GENERAL
The City and County of Denver (the City) allows Developers, through a variance process, to install underground water quality after all above ground options have been exhausted. The most common type of underground water quality device that is installed is a Sand Filter Basin. However, requests are often made to use proprietary devices. Previously these requests had to be approved by committee and reviewed by the Public Works Water Quality Division. This Policy creates a minimum standard for approved devices that work as good as, or better than Sand Filter Basins. Storm detention and other water quality requirements are not changed through the use of this policy. The variance process will still have to be followed for all underground devices, but additional committee review and approval will not be needed for proprietary devices that meet these requirements. All current policies, rules, and regulations in the Storm Drainage Design and Technical Criteria Manual will need to be followed.

PURPOSE
The City will accept underground water quality devices that have been certified for basic stormwater treatment by the Washington State Department of Ecologies General Use Level Designation (GULD) for Basic Treatment. If the device is not GULD Certified, Denver will accept the use of a device that has been Tier II tested and certified by the State of New Jersey Department of Environmental Protection (NJDEP) to provide a Total Suspended Solids (TSS) removal rate of 80%.

The City reserves the right to refuse the use of any of these devices based on materials or methods that do not meet the City's current minimum standards. Additionally, the City may place further restrictions and/or requirements that may supersede the GULD or NJDEP certifications if it is deemed in the interest of the City. At this time, Wastewater Operations will not sign an operation and maintenance plan for these devices; therefore, the Engineering, Regulatory, and Analytics Group will not approve these devices on projects where they would be maintained by the City.
PROCEDURE
Policy will be enforced during the design review process by Development Services and the Engineering, Regulatory, and Analytics Group. Construction and acceptance will be enforced by the Right-of-Way Services – Construction Inspection and Capital Project Management groups. Operation and Maintenance will be inspected by the Public Works Water Quality group.

Attachments:
Proprietary Underground Water Quality Devices Policy and Design

End of Document
Underground Water Quality
Devices Policy and Design
By Sam Stevens, P.E., Ryan Crum P.E., Ted Christianson, P.E.
Darren Mollendor, P.E., Walt Hime, P.E., and Alan Sorrel, P.E.

1.0 Policy

The City and County of Denver (the City) allows Developers, through a variance process, to install underground water quality after all above ground options have been exhausted. The City will continue to allow Sand Filter Basins to be installed underground through this process. This Policy creates a minimum standard for approved devices that work as good as, or better than Sand Filter Basins. Storm detention and other water quality requirements are not changed through the use of this policy. The variance process will still have to be followed for all underground devices, but additional committee review and approval will not be needed for proprietary devices that meet these requirements. This is not a standalone document and all current policies, rules, and regulations in the Storm Drainage Design and Technical Criteria Manual will have to be followed.

2.0 Requirements

2.1 Certification for Proprietary Underground Water Quality Devices

Sand filters have been accepted in the past and will continue to be accepted provided that they meet current standards established by the City. Alternatively, the City will accept underground water quality devices that have been certified for basic stormwater treatment by the Washington State Department of Ecologies General Use Level Designation (GULD) for Basic Treatment\(^1\). If the device is not GULD Certified, the City will accept the use of a device that has been Tier II tested and certified by the State of New Jersey Department of Environmental Protection (NJDEP) to provide a Total Suspended Solids (TSS) removal rate of 80%\(^2\).

The City reserves the right to refuse the use of any of these devices based on materials or methods that do not meet the City's current minimum standards. Additionally, the City may place further restrictions and/or requirements that may supersede the GULD or NJDEP certifications if it is deemed in the interest of the City.

\(^2\) [http://www.njstormwater.org/treatment.html](http://www.njstormwater.org/treatment.html)
2.2 **Design**

2.2.1 **Site Specific**

The City requires implementation of the Four Step Process for all new development or redevelopment projects. This approach should be considered early in the conceptual design of a site when the potential exists for the use of underground water quality. Using the Four Step Process will improve aesthetics, create water quality benefits, and reduce the volume of water to be treated.

The first step in the Four Step Process is utilizing Low Impact Development (LID) strategies to reduce runoff. LID techniques manage stormwater runoff by replicating pre-development runoff characteristics. The designer should incorporate ways to maximize surface water quality by minimizing directly connected impervious areas. The Four Step Process must be utilized to the maximum extent possible when incorporating underground water quality. The full Four Step Process is outlined the Storm Drainage Design and Technical Criteria Manual Chapter 14.4.


2.2.2 **Treatment Train**

BMPs in series will be accepted by the City if they are able to meet the total TSS removal requirement. To calculate the removal rate use the equation developed from the New Jersey BMP Manual:

\[
R = A + B - [(A \times B) / 100]
\]

Where:
- \( R \) = Total TSS Removal Rate
- \( A \) = TSS Removal Rate of the First or Upstream BMP
- \( B \) = TSS Removal Rate of the Second or Downstream BMP

This technique may be applied if there are two or more BMPs in a series. See [http://www.njstormwater.org/bmp_manual/NJ_SWBMP_4%20print.pdf](http://www.njstormwater.org/bmp_manual/NJ_SWBMP_4%20print.pdf) for an example.

Treatment trains of the same technology are not credited for use in series (i.e. a filter downstream from a filter). In a series application, the BMPs need to be different and installed in a logical fashion to progressively treat runoff. For example, a screen type device would not be applicable downstream of a filter device.
Grassy swales, grated inlets, and/or anything that provides the function of an easily maintained trash rack must be provided where possible to trap large debris at the surface and reduce maintenance and clogging. Grades of 0.5% in curbs and valley pans can also trap debris at the surface and provide a similar function. This flat of a grade should only be considered in parking lots or private drives where there is ample room for debris to collect and not affect the primary flow capacity function of the curb and gutter. The designer must incorporate as much surface infiltration as possible prior to storm water entering the underground system. When treating streets and parking areas, the designer should consider using a sediment/trash device prior to a filter device. This will reduce clogging and extend the life of the filters.

2.2.3 **Treatment Area and Sizing**

The design of the water quality system must be sized so that the device or devices will treat the 2-year storm event of the area that drains to it, either by treating the peak flow, or the runoff volume associated with the 2-year storm event.

The device must be sized, at a minimum, to treat the flow for the 2-year design event and bypass flows that are greater. The full pipe velocity of both the inlet and outlets must be between 2.5 and 4 FPS at design capacity. The bypass flow and hydraulic grade line need to be considered and addressed in the drainage report. Adjacent structures must be shown on the construction documents with finished floor elevation (FFE).

Additionally, manufacturer’s recommendations should be followed when sizing a device and determining maintenance frequencies. All portions of the devices shall be easily accessible with appropriate sizing and surfacing as dictated by required maintenance equipment and/or methods. A maintenance plan is required and must be included with the drainage report. The access points should have a minimum diameter of 24” and provide access to both the inlet and the outlet of the structure. Underground BMPs must be placed in a maintenance easement (see Table 3.2, Storm Design and Technical Criteria Manual Sec. 3.3.3).

2.2.4 **Infiltration Devices**

Infiltrating devices have additional constraints to protect proposed and existing infrastructure. A geotechnical engineer must be consulted prior to locating these devices to evaluate potential concerns with adjacent structures. The engineer will need to test and verify infiltration rates at the site prior to a volume reduction credit being given for the required water quality or detention for the site. This documentation must be included in the drainage report with any proposal to have required detention volumes reduced.
2.2.5 **Installation**

Manufacturer specifications must be followed during installation. Special drawings and/or details must be approved by the City prior to installation. The City requires inspection of construction to be observed continuously by a licensed professional engineer, and a signed Certificate of Inspection letter to be submitted to the City prior to a Certificate of Occupancy being issued. Privately owned devices must be installed on private property and located within a maintenance easement (see Table 3.2, Storm Design and Technical Criteria Manual Sec. 3.3.3). Typically, Major Encumbrances for installation on city-owned land will not be approved since the device may interfere with future utility projects.

2.2.6 **Overflows / Offline Devices / Re-entrainment**

The City and County of Denver strongly recommends using an off-line water quality device as opposed to an on-line water quality device. Off-line devices will bypass most or all of the runoff from storms larger than the 2-year design storm through an upstream diversion around the treatment portion of the device. This reduces the size of the required device overflow; reduces the long-term pollutant loading and associated maintenance for the device; and reduces the threat of re-suspension and the release of trapped material by larger storm inflows.

All manufactured treatment devices must be able to safely overflow or bypass flows in excess of the 2-year design storm to downstream drainage systems. All such flows must be conveyed in such a manner that trapped material, including floatables, is not re-suspended and released.

The designer must check the capacity of the downstream conveyance system to ensure the adequacy for the overflows or bypass flows. All manufactured treatment devices must also have similar provisions to safely overflow and/or bypass runoff in the event of internal component clogging, blockage, and/or failure.

2.2.7 **Tailwater**

The hydraulic design of all manufactured treatment devices must not cause adverse impacts to downstream conveyances, detention, or water quality facilities. This includes instances where the lowest invert in the outlet or overflow structure is below the tailwater elevation of a receiving stream or piping network.

2.2.8 **Release Rates**

If a proprietary water quality device is used in conjunction with underground detention, it must have a release rate consistent with full spectrum detention. Full spectrum detention is matching predevelopment discharge rates over a wide range of storm events, especially during frequent storms where urban runoff impacts are most evident. If 100-year detention is required, the outlet will need to accommodate 100-year release rates and the
maximum release rate for Excess Urban Runoff Control Volume (EURV) as recommended by the UDFCD.

2.2.9 **As Builts**

Upon completion of construction, as-built drawings shall be submitted as required by the City. As-builts must be certified by a professional engineer and must be approved by the City prior to project acceptance.

2.3 **Operation and Maintenance Plan**

2.3.1 **Operation and Maintenance (O&M) Plan**

Include an Operations and Maintenance Plan in the Drainage Report which addresses the following:

**Maintenance Plan Requirements**
- How maintenance is to be performed
- Maintenance area accessibility by people and equipment
- List special equipment or methods needed for access and identify any confined space entry areas
- Estimated maintenance frequency and triggers (include post storm inspections and maintenance needs)
- Maintenance equipment and materials required
- Maintenance service contract availability
- How solids/spent media are classified (waste type) and disposed
- Whether the system or treatment will suffer due to delayed maintenance, and if so, tell how it is restored
- If vendor goes out of business or product model changes, describe how/where the facility owner will find needed parts, materials, and service, or provide an alternate system that will fit the sites constraints
- Operation and Maintenance Sample Report

**Life Cycle Cost**
- Capital and annual maintenance costs: base the cost analysis on GULD test results or Tier II Test Results. Maintenance cost shall include cleaning and replacement of the device and media based on manufacturer’s recommendations
- Estimate the useful facility life prior to replacement
- Costs for inspections, testing, and reporting
• An owner's signature sheet acknowledging the life cycle costs and ongoing maintenance requirements - see below:

Operation and Maintenance Plan Signature Sheet

I verify that I have read, understand, and agree to the Operation and Maintenance (O&M) Plan. The facilities will be maintained in accordance with the City and County of Denver approved Drainage Report for the (name of Development and address). The cost and expense of maintaining the water quality facilities as outlined in this report will be the responsibility of the lot(s) owner(s), heirs, assigns, and successors.

(Property Owner Signature) ____________________________  (Date) ________.
Name
Address
Contact Number
Email

(Entity Responsible for Maintenance if Not Owner Signature) ____________ (Date) ________.
Name
Address
Contact Number
Email

2.3.2 Inspections and Cleaning Frequency

Every underground water quality BMP must be thoroughly inspected and cleaned as required by the manufacturer, but at a minimum of once every 12 months. An O&M Report must be prepared by a licensed sewer contractor or a vendor certified for maintenance by the manufacturer of the device. The report must document and certify that the underground water quality BMP has been inspected, cleaned, and state the condition of any media/filter with predicted date of replacement if applicable. The report should contain a video or pictures if used to inspect the underground facility. The report must specify if the owner has changed since the last report. The report is to be filed on site, made available to the City upon request, and kept for a minimum of three (3) years. A sample O&M report shall be included in the O&M Plan.

Additional inspections should be performed by the owner or owner’s representative on a semi-annual basis per manufacturer's recommendations and after significant storm events to ensure functionality. Items to be inspected regularly and during cleaning and maintenance activities include the manufacturer's recommendation and the following if applicable:

• Structure clear of debris and functional
• Trash rack clear of debris and functional
• Measurement of sediment accumulation
• Condition of concrete and masonry
- Condition of pipes
- Control valve operational condition
- Outfall channel condition
- Complaints from local residents
- Any public hazards observed
- Other details as specified by manufacturer or O&M Plan

References:


