Water & Sewerage Department
CITY OF DETROIT

Stormwater Management: Ordinance & Design Manual Key Updates / Site Plan Workshop

January 27, 2021

WORKSHOP AGENDA

- 1:00 p.m. Welcome and Introduction: DWSD Stormwater Management Group
- 1:10 p.m. Key Changes to the Stormwater Management Regulations and Design Manual
- 1:45 p.m. Determining Applicability of the Regulations
- 1:50 p.m. Understanding and Applying the Regulations to Site Plans
  - Key Performance Standards
  - Alternative Compliance
  - Example Site Plans
- 2:30 p.m. 10-minute BREAK
- 2:40 p.m. Developing and Submitting a Post-Construction Stormwater Management Plan
- 3:10 p.m. Site Plan Review and Approval Process
- 3:20 p.m. Q&A

Watch the presentation via Zoom here.

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Q&A Protocol

? ? ? ?

Have a question for our team?

- Two options for asking questions:
  - Use the CHAT feature in Zoom to type a question, OR
  - Email Erin Washington at:

Erin.Washington@ohm-advisors.com

  - Questions will be collected, sorted, and read after each major topic and at the end of the seminar

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Poll Questions

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Welcome & Introduction

INTRODUCTIONS

DWSD

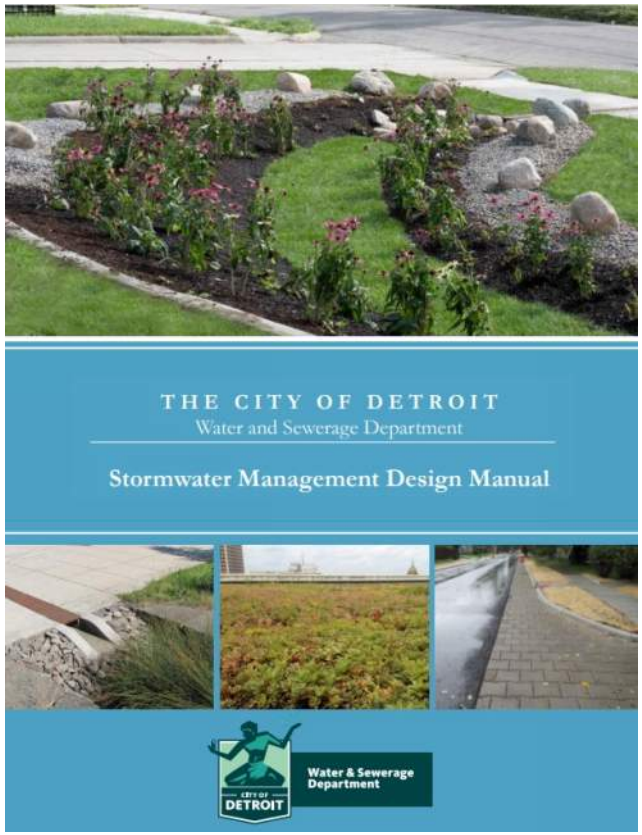
- Palencia Mobley, P.E., Deputy Director and Chief Engineer
- Lisa Wallick, P.E., SMG Manager
- Sarah Stoolmiller, SMG Engineer
- Barry Brown, SMG Engineer

OHM Advisors

- Greg Kacvinsky, P.E.
- Hannah Slabaugh, P.E.

Acknowledgements

- Don Carpenter, P.E. Drummond Carpenter



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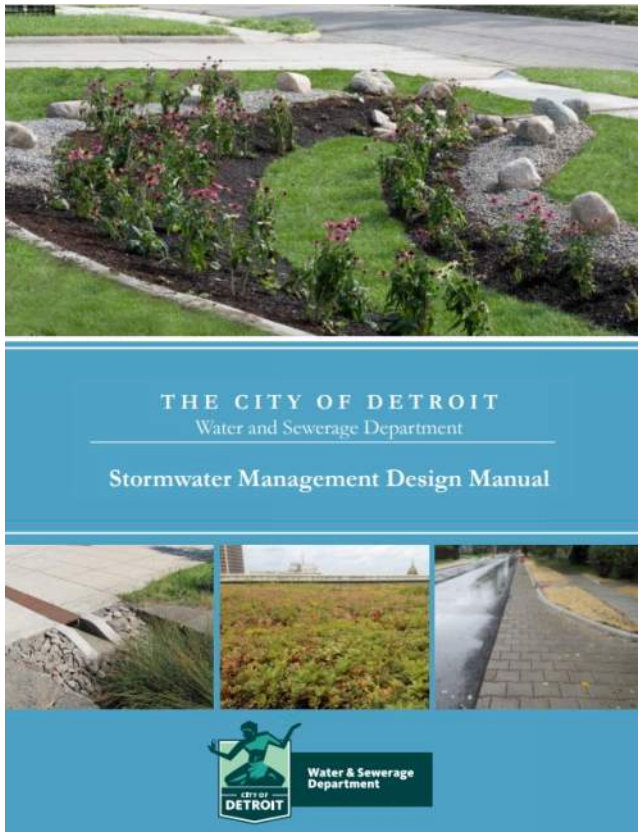
WORKSHOP GOALS

- Summarize key updates on the Stormwater Management Design Manual
- Assist developers, planners, and designers in understanding how to comply with Detroit's Stormwater Management Regulations
- Provide understanding of available technical resources, including Detroit's Stormwater Management Design Manual
- Answer participant questions and document questions to provide answers after workshop



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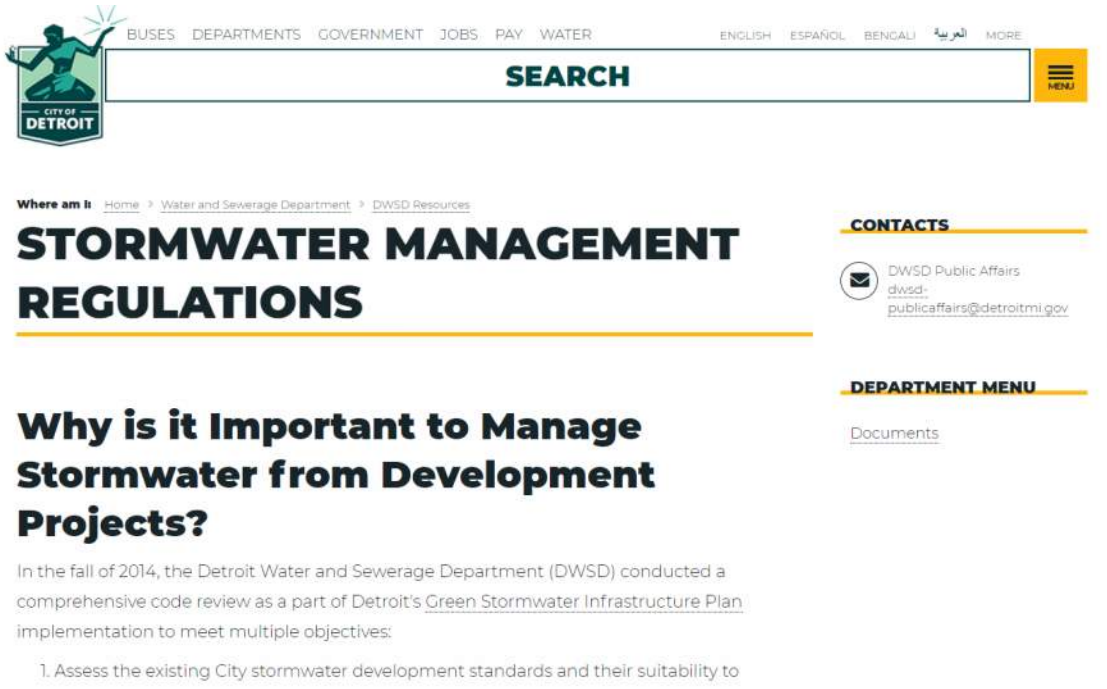
STORMWATER REGULATIONS

Importance of Stormwater Rules

- Consistent standards across all properties
- Reduce the potential for flooding
- Increase the use of Green Stormwater Infrastructure (GSI)
  - Reduce flow to the combined sewer
  - Reduce CSO frequency & enhance water quality in the Rouge and Detroit Rivers
- Meet regulatory commitments (CSO Permit and MS4 Permit)
- Make Detroit's infrastructure more resilient against the impacts of climate change

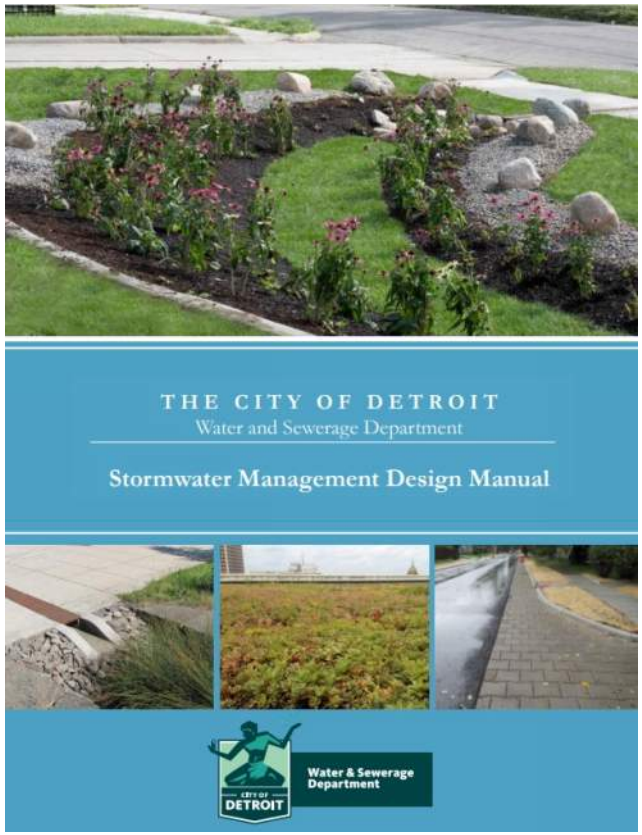


https://detroitmi.gov/departments/water-and-sewerage-department/dwsd-resources/stormwater-management-regulations

WHAT'S INSIDE THE DESIGN MANUAL?

- Regulatory Requirements
- Hydrologic Procedures
- Drainage Conveyance
- Soil & Aggregates
- Stormwater Control Measure (SCM) Design Specifications:
  - Detention Practices
  - Bioretention
  - Infiltration Practices
  - Permeable Pavement
  - Rainwater Harvesting
  - Living Roofs and Walls
  - Stormwater Wetlands
  - Manufactured Treatment Systems
  - Trees for Stormwater Management

Key focus for today



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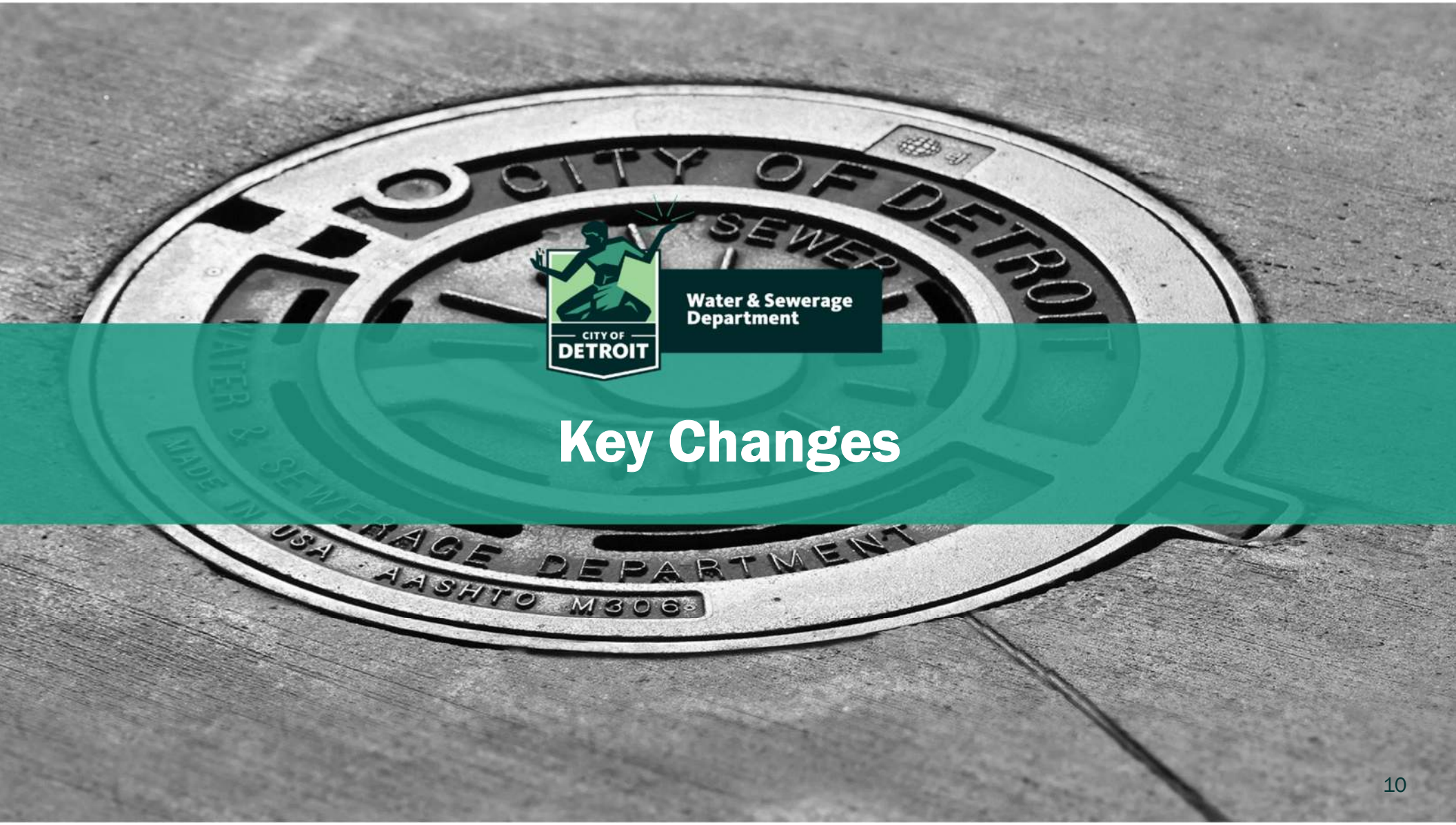

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Key Changes

AMENDED STORMWATER ORDINANCE

Key Changes - ORDINANCE

- Amended Stormwater Ordinance effective December 9, 2020 with modifications to:
  - Definitions
  - Exemptions
  - Performance Standards
  - Stormwater Management Plan (Report)
  - O&M
  - Alternative Compliance (Retention Volume)
    - Sets minimum infiltration rate
    - On-site alternative compliance option
  - Ordinance leaves more specifics to the Design Manual

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UPDATED DESIGN MANUAL

Key Changes – DESIGN MANUAL

- Updated Design Manual reflects changes to Ordinance
- Published in December 2020 (posted early January 2021)
- Focus on Chapters 2, 4, and 8
  - Major changes discussed today
  - Other minor changes throughout chapters; recommend reviewing Chapters 2, 4, and 8 before next site plan submittal

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DESIGN MANUAL: DECEMBER 2020 UPDATE

Key Changes to Chapter 2 – REGULATORY REQUIREMENTS

- Regulated Area equal to the Construction Area (CA) whenever CA < 50% of site
- Retention Volume requirement simplified to 1.0-inch storm event
- Clarified direct discharge requirements
- Specific in-situ infiltration criteria
- Changes to Alternative Compliance
  - Added *onsite* Alternative Compliance option

Performance Standards for Direct Discharges*

Performance Standard	Criteria
Water Quality	EGLE water quality criteria apply (applicant shall obtain a discharge permit from EGLE)
Channel Protection	EGLE channel protection criteria apply (applicant shall obtain a discharge permit from EGLE)
Flood Control	Applicant must demonstrate that there will be no potential cross-connections with any City-owned conveyance, including inlets, pipes, roadways, culverts, and bridges. No cross connection may occur for any storm event up to the 100-year / 24-hour event. Cross connections include any flow into a City-owned conveyance via overland flow, site flooding, detention pond overtopping, or any other hydraulic connection.

* Direct discharges are sites where 100% of the Regulated Area discharges stormwater directly to the Detroit River or Rouge River via a conveyance not owned by the City of Detroit. Surface discharges to City roads are not allowed. If any portion of the Regulated Area is connected to a City-owned conveyance, that portion of the property shall be subject to the performance standards outlined in Tables 2-1 to 2-4.

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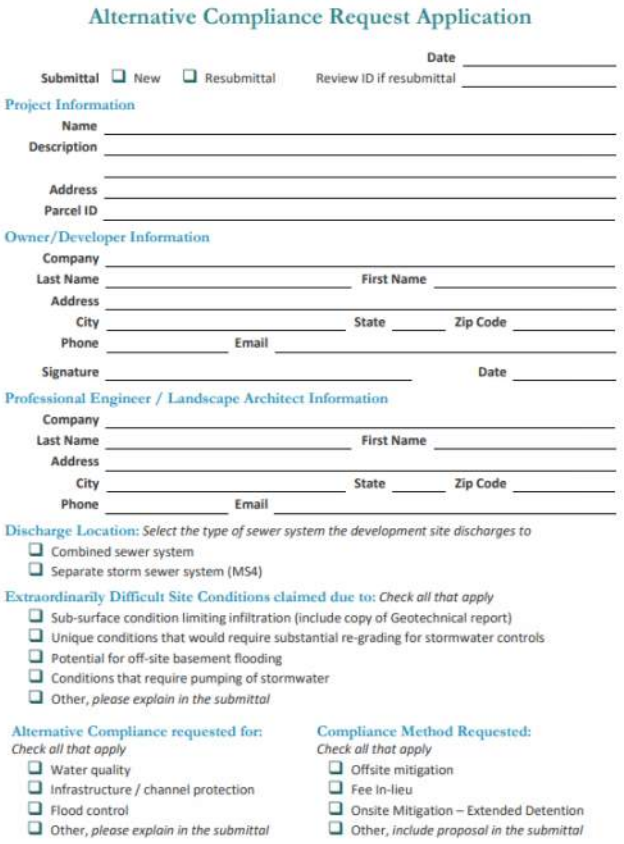
DESIGN MANUAL: DECEMBER 2020 UPDATE

Key Changes to Chapter 2 – REGULATORY REQUIREMENTS

- Extended Detention added as onsite alternative compliance option
  - 48-hour detention of 2-yr/24-hr runoff volume equivalent
- Updated Alternative Compliance Request form and checklist to accommodate onsite options
- Added example site plans with guidance on use of equations (Appendix 2D)
  - Step-by-step process to calculate key design volumes and achieve compliance
  - Examples for sites with *and* without viable retention (infiltration) options



Alternative Compliance Request Application

Date

Submittal ❑ New ❑ Resubmittal Review ID if resubmittal

Project Information

Name

Description

Address

Parcel ID

Owner/Developer Information

Company

Last Name First Name

Address

City State Zip Code

Phone Email

Signature Date

Professional Engineer / Landscape Architect Information

Company

Last Name First Name

Address

City State Zip Code

Phone Email

Discharge Location: *Select the type of sewer system the development site discharges to*

❑ Combined sewer system

❑ Separate storm sewer system (MS4)

Extraordinarily Difficult Site Conditions claimed due to: *Check all that apply*

❑ Sub-surface condition limiting infiltration (include copy of Geotechnical report)

❑ Unique conditions that would require substantial re-grading for stormwater controls

❑ Potential for off-site basement flooding

❑ Conditions that require pumping of stormwater

❑ Other, *please explain in the submittal*

Alternative Compliance requested for:
Check all that apply

❑ Water quality

❑ Infrastructure / channel protection

❑ Flood control

❑ Other, *please explain in the submittal*

Compliance Method Requested:
Check all that apply

❑ Offsite mitigation

❑ Fee In-lieu

❑ Onsite Mitigation – Extended Detention

❑ Other, *include proposal in the submittal*

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ALTERNATIVE COMPLIANCE

Key Modifications in Chapter 2 – REGULATORY REQUIREMENTS

- Specific criteria for Alternative Compliance to Retention Volume requirement:
  - Added existing soil infiltration capacity < 0.20 inches/hour
  - Defined minimum groundwater depth: less than 2 vertical feet from bottom of Stormwater Control Measure

Additional Extraordinarily Difficult Site Conditions, including soil contamination, are listed in Chapter 2 of the Design Manual

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DESIGN MANUAL: DECEMBER 2020 UPDATE

Key Changes to Chapter 4 – HYDROLOGIC PROCEDURES

- Water Quality Volume: 1.0 inch for all sites
  - 'Natural Conditions' language removed
- Computational methods updated
  - Simplified equations for Water Quality volume
  - New Alternative Compliance (Extended Detention volume)
- 20-acre cutoff for detention basin volume calculations:
  - ≤ 20 acres: simplified equations
  - > 20 acres: modeling/routing required

Table 4-5 Computational Methods

Process Description	Approved Methodologies
Stormwater conveyance system sizing, including routing flow offsite through the municipal collection system	Rational Method, EPA SWMM, HydroCAD, StormCAD, or other DWSD-approved model
Surface runoff volume for the water quality storm (a/k/a 'retention volume')	Simple Method for 1-inch storm: $V_R = 3{,}630 * C * A$ (Eq. 4.11)
Surface runoff volume for Extended Detention (alternative compliance for retention)	Simple Method for 1.9-inch storm: $V_{ED} = 6{,}897 * C * A$ (Eq. 4.12)
Surface runoff generation for discrete design storms (1- to 100-yr events)	Simple Method [(1)], NRCS Curve Number Approach, EPA SWMM, HEC-HMS, TR-55, TR-20, HydroCAD, StormCAD, or other DWSD-approved model
Detention basin volumetric sizing for large storms (10- to 100-yr events)	Modified Rational Method [(1)], NRCS Curve Number Approach, EPA SWMM, HEC-HMS, TR-20, HydroCAD, StormCAD, or other DWSD-approved model
Routing flow on site through SCMs and stormwater controls	Hydrologic modeling packages, such as EPA SWMM, HEC-HMS, TR-20, HydroCAD, StormCAD, or other DWSD-approved model

(1) Simple Method and/or Modified Rational Method are suitable for design calculations for sites up to 20 acres. For sites larger than 20 acres, use hydrologic calculations from the NRCS Curve Number Approach, EPA SWMM, or other DWSD-approved model.

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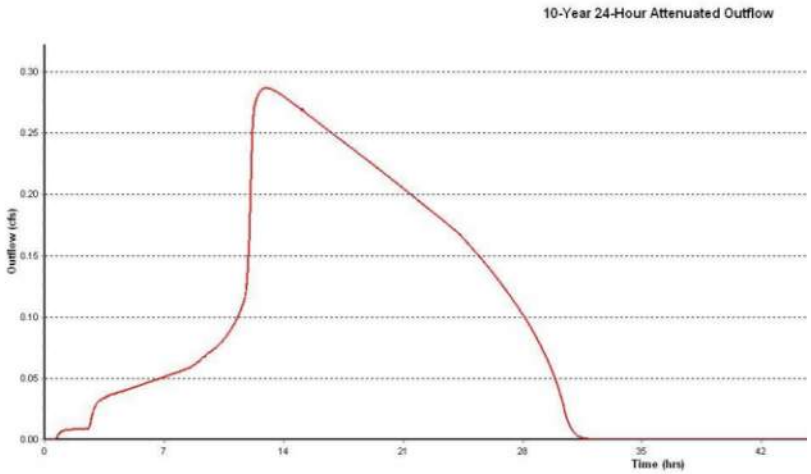
DESIGN MANUAL: DECEMBER 2020 UPDATE

Key Changes to Chapter 4 – HYDROLOGIC PROCEDURES

- Clarifications on Time of Concentration calculations
- Additions and clarifications for runoff coefficients
  - Lower Limit / Upper Limit explained
- Added references for common hydrologic/hydraulic modeling programs:
  - SWMM
  - HydroCAD / StormCAD
  - WinTR-55, WinTR-20
  - HEC-HMS



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DESIGN MANUAL: DECEMBER 2020 UPDATE

Key Changes to Chapter 8 - BIORETENTION

- Additional guidance on minimum in-situ infiltration requirements
  - 0.2 in/hr (measured)
- Increased void ratio for bioretention soil mix (0.20 to 0.30)
- Updated requirements for compliance with retention volume:
  - No distinction between infiltrated volume and discharge volume through an underdrain
  - Underdrains encouraged when measured in-situ infiltration is less than 1.0 inch/hour
- Bioretention volume includes surface storage, subsurface storage, *and* active infiltration volume

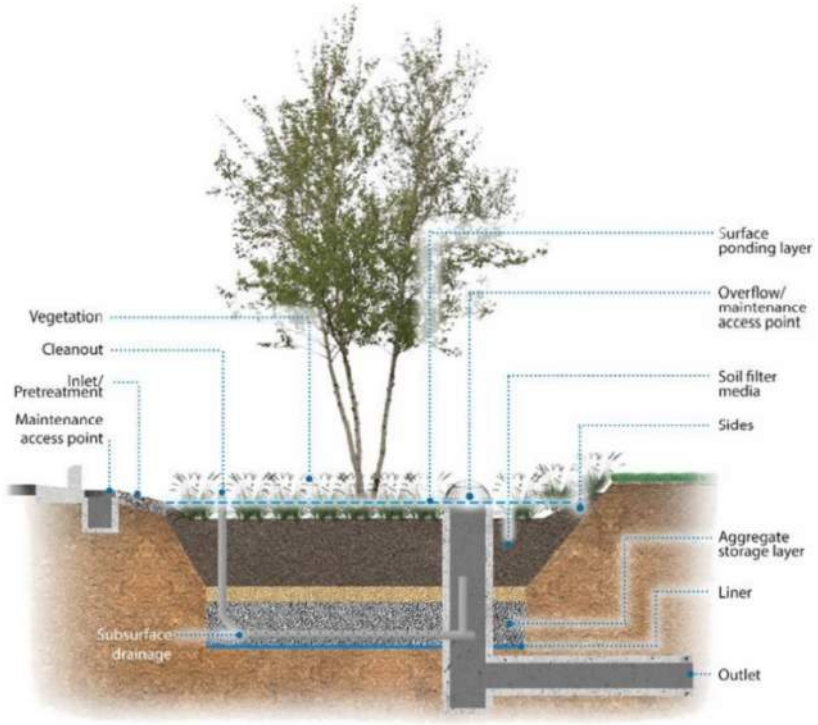

Figure 8-1 Components of a typical bioretention practice

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Applicability of Stormwater Regulations

APPLICABILITY OF STORMWATER REGULATIONS

Applicability Threshold

Any new or redevelopment project which creates or replaces 0.5 acres (21,780 square feet) or more of impervious surface will be considered a regulated construction activity and will be subject to the stormwater management requirements

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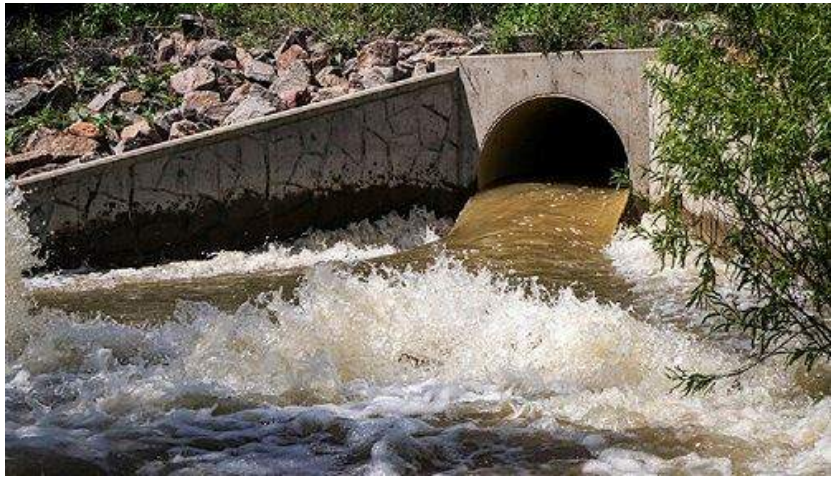
APPLICABILITY OF STORMWATER REGULATIONS

Direct Discharges

Direct discharge was removed from 'exemptions' for clarification purposes; applicant must demonstrate there will be no stormwater connections to the City-owned system up to and including the 100-year storm event



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APPLICABILITY OF STORMWATER REGULATIONS

Exemptions

- Construction of one Single Family detached dwelling as defined in the Zoning Ordinance (not part of a common plan of development)
- Emergency maintenance work performed for the protection of public health and safety
- Regulated construction activity done to protect public health as part of a Due Care Plan that is required and approved by a state or federal regulatory agency

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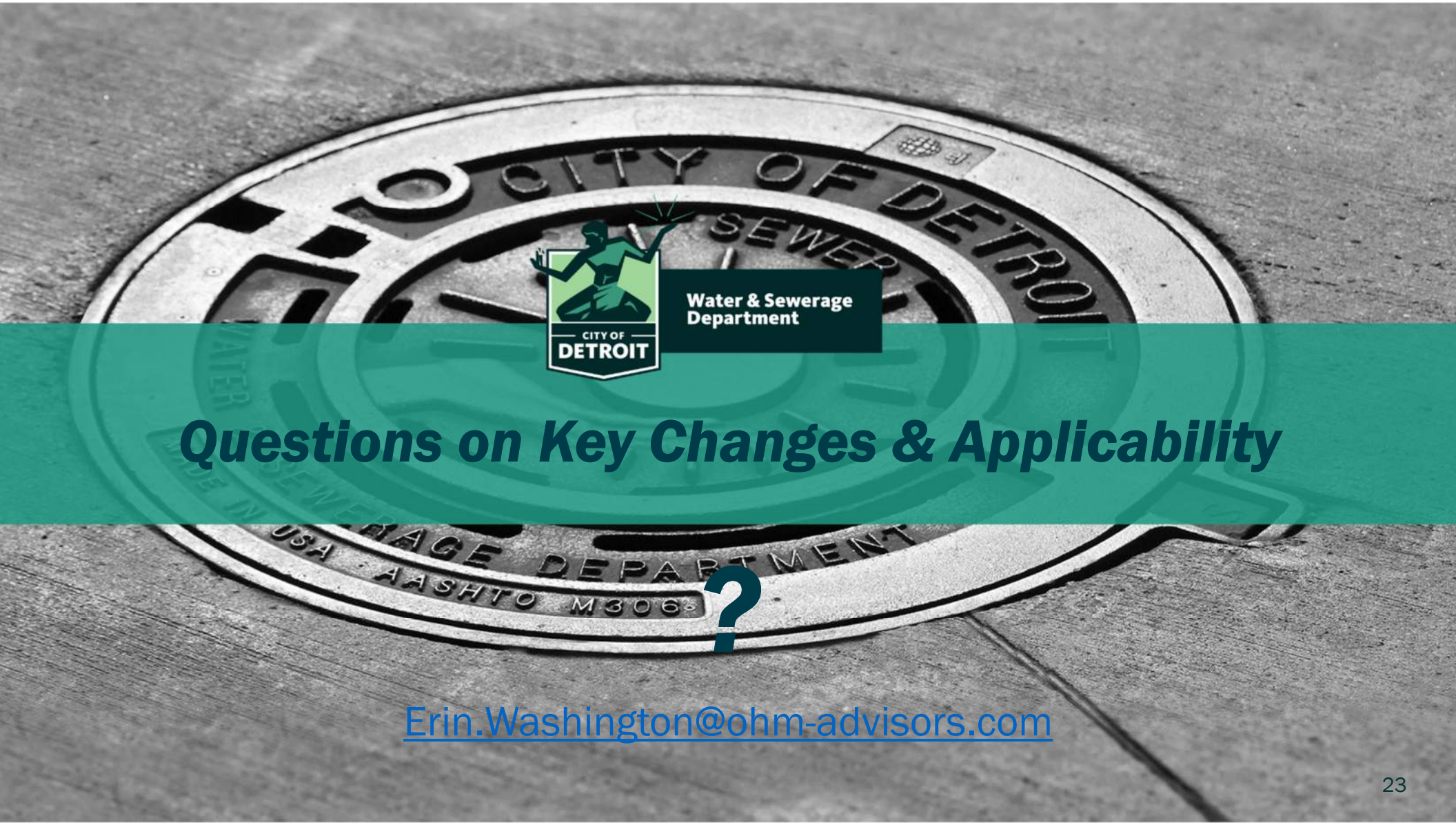

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Questions on Key Changes & Applicability

?

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Understanding & Applying the Regulations

APPLYING THE REGULATIONS

Purpose of Stormwater Management Performance Standards

- Improve water quality
- Provide more climate resiliency for Detroit's infrastructure
- Protect channels of receiving waters
- Reduce the severity of flooding
- Reduce flow volumes the combined sewer system and reduce CSO frequency

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APPLYING THE REGULATIONS

Key Components of Stormwater Rules

- Intercept and control stormwater runoff before it enters a DWSD sewer
- For the 1-inch storm:
  - Control Total Suspended Solids (TSS)
    - 80% reduction or effluent concentration below 80 mg/L
  - Retain or infiltrate the entire runoff volume
  - When infiltration is not feasible, seek Alternative Compliance
- For the 2-year / 24-hour storm:
  - No peak flow increase
  - This will generally be automatically achieved through other compliance measures, including flood control

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APPLYING THE REGULATIONS

Key Components of Stormwater Rules

- Flood Control (Regulated Area less than 5 acres)
  - Provide storage volume and outlet control to limit the peak 10-yr/24-hr discharge to 0.15 cfs/acre
- Flood Control (Regulated Area 5 acres or larger)
  - Provide storage volume and outlet control to limit the peak 100-yr/24-hr discharge to 0.15 cfs/acre

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APPLYING THE REGULATIONS

Regulated Area

- For all stormwater performance measures, the Regulated Area will be:
  - Equal to the Construction Area if the Construction Area is less than 50% of the Development Site
  - Equal to the entire Development Site if the Construction Area is 50% or more of the Development Site

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APPLYING THE REGULATIONS

Standards Vary By Location

- Combined Sewer System (97% of Detroit)
- Separate Storm Sewer System (MS4)
  - Includes isolated areas along the Detroit and Rouge Rivers; very small percentage of Detroit
- Check with DWSD if uncertain whether your site is in an MS4 area
- Future sewer separation projects may increase the overall MS4 area
- Standards are very similar with lone exception being volume control (see figure)

Table 2-4 Stormwater Performance Standards for Separate Sewer System (MS4)

Performance Standard	Criteria
Water Quality	(1) Remove 80% of the total suspended solids (TSS) projected to be in uncontrolled runoff from the Regulated Area in the post-construction condition during a 1.0-inch rain event, **or**; (2) Have an effluent TSS concentration of less than or equal to 80 mg/L for the Regulated Area during a 1.0-inch rain event, **or;** (3) Satisfy the Volume Control requirement below; this automatically meets the TSS requirement
Channel Protection	Post-construction peak flow rate shall not exceed the pre-development peak flow rate for the ***2-year, 24-hour storm***, as measured over the Regulated Area Volume Control: Retain and infiltrate the first one (1) inch of rainfall over the Regulated Area ***or*** retain and infiltrate the volume necessary to limit the 2-year/24-hour rainfall volume to existing pre-development conditions over the Regulated Area (choose option that results in the higher volume)
Flood Control	Same as flood control standards for combined sewer system (see Table 2-3)

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APPLYING THE REGULATIONS

TSS Control / Sediment Removal

- For the 1-inch storm:
  - Control Total Suspended Solids (TSS)
    - 80% reduction or effluent concentration below 80 mg/L
- Automatically achieved if retention volume is provided through reuse or infiltration
- Otherwise, generally achieved using:
  - Sediment forebay
  - Wet detention pond
  - Mechanical separator
- See Chapter 14 of the Design Manual for Manufactured Treatment Devices

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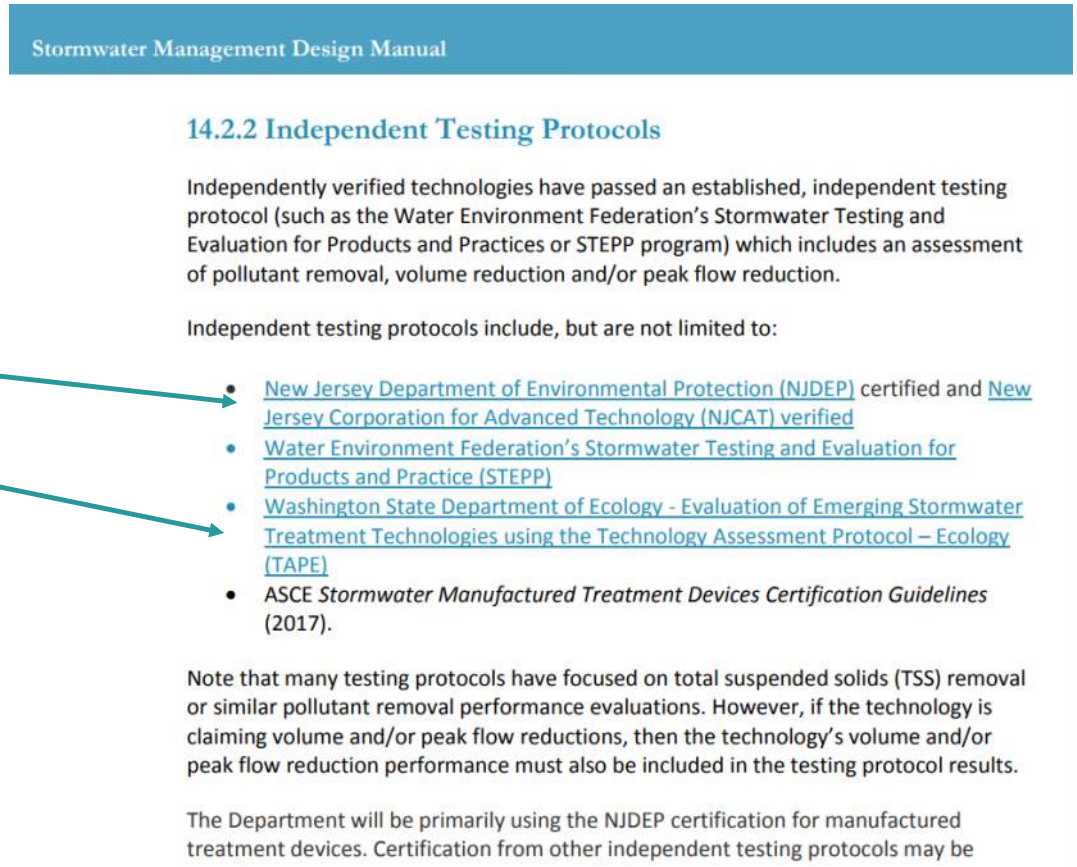
APPLYING THE REGULATIONS

Mechanical Separators – Advice and Lessons Learned

- Stick to the lists of approved manufacturers referenced in Chapter 14 (hyperlinks on Page 14-3)
  - NJCAT
  - TAPE
- Always locate mechanical separators upstream of detention storage



Stormwater Management Design Manual

14.2.2 Independent Testing Protocols

Independently verified technologies have passed an established, independent testing protocol (such as the Water Environment Federation's Stormwater Testing and Evaluation for Products and Practices or STEPP program) which includes an assessment of pollutant removal, volume reduction and/or peak flow reduction.

Independent testing protocols include, but are not limited to:

- New Jersey Department of Environmental Protection (NJDEP) certified and New Jersey Corporation for Advanced Technology (NJCAT) verified
- Water Environment Federation's Stormwater Testing and Evaluation for Products and Practice (STEPP)
- Washington State Department of Ecology - Evaluation of Emerging Stormwater Treatment Technologies using the Technology Assessment Protocol – Ecology (TAPE)
- ASCE *Stormwater Manufactured Treatment Devices Certification Guidelines* (2017).

Note that many testing protocols have focused on total suspended solids (TSS) removal or similar pollutant removal performance evaluations. However, if the technology is claiming volume and/or peak flow reductions, then the technology's volume and/or peak flow reduction performance must also be included in the testing protocol results.

The Department will be primarily using the NJDEP certification for manufactured treatment devices. Certification from other independent testing protocols may be

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APPLYING THE REGULATIONS

Pre-Approved Lists of Mechanical Separators

- Excerpt from the TAPE website
- Focus on “Pretreatment” and “Enhanced” tabs
- Pretreatment
  - 50% removal of TSS for an influent concentration range of 100 mg/L to 200mg/L
  - Influent TSS concentration < 100 mg/L, effluent goal is < 50mg/L
- Basic
  - 80% removal of TSS for an influent concentration range of 100 mg/L to 200mg/L
  - Influent TSS concentration < 100 mg/L, effluent goal is < 20mg/L
- ‘Pretreatment’ devices generally adequate for 80 mg/L requirement

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DEPARTMENT OF ECOLOGY
State of Washington

State of Washington Department of Ecology
Emerging Stormwater Treatment Technologies

Approved technologies

The following table lists the devices that have received a designation through the TAPE process.

In addition to our certification, local jurisdiction approval is required (and not guaranteed) for installation of treatment technologies we have evaluated and given a use designation.

All | Pretreatment | Oil | Enhanced | Basic | Phosphorus | Construction

Manufacturer	Device Name	Treatment Type	Use Designatic
Advanced Drainage Systems BaySaver	BaySeparator	Pretreatment	General Us Level
AquaShield, Inc.	Aqua-Swirl System	Pretreatment	General Us Level
CONTECH Engineered Solutions, LLC.	CDS Stormwater Treatment System	Pretreatment	General Us Level
CONTECH Engineered Solutions, LLC.	Vortechs System	Pretreatment	General Us Level
Hydro International	Downstream Defender	Pretreatment	General Us Level
Imbrium Systems	Stormceptor	Pretreatment	General Us Level
Oldcastle Infrastructure, Inc.	Nutrient Separating Baffle Box	Pretreatment	Conditiona Use Level

Showing 1 to 7 of 7 entries (filtered from 97 total entries)

APPLYING THE REGULATIONS

Retention Volume

- For the 1-inch storm:
  - Retain all runoff volume on site using infiltration / evapotranspiration, water reuse, or a combination of the two
  - $V_R = 3630 \times C \times A$
- All site plans must comply with the Retention Volume unless it can be demonstrated that infiltration is not feasible (three most common conditions):
  - In-situ infiltration less than 0.20 in/hr (must be verified by direct infiltration testing and Professional Engineer certification of results)
  - Observed groundwater within 2 vertical feet of bottom of proposed infiltration measure (4 feet preferred)
  - Soil contamination (Environmental Site Assessment required)

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APPLYING THE REGULATIONS

Retention Volume

- For sites where retention is deemed feasible (assuming infiltration is the selected stormwater management option):
  - Identify preliminary footprint for infiltration practice(s)
  - Calculate total storage
    - Surface storage (applicable for bioretention cells with surface storage, up to 12-inch depth)
    - Subsurface storage (void space within soil media and stone layers)
    - Active infiltration (applicable only when no underdrain is used); applied to the infiltration zone over a 6-hour period
  - Adjust footprint as necessary to achieve required retention volume

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APPLYING THE REGULATIONS

Retention Volume

- Tips and tricks for design (bioretention)
  - Start with a bioretention footprint approximately 10% of the contributing impervious area and adjust as necessary
  - Maximizing surface storage depth (up to 12 inches) reduces footprint
  - Use underdrain when measured infiltration rate is less than 1.0 inch/hour
  - When underdrain is used, assume dewatering rate is adequate for complete drawdown in the required timeframe

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APPLYING THE REGULATIONS

Retention Volume

- Water Reuse (onsite storage and reuse)
  - Must demonstrate adequate site demand for stormwater reuse (Water Use Plan)
    - Irrigation
    - Gray water system in building(s)
    - Dewatering timeframe comparable to infiltration practices
  - May require special pre-treatment and maintenance schedule (more than typical stormwater systems)
  - May be subject to other City, State, and Federal code restrictions
  - See Chapter 11 (Rainwater Harvesting) for design guidance

Cistern with informational signage, Raleigh, NC

APPLYING THE REGULATIONS

Retention Volume

- For sites where infiltration/retention is not feasible:
  - Complete an Alternative Compliance Application (see Appendix 2B)
  - Select onsite, offsite, or Fee-in-Lieu Alternative Compliance
- Onsite Alternative Compliance
  - Extended Detention
  - Provide volume for 48-hour discharge of the 1.9-inch storm (roughly equivalent to 2-yr/24-hr excess runoff volume relative to pre-settlement conditions)
    - $V_{ED} = 6897 \times C \times A$
  - Subset of flood control volume (results in two hydraulic controls: one for Extended Detention, and one for Flood Control)

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APPLYING THE REGULATIONS

Flood Control

- For sites greater than 20 acres, use a stormwater runoff / routing model to demonstrate compliance to the flood control standards
- For sites smaller than 20 acres, applicants may use the Modified Rational Method to calculate storage volume
  - Equations 4-1, 4-7, 4-8, and 4-9
- Sediment forebay (if used) can count toward flood control volume
- Retention/infiltration stormwater control measures can count toward flood control volume

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APPLYING THE REGULATIONS

Site Plan Example 1

- Development Site Area = 32.6 acres
- Construction Area = 22.9 acres
- Regulated Area = 32.6 acres
- New or replacement impervious area = 20.4 acres
- Other site characteristics:
  - No known soil contamination
  - Measured infiltration rate: 1.0 in/hr
  - Prevailing groundwater depth: 7 feet
    - Allows for BMP depth of 3-5 feet to achieve minimum 2-4 vertical feet of clearance
  - Discharges to a combined sewer

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APPLYING THE REGULATIONS

Site Plan Example 1

- Development Site Area = 32.6 acres
- Construction Area = 22.9 acres
- Regulated Area = 32.6 acres
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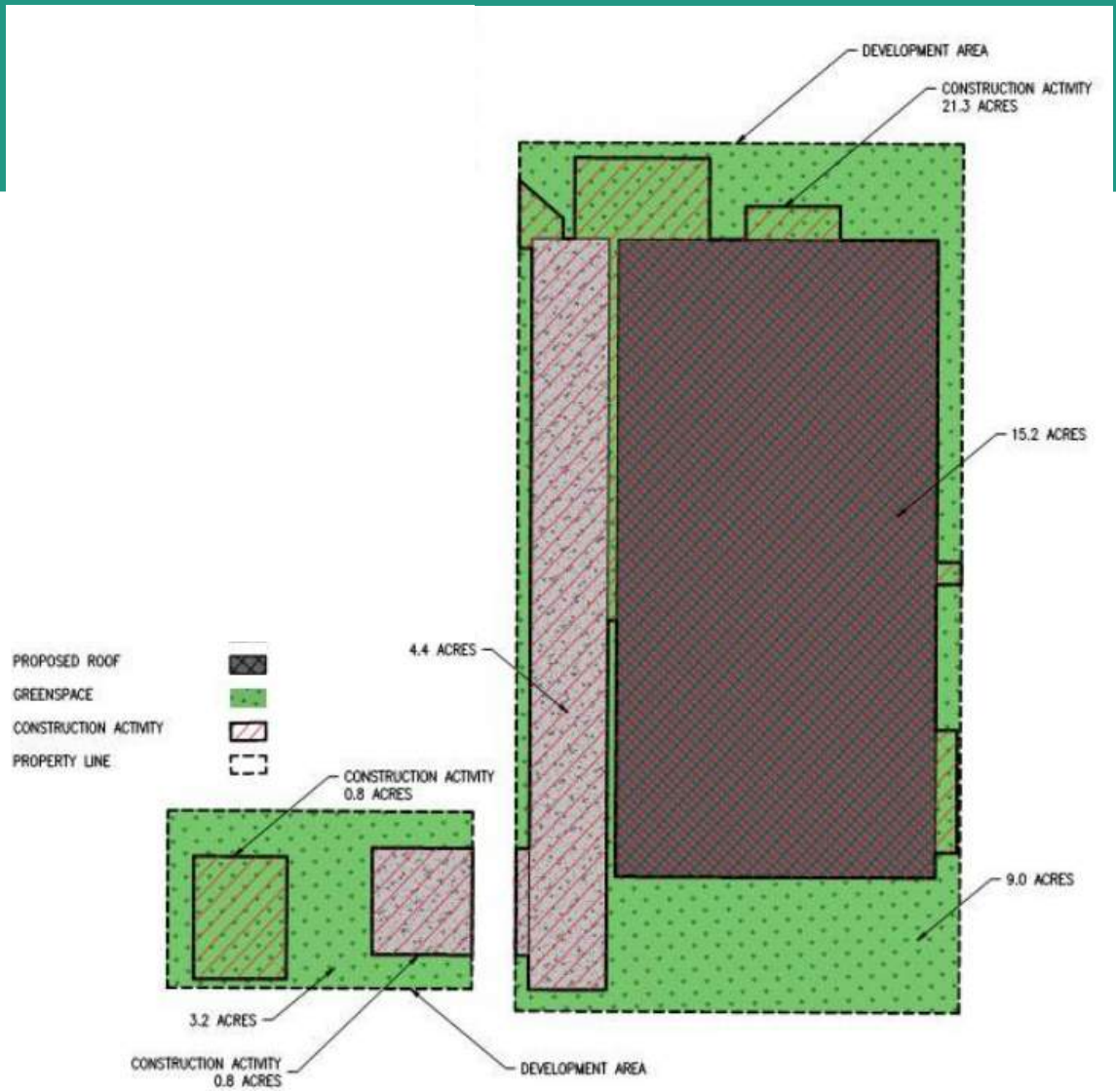

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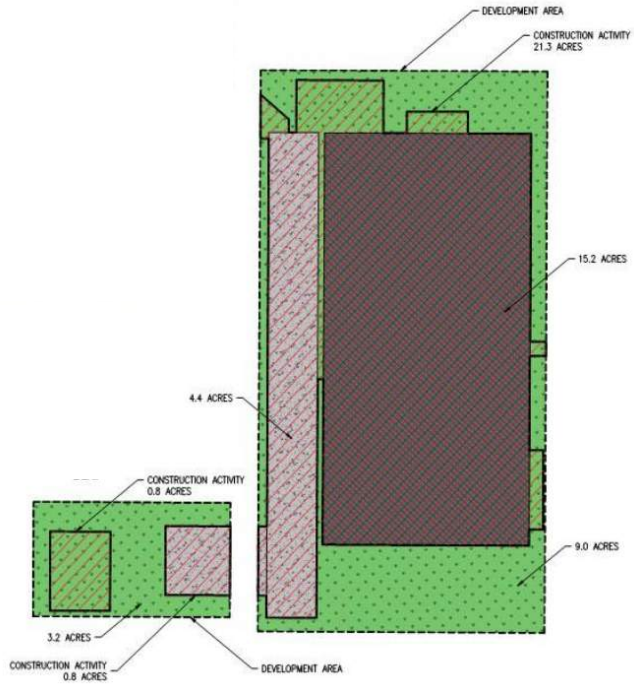
APPLYING THE REGULATIONS

Site Plan Example 1 – Calculate Key Regulatory Volumes

- Retention Volume Requirement can be met due to existing soil characteristics:
  - Measured infiltration rate: 1.0 in/hr
  - Design infiltration rate: 0.50 in/hr
- Retention Volume calculated as the runoff resulting from 1.0 inch of rainfall:
  - $V_R = 3630 \times C \times A$
  - $V_R = 3630 \times 0.56 * 32.6 \text{ ac} = 66{,}269 \text{ CF}$
- Proposed design: bioretention
  - 66,269 CF to be provided in surface storage and subsurface storage



Retention volume can be used to satisfy TSS requirements ***and*** count towards flood control volume

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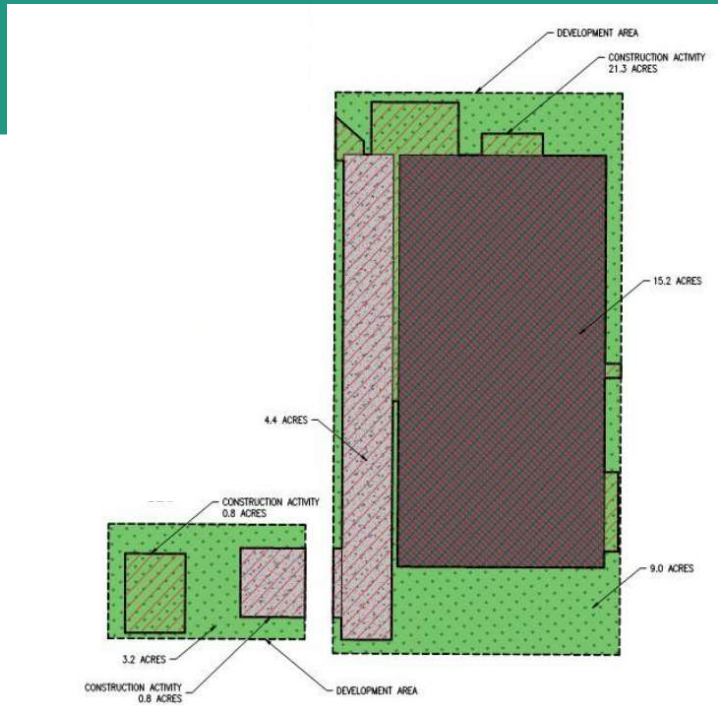
APPLYING THE REGULATIONS

Site Plan Example 1 – Calculate Key Regulatory Volumes

- Infrastructure Protection (2-yr / 24-hr storm)
  - $V_{2\text{-yr}} = 6897 \times \Delta C \times A$

    (ΔC = change in runoff coefficient)
  - $V_{2\text{-yr}} = 6897 \times (0.56 - 0.29) \times 32.6$
  - $V_{2\text{-yr}} = 60{,}707$ cubic feet



2-yr storage volume is less than the required Retention Volume (66,269 CF)
Retention volume will satisfy Infrastructure Protection Requirement

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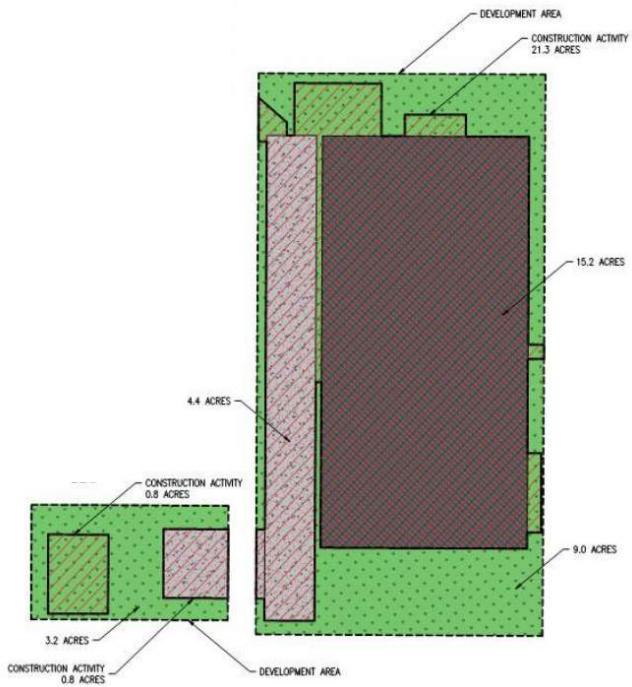
APPLYING THE REGULATIONS

Site Plan Example 1 – Calculate Key Regulatory Volumes

- Flood Control (100-yr / 24-hr storm)
  - Site is larger than 5 acres; 100-yr storm applies
  - Site is larger than 20 acres:
    - Modified Rational Method may be used to estimate detention pond volume
    - Modeling/routing necessary to confirm detention pond design
  - Modified Rational Method (Chapter 4)



$$D_{100} = 50 * \left(\frac{Q_R}{C}\right)^{-0.984}$$

Q_R = 0.15 cfs/acre

T = Return Period (100 yrs)

$$D_{100} = 50 * \left(\frac{0.15}{0.56}\right)^{-0.984} = 183\ min$$

$$i = \frac{38.42 * T^{0.208}}{(12.33 + D)^{0.841}}$$

$$i = \frac{38.42 * 100^{0.208}}{(12.33 + 183)^{0.841}} = 1.19\ in/hr$$

For sites smaller than 20 acres, the Modified Rational Method (Chapter 4 equations) are sufficient for sizing the detention pond

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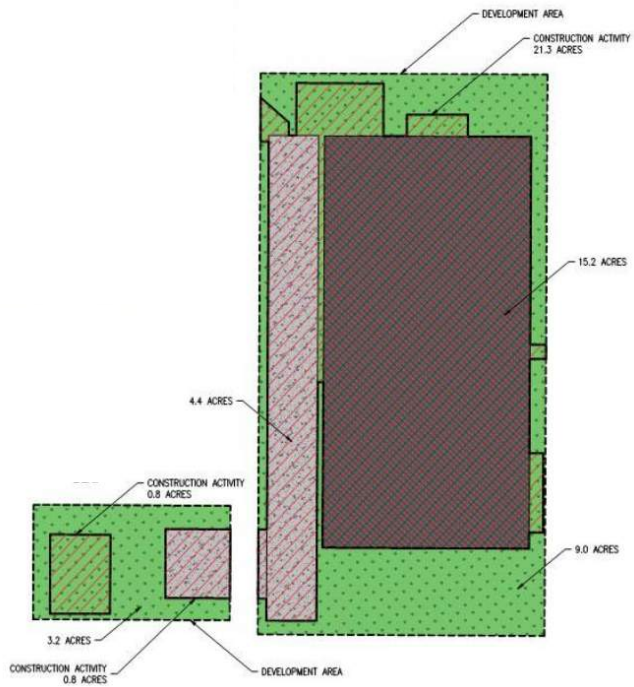
APPLYING THE REGULATIONS

Site Plan Example 1 – Calculate Key Regulatory Volumes

- Flood Control (100-yr / 24-hr storm)
  - Required storage volume for detention pond:

$$V_{100} = (60.5 * D_{100} * C * A * i) - (60 * D_{100} * Q_R * A)$$

$$V_{100} = (60.5 * 183 * 0.56 * 32.6 * 1.19) - (60 * 183 * 0.15 * 32.6) = 185,992\ ft^3$$



Chapter 4 equations are useful to approximate pond size for preliminary design; using a stormwater routing model confirms sizing and outlet hydraulics

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APPLYING THE REGULATIONS

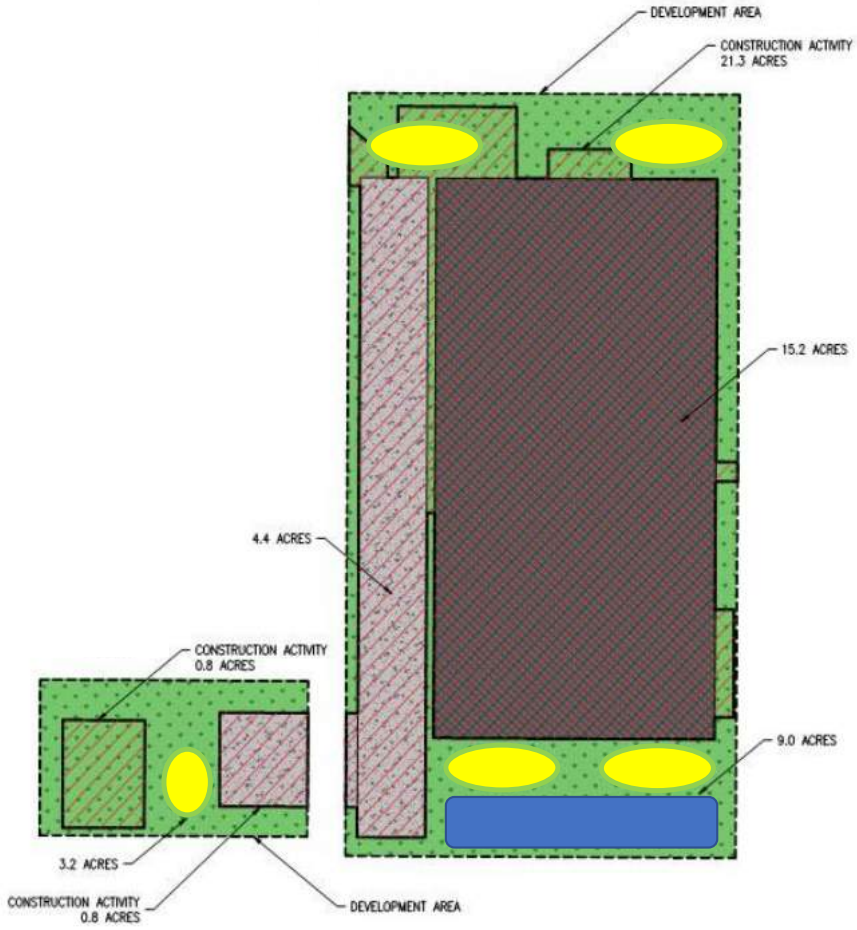
Site Plan Example 1 – Calculate Key Regulatory Volumes

- Detention pond volume adjustment for retention volume:

$$V_{n-adjusted} = V_n - V_R$$

$$V_{100-adjusted} = 185,992 - 66,269 = 119,723\ ft^3$$

- Next step: determine where volume will be achieved:
  - Retention Volume (66,269 CF)
  - Detention Volume (119,723 CF)



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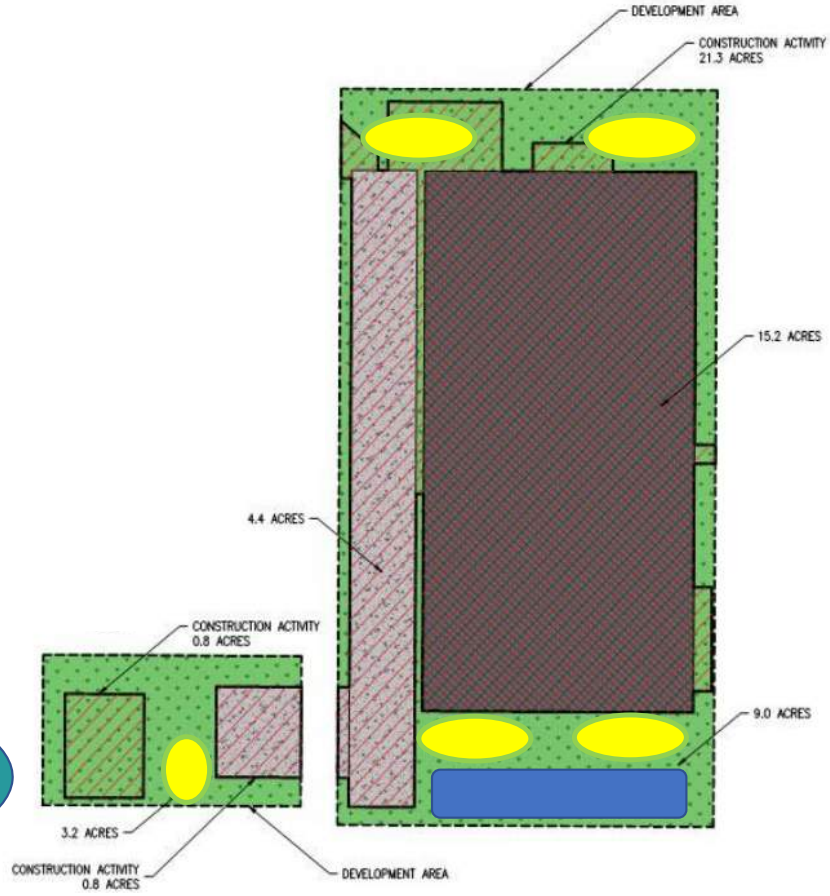
APPLYING THE REGULATIONS

Site Plan Example 1 – Bioretention

- Design infiltration rate = 0.50 in/hr
- Underdrain allowed, but not required
- Three components of bioretention volume:
  - Surface
    - Storage volume at design depth (12 inches maximum)
  - Subsurface
    - Void space in underlying soils (0.30)
  - Active infiltration (6 hours @ 0.50 in/hr)
    - Applied to bottom contour of bioretention cells

Don't forget to roto-till (or scarify) the bottom of bioretention cell prior to placement of engineered fill



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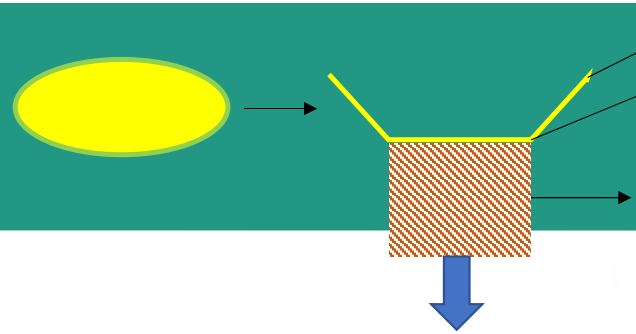
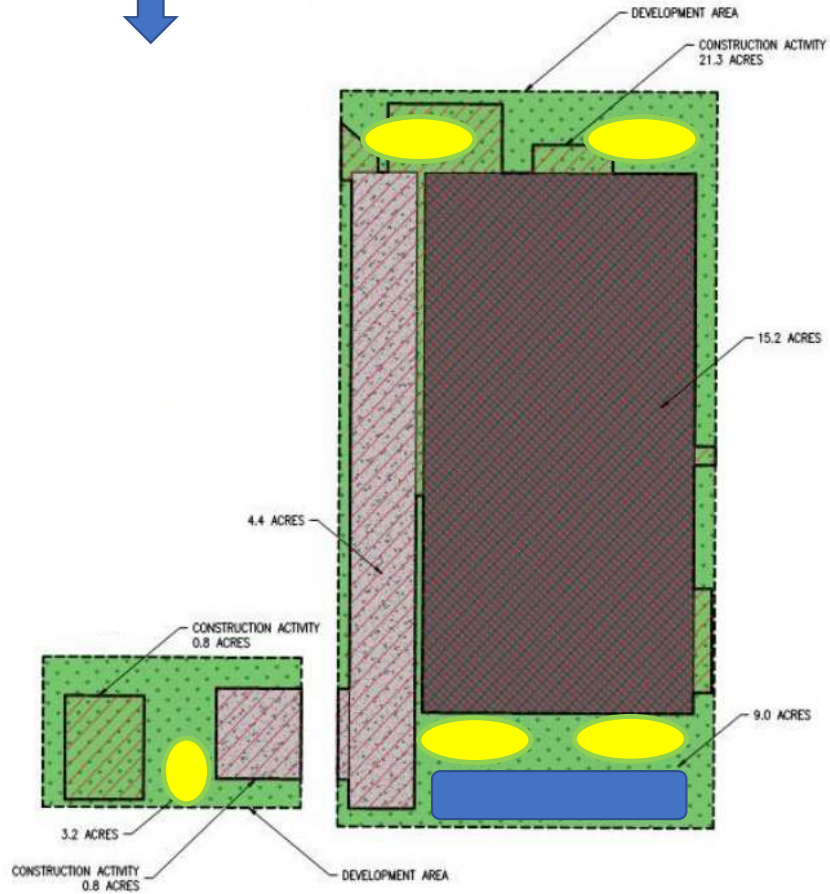
APPLYING THE REGULATIONS



Site Plan Example 1 – Bioretention

- Calculate volume:
  - Surface
    - Five (5) bioretention cells, each with a 9,000 square foot top contour and 7,000 square foot bottom contour
    - Maximum ponding depth: 12 inches
    - Surface storage: 40,000 CF
  - Subsurface
    - Engineered soils occupy bottom contour, depth of 2 feet, + 6 inches stone drainage layer:
    - 7,000 SF * 5 cells * 2.5 ft. * 0.30 = 26,250 CF
  - Active infiltration (6 hours @ 0.50 in/hr)
    - Applied to bottom contour of bioretention cells
    - 7,000 SF * 5 cells * 0.5/12 * 6 hrs = 8,750 CF



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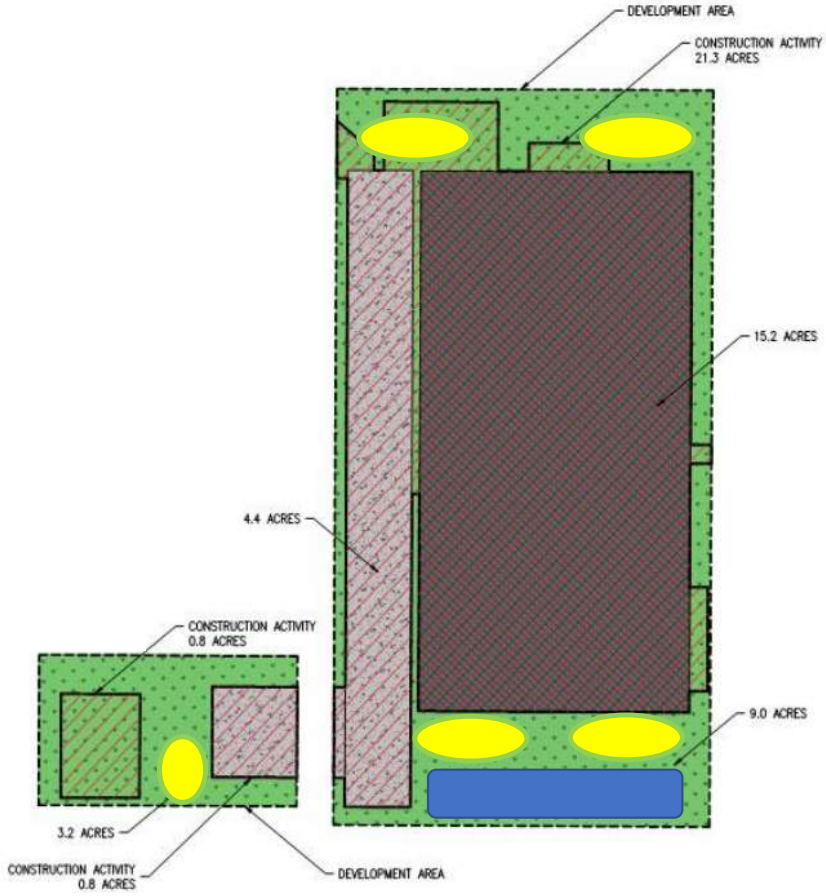
APPLYING THE REGULATIONS

Site Plan Example 1 – Bioretention

- Calculate volume:
  - Surface storage: 40,000 CF
  - Subsurface storage: 26,250 CF
  - Active infiltration: 8,750 CF
  - TOTAL VOLUME = 75,000 CF > 66,269 (required)
- Bioretention cells oversized by ~ 13%
- Adjust footprint as necessary to meet volume requirement
- Check loading ratio:
  - Total impervious area = 888,624 square feet
  - Total infiltration footprint: 45,000 square feet
  - LOADING RATIO: 19.7 (very high)



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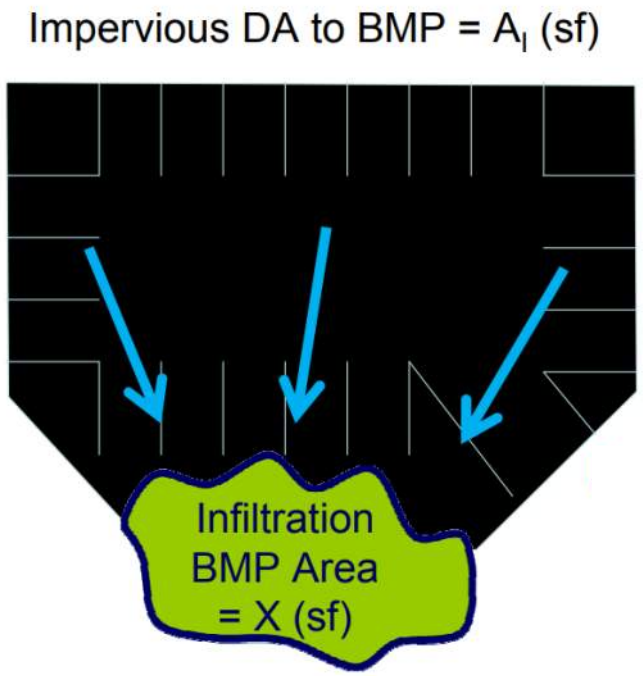
BIORETENTION / RETENTION: LOADING RATIOS

LOADING RATIO

- Ratio of tributary impervious area to the bioretention cell footprint
  - A_I/X
  - 19.7 in site plan example
- Appropriate ratios can vary depending on pollutant loading from drainage area:
  - Loading Ratio of 5 is considered ideal
  - Higher Loading Ratios (> 10) can result in pollutant overloading
  - Generally best to keep Loading Ratio < 10
  - Larger Loading Ratios are ok with upstream pretreatment (catch basin/sump or similar)
  - Usually limited by available space (many sites max out at 5%-10% area available for infiltration)

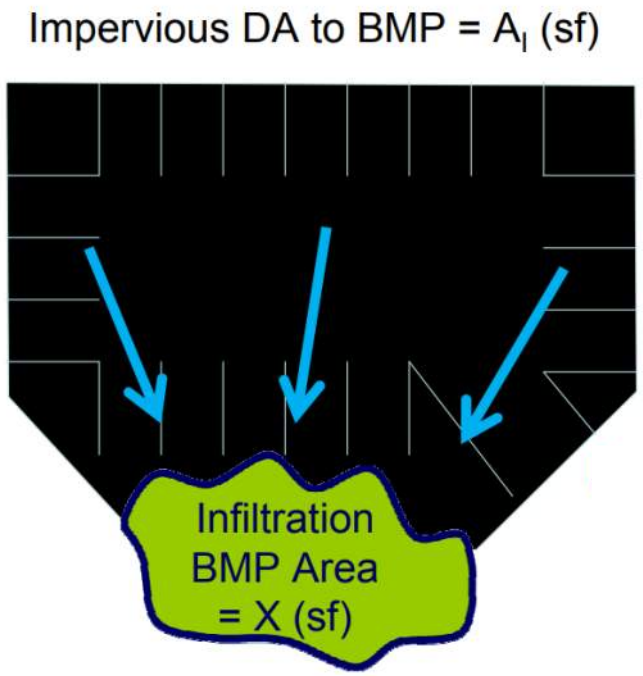


Source: Pennsylvania Dept. of Environmental Protection

BIORETENTION / RETENTION: LOADING RATIOS

LOADING RATIO

- How would this impact the design example?
  - Loading Ratio = 19.7
- Take the following design measures:
  - Reduce ponding depth and increase footprint of bioretention cells (especially those downstream of parking/drive areas)
    - 12-inch ponding depth to 6-inch or 9-inch
  - Design sump structures at each inlet point
  - Install flow spreaders / energy dissipators upstream of each infiltration area
  - Attempt to bring Loading Ratio closer to a value of 10



Source: Pennsylvania Dept. of Environmental Protection

BIORETENTION / RETENTION: PLANNING & DESIGN

INFILTRATION STORMWATER CONTROL MEASURES

- Design recommendations
  - Try to keep Loading Ratio < 10
    - Lower Loading Ratios for dirtier surfaces with higher pollutant buildup
    - Higher Loading Ratios may be ok for rooftop (cleaner) areas
  - Pre-treatment recommended (sump, sediment trap), especially when Loading Ratio approaches and exceeds 10
  - Loading ratio is at designer's discretion, but remember:
    - Higher Loading Ratios = more pre-treatment necessary
    - Higher Loading Ratios = higher maintenance costs

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BIORETENTION / RETENTION: PLANNING & DESIGN

INFILTRATION STORMWATER CONTROL MEASURES

- Design recommendations
  - Inlet design is very important
    - Must have enough capacity to receive flow from surrounding areas
    - Dissipate energy
    - Trap solids
  - Make it easier for long-term maintenance:
    - Install trap/sump at each inlet
    - Maintenance of infiltration practices is primarily solids removal; faster and cheaper to accumulate solids at a single point

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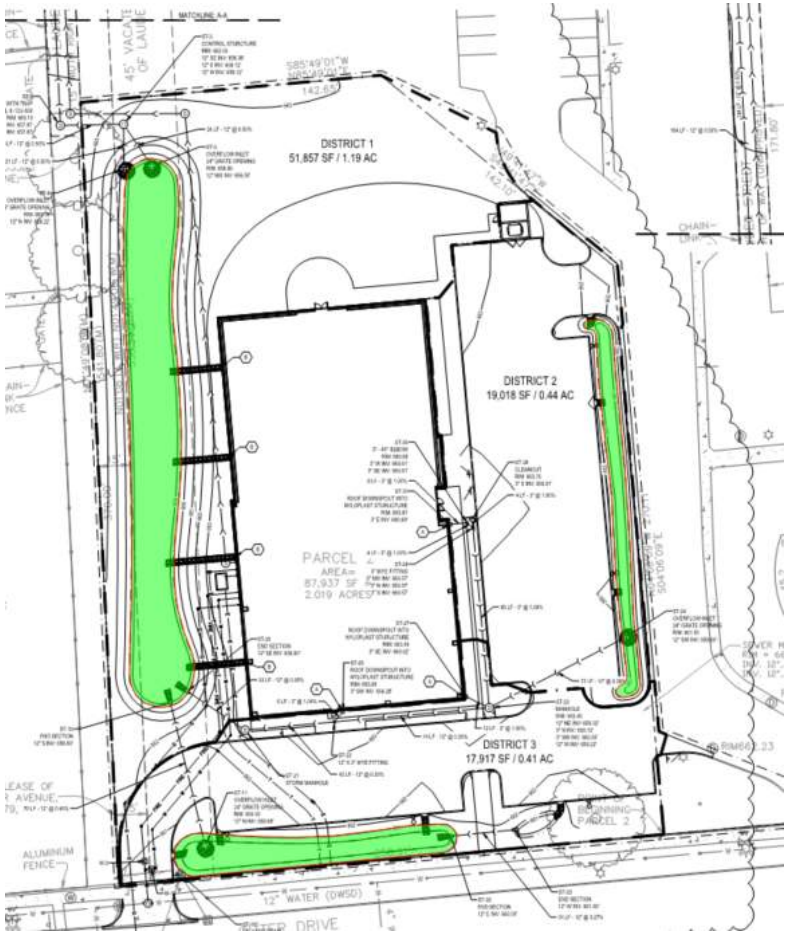
BIORETENTION / RETENTION: PLANNING & DESIGN

EXAMPLE: Racquet Up Detroit

- Owner: Racquet Up Detroit
- Engineer: SmithGroup
  - Total impervious area: 1.09 acres
  - Measured infiltration rates:
    - 0.3 in/hr to 1.3 in/hr
  - Total infiltration BMP footprint: 0.12 acres
  - Loading Ratio ~ 9
    - Nearly half of the impervious area is rooftop (cleaner runoff)
    - Larger bioretention cell doubles as flood control (detention pond)



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BIORETENTION / RETENTION: PLANNING & DESIGN

EXAMPLE: Racquet Up Detroit

- Owner: Racquet Up Detroit
- Engineer: SmithGroup
- Key design characteristics
  - Infiltration BMP depths: 6-11 inches
  - Roof leads discharge to riprap channel prior to bioretention cell
  - Surface water drawdown time:
    - 11-23 hours (< 24 hours)
  - Total drawdown time:
    - 15-38 hours (< 72 hours)
  - Bioretention soil depth: 12 inches

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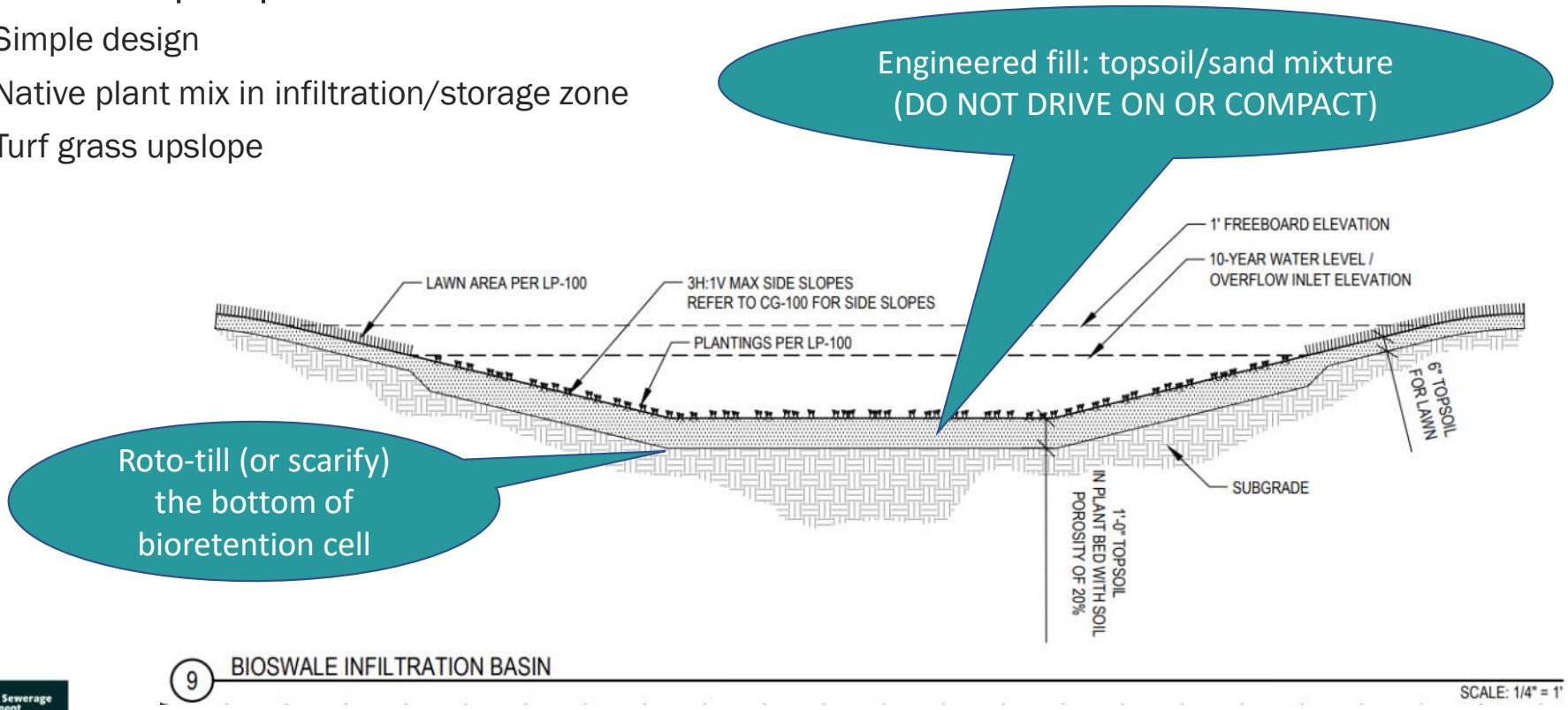
BIORETENTION / RETENTION: PLANNING & DESIGN

EXAMPLE: Racquet Up Detroit

- Simple design
- Native plant mix in infiltration/storage zone
- Turf grass upslope



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APPLYING THE REGULATIONS: ALTERNATIVE COMPLIANCE

WHEN INFILTRATION IS NOT FEASIBLE

- Fee-in-Lieu
- Offsite Alternative Compliance
- Onsite Alternative Compliance: Extended Detention
  - Simple equation → $V_{ED} = 6897 \times C \times A$
  - Targets 2-yr/24-hr storm (a/k/a 'Bank Full' event)
  - Subset of flood control volume (extended detention volume is usually part of the detention pond

PLANNING/DESIGN STEPS

- Demonstrate infiltration is not feasible
  - Geotechnical analysis / environmental assessment
- Complete Alternative Compliance Form and receive approval from DWSD
- Upon approval from DWSD, perform the following calculations
  - $V_{ED} = 6897 \times C \times A$
  - Calculate average discharge rate (48-hour discharge)
    - $Q_{ED} = V_{ED} / 172{,}800$ (cfs)
  - Calculate storage elevation at 50% of V_{ED}
  - Using the 50% storage head, size the orifice to achieve the average discharge rate (Q_{ED}) calculated above
  - If orifice size is < 0.75 inch, set orifice at 0.75 inch

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Questions on Example Site Plan

?

Erin.Washington@ohm-advisors.com

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10-Minute BREAK

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Post-Construction Stormwater Management Plan

POST-CONSTRUCTION STORMWATER MANAGEMENT PLAN

a/k/a "Stormwater Narrative" or "Stormwater Report"

- Required Components (see Chapter 2, page 2-14)
  - Map showing drainage boundary and discharge location(s)
  - Key metrics, including:
    - Total development site (total parcel area)
    - Total construction area (and as a % of development site)
    - Total new or replacement impervious area
    - Measured infiltration rate(s)
  - All calculations demonstrating retention volume and flood control volume (include model data if applicable)
  - Narrative describing stormwater design components and summary of key volumes, flow rates, and site information
  - Reference to Geotechnical/Environmental data impacting retention requirement
    - If applicable, include Alternative Compliance Application

In-Situ Infiltration Rates

The method of testing for infiltration rates is at the discretion of the applicant. DWSD staff do ***not*** need to witness infiltration testing.

However, infiltration testing must be performed by geotechnical professionals; the measured infiltration rate(s) must be certified by a Professional Engineer registered in Michigan.

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POST-CONSTRUCTION STORMWATER MANAGEMENT PLAN

a/k/a “Stormwater Narrative” or “Stormwater Report”

- Required Components (see Chapter 2, page 2-14)
  - Preliminary calculations for drainage charge credits (flood control and volumetric credits, if applicable)
  - Hydraulic calculations for sewer pipe and outlet design
  - Operations & Maintenance Plan
    - Including Certification Statement (Appendix 2C)
  - Copies of all applicable state and federal permits related to erosion control and stormwater management

← New requirement

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POST-CONSTRUCTION STORMWATER MANAGEMENT PLAN

a/k/a “Stormwater Narrative” or “Stormwater Report”

- Include Following Tables:

Table 1: Site Conditions

	Value	Unit
New of Replaced Impervious Area		Acres
Construction Activity Area		Acres
Measured Infiltration Rate		in/hr
Existing Site Runoff Coefficient, C		unitless
Proposed Site Runoff Coefficient, C		unitless
Regulated Area		Acres

Table 2: Hydrologic Summary Table

Performance Standard	Design Storm	Volume (CF)	Peak Flow (cfs)
Water Quality (Retention Requirement)	1.0-inch rainfall		X
Infrastructure Protection (2-yr/24-hr storm)	Pre-Construction 2-yr, 24-Hr Storm	X	
	Post-Construction 2-yr, 24-Hr Storm		
Flood Control	Post Construction 100-yr (or 10-yr), 24-Hr Storm		

POST-CONSTRUCTION STORMWATER MANAGEMENT PLAN

Example
Stormwater Model
Output/Summary

Hydrograph Report

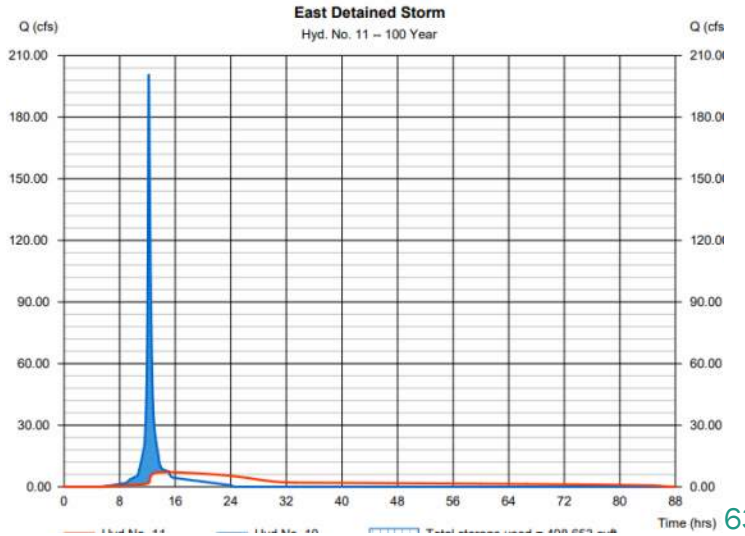
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2019.2 — Thursday, 10 / 29 / 2020

Hyd. No. 11

East Detained Storm

Hydrograph type	= Reservoir	Peak discharge	= 7.150 cfs
Storm frequency	= 100 yrs	Time to peak	= 15.10 hrs
Time interval	= 2 min	Hyd. volume	= 672,306 cuft
Inflow hyd. No.	= 10 - East Site Storm	Max. Elevation	= 632.01 ft
Reservoir name	= East Detention Basin	Max. Storage	= 498,653 cuft

Storage Indication method used.



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POST-CONSTRUCTION STORMWATER MANAGEMENT PLAN

Example O&M Plan

- Plan should be part of Stormwater Report
- O&M Certification signed by owner and sealed by designer
- Recorded with Wayne County Register of Deeds

Long–Term Maintenance Plan and Schedule
Table 1 identifies the maintenance activities to be performed, organized by category (monitoring/inspections, preventative maintenance and remedial actions). While performing maintenance, chemicals should not be applied to the detention basin or water courses. Table 1 also identifies site specific work needed to ensure that the storm water management system functions properly as designed.

TABLE 1: STORM WATER MANAGEMENT SYSTEM LONG–TERM MAINTENANCE SCHEDULE

MAINTENANCE ACTIVITIES / SYSTEM COMPONENTS	Catch Basins, Inlets & Storm Sewers	Swales	Basin Inlets, Outlets & Gratings	Forebays and Detention Basins	Outlet Control Structures	Overflow Spillways	Riprap	Buffer Areas	Pavement Areas	FREQUENCY
MONITORING/INSPECTION										
Inspect for sediment accumulation**/clogging of stone filter	X	X	X	X	X	X				Annually
Inspect for erosion and integrity of banks and berms		X	X	X		X	X	X		Annually and after major events
Inspect for floatables, dead vegetation and debris	X	X	X	X	X	X	X	X		Annually and after major events
Inspect all components during wet weather and compare to as–built plans	X	X	X	X	X	X	X	X	X	Annually
Monitor plantings/vegetation		X		X		X		X		2 times a year
Ensure means of access for maintenance remain clear/open	X	X	X	X	X	X	X	X		Annually
PREVENTIVE MAINTENANCE										
Mowing		X		X				X		Up to 2 times/year*
Remove accumulated sediment	X	X	X	X	X	X	X			As needed**
Remove floatables, dead vegetation and debris	X	X	X	X	X	X	X			As needed
Replace or wash/reuse stone riser debris					X	X				Every 3 years; more frequently if needed***
Remove invasive plant species		X		X				X		Annually
Sweeping of pavement surfaces (streets and parking areas)									X	As needed
REMEDIAL ACTIONS										
Repair/stabilize areas of erosion		X	X	X		X	X	X		As needed
Replace dead plantings, bushes, trees		X		X				X		As needed
Reseed bare areas		X		X		X		X		As needed
Structural repairs or replacement in kind	X		X		X	X	X		X	As needed
Make adjustments/repairs to ensure proper functioning	X	X	X	X	X	X	X	X	X	As needed
Oil and gasoline spills									X	Immediately

* NOT TO EXCEED THE LENGTH ALLOWED BY CITY ORDINANCE.
** FOREBAYS AND DETENTION BASINS TO BE CLEANED WHENEVER SEDIMENT ACCUMULATES TO A DEPTH OF 6–12 INCHES OR IF SEDIMENT RESUSPENSION IS OBSERVED
*** REPLACE STONE IF IT CAN NOT BE ADEQUATELY CLEANED.

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POST-CONSTRUCTION STORMWATER MANAGEMENT PLAN

Example O&M Plan:

1. Monitoring / Inspection
2. Preventative Maintenance
3. Remedial Action and Repairs

TABLE 1: STORM WATER MANAGEMENT SYSTEM LONG–TERM MAINTENANCE SCHEDULE

MAINTENANCE ACTIVITIES	SYSTEM COMPONENTS	Catch Basins, Inlets & Storm Sewers	Swales	Basin Inlets, Outlets & Gratings	Forebays and Detention Basins	Outlet Control Structures	Overflow Spillways	Riprap	Buffer Areas	Pavement Areas	FREQUENCY
MONITORING/INSPECTION											
Inspect for sediment accumulation**/clogging of stone filter		X	X	X	X	X	X				Annually
Inspect for erosion and integrity of banks and berms			X	X	X		X	X	X		Annually and after major events
Inspect for floatables, dead vegetation and debris		X	X	X	X	X	X	X	X		Annually and after major events
Inspect all components during wet weather and compare to as–built plans		X	X	X	X	X	X	X	X	X	Annually
Monitor plantings/vegetation			X		X		X		X		2 times a year
Ensure means of access for maintenance remain clear/open		X	X	X	X	X	X	X	X		Annually
PREVENTIVE MAINTENANCE											
Mowing			X		X				X		Up to 2 times/year*
Remove accumulated sediment		X	X	X	X	X	X	X			As needed**
Remove floatables, dead vegetation and debris		X	X	X	X	X	X	X			As needed
Replace or wash/reuse stone riser debris						X	X				Every 3 years; more frequently if needed***
Remove invasive plant species			X		X				X		Annually

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Site Plan Review and Approval Process

SITE PLAN REVIEW & APPROVAL PROCESS

If Stormwater Management Regulations apply to a project, the site owner must:

- Comply with stormwater performance standards
- If applicable, demonstrate need for Alternative Compliance and include in the design documents
- Perform required site investigations, including geotechnical (infiltration testing) and, if applicable, an environmental assessment
- Develop and submit a compliant site plan and Post-Construction Stormwater Management Plan to DWSD for review and approval
- Pay required fees
- Implement (construct) approved components of the Stormwater Management Plan
- Record Restrictive Covenant and stormwater control design plans with the Wayne County Register of Deeds
- Request post-construction inspection (needed prior to Certificate of Occupancy)

CONSTRUCTION APPROVAL PROCESS

Prior to receiving a Certificate of Occupancy, the applicant must:

- Implement (construct) approved components of the Stormwater Management Plan
- Record Restrictive Covenant, stormwater control design plans, and the O&M Plan for the regulated parcel(s) with the Wayne County Register of Deeds
- Request and schedule post-construction inspection
- Receive letter from the inspector stating that all stormwater control measures have been constructed per the Stormwater Management Plan
- Certificate of Occupancy granted after successful completion of above

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SITE PLAN REVIEW AND APPROVAL PROCESS

- Plans are routed to DWSD stormwater management group when a project is submitted to BSEED for a special land use permit (SLU#), site plan review (SPR#), or a building permit (BLD#)
- Most reviews take 10 business days
  - Projects submitted for special land use do *not* require a full stormwater review
    - DWSD will simply comment that stormwater management will be required, if applicable
  - Projects needing site plan review must demonstrate that stormwater has been considered, the project team is aware of the amount of stormwater management required, and that it can "fit" on the site. These plans should be 30-50% complete. An alternative compliance application should be submitted if needed.
  - Projects seeking building permits must have their stormwater system 100% designed with all necessary documents and a stormwater narrative.

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General Q&A Session

?

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Final Poll Question

THANK YOU!

Sarah Stoolmiller, Engineer

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For more information visit: www.detroitmi.gov/dwsd

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