CITY OF RENTON

SURFACE WATER DESIGN MANUAL

REFERENCE 1

SURFACE WATER RUNOFF POLICY

See Renton Municipal Code (RMC) Section 4-6-030

<http://www.codepublishing.com/WA/Renton/>

REFERENCE 2

ADOPTED CRITICAL DRAINAGE AREAS

Does not apply to the City.

REFERENCE 3

OTHER ADOPTED AREA SPECIFIC DRAINAGE REQUIREMENTS

Does not apply to the City.

REFERENCE 4

OTHER DRAINAGE RELATED REGULATIONS AND GUIDELINES

4-A GRADING CODE SOIL AMENDMENT STANDARD

See Soil Amendment BMP in Appendix C of the City of Renton Surface Water Design Manual

4-B CLEARING AND GRADING SEASONAL LIMITATIONS

See RMC Section 4-4-060

<http://www.codepublishing.com/WA/Renton/>.

4-C LANDSCAPE MANAGEMENT PLAN GUIDELINES

Does not apply to the City.

4-D SHARED FACILITY MAINTENANCE RESPONSIBILITY GUIDANCE

Does not apply to the City.

CITY OF RENTON

SURFACE WATER DESIGN MANUAL

REFERENCE 5

WETLAND HYDROLOGY PROTECTION GUIDELINES

WA State Department of Ecology Wetland Protection Requirements and Guidelines

- Appendix I-C.4 Wetland Hydroperiod Protection
- Appendix I-C.5 Wetland Hydroperiod Data Collection and Evaluation Procedures
- Appendix I-C.8 Wetland Protection Definitions

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REFERENCE 5

WETLAND HYDROLOGY PROTECTION GUIDELINES

This Reference is excerpted from the Washington State Department of Ecology's 2019 Stormwater Management Manual for Western Washington (SMMWW), with modifications where necessary to refer to City of Renton Surface Water Design Manual (SWDM) sections and terminology. “Flow Control BMPs” in the following text refer to what are termed “flow control facilities” in the SWDM.

I-C.4 Wetland Hydroperiod Protection

Protection of many wetland functions and values depends on maintaining the existing wetland’s hydroperiod. This means maintaining the annual fluctuations in water depth and its timing as closely as possible. If a project or threshold discharge area within a project discharging to a wetland require a flow control facility per Core Requirement # 3 of the SWDM, the project must apply the following Wetland Hydroperiod Protection.

The Wetland Hydroperiod Protection is separated into two methods (Methods 1 and 2) that are dependent on the wetland category, and whether the project proponent has legal access to the wetland.

The first method requires a minimum one year of monitoring followed by continuous simulation modeling of the wetland stage (called Method 1). Method 1 shall be applied to the wetlands listed below.

- Category I or II depressional or riverine impounding (including special characteristics Category I or II) wetlands that the project proponent owns, or the project proponent has legal access to - for purposes of conducting monitoring in the wetland.

Method 1 takes into account wetland specific information and field data, therefore, it allows more detailed evaluation of effects of stormwater on wetland functions. In cases where the project proponent neither owns nor has legal access to the Category I or II wetlands receiving stormwater from a proposed project, Method 2 shall be used.

Method 2 uses a site discharge volume model to evaluate hydrologic changes in a wetland, with no additional wetland monitoring requirement. Method 2 shall be applied to the wetlands listed below.

- Category I or II wetlands that are off-site or the project proponent doesn’t have legal access to conduct monitoring in the wetland,
- Category I or II riverine, slope or lake-fringe wetlands,
- Category III and IV wetlands with habitat score greater than 5,
- Category III or IV interdunal special characteristic wetlands,
- Category III and IV wetlands that provide habitat for rare, threatened, endangered or sensitive species,
- Category III and IV wetlands that contain a breeding population of any native amphibian species.
    - o If the wetland has permanent or seasonal ponding or inundation, assume that it has a breeding population of native amphibians.

o For seasonal ponding, if the wetland has surface ponding after May 1 of a normal water year or drier, assume that it has a breeding population of native amphibians.

o See the Wetland Rating System for guidance on identifying field indicators.

o Recent aerial images of surface water in the wetland during normal water year or drier year can also indicate presence of permanent or seasonal ponding.

Method 1: 1-yr Wetland Monitoring and Wetland Stage Modeling

Method 1 criteria and analysis is based on the presumption that a wetland has limited water level fluctuation and water holding capacity. The risk to the wetland will be minimal if the frequency and duration of water level fluctuation (WLF) in the wetland and the WLF timing post project remain as similar to pre-project levels as possible. Therefore, the criteria sets limits on the frequency and duration of stage excursions (greater WLF than the pre-project level), as well as on overall WLF after development. The criteria were developed based on studies in Wetlands and Urbanization, Implications for the Future (Azous and Horner, 1997)".

One water year of field monitoring will characterize the existing WLF and water holding capacity of the wetland, and it will be used to calculate the allowable WLF by the proposed development.

A hydrologic assessment to measure or estimate elements of the hydroperiod under pre-project and post-project conditions should be performed with the aid of a qualified scientist or wetland specialist.

Criteria for Method 1

The project proponent must meet the following six Method 1 criteria in order to comply with the Wetland Hydroperiod Protection requirements.

Criteria 1. Mean Monthly WLF Limit

• If the pre-project (monitored) mean monthly WLF for a given calendar month is < 15cm (0.49ft, 5.91inch), the post-project mean WLF of the wetland for that calendar month may increase to no more than 20 cm (0.66ft, 7.87inch).

• If the pre-project (monitored) mean monthly WLF for a given calendar month is > 15 cm (0.49ft, 5.91inch), the post-project mean monthly WLF of the wetland for that calendar month may increase by up to, but no more than, 5 cm (0.16ft, 1.97inch).

• Without one year of monitoring data, assume the pre-project mean monthly WLF for any month is > 15 cm (0.49ft, 5.91inch), and the post-project mean monthly WLF of the wetland for that calendar month may increase by up to, but no more than, 5 cm (0.16ft, 1.97inch).

Criteria 2. Mean Annual WLF Limit

• If the pre-project (monitored) mean annual WLF is < 15cm (0.49ft), the post-project mean annual WLF of the wetland may increase to no more than 20 cm (0.66ft, 7.87inch).

• If the pre-project (monitored) mean annual WLF is > 15 cm (0.49ft, 5.91inch), the post - project mean annual WLF of the wetland may increase by up to, but no more than, 5 cm (0.16ft, 1.97inch).

• Without one year of monitoring data, assume the pre-project mean annual WLF is > 15 cm (0.49ft, 5.91inch), and the post-project mean annual WLF of the wetland may increase by up to, but no more than, 5 cm (0.16ft, 1.97inch)

Criteria 3. Frequency of Stage Excursions

• The frequency of stage excursions of 15 cm (0.49ft, 5.91inch) above or below the preproject stage must not exceed an annual average of six.

Criteria 4. Durations of Stage Excursions

• The duration of stage excursions of 15 cm (0.49ft, 5.91inch) above or below the preproject stage must not exceed 3 days per excursion. AND

o For a Wetland that Provides Habitat for Native Amphibians: The stage excursions above or below the pre-project stage must not exceed 8 cm (0.26ft, 3.15inch) for more than 1 day in any 30-day period between January 1 and May 31. The hydroperiod limits characterize wetlands inhabited by breeding native amphibians and apply to breeding zones during the period of January 1 through May 31. If these limits are exceeded, then amphibian breeding success is likely to decline. OR

o For a Peat Wetland: The duration of stage excursions in the post-project scenario cannot be above the pre-project stage for more than 1 day in any year, and applies to all zones over the entire year. If this limit is exceeded, then characteristic bog or fen wetland vegetation is likely to decline.

Criteria 5. Total Dry Period Change

• The total dry period (when pools dry down to the soil surface everywhere in the wetland) must not increase or decrease by more than two weeks in any year between the preproject and post-project scenarios.

Criteria 6. Perennial to Ephemeral or Seasonal Avoidance

• Alterations to watershed and wetland hydrology that may cause perennial wetlands to become ephemeral or seasonal post-project must be avoided.

• If modeled wetland stage indicates that the wetland is perennial, the dry period at the post-project scenario should not exceed 1 day in any year.

Additional guidance, as well as an Excel template to assist with the calculations to verify compliance with Method 1 is provided in I-C.5 Wetland Hydroperiod Data Collection and Evaluation Procedures.

Method 2: Site Discharge Modeling

An alternative way to predict the risk to the wetland hydroperiod from stormwater discharges is to assess the changes in total volume of flows into a wetland that result from the development project. The size of the wetland and its capacity are not known or needed to utilize Method 2. The risk to wetland functions will be assumed to increase as the total discharge volumes from the site into the wetland diverge from the pre-project conditions. The risk will be decreased if the divergence is smaller.

As stormwater generated at the project site passes through the wetland buffer, total discharge volumes from the site to the wetland are to be calculated at the outflow of the wetland buffer. The existing or required length and area of wetland buffer per local and/or state regulations around the wetland should be included as an element in the model under both pre-project (existing) and post-project scenarios.

Criteria for Method 2

The project proponent must ensure they are meeting both of the following Method 2 criteria in order to comply with Wetland Hydroperiod Protection.

Criteria 1. Mean Daily Total Discharge Volumes from the Site

Total volume of water into a wetland on daily basis should not be more than 20% higher or lower than the pre-project volumes.

- Calculate the average of the total discharge volumes from the site for each day over the period of precipitation record in the approved model for pre- and post-project scenarios. There will be 365 (366 for a leap year) average daily values for the pre-project scenario and 365 (366 for a leap year) for the post-project. No day can exceed 20% change in volume.

Criteria 2. Mean Monthly Total Discharge Volumes from the Site

Total volume of water into a wetland on a monthly basis should not be more than 15% higher or lower than the pre-project volumes.

- Calculate the average of the monthly total discharge volumes from the site for each calendar month over the period of precipitation record in the approved model for pre- and post-project scenarios. No month can exceed 15% change in volume.

The guidance for implementing Method 2 and assessing the criteria above in the respective model is provided in section I-C.5 Wetland Hydroperiod Data Collection and Evaluation Procedures.

Limitations

Method 2 may not result in complete protection of wetland functions and values as these criteria are based on risk to the resource rather than an actual understanding of the impacts. When applicable, Ecology recommends application of the Wetland Hydroperiod Protection with wetland-specific monitoring as described in Method 1.

I-C.5 Wetland Hydroperiod Data Collection and Evaluation Procedures

Method 1

Field Monitoring and Data Collection

Field monitoring data of the wetland must be collected to determine the existing pre-project hydroperiod, which will then be compared to model outputs to verify compliance with the Hydroperiod Protection Criteria. Without one year of hydroperiod monitoring, the minimum allowable WLF change can be used (see Criteria for Method 1 in I-C.4 Wetland Hydroperiod Protection and Steps to Verify Compliance with the Method 1 Hydroperiod Protection Criteria below).

An Ecology approved continuous simulation model will be needed for data analysis. Relevant historic monitoring information can also inform the pre-project condition of the wetland. The following lists describe the minimum required wetland specific information in order to implement the Method 1 Wetland Hydroperiod Protection guidance.

1. Contour Data or Water Storage Capacity

Bathymetry, or wetland contours, is indicative of the water storage capacity of the wetland that will be used in the model simulation.

If possible, the bathymetry of the wetland should be surveyed. LIDAR data or GIS analysis may also be used to provide approximate wetland contours.

In the absence of bathymetry data, approximate the bathymetry using the permanent ponding area and assume that the storage will occur on top of that area. This resulting storage area will be lower than the actual area, providing a more protective model.

2. Hydroperiod Monitoring

Collect at least one year of water levels (instantaneous water stage and crest stage) using a crest stage gage or continuous water level loggers in the wetland. Water levels should be collected at least monthly over a year.

Average base stage = (Instantaneous stage at the beginning of interval + Instantaneous stage at the end of interval)/2

3. Flow Monitoring

The goal of this monitoring is to construct a relationship in the model to simulate how flows will be released from the wetland for each given stage. A simplified monitoring approach may be appropriate for a simple wetland flow regime. For instance, where a well-defined outlet controls the outflows from a wetland, instantaneous monitoring of the outflow for the typical range of flows may be sufficient. In this simple case, a velocity and cross-section and stage monitoring at the outlet can be sufficient to create the relationship for the model. These measurements may be performed in conjunction with the hydroperiod monitoring described above. Additional field visits timed with precipitation or dry periods may be necessary to ensure that the outflow relationship covers the range of modeled flows.

Ecology acknowledges that it can be challenging to determine the location(s) of flows to and from wetlands. In some cases, there will be a clear channel that is the source of the inflows and outflows, while in others, the water may disperse over a wide area. An alternative would be to gather nearly continuous (every 15 minute) rainfall data along with wetland stage data (hydroperiod monitoring) and adjust the storage and discharge rate within the model using these data. If the flow data or estimation in the model are not available, assume there is no surface outflow for the wetland (closed depression).

Chapter 8 of Wetlands and Urbanization, Implications for the Future (Azous and Horner, 1997)" indicates that a complete wetland water balance includes precipitation, evapotranspiration, surface inflow, surface outflow, groundwater exchange, and change in wetland storage using a tipping-bucket gage and continuous flow measurements. The wetland assessment as part of this Method 1 needs to consider the more protective approach to develop that relationship. A scientist (e.g. wetland scientist or hydrologist) may determine that the groundwater flow is a significant characteristic of the outflow of the system. In this case the project proponent may need to determine the groundwater regime of the system.

Model Construction and Simulation

The project proponent should develop a stage-storage-discharge (SSD) table that represents the volume of water that ponds in the wetland and the flow rate of water that discharges from the wetland at a given stage.

Having a reliable SSD table that represents the wetland is essential to evaluate the effects of development in the model. Wetland bathymetry and contour data by field measurement or using equations to represent the volume-area-depth relations of wetlands and wetland flow monitoring data are critical to develop the SSD table for the wetland.

In the absence of actual wetland flow monitoring data, it may be possible to develop a SSD table for the wetland by combining the model simulated flows with the field data obtained on the wetland WLF (hydroperiod monitoring) data. This would require an iterative modeling process. The modeling iterations would involve manually changing the discharge rates in the SSD table until the resulting simulated WLF approach WLF from the field monitoring data. The project proponent or modeler should provide the details of how this estimated in its hydrologic assessment report, so that it can be reviewed by the local jurisdiction.

With an SSD table, the following are necessary for the model simulation to evaluate the discharge of development in the model and determine compliance with the Method 1 Wetland Hydroperiod Protection criteria.

- Pre-project condition land uses and associated acreage for the entire contributing area that drains to the wetland.
- Post-project condition land uses and associated acreage for the entire contributing area that drains to the wetland.
- Percentage of developing project area compared to total acreage of contributing area that drains to the wetland.

Pre-Project Simulation

1. Identify existing impervious and pervious surfaces that discharge to the wetland and use the model elements to represent the land use and associated acreage for all hydrologically contributing areas to the wetland.

2. Add the wetland buffer using the lateral flow soil basin, or include it as part of the contributing area land use.

3. Connect the runoff from the contributing basin(s) including interflow and groundwater to the SSD table that represents the wetland.

4. Set the outflow of the wetland as the Point of Compliance (POC).

Post-Project Simulation

1. Identify anticipated impervious and pervious surfaces that discharge to the wetland and use the model elements to represent the land use and associated acreage for all hydrologically contributing areas to the wetland.

2. Identify any Flow Control BMPs in the contributing area draining to the wetland and use the appropriate model elements to represent these facilities.

3. Add the wetland buffer using the lateral flow soil basin, or include it as part of the contributing area land use.

4. Connect the runoff from the contributing basin(s) (including the buffer) including interflow and groundwater to the same SSD table that was used in the pre-project scenario.

5. Connect flows from any Flow Control BMP elements through the downstream element(s) to SSD table that represents the wetland.

6. Connect any infiltration from Flow Control BMP elements to groundwater of SSD table (if applicable).

7. Set the outflow of the wetland as the POC.

The order of the steps above depends on the type of elements and their intended function and could change to be more representative of the contributing flow pathways to the wetland.

Once the model simulations are done for post and pre-project scenarios, export the SSD table stage data for the full period of record: daily, monthly and yearly average, and Max and Min stage.

These model outputs, together with monitored WLF, are to be used to verify compliance with the Method 1 Hydroperiod Protection Criteria in I-C.4 Wetland Hydroperiod Protection.

Steps to Verify Compliance with the Method 1 Hydroperiod Protection Criteria

Ecology has provided an Excel template to assist with the calculations in the steps below. The Excel template may be downloaded from the interactive online version of the 2019 Stormwater Management Manual for Western Washington.

1) Calculate the Existing WLF of Wetland using Monitored Water Levels

Using the measurements of crest and instantaneous stage during a series of time intervals over a year, calculate water level fluctuation (WLF) between measurements.

Calculate mean annual and mean monthly WLF as the arithmetic averages of a year and each month for which data are available.

Water level fluctuation (WLF) = Crest stage - Average base stage

2) Estimate the WLF by Continuous Simulation of Stages in the Model

Using modeled daily, monthly and yearly stages (average, max and min) for the full period of record, calculate daily, monthly or annual WLF as follows:

WLF = Max stage - average stage

3) Calculate Allowable WLF change

Allowable WLF change by the proposed project is determined by two factors: Monitored WLF of the wetland, and the size of the proposed project relative to the wetland's contributing basin area.

Allowable WLF change for the proposed project is calculated as follows:

- If monitored WLF is < 15 cm (0.49 ft, 5.91 inch),
    - o Allowable WLF change for the wetland (A) = 20 cm (0.66 ft, 7.87 inch) - monitored WLF
    - o Allowable W LF change for the proposed project = A / percentage of development by proposed project in the contributing basin area.
- If monitored WLF for a given calendar month is > 15 cm (0.49 ft, 5.91 inch),

o Allowable WLF of the wetland (A) for that calendar month may increase by up to, but no more than, 5 cm (0.1 6ft, 1.97 inch).

o Allowable W LF change for the proposed project = 5 cm / percentage of development by proposed project in the contributing basin area.

For example, if the project develops 10 acres of a 100 acre basin (10 %), the project can cause no more than 10 % of total allowable WLF change in the wetland. If the total allowable WLF change for the wetland is 10 cm (0.32 ft, 3.94 inch), the allowable WLF change for the proposed site is 1.0 cm (0.032 ft, 0.394 inch).

4) Verify Compliance with the Criteria

Compare each modeled daily, monthly or annual WLF with the calculated allowable WLF (factored by percentage of development by proposed project in the contributing basin area). If any of the modeled WLF difference between pre-project and post-project scenarios exceeds the calculated allowable WLF change for the proposed project, it means the proposed project does not comply with Method 1 Wetland Hydroperiod Protection.

For criteria about durations and frequencies, assess individual modeled stage outputs to verify compliance.

Method 2

Model Construction and Simulation

When modeling, include the wetland buffer as the final element in both pre- and post-project scenarios, downstream of the project area including any Flow Control BMPs. The point of compliance (POC) should be assigned to capture the total (surface, interflow, and ground water) volume leaving the wetland buffer for both the pre-project and the post-project scenarios.

Pre-project simulation

1. Identify existing impervious and pervious surfaces that discharge to the wetland and use the model elements to represent these land areas.

2. Identify the wetland buffer area and use the lateral flow soil basin to represent the wetland buffer.

3. Connect the model elements to the wetland buffer ensuring that impervious land areas are connected to surface flows and that for any other model elements all flows (surface, interflow, and ground water) are connected.

4. Set the wetland buffer element as the most downstream element.

5. Set the POC at the outflow of the wetland buffer element including surface runoff, interflow, and ground water.

Post-project simulation

1. Identify anticipated post-project impervious and pervious surfaces that discharge to the wetland and use the model elements to represent these land areas.

2. Identify any Flow Control BMPs and use the appropriate the model elements to represent these facilities.

3. Identify the wetland buffer area and use the lateral flow soil basin to represent the wetland buffer.

4. Connect the model elements to the wetland buffer ensuring that impervious land areas are connected to surface flows and that for any other model elements all flows (surface, interflow, and ground water) are connected.

5. Connect any Flow Control BMP elements to the wetland buffer ensuring that surface flows are connected to surface water and any infiltration is connected to ground water.

6. Set the wetland buffer element as the most downstream element.

7. Set the POC at the outflow of the wetland buffer element including surface runoff, interflow, and ground water.

Once the model simulations are done for post and pre-project scenarios, verify compliance with the Method 2 Hydroperiod Protection Criteria.

Strategies to meet the Wetland Hydroperiod Protection Criteria

Consider the following strategies to minimize impacts on the wetland hydroperiod and to meet the criteria. The list is in order of preference:

- Increasing the retention of natural pervious cover.
- Reducing the level of development.
- Reducing the total amount of impervious surfaces.
- Increasing infiltration using on-site LID techniques.
- Increasing or maintaining larger wetland buffer zones.
- Increasing infiltration and/or storage capacity of Flow Control BMPs.

I-C.8 Wetland Protection Definitions

The following terms are applicable only to this Appendix.

Buffer

The area (either upland, open water, or another wetland) that surrounds a wetland or watercourse and that reduces adverse impacts to the ecosystem functions and values from adjacent development.

Hydroperiod

The seasonal occurrence of flooding and/or soil saturation; it encompasses the depth, frequency, duration, and seasonal pattern of inundation.

Peat Wetland

Unique, irreplaceable bogs and fens that can exhibit water pH in a wide range from highly acidic to alkaline, including fens typified by Sphagnum species, Rhododendron groenlandicum (Labrador tea), Drosera rotundifolia (sundew), and Vaccinium oxycoccos (bog cranberry); marl fens; estuarine peat deposits; and other moss peat systems with relatively diverse, undisturbed flora and fauna. Bog is the common name for peat systems having the Sphagnum association described, but this term applies strictly only to systems that receive water income from precipitation exclusively.

Perennial Wetland

Wetlands where at least a portion of their area has permanent surface water (i.e., flooded or inundated throughout the year), in a normal water year or wetter.

POC

Point of compliance

Riverine impounding wetland

Riverine impounded wetlands retain surface water significantly longer than the duration of the flood event. Riverine impounded wetlands tend to hold water for more than a week after a flood event. These wetlands are found in a topographic depression on the valley floor, or in areas where natural or human made barriers to downstream flow occur.

Seasonal wetland, Seasonal ponding

A wetland that has water above the soil surface for a period of time (usually between two months to less than one year) during and/or after the wettest season but in typical years dries to or below the soil surface in warmer, drier weather.

SSD

stage-storage-discharge

Stage excursion

A post-project departure, either higher or lower, from the water depth existing under a given set of conditions in the pre-development state.

Water Level Fluctuation (WLF)

This is a defining characteristic of a wetland. Water level fluctuation (WLF) during a monitoring interval is as follows:

Average base stage = (Instantaneous stage at beginning of interval + Instantaneous stage at end of interval)/2

Wetland functions

The ecological (physical, chemical, and biological) processes or attributes of a wetland. Functions are often defined in terms of the processes that provide value to society, but they can also be defined based on processes that are not value based. Wetland functions include food chain support, provision of ecosystem diversity and fish and wildlife habitat, flood flow alteration, ground water recharge and discharge, water quality improvement, and soil stabilization.

Wetlands

Those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas. Wetlands do not include those artificial wetlands intentionally created from nonwetland sites, including, but not limited to, irrigation and drainage ditches, grass-lined swales, canals, detention facilities, wastewater treatment facilities, farm ponds, and landscape amenities, or those wetlands created after July 1, 1990, that were unintentionally created as a result of the construction of a road, street, or highway. Wetlands may include those artificial wetlands intentionally created from nonwetland areas to mitigate the conversion of wetlands. (Waterbodies not included in the definition of wetlands as well as those mentioned in the definition are still waters of the state.)

WLF

See Water Level Fluctuation definition References 11 Amanda L. Azous and Richard R. Horner (eds.), Wetlands and Urbanization, Implications for the Future, Final Report of the Puget Sound Wetlands and Stormwater Management Research Program, 1997. (vi)

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CITY OF RENTON

SURFACE WATER DESIGN MANUAL

REFERENCE 6

HYDROLOGIC/HYDRAULIC DESIGN METHODS

6-A INFILTRATION RATE TEST METHODS

6-B POND GEOMETRY CALCULATIONS

6-C INTRODUCTION TO LEVEL POOL ROUTING

6-D SUPPLEMENTAL MODELING GUIDELINES

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REFERENCE 6-A

INFILTRATION RATE TEST METHODS

See the City of Renton *Surface Water Design Manual* (SWDM) Chapter 5 and Appendix C for applications and limitations for the use of the infiltration rate test methods below.

PILOT INFILTRATION TEST (PIT)

Source: Stormwater Management Manual for Western Washington (SMMWW 2014)

In-situ infiltration measurements using the Pilot Infiltration Test (PIT) described below is the preferred method for estimating the measured (initial) saturated hydraulic conductivity (Ksat) of the soil profile beneath the proposed infiltration facility. The larger PIT reduces some of the scale errors associated with relatively small-scale double ring infiltrometer or "stove-pipe" infiltration tests. It is not a standard test but rather a practical field procedure recommended by Ecology's Technical Advisory Committee.

LARGE-SCALE PILOT INFILTRATION TEST (PIT)

Infiltration Test

- Excavate the test pit to the estimated surface elevation of the proposed infiltration facility. Lay back the slopes sufficiently to avoid caving and erosion during the test. Alternatively, consider shoring the sides of the test pit.
- The horizontal surface area of the bottom of the test pit should be approximately 100 square feet. Accurately document the size and geometry of the test pit.
- Install a vertical measuring rod (minimum 5-ft. long) marked in half-inch increments in the center of the pit bottom.
- Use a rigid 6-inch diameter pipe with a splash plate on the bottom to convey water to the pit and reduce side-wall erosion or excessive disturbance of the pond bottom. Excessive erosion and bottom disturbance will result in clogging of the infiltration receptor and yield lower than actual infiltration rates.
- Add water to the pit at a rate that will maintain a water level between 6 and 12 inches above the bottom of the pit. A rotameter can be used to measure the flow rate into the pit.

  Note: The depth should not exceed the proposed maximum depth of water expected in the completed facility. For infiltration facilities serving large drainage areas, designs with multiple feet of standing water can have infiltration tests with greater than 1 foot of standing water.

  Every 15–30 min, record the cumulative volume and instantaneous flow rate in gallons per minute necessary to maintain the water level at the same point on the measuring rod.

  Keep adding water to the pit until one hour after the flow rate into the pit has stabilized (constant flow rate; a goal of 5% variation or less variation in the total flow) while maintaining the same pond water level. The total of the pre-soak time plus one hour after the flow rate has stabilized should be no less than 6 hours.

- After the flow rate has stabilized for at least one hour, turn off the water and record the rate of infiltration (the drop rate of the standing water) in inches per hour from the measuring rod data, until the pit is empty. Consider running this falling head phase of the test several times to estimate the dependency of infiltration rate with head.
- At the conclusion of testing, over-excavate the pit to see if the test water is mounded on shallow restrictive layers or if it has continued to flow deep into the subsurface. The depth of excavation varies depending on soil type and depth to hydraulic restricting layer, and is determined by the engineer or certified soils professional. Mounding is an indication that a mounding analysis is necessary.

Data Analysis

Calculate and record the saturated hydraulic conductivity rate in inches per hour in 30 minutes or one-hour increments until one hour after the flow has stabilized.

Note: Use statistical/trend analysis to obtain the hourly flow rate when the flow stabilizes. This would be the lowest hourly flow rate.

Apply appropriate correction factors to determine the site-specific design infiltration rate. See the discussion of correction factors for infiltration facilities in SWDM Section 5.4.1.

Example

The area of the bottom of the test pit is 8.5 feet by 11.5 feet.

Water flow rate was measured and recorded at intervals ranging from 15 to 30 minutes throughout the test. Between 400 minutes and 1,000 minutes the flow rate stabilized between 10 and 12.5 gallons per minute or 600 to 750 gallons per hour, or an average of (9.8 + 12.3) / 2 = 11.1 inches per hour.

SMALL-SCALE PILOT INFILTRATION TEST (PIT)

A smaller-scale PIT can be substituted for the large-scale PIT in any of the following instances.

- The drainage area to the infiltration site is less than 1 acre.
- The testing is for LID BMPs that serve small drainage areas and /or are widely dispersed throughout a project site.
- The site has a high infiltration rate, making a large-scale PIT difficult, and the site geotechnical investigation suggests uniform subsurface characteristics.

Infiltration Test

- Excavate the test pit to the estimated surface elevation of the proposed infiltration facility. In the case of bioretention, excavate to the estimated elevation at which the imported soil mix will lie on top of the underlying native soil. For trenches, excavate to the proposed bottom of the trench. For permeable pavements, excavate to the elevation at which the imported subgrade materials, or the pavement itself, will contact the underlying native soil. If the native soils (road subgrade) will have to meet a minimum subgrade compaction requirement, compact the native soil to that requirement prior to testing. Note that the permeable pavement design guidance recommends compaction not exceed 90%–92%. Finally, lay back the slopes sufficiently to avoid caving and erosion during the test. Alternatively, consider shoring the sides of the test pit.
- The horizontal surface area of the bottom of the test pit should be 12 to 32 square feet. It may be circular or rectangular, but accurately document the size and geometry of the test pit.
- Install a vertical measuring rod adequate to measure the ponded water depth and that is marked in half-inch increments in the center of the pit bottom.

- Use a rigid pipe with a splash plate on the bottom to convey water to the pit and reduce side-wall erosion or excessive disturbance of the pond bottom. Excessive erosion and bottom disturbance will result in clogging of the infiltration receptor and yield lower than actual infiltration rates. Use a 3-inch diameter pipe for pits on the smaller end of the recommended surface area, and a 4-inch pipe for pits on the larger end of the recommended surface area.
- Pre-soak period: Add water to the pit so that there is standing water for at least 6 hours. Maintain the pre-soak water level at least 12 inches above the bottom of the pit.
- At the end of the pre-soak period, add water to the pit at a rate that will maintain a 6-12 inch water level above the bottom of the pit over a full hour. The depth should not exceed the proposed maximum depth of water expected in the completed facility.
- Every 15 minutes, record the cumulative volume and instantaneous flow rate in gallons per minute necessary to maintain the water level at the same point (between 6 inches and 1 foot) on the measuring rod. The specific depth should be the same as the maximum designed ponding depth (usually 6–12 inches).
- After one hour, turn off the water and record the rate of infiltration (the drop rate of the standing water) in inches per hour from the measuring rod data, until the pit is empty.
- A self-logging pressure sensor may also be used to determine water depth and drain-down.
- At the conclusion of testing, over-excavate the pit to see if the test water is mounded on shallow restrictive layers or if it has continued to flow deep into the subsurface. The depth of excavation varies depending on soil type and depth to hydraulic restricting layer, and is determined by the engineer or certified soils professional. The soils professional should judge whether a mounding analysis is necessary.

Data Analysis

See the explanation above under the guidance for the large-scale pilot infiltration test.

SINGLE-RING PERCOLATION TEST PROCEDURE

(See SWDM Section 5.2 and Appendix C for limitations on the use of this procedure)

Preparation for Test

A single ring made of steel or other durable material a minimum of 3 feet in diameter and a minimum of 6 inches high and an adequate supply of clear water is needed. Tests must be performed in undisturbed native soil in suitable locations to determine soil percolation rates for the proposed infiltration facility. The surface of the soil where the test is to be run must be accurately leveled and the ring imbedded and sealed in the soil to prevent water from running under the ring and onto the surface.

Soaking Period

The ring shall be carefully filled with at least 6 inches of clear water. The depth of water should be maintained for at least 4 hours and preferably overnight if fine-grained soils are present. Automatic siphons or float valves may be employed to automatically maintain the water level during the soaking period. It is extremely important that the soil be allowed to soak for a sufficiently long period of time to allow the soil to swell if accurate results are to be obtained.

In sandy soils with little or no fines, soaking is not necessary. If, after filling the ring twice with 6 inches of water, the water seeps completely away in less than ten minutes, the test can proceed immediately.

Measurement of the Percolation Rate

Except for sandy soils, percolation rate measurements are made 15 hours but no more than 30 hours after the soaking period began. The water level is adjusted to 6 inches above the soil surface and successive measurements are taken to determine the percolation rate. At no time during the test is the water level allowed to rise more than 6 inches above the soil surface.

Immediately after adjustment, the water level is measured from a fixed reference point to the nearest 1/16th inch at 30-minute intervals. The test is continued until two successive water level drops do not vary by more than 1/16 inch within a 90-minute period. After each measurement, the water level is readjusted to the 6-inch level. The last water level drop is used to calculate the percolation rate.

In sandy soils or soils in which the first 6-inch of water added after the soaking period seeps away in less than 30 minutes, water level measurements are made at 10-minute intervals for a 1-hour period. The last water level drop is used to calculate the percolation rate.

Calculation of the Percolation Rate

The percolation rate is calculated for each test by dividing the time interval used between measurements by the magnitude of the last water level drop. This calculation results in a percolation rate in terms of minutes/inch. To determine the percolation rate for the area, the rates obtained from each hole are averaged.

Example: If the last measured drop in water level after 30 minutes is 5/8-inch, then:

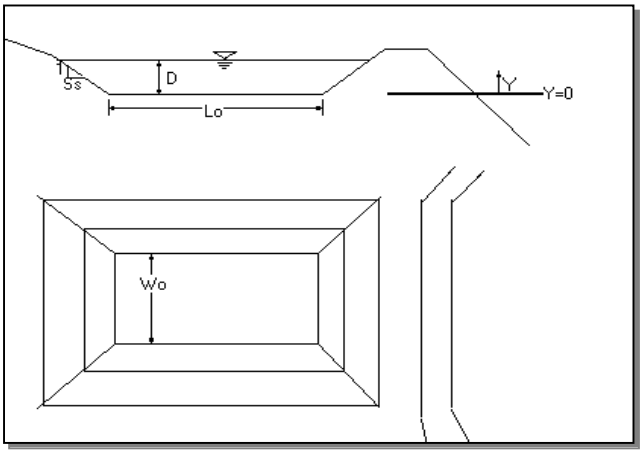
Percolation rate = (30 minutes)/(5/8 inch) = 48 minutes/inch.

REFERENCE 6-B

POND GEOMETRY CALCULATIONS

<Known>

Volume	(V)
Pond Depth	(D)
Side Slope	(Ss)
Length-to-Width Ratio	(R)



<Find>

Bottom Area of Rectangular Pond, A_o

<Solution>

Y = depth of section measured from bottom, from zero to D
W_0= width at pond bottom

The pond width (W) at any depth, Y:

$$W_Y = W_0 + 2S_S Y \quad \text{(Eq. 1)}$$

The pond length (L) at any depth, Y:

$$L_Y = RW_0 + 2S_S Y \quad \text{(Eq. 2)}$$

The pond area at any depth, Y:

$$A_Y = L_Y W_Y = \left(RW_0 + 2S_S Y\right)\left(W_0 + 2S_S Y\right) \quad \text{(Eq. 3)}$$

or,

$$A_Y = RW_0^2 + (R+1)2W_0 S_S Y + 4S_S^2 Y^2 \quad \text{(Eq. 4)}$$

The equation for the pond-full volume (V) is obtained by integrating between Y=0 and Y=D:

$$V = \int_0^D \left(RW_0^2 + (R+1)2W_0 S_S Y + 4S_S^2 Y^2\right) dY \quad \text{(Eq. 5)}$$

or,

$$V = \left[RW_0^2 Y + (R+1) W_0 S_S Y^2 + \frac{4}{3} S_S^2 Y^3 \right]\Bigg|_0^D \quad \text{(Eq. 6)}$$

or,

$$V = RDW_0^2 + S_S D^2 (R+1) W_0 + \frac{4}{3} S_S^2 D^3 \quad \text{(Eq. 7)}$$

Where

V = Volume of rectangular pond
D = Depth
W_0 = Bottom width
R = Length-to-width ratio
Ss = Side Slope

Rearrange equation to solve for W_0 using quadratic equation, $0 = ax^2 + bx + c$:

$$0 = RDW_0^2 + S_S D^2 (R+1) W_0 + \frac{4}{3} S_S^2 D^3 - V \quad \text{(Eq. 8)}$$

Use Quadratic Equation to solve for positive solution of W_0, $x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$:

$$W_0 = \frac{-S_S D^2 (R+1) \pm \sqrt{\left[S_S D^2 (R+1)\right]^2 - 4RD\left(\frac{4}{3} S_S^2 D^3 - V\right)}}{2RD} \quad \text{(Eq. 9)}$$

Use Equation 2 for Length of pond at Y=0:

$$L_0 = RW_0$$

Use Equation 3 for Area of pond at Y=0:

$$A_O = L_0 W_0 = RW_0^2$$

REFERENCE 6-C

INTRODUCTION TO LEVEL POOL ROUTING

STORAGE ROUTING/WATER LEVEL ANALYSIS METHODS

INTRODUCTION TO LEVEL POOL ROUTING

The level pool routing technique is one of the simplest and most commonly used routing methods. It is described in the *Handbook of Applied Hydrology* (Chow, Ven Te, 1964) and elsewhere, and it is based on the continuity equation:

Inflow - Outflow = Change in storage

$$\left[\left(\frac{I_1 + I_2}{2}\right) - \left(\frac{O_1 + O_2}{2}\right)\right] = \frac{\Delta S}{\Delta t} = S_2 - S_1 \qquad \text{(Ref 6C-1)}$$

where I = inflow at time 1 and time 2
O = outflow at time 1 and time 2
S = storage at time 1 and time 2
Δt = time interval, t_2 - t_1

The time interval, Δt, must be consistent with the time interval of the inflow hydrograph or time series. The Δt variable can be eliminated by dividing it into the storage variables to obtain the following rearranged equation:

$$I_1 + I_2 + 2S_1 - O_1 = O_2 + 2S_2 \qquad \text{(Ref 6C-2)}$$

If the time interval, Δt, is in minutes, the units of storage S are now [cf/min] which can be approximated to cfs by multiplying by 1 min/60 sec.

The terms on the left-hand side of the equation are known from the inflow time series and from the storage and outflow values of the previous time step. The unknowns O_2 and S_2 can be solved using the stage-storage and stage-discharge relationships for the storage facility being analyzed or sized. The level pool routing procedure calls for this calculation to be made for each time step of the inflow time series in order to generate the outflow time series for the facility. Because of the repetitive nature of this procedure, it is best performed using a computer.

Developing the Stage-Storage Relationship

The following methods and equations are used for determining the stage-storage relationships of various facility types:

Facilities with Vertical Sides

For vertical-sided facilities such as vaults, the stored volume is simply the bottom area times the height.

Ponds with 3:1 Side Slopes

For ponds with 3:1 side slopes, the stored volume can be approximated by averaging the pond surface area with the bottom area. The following equation was derived based on this assumption and for a square pond but provides a reasonable trial estimation for typical ponds of other shapes.

$$S(H) = 12H^3 + 6\sqrt{A_b}H^2 + A_bH \qquad \text{(Ref 6C-3)}$$

where H = stage height (ft) or water depth above pond bottom
A_b = area of pond bottom (sf)
$S(H)$ = storage (cf) at stage height H

Note: Actual pond volumes and surface areas should be computed based on the methods outlined in Reference Section 6-B, or the following equation:

$$V = \frac{h}{3}(A_t + A_b + \sqrt{A_t A_b}) \qquad \text{(Ref 6C-4)}$$

where h = *depth*
At = *area of top*
Ab = *area of the bottom*

Irregularly Shaped Storage Areas

The stage-storage relationship for irregularly shaped storage areas may be developed as follows:

1. Obtain topographic contours of an existing or proposed storage facility location and determine (with a planimeter or otherwise) the area enclosed by each contour. For example, in Figure A below, each contour represents a one-foot interval. Contour 71 is the lowest portion of the facility location and represents zero storage. Contour 76 represents a potential stage of 5 feet above the bottom the facility.
2. Calculate the average end area within each set of contours. For the example in Figure A, the average end area between contours 71 and 72 would be:

$$\frac{600 + 4400}{2} = 2500 \text{ sf}$$

3. Calculate the volume between each set of contours by multiplying the average end area within each set of contours by the difference in elevation. To illustrate, the volume between contours 71 and 72 would be:

(2500 sf)(1 ft) = 2500 cf

Similarly,

Area 72-73 = 6,550 cf
Area 73-74 = 10,050 cf
Area 74-75 = 12,950 cf
Area 75-76 = 16,750 cf

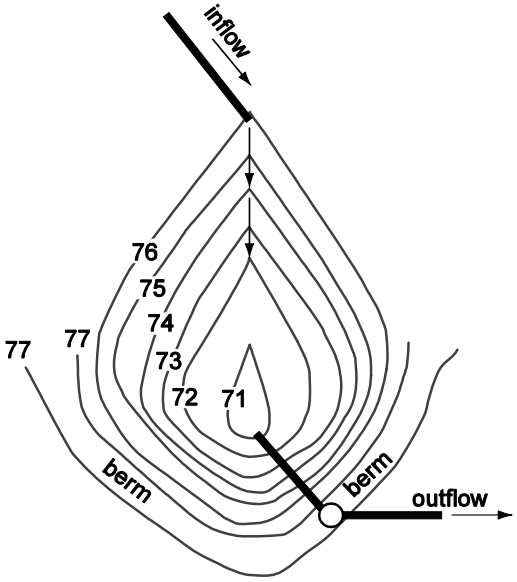
4. Define the total storage below each contour. This is just the sum of the volumes computed in the previous step up to the contour in question. For example, there is no storage below contour 71, 2500 cf below contour 72, and (6550 + 2500) = 9050 cf below contour 73.

In summary,

Contours	Stage	Sum of Volumes			Total Volume	
Contours 71-72	1	0	+	2,500	=	2,500 cf
Contours 72-73	2	2,500	+	6,500	=	9,050 cf
Contours 73-74	3	9,050	+	10,050	=	19,100 cf
Contours 74-75	4	19,100	+	12,950	=	32,050 cf
Contours 75-76	5	32,050	+	16,750	=	48,800 cf

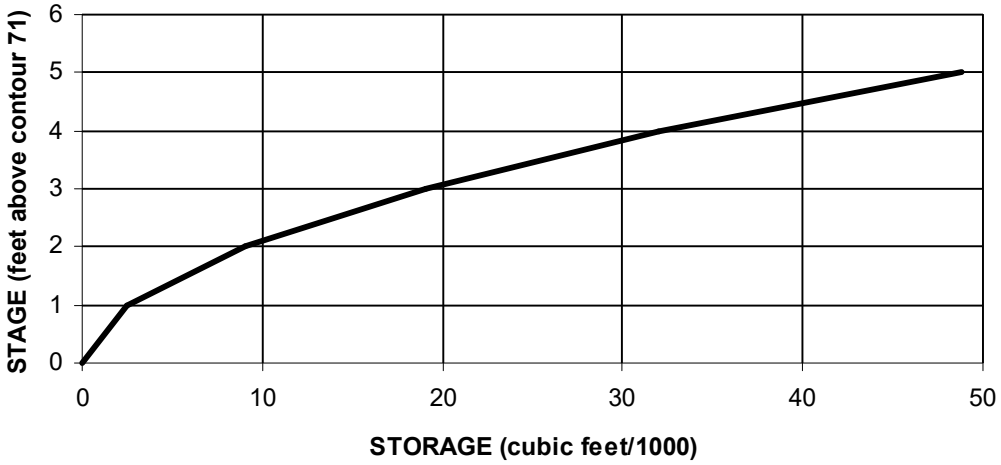
Figure B below is a plot of the stage-storage relationship for this example.

FIGURE A – STORAGE AREA CONTOURS AT ONE-FOOT INTERVALS



Area within each contour	
71	600 sq. ft.
72	4400 sq. ft.
73	8700 sq. ft.
74	11,400 sq. ft.
75	14,500 sq. ft.
76	19,000 sq. ft.

FIGURE B – STAGE-STORAGE RELATIONSHIP



Developing the Stage-Discharge Relationship

The stage-discharge relationship is determined by computing the peak discharge rate for each stage height used in the stage-storage relationship. Peak discharge rates are computed using the appropriate flow equation(s) or headwater data corresponding to the type of outlet present or proposed.

REFERENCE 6-D

SUPPLEMENTAL MODELING GUIDELINES

Following is a list of approved models and default parameters for use specifically with the City of Renton *Surface Water Design Manual (SWDM)*. For general use of the model(s), including default parameters, assumptions and limitations of the model(s), see the user's documentation provided with the software.

NOTE: Modification of the default modeling parameters shall only be considered through the adjustment process per Section 1.4.

APPROVED MODELS

*Note: **KCRTS** is no longer maintained by King County and is **not an approved model for use with the SWDM**.*

Stormwater Runoff and Water Quality Design

- MGS Flood <http://mgsengr.com/mgsfloodhome.html> (Note: This model is not allowed for explicit modeling of bioretention)
- WWHM2012
  The latest update distributed by Ecology is downloadable at:
  <https://ecology.wa.gov/Regulations-Permits/Guidance-technical-assistance/Stormwater-permittee-guidance-resources/Stormwater-manuals/Western-Washington-Hydrology-Model#latest>
- WWHM 4
  <http://www.clearcreeksolutions.info/>
- Hydrologic Simulation Program (Fortran) (HSPF)
  <http://water.usgs.gov/software/HSPF/>

Groundwater Mounding Evaluation

- MODRET ver. 6.1 or later (*Infiltration module ONLY*)
  <https://www.modret.com/software>
- MODFLOW
  <http://water.usgs.gov/ogw/modflow/>

Backwater Analysis

- KCBW
  <http://www.kingcounty.gov/environment/waterandland/stormwater/documents/surface-water-design-manual/hydrologic-hydraulic-model-software.aspx>
- Several others as accepted during the CED plan review process
- Spreadsheets often used, depending on conveyance network complexity

PARAMETERS USED IN MODELING

Follow the guidance in the software user's documentation except as indicated below. Revision of default or specific parameters requires an approved adjustment per SWDM Section 1.4

General Default Parameters

Pervious and Impervious Land Categories (PERLND and IMPLND parameter values)

- In WWHM, MGS Flood and HSPF, pervious land categories are represented by PERLNDs; impervious land categories by IMPLNDs.

  WWHM and MGS Flood provide over 20 unique PERLND parameters that describe various hydrologic factors that influence runoff and 4 parameters to represent IMPLND.

  These default values are based on regional parameter values developed by the U.S. Geological Survey for watersheds in western Washington (Dinicola, 1990), and for the WWHM model, additional HSPF modeling work conducted by AQUA TERRA Consultants. A complete description of the PERLND parameters can be found in the HSPF User Manual, 8. ***The values are not to be revised unless approved through the adjustment process in Section 1.4.***

  The precipitation stations used to develop the values represent rainfall at elevations below 1,500 feet. WWHM and MGS Flood do not include snowfall and snowmelt in their analyses.

- When sizing flow control facilities, the infiltration needs to be turned off for infiltrative BMPs to avoid double-counting the infiltration/credit benefit in the sizing.

Default Parameters and SWDM-Specific Guidelines by Model (periodically updated)

MGS Flood:

<http://mgsengr.com/mgsfloodhome.html>

Applicability and Limitations to MGS Flood[1]
(See the full discussion of Applications and Limitations in the User's Documentation)

MGS Flood is intended for the analysis of stormwater detention facilities in the lowlands of western Washington. The program utilizes the HSPF routines for computing runoff from rainfall for pervious and impervious land areas. The program does not include routines for simulating the accumulation and melt of snow and its use should be limited to lowland areas where snowmelt is typically not a major contributor to floods or to the annual runoff volume. In general, these conditions correspond to an elevation below approximately 1,500 feet.

The program is applicable for the analysis of stormwater facilities for small sites (several thousand square feet) to watersheds (10s of square miles). The program includes precipitation timeseries with a 15-minute time step for much of western Washington.

MGS Flood is not currently allowed for explicit modeling of bioretention. It will be allowed for such use when Ecology has approved it for the same.

Guidelines for Use of MGS Flood with the SWDM:

1. Use of the Extended Precipitation Timeseries per the general model guidance is required.
2. Use the flow control exception threshold of 0.1 cfs with the 1-hr timestep. Where the 15-minute timestep is required in design (e.g., water quality facility sizing), multiply the 1-hr timestep peak value by 1.6 to approximate the 15-min timestep peak value (Reference: SMMWW 2014 BMP T9.10: Basic Biofiltration Swale, Stability Check SC-1).

Western Washington Hydrology Model (WWHM2012, WWHM4):

<https://ecology.wa.gov/Regulations-Permits/Guidance-technical-assistance/Stormwater-permittee-guidance-resources/Stormwater-manuals/Western-Washington-Hydrology-Model#latest>

[1] Source: *MGS Flood User's Manual, Proprietary Version,* with references to City of Renton requirements added

Applicability and Limitations to WWHM2012/WWHM4[2]
(See the full discussion of Applications and Limitations in the User's Documentation)

Ecology created WWHM for the specific purpose of sizing stormwater control facilities for new developments in western Washington. WWHM can be used for a range of conditions and developments; however, certain limitations are inherent in this software.

WWHM uses the EPA HSPF software program to do all of the rainfall-runoff and routing computations. Therefore, HSPF limitations are included in the approved model. For example, backwater or tailwater control situations are not explicitly modeled by HSPF. This is also true in the approved model.

Earlier versions of WWHM, WWHM1 and WWHM2 had limited routing capabilities. The routing capabilities of WWHM2012 have improved and the user can input multiple stormwater control facilities and runoff is routed through them. If the proposed development site involves routing through a natural lake or wetland in addition to multiple stormwater control facilities, WWHM2012 can be used to do the routing computations and additional analysis.

Routing effects become more important as the drainage area increases. For this reason, Ecology recommends that WWHM not be used for drainage areas greater than one-half square mile (320 acres). WWHM can be used for small drainage areas less than an acre in size.

Guidelines for use of WWHM2012 or WWHM4 with the SWDM:

1. The City allows credit for Basic and Enhanced Basic water quality treatment for flows directed through the Ecology-approved bioretention soil mix. Refer to SWDM Section 6.8 for additional guidance related to using bioretention facilities to provide water quality treatment.
2. Water quality facility sizing: On-site BMPs serving pollution-generating surfaces may require water quality treatment located immediately upstream. These water quality facilities may be sized using the tributary area characterized by BMP flow control credits.
3. Water quality reporting: When using the water quality summary feature, ensure the water quality design meets the water quality sizing requirements in SWDM Chapter 6.
4. Submittals for permit review:

   Electronic files – include the following files from the model run(s):

   - WWHM2012 binary project file (.WHM file extension)
   - WWHM2012 ASCII project file (.WH2 file extension)
   - WWHM2012 WDM file (.WDM file extension)
   - WWHM2012 report file (PDF)
     - Note: When viewing or printing the project report in text mode, the water quality reporting specific to elements, as selected in the LID Report accessed from the LID icon to the right of the Tools icon, will not display properly unless landscape orientation and legal size paper are selected as viewing/printing options.

MODRET ver. 6.1 (Infiltration module ONLY):

<https://www.modret.com/software>

Training available for the software: <www.suncam.com>

Applicability and Limitations for MODRET ver. 6.1[3]

[2] Source: *Stormwater Management Manual for Western Washington (SMMWW), 2014 update*

[3] Source: *MODRET ver.6.1 Help files,* with references to City of Renton requirements added.

The use of MODRET for SWDM applications is limited to groundwater mounding analyses using the Infiltration module of the model.

MODRET (Computer **MOD**EL to Design **RET**ENTION Ponds) was originally developed in 1990, by Nicolas E. Andreyev, P.E. as a complement to a research and development project for the Southwest Florida Water Management District (SWFWMD), Brooksville, Florida. Since 1990 there have been several revisions to the original model. The user is assumed to be a professional with a background in hydrology and/or hydrogeology, and has a good command in surface runoff and groundwater flow modeling. It is assumed that the user has read the "Stormwater Retention Pond Infiltration Analysis in Unconfined Aquifers" manual (Andreyev, Wiseman, 1989, available from the author or from DNRP) and understands the applicability and limitations of the MODRET program. It is also assumed that the user is familiar with the use of personal computers, Microsoft Windows operating system and its environment.

As a whole, MODRET 6.1 is not compliant with City requirements and SWDM methodologies. The model is tailored around southwest Florida regulatory requirements and methodologies, and allows generation of runoff hydrographs with various methods, calculation of infiltration losses from a retention pond, discharge (overflow) through various types of weirs and orifices, and generation of graphical results. However, the model's methodology and graphic output closely follow southwest Florida requirements and are not applicable for use in the City. The model's use with the SWDM is limited to the infiltration module and to the tabular output produced by the module.

Guidelines for use of MODRET 6.1 with the SWDM:

MODRET is a stormwater model based on USGS's MODFLOW and is fashioned around Florida regulatory requirements for stormwater control and pollution abatement. It is single event-based, thus it is limited in its application to the City's continuous Runoff Files Method requirements. However, it is a popular tool for evaluating groundwater mounding in infiltration facilities and is mandated by Ecology for the purpose. The Infiltration module in MODRET is the only module to be used with the SWDM.

Due to the model's event-based limitation, the Infiltration module's graphics output screens do not provide useful information for mounding analyses conducted under this manual and are not to be used unless justified by the professional preparing the analysis and report. The Input screen is the main entry point for data input. The View screen states the maximum water surface results at the bottom of the screen (scroll down to view), and the time-based results in the View screen allow a check against the seasonal rainfall pattern in the hydrograph file.

Infiltration Module Input Screen

Unsaturated Analysis: Yes/No – The unsaturated analysis in MODRET is an initial transitional stage where the available pore volume fills until the saturated condition is achieved. A conservative approach would not include the unsaturated analysis, ignoring the benefit of the filling of the pore volume.

Runoff Data – (selected when the inputs are completed and RUN is selected) Do not use the MANUAL option in the dropdown. Runoff data shall be prepared per Section 5.4.1, *Groundwater Mounding Analysis* and selected with the HYDROGRAPH option in the dropdown menu. The data is exported from the approved model and manipulated in a spreadsheet to the format described in the MODRET documentation, then saved as a Formatted Text space-delimited file (.PRN file extension). This file is then modified by manually changing its filename extension from .PRN to .SCS. The file is then placed in the MODRET working directory and will appear among the selections when the HYDROGRAPH option is selected.

Design Highwater Elevation, ***Area at Starting Water Level*** (area of pond bottom), ***Elevation of Pond Bottom***, ***Elevation of Starting Water Level*** (same as pond bottom), ***Pond Length to Width Ratio –*** Values are taken or calculated from the design plans for the facility.

Volume Between Starting Water Level and Estimated High Water Level – Enter the calculated **net** volume of storage, that is, the gross storage volume of the facility multiplied by the calculated Average Effective Storage Coefficient of Pond (1.0 for an open pond, <1 for gravel trenches or tanks bedded in washed rock). The model does not do this calculation.

Average Effective Storage Coefficient of Pond – Calculate from facility design plan.(1.0 for an open pond, < 1.0 for gravel trenches or tanks bedded in washed rock); use 0.35 porosity for typical 2″ washed drain rock, justify any other porosity value.

Elevation of Effective Aquifer Base, Elevation of Seasonal High Groundwater Table – Values determined from subsurface exploration and documented/justified in the geotechnical summary provided with the analysis. Accurate aquifer thickness data (i.e., location of the aquifer base) can be beneficial to the analysis results, but the data is often incomplete, limiting the reportable aquifer thickness to the depth of the exploration.

Average Effective Storage Coefficient of Soil for Unsaturated Analysis, Average Effective Storage Coefficient of Soil for Saturated Analysis – Values determined from subsurface exploration and documented/justified in the geotechnical summary provided with the analysis. The two values are typically not the same and should reflect the specific yield characteristic of the soil (the moisture content of the unsaturated soil left due to capillary forces and surface tension after gravity draining of the saturated soil).

Unsaturated Vertical Hydraulic Conductivity, Saturated Horizontal Hydraulic Conductivity – The infiltration rate entered into the model should be the facility design infiltration rate, adjusted to exclude the geometry reduction factor, $f_{geometry}$. This infiltration rate is entered as the *Unsaturated Vertical Hydraulic Conductivity (Kvu)* and is derived from field or lab tests (field tests include a saturation period for the receptor soils, but the results are assumed to reflect the unsaturated condition unless otherwise justified). The *Saturated Horizontal Hydraulic Conductivity* is the dominant mechanism behind mounding, being the lateral movement of the inflow volume through the soil when confined by the water table or impervious stratum below, once the pore volume in the vadose zone is filled. It is indirectly related to the Unsaturated Vertical Hydraulic Conductivity and can be approximated per the guidance in Section 5.4.1 or determined though lab tests or field pumping tests.

The effects of the geometry on groundwater mounding are captured by the model in lieu of applying the reduction factor, $f_{geometry}$, so accurate determination of the geometrical inputs is necessary for the modeling results to be valid. Geometry influencing the analysis includes length to width ratio (L:W), design pond depth, net storage volume in the facility, separation of the facility bottom from the seasonal high groundwater table and/or impermeable layer, and location and thickness of the underlying aquifer

Factor of Safety for Kvu – A factor of safety of 1.0 for *Kvu* may be applied when following the guidance for determining the value for Unsaturated Vertical Hydraulic Conductivity above. The input screen for MODRET suggests a value of 2.0; software and supporting documentation indicate the suggestion accounts for plugging by sedimentation and variability of the receptor soil characteristics and field testing results. The reduction factors described in Section 5.4.1 for the Simplified Method achieve this purpose and are to be applied to determine the value for *Kvu* for MODRET input. Additional factor(s) of safety may be applied according to professional judgment.

Time Increment(s) During/After/Total for Storm Event – Use the program defaults unless otherwise justified by the professional preparing the analysis.

Additional guidance

- Allowable stress periods maximum 400 or so; time steps (aka data points) maximum count 9999 for hydrograph input files.
- The MODRET report printout will be very long (approximately 80 pages) when the water year hydrograph files described above under *Input Screen/Runoff Data* are applied. The additional pages are largely a printout of the View screen, where the progress of the model run is displayed

and the maximum high water elevation information (i.e., the primary result of concern) appears at the end of the table. Consult CED review staff to determine if the intermediate portion is necessary to be included in the review submittal.

- The hydrograph input file format is described in the model appendices. It is helpful to view one of the installed .SCS files as an example for preparing the files. In a spreadsheet (e.g., Microsoft Excel), manipulate the time series file produced by the approved model to the format described in the appendix using Courier font, save as a .PRN file (i.e., Space Delimited). After exiting the spreadsheet program, replace the saved file's extension with .SCS and move the file to the working folder for MODRET. The file will show in the Hydrograph selection process of the Infiltration module.
- If the Help module in MODRET does not function, open the document(s) directly from the program folder.

Guidance for use of MODRET 6.1 with other software

- MODRET and 64 bit Win 7/8 compatibility:
- MODRET is a 32 bit program that will work on 64 bit operating systems. By default, a 32-bit program will install to the "Program Files (x86)" directory on a 64-bit operating system, which causes problems for MODRET. To work around this, change the install directory to C:\MODRET. (DURING INSTALLATION)
- MODRET and Win 7/8 display compatibility:
- The menus in MODRET appear black in Win 7/8. To work around this, change the display theme to the Classic, High Contrast Black, or High Contrast White theme and the menu text will display properly.
- MODRET and Acrobat for Internet Explorer:

During installation, you may receive an error related to AcroIEHelper.dll. Choose Ignore and continue with the installation. As long as you can continue viewing PDFs in your browser, this should not be an issue.

CITY OF RENTON

SURFACE WATER DESIGN MANUAL

REFERENCE 7

ENGINEERING PLAN SUPPORT

7-A CITY OF RENTON SURVEY AND DRAFTING STANDARDS

See the *Survey and Drafting Standards* document on the City's website*:* <https://rentonwa.gov/city_hall/community_and_economic_development/permits/civil_construction>

7-B SURFACE WATER STANDARD PLAN NOTES, EROSION AND SEDIMENT CONTROL STANDARD PLAN NOTES, AND EXAMPLE OF CONSTRUCTION SEQUENCE

See Surface Water Standard Plans 267.00 and 267.10 for the Surface Water Standard Plan Notes and 268.00 for the Erosion and Sediment Control Standard Plan Notes:

<https://edocs.rentonwa.gov/Documents/Browse.aspx?id=990403&dbid=0&repo=CityofRenton>

See attached Example of Construction Sequence.

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CITY OF RENTON

SURFACE WATER DESIGN MANUAL

REFERENCE 7-B

SURFACE WATER STANDARD PLAN NOTES, EROSION AND SEDIMENT CONTROL STANDARD PLAN NOTES, AND EXAMPLE OF CONSTRUCTION SEQUENCE

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REFERENCE 7-B

See Surface Water Standard Plans 267.00 and 267.10 for the Surface Water Standard Plan Notes and 268.00 for the Erosion and Sediment Control Standard Plan Notes:

<https://edocs.rentonwa.gov/Documents/Browse.aspx?id=990403&dbid=0&repo=CityofRenton>

EXAMPLE OF CONSTRUCTION SEQUENCE

CONSTRUCTION STORMWATER POLLUTION PREVENTION RECOMMENDED CONSTRUCTION SEQUENCE

1. Pre-construction meeting.
2. Post sign with name and phone number of CSWPP/ESC supervisor (may be consolidated with the required notice of construction sign).
3. Flag or fence clearing limits.
4. Install catch basin protection and stormwater BMP area protection as required.
5. Grade and install construction entrance(s).
6. Install perimeter protection (silt fence, brush barrier, etc.).
7. Construct sediment ponds and traps.
8. Grade and stabilize construction roads.
9. Construct surface water controls (interceptor dikes, pipe slope drains, etc.) simultaneously with clearing and grading for project development. Construct SWPPS controls in anticipation of scheduled construction activity (e.g., concrete-related pH measures for utility, vault or roadway construction)
10. Maintain erosion control measures in accordance with Appendix D of the City of Renton *Surface Water Design Manual* and manufacturer's recommendations.
11. Relocate erosion control measures or install new measures so that as site conditions change the erosion and sediment control and pollution prevention is always in accordance with the City's Erosion and Sediment Control Standards.
12. Cover all areas that will be unworked for more than seven days during the dry season or two days during the wet season with straw, wood fiber mulch, compost, or equivalent.
13. Stabilize all areas that reach final grade within seven days.
14. Seed or sod any areas to remain unworked for more than 30 days.
15. Upon completion of the project, all disturbed areas must be stabilized and BMPs removed if appropriate.

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CITY OF RENTON

SURFACE WATER DESIGN MANUAL

REFERENCE 8

PLAN REVIEW FORMS AND WORKSHEETS

8-A TECHNICAL INFORMATION REPORT (TIR) WORKSHEET

See attached.

8-B OFF-SITE ANALYSIS DRAINAGE SYSTEM TABLE

See attached.

8-C WATER QUALITY FACILITY SIZING WORKSHEETS

See Reference Section 8-C of the 2021 King County Surface Water Design Manual at:

<https://kingcounty.gov/services/environment/water-and-land/stormwater/documents/surface-water-design-manual.aspx>

8-D FLOW CONTROL AND WATER QUALITY FACILITY SUMMARY SHEET AND SKETCH

See the "Flow Control and Water Quality Facility Summary Sheet" document on the City's Civil Construction webpage at:

<https://rentonwa.gov/city_hall/community_and_economic_development/permits/civil_construction>

8-E CSWPP WORKSHEET FORMS

See attached.

8-F ADJUSTMENT APPLICATION AND PROCESS GUIDELINES

Does not apply to the City.

8-G DEDICATION AND INDEMNIFICATION CLAUSE – FINAL RECORDING

Does not apply to the City.

8-H BOND QUANTITIES WORKSHEET

See the "Bond Quantity Worksheet" document on the City's Civil Construction webpage at:

<https://rentonwa.gov/city_hall/community_and_economic_development/permits/civil_construction>

8-I MAINTENANCE AND DEFECT AGREEMENT

See the "Maintenance and Defect Agreement" document on the City's Civil Construction webpage at:

<https://rentonwa.gov/city_hall/community_and_economic_development/permits/civil_construction>

8-J DRAINAGE FACILITY COVENANT

See the "Declaration of Covenant for Inspection and Maintenance of Drainage Facilities and On-Site BMPs" document on the City's Civil Construction webpage at:

<https://rentonwa.gov/city_hall/community_and_economic_development/permits/civil_construction>

8-K DRAINAGE RELEASE COVENANT

See the "Release of Easement" and "Partial Release of Easement" documents on the City's Civil Construction webpage at:

<https://rentonwa.gov/city_hall/community_and_economic_development/permits/civil_construction>

8-L DRAINAGE EASEMENT

See the "Easement – Public Utilities" document on the City's Civil Construction webpage at:

<https://rentonwa.gov/city_hall/community_and_economic_development/permits/civil_construction>

8-M ON-SITE BMP COVENANT AND MAINTENANCE INSTRUCTIONS (RECORDABLE FORMAT)

See the "Declaration of Covenant for Inspection and Maintenance of Drainage Facilities and On-Site BMPs" document on the City's Civil Construction webpage at:

<https://rentonwa.gov/city_hall/community_and_economic_development/permits/civil_construction>

See attached Maintenance Instructions.

8-N IMPERVIOUS SURFACE LIMIT COVENANT

See the "Impervious Surface Limit Covenant" document on the City's Civil Construction webpage at:

<https://rentonwa.gov/city_hall/community_and_economic_development/permits/civil_construction>

8-O CLEARING LIMIT COVENANT

See the "Clearing Limit Covenant" document on the City's Civil Construction webpage at:

<https://rentonwa.gov/city_hall/community_and_economic_development/permits/civil_construction>

8-P RIVER PROTECTION EASEMENT – CITY OF RENTON

See the "River Protection Easement" document on the City's Civil Construction webpage at:

<https://rentonwa.gov/city_hall/community_and_economic_development/permits/civil_construction>

8-Q LEACHABLE METALS COVENANT

See the City's Surface Water Design Standards website at:

<https://rentonwa.gov/city_hall/community_and_economic_development/permits/civil_construction>

8-R AGREEMENT TO CONSTRUCT IMPROVEMENTS

See the "Agreement to Construct Improvements" document on the City's Civil Construction webpage at:

<https://rentonwa.gov/city_hall/community_and_economic_development/permits/civil_construction>

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CITY OF RENTON

SURFACE WATER DESIGN MANUAL

REFERENCE 8-A

TECHNICAL INFORMATION REPORT (TIR) WORKSHEET

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REFERENCE 8-A

TECHNICAL INFORMATION REPORT (TIR) WORKSHEET

Part 1 PROJECT OWNER AND PROJECT ENGINEER

Project Owner _____
Phone _____
Address _____
_____
Project Engineer _____
Company _____
Phone _____

Part 2 PROJECT LOCATION AND DESCRIPTION

Project Name _____
CED Permit # _____
Location Township _____
Range _____
Section _____
Site Address _____
_____

Part 3 TYPE OF PERMIT APPLICATION

- ❑ Land Use (e.g., Subdivision / Short Subd.)
- ❑ Building (e.g., M/F / Commercial / SFR)
- ❑ Grading
- ❑ Right-of-Way Use
- ❑ Other _____

Part 4 OTHER REVIEWS AND PERMITS

- ❑ DFW HPA
- ❑ COE 404
- ❑ DOE Dam Safety
- ❑ FEMA Floodplain
- ❑ COE Wetlands
- ❑ Other _____
- ❑ Shoreline Management
- ❑ Structural Rockery/Vault/_____
- ❑ ESA Section 7

Part 5 PLAN AND REPORT INFORMATION

Technical Information Report

Type of Drainage Review (check one):

- ❑ Full
- ❑ Targeted
- ❑ Simplified
- ❑ Large Project
- ❑ Directed

Date (include revision dates): _____
_____
Date of Final: _____

Site Improvement Plan (Engr. Plans)

Plan Type (check one):

- ❑ Full
- ❑ Modified
- ❑ Simplified

Date (include revision dates): _____
_____
Date of Final: _____

TECHNICAL INFORMATION REPORT (TIR) WORKSHEET

Part 6 SWDM ADJUSTMENT APPROVALS

Type (circle one): Standard / Blanket

Description: (include conditions in TIR Section 2)

_____

_____

_____

Approved Adjustment No. _____ Date of Approval: _____

Part 7 MONITORING REQUIREMENTS

Monitoring Required: Yes / No

Start Date: _____

Completion Date: _____

Describe: _____

_____

_____

Re: SWDM Adjustment No. _____

Part 8 SITE COMMUNITY AND DRAINAGE BASIN

Community Plan: _____

Special District Overlays: _____

Drainage Basin: _____

Stormwater Requirements: _____

Part 9 ONSITE AND ADJACENT SENSITIVE AREAS

- ❑ River/Stream _____
- ❑ Lake _____
- ❑ Wetlands _____
- ❑ Closed Depression _____
- ❑ Floodplain _____
- ❑ Other _____
  _____
- ❑ Steep Slope _____
- ❑ Erosion Hazard _____
- ❑ Landslide Hazard _____
- ❑ Coal Mine Hazard _____
- ❑ Seismic Hazard _____
- ❑ Habitat Protection _____
- ❑ _____

TECHNICAL INFORMATION REPORT (TIR) WORKSHEET

Part 10 SOILS

Soil Type	Slopes	Erosion Potential
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____

❑ High Groundwater Table (within 5 feet) ❑ Sole Source Aquifer

❑ Other _____ ❑ Seeps/Springs

❑ Additional Sheets Attached

Part 11 DRAINAGE DESIGN LIMITATIONS

REFERENCE	LIMITATION / SITE CONSTRAINT
❑ Core 2 – Offsite Analysis	_____
❑ Sensitive/Critical Areas	_____
❑ SEPA	_____
❑ LID Infeasibility	_____
❑ Other	_____
❑ _____	_____

❑ Additional Sheets Attached

Part 12 TIR SUMMARY SHEET **(provide one TIR Summary Sheet per Threshold Discharge Area)**

Threshold Discharge Area:
(name or description)

Core Requirements (all 9 apply):

Discharge at Natural Location	Number of Natural Discharge Locations:
Offsite Analysis	Level: 1 / 2 / 3 dated:_____
Flow Control (include facility summary sheet)	Standard: _____ or Exemption Number: _____
Conveyance System	Spill containment located at: _____
Erosion and Sediment Control / Construction Stormwater Pollution Prevention	CSWPP/CESCL/ESC Site Supervisor: _____ Contact Phone: _____ After Hours Phone: _____
Maintenance and Operation	Responsibility (circle one): Private / Public If Private, Maintenance Log Required: Yes / No
Financial Guarantees and Liability	Provided: Yes / No

TECHNICAL INFORMATION REPORT (TIR) WORKSHEET

Part 12 TIR SUMMARY SHEET	**(provide one TIR Summary Sheet per Threshold Discharge Area)**
Water Quality (include facility summary sheet)	Type (circle one): Basic / Sens. Lake / Enhanced Basic / Bog or Exemption No. _____
On-site BMPs	Describe:
Special Requirements (as applicable):	
Area Specific Drainage Requirements	Type: SDO / MDP / BP / Shared Fac. / None Name: _____
Floodplain/Floodway Delineation	Type (circle one): Major / Minor / Exemption / None 100-year Base Flood Elevation (or range): _____ Datum:
Flood Protection Facilities	Describe:
Source Control (commercial / industrial land use)	Describe land use: Describe any structural controls:
Oil Control	High-Use Site: Yes / No Treatment BMP: _____ Maintenance Agreement: Yes / No with whom? _____
Other Drainage Structures	
Describe:	

TECHNICAL INFORMATION REPORT (TIR) WORKSHEET

Part 13 EROSION AND SEDIMENT CONTROL REQUIREMENTS

MINIMUM ESC REQUIREMENTS DURING CONSTRUCTION		MINIMUM ESC REQUIREMENTS AFTER CONSTRUCTION
❑ Clearing Limits ❑ Cover Measures ❑ Perimeter Protection ❑ Traffic Area Stabilization ❑ Sediment Retention ❑ Surface Water Collection ❑ Dewatering Control ❑ Dust Control ❑ Flow Control ❑ Control Pollutants ❑ Protect Existing and Proposed BMPs/Facilities ❑ Maintain Protective BMPs / Manage Project		❑ Stabilize exposed surfaces ❑ Remove and restore Temporary ESC Facilities ❑ Clean and remove all silt and debris, ensure operation of Permanent BMPs/Facilities, restore operation of BMPs/Facilities as necessary ❑ Flag limits of sensitive areas and open space preservation areas ❑ Other _____

Part 14 STORMWATER FACILITY DESCRIPTIONS (Note: Include Facility Summary and Sketch)

Flow Control	Description	Water Quality	Description	On-site BMPs	Description
❑ Detention ❑ Infiltration ❑ Regional Facility ❑ Shared Facility ❑ Other	_____ _____ _____ _____ _____ _____ _____ _____ _____ _____	❑ Vegetated Flowpath ❑ Wetpool ❑ Filtration ❑ Oil Control ❑ Spill Control ❑ Other	_____ _____ _____ _____ _____ _____ _____ _____ _____ _____	❑ Full Dispersion ❑ Full Infiltration ❑ Limited Infiltration ❑ Rain Gardens ❑ Bioretention ❑ Permeable Pavement ❑ Basic Dispersion ❑ Soil Amendment ❑ Perforated Pipe Connection ❑ Other	_____ _____ _____ _____ _____ _____ _____ _____ _____ _____

TECHNICAL INFORMATION REPORT (TIR) WORKSHEET

Part 15 EASEMENTS/TRACTS		Part 16 STRUCTURAL ANALYSIS
❑ Drainage Easement ❑ Covenant ❑ Native Growth Protection Covenant ❑ Tract ❑ Other _____		❑ Cast in Place Vault ❑ Retaining Wall ❑ Rockery > 4′ High ❑ Structural on Steep Slope ❑ Other _____

Part 17 SIGNATURE OF PROFESSIONAL ENGINEER

I, or a civil engineer under my supervision, have visited the site. Actual site conditions as observed were incorporated into this worksheet and the attached Technical Information Report. To the best of my knowledge the information provided here is accurate.

_____

Signed/Date

CITY OF RENTON

SURFACE WATER DESIGN MANUAL

REFERENCE 8-B

OFF-SITE ANALYSIS DRAINAGE SYSTEM TABLE

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REFERENCE 8-B

OFF-SITE ANALYSIS DRAINAGE SYSTEM TABLE

CITY OF RENTON SURFACE WATER DESIGN MANUAL, CORE REQUIREMENT #2

Basin:		**Subbasin Name:**		**Subbasin Number:**		**Date**	

Symbol	**Drainage Component Type, Name, and Size**	**Drainage Component Description**	**Slope**	**Distance from Site Discharge**	**Existing Problems**	**Potential Problems**	**Observations of Field Inspector, Resource Reviewer, or Resident**
See map	Type: sheet flow, swale, stream, channel, pipe, pond, flow control/ treatment/on-site BMP/facility Size: diameter, surface area	drainage basin, vegetation, cover, depth, type of sensitive area, volume	%	¼ ml = 1,320 ft.	Constrictions, under capacity, ponding, overtopping, flooding, habitat or organism destruction, scouring, bank sloughing, sedimentation, incision, other erosion		Tributary area, likelihood of problem, overflow pathways, potential impacts

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CITY OF RENTON

SURFACE WATER DESIGN MANUAL

REFERENCE 8-E

CSWPP WORKSHEET FORMS

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REFERENCE 8-E

CSWPP WORKSHEET FORMS

ESC MAINTENANCE REPORT

Performed By: _____

Date: _____

Project Name: _____

CED Permit #: _____

Clearing Limits

Damage	OK_____	Problem_____
Visible	OK_____	Problem_____
Intrusions	OK_____	Problem_____
Other	OK_____	Problem_____

Mulch

Rills/Gullies	OK_____	Problem_____
Thickness	OK_____	Problem_____
Other	OK_____	Problem_____

Nets/Blankets

Rills/Gullies	OK_____	Problem_____
Ground Contact	OK_____	Problem_____
Other	OK_____	Problem_____

Plastic

Tears/Gaps	OK_____	Problem_____
Other	OK_____	Problem_____

Seeding

Percent Cover	OK_____	Problem_____
Rills/Gullies	OK_____	Problem_____
Mulch	OK_____	Problem_____
Other	OK_____	Problem_____

Sodding

Grass Health	OK_____	Problem_____
Rills/Gullies	OK_____	Problem_____
Other	OK_____	Problem_____

Perimeter Protection including Silt Fence

Damage	OK_____	Problem_____
Sediment Build-up	OK_____	Problem_____
Concentrated Flow	OK_____	Problem_____
Other	OK_____	Problem_____

Flow Control, Treatment, and On-site BMP/Facility Protection

Damage	OK_____	Problem_____
Sedimentation	OK_____	Problem_____
Concentrated Flow	OK_____	Problem_____
Rills/Gullies	OK_____	Problem_____
Intrusions	OK_____	Problem_____
Other	OK_____	Problem_____

Brush Barrier

Damage	OK_____	Problem_____
Sediment Build-up	OK_____	Problem_____
Concentrated Flow	OK_____	Problem_____
Other	OK_____	Problem_____

Vegetated Strip

Damage	OK_____	Problem_____
Sediment Build-up	OK_____	Problem_____
Concentrated Flow	OK_____	Problem_____
Other	OK_____	Problem_____

Construction Entrance

Dimensions	OK_____	Problem_____
Sediment Tracking	OK_____	Problem_____
Vehicle Avoidance	OK_____	Problem_____
Other	OK_____	Problem_____

Wheel Wash

Dimensions	OK_____	Problem_____
Sed build up or tracking	OK_____	Problem_____
Other	OK_____	Problem_____

Construction Road

Stable Driving Surf.	OK_____	Problem_____
Vehicle Avoidance	OK_____	Problem_____
Other	OK_____	Problem_____

Sediment Trap/Pond

Sed. Accumulation	OK_____	Problem_____
Overtopping	OK_____	Problem_____
Inlet/Outlet Erosion	OK_____	Problem_____
Other	OK_____	Problem_____

Catch Basin/Inlet Protection

Sed. Accumulation	OK_____	Problem_____
Damage	OK_____	Problem_____
Clogged Filter	OK_____	Problem_____
Other	OK_____	Problem_____

Interceptor Dike/Swale

Damage	OK_____	Problem_____
Sed. Accumulation	OK_____	Problem_____
Overtopping	OK_____	Problem_____
Other	OK_____	Problem_____

Pipe Slope Drain

Damage	OK_____	Problem_____
Inlet/Outlet	OK_____	Problem_____
Secure Fittings	OK_____	Problem_____
Other	OK_____	Problem_____

Ditches

Damage	OK_____	Problem_____
Sed. Accumulation	OK_____	Problem_____
Overtopping	OK_____	Problem_____
Other	OK_____	Problem_____

Outlet Protection

Scour	OK_____	Problem_____
Other	OK_____	Problem_____

Level Spreader

Damage	OK_____	Problem_____
Concentrated Flow	OK_____	Problem_____
Rills/Gullies	OK_____	Problem_____
Sed. Accumulation	OK_____	Problem_____
Other	OK_____	Problem_____

Dewatering Controls

Sediment	OK_____	Problem_____

Dust Control

Palliative applied	OK_____	Problem_____

Miscellaneous

Wet Season Stockpile	OK_____	Problem_____
Other	OK_____	Problem_____

Comments:

_____

_____

_____

Actions Taken:

_____

_____

_____

Problems Unresolved:

_____

_____

_____

BMP Implementation	Completed by: _____ Title: _____ Date: _____

Develop a plan for implementing each BMP. Describe the steps necessary to implement the BMP (i.e., any construction or design), the schedule for completing those steps (list dates), and the person(s) responsible for implementation.

BMPs	Description of Action(s) Required for Implementation	Scheduled Milestone and Completion Date(s)	Person Responsible for Action
Good Housekeeping	1.		
	2.		
	3		
Preventive Maintenance	1.		
	2.		
	3.		
	4.		
Spill Prevention and Emergency Cleanup	1.		
	2.		
	3.		
Inspections	1.		
	2.		
	3.		

BMPs	Description of Action(s) Required for Implementation	Schedule Milestone and Completion Date(s)	Person Responsible for Action
Source Control BMPs	1.		
	2.		
	3		
	4.		
	5.		
	6.		
	7.		
	8.		
Water Quality Facilities	1.		
	2.		
	3.		
	4.		
Flow Control Facilities	1.		
	2.		
	3.		
	4.		
On-Site BMPs	1.		
	2.		
	3.		
	4.		

Pollution Prevention Team	**Completed by: _____** **Title: _____** **Date: _____**
Responsible Official:_____	Title:_____
Team Leader:_____	Office Phone:_____
	Cell Phone:_____
Responsibilities: _____ _____ _____	
(1)_____	Title:_____
	Office Phone:_____
	Cell Phone:_____
Responsibilities: _____ _____ _____	
(2)_____	Title:_____
	Office Phone:_____
	Cell Phone:_____
Responsibilities: _____ _____ _____	

Employee Training	Completed by: _____ Title: _____ Date: _____

Describe the annual training of employees on the SWPPP, addressing spill response, good housekeeping, and material management practices.

Training Topics 1.) LINE WORKERS	Brief Description of Training Program/Materials (e.g., film, newsletter course)	Schedule for Training (list dates)	Attendees
Spill Prevention and Response			
Good Housekeeping			
Material Management Practices			
2.) P2 TEAM:			
SWPPP Implementation			
Monitoring Procedures			

List of Significant Spills and Leaks	Completed by:_____ Title:_____ Date:_____

List all spills and leaks of toxic or hazardous pollutants that were significant but are not limited to, release of oil or hazardous substances in excess of reportable quantities. Although not required, we suggest you list spills and leaks of non-hazardous materials.

Date (month/ day/ year)	Location (as indicated on site map)	Description				Response Procedure		Preventive Measure Taken
		Type of Material	Quantity	Source, If Known	Reason for Spill/Leak	Amount of Material Recovered	Material no longer exposed to stormwater (Yes/No)	

Potential Pollutant Source Identification	**Completed by:** _____ **Title:** _____ **Date:** _____

List all potential stormwater pollutants from materials handled, treated, or stored onsite.

Potential Stormwater Pollutant	Stormwater Pollutant Source	Likelihood of pollutant being present in your stormwater discharge. If yes, explain

Material Inventory	Completed by: _____ Title: _____ Date: _____

List materials handled, treated, stored, or disposed of at the project site that may potentially be exposed to precipitation or runoff.

Material	Purpose/Location	Quantity (Units) (indicate per wk. or yr.) Used	Produced	Stored		Likelihood of contact with stormwater If Yes, describe reason:		Past Spill or Leak Yes	No

CITY OF RENTON

SURFACE WATER DESIGN MANUAL

REFERENCE 8-M

ON-SITE BMP COVENANT AND MAINTENANCE INSTRUCTIONS (RECORDABLE FORMAT)

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MAINTENANCE INSTRUCTIONS FOR FULL DISPERSION

Your property contains an on-site BMP (best management practice) called "***full dispersion.***"

Full dispersion is a strategy for minimizing the area disturbed by development (i.e., impervious or nonnative pervious surfaces, such as concrete areas, roofs, and lawns) relative to native vegetated areas (e.g., forested surface) together with the application of dispersion techniques that utilize the natural capacity of the native vegetated areas to mitigate the stormwater runoff quantity and quality impacts of the developed surfaces.

This on-site BMP has two primary components that must be maintained per Appendix A of the City of Renton's Surface Water Design Manual:

(1) the devices that disperse runoff from the developed surfaces, and

(2) the native vegetated area and flowpath receiving the dispersed runoff.

Dispersion Devices

The **dispersion devices** used on your property include the following as indicated on the site plan (CHECK THE BOX(ES) THAT APPLY):

❑splash blocks, ❑rock pads, ❑gravel filled trenches, ❑sheet flow.

MAINTENANCE RESTRICTIONS

The size, placement, composition, and downstream flowpaths of these devices as depicted by the site plan and design details must be maintained and may not be changed without written approval from the City of Renton or through a future development permit from the City of Renton.

INSPECTION FREQUENCY AND MAINTENANCE GUIDELINES

Dispersion Devices

- Dispersion devices must be inspected annually and after major storm events to identify and repair any physical defects.
- When native soil is exposed or erosion channels are present, the sources of the erosion or concentrated flow need to be identified and mitigated.
- Bare spots should be re-vegetated with native vegetation.
- Concentrated flow can be mitigated by leveling the edge of the pervious area and/or regrading or replenishing the rock in the dispersion device, such as in rock pads and gravel-filled trenches.

Native Growth Retention Area

- The native vegetated surface required for full dispersion is delineated as a "native growth retention area" on the on-site BMP site plan. The trees, vegetation, ground cover, and soil conditions in this area may not be disturbed, except as allowed by the following provisions for that portion of the native growth retention area outside of critical areas and critical area buffers:

    1. Individual trees that have a structural defect due to disease or other defects, and which threaten to damage a structure, road, parking area, utility, or place of employment or

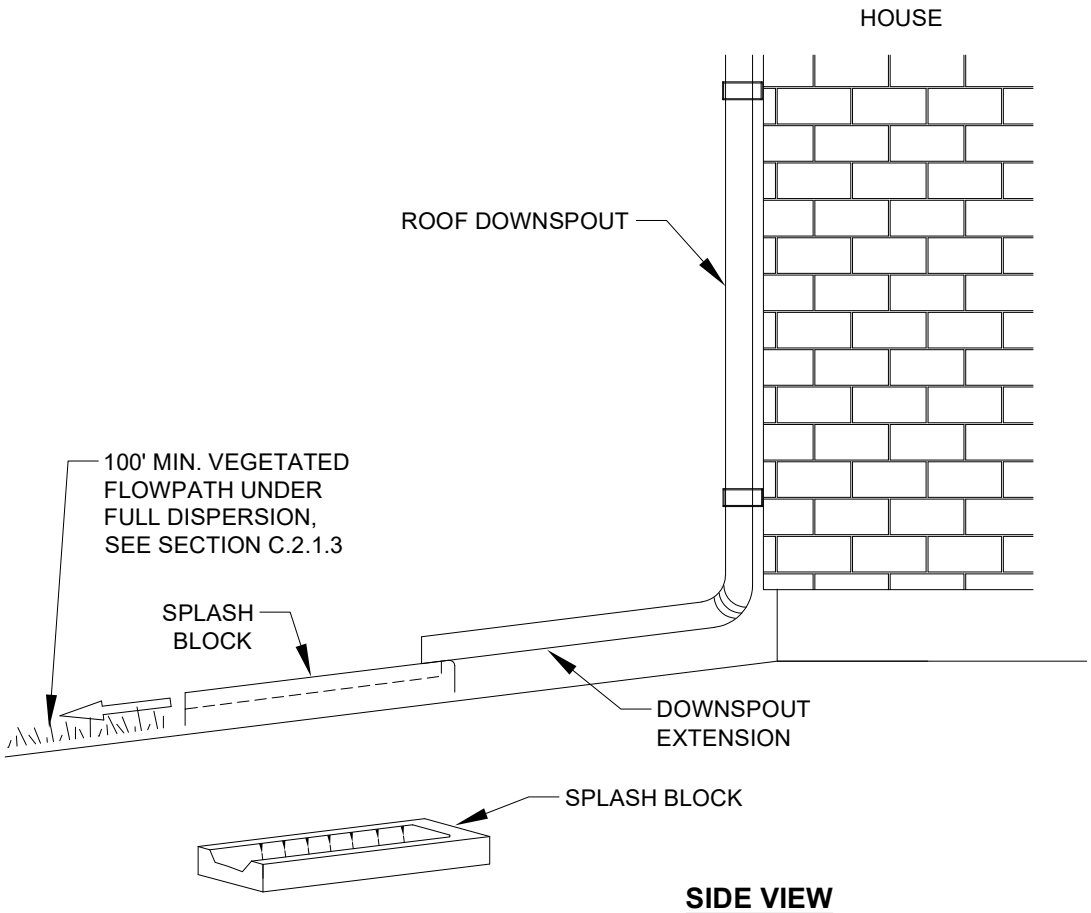
public assembly, or block emergency access, may be topped, pruned, or removed as needed to eliminate the threat.

2. Dead or fallen trees, tree limbs within ten feet of the ground, and branches overhanging a residence may be removed to reduce the danger of wildfire.
3. Noxious weeds (i.e., plant species listed on the State noxious weed list in Chapter 16-750 WAC) and invasive vegetation (i.e., plant species listed as obnoxious weeds on the noxious weed list adopted by King County) may be removed.
4. Passive recreation uses and related facilities, including pedestrian, equestrian community and bicycle trails, nature viewing areas, fishing and camping areas, and other similar uses that do not require permanent structures, are allowed if clearing and soil compaction associated with these uses and facilities does not exceed eight percent of the native growth retention area.

RECORDING REQUIREMENT

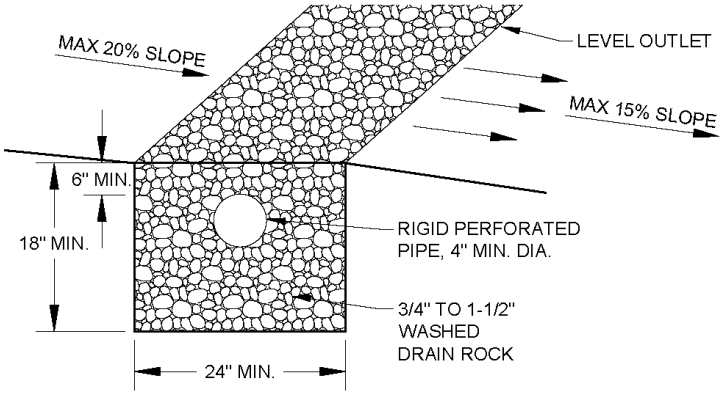
These full dispersion on-site BMP maintenance and operation instructions must be recorded as an attachment to the required **declaration of covenant and grant of easement** per Requirement 3 of Section C.1.3.4 of the City of Renton *Surface Water Design Manual*. The intent of these instructions is to explain to future property owners, the purpose of the BMP and how it must be maintained and operated. These instructions are intended to be a minimum; the City of Renton may require additional instructions based on site-specific conditions. See the City of Renton's Surface Water Design Manual website for additional information and updates.

TYPICAL FULL DISPERSION APPLICATIONS

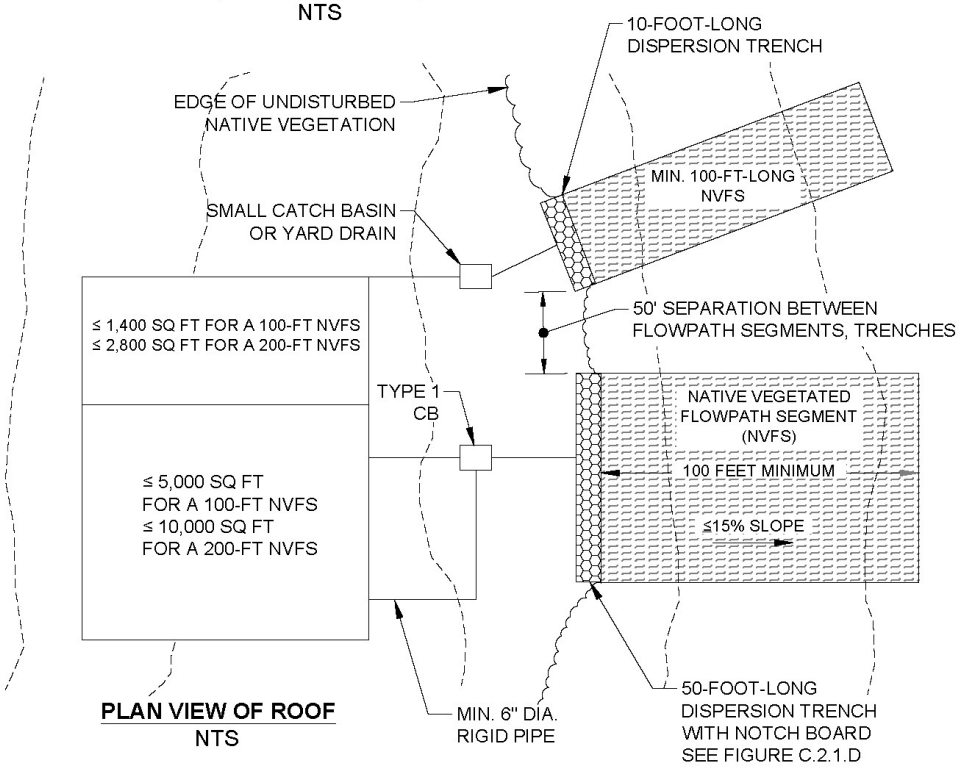


SIDE VIEW
NTS

TYPICAL FULL DISPERSION APPLICATIONS

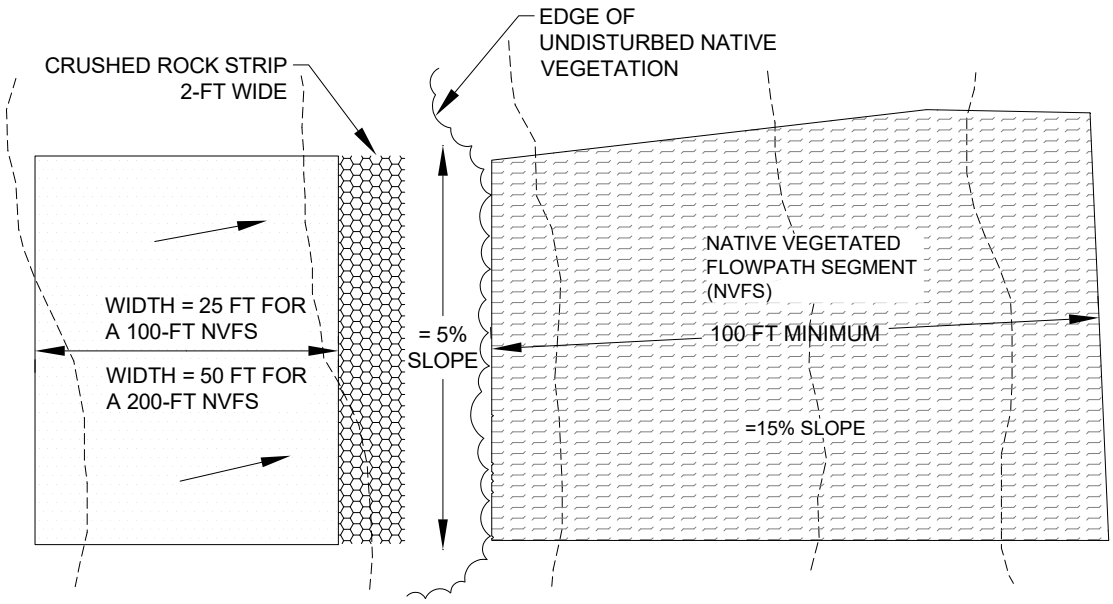


TRENCH SECTION
NTS



PLAN VIEW OF ROOF
NTS

TYPICAL FULL DISPERSION APPLICATIONS



PLAN VIEW
NTS

MAINTENANCE INSTRUCTIONS FOR FULL INFILTRATION

Your property contains an on-site BMP (best management practice) called "***full infiltration***," which was installed to mitigate the stormwater quantity and quality impacts of some or all of the impervious surfaces on your property.

Full infiltration is a method of soaking runoff from impervious area (such as paved areas and roofs) into the ground. If properly installed and maintained per Appendix A of the City of Renton's Surface Water Design Manual, full infiltration can manage runoff so that a majority of precipitation events are absorbed. Infiltration devices, such as gravel filled trenches, drywells, and ground surface depressions, facilitate this process by putting runoff in direct contact with the soil and holding the runoff long enough to soak most of it into the ground. To be successful, the soil condition around the infiltration device must be reliably able to soak water into the ground for a reasonable number of years.

Infiltration Devices

The **infiltration devices** used on your property include the following as indicated on the site plan (CHECK THE BOX(ES) THAT APPLY):

❑gravel filled trenches, ❑drywells, ❑ground surface depressions.

MAINTENANCE RESTRICTIONS

The size, placement, and composition of these devices as depicted by the site plan and design details must be maintained and may not be changed without written approval from the City of Renton or through a future development permit from the City of Renton.

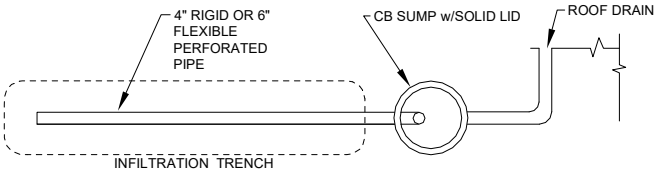
INSPECTION FREQUENCY AND MAINTENANCE GUIDELINES

- Infiltration devices must be inspected annually and after major storm events to identify and repair any physical defects.
- Maintenance and operation of the system should focus on ensuring the system's viability by preventing sediment-laden flows from entering the device. Excessive sedimentation will result in a plugged or non-functioning facility.
- If the infiltration device has a catch basin, sediment accumulation must be removed on a yearly basis or more frequently if necessary.
- Prolonged ponding around or atop a device may indicate a plugged facility. If the device becomes plugged, it must be replaced.
- Keeping the areas that drain to infiltration devices well swept and clean will enhance the longevity of these devices.
- For roofs, frequent cleaning of gutters will reduce sediment loads to these devices.

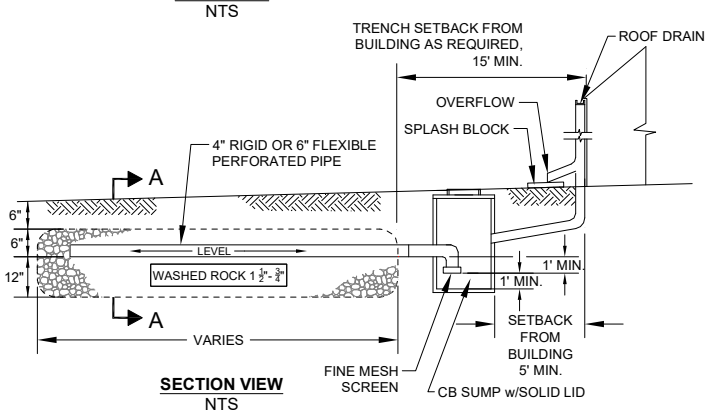
RECORDING REQUIREMENT

These full infiltration on-site BMP maintenance and operation instructions must be recorded as an attachment to the required **declaration of covenant and grant of easement** per Requirement 3 of Section C.1.3.4 of the City of Renton *Surface Water Design Manual*. The intent of these instructions is to explain to future property owners, the purpose of the BMP and how it must be maintained and operated. These instructions are intended to be a minimum; the City of Renton may require additional instructions based on site-specific conditions. See the City of Renton's Surface Water Design Manual website for additional information and updates.

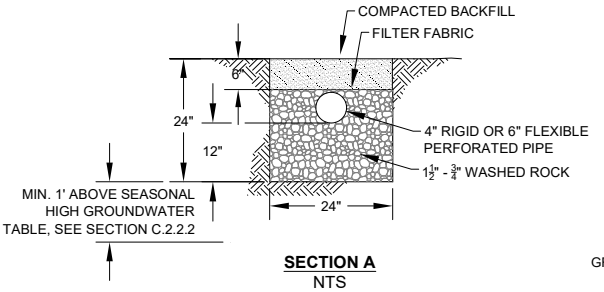
TYPICAL FULL INFILTRATION APPLICATIONS



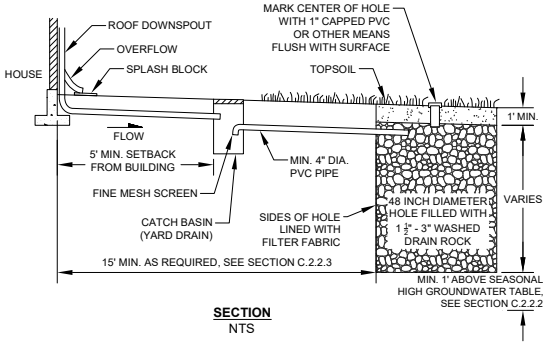
PLAN VIEW
NTS



SECTION VIEW
NTS



SECTION A
NTS



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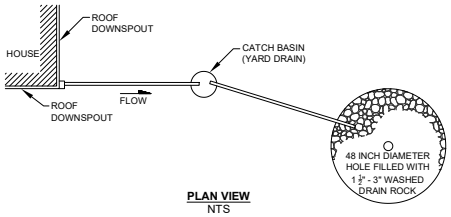
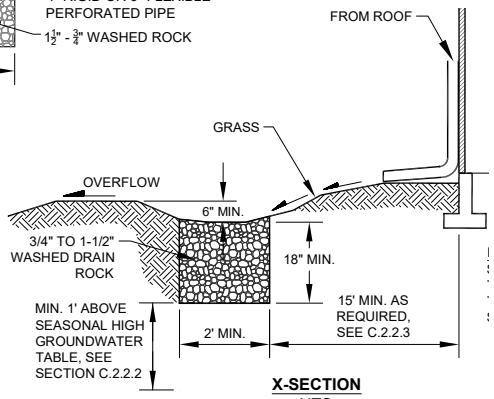
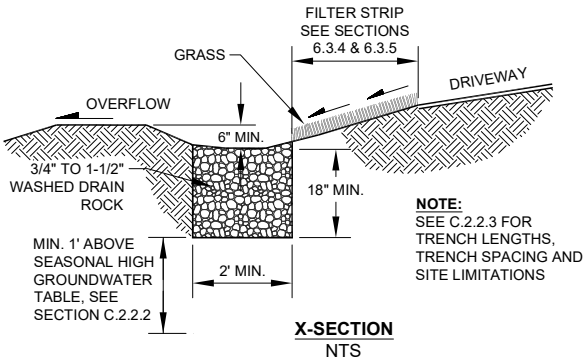


PLAN VIEW
NTS



X-SECTION
NTS



NOTE:
SEE C.2.2.3 FOR TRENCH LENGTHS, TRENCH SPACING AND SITE LIMITATIONS

X-SECTION
NTS

MAINTENANCE INSTRUCTIONS FOR A RAIN GARDEN

Your property contains an on-site BMP (best management practice) called a "***rain garden***," which was installed to mitigate the stormwater quantity and quality impacts of some or all of the impervious or nonnative pervious surfaces on your property.

Rain gardens include vegetated closed depressions (ponds) that retain and filter stormwater from an area of impervious surface or nonnative pervious surface on your property. The soil in the rain garden has been enhanced to encourage and support vigorous plant growth that serves to filter the water and sustain infiltration capacity. Depending on soil conditions, the rain garden area may have water in it throughout the wet season and may overflow during major storm events. This on-site BMP shall be maintained per Appendix A of the City of Renton's Surface Water Design Manual.

MAINTENANCE RESTRICTIONS

The size, placement, and design of the rain garden as depicted by the site plan and design details must be maintained and may not be changed without written approval from the City of Renton or through a future development permit from City of Renton. Plant materials may be changed to suit tastes, but chemical fertilizers and pesticides must not be used.

INSPECTION FREQUENCY AND MAINTENANCE GUIDELINES

- Rain gardens must be inspected annually for physical defects and sediment accumulation.
- Rain gardens have inflow and overflow inlets and outlets. These need to be maintained to ensure that water is moving into and out of the rain garden. Check inlets/outlets for debris/sediment blockage, bare spots (exposed soil), or other signs of erosion damage (soil movement). Remove debris and obstructions as necessary.
- After major storm events, the system should be checked to see that the overflow system is working properly and sedimentation is not occurring at the inlet. If erosion damage or bare spots are evident, they should be stabilized with soil, plant material, mulch, or landscape rock. Sediment deposits should be carefully removed and the sediment source eliminated.
- Plants must be adapted to wet winter conditions and dry summer conditions. Vegetation is to be watered and pruned as needed.
- Frequent watering is required to keep the plants healthy:
    - Year 1: weekly,
    - Year 2: bimonthly,
    - Year 3: bimonthly,
    - Year 4 & beyond: as needed for established plantings and dry periods.
- Chemical fertilizers and pesticides must not be used.
- Soil must be replaced in areas where sediment accumulation is preventing adequate infiltration of water through the soil.
- Compacted soil should be decompacted.
- Trash and debris must be removed often from the rain garden depression.

- Mulch must be applied to bare soil at a minimum of 2 inches to maintain healthy growth.
- Compost may be added if soil nutrients are no longer adequate to support plant growth.
- Vegetation should be maintained as follows:

  1) Replace all dead vegetation as soon as possible;

  2) Remove fallen leaves and debris as needed;

  3) Remove all noxious vegetation when discovered;

  4) Manually weed without herbicides or pesticides;

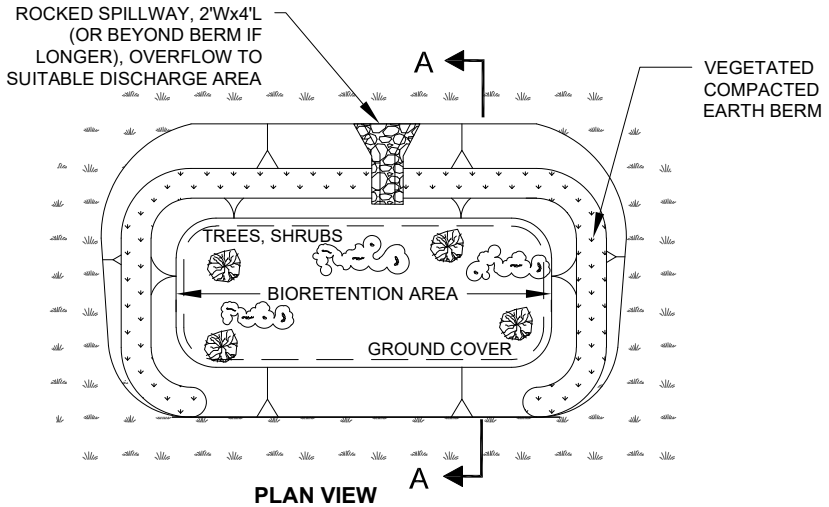
  5) To protect infiltration performance, do not compact soils in the bioretention cell with heavy maintenance equipment and/or excessive foot traffic;

  6) During drought conditions, use mulch to prevent excess solar damage and water loss.

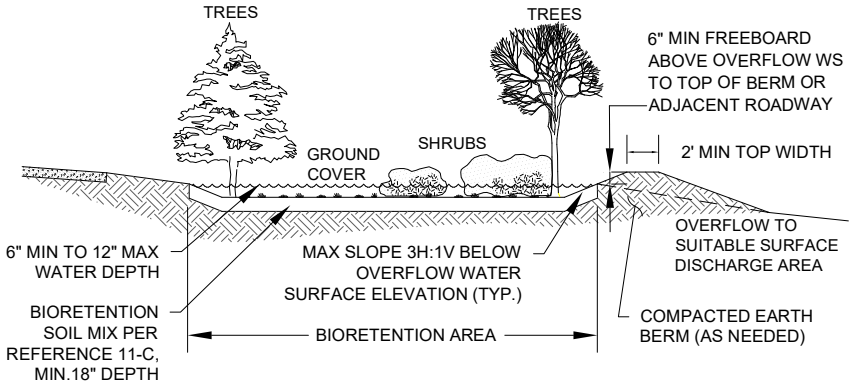
RECORDING REQUIREMENT

These rain garden on-site BMP maintenance and operation instructions must be recorded as an attachment to the required **declaration of covenant and grant of easement** per Requirement 3 of Section C.1.3.4 of the City of Renton *Surface Water Design Manual*. The intent of these instructions is to explain to future property owners, the purpose of the BMP and how it must be maintained and operated. These instructions are intended to be a minimum; the City of Renton may require additional instructions based on site-specific conditions. See the City of Renton's Surface Water Design Manual website for additional information and updates.

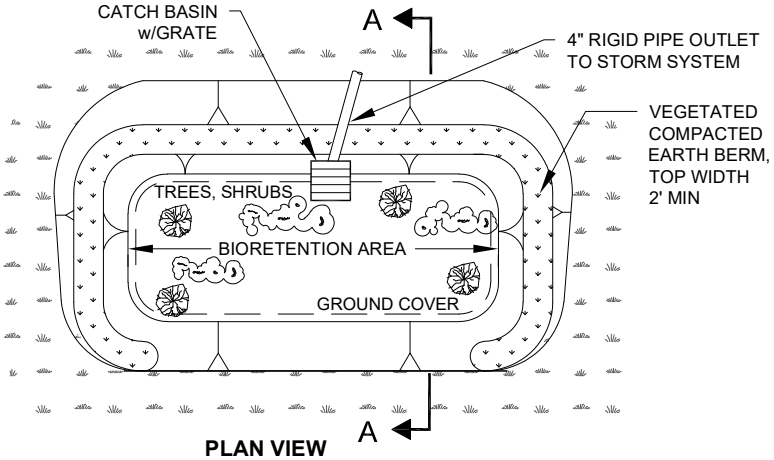
TYPICAL RAIN GARDEN (SPILLWAY OR CATCH BASIN OUTLET)



PLAN VIEW
NTS



SECTION A-A
NTS



PLAN VIEW
NTS

MAINTENANCE INSTRUCTIONS FOR A BIORETENTION CELL

Your property contains an on-site BMP (best management practice) called "***bioretention***," which was installed to mitigate the stormwater quantity and quality impacts on both the impervious (paved or roof) and pervious surfaces (lawn or landscape) on your property.

Bioretention cells, like rain gardens, are vegetated closed depressions or ponds that retain and filter stormwater from an area of impervious surface or nonnative pervious surface. Bioretention cells rely on effective infiltration performance more so than rain gardens. The soil in the bioretention cell has been enhanced to encourage and support vigorous plant growth that serves to filter the water and sustain a minimum infiltration capacity. Depending on soil conditions, bioretention cells may have water in them throughout the wet season and may overflow during major storm events. However, standing water can also be an indicator that periodic maintenance is required to sustain infiltrative performance. This on-site BMP shall be maintained per Appendix A of the City of Renton's Surface Water Design Manual.

MAINTENANCE RESTRICTIONS

The size, placement, and design of the rain garden as depicted by the site plan and design details must be maintained and may not be changed without written approval from the City of Renton or through a future development permit from the City of Renton. Chemical fertilizers and pesticides must not be used.

INSPECTION FREQUENCY AND MAINTENANCE GUIDELINES

- Bioretention cells must be inspected annually for physical defects and sediment accumulation.
- Bioretention cells have inflow and overflow inlets and outlets. These need to be maintained to ensure that water is moving into and out of the bioretention area. Check inlets/outlets for debris/sediment blockage, bare spots (exposed soil), or other signs of erosion damage (soil movement). Remove debris and obstructions as necessary.
- After major storm events, the bioretention cell should be checked to see that the overflow system is working properly and sedimentation is not occurring at the inlet. If erosion damage or bare spots are evident, they should be stabilized with soil, plant material, mulch, or landscape rock. Sediment deposits should be carefully removed and the sediment source eliminated.
- Plants must be adapted to wet winter conditions and dry summer conditions. Vegetation is to be watered and pruned as needed.
- Frequent watering is required to keep the plants healthy:
    - Year 1: weekly,
    - Year 2: bimonthly,
    - Year 3: bimonthly,
    - Year 4 and beyond: as needed for established plantings and dry periods.
- Chemical fertilizers and pesticides must not be used.
- Bioretention soil must be replaced in areas where sediment accumulation is preventing adequate infiltration of water through the soil.

- Compacted soil should be decompacted.
- Trash and debris must be removed often from the bioretention depression.
- Mulch must be applied to bare soil at a minimum of 2 inches to maintain healthy growth.
- Compost may be added if soil nutrients are no longer adequate to support plant growth.
- Plant materials may be changed to suit tastes.
- Vegetation should be maintained as follows:

  1) Replace all dead vegetation as soon as possible;

  2) Remove fallen leaves and debris as needed;

  3) Remove all noxious vegetation when discovered;

  4) Manually weed without herbicides or pesticides;

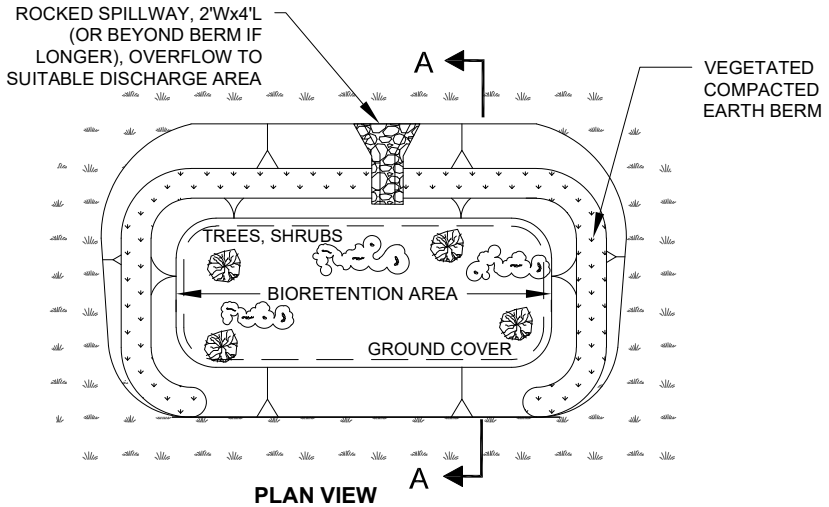
  5) To protect infiltration performance, do not compact soils in the bioretention cell with heavy maintenance equipment and/or excessive foot traffic;

  6) During drought conditions, use mulch to prevent excess solar damage and water loss.

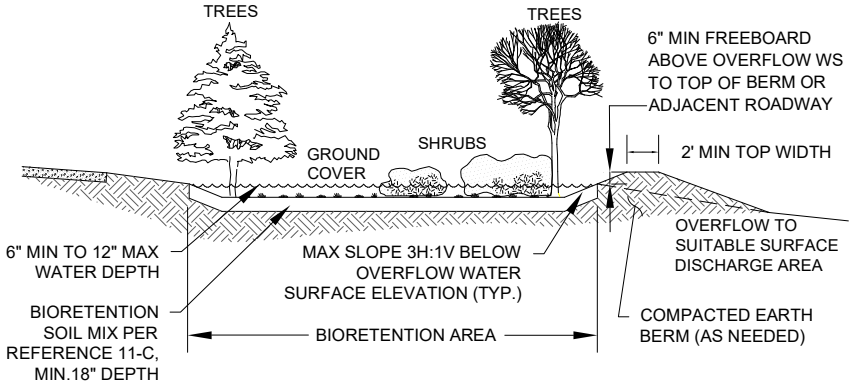
RECORDING REQUIREMENT

These bioretention on-site BMP maintenance and operation instructions must be recorded as an attachment to the required **declaration of covenant and grant of easement** per Requirement 3 of Section C.1.3.4 of the City of Renton *Surface Water Design Manual*. The intent of these instructions is to explain to future property owners, the purpose of the BMP and how it must be maintained and operated. These instructions are intended to be a minimum; the City of Renton may require additional instructions based on site-specific conditions. See the City of Renton's Surface Water Design Manual website for additional information and updates.

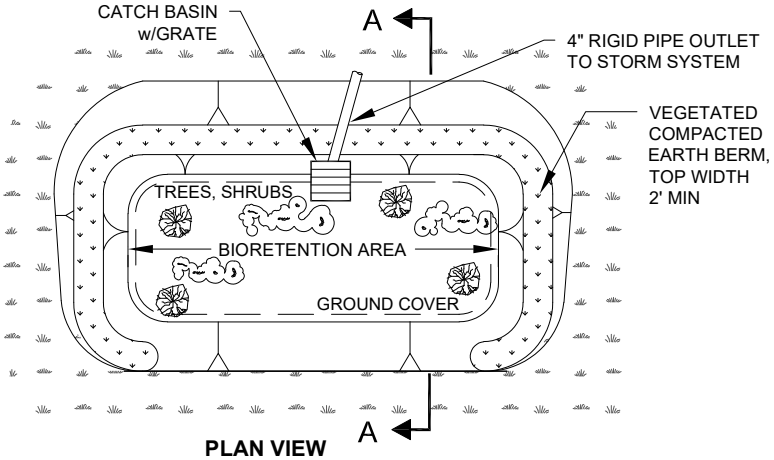
TYPICAL BIORETENTION CELL (SPILLWAY OR CATCH BASIN OUTLET)



PLAN VIEW
NTS



SECTION A-A
NTS



PLAN VIEW
NTS

MAINTENANCE INSTRUCTIONS FOR VEGETATED PERMEABLE PAVEMENT (GRASSED MODULAR GRID PAVEMENT)

Your property contains an on-site BMP (best management practice) called "***grassed modular grid pavement***," which was installed to minimize the stormwater quantity and quality impacts of some or all of the paved surfaces on your property.

Grassed modular grid pavement has the runoff characteristics of a lawn while providing the weight-bearing capacity of concrete pavement. The grassed surface not only minimizes runoff quantity, it helps to filter pollutants generating by vehicular use of the surface.

MAINTENANCE RESTRICTIONS

The composition and area of grassed modular grid pavement as depicted by the site plan and design details must be maintained and may not be changed without written approval from the City of Renton or through a future development permit from the City of Renton.

INSPECTION FREQUENCY AND MAINTENANCE GUIDELINES

- Grassed modular grid pavement must be inspected after one major storm each year to make sure it is working properly. More frequent inspection is recommended.
- Prolonged ponding or standing water on the pavement surface is a sign that the system is defective and may need to be replaced. If this occurs, or if any modification, surface restoration or stabilization is planned (except for mowing and periodic maintenance), contact the pavement installer or the City of Renton for further instructions.
- The grassed surface of the pavement must be regularly mowed and maintained in a good condition. Bare spots must be replanted in the spring or fall.

RECORDING REQUIREMENT

These vegetated permeable pavement on-site BMP maintenance and operation instructions must be recorded as an attachment to the required **declaration of covenant and grant of easement** per Requirement 3 of Section C.1.3.4 of the City of Renton *Surface Water Design Manual*. The intent of these instructions is to explain to future property owners, the purpose of the BMP and how it must be maintained and operated. These instructions are intended to be a minimum; the City of Renton may require additional instructions based on site-specific conditions. See the City of Renton's Surface Water Design Manual website for additional information and updates.

MAINTENANCE INSTRUCTIONS FOR PERMEABLE PAVEMENT (NON-VEGETATED)

Your property contains an on-site BMP (best management practice) called "***permeable pavement***," which was installed to minimize the stormwater quantity and quality impacts of some or all of the paved surfaces on your property.

Permeable pavements reduce the amount of rainfall that becomes runoff by allowing water to seep through the pavement into a free-draining gravel or sand bed, where it can be infiltrated into the ground. This on-site BMP shall be maintained per Appendix A of the City of Renton's Surface Water Design Manual.

Permeable Pavements

The type(s) of **permeable pavement** used on your property is (CHECK THE BOX(ES) THAT APPLY):

- ❑ Porous concrete
- ❑ Porous asphalt
- ❑ Permeable pavers
- ❑ Modular grid pavement

MAINTENANCE RESTRICTIONS

The area covered by permeable pavement as depicted by the site plan and design details must be maintained as permeable pavement and may not be changed without written approval from the City of Renton or through a future development permit from the City of Renton.

INSPECTION FREQUENCY AND MAINTENANCE GUIDELINES

- Permeable pavements must be inspected after one major storm each year to make sure it is working properly. More frequent inspection is recommended.
- Prolonged ponding or standing water on the pavement surface is a sign that the system is defective and may need to be replaced. If this occurs, contact the pavement installer or the City of Renton for further instructions.
- A typical permeable pavement system has a life expectancy of approximately 25 years. To help extend the useful life of the system, the surface of the permeable pavement should be kept clean, stable and free of leaves, debris, and sediment through regular sweeping or vacuum sweeping. Aggregate fill in modular grid pavement may need periodic surface replenishment.
- The owner is responsible for the repair of all ruts, deformation, and/or broken paving grids or pavers.
- Modular grid pavement and permeable pavers filled with gravel or with gravel in the joints may need to be refilled periodically.

RECORDING REQUIREMENT

These permeable pavement on-site BMP maintenance and operation instructions must be recorded as an attachment to the required **declaration of covenant and grant of easement** per Requirement 3 of Section C.1.3.4 of the City of Renton *Surface Water Design Manual*. The intent of these instructions is to explain to future property owners, the purpose of the BMP and how it must be maintained and operated. These instructions are intended to be a minimum; the City of Renton may require additional instructions based on site-specific conditions. See the City of Renton's Surface Water Design Manual website for additional information and updates.

MAINTENANCE INSTRUCTIONS FOR BASIC DISPERSION

Your property contains an on-site BMP (best management practice) called "***basic dispersion***," which was installed to mitigate the stormwater quantity and quality impacts of some or all of the impervious surfaces or non-native pervious surfaces on your property.

Basic dispersion is a strategy for utilizing any available capacity of onsite vegetated areas to retain, absorb, and filter the runoff from developed surfaces. This on-site BMP has two primary components that must be maintained:

(1) The devices that disperse runoff from the developed surfaces and

(2) The vegetated area over which runoff is dispersed.

Dispersion Devices

The **dispersion devices** used on your property include the following as indicated on the site plan (CHECK THE BOX(ES) THAT APPLY):

❑ splash blocks, ❑ rock pads, ❑ gravel filled trenches, ❑ sheet flow.

MAINTENANCE RESTRICTIONS

The size, placement, composition, and downstream flowpaths of these devices as depicted by the site plan and design details must be maintained and may not be changed without written approval from the City of Renton or through a future development permit from the City of Renton.

INSPECTION FREQUENCY AND MAINTENANCE GUIDELINES

This on-site BMP has two primary components that must be maintained per Appendix A of the City of Renton's Surface Water Design Manual:

(1) The devices that disperse runoff from the developed surfaces and

(2) The vegetated flowpath area over which runoff is dispersed.

Maintenance of Dispersion Devices

- Dispersion devices must be inspected annually and after major storm events to identify and repair any physical defects.
- When native soil is exposed or erosion channels are present, the sources of the erosion or concentrated flow need to be identified and mitigated.
- Concentrated flow can be mitigated by leveling the edge of the pervious area and/or realigning or replenishing the rocks in the dispersion device, such as in rock pads and gravel filled trenches.

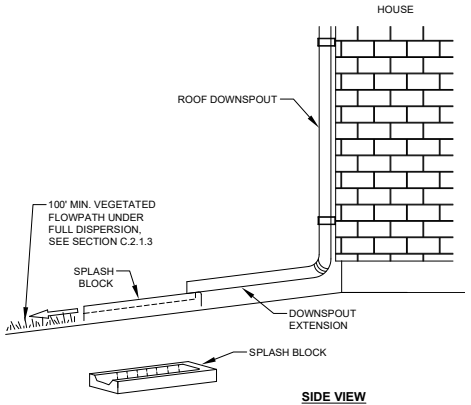
Maintenance of Vegetated Flowpaths

- The vegetated area over which runoff is dispersed must be maintained in good condition free of bare spots and obstructions that would concentrate flows.

RECORDING REQUIREMENT

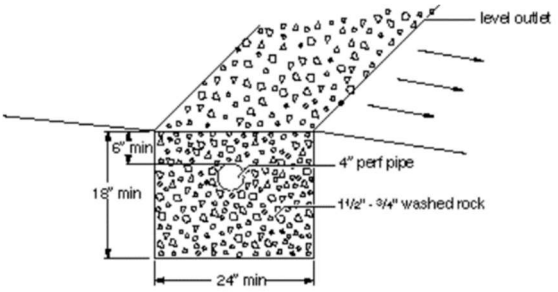
These basic dispersion on-site BMP maintenance and operation instructions must be recorded as an attachment to the required **declaration of covenant and grant of easement** per Requirement 3 of Section C.1.3.4 of the City of Renton *Surface Water Design Manual*. The intent of these instructions is to explain to future property owners, the purpose of the BMP and how it must be maintained and operated. These instructions are intended to be a minimum; the City of Renton may require additional instructions based on site-specific conditions. See the City of Renton's Surface Water Design Manual website for additional information and updates.

TYPICAL SPLASH BLOCK



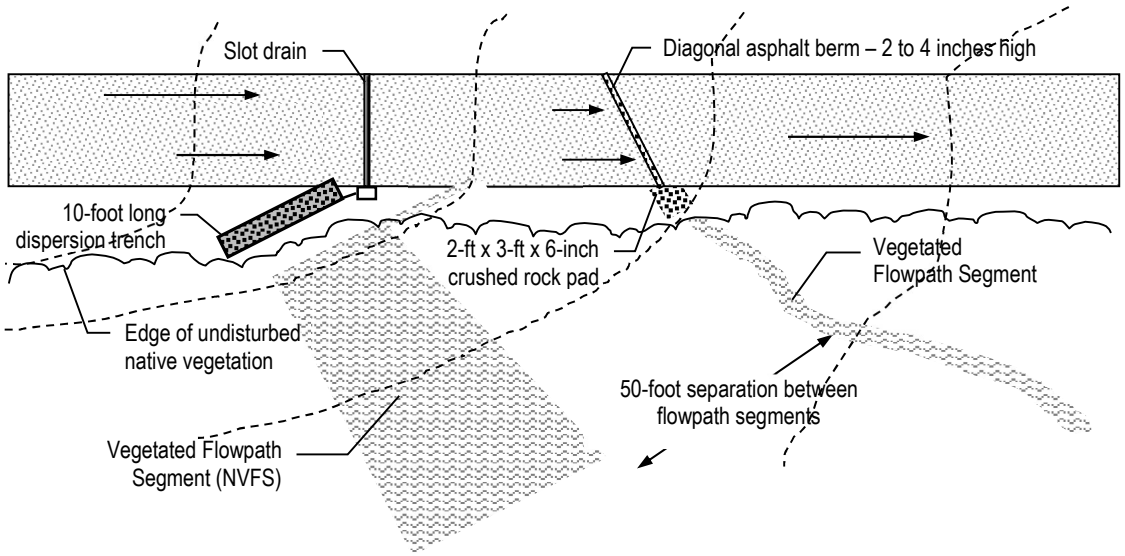
SIDE VIEW
NTS

TYPICAL 10-FOOT DISPERSION TRENCH CROSS-SECTION



TRENCH X-SECTION
NTS

TYPICAL DRIVEWAY APPLICATION OF DISPERSION TRENCH AND ROCK PAD



PLAN VIEW OF DRIVEWAY
NTS

MAINTENANCE INSTRUCTIONS FOR LIMITED INFILTRATION

Your property contains an on-site BMP (best management practice) called "***limited infiltration***," which was installed to mitigate the stormwater quantity and quality impacts of some or all of the impervious surfaces on your property.

Limited infiltration is a method of soaking runoff from impervious area (such as paved areas and roofs) into the ground. Infiltration devices, such as gravel filled trenches, drywells, and ground surface depressions, facilitate this process by putting runoff in direct contact with the soil and holding the runoff long enough to soak most of it into the ground. To be successful, the soil condition around the infiltration device must be able to soak water into the ground for a reasonable number of years. This on-site BMP shall be maintained per Appendix A of the City of Renton's Surface Water Design Manual.

Infiltration Devices

The **infiltration devices** used on your property include the following as indicated on the site plan (CHECK THE BOX(ES) THAT APPLY):

❑ gravel filled trenches, ❑ drywells

MAINTENANCE RESTRICTIONS

The size, placement, and composition of these devices as depicted by the site plan and design details must be maintained and may not be changed without written approval from the City of Renton or through a future development permit from the City of Renton.

INSPECTION FREQUENCY AND MAINTENANCE GUIDELINES

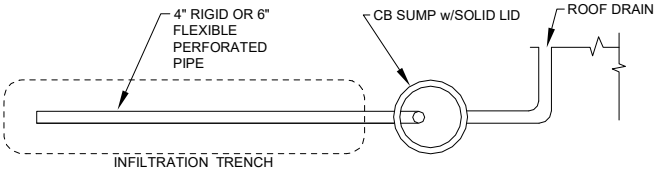
To be successful, the soil condition around the infiltration device must be able to soak water into the ground for a reasonable number of years.

- Infiltration devices must be inspected annually and after major storm events to identify and repair any physical defects.
- Maintenance and operation of the system should focus on ensuring the system's viability by preventing sediment-laden flows from entering the device. Excessive sedimentation will result in a plugged or non-functioning facility.
- If the infiltration device has a catch basin, sediment accumulation must be removed on a yearly basis or more frequently if necessary.
- Prolonged ponding around or atop a device may indicate a plugged facility. If the device becomes plugged, it must be replaced.
- Keeping the areas that drain to infiltration devices well swept and clean will enhance the longevity of these devices.
- For roofs, frequent cleaning of gutters will reduce sediment loads to these devices.

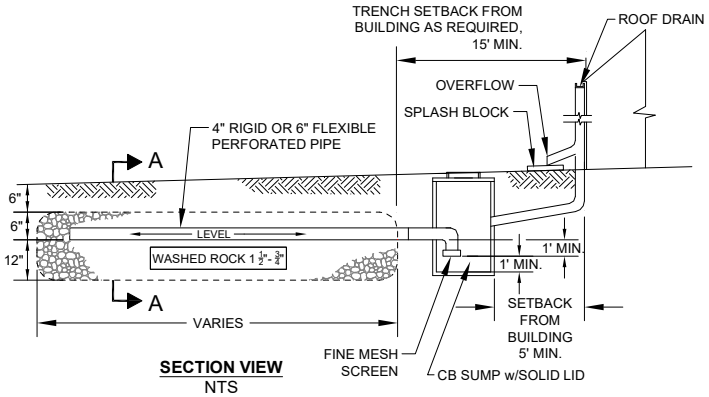
RECORDING REQUIREMENT

These limited infiltration on-site BMP maintenance and operation instructions must be recorded as an attachment to the required **declaration of covenant and grant of easement** per Requirement 3 of Section C.1.3.4 of the City of Renton *Surface Water Design Manual*. The intent of these instructions is to explain to future property owners, the purpose of the BMP and how it must be maintained and operated. These instructions are intended to be a minimum; the City of Renton may require additional instructions based on site-specific conditions. See the City of Renton's Surface Water Design Manual website for additional information and updates.

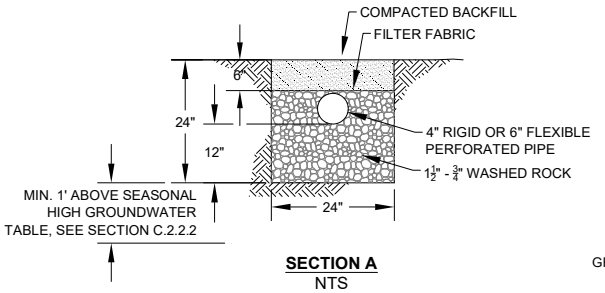
INFILTRATION TRENCH AND DRYWELL SYSTEMS



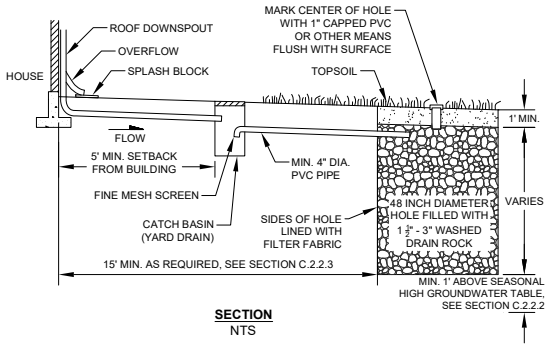
PLAN VIEW
NTS



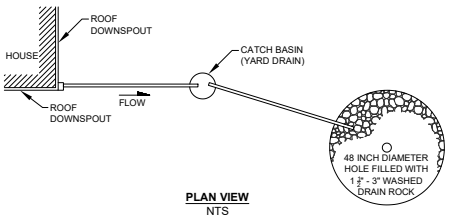
SECTION VIEW
NTS



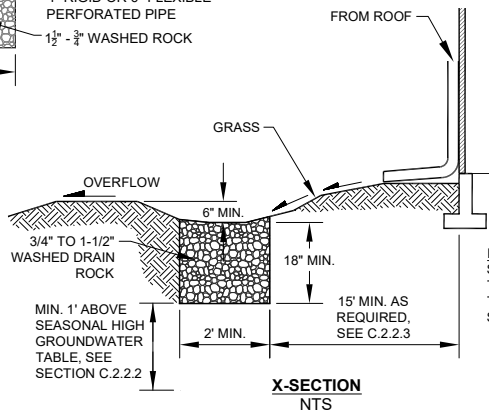
SECTION A
NTS



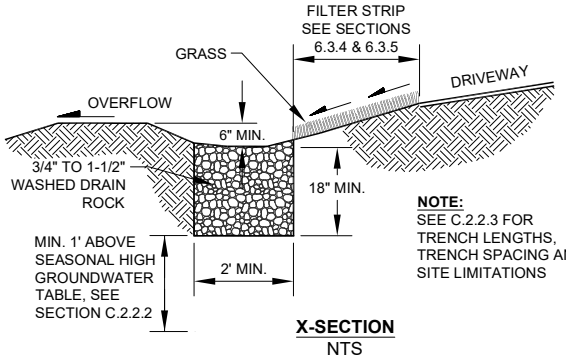
SECTION
NTS



PLAN VIEW
NTS



X-SECTION
NTS



NOTE:
SEE C.2.2.3 FOR TRENCH LENGTHS, TRENCH SPACING AND SITE LIMITATIONS

X-SECTION
NTS

MAINTENANCE INSTRUCTIONS FOR RAINWATER HARVESTING

Your property contains an on-site BMP (best management practice) called "**rainwater harvesting,**" which was installed to minimize the stormwater runoff impacts of impervious surface on your property.

Rainwater harvesting is a means for the collection and storage of roof runoff for domestic or irrigation use. **Rainwater harvesting systems** include a collection area, a filtering system, a storage device, and an outflow device. This on-site BMP shall be maintained per Appendix A of the City of Renton's Surface Water Design Manual.

MAINTENANCE RESTRICTIONS

The size, components, and configuration of the rainwater system as depicted by the site plan and design details must be maintained and may not be changed without written approval from the City of Renton or through a future development permit from the City of Renton.

INSPECTION FREQUENCY AND MAINTENANCE GUIDELINES

Rainwater harvesting systems include a *collection area*, a *filtering system*, a *storage device*, and an *outflow device*:

- The *collection area* (e.g., roof) should be routinely inspected for debris and other material that could impede the entrance and/or exit of surface flows.
- The *filtering system* should be periodically inspected for effectiveness and replaced or replenished as recommended by the manufacturer.
- The *storage device* must be drained completely during the dry season (May 1 – September 30) in order to provide the needed capacity for an entire wet season.
- A maintenance log should be kept on site with the aforementioned information and dates of maintenance performance. City of Renton inspection staff may request to view the maintenance log at any time.

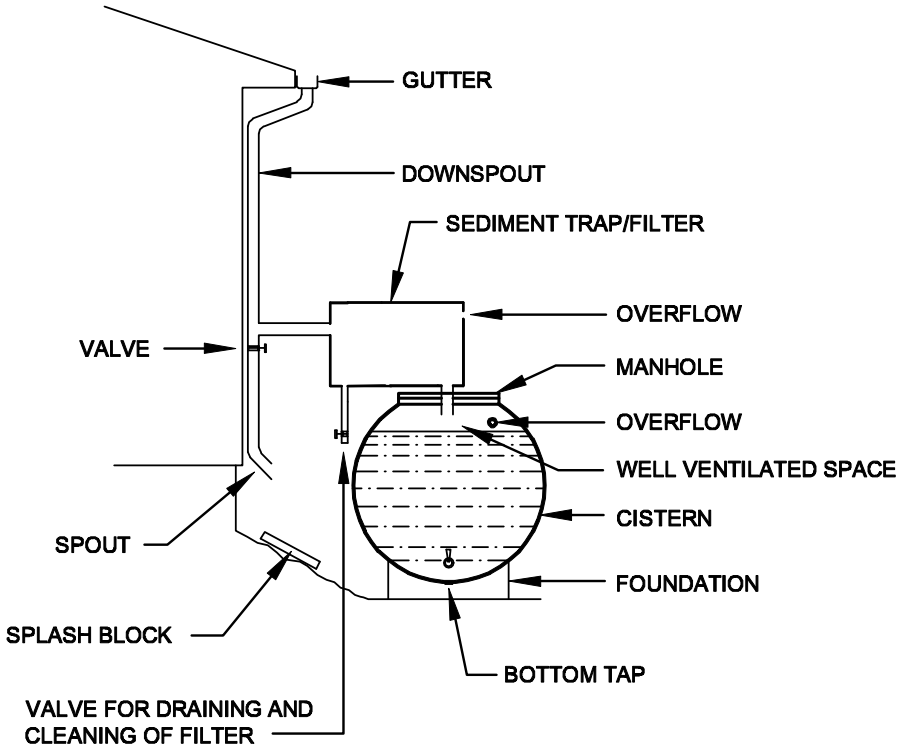
RECORDING REQUIREMENT

These rainwater harvesting on-site BMP maintenance and operation instructions must be recorded as an attachment to the required **declaration of covenant and grant of easement** per Requirement 3 of Section C.1.3.4 of the City of Renton *Surface Water Design Manual*. The intent of these instructions is to explain to future property owners, the purpose of the BMP and how it must be maintained and operated. These instructions are intended to be a minimum; the City of Renton may require additional instructions based on site-specific conditions. See the City of Renton's Surface Water Design Manual website for additional information and updates.

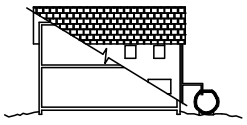
RAINWATER HARVESTING SYSTEM DESIGN REQUIREMENTS:

- To ensure the system functions as designed and provides the required stormwater management, system-specific maintenance and operation instructions must be submitted with the small project drainage plan and approved by the City of Renton. Such instructions should be prepared by the system's manufacturer or installer.
- A minimum 5-foot setback shall be maintained between any part of the rainwater harvesting system and any property line.

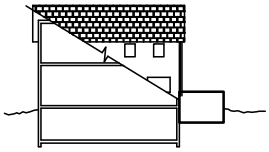
TYPICAL ABOVE GROUND RESERVOIR CONFIGURATION (STENSROD, 1978)



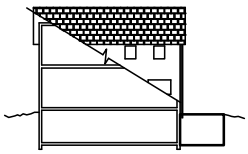
VARIOUS POSSIBLE CONFIGURATIONS (TYPICAL) (STENSROD, 1978)



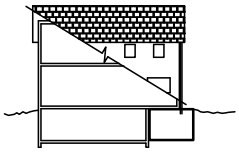
RESERVOIR ABOVE GROUND
(INSULATE IF NECESSARY)



PARTIALLY BURIED RESERVOIR



RESERVOIR BURIED OUTSIDE
BASEMENT



RESERVOIR IN BASEMENT

MAINTENANCE INSTRUCTIONS FOR VEGETATED ROOFS

Your property contains an on-site BMP (best management practice) called a "***vegetated roof***," which was installed to minimize the stormwater runoff impacts of the impervious surfaces on your property.

Vegetated roofs (also called green roofs) consist of a pervious growing medium, plants, and a moisture barrier. The benefits of this device are a reduction in runoff peaks and volumes due to the storage capabilities of the soil and increased rate of evapotranspiration. This on-site BMP shall be maintained per Appendix A of the City of Renton's Surface Water Design Manual.

MAINTENANCE RESTRICTIONS

- The composition and area of vegetated roof as depicted by the site plan and design details must be maintained and may not be changed without written approval from the City of Renton or through a future development permit from the City of Renton.
- Vegetated roofs must not be subject to any use that would significantly compact the soil.

INSPECTION FREQUENCY AND MAINTENANCE GUIDELINES

Vegetated roofs (also called green roofs) consist of a *pervious growing medium*, *plants*, and a *moisture barrier*:

- Vegetated roofs must be inspected annually for physical defects and to make sure the vegetation is in good condition.
- If erosion channels or bare spots are evident, they should be stabilized with additional soil similar to the original material.
- A supplemental watering program may be needed the first year to ensure the long-term survival of the roof's vegetation.
- Vegetation should be maintained as follows:

  (1) Vegetated roofs must not be subject to any use that would significantly compact the soil;

  (2) Replace all dead vegetation as soon as possible;

  (3) Remove fallen leaves and debris;

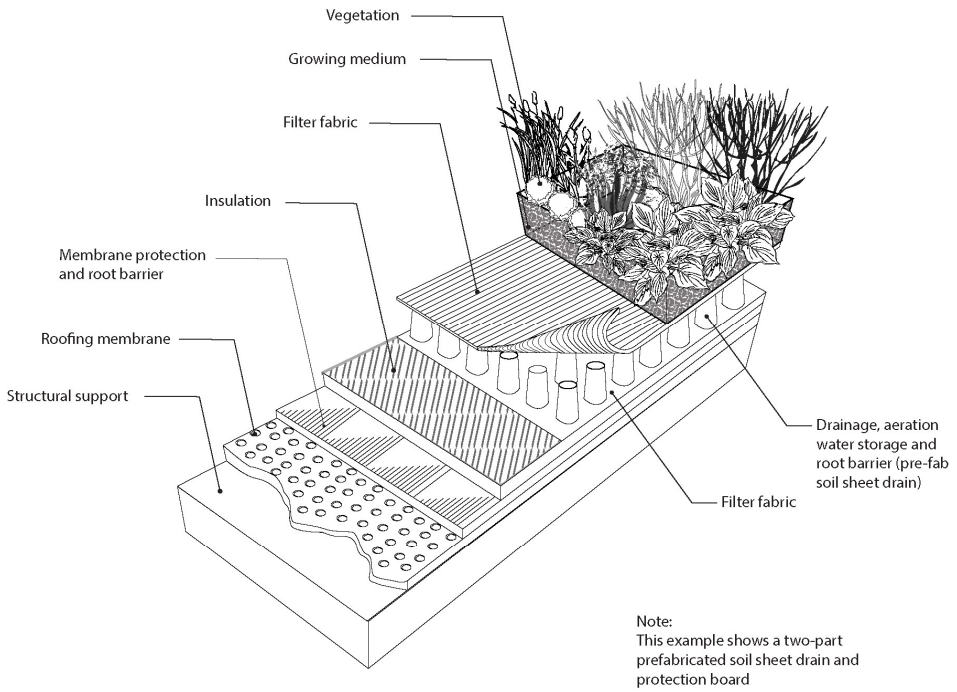
  (4) Remove all noxious vegetation when discovered;

  (5) Manually weed without herbicides or pesticides

RECORDING REQUIREMENT

These vegetated roof on-site BMP maintenance and operation instructions must be recorded as an attachment to the required **declaration of covenant and grant of easement** per Requirement 3 of Section C.1.3.4 of the City of Renton *Surface Water Design Manual*. The intent of these instructions is to explain to future property owners, the purpose of the BMP and how it must be maintained and operated. These instructions are intended to be a minimum; the City of Renton may require additional instructions based on site-specific conditions. See the City of Renton's Surface Water Design Manual website for additional information and updates.

TYPICAL VEGETATED ROOF CROSS-SECTION



Note:
This example shows a two-part prefabricated soil sheet drain and protection board

MAINTENANCE INSTRUCTIONS FOR REDUCED IMPERVIOUS SURFACE BMP: *RESTRICTED FOOTPRINT*

Your property contains an on-site BMP (best management practice) known as "***restricted footprint***," the practice of *restricting the amount of impervious surface that may be added* to a property so as to minimize the stormwater runoff impacts caused by impervious surface.

MAINTENANCE RESTRICTIONS

The **total impervious surface** on your property **may not exceed** _____ square feet without written approval from the City of Renton or through a future development permit from the City of Renton.

RECORDING REQUIREMENT

These reduced impervious surface on-site BMP maintenance and operation instructions must be recorded as an attachment to the required **declaration of covenant and grant of easement** per Requirement 3 of Section C.1.3.4 of the City of Renton *Surface Water Design Manual*. The intent of these instructions is to explain to future property owners, the purpose of the BMP and how it must be maintained and operated. These instructions are intended to be a minimum; the City of Renton may require additional instructions based on site-specific conditions. See the City of Renton's Surface Water Design Manual website for additional information and updates.

MAINTENANCE INSTRUCTIONS FOR REDUCED IMPERVIOUS SURFACE BMP: *WHEEL STRIP DRIVEWAY*

Your property contains an on-site BMP (best management practice) called a "***wheel strip driveway***," which was installed to minimize or mitigate for the stormwater runoff impacts of some or all of the impervious surfaces on your property.

MAINTENANCE RESTRICTIONS

The placement and composition of the wheel strip driveway as depicted by the site plan and design details must be maintained and may not be changed without written approval from the City of Renton or through a future development permit from the City of Renton.

RECORDING REQUIREMENT

These reduced impervious surface on-site BMP maintenance and operation instructions must be recorded as an attachment to the required **declaration of covenant and grant of easement** per Requirement 3 of Section C.1.3.4 of the City of Renton *Surface Water Design Manual*. The intent of these instructions is to explain to future property owners, the purpose of the BMP and how it must be maintained and operated. These instructions are intended to be a minimum; the City of Renton may require additional instructions based on site-specific conditions. See the City of Renton's Surface Water Design Manual website for additional information and updates.

WHEEL STRIP DRIVEWAY DESIGN REQUIREMENTS for the typical 10-foot driveway width:

- The two **pavement strips** must be no more than 2.5 feet wide.
- At least 4 feet of the 10-foot driveway width must be **amended soil planted with grass**.
- The **amended soil** must consist of at least 4 inches of well-rotted compost tilled into the upper 8 inches of the soil between the impervious strips.

MAINTENANCE INSTRUCTIONS FOR REDUCED IMPERVIOUS SURFACE BMP: *MINIMUM DISTURBANCE FOUNDATION*

Your property contains an on-site BMP (best management practice) known as a "***minimum disturbance foundation***," which was installed to minimize or mitigate for the stormwater runoff impacts of some or all of the impervious surfaces on your property.

This means that all or a portion of the finished living space in your house is elevated over a pervious surface through the use of piers or piles. The pervious surface is intended to provide additional capacity to absorb and store the stormwater runoff from your roof and surrounding areas.

MAINTENANCE RESTRICTIONS

- The design of this system as depicted by the site plan and design details must be maintained and may not be changed without written approval from the City of Renton or through a future development permit from the City of Renton.
- In addition, the pervious surface beneath the elevated portion of your house must not be used in manner that compacts the soil or provides an opportunity for pollutants to enter the soil or storm runoff.

RECORDING REQUIREMENT

These reduced impervious surface on-site BMP maintenance and operation instructions must be recorded as an attachment to the required **declaration of covenant and grant of easement** per Requirement 3 of Section C.1.3.4 of the City of Renton *Surface Water Design Manual*. The intent of these instructions is to explain to future property owners, the purpose of the BMP and how it must be maintained and operated. These instructions are intended to be a minimum; City of Renton may require additional instructions based on site-specific conditions. See the City of Renton's Surface Water Design Manual website for additional information and updates.

MINIMUM DISTURBANCE FOUNDATION DESIGN REQUIREMENTS

- The **pervious surface beneath** the elevated portion of the structure must be either undisturbed native soil or amended soil. Any amended soil must consist of at least 4 inches of well-rotted compost tilled into the upper 8 inches of the soil.
- **Runoff** from the structure must be discharged via downspouts or sheet flow onto a vegetated surface or into a 4- to 6-inch gravel bed within close proximity of the elevated structure. Runoff discharging from downspouts onto a vegetated surface must be via splash blocks.

MAINTENANCE INSTRUCTIONS FOR REDUCED IMPERVIOUS SURFACE BMP: *OPEN GRID DECKING OVER PERVIOUS SURFACE*

Your property contains an on-site BMP (best management practice) called "***open grid decking over pervious surface***," which was installed to minimize or mitigate for the stormwater runoff impacts of some or all of the impervious surfaces on your property.
The decking has evenly spaced openings that allow rain water to reach the uncompacted soil below, where it has an opportunity to soak into the ground.

MAINTENANCE RESTRICTIONS

- The area and openings of the decking as depicted by the site plan and design details must be maintained and may not be changed without written approval from the City of Renton or through a future development permit from the City of Renton.
- In addition, the pervious surface beneath the decking must not be used in manner that compacts the soil.

INSPECTION FREQUENCY AND MAINTENANCE GUIDELINES

- Check monthly or as needed (e.g., weekly during the autumn season) to assure openings in the decking are not blocked and are draining freely. Sweep and/or vacuum as needed.
- Avoid the use of chemicals or other pollutants on the deck where they have an opportunity to pass through the decking and soak into the ground.

RECORDING REQUIREMENT

These reduced impervious surface on-site BMP maintenance and operation instructions must be recorded as an attachment to the required **declaration of covenant and grant of easement** per Requirement 3 of Section C.1.3.4 of the City of Renton *Surface Water Design Manual*. The intent of these instructions is to explain to future property owners, the purpose of the BMP and how it must be maintained and operated. These instructions are intended to be a minimum; the City of Renton may require additional instructions based on site-specific conditions. See the City of Renton's Surface Water Design Manual website for additional information and updates.

OPEN GRID DECKING DESIGN REQUIREMENTS:

- The pervious surface beneath the decking must be either undisturbed native soil or amended soil.
- Any amended soil must consist of at least 4 inches of well-rotted compost tilled into the upper 8 inches of the soil.

MAINTENANCE INSTRUCTIONS FOR NATIVE GROWTH RETENTION CREDIT

Your property contains an on-site BMP (best management practice) known as "***native growth retention***," the practice of preserving a portion of a property in a native vegetated condition (e.g., forest) so as to minimize increases in stormwater runoff from clearing and to offset the stormwater runoff impacts caused by impervious surfaces on your property.

This native vegetated area on your property was *set aside by covenant* as "native growth retention area." This on-site BMP shall be maintained per Appendix A of the City of Renton's Surface Water Design Manual.

MAINTENANCE RESTRICTIONS

The "**native growth retention area**" is delineated on the site plan attached to the covenant. The trees, vegetation, ground cover, and soil conditions in this area may not be disturbed, except as allowed by the following provisions:

1. Trees may be harvested in accordance with a King County-approved forest management plan if approved by King County prior to annexation to the City.
2. Individual trees that have a structural defect due to disease or other defects, and which threaten to damage a structure, road, parking area, utility, or place of employment or public assembly, or block emergency access, may be topped, pruned, or removed as needed to eliminate the threat.
3. Dead or fallen trees, tree limbs within ten feet of the ground, and branches overhanging a residence may be removed to reduce the danger of wildfire.
4. Noxious weeds (i.e., plant species listed on the State noxious weed list in Chapter 16-750 WAC) and invasive vegetation (i.e., plant species listed as obnoxious weeds on the noxious weed list adopted by King County) may be removed.
5. Passive recreation uses and related facilities, including pedestrian, equestrian community and bicycle trails, nature viewing areas, fishing and camping areas, and other similar uses that do not require permanent structures, are allowed if clearing and soil compaction associated with these uses and facilities does not exceed eight percent of the native growth retention area.

RECORDING REQUIREMENT

These native growth retention credit on-site BMP maintenance and operation instructions must be recorded as an attachment to the required **declaration of covenant and grant of easement** per Requirement 3 of Section C.1.3.4 of the City of Renton *Surface Water Design Manual*. The intent of these instructions is to explain to future property owners, the purpose of the BMP and how it must be maintained and operated. These instructions are intended to be a minimum; the City of Renton) may require additional instructions based on site-specific conditions. See the City of Renton's Surface Water Design Manual website for additional information and updates.

MAINTENANCE INSTRUCTIONS FOR A PERFORATED PIPE CONNECTION

Your property contains an on-site BMP (best management practice) called a "***perforated pipe connection***," which was installed to reduce the stormwater runoff impacts of some or all of the impervious surface on your property.

A perforated pipe connection is a length of drainage conveyance pipe with holes in the bottom, designed to "leak" runoff, conveyed by the pipe, into a gravel filled trench where it can be soaked into the surrounding soil. The connection is intended to provide opportunity for infiltration of any runoff that is being conveyed from an impervious surface (usually a roof) to a local drainage system such as a ditch or roadway pipe system. This on-site BMP shall be maintained per Appendix A of the City of Renton's Surface Water Design Manual.

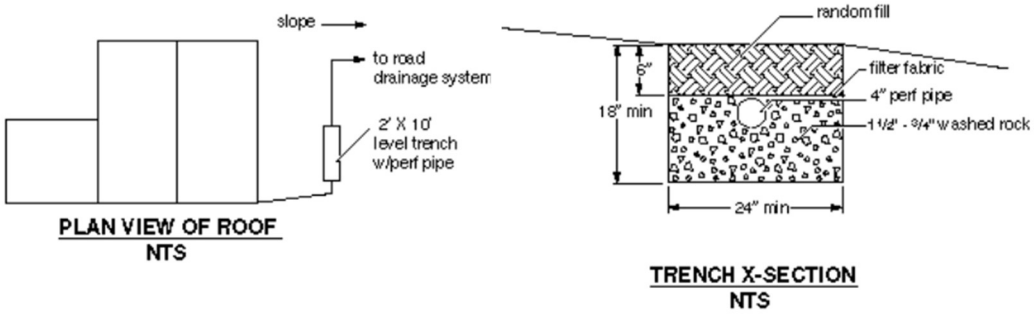
MAINTENANCE RESTRICTIONS

- The size and composition of the perforated pipe connection as depicted by the site plan and design details must be maintained and may not be changed without written approval from the City of Renton or through a future development permit from the City of Renton.
- The soil overtop of the perforated portion of the system must not be compacted or covered with impervious materials.

RECORDING REQUIREMENT

These **perforated pipe connection** on-site BMP maintenance and operation instructions must be recorded as an attachment to the required **declaration of covenant and grant of easement** per Requirement 3 of Section C.1.3.4 of the City of Renton *Surface Water Design Manual*. The intent of these instructions is to explain to future property owners, the purpose of the BMP and how it must be maintained and operated. These instructions are intended to be a minimum; the City of Renton may require additional instructions based on site-specific conditions. See the City of Renton's Surface Water Design Manual website for additional information and updates.

TYPICAL PERFORATED PIPE CONNECTION FOR A SINGLE FAMILY RESIDENCE



MAINTENANCE INSTRUCTIONS FOR SOIL AMENDMENT

Your property contains an on-site BMP (best management practice) called "***soil amendment***," which was installed to mitigate the stormwater quantity and quality impacts of some or all of the pervious surfaces on your property.

Soil amendment is a method of regaining greater stormwater functions in the post development landscape by increasing treatment of pollutants and sediments, and minimizing the need for some landscaping chemicals. To be successful, the soil condition must be able to soak water into the ground for a reasonable number of years. This on-site BMP shall be maintained per Appendix A of the City of Renton's Surface Water Design Manual.

MAINTENANCE RESTRICTIONS

The size, placement, and composition of these devices as depicted by the site plan and design details must be maintained and may not be changed without written approval from the City of Renton or through a future development permit from the City of Renton.

INSPECTION FREQUENCY AND MAINTENANCE GUIDELINES

To be successful, the soil must be able to soak water into the ground for a reasonable number of years.

- Return leaf fall and shredded woody materials from the landscape to the site when possible in order to replenish soil nutrients and structure.
- On turf areas, "grasscycle" (mulch-mow or leave the clippings) to build turf health.
- Maintain 2 to 3 inches of mulch over bare areas in landscape beds.
- Re-seed bare turf areas until the vegetation fully covers the ground surface.
- Avoid using pesticides (bug and weed killers) which damage the soil.
- Where fertilization is needed (mainly turf and annual flower beds), a moderate fertilization program should be used which relies on compost, natural fertilizers, or slow-release synthetic balanced fertilizers.

RECORDING REQUIREMENT

These on-site BMP maintenance and operation instructions must be recorded as an attachment to the required **declaration of covenant and grant of easement** per Requirement 3 of Section C.1.3.4 of the City of Renton *Surface Water Design Manual*. The intent of these instructions is to explain to future property owners, the purpose of the BMP and how it must be maintained and operated. These instructions are intended to be a minimum; the City of Renton may require additional instructions based on site-specific conditions. See the City of Renton's Surface Water Design Manual website for additional information and updates.

MAINTENANCE INSTRUCTIONS FOR TREE RETENTION

Your property contains an on-site BMP (best management practice) called "***tree retention***," which was installed to mitigate the stormwater quantity and quality impacts of some or all of the impervious surfaces on your property.

Tree retention provides flow control via interception, transpiration, and increased infiltration. This on-site BMP shall be maintained per Appendix A of the City of Renton's Surface Water Design Manual.

MAINTENANCE RESTRICTIONS

The size, placement, and composition of these devices as depicted by the site plan and design details must be maintained and may not be changed without written approval from the City of Renton or through a future development permit from the City of Renton.

INSPECTION FREQUENCY AND MAINTENANCE GUIDELINES

To be successful, the soil must be able to soak water into the ground for a reasonable number of years.

- Trees should be pruned in an appropriate manner for each species.
- Pruning should be performed by landscape professionals familiar with proper pruning techniques.
- Dead trees shall be replaced with like species within 30 days (as practical depending on weather/planting season).

RECORDING REQUIREMENT

These on-site BMP maintenance and operation instructions must be recorded as an attachment to the required **declaration of covenant and grant of easement** per Requirement 3 of Section C.1.3.4 of the City of Renton *Surface Water Design Manual*. The intent of these instructions is to explain to future property owners, the purpose of the BMP and how it must be maintained and operated. These instructions are intended to be a minimum; the City of Renton may require additional instructions based on site-specific conditions. See the City of Renton's Surface Water Design Manual website for additional information and updates.

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CITY OF RENTON

SURFACE WATER DESIGN MANUAL

REFERENCE 9

INTERIM CHANGES TO REQUIREMENTS

9-A BLANKET ADJUSTMENTS

None at this time.

9-B ADMINISTRATIVE CHANGES

Does not apply to the City.

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CITY OF RENTON

SURFACE WATER DESIGN MANUAL

REFERENCE 10

KING COUNTY-IDENTIFIED WATER QUALITY PROBLEMS

Does not apply to the City.

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CITY OF RENTON

SURFACE WATER DESIGN MANUAL

REFERENCE 11

MATERIALS

11-A VACANT

No text association with this section.

11-B VACANT

No text association with this section.

11-C BIORETENTION SOIL MEDIA STANDARD SPECIFICATIONS

See attached.

11-D VACANT

No text association with this section.

11-E ROOFING ERODIBLE OR LEACHABLE MATERIALS

See attached.

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CITY OF RENTON

SURFACE WATER DESIGN MANUAL

REFERENCE 11-C

BIORETENTION SOIL MEDIA STANDARD SPECIFICATIONS

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REFERENCE 11-C

BIORETENTION SOIL MEDIA STANDARD SPECIFICATIONS

11-C.1 COMPOST

Compost products shall be the result of the biological degradation and transformation of uncontaminated biological organic materials under controlled conditions designed to promote aerobic decomposition. Compost shall be stable with regard to oxygen consumption, carbon dioxide generation, and seed germination and seedling vigor. Compost shall be mature with regard to its suitability for use in stormwater facilities and BMPs, post-construction soil amendment, general landscaping, or an erosion control BMP as defined below.

Compost shall be tested at a minimum in accordance with the U.S. Composting Council "Testing Methods for the Examination of Compost and Composting" (TMECC), as established in the Composting Council's "Seal of Testing Assurance" (STA) program. Most Washington compost facilities now use these tests. All tests must be done on compost screened to specification for its intended use.

11-C.1.A SPECIFICATION 1 COMPOST

1. Compost must be produced at a facility that is permitted by the jurisdictional health authority. Permitted compost facilities in Washington are included on a list available at <http://www.ecy.wa.gov/programs/swfa/organics/soil.html>.
2. Compost must meet the definition of "composted material" in WAC 173-350-100, and must comply with testing parameters and other standards including not exceeding contaminant limits identified in Table 220-B. Testing Parameters, in WAC 173-350-220; and "Physical contaminants" (as defined in WAC 173-350-100) content less than 1% by weight (TMECC 03.08-A) total, not to exceed 0.25 percent film plastic by dry weight.
3. The compost product must originate a minimum of 65 percent by volume from recycled plant waste comprised of "yard debris," "crop residues," and "bulking agents" as those terms are defined in WAC 173-350-100. A maximum of 35 percent by volume of "post-consumer food waste" as defined in WAC 173-350-100 may be substituted for recycled plant waste. Biosolids, manure, and/or bedding straw or wood chips or shavings containing animal excreta are not allowed.
4. Wood waste from chemically treated lumber and manufactured wood products containing adhesives or any other chemical is not allowed; painted and stained wood are not allowed; and only sawdust from virgin lumber allowed. No other toxic or otherwise harmful materials are allowed.
5. For *high-density residential subdivision development, multi-family, commercial, and industrial projects*, and *road projects considered high ADT projects*,[1] the Manufacturer or Vendor shall provide to the end buyer a list of feedstock sources by percentage by volume in the final compost product.
6. Compost shall have a moisture content that has no visible free water or dust produced when handling the material.

[1] Land uses as described in Bullets 1, 2, and 3, SWDM Section 1.2.8.1, Subsection A "Basic WQ Treatment Areas, Required Treatment Menu."

7. Compost shall have an organic matter content of 40 percent to 65 percent by dry weight as determined by loss of ignition test method ASTM D 2974, or by U.S. Composting Council TMECC 05.07A "Loss-On-Ignition Organic Matter Method (LOI)."
8. Compost shall have a carbon to nitrogen ratio below 25:1, although the carbon to nitrogen ratio may be as high as 35:1 for plantings composed entirely of plants native to the Puget Sound Lowlands region. The carbon to nitrogen ratio shall be calculated on a dry weight basis using TMECC 5.02A ("Carbon to Nitrogen Ratio"), which uses TMECC 04.01A, "Organic Carbon" divided by the dry weight of "Total N" (TMECC 04.02D).
9. Compost pH shall be between 6.0 and 8.5 when tested in accordance with U.S. Composting Council TMECC 04.11-A, "1:5 Slurry pH."
10. Soluble salt content shall be less than 4.0 dS/m (mmhos/cm) when tested in accordance with U.S. Composting Council TMECC 04.10 "Electrical Conductivity, 1:5 Slurry Method, Mass Basis."
11. Compost maturity indicators from a cucumber bioassay (TMECC 05.05-A "Germination Seedling Emergence and Relative Growth) must be greater than 80% for both emergence and vigor").
12. Stability shall be 7-mg CO_2 – C/g OM/day or below in as determined by U.S. Composting Council TMECC 05.08-B "Carbon Dioxide Evolution Rate," to establish low oxygen use and low CO_2 generation rates.

Compost shall be screened to the Fine Compost size gradation specification in Section 11-C.1.C of this Reference.

11-C.1.B SPECIFICATION 2 COMPOST

1. Specification 2 Compost manufacturing, feedstocks, and testing are all identical to Specification 1 Compost except that:
   a) A maximum of 35 percent by volume of biosolids or manure may be substituted for recycled plant waste.
   b) Compost may be fine or coarse gradation depending on use and need to meet other screened material quality criteria.
   c) Carbon to Nitrogen ratio may be up to 40:1 for coarse compost to be used as a surface mulch (not in a soil mix).

11-C.1.C COMPOST SCREENING SIZE GRADATIONS

Where compost gradation is specified, it must meet the following size gradations when tested in accordance with the U.S. Composting Council "Test Methods for the Examination of Compost and Composting" (TMECC) Test Method 02.02-B.

Fine Compost shall meet the following gradation by dry weight:

Minimum percent passing 2″ sieve	100%
Minimum percent passing 1″ sieve	99%
Minimum percent passing 5/8″ sieve	90%
Minimum percent passing 1/4″ sieve	75%

Coarse Compost shall meet the following gradation by dry weight:

Minimum Percent passing 3″ sieve	100%
Minimum Percent passing 1″ sieve	90%
Minimum Percent passing 3/4″ sieve	70%
Minimum Percent passing 1/4″ sieve	40%

11-C.1.D COMPOST ACCEPTANCE REQUIREMENTS

The Contractor shall submit the following information to CED for approval:

1. If the manufacturer is not exempt under Table 220-A, "Terms and Conditions for Solid Waste Permit Exemptions," a copy of the Solid Waste Handling Permit issued to the compost manufacturer by the Jurisdictional Health Department in accordance with WAC 173-350 (Minimum Functional Standards for Solid Waste Handling) or for biosolids composts a copy of the Coverage Under the General Permit for Biosolids Management issued to the manufacturer by the Department of Ecology in accordance with WAC 173-308 (Biosolids Management).
2. The Applicant shall provide written verification and lab analyses that the material complies with the processes, testing, and standards specified in WAC 173-350 and these Specifications. An independent Seal of Testing Assurance (STA) Program certified laboratory[2] or a laboratory accredited by WA Ecology[3] for the specified methods shall perform the analyses. Lab analysis shall be for the compost delivered on site for project use.
3. A copy of the STA laboratory's Seal of Testing Assurance STA certification as issued by the U.S. Composting Council, or a copy of the Ecology-certified laboratory's accreditation for the specified methods.

11-C.2 BIORETENTION SOIL MIX SPECIFICATIONS

Follow the specification below for the approved default bioretention soil mix. Alterations to this specification require an approved adjustment.

11-C.2.A DEFAULT BIORETENTION SOIL MIX

Bioretention Soil Mix (BSM) shall be a well-blended homogeneous mixture of Bioretention Mineral Aggregate and Bioretention Compost measured on a volume basis composed of:

- 35 to 40 percent by volume Specification 1 Compost per Section 11-C.1.A above and Section 11-C.2.B below.
- 60 to 65 percent by volume Bioretention Mineral Aggregate per Section 11-C.2.C below.

Projects which prefer to create a custom Bioretention Soil Mix rather than using the default requirement above must demonstrate compliance with criteria as described in Ecology's *Stormwater Management Manual for Western Washington (2014) Volume V – Runoff Treatment BMPs*, except that any more stringent compost criteria required by this Reference 11-C are applicable.

11-C.2.B BIORETENTION COMPOST

Bioretention Compost shall be Specification 1, Fine Compost per Sections 11-C.1.A and 11-C.1.C of this Reference. Fine Specification 1 Compost shall be used for Bioretention Soil Mix and for any compost used to amend bioretention cell soil.

[2] A list of STA certified laboratories can be found at <http://compostingcouncil.org/labs/>.

[3] A list of WA Ecology accredited laboratories can be found at <http://www.ecy.wa.gov/programs/eap/labs/>. Only laboratories certified for the specified methods may be used for compost testing.

11-C.2.C BIORETENTION SOIL MIX AGGREGATE

Aggregate Gradation

The following table provides a gradation guideline for the aggregate component of a Bioretention Soil Mix specification in western Washington. This sand gradation is often supplied as a well-graded utility or screened. With compost, this blend provides enough fines for adequate water retention, hydraulic conductivity within recommended range (see below), pollutant removal capability, and plant growth characteristics for meeting design guidelines and objectives.

TABLE 11-C.2.A BIORETENTION SOIL MIX MINERAL AGGREGATE GRADATION

Sieve Size	Percent Passing
3/8″	100
#4	95–100
#10	75–90
#40	25–40
#100	4–10
#200	2–4

Where existing soils meet the above aggregate gradation, those soils may be amended rather than importing mineral aggregate.

11-C.3 BIORETENTION MULCH

Mulch may only be composed of either chipped wood as defined in Section 11-C.3.A, or compost as defined in Section 11-C.3.B. Mulch may not be made of synthetic materials including but not limited to recycled tire material, virgin rubber material, plastics; or pre-or post-consumer cardboard.

11-C.3.A ARBORIST'S WOOD CHIP MULCH

Arborist Wood Chip Mulch shall be coarse ground wood chips (approximately 1/2″ to 6″ along the longest dimension) derived from the mechanical grinding or shredding of the above-ground portions of trees. It may contain wood, wood fiber, bark, branches, and leaves, but may not contain visible amounts of soil. It shall be free of weeds and weed seeds including but not limited to plants on the King County Noxious Weed list available at: <www.kingcounty.gov/weeds>, and shall be free of invasive plant portions capable of re-sprouting, including but not limited to horsetail, ivy, clematis, knotweed, etc. It may not contain more than 0.5% by dry weight of manufactured inert material (plastic, concrete, ceramics, metal, etc.).

Arborist Wood Chip Mulch, when tested, shall meet the following loose volume gradation:

TABLE 11-C.3.A ARBORIST WOOD MULCH GRADATION

Sieve Size	Percent Passing
1 inch	100
2″	95–100
1″	70–100
5/8	0–50
No. 4	0 – 30

Prior to delivery, the Applicant shall provide the following:

1. The source of the product and species of trees included in it;
2. A sieve analysis verifying the product meets the above size gradation requirement;
3. A representative sample of the product for County approval.

11-C.3.B COMPOST MULCH SPECIAL REQUIREMENTS

- Compost Mulch for Bioretention must meet the **Specification 1** compost requirements of Section 11-C.1.A, except that the gradation must be **Coarse Compost** per Section 11-C.1.C
- Compost Mulch for other facilities and BMPs must meet either **Specification 1 or Specification 2** compost of Section 11-C.1.A or 11-C.1.B respectively, except that the gradation must be **Coarse Compost** per Section 11-C.1.C.

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CITY OF RENTON

SURFACE WATER DESIGN MANUAL

REFERENCE 11-E

ROOFING ERODIBLE OR LEACHABLE MATERIALS

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REFERENCE 11-E

ROOFING ERODIBLE OR LEACHABLE MATERIALS

METAL ROOFING COATING: INERT, NON-LEACHABLE MATERIAL

Metal roofs are considered to be pollution generating impervious surface unless they are coated with PVDF (Polyvinylidene Fluoride) with a manufacturer's 25-year or better guarantee of no metals leaching, and are not subject to venting significant amounts of dusts, mists, or fumes from manufacturing, commercial, or other indoor activities.

NON-METAL ROOFING TYPES THAT MAY POSE RISK BUT ARE NOT CURRENTLY REGULATED

The following roof types are currently not regulated as pollution generating surfaces, but there is some evidence that they may pose risks to water quality. This information is provided to assist the public in making more informed choices.

These roof types include any roofing manufactured or treated with biocides for moss, algae, rot, or plant control; i.e., those containing any heavy metal such as copper, lead, zinc, silver, or arsenic, or organic biocides such as (R,S)-mecoprop bi-ester[4] and terbutryn, carbendazim, and Irgarol 1051[5].

Other roof types that may pose risk include synthetic roofing materials that use zinc or any other leachable heavy metal as a manufacturing catalyst or for any other purpose, any roofing material containing any heavy metal as a UV stabilizer or for pigmentation[6]. Phthalates have also been noted as leaching from some synthetic roofing.

❑ SPECIFIC EXAMPLES OF NON-METAL AND COATED METAL ROOFS FOR WHICH THERE IS DOCUMENTED EVIDENCE, OF SOME RUNOFF RISK

Roofs with Potential Risk Based on Regional Monitoring of Regionally Supplied Materials[7,8]

- Asphalt shingles with algae resistance (AR)
- EPDM (ethylene propylene diene monomer)

[4] Bucheli, Thomas D., Stephan R. Müller, Andreas Voegelin, and René P. Schwarzenbach. 1998. Bituminous Roof Sealing Membranes as Major Sources of the Herbicide (R,S)-Mecoprop in Roof Runoff Waters: Potential Contamination of Groundwater and Surface Waters. Environmental Science & Technology 32 (22):3465-3471.

[5] Background literature review in support of the regional study by Ecology. Winters, Nancy. 2013. Quality Assurance Project Plan. Roofing Materials Assessment: Investigation of Toxic Chemicals in Roof Runoff. Publication No. 13-03-105. Lacey, WA: Washington State Department of Ecology.

[6] Polybrominated diphenyl ethers (PBDE) or other fire retardants may be an issue in Central and Eastern Washington, but according to manufacturers on Ecology's Roofing Task Force, these are not applied in Western Washington.

[7] Materials provided by Western Washington manufacturers and/or vendors. First year of study. Winters, Nancy, and Kyle Graunke. 2014. Roofing Materials Assessment – Investigation of Toxic Chemicals in Roof Runoff. Lacey, WA. <https://fortress.wa.gov/ecy/publications/SummaryPages/1403003.html>.

[8] Materials provided by Western Washington manufacturers and/or vendors. Winters, Nancy, Melissa McCall, and Allison Kingfisher. 2014. Roofing Materials Assessment – Investigation of Toxic Chemicals in Roof Runoff from Constructed Panels in 2013 and 2014. Publication No. 14-03-033. Lacey, WA.

- Manufacturer-painted galvanized steel, painted with silicone-modified polyester paint[9,7]
- PVC (polyvinyl chloride)
- Treated wood shakes

Roofs with Potential Risk Based on Other Studies[9]

- Asphalt shingles
- Asphalt fiberglass shingles
- Asphalt (residential)
- Asphalt impregnated with copper
- Asphalt roofs with moss-control zinc strips
- Bituminous roof sealing membrane for green roof, treated to inhibit root penetration
- Built-up commercial
- Built-up with coal tar
- Cedar shakes
- Ceramic tile
- Clay tile
- Concrete tile
- Ethylene propylene diene monomer (EPDM or rubber roofing)
- Galfan (aluminum-coated)
- Gravel
- Impregnated wood
- Ondura
- Painted steel
- Pressure treated/water sealed wood
- Polyester
- Polyvinyl Chloride (PVC)
- Synthetic roofing materials, e.g., thermoplastic olefin (TPO)
- Rubber
- Treated roofing materials (non-specific as cited)
- Vegetated roof
- Wood shingle

[9] Background literature review in support of the regional study by Ecology. Winters, Nancy. 2013. Quality Assurance Project Plan. Roofing Materials Assessment: Investigation of Toxic Chemicals in Roof Runoff. Publication No. 13-03-105. Lacey, WA: Washington State Department of Ecology.

CITY OF RENTON

SURFACE WATER DESIGN MANUAL

REFERENCE 12

VACANT

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SURFACE WATER DESIGN MANUAL

REFERENCE 13

VACANT

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CITY OF RENTON

SURFACE WATER DESIGN MANUAL

REFERENCE 14

SUPPLEMENTAL APPROVED FACILITIES

14-A CITY OF RENTON APPROVED PROPRIETARY FACILITIES FOR USE ON PRIVATE DEVELOPMENT PROJECTS

14-B CITY OF RENTON APPROVED PROPRIETARY FACILITIES FOR USE IN PUBLIC PROJECTS

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REFERENCE 14-A

CITY OF RENTON APPROVED PROPRIETARY FACILITIES FOR USE ON PRIVATE DEVELOPMENT PROJECTS

The proprietary facilities summarized in Table 14.A are approved by the City for use on private development projects. The General Use Level Designation (GULD) letters for each of the approved facilities listed in Table 14.A are included in this reference section. These GULD letters outline the sizing requirements and maintenance requirements for each approved proprietary facility. Appendix A also includes more detailed maintenance information for the proprietary facilities listed in Reference Section 14-B.

TABLE 14.A PROPRIETARY FACILITIES- CURRENT APPROVALS

Proprietary Facility Name	Basic WQ	Enhanced Basic WQ	Lake Protection	High-Use	Pretreatment
Aqua-Swirl CONCENTRATOR Stormwater Treatment System					X
BayFilter Stormwater Treatment System w/ Enhanced 545 Media Cartridge	X		X		
BaySeparator Stormwater Treatment System					X
BioPod	X	X	X		
Boxless BioPod	X	X	X		
CDS					X
Downstream Defender					X
EcoStorm Plus	X				
Filterra	X	X	X	X	
Filterra Bioscape	X	X	X	X	
Jellyfish Filter	X		X		
Kraken Filter	X		X		
Modular Wetlands Linear	X	X	X		
PerkFilter w/ ZPC Media	X		X		
Stormceptor					X
StormFilter w/ PhosphoSorb Media	X		X		
StormFilter w/ ZPG Media	X				
StormGarden Biofilter	X		X		
StormTree	X	X	X		

Up-Flo Filter w/ Filter Ribbons	X		X		
Vortechs					X
WetlandMod	X	X			
Other Facilities with a General Use Level Designation (GULD) for respective treatment	X	X	X	X	X

REFERENCE 14-B

CITY OF RENTON APPROVED PROPRIETARY FACILITIES FOR USE IN PUBLIC PROJECTS

The proprietary facilities summarized in Table 14.B are approved by the City for use in public projects. The City reserves the right to modify the list of proprietary facilities approved for public maintenance at any time. The General Use Level Designation (GULD) letters for each of the approved facilities listed in Table 14.B are included in Reference Section 14-A. These GULD letters outline the sizing requirements and maintenance requirements for each approved proprietary facility. Appendix A also includes more detailed maintenance information for the proprietary facilities listed in Table 14.B.

TABLE 14.B PROPRIETARY FACILITIES AND APPLICABILITY

Proprietary Facility Name	Basic WQ	Enhanced Basic WQ	Lake Protection	High-Use	Pretreatment
BayFilter StormwaterTreatment System w/ Enhanced 545 Media Cartridge	X		X		
BioPod	X	X	X		
Boxless BioPod	X	X	X		
Filterra	X	X	X	X	
Modular Wetlands Linear	X	X	X		
PerkFilter w/ ZPC Media	X		X		
StormFilter w/ ZPG Media	X				
WetlandMod	X	X			

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