridge	D/B	Brems	A
Brevort	D/B	Brimley	B	Bronson	B
Brookston	D/B	Bruce	D/B	Burleigh	D/A
Burt	D	Cassopolis	B	Cadmus	B
Capac	C	Carbondale	D/A	Carlisle	D/A
Cathro	D/A	Celina	C	Ceresco	B
Champion	B	Channahon	D	Channing	B
Charity	D	Charlevoix	B	Chatham	B
Cheboygan	B	Chelsea	A	Chesaning	B
Chestonia	D	Chippeny	D	Cohoctah	D/B
Coloma	A	Colonville	C	Colwood	D/B
Conover	C	Coral	C	Corunna	D/B
Coupee	B	Covert	A	Crosier	C
Croswell	A	Cunard	B	Cushing	B
Dawson	D/A	Deer Park	A	Deerton	A
Deford	D/A	Del Rey	C	Detour	B

Appendix B – Hydrologic Soil Groups for Michigan Soils, contd.

These soils data were last reviewed and updated in March 1990. To obtain current soils data by county, visit the NRCS Soil Data Mart at http://soildatamart.nrcs.usda.gov/ (this URL is current as of the date of this report).

NOTE: When two soil groups are listed (such as D/B) this indicates the hydrologic group for the soil under undrained/drained conditions.

Soil Series	Hydrologic Group	Soil Series	Hydrologic Group	Soil Series	Hydrologic Group
Dighton	B	Dixboro	B	Dora	D/B
Dowagiac	B	Dresden	B	Dryburg	B
Dryden	B	Duel	A	Dungridge	B
East Lake	A	Eastport	A	Edmore	D
Edwards	D/B	Eel	B	Eleva	B
Elmdale	B	Elston	B	Elvers	D/B
Emmet	B	Ensign	D	Ensley	D/B
Epoufette	D/B	Epworth	A	Ermatinger	D/B
Esau	A	Escanaba	A	Essexville	D/A
Evart	D	Fabius	B	Fairport	C
Fence	B	Fibre	D/B	Filion	D
Finch	C	Fox	B	Frankenmuth	C
Freda	D	Frenchette	B	Froberg	D
Fulton	D	Gaastra	C	Gagetown	B
Gay	D/B	Genesee	B	Gilchrist	A
Gilford	D/B	Gladwin	A	Glawe	D/B
Glendora	D/A	Glynwood	C	Gogebic	B
Gogomain	D/B	Goodman	B	Gorham	D/B
Grace	B	Granby	D/A	Grattan	A
Graveraet	B	Graycalm	A	Grayling	A
Greenwood	D/A	Grindstone	C	Grousehaven	D
Guardlake	A	Guelph	B	Gutport	D
Hagensville	C	Halfaday	A	Hatmaker	C
Henrietta	D/B	Hessel	D/B	Hettinger	D/C
Hillsdale	B	Hodenpyl	B	Houghton	D/A
Hoytville	D/C	Huntington	B	Ingalls	B
Ingersoll	B	Ionia	B	Iosco	B
Isabella	B	Ishpeming	A	Ithaca	C
Jacobsville	D	Jeddo	D/C	Jesso	C
Johnswood	B	Kakkawlin	C	Kalamazoo	B
Kalkaska	A	Kallio	C	Karlin	A
Kawbawgam	C	Kendallville	B	Kent	D
Keowns	D/B	Kerston	D/A	Keweenaw	A
Kibbie	B	Kidder	B	Kilmanagh	C

Appendix B – Hydrologic Soil Groups for Michigan Soils, contd.

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NOTE: When two soil groups are listed (such as D/B) this indicates the hydrologic group for the soil under undrained/drained conditions.

Soil Series	Hydrologic Group	Soil Series	Hydrologic Group	Soil Series	Hydrologic Group
Kingsville	D/A	Kinross	D/A	Kiva	A
Klacking	A	Kokomo	D/B	Koontz	D
Krakow	B	Lacota	D/B	Lamson	D/B
Landes	B	Lapeer	B	Latty	D
Leelanau	A	Lenawee	D/B	Leoni	B
Liminga	A	Linwood	D/A	Locke	B
Lode	B	London	C	Longrie	B
Loxley	D/A	Lupton	D/A	Mackinac	B
Macomb	B	Mancelona	A	Manistee	A
Manitowish	B	Markey	D/A	Marlette	B
Martinsville	B	Martisco	D/B	Matherton	B
Maumee	D/A	McBride	B	Mecosta	A
Melita	A	Menagha	A	Menominee	A
Mervin	D/A	Metamora	B	Metea	B
Miami	B	Michigamme	C	Millsdale	D/B
Milton	C	Minoa	C	Minocqua	D/B
Minong	D	Misery	C	Mitiwanga	C
Moltke	B	Monico	C	Monitor	C
Montcalm	A	Moquah	B	Morley	C
Morocco	B	Mudsock	D/B	Munising	B
Munuscong	D/B	Mussey	D/B	Nadeau	B
Nahma	D/B	Napoleon	D/A	Nappanee	D
Nester	C	Net	C	Newaygo	B
Newton	D/A	Nottawa	B	Nunica	C
Oakville	A	Ockley	B	Oconto	B
Ocqueoc	A	Ogemaw	D/C	Okee	B
Oldman	C	Olentangy	D/A	Omega	A
Omena	B	Onaway	B	Onota	B
Ontonagon	D	Ormas	B	Oshtemo	B
Otisco	A	Ottokee	A	Owosso	B
Paavola	B	Padus	B	Palms	D/A
Parkhill	D/B	Paulding	D	Pelkie	A
Pella	D/B	Pemene	B	Pence	B
Pendleton	C	Pequaming	A	Perrin	B

Appendix B – Hydrologic Soil Groups for Michigan Soils, contd.

These soils data were last reviewed and updated in March 1990. To obtain current soils data by county, visit the NRCS Soil Data Mart at http://soildatamart.nrcs.usda.gov/ (this URL is current as of the date of this report).

NOTE: When two soil groups are listed (such as D/B) this indicates the hydrologic group for the soil under undrained/drained conditions.

Soil Series	Hydrologic Group	Soil Series	Hydrologic Group	Soil Series	Hydrologic Group
Perrinton	C	Pert	D	Peshekee	D
Petticoat	B	Pewamo	D/C	Pickford	D
Pinconning	D/B	Pinnebog	D/A	Pipestone	B
Plainfield	A	Pleine	D	Ponozzo	C
Posen	B	Poseyville	C	Potagannissing	D
Poy	D	Proctor	B	Randolph	C
Rapson	B	Remus	B	Rensselaer	D/B
Richter	B	Riddles	B	Rifle	D/A
Riggsville	C	Rimer	C	Riverdale	A
Rockbottom	B	Rockcut	B	Rodman	A
Ronan	D	Rondeau	D/A	Roscommon	D/A
Roselms	D	Rousseau	A	Rubicon	A
Rudyard	D	Ruse	D	Saganing	D/A
Sanilac	B	Saranac	D/C	Sarona	B
Satago	D	Saugatuck	C	Saylesville	C
Sayner	A	Scalley	B	Schoolcraft	B
Sebewa	D/B	Selfridge	B	Selkirk	C
Seward	B	Shebeon	C	Shelldrake	A
Shelter	B	Shiawassee	C	Shinrock	C
Shoals	C	Sickles	D/B	Sims	D
Sisson	B	Skanee	C	Sleeth	C
Sloan	D/B	Solona	C	Soo	D/C
Sparta	A	Spinks	A	Springlake	A
St. Clair	D	St. Ignace	D	Stambaugh	B
Steuben	B	Sturgeon	B	Sugar	B
Summerville	D	Sundell	B	Sunfield	B
Superior	D	Tacoosh	D/B	Tallula	B
Tamarack	B	Tappan	D/B	Tawas	D/A
Teasdale	B	Tedrow	B	Tekenink	B
Thetford	A	Thomas	D/B	Tobico	D/A
Toledo	D	Tonkey	D/B	Toogood	A
Trenary	B	Trimountain	B	Tula	C
Tuscola	B	Tustin	B	Twining	C
Tyre	D/A	Ubly	B	Velvet	C

Appendix B – Hydrologic Soil Groups for Michigan Soils, contd.

These soils data were last reviewed and updated in March 1990. To obtain current soils data by county, visit the NRCS Soil Data Mart at http://soildatamart.nrcs.usda.gov/ (this URL is current as of the date of this report).

NOTE: When two soil groups are listed (such as D/B) this indicates the hydrologic group for the soil under undrained/drained conditions.

Soil Series	Hydrologic Group	Soil Series	Hydrologic Group	Soil Series	Hydrologic Group
Vestaburg	D/A	Vilas	A	Volinia	B
Wainola	B	Waiska	B	Wakefield	B
Wallace	B	Wallkill	D/C	Warners	D/C
Wasepi	B	Washtenaw	D/C	Watton	C
Waucedah	D	Wauseon	D/B	Wautoma	D/B
Wega	B	Westbury	C	Whalan	B
Wheatley	D/A	Whitaker	C	Whitehall	B
Willette	D/A	Winneshiek	B	Winterfield	D/A
Wisner	D/B	Witbeck	D/B	Wixom	B
Wolcott	D/B	Woodbeck	B	Yalmer	B
Ypsi	C	Zeba	B	Ziegenfuss	D
Zilwaukee	D	Zimmerman	A		

Attachment E

Post-Construction Stormwater Worksheet

UNIVERSITY OF MICHIGAN – NPDES PERMIT
POST-CONSTRUCTION STORM WATER WORKSHEET

Construction and redevelopment projects on U-M property (including, but not limited to the Ann Arbor, Dearborn and Flint campuses) are regulated under a National Pollutant Discharge Elimination System (NPDES) permit for storm water discharges, as issued by the Michigan Department of Environment, Great Lakes, and Energy (EGLE). The following information is required from the project, and must be submitted to your campus EHS office.

A. Complete Project Information:

Project Name:

Project Number:

Total Area of Earth Disturbance for the project (to the nearest 0.1 acres): **1 acre = 43,560 sq. ft.**

Design Supervisor:

Design Supervisor Phone:

Project Start Date:

Project Completion Date:

B. Complete Questions 1 & 2 –

1. Is this project part of a larger common plan of development which will disturb 1 acre or greater (for the entire planned development)?
   YES ☐ NO ☐

2. Is the Total Disturbed Acreage of Project 1 acre or greater (to the nearest 0.1 acre):
   YES ☐ NO ☐

C. Email Completed Worksheet (Page 1) to: Ann Arbor – EHS-EP3

stormwater@umich.edu

D. Evaluate –

If both answers to 1 and 2 are NO, employ elective stormwater BMPs as applicable to meet project needs.

If you answered YES to either 1 OR 2, the project **must** prepare a Post-Construction Storm Water Plan for the site. First, email this page to Ann Arbor EHS stormwater team: stormwater@umich.edu. Then, refer to the Post-Construction Storm Water Plan Checklist to aid you in identifying and completing the required elements for the post-construction storm water plan. Please work with the U-M stormwater team during development of the plan. Prior to finalizing the plan, you must have approval from the stormwater team.

Post-Construction Storm Water Plan – Checklist

Provide the post-construction storm water management plan, all calculations, and BMP details, including TSS designed removal rates and the O&M plan to U-M EHS Ann Arbor for review and comment. Email to: stormwater@umich.edu

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Minimum Treatment Volume Standard Requirements:

1. What is the volume (cubic feet) required for storage of one (1) inch of runoff from the entire site?

2. What is the calculated site runoff from the *90 percent annual non-exceedance storm* for the region. For Ann Arbor, Flint and Dearborn, use 0.9 inches of rain. For all other locations, use the storm/rainfall information found in the MDEQ (EGLE) memo *90 percent annual non-exceedance storms.* See Post-Construction Storm Water Management information found on the UM-EHS website. Click the Construction tab at top of the page, then the Environmental Considerations tab.

3. Explain how the site-specific design addresses the treatment methods required to achieve:

a. 80 percent removal of total suspended solids (TSS) as compared with uncontrolled runoff,
OR
b. Discharge concentrations of TSS not to exceed 80 milligrams per liter (mg/l)
OR
c. Other alternative approaches may be available based on a case-by-case review. Please see the EHS Guideline for Stormwater Management – Post Construction Requirements for more details.

Channel Protection Criteria:

Items 4 and 5 (below) require the utilization of the *NOAA Atlas 14 Point Precipitation Frequency Estimates* (for rainfall amount) AND the calculation methodology provided by the MDEQ's guidance document *Computing Flood Discharges for Small Ungaged Watersheds* ***(revised June 2010)***.

4. What is the volume and peak flow rate for the existing conditions at the site, for the 2-year, 24-hour event?

5. What is the volume and peak flow rate for the proposed conditions at the site, for the 2-year, 24-hour event?

Operation & Maintenance Plan

6. Provide a plan for all structural and vegetative BMPs installed to meet the storm water requirements of the NPDES permit maintaining maximum design performance through long-term operation and maintenance. Include inspection frequencies needed, estimated maintenance frequency, criteria for maintenance (e.g. 12" sediment or 25% of storage capacity, etc.), and the manufacturers recommendations/manual.

Preferred Design Elements for Storm Water Protection*:

- Preserve /restore undisturbed natural areas
- Preserve riparian buffers, floodplains, & shorelines
- Preserve steep slopes
- Preserve porous and erodible soils
- Preserve existing topography
- Restore prairie/meadow areas
- Site reforestation
- Soil amendments/soil rejuvenation
- Avoid sensitive areas
- Reduce clearing and grading limits
- Conservation development
- Reduce roadway lengths and widths
- Shorter or shared driveways
- Shared parking
- Reduce building footprints
- Reduce parking lot footprints
- Reduce setbacks and frontages
- Use fewer or alternative cul-de-sacs
- Use natural drainage ways
- Infill and redevelopment within targeted development zones
- Cover loading areas
- Covered fueling areas
- Covered vehicle storage areas
- Storm drain disconnection
- Downspout disconnection
- Covered dumpsters
- Covered material storage areas
- Secondary containment structures

*Source – Center for Watershed Protection, *Managing Stormwater in Your Community: A Guide for Building an Effective Post-Construction Program,* EPA Publication No:833-R-08-001

Attachment F

TR-55 CN Tables 2-2a through 2-2d

Table 2-2a Runoff curve numbers for urban areas [1/]

Cover description		Curve numbers for hydrologic soil group			
Cover type and hydrologic condition	Average percent impervious area [2/]	A	B	C	D
Fully developed urban areas (vegetation established)					
Open space (lawns, parks, golf courses, cemeteries, etc.) [3/]:					
Poor condition (grass cover < 50%)		68	79	86	89
Fair condition (grass cover 50% to 75%)		49	69	79	84
Good condition (grass cover > 75%)		39	61	74	80
Impervious areas:					
Paved parking lots, roofs, driveways, etc. (excluding right-of-way)		98	98	98	98
Streets and roads:					
Paved; curbs and storm sewers (excluding right-of-way)		98	98	98	98
Paved; open ditches (including right-of-way)		83	89	92	93
Gravel (including right-of-way)		76	85	89	91
Dirt (including right-of-way)		72	82	87	89
Western desert urban areas:					
Natural desert landscaping (pervious areas only) [4/]		63	77	85	88
Artificial desert landscaping (impervious weed barrier, desert shrub with 1- to 2-inch sand or gravel mulch and basin borders)		96	96	96	96
Urban districts:					
Commercial and business	85	89	92	94	95
Industrial	72	81	88	91	93
Residential districts by average lot size:					
1/8 acre or less (town houses)	65	77	85	90	92
1/4 acre	38	61	75	83	87
1/3 acre	30	57	72	81	86
1/2 acre	25	54	70	80	85
1 acre	20	51	68	79	84
2 acres	12	46	65	77	82
Developing urban areas					
Newly graded areas (pervious areas only, no vegetation) [5/]		77	86	91	94
Idle lands (CN's are determined using cover types similar to those in table 2-2c).					

1 Average runoff condition, and $I_a = 0.2S$.

2 The average percent impervious area shown was used to develop the composite CN's. Other assumptions are as follows: impervious areas are directly connected to the drainage system, impervious areas have a CN of 98, and pervious areas are considered equivalent to open space in good hydrologic condition. CN's for other combinations of conditions may be computed using figure 2-3 or 2-4.

3 CN's shown are equivalent to those of pasture. Composite CN's may be computed for other combinations of open space cover type.

4 Composite CN's for natural desert landscaping should be computed using figures 2-3 or 2-4 based on the impervious area percentage (CN = 98) and the pervious area CN. The pervious area CN's are assumed equivalent to desert shrub in poor hydrologic condition.

5 Composite CN's to use for the design of temporary measures during grading and construction should be computed using figure 2-3 or 2-4 based on the degree of development (impervious area percentage) and the CN's for the newly graded pervious areas.

Table 2-2b Runoff curve numbers for cultivated agricultural lands [1/]

Cover description			Curve numbers for hydrologic soil group			
Cover type	Treatment [2/]	Hydrologic condition [3/]	A	B	C	D
Fallow	Bare soil	—	77	86	91	94
	Crop residue cover (CR)	Poor	76	85	90	93
		Good	74	83	88	90
Row crops	Straight row (SR)	Poor	72	81	88	91
		Good	67	78	85	89
	SR + CR	Poor	71	80	87	90
		Good	64	75	82	85
	Contoured (C)	Poor	70	79	84	88
		Good	65	75	82	86
	C + CR	Poor	69	78	83	87
		Good	64	74	81	85
	Contoured & terraced (C&T)	Poor	66	74	80	82
		Good	62	71	78	81
	C&T+ CR	Poor	65	73	79	81
		Good	61	70	77	80
Small grain	SR	Poor	65	76	84	88
		Good	63	75	83	87
	SR + CR	Poor	64	75	83	86
		Good	60	72	80	84
	C	Poor	63	74	82	85
		Good	61	73	81	84
	C + CR	Poor	62	73	81	84
		Good	60	72	80	83
	C&T	Poor	61	72	79	82
		Good	59	70	78	81
	C&T+ CR	Poor	60	71	78	81
		Good	58	69	77	80
Close-seeded or broadcast legumes or rotation meadow	SR	Poor	66	77	85	89
		Good	58	72	81	85
	C	Poor	64	75	83	85
		Good	55	69	78	83
	C&T	Poor	63	73	80	83
		Good	51	67	76	80

[1] Average runoff condition, and I_a=0.2S

[2] Crop residue cover applies only if residue is on at least 5% of the surface throughout the year.

[3] Hydraulic condition is based on combination factors that affect infiltration and runoff, including (a) density and canopy of vegetative areas, (b) amount of year-round cover, (c) amount of grass or close-seeded legumes, (d) percent of residue cover on the land surface (good ≥ 20%), and (e) degree of surface roughness.

Poor: Factors impair infiltration and tend to increase runoff.

Good: Factors encourage average and better than average infiltration and tend to decrease runoff.

Table 2-2c Runoff curve numbers for other agricultural lands [1/]

Cover description		Curve numbers for hydrologic soil group			
Cover type	Hydrologic condition	A	B	C	D
Pasture, grassland, or range—continuous forage for grazing. [2/]	Poor	68	79	86	89
	Fair	49	69	79	84
	Good	39	61	74	80
Meadow—continuous grass, protected from grazing and generally mowed for hay.	—	30	58	71	78
Brush—brush-weed-grass mixture with brush the major element. [3/]	Poor	48	67	77	83
	Fair	35	56	70	77
	Good	30 [4/]	48	65	73
Woods—grass combination (orchard or tree farm). [5/]	Poor	57	73	82	86
	Fair	43	65	76	82
	Good	32	58	72	79
Woods. [6/]	Poor	45	66	77	83
	Fair	36	60	73	79
	Good	30 [4/]	55	70	77
Farmsteads—buildings, lanes, driveways, and surrounding lots.	—	59	74	82	86

1 Average runoff condition, and $I_a = 0.2S$.

2 *Poor:* <50%) ground cover or heavily grazed with no mulch.
Fair: 50 to 75% ground cover and not heavily grazed.
Good: > 75% ground cover and lightly or only occasionally grazed.

3 *Poor*: <50% ground cover.
Fair: 50 to 75% ground cover.
Good: >75% ground cover.

4 Actual curve number is less than 30; use CN = 30 for runoff computations.

5 CN's shown were computed for areas with 50% woods and 50% grass (pasture) cover. Other combinations of conditions may be computed from the CN's for woods and pasture.

6 *Poor:* Forest litter, small trees, and brush are destroyed by heavy grazing or regular burning.
Fair: Woods are grazed but not burned, and some forest litter covers the soil.
Good: Woods are protected from grazing, and litter and brush adequately cover the soil.

Table 2-2d Runoff curve numbers for arid and semiarid rangelands [1/]

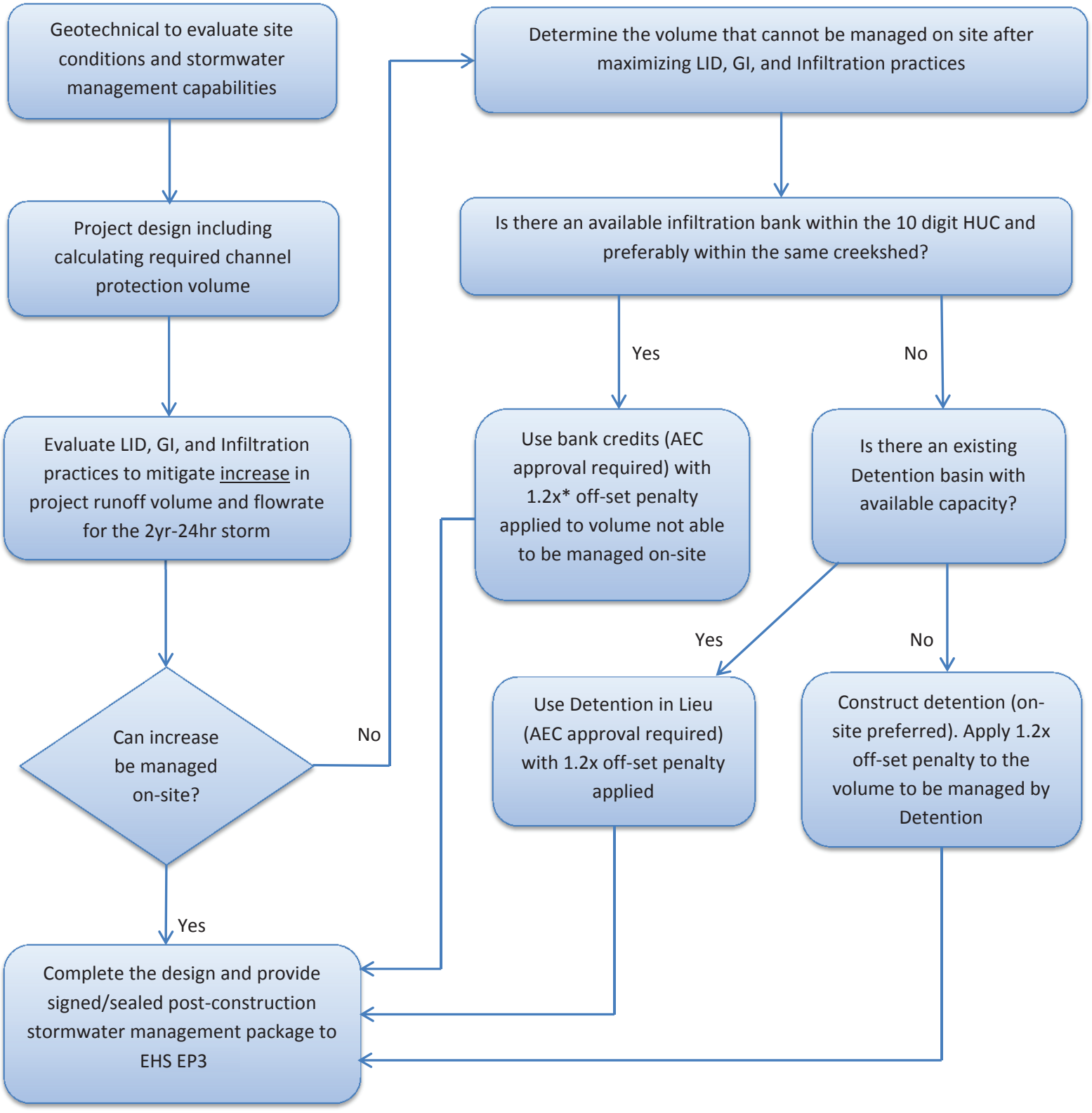
Cover description		Curve numbers for hydrologic soil group			
Cover type	Hydrologic condition [2/]	A [3/]	B	C	D
Herbaceous—mixture of grass, weeds, and low-growing brush, with brush the minor element.	Poor		80	87	93
	Fair		71	81	89
	Good		62	74	85
Oak-aspen—mountain brush mixture of oak brush, aspen, mountain mahogany, bitter brush, maple, and other brush.	Poor		66	74	79
	Fair		48	57	63
	Good		30	41	48
Pinyon-juniper—pinyon, juniper, or both; grass understory.	Poor		75	85	89
	Fair		58	73	80
	Good		41	61	71
Sagebrush with grass understory.	Poor		67	80	85
	Fair		51	63	70
	Good		35	47	55
Desert shrub—major plants include saltbush, greasewood, creosotebush, blackbrush, bursage, palo verde, mesquite, and cactus.	Poor	63	77	85	88
	Fair	55	72	81	86
	Good	49	68	79	84

1 Average runoff condition, and I_a, = 0.2S. For range in humid regions, use table 2-2c.
2 Poor: <30% ground cover (litter, grass, and brush overstory).
Fair: 30 to 70% ground cover.
Good: > 70% ground cover.
3 Curve numbers for group A have been developed only for desert shrub.

Attachment G

Detention in Lieu Flow Chart

Channel Protection Process Flowchart – 02/05/2021



*Offset ratio can be waived for off-site infiltration practices if the project site stormwater enters the infiltration feature through storm pipe or constructed stormwater conveyance (such as a swale or ditch) prior to discharge to surface waters of the State. Because there are no impacts to receiving waters, the use of an offset protection factor is not required.

Attachment H

U-M Ann Arbor 10 Digit HUC Graphic

10 Digit Hydrologic Units

Notes:
Saginaw Forest is within HU 0409000503.

1 inch = 3,000 feet

N
W
E
S