Preliminary Drainage Report

Life Plan Humboldt Housing Development
Hiller Road Site
McKinleyville, California

Prepared for:

Life Plan Humboldt

March 2025
024218

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Prepared by:

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March 2025
QA/QC: JOB and CWC
Reference: 024218

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Abbreviations & Acronyms

Units of Measure

Term	Definition
CFS	cubic feet per second
ft	feet
GAL	gallons
in/hr	inches per hour
min	minutes
SF	square feet
Tc	time of concentration

Additional Terms

Term	Definition
ADA	Americans with Disabilities Act
DMA	drainage management area
Filterra	Contech Peak Diversion Filterra unit
FTPD	Filterra Peak Diversion
LID	low-impact development
MS4	Small Municipal Separate Storm Sewer System
NRCS	Natural Resource Conservation Service
O&M	operation and maintenance

1.0 Project Information and Description

The Life Plan Humboldt project consists of constructing a housing development, including low income housing, which will be developed on a separate parcel on the eastern portion of the existing site, located in McKinleyville, California. The project is located within Section 6, Township 06 North, Range 01 East, and Section 31, Township 07 North, Range 01 East. The site is on an existing parcel that is approximately 14.8 acres in size south of Hiller Road and east of Central Ave. The project will split this parcel up into two parcels, an approximately 2.0-acre parcel that will hold the affordable housing development and a parcel that is approximately 12.8 acres for the Life Plan Humboldt project.

To support the planned development, SHN has prepared this preliminary drainage study to determine the feasibility of stormwater management on the site, and the general sizing of potential stormwater management features to meet regulatory requirements. The stormwater features may include conventional detention ponds in areas with sufficient green space to allow for above-ground stormwater management but could utilize underground storage systems in areas where space is confined. The design for the project is still in the conceptual stages, so the design of the stormwater management system for the site will need to be refined as the site layout evolves.

1.1 Existing Conditions

The existing site consists of turf grass lawn space, and unimproved forested area. Additionally, a wetland area was delineated by others in the northeast part of the site, the wetland is approximately 0.55 acres. The pre-project area of 14.8 acres consists largely of pervious areas. Of this area, approximately 2.0 acres will become a parcel that will be the site of an affordable housing development. The remaining 12.8 acres will be a parcel that will be developed as the Life Plan Humboldt project, the wetland described is entirely located within the Life Plan Humboldt parcel. Some small existing impervious areas were noted within the limits of the proposed development. These existing impervious areas were assumed pervious to provide a conservatively low estimate of existing peak flows. Existing drainage on the majority of the site is generally to the northeast towards the existing wetland, though the western portion of the site drains westward towards an adjacent parcel.

A figure showing the existing site conditions is included in Appendix 1, Figure 1.

A geotechnical investigation has yet been conducted for the site. SHN accessed publicly available soil data from the National Resource Conservation Service's (NRCS) Web Soil Survey to evaluate soil conditions at the site. The majority of the soils are classified as the Halfbluff-Tepona-Urban Land, this soil unit is generally comprised of fine-grained sandy loams and loamy sand and is assigned a 'C' Hydrologic Soil Group (HSG) rating. A small area of the site is classified as Arcata and Candymountain Soils, which consists chiefly of fine to very fine-grained sandy loam and is described as a 'B' HSG rating. Direct observation of soils immediately south of the project site, within the same mapped soil units was conducted by SHN in August of 2015. The recorded boring logs indicate the presence of silty sands and sandy silts, which is reasonably consistent with the descriptions provided by NRCS. Thus, the hydrologic soil ratings provided by NRCS were used to construct the stormwater models used for analysis.

The site is located within the Community of McKinleyville and is subject to the Humboldt County MS4 Permit as well as the Community of McKinleyville County Storm Water Management Program. A figure showing the proposed site layout and the storm drain system is included in Appendix 1, Figure 2.

1.2 Proposed Project Conditions

The proposed project consists of site grading; construction of 37 cottage-style housing buildings, 6 large multi-unit buildings with community areas, and an affordable housing building. It also includes accessible travel paths, driveways, and several parking spaces (some of which will be Americans with Disabilities Act [ADA] accessible). Runoff from the proposed project impervious surface will be conveyed to several Contech Filterra units via a storm drain system. The Filterra chambers will provide treatment of the stormwater runoff to meet the water quality objectives of the MS4 permit. Stormwater exiting the Filterra chambers will then be directed to downstream detention basins that will detain peak flows to comply with the County's peak flow mitigation requirements in McKinleyville.. During large storm events, the Filterra chambers have internal weirs that allow large flows to bypass the treatment chamber. Information regarding the Filterra chambers is provided in Appendix 2.

Since the site development process has not been finalized, SHN has assumed conservative allowances for various features such as courtyards, walking paths and other amenities. These assumptions were based on the locations, extent, and cumulative area of the proposed buildings. Allowances for sidewalks and paths were assumed based on length of road and an assumed width while courtyard areas were determined by a percentage of the cumulative area dedicated to the proposed buildings. Table 1 summarizes the assumed areas used in the analysis for both the affordable housing parcel and the Life Plan Humboldt parcel as well as the whole site.

Table 1. Proposed Site Areas

Parcel	Overall Area (SF)	Buildings (SF)	Roads and Parking (SF)	Sidewalks and Paths (SF)	Courtyard (SF)	Permeable Area (SF)
Life Plan Humboldt	559,566	119,458	98,393	34,693	29,865	277,157
Affordable Housing	86,438	14,762	32,812	1,210	3,691	33,963
Whole Site	646,004	134,220	131,205	35,903	33,556	311,120

The eastern, western, and southern boundaries of the site are constrained by private property, the northern boundary is constrained by the existing Hiller Road right-of-way.

A figure showing the proposed site layout and the storm drain system is included in Appendix 1, Figure 2.

2.0 Project Stormwater Mitigation Requirements

The total post-project impervious surface area of 334,883 SF (7.7 acres) is comprised of new buildings, accessible travel paths, driveways roadway, parking spaces, and pedestrian common areas (playground/plaza areas). Of this impervious coverage, 282,409 SF (6.5 acres) is contained within the Life Plan Humboldt parcel, and 52,474 SF (1.2 acres) is within the affordable housing parcel. The project site is divided into four drainage management areas (DMAs) as shown in Appendix 1, Figure 2.

The project will create or replace 334,883 SF of impervious surface, greater than 5,000 SF, so it is classified as a “Regulated Project” according to the Phase II Small Municipal Separate Storm Sewer

System (MS4) Program, Section E.12.c(ii). Additionally, since the project creates or replaces more than 1 acre (43,560 SF) of impervious surface, hydromodification controls are required and the project is considered a "Hydromodification Project". Per the development standards for the McKinleyville area, an additional peak flow requirement is applicable to the project: the post-development 100-year peak flow shall not exceed the predevelopment 2-year peak flow. Per discussions with Humboldt County staff, the Skupe basin sizing method shall be used to demonstrate that this criterion is met. A summary of this method is provided in Appendix 3.17

Filterra facilities are not listed as an approved treatment method in the Humboldt LID Manual, but are applicable as an alternative design measure per Section E.12.e.ii.g of the MS4 Permit. The Filterra treatment capacity is determined by taking the rainfall intensity found in the flow-based criteria section of the MS4 Permit (E.12.e.ii.c.2.a) of 0.2 in/hr and using the rational method to determine a water quality flowrate; this flowrate is divided by the infiltration rate of the Filterra soil media. The depth of the soil media is a design variable that will be evaluated as the site design progresses. The design of these facilities will be conducted to meet the MS4 permit requirements. Information regarding the Filterra chambers is provided in Appendix 2.

Complete forms for the Humboldt County Low-Impact Development (LID) Manual Stormwater Control Plan will be furnished as the design of this project unfolds.

3.0 Stormwater Analysis

As stated above, the site is classified as a regulated project and has been divided into four DMAs, SHN used the National Oceanic and Atmospheric Administration's (NOAA) Precipitation Frequency Data Server to determine location-specific rainfall depths for the 2-year and 100-year 24-hour storms. The storm depths were determined to be 3.47 inches (2-year, 24-hour event) and 7.32 inches (100-year, 24-hour event). These depths were fitted to a standard SCS Type 1a distribution to develop the precipitation input for peak flow calculations. Peak flows were computed using the SCS (now NRCS) TR-55 method. Time of concentration was calculated for the parcel in the existing condition using the methods described in TR-55. Flow paths through the site from the hydrologically-most-distant part of the site were analyzed to compute travel time for sheet flow and shallow concentrated flow. In developed conditions, the minimum time of concentration suggested in TR-55 was used.

The peak flows calculated for the predevelopment 2-year storm and post-development 100-year storm were then used as inputs to the Skupe sizing method to determine the storage volume required to meet the regulatory requirements.

Water quality requirements described in the Humboldt County LID Design Manual will be accomplished by routing runoff from the site through Filterra systems. Stormwater management features will be sized to comply with the Community of McKinleyville County Storm Water Management Program peak flow performance standard, which requires that the site's post-development 100-year peak flow meets the predevelopment 2-year peak flow. Since this is a more restrictive requirement than the hydromodification requirement in the MS4 permit, meeting the Country's peak flow requirements for McKinleyville will also satisfy the MS4 hydromodification requirement.

3.1 Existing Conditions Modeling

The existing conditions of the project site were modelled as one watershed, with a total area of 646,004 SF (14.8 acres), with 559,566 SF (12.8 acres) within the Life Plan Humboldt parcel and 86,438 SF (2.0

acres) within the affordable housing parcel. A small portion of the site is situated in areas mapped as HSG B. This area is covered with turfgrass. The rest of the site is within HSG C soils and includes turf areas and wooded areas. All land cover was assumed to be in good condition for the existing conditions model. Turf areas were given a curve number of 61 for HSG B soils and 74 for HSG C soils, wooded areas were assigned a curve number of 70. Table 2 below shows the areas used in the existing conditions model.

SHN evaluated several time-of-concentration flow paths, which were selected to represent the travel path rainfall would take to traverse beyond the site boundary from the hydrologically-most-distant point within the watershed. A 300-foot maximum sheet flow length was assumed in all calculations, this assumption is consistent with TR-55 guidance. SHN computed the travel time for each identified flow path. The longest computed travel time was used as the time of concentration for the existing conditions model. Table 2 below shows the time of concentration (tc) used in the existing conditions model.

Table 2. Existing Conditions Model Results

A	B	C	D	E	F	G	H
DMA	**Overall Area (SF)**	**Lawn Area – CN 61**	**Lawn Area – CN 74**	**Wooded Area – CN 70**	**Composite Curve Number***	**Tc (min)**	**2-yr Peak Flow (cfs)**
Entire Project Site	646,004	39,204	367,220	239,580	71.7	37.3	2.26 cfs
Formulas	**= C + D +E**						

* Area-weighted average curve number, using CN = 61 for lawns in HSG B soils, CN = 74 for lawns in HSG C soils and CH = 70 for wooded areas in HSG C soils.

3.2 Definition of Project Drainage Management Areas

The proposed condition of the site was broken into four drainage management areas, Which are described in more detail below. DMA areas are shown in Appendix 1, Figure 2.

DMA 1—West Housing Area includes runoff from an area of 84,331 SF near the western extent of the project. Existing grades are lower in this area than much of the rest of the site, and it is situated on a part of the site that drains to the west. The project site includes 18 cottage buildings, interior (non-public sidewalk) walkways, private roadways, parking spaces, landscaped areas, and common use areas. DMA 1 includes 43,683 SF of impervious area comprised of 22,626 SF of roof impervious area and 21,057 of non-roof impervious areas.

DMA 2—Main site includes runoff from the majority of the project site. It includes roofs of 19 cottage buildings, 6 large multi-unit buildings with community areas, private roadways, parking spaces, landscaped areas, and common use areas. DMA 2 includes 212,768 SF of impervious area comprised of 96,832 SF of roof impervious area and 115,936 SF of non-roof impervious areas.

DMA 3—Affordable Housing Area includes runoff from the parcel associated with an affordable housing building. It includes runoff from the roof of the affordable housing building and associated walkways, private roadways, parking spaces, landscaped areas, and common use areas. DMA 3 includes

52,474 SF of impervious area comprised of 14,762 SF of roof impervious area and 37,712 of non-roof impervious areas.

DMA 4—Offsite Road Connection includes runoff from the proposed Nursery Way connection to Hiller Road. This DMA includes the entire right-of-way associated with the connecting road. Since this area will likely become part of the public road system, SHN assumed that stormwater treatment features on private land would not be able to treat this area directly. This DMA includes 25,957 SF of impervious area comprised of sidewalk and road, along with 15,232 SF of permeable surface. As the project design progresses, the feasibility of direct treatment of this DMA will be re-evaluated.

Stormwater Management features were established for DMAs 1, 2 and 3 to comply with the stormwater management requirements. Since DMA 4 may not be treated by private stormwater treatment and detention features, the sizing exercise assumed that the stormwater treatment and detention features in DMAs 1, 2 and 3 would need to compensate for runoff generated in DMA 4. Thus, the stormwater features sited on the development are oversized relative to the DMAs draining to them, to be able to account for the runoff generated by DMA 4.

3.3 DMA Modeling Assumptions

Since the design process for the site is not complete and since the intent of this exercise is to provide a preliminary sizing estimate for stormwater siting purposes, several assumptions were incorporated into the stormwater modeling effort conducted for the site. Impervious areas for housing units, roadway and parking lot areas were obtained from preliminary design drawings. Impervious common areas were assumed to occupy 25 percent of the area associated with the buildings. Sidewalks were assumed to be five feet in width and were assumed to be placed on either side of roadways and were assumed to connect sides of the housing buildings to nearby parking stalls. An impervious multi-use path with a width of 10 feet was assumed to connect the site to Hiller Road. Permeable areas were assumed to be turf-grass in good condition for all areas not covered by impervious surfaces. Though some permeable area is likely to be sited in HSG B soils, all permeable areas were assumed to be in HSG C soils, since HSG C is the dominant rating across the site. This assumption would conservatively overestimate the calculated peak runoff flow rate in the proposed condition.

The exact extent and size of the post-development DMAs is not known at this time. With this in mind, calculating a time of concentration is difficult, since the calculation is sensitive to the positions of pervious and impervious areas within a DMA, finish-grade slopes, DMA size, and other variables that are likely to change with the project. In lieu of calculating a time of concentration (tc) for each DMA, SHN conservatively assumed a tc of 6.0 minutes for all DMAs. This is the minimum value recommended for the TR-55 modeling approach. Smaller tc values compress the runoff hydrograph, meaning that for a given runoff volume, a smaller tc will produce a larger peak flow rate than a larger tc. Thus, the modeling assumptions are conservative in that they represent the maximum peak flow rates that could be expected for the DMAs with the land use parameters characterized in Table 3 on the following page.

Table 3. Land Use Assumptions by DMA – Proposed Conditions

A	B	C	D	E	F	G
DMA	Overall Area (SF)	Impervious Area (SF)	Permeable Area (SF)	Impervious Area Curve Number (CN)	Permeable Area Area Curve Number (CN)	Weighted Curve Number (CN)
1 (West)	84,331	43,684	40,647	98	74	86.4
2 (Main)	434,046	212,768	221,278	98	74.7*	86.1
3 (Affordable Housing)	86,438	52,475	33,963	98	74	88.6
4 (Offsite)	41,189	25,957	15,232	98	74	89.1
Formulas			**= B - C**			**=(C*E+D*F)/(D+F)**

* Pervious curve number assumes 31,883 SF of wetland has CN of 79 (conservatively high post-development flow), CN is area-weighted average.

3.4 Post-development Modeling and Stormwater Sizing

Since the design process for the site is not complete, the intent of this exercise is to provide a preliminary sizing estimate for stormwater siting purposes. Stormwater management design will be updated on an iterative basis as more site design details are evaluated and incorporated into the analysis. For this exercise, the Skupe Sizing Method was used to calculate the total volume required for stormwater management purposes. Based on previous correspondence, this method is satisfactory to demonstrate compliance with the Community of McKinleyville County Stormwater Management Program's stormwater management objectives. This graphical method plots inflow peak runoff flow rates and allowable peak flow rates on an x-y plot where the x-axis is time and the y-axis is flow. The method employs the following steps:

1. Calculate the peak inflow rate to the stormwater management feature, plot a point with this peak flow as the y-value, and the assumed tc as the x-value. In this application, the peak inflow rate is the 100-year peak flow rate in the post-construction condition.
2. Connect a line from the origin (0,0) to the point plotted in Step 1, and another from the point to a y-value of zero and an x-value of three times the tc value, this is the assumed post-construction inflow hydrograph.
3. Calculate the allowable outflow and find its position on the receding limb of the inflow hydrograph calculated in Step 2. draw a line from that point back to the origin. This line is the ascending limb of the allowable outflow hydrograph, the receding limb of this hydrograph is identical to the receding limb of the inflow hydrograph from the time the allowable flow is reached to the end of the hydrograph (at an x-value of three times the tc value)
4. The volume that is above the outflow hydrograph, but contained within the inflow hydrograph is the volume of storage required to meet the peak flow criteria. Select a scaling factor, ranging between 1.2 and 2.0 to account for design uncertainties and apply this value to the calculated volume to determine the required volume for peak flow rate compliance. For this analysis, a scaling factor of 2.0 was used to provide conservatively large sizing calculation results.

See Appendix 3 for a schematic representation of this method and additional details. For this exercise, the allowable flow rate is the predevelopment 2-year peak flow rate with the peak flow rate from 100-year event based on the tributary area within DMA 4, reference Section 3.2, subtracted from it. The peak inflow rate is the total of the post-development 100-year peak flow rates from each DMA.

The same methodology used to calculate the predevelopment flow rate was used to calculate post-development flow rates for each DMA. The peak flow rates from this analysis are summarized in Table 4.

Table 4. Post-development Flow Rate Calculations

DMA	Overall Area (SF)	Peak Flow Rate (CFS)
1 (West)	84,331	2.76
2 (Main)	434,046	14.18
3 (Northeast)	86,438	2.96
4 (Offsite)	41,189	1.42
Total	*646,004*	*21.32*

Table 5 below summarizes the inflows, allowable outflows, volumes, required storage and time components used to perform the Skupe calculations. It also summarizes the volumes calculated from the hydrographs generated as part of the method. The required storage is also displayed.

Table 5. Skupe Sizing Method Inputs and Calculations

A	B	C	D	E	F	G	H
Peak Inflow (CFS)	**Tc (min)**	**Time Base (min)**	**Inflow Volume (CF)**	**Allowable Peak Outflow (CFS)***	**Allowable Outflow Volume (CF)**	**K Factor****	**Storage Volume Required (CF)**
21.32	6.0	18.0	11,512	0.84	453	2.0	22,118
Formulas		**= 3 x B**	**=0.5 x A x C**		**=0.5 x E x C**		**=G x (D - F)**

* Calculated by subtracting the peak flow from DMA 4 from 2-year predevelopment peak flow calculated for the entire site.

** Per the Skupe Method guidance, this number varies from 1.2 to 2.0 to "account for non linearity of actual hydrographs", 2.0 was selected to provide the largest estimate of storage volume required.

The Skupe Method was used to determine the storage volume required on a sitewide level. To determine the sizing required for each DMA, the total volume required was partitioned on the basis of peak flow generated. The calculation assumed that the runoff from DMA 4 would need to be accounted for in DMAs 1, 2 and 3. This was done by lowering the allowable peak flow rate, which increased the storage volume calculation. The calculated storage volume was then split up between DMAs 1, 2 and 3 on a flow-weighted average basis. Thus, the amount of additional storage provided in DMAs 1, 2 and 3 is proportional to the amount of runoff generated in the post-construction condition.
To determine the area needed for siting the stormwater management features, SHN applied an assumed depth of 2 feet to the runoff volumes calculated for each DMA. General engineering assumptions were then used to grade a stormwater pond with a bottom footprint equal to the area calculated. The stormwater areas shown in Appendix 1, Figure 2 are the result of this exercise and a preliminary grading

exercise to determine how much footprint is required to be dedicated to stormwater management. The grading exercise also included conservative assumptions and factors of safety to promote oversizing of the areas dedicated to stormwater management in order to provide flexibility as the design progresses. Table 6, on the following page, summarizes the volume and area calculations.

Table 6. Stormwater Management Feature Volume and Area Calculations

A	B	C	D	E	F
DMA	Peak Flow (CFS)	Fraction of Peak Flow	Volume Required (CF)*	Bottom Storage Footprint (sf)**	Stormwater Feature Area (SF)
1	2.76	0.139	3,200	1,600	3,900
2	14.18	0.712	15,800	7,900	12,100
3	2.96	0.149	3,100	1,550	3,100
Formulas		C=B/(sum(B1:B3))		=D/2	

* Calculated by multiply peak flow fraction (column C) by 22,118 cf (storage volume calculated, see Table 4) and rounding up to the nearest 100 cf.

** Bottom storage footprint was calculated assuming vertical walls and a 2-foot detention depth. The vertical wall assumption was selected to conservatively oversize

4.0 Opportunities and Constraints

The following are the opportunities and constraints that were considered for the stormwater management features of the site.

Opportunities for stormwater management include:

- Ample green space in some parts of the site for peak flow detention.
- Use of underground storage chambers for peak flow detention.
- Use of small footprint Filterra units to provide water quality treatment to as much stormwater as possible.

Constraints on the site include:

- There is no subsurface municipal storm drain system to convey runoff to. All runoff from the project site must drain to surface drainage ditches.
- Existing topographic and drainage patterns.
- Wetland boundaries limit siting of stormwater features.
- The Nursery Way road connection will be public and cannot be routed into private facilities.
- The site is large, requiring significant space for stormwater treatment and detention.

5.0 Stormwater Mitigation Summary

This project meets the stormwater mitigation requirements of the Phase II Small MS4 Program for Regulated Projects through the use of Filterra Peak Diversion unit. Stormwater management features shown on Appendix 1, Figure 2 were sized to meet peak flow requirements in the Community of McKinleyville County Storm Water Management Program as well as the Phase II Small MS4 Program for Hydromodification Projects.

6.0 References

County of Humboldt. (August 18, 2021). "Humboldt Low Impact Development Stormwater Manual v3.0." Eureka, CA:Humboldt County.

Existing and Proposed Project Figures

1

LAND COVER DESCRIPTION	AREA (SF)	SOIL RATING	CURVE NUMBER
EXISTING LAWN – GOOD CONDITION	39,204	B	61
EXISTING LAWN – GOOD CONDITION	367,220	C	74
EXISTING WOODS – GOOD CONDITION	239,580	C	70
TOTAL	646,004	–	71.73

FLOW CLASSIFICATION	LENGTH (FT)	AVERAGE SLOPE	TRAVEL TIME (MIN)
SHEET FLOW[1]	300	0.89%	31.3
SHALLOW CONCENTRATED FLOW	340	1.83%	6.0
TOTAL (TIME OF CONCENTRATION)	640	–	37

1 – 300 FEET ASSIGNED AS MAXIMUM SUGGESTED LENGTH PER TR–55

N

0 120

1"=120'

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Existing Conditions

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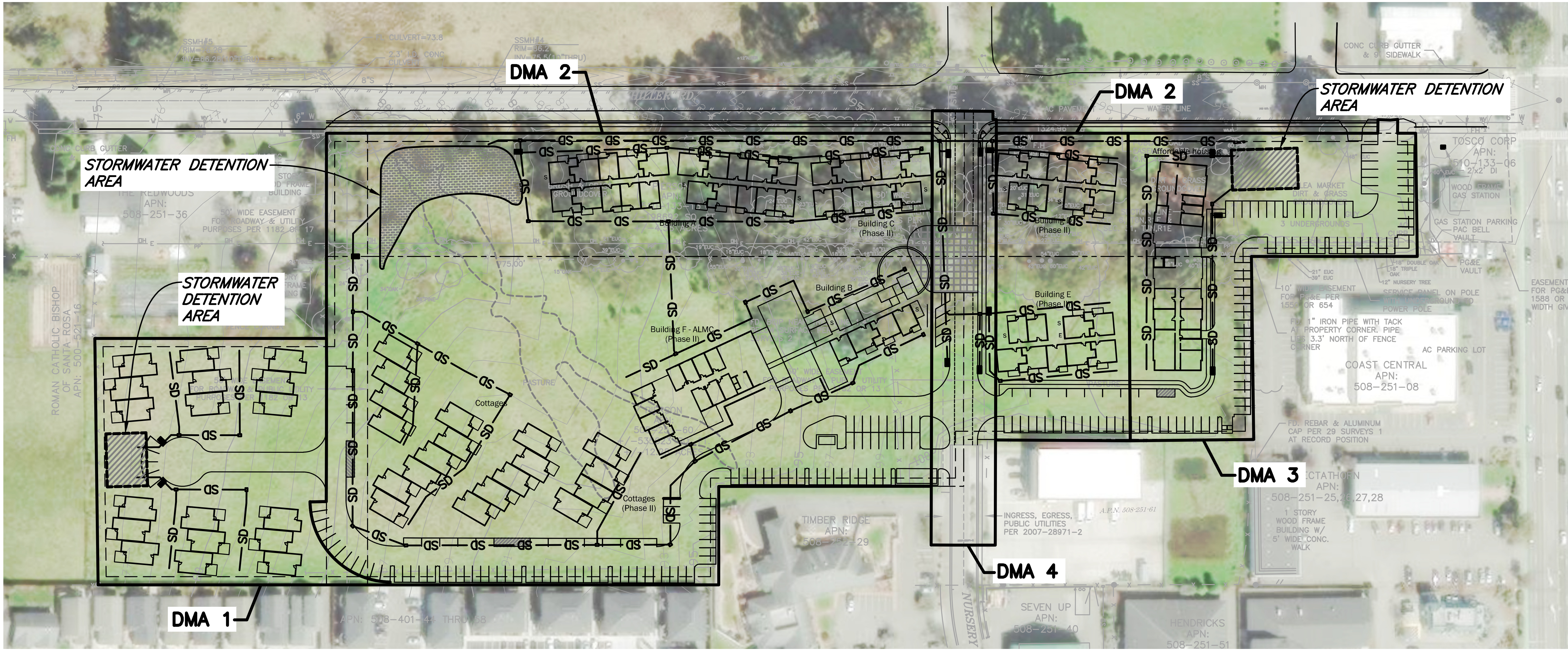
Figure 1



LAND USE PARAMETERS		DMA 1 AREA (SF)	DMA 2 AREA (SF)	DMA 3 AREA (SF)	DMA 4 AREA (SF)
LAND COVER DESCRIPTION	CURVE NUMBER				
BUILDINGS	98	5,657	24,208	3,691	–
ROADWAYS/PARKING LOTS	98	7,781	67,436	32,812	23,176
SIDEWALKS	98	7,620	24,292	1,210	2,781
COURTYARD	98	5,657	24,205	3,691	–
TURFGRASS	74	57,616	262,019	45,034	15,232
WETLAND[2]	79	–	31,883	–	–
TOTAL	–	84,331	434,046	86,438	41,189

2 – WETLAND ASSUMED TO BE PARTIALLY SATURATED LAWN SPACE AS A MEANS OF PRODUCING A CONSERVATIVELY HIGH ESTIMATE OF RUNOFF

NOTE:

1. *TIME OF CONCENTRATION ASSUMED TO BE 6 MINUTES FOR ALL PROPOSED DMAs.*

0 120
1"=120'

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Figure
2

Filterra Compliance Documents & Specifications

2

WASHINGTON STATE DEPARTMENT OF ECOLOGY

September 2019

GENERAL USE LEVEL DESIGNATION FOR BASIC (TSS), ENHANCED, PHOSPHORUS & OIL TREATMENT

For

CONTECH Engineered Solutions Filterra®

Ecology's Decision:

Based on Contech's submissions, including the Final Technical Evaluation Reports, dated August 2019, March 2014, December 2009, and additional information provided to Ecology dated October 9, 2009, Ecology hereby issues the following use level designations:

1. A General Use Level Designation for Basic, Enhanced, Phosphorus, and Oil Treatment for the Filterra® system constructed with a minimum media thickness of 21 inches (1.75 feet), at the following water quality design hydraulic loading rates:

Treatment	Infiltration Rate (in/hr) for use in Sizing
Basic	175
Phosphorus	100
Oil	50
Enhanced	175

2. The Filterra is not appropriate for oil spill-control purposes.

3. Ecology approves Filterra systems for treatment at the hydraulic loading rates listed above, to achieve the maximum water quality design flow rate. Calculate the water quality design flow rates using the following procedures:

   - Western Washington: for treatment installed upstream of detention or retention, the water quality design flow rate is the peak 15-minute flow rate as calculated using the latest version of the Western Washington Hydrology Model or other Ecology-approved continuous runoff model.
   - Eastern Washington: For treatment installed upstream of detention or retention, the water quality design flow rate is the peak 15-minute flow rate as calculated using one of the three flow rate based methods described in Chapter 2.2.5 of the Stormwater Management Manual for Eastern Washington (SWMMEW) or local manual.
   - Entire State: For treatment installed downstream of detention, the water quality design flow rate is the full 2-year release rate of the detention facility.

4. This General Use Level Designation has no expiration date, but Ecology may revoke or amend the designation, and is subject to the conditions specified below.

Ecology's Conditions of Use:

Filterra systems shall comply with these conditions shall comply with the following conditions:

1. Design, assemble, install, operate, and maintain the Filterra systems in accordance with applicable Contech Filterra manuals and this Ecology Decision.
2. The minimum size filter surface-area for use in Washington is determined by using the design water quality flow rate (as determined in this Ecology Decision, Item 3, above) and the Infiltration Rate from the table above (use the lowest applicable Infiltration Rate depending on the level of treatment required). Calculate the required area by dividing the water quality design flow rate (cu-ft/sec) by the Infiltration Rate (converted to ft/sec) to obtain required surface area (sq-ft) of the Filterra unit.
3. Each site plan must undergo Contech Filterra review before Ecology can approve the unit for site installation. This will ensure that design parameters including site grading and slope are appropriate for use of a Filterra unit.
4. Filterra media shall conform to the specifications submitted to and approved by Ecology and shall be sourced from Contech Engineered Solutions, LLC with no substitutions.
5. Maintenance includes removing trash, degraded mulch, and accumulated debris from the filter surface and replacing the mulch layer. Use inspections to determine the site-specific maintenance schedules and requirements. Follow maintenance procedures given in the most recent version of the Filterra Operation and Maintenance Manual.
6. Maintenance: The required maintenance interval for stormwater treatment devices is often dependent upon the degree of pollutant loading from a particular drainage basin. Therefore, Ecology does not endorse or recommend a "one size fits all" maintenance cycle for a particular model/size of manufactured treatment device.
   - Contech designs Filterra systems for a target maintenance interval of 6 months in the Pacific Northwest. Maintenance includes removing and replacing the mulch layer above the media along with accumulated sediment, trash, and captured organic materials therein, evaluating plant health, and pruning the plant if deemed necessary.
   - Conduct maintenance following manufacturer's guidelines.
7. Filterra systems come in standard sizes.
8. Install the Filterra in such a manner that flows exceeding the maximum Filterra operating rate are conveyed around the Filterra mulch and media and will not resuspend captured sediment.
9. Discharges from the Filterra units shall not cause or contribute to water quality standards violations in receiving waters.

Approved Alternate Configurations

Filterra Internal Bypass - Pipe (FTIB-P)

1. The Filterra® Internal Bypass – Pipe allows for piped-in flow from area drains, grated inlets, trench drains, and/or roof drains. Design capture flows and peak flows enter the structure through an internal slotted pipe. Filterra® inverted the slotted pipe to allow design flows to drop through to a series of splash plates that then disperse the design flows over the top surface of the Filterra® planter area. Higher flows continue to bypass the slotted pipe and convey out the structure.
2. To select a FTIB-P unit, the designer must determine the size of the standard unit using the sizing guidance described above.

Filterra Internal Bypass – Curb (FTIB-C)

1. The Filterra® Internal Bypass –Curb model (FTIB-C) incorporates a curb inlet, biofiltration treatment chamber, and internal high flow bypass in one single structure. Filterra® designed the FTIB-C model for use in a "Sag" or "Sump" condition and will accept flows from both directions along a gutter line. An internal flume tray weir component directs treatment flows entering the unit through the curb inlet to the biofiltration treatment chamber. Flows in excess of the water quality treatment flow rise above the flume tray weir and discharge through a standpipe orifice; providing bypass of untreated peak flows. Americast manufactures the FTIB-C model in a variety of sizes and configurations and you may use the unit on a continuous grade when a single structure providing both treatment and high flow bypass is preferred. The FTIB-C model can also incorporate a separate junction box chamber to allow larger diameter discharge pipe connections to the structure.
2. To select a FTIB-C unit, the designer must determine the size of the standard unit using the sizing guidance described above.

Filterra® Shallow

1. The Filterra Shallow provides additional flexibility for design engineers and designers in situations where various elevation constraints prevent application of a standard Filterra configuration. Engineers can design this system up to six inches shallower than any of the previous Filterra unit configurations noted above.
2. Ecology requires that the Filterra Shallow provide a media contact time equivalent to that of the standard unit. This means that with a smaller depth of media, the surface area must increase.
3. To select a Filterra Shallow System unit, the designer must first identify the size of the standard unit using the modeling guidance described above.
4. Once the size of the standard Filterra unit is established using the sizing technique described above, use information from the following table to select the appropriate size Filterra Shallow System unit.

Shallow Unit Basic, Enhanced, and Oil Treatment Sizing

Standard Depth	Equivalent Shallow Depth
4x4	4x6 or 6x4
4x6 or 6x4	6x6
4x8 or 8x4	6x8 or 8x6
6x6	6x10 or 10x6
6x8 or 8x6	6x12 or 12x6
6x10 or 10x6	13x7

Notes:
1. Shallow Depth Boxes are less than the standard depth of 3.5 feet but no less than 3.0 feet deep (TC to INV).

Applicant: Contech Engineered Solutions, LLC.

Applicant's Address: 11815 NE Glenn Widing Drive
Portland, OR 97220

Application Documents:

- State of Washington Department of Ecology Application for Conditional Use Designation, Americast (September 2006)
- Quality Assurance Project Plan Filterra® Bioretention Filtration System Performance Monitoring, Americast (April 2008)
- Quality Assurance Project Plan Addendum Filterra® Bioretention Filtration System Performance Monitoring, Americast (June 2008)
- Draft Technical Evaluation Report Filterra® Bioretention Filtration System Performance Monitoring, Americast (August 2009)
- Final Technical Evaluation Report Filterra® Bioretention Filtration System Performance Monitoring, Americast (December 2009)
- Technical Evaluation Report Appendices Filterra® Bioretention Filtration System Performance Monitoring, Americast, (August 2009)
- Memorandum to Department of Ecology Dated October 9, 2009 from Americast, Inc. and Herrera Environmental Consultants
- Quality Assurance Project Plan Filterra® Bioretention System Phosphorus treatment and Supplemental Basic and Enhanced Treatment Performance Monitoring, Americast (November 2011)
- Filterra® letter August 24, 2012 regarding sizing for the Filterra® Shallow System.
- University of Virginia Engineering Department Memo by Joanna Crowe Curran, Ph. D dated March 16, 2013 concerning capacity analysis of Filterra® internal weir inlet tray.
- Terraphase Engineering letter to Jodi Mills, P.E. dated April 2, 2013 regarding Terraflume Hydraulic Test, Filterra® Bioretention System and attachments.
- Technical Evaluation Report, Filterra® System Phosphorus Treatment and Supplemental Basic Treatment Performance Monitoring. March 27th, 2014.
- State of Washington Department of Ecology Application for Conditional Use Level Designation, Contech Engineered Solutions (May 2015)

- Quality Assurance Project Plan Filterra® Bioretention System, Contech Engineered Solutions (May 2015)
- Filterra Bioretention System Armco Avenue General Use Level Designation Technical Evaluation Report, Contech Engineered Solutions (August 2019)

Applicant's Use Level Request:

General Level Use Designation for Basic (175 in/hr), Enhanced (175 in/hr), Phosphorus (100 in/hr), and Oil Treatment (50 in/hr).

Applicant's Performance Claims:

Field-testing and laboratory testing show that the Filterra® unit is promising as a stormwater treatment best management practice and can meet Ecology's performance goals for basic, enhanced, phosphorus, and oil treatment.

Findings of Fact:

Field Testing 2015-2019

1. Contech completed field testing of a 4 ft. x 4 ft. Filterra® unit at one site in Hillsboro, Oregon from September 2015 to July 2019. Throughout the monitoring period a total of 24 individual storm events were sampled, of which 23 qualified for TAPE sampling criteria.
2. Contech encountered several unanticipated events and challenges that prevented them from collecting continuous flow and rainfall data. An analysis of the flow data from the sampled events, including both the qualifying and non-qualifying events, demonstrated the system treated over 99 % of the influent flows. Peak flows during these events ranged from 25 % to 250 % of the design flow rate of 29 gallons per minute.
3. Of the 23 TAPE qualified sample events, 13 met requirements for TSS analysis. Influent concentrations ranged from 20.8 mg/L to 83 mg/L, with a mean concentration of 46.3 mg/L. The UCL95 mean effluent concentration was 15.9 mg/L, meeting the 20 mg/L performance goal for Basic Treatment.
4. All 23 TAPE qualified sample events met requirements for dissolved zinc analysis. Influent concentrations range from 0.0384 mg/L to 0.2680 mg/L, with a mean concentration of 0.0807 mg/L. The LCL 95 mean percent removal was 62.9 %, meeting the 60 % performance goal for Enhanced Treatment.
5. Thirteen of the 23 TAPE qualified sample events met requirements for dissolved copper analysis. Influent concentrations ranged from 0.00543 mg/L to 0.01660 mg/L, with a mean concentration of 0.0103 mg/L. The LCL 95 mean percent removal was 41.2 %, meeting the 30 % performance goal for Enhanced Treatment.
6. Total zinc concentrations were analyzed for all 24 sample events. Influent EMCs for total zinc ranged from 0.048 mg/L to 5.290 mg/L with a median of 0.162 mg/L. Corresponding effluent EMCs for total zinc ranged from 0.015 mg/L to 0.067 mg/L with a median of

0.029 mg/L. Total event loadings for the study for total zinc were 316.85 g at the influent and 12.92 g at the effluent sampling location, resulting in a summation of loads removal efficiency of 95.9 %.

7. Total copper concentrations were analyzed for all 24 sample events. Influent EMCs for total copper ranged from 0.003 mg/L to 35.600 mg/L with a median value of 0.043 mg/L. Corresponding effluent EMCs for total copper ranged from 0.002 mg/L to 0.015 mg/L with a median of 0.004 mg/L. Total event loadings for total copper for the study were 1,810.06 g at the influent and 1.90 g at the effluent sampling location, resulting in a summation of loads removal efficiency of 99.9 %.

<u>Field Testing 2013</u>

1. Filterra completed field-testing of a 6.5 ft x 4 ft. unit at one site in Bellingham, Washington. Continuous flow and rainfall data collected from January 1, 2013 through July 23, 2013 indicated that 59 storm events occurred. Water quality data was obtained from 22 storm events. Not all the sampled storms produced information that met TAPE criteria for storm and/or water quality data.
2. The system treated 98.9 % of the total 8-month runoff volume during the testing period. Consequently, the system achieved the goal of treating 91 % of the volume from the site. Stormwater runoff bypassed Filterra treatment during four of the 59 storm events.
3. Of the 22 sampled events, 18 qualified for TSS analysis (influent TSS concentrations ranged from 25 to 138 mg/L). The data were segregated into sample pairs with influent concentration greater than and less than 100 mg/L. The UCL95 mean effluent concentration for the data with influent less than 100 mg/L was 5.2 mg/L, below the 20-mg/L threshold. Although the TAPE guidelines do not require an evaluation of TSS removal efficiency for influent concentrations below 100 mg/L, the mean TSS removal for these samples was 90.1 %. Average removal of influent TSS concentrations greater than 100 mg/L (three events) was 85 %. In addition, the system consistently exhibited TSS removal greater than 80 % at flow rates equivalent to a 100 in/hr infiltration rate and was observed at 150 in/hr.
4. Ten of the 22 sampled events qualified for TP analysis. Americast augmented the dataset using two sample pairs from previous monitoring at the site. Influent TP concentrations ranged from 0.11 to 0.52 mg/L. The mean TP removal for these twelve events was 72.6 %. The LCL95 mean percent removal was 66.0, well above the TAPE requirement of 50 %. Treatment above 50 % was evident at 100 in/hr infiltration rate and as high as 150 in/hr. Consequently, the Filterra test system met the TAPE Phosphorus Treatment goal at 100 in/hr. Influent ortho-P concentrations ranged from 0.005 to 0.012 mg/L; effluent ortho-P concentrations ranged from 0.005 to 0.013 mg/L. The reporting limit/resolution for the ortho-P test method is 0.01 mg/L, therefore the influent and effluent ortho-P concentrations were both at and near non-detect concentrations.

Field Testing 2008-2009

1. Filterra completed field-testing at two sites at the Port of Tacoma. Continuous flow and rainfall data collected during the 2008-2009 monitoring period indicated that 89 storm events occurred. The monitoring obtained water quality data from 27 storm events. Not all the sampled storms produced information that met TAPE criteria for storm and/or water quality data.
2. During the testing at the Port of Tacoma, 98.96 to 99.89 % of the annual influent runoff volume passed through the POT1 and POT2 test systems respectively. Stormwater runoff bypassed the POT1 test system during nine storm events and bypassed the POT2 test system during one storm event. Bypass volumes ranged from 0.13 % to 15.3% of the influent storm volume. Both test systems achieved the 91 % water quality treatment-goal over the 1-year monitoring period.
3. Consultants observed infiltration rates as high as 133 in/hr during the various storms. Filterra did not provide any paired data that identified percent removal of TSS, metals, oil, or phosphorus at an instantaneous observed flow rate.
4. The maximum storm average hydraulic loading rate associated with water quality data is <40 in/hr, with the majority of flow rates < 25 in/hr. The average instantaneous hydraulic loading rate ranged from 8.6 to 53 in/hr.
5. The field data showed a removal rate greater than 80 % for TSS with an influent concentration greater than 20 mg/L at an average instantaneous hydraulic loading rate up to 53 in/hr (average influent concentration of 28.8 mg/L, average effluent concentration of 4.3 mg/L).
6. The field data showed a removal rate generally greater than 54 % for dissolved zinc at an average instantaneous hydraulic loading rate up to 60 in/hr and an average influent concentration of 0.266 mg/L (average effluent concentration of 0.115 mg/L).
7. The field data showed a removal rate generally greater than 40 % for dissolved copper at an average instantaneous hydraulic loading rate up to 35 in/hr and an average influent concentration of 0.0070 mg/L (average effluent concentration of 0.0036 mg/L).
8. The field data showed an average removal rate of 93 % for total petroleum hydrocarbon (TPH) at an average instantaneous hydraulic loading rate up to 53 in/hr and an average influent concentration of 52 mg/L (average effluent concentration of 2.3 mg/L). The data also shows achievement of less than 15 mg/L TPH for grab samples. Filterra provided limited visible sheen data due to access limitations at the outlet monitoring location.
9. The field data showed low percentage removals of total phosphorus at all storm flows at an average influent concentration of 0.189 mg/L (average effluent concentration of 0.171 mg/L). We may relate the relatively poor treatment performance of the Filterra system at this location to influent characteristics for total phosphorus that are unique to the Port of Tacoma site. It appears that the Filterra system will not meet the 50 % removal performance goal when the majority of phosphorus in the runoff is expected to be in the dissolved form.

Laboratory Testing

1. Filterra performed laboratory testing on a scaled down version of the Filterra unit. The lab data showed an average removal from 83-91 % for TSS with influents ranging from 21 to 320 mg/L, 82-84 % for total copper with influents ranging from 0.94 to 2.3 mg/L, and 50-61 % for orthophosphate with influents ranging from 2.46 to 14.37 mg/L.
2. Filterra conducted permeability tests on the soil media.
3. Lab scale testing using Sil-Co-Sil 106 showed removals ranging from 70.1 % to 95.5 % with a median removal of 90.7 %, for influent concentrations ranging from 8.3 to 260 mg/L. Filterra ran these laboratory tests at an infiltration rate of 50 in/hr.
4. Supplemental lab testing conducted in September 2009 using Sil-Co-Sil 106 showed an average removal of 90.6 %. These laboratory tests were run at infiltration rates ranging from 25 to 150 in/hr for influent concentrations ranging from 41.6 to 252.5 mg/L. Regression analysis results indicate that the Filterra system's TSS removal performance is independent of influent concentration in the concentration rage evaluated at hydraulic loading rates of up to 150 in/hr.

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Ecology web link: http://www.ecy.wa.gov/programs/wq/stormwater/newtech/index.html

Ecology: Douglas C. Howie, P.E.
Department of Ecology
Water Quality Program
(360) 407-6444
douglas.howie@ecy.wa.gov

Date	**Revision**
December 2009	GULD for Basic, Enhanced, and Oil granted, CULD for Phosphorus
September 2011	Extended CULD for Phosphorus Treatment
September 2012	Revised design storm discussion, added Shallow System.
January 2013	Revised format to match Ecology standards, changed Filterra contact information
February 2013	Added FTIB-P system
March 2013	Added FTIB-C system
April 2013	Modified requirements for identifying appropriate size of unit

June 2013	Modified description of FTIB-C alternate configuration
March 2014	GULD awarded for Phosphorus Treatment. GULD updated for a higher flow-rate for Basic Treatment.
June 2014	Revised sizing calculation methods
March 2015	Revised Contact Information
June 2015	CULD for Basic and Enhanced at 100 in/hr infiltration rate
September 2019	GULD for Basic and Enhanced at 175 in/hr infiltration rate

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Filterra® Bioretention System Compliance with the Phase II Small MS4 General Permit
July 28th, 2017

Phase II Small MS4 General Permit 2013-0001-DWQ February 5, 2013
E.12. Post-Construction Storm Water Management Program
E.12.e. Low Impact Development (LID) Design Standards

E.12.e.(ii)(f) Storm Water Treatment Measures and Baseline Hydromodification Management Measures - After implementation of Site Design Measures, remaining runoff from impervious DMAs must be directed to one or more facilities designed to infiltrate, evapotranspire, and/or bioretain. Facilities must be demonstrated to be at least as effective as the prescribed 5in/hr bioretention system (this represents a minimum control measure).

E.12.e.(ii)(g) Alternative Designs — Facilities, or a combination of facilities, of a different design than in Section E.12.e.(ii)(f) may be permitted if all of the following measures of equivalent effectiveness are demonstrated:

1) Equal or greater amount of runoff infiltrated or evapotranspired;
2) Equal or lower pollutant concentrations in runoff that is discharged after biotreatment;
3) Equal or greater protection against shock loadings and spills;
4) Equal or greater accessibility and ease of inspection and maintenance.

The Filterra® Bioretention System through demonstrating the 4 measures of equivalent effectiveness to bioretention will meet the Phase II Small MS4 General Permit, *Section E.12.e.(ii)(g) Alternative Deigns* for Low Impact Development (LID) Design Standards.

- Filterra is an engineered biofiltration device with components that make it similar to bioretention in pollutant removal and application, but has been optimized for high volume/flow treatment in a compact system. Its small footprint allows Filterra to be used on highly developed sites such as landscaped areas, parking lots, and streetscapes. Filterra is adaptable and can be used alone or in combination with perforated pipes or chambers to optimize runoff reduction.[1]

Figure 1. Filterra® Bioretention System

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1) Equal or greater amount of runoff infiltrated or evapotranspired;
   The Filterra® Bioretention System either standalone, with a perforated bottom or when combined with underground storage for infiltration demonstrates equal or greater amounts of runoff infiltrated.
   - For infiltrating soils (HSGs A and B) additional underground storage will be required to satisfy infiltration requirements. If the entire Volumetric Criteria, per Section E.12.e.(ii)(c), can be infiltrated using underground storage see *Underground Infiltration Compliance with the Phase II Small MS4 General Permit*.
   - For low permeable soils (HSGs C and D) it is assumed that no quantifiable infiltration will occur.
   - For sites where infiltration is technically infeasible, no quantifiable infiltration is permitted.
   - Note that The Filterra® Bioretention System is likely to require significantly less irrigation than larger conventional bioretention systems due to their compact footprint and the fact that over 70% of annual evapotranspiration occurs in the dry summer months.

2) Equal or lower pollutant concentrations in runoff that is discharged after biotreatment;
   The Filterra® Bioretention System demonstrates equal or lower pollutant concentrations in runoff that is discharged after biotreatment.
   - The Filterra design is an optimized form of bioretention that includes all the same unit processes facilitating pollutant removal.[2]
     - 9” surface reservoir depth (Phase II, E.12.e. (f) requires 6” surface reservoir depth)
     - 3” mulch depth
     - 21” engineered media depth (plant medium containing organics), (Phase II, E.12.e. (f) requires 18” planting medium containing organics)
     - Over 300 drought tolerant tree, plant and shrub choices
     - 6”-12” drainage (gravel) layer with underdrain
   - Effluent concentrations achieved in the full-scale studies were generally equal to or lower than median effluent concentrations for the biofilter and media filter classes of BMPs reported in the International Stormwater BMP Database.[3][4]
   - Filterra showed statistically significant removals for a broader range of pollutants than were shown for the biofilter and media filter categories in the International Stormwater BMP Database.[3][4]
   - Filterra media’s pollutant removal performance (demonstrated by effluent concentration) is comparable to or better than traditional bioretention systems.[4]
   - Filterra system continues to meet pollutant removal performance expectations as the systems age and receive regular maintenance.[5]
   - Performance of the Filterra (using 165 sampled data pairs) showed equal or lower pollutant concentrations than that of conventional bioretention (using 234 sampled data pairs from bioretention with a similar specification to CA bioretention). [6]

3) Equal or greater protection against shock loadings and spills;
   The Filterra® Bioretention System demonstrates equal or greater protection against shock loadings and spills.
   - The Filterra system has a 9” surface reservoir depth that is available to capture and retain trash, sediment and debris loads. If heavy loads of particulate materials enter the system, they will be predominately be retained by the mulch layer which can be easily cleaned or removed and replaced.
   - All Filterra systems are off-line, with flows in excess of the design treatment flow rate routed around the bioretention cell, so there is minimal risk of exporting previously captured pollutants at extreme flow rates.
   - The influence of reduction in bioretention media flow rate on capture efficiency is relatively minor; a reduction in media flow rate of 50 percent from 140 to 70 inches/hour results in an expected decline in capture efficiency of less than 10 percent.[3][4]

- Filterra is effective at capturing hydrocarbons. Field monitoring has demonstrated a TPH removal efficiency of 96 percent and a median TPH effluent concentration of 1.2 mg/L.[3]
- Volatilization may also occur if VOCs (i.e. Gasoline) are captured in the filter media.[3]
- *NJCAT Verification, 4.2 Sediment Mass Loading Testing*: Over 4.5 years, and with no maintenance, 384lbs of sediment was loaded into the Filterra unit without any decrease in infiltration and removal rates.[7]
- *NJCAT Verification, 4.3 Scour Testing*: Less than 1% mass loss during scour testing.[7]
- Field installations have demonstrated The Filterra® Bioretention System to be able to withstand a 100-year event, flash flooding and large amounts of debris and sediment with performance as expected and no damage to the system and components.[8]

4) Equal or greater accessibility and ease of inspection and maintenance.
The Filterra® Bioretention System demonstrates equal or greater accessibility and ease of inspection and maintenance.
   - Inspection and maintenance is a simple, inexpensive and safe operation that does not require confined space access, pumping or vacuum equipment or specialized tools.[9]
   - Properly trained landscape personnel can effectively inspect and maintain Filterra systems by following instructions in this manual. [9]
   - Maintenance typically requires only minor trash removal and replacement of mulch. [9]
   - Maintenance typically requires only 0.5 man hours per system. [9]
   - Maintenance typically costs $100-$300 per year per system.
   - It has been found that in regions which receive between 30-50 inches of annual rainfall, (2) two visits are generally required; regions with less rainfall often only require (1) one visit per annum. [9]
   - The semiannual maintenance schedule recommended for east coast installations and annual maintenance schedule for west coast installations appears to be sufficient, based on results from maximum capacity flow rate tests demonstrating that the media flow rate was maintained at or above 100 to 140 inches/hour for Filterra systems of varying age and varying maintenance periods.[3]
   - As long as routine maintenance is performed, the Filterra® system will theoretically last indefinitely, since it essentially sequesters and recycles nutrients, metals, and organics in the biomass (i.e., plant and microbes).[3]
   - Commercial Filterra units have been field-tested in our long-term performance studies to show almost NO appreciable reduction in flowrate despite maintenance not being performed for 1 ½ to 2 years.[4]

Please contact Contech Engineering Solutions for more information.

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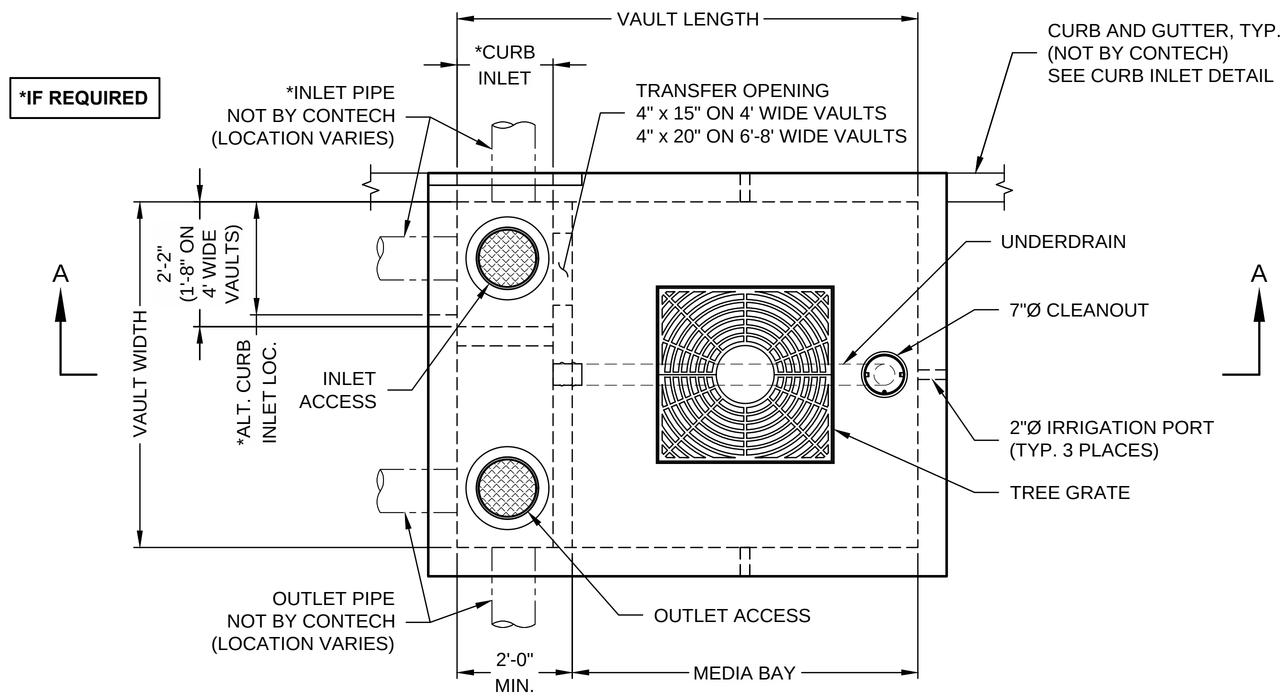
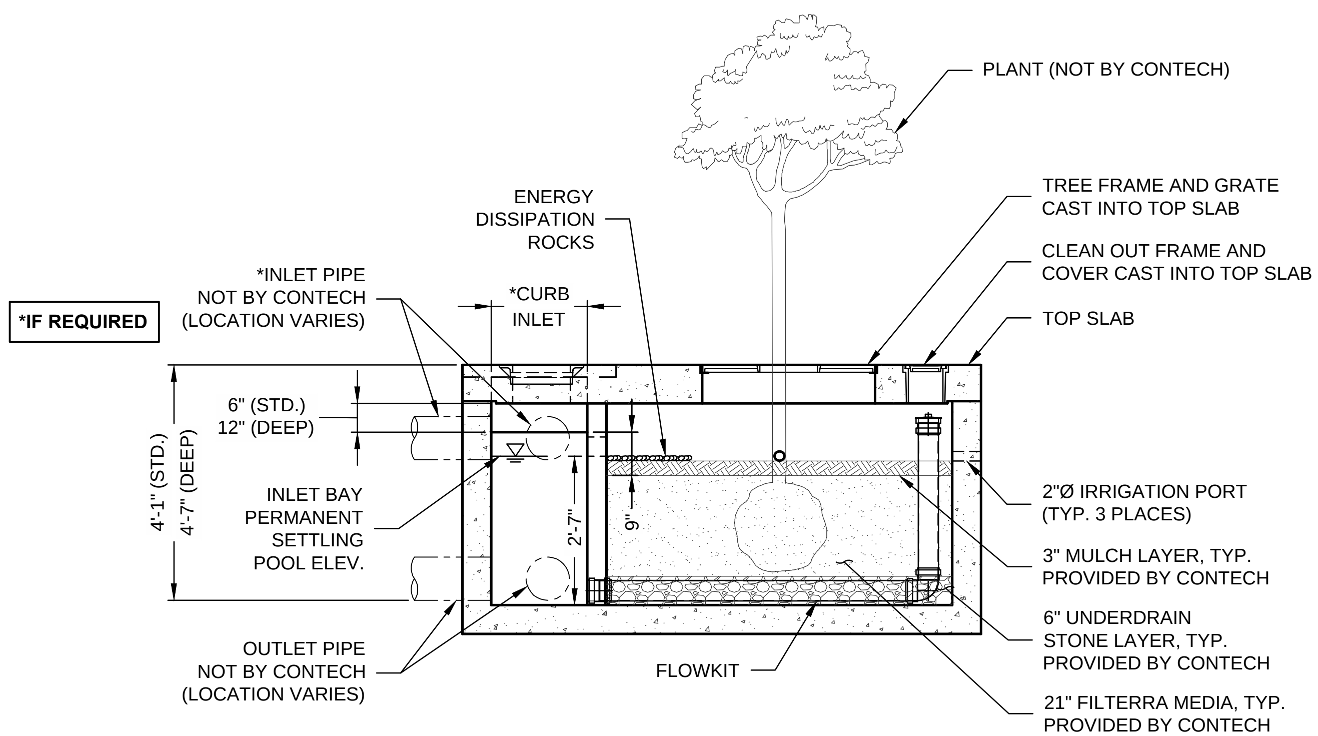
References:
1. *Filterra® Bioretention System Solution Guide*
2. *Key Features of High Performance Biofiltration*
3. *Filterra® Bioretention Systems: Technical Basis for High Flow Rate Treatment and Evaluation of Stormwater Quality Performance*
4. *Filterra High-Performance Media: A New Standard of Performance in Stormwater Quality Treatment*
5. *Filterra Performance Over Time*
6. *Filterra Equivalency Analysis and Design Criteria*
7. *NJCAT Technology Verification; Filterra® Bioretention Systems, May 2014*
8. *Case Study; Ellicott City Parking Lot E*
9. *Filterra Operation & Maintenance (OM) Manual v01*



PLAN VIEW



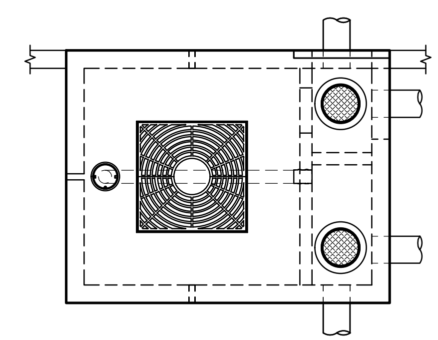
SECTION A-A
(STANDARD DEPTH SHOWN)

FTPD CONFIGURATION

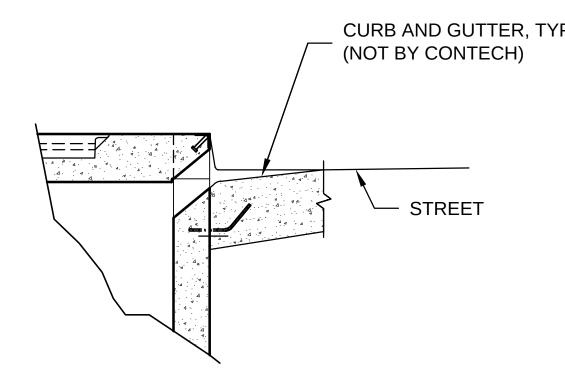
(OPTIONS: DEEP "-D", THROAT INLET "-T", PIPE INLET "-P", PIPE AND THROAT INLET "-PT')

MODEL NAME	PART NUMBER	AVAILABILITY	MEDIA AREA (SF)	MEDIA BAY SIZE	VAULT SIZE (W x L)	WEIR LENGTH/ MAX. CURB OPENING	*MAX. BYPASS FLOW (CFS) STD / DEEP	INLET/ OUTLET ACCESS DIA.	TREE GRATE QTY. AND SIZE
FTPD 4x4 (4x6 VAULT)	FTPD0404	ALL	16	4 x 4	4 x 6	1'-8"	1.4 / 4.6	12"/12"	(1) 3' x 3'
FTPD 4x6 (4x8 VAULT)	FTPD0406	ALL (EXCEPT DE, MD, NJ, PA, VA, WV)	24	4 x 6	4 x 8	1'-8"	1.4 / 4.6	12"/12"	(1) 3' x 3'
FTPD 6x4 (6x6 VAULT)	FTPD0604	ALL (EXCEPT CA, TX)	24	6 x 4	6 x 6	1'-8"	1.4 / 4.6	12"/12"	(1) 3' x 3'
FTPD 4.5x5.8 (4.5x7.8 VAULT)	FTPD045058	DE, MD, NJ, PA, VA, WV ONLY	26	4.5 x 5.83	4.5 x 7.83	1'-8"	1.4 / 4.6	12"/12"	(1) 3' x 3'
FTPD 6x6 (6x8 VAULT)	FTPD0606	ALL	36	6 x 6	6 x 8	1'-8"	1.4 / 4.6	12"/12"	(1) 3' x 3'
FTPD 6x8 (6x10 VAULT)	FTPD0608	ALL (EXCEPT CA, TX)	48	6 x 8	6 x 10	1'-8"	1.4 / 4.6	12"/12"	(1) 4' x 4'
FTPD 8x7 (8x10 VAULT)	FTPD0807	CA, TX ONLY	56	8 x 7	8 x 10	2'-6"	2.1 / 6.8	24"/24"	(1) 4' x 4'
FTPD 6x10 (6x12 VAULT)	FTPD0610	ALL (EXCEPT CA, TX)	60	6 x 10	6 x 12	1'-8"	1.4 / 4.6	12"/12"	(1) 4' x 4'
FTPD 7x10 (7x13 VAULT)	FTPD0710	ALL (EXCEPT CA, TX)	70	7 x 10	7 x 13	2'-6"	2.1 / 6.8	24"/24"	(1) 4' x 4'
FTPD 8x9 (8x12 VAULT)	FTPD0809	CA, TX ONLY	72	8 x 9	8 x 12	2' -6"	2.1 / 6.8	24"/24"	(1) 4' x 4'
FTPD 8x10.5 (8x14 VAULT)	FTPD08105	ALL	84	8 x 10.5	8 x 14	3'-0"	2.5 / 8.2	24"/24"	(1) 4' x 4'
FTPD 8x12.5 (8x16 VAULT)	FTPD08125	ALL (EXCEPT OR, WA)	100	8 x 12.5	8 x 16	3'-0"	2.5 / 8.2	24"/24"	(2) 4' x 4'
FTPD 9x11.5 (9x15 VAULT)	FTPD09115	OR, WA ONLY	103	9 x 11.5	9 x 15	3'-0"	2.5 / 8.2	24"/24"	(2) 4' x 4'

*MAX BYPASS FLOW IS INTERNAL WEIR FLOW. CAPACITIES SHOWN ARE FOR STANDARD DEPTH AND DEEP (-D), RESPECTIVELY. SITE SPECIFIC ANALYSIS IS REQUIRED TO DETERMINE CURB INLET FLOW CAPACITY.



ALTERNATE ORIENTATION



CURB INLET DETAIL

INTERNAL PIPE CONFIGURATION MAY VARY DEPENDING UPON OUTLET LOCATION

filterra
FOR PATENT INFORMATION, GO TO www.ContechES.com/IP

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800-338-1122 513-645-7000 513-645-7993 FAX

FILTERRA PEAK DIVERSION (FTPD)
CONFIGURATION DETAIL

I:\COMMON\CAD\TREATMENT\54 FILTERRA\40 STANDARD DRAWINGS\FTPD - PEAK DIVERSION\FTPD\LAYOUT DETAILS\DWG\FTPD - FILTERRA PEAK DIVERSION CONFIG DTL.DWG 3/17/2023 8:03 AM

Operation & Maintenance (OM) Manual v01

filterra®

Bioretention Systems

CONTECH®

ENGINEERED SOLUTIONS

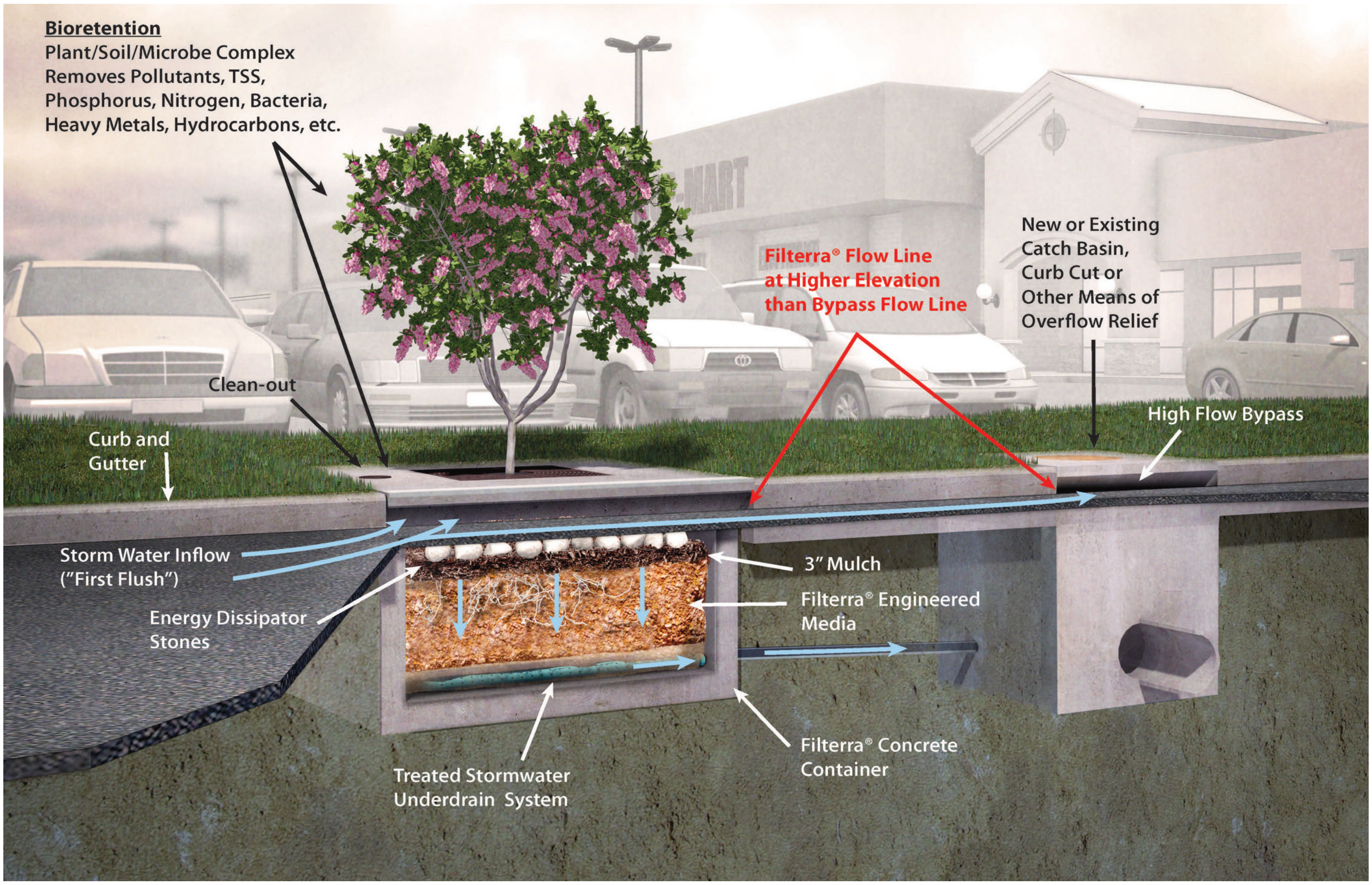
filterra®
Bioretention Systems

Table of Contents

CONTECH®
ENGINEERED SOLUTIONS

General Description

The following general specifications describe the general operations and maintenance requirements for the Contech Engineered Solutions LLC stormwater bioretention filtration system, the Filterra®. The system utilizes physical, chemical and biological mechanisms of a soil, plant and microbe complex to remove pollutants typically found in urban stormwater runoff. The treatment system is a fully equipped, pre-constructed drop-in place unit designed for applications in the urban landscape to treat contaminated runoff.



Stormwater flows through a specially designed filter media mixture contained in a landscaped concrete container. The mixture immobilizes pollutants which are then decomposed, volatilized and incorporated into the biomass of the Filterra® system's micro/macro fauna and flora. Stormwater runoff flows through the media and into an underdrain system at the bottom of the container, where the treated water is discharged. Higher flows bypass the Filterra® to a downstream inlet or outfall. Maintenance is a simple, inexpensive and safe operation that does not require confined space access, pumping or vacuum equipment or specialized tools. Properly trained landscape personnel can effectively maintain Filterra® Stormwater systems by following instructions in this manual.

Basic Operations

Filterra® is a bioretention system in a concrete box. Contaminated stormwater runoff enters the filter box through the curb inlet spreading over the 3-inch layer of mulch on the surface of the filter media. As the water passes through the mulch layer, most of the larger sediment particles and heavy metals are removed through sedimentation and chemical reactions with the organic material in the mulch. Water passes through the soil media where the finer particles are removed and other chemical reactions take place to immobilize and capture pollutants in the soil media. The cleansed water passes into an underdrain and flows to a pipe system or other appropriate discharge point. Once the pollutants are in the soil, the bacteria begin to break down and metabolize the materials and the plants begin to uptake and metabolize the pollutants. Some pollutants such as heavy metals, which are chemically bound to organic particles in the mulch, are released over time as the organic matter decomposes to release the metals to the feeder roots of the plants and the cells of the bacteria in the soil where they remain and are recycled. Other pollutants such as phosphorus are chemically bound to the soil particles and released slowly back to the plants and bacteria and used in their metabolic processes. Nitrogen goes through a very complex variety of biochemical processes where it can ultimately end up in the plant/bacteria biomass, turned to nitrogen gas or dissolves back into the water column as nitrates depending on soil temperature, pH and the availability of oxygen. The pollutants ultimately are retained in the mulch, soil and biomass with some passing out of the system into the air or back into the water.

Design and Installation

Each project presents different scopes for the use of Filterra® systems. To ensure the safe and specified function of the stormwater BMP, Contech reviews each application before supply. Information and help may be provided to the design engineer during the planning process. Correct Filterra® box sizing (by rainfall region) is essential to predict pollutant removal rates for a given area. The engineer shall submit calculations for approval by the local jurisdiction. The contractor is responsible for the correct installation of Filterra units as shown in approved plans. A comprehensive installation manual is available at www.conteches.com.

Maintenance

Why Maintain?

All stormwater treatment systems require maintenance for effective operation. This necessity is often incorporated in your property's permitting process as a legally binding BMP maintenance agreement.

- Avoid legal challenges from your jurisdiction's maintenance enforcement program.
- Prolong the expected lifespan of your Filterra media.
- Avoid more costly media replacement.
- Help reduce pollutant loads leaving your property.

Simple maintenance of the Filterra® is required to continue effective pollutant removal from stormwater runoff before discharge into downstream waters. This procedure will also extend the longevity of the living biofilter system. The unit will recycle and accumulate pollutants within the biomass, but is also subjected to other materials entering the throat. This may include trash, silt and leaves etc. which will be contained within the void below the top grate and above the mulch layer. Too much silt may inhibit the Filterra's® flow rate, which is the reason for site stabilization before activation. Regular replacement of the mulch stops accumulation of such sediment.

When to Maintain?

Contech includes a 1-year maintenance plan with each system purchase. Annual included maintenance consists of a maximum of two (2) scheduled visits. Additional maintenance may be necessary depending on sediment and trash loading (by Owner or at additional cost). The start of the maintenance plan begins when the system is activated for full operation. Full operation is defined as the unit installed, curb and gutter and transitions in place and activation (by Supplier) when mulch and plant are added and temporary throat protection removed.

Activation cannot be carried out until the site is fully stabilized (full landscaping, grass cover, final paving and street sweeping completed). Maintenance visits are scheduled seasonally; the spring visit aims to clean up after winter loads including salts and sands while the fall visit helps the system by removing excessive leaf litter.

It has been found that in regions which receive between 30-50 inches of annual rainfall, (2) two visits are generally required; regions with less rainfall often only require (1) one visit per annum. Varying land uses can affect maintenance frequency; e.g. some fast food restaurants require more frequent trash removal. Contributing drainage areas which are subject to new development wherein the recommended erosion and sediment control measures have not been implemented may require additional maintenance visits.

Some sites may be subjected to extreme sediment or trash loads, requiring more frequent maintenance visits. This is the reason for detailed notes of maintenance actions per unit, helping the Supplier and Owner predict future maintenance frequencies, reflecting individual site conditions.

Owners must promptly notify the (maintenance) Supplier of any damage to the plant(s), which constitute(s) an integral part of the bioretention technology. Owners should also advise other landscape or maintenance contractors to leave all maintenance to the Supplier (i.e. no pruning or fertilizing).

Exclusion of Services

It is the responsibility of the owner to provide adequate irrigation when necessary to the plant of the Filterra® system.

Clean up due to major contamination such as oils, chemicals, toxic spills, etc. will result in additional costs and are not covered under the Supplier maintenance contract. Should a major contamination event occur the Owner must block off the outlet pipe of the Filterra® (where the cleaned runoff drains to, such as drop inlet) and block off the throat of the Filterra®. The Supplier should be informed immediately.

Maintenance Visit Summary

Each maintenance visit consists of the following simple tasks (detailed instructions below).

1. Inspection of Filterra® and surrounding area
2. Removal of tree grate and erosion control stones
3. Removal of debris, trash and mulch
4. Mulch replacement
5. Plant health evaluation and pruning or replacement as necessary
6. Clean area around Filterra®
7. Complete paperwork

Maintenance Tools, Safety Equipment and Supplies

Ideal tools include: camera, bucket, shovel, broom, pruners, hoe/rake, and tape measure. Appropriate Personal Protective Equipment (PPE) should be used in accordance with local or company procedures. This may include impervious gloves where the type of trash is unknown, high visibility clothing and barricades when working in close proximity to traffic and also safety hats and shoes. A T-Bar or crowbar should be used for moving the tree grates (up to 170 lbs ea.). Most visits require minor trash removal and a full replacement of mulch. See below for actual number of bagged mulch that is required in each unit size. Mulch should be a double shredded, hardwood variety; do not use colored or dyed mulch. Some visits may require additional Filterra® engineered soil media available from the Supplier.

Box Length	Box Width	Filter Surface Area (ft^2)	Volume at 3" (ft^3)	# of 2 ft^3 Mulch Bags
4	4	4	4	2
6	4	6	6	3
8	4	8	8	4
6	6	9	9	5
8	6	12	12	6
10	6	15	15	8
12	6	18	18	9
13	7	23	23	12

Maintenance Visit Procedure

Keep sufficient documentation of maintenance actions to predict location specific maintenance frequencies and needs. An example Maintenance Report is included in this manual.

1. Inspection of Filterra® and surrounding area

- Record individual unit before maintenance with photograph (numbered). Record on Maintenance Report (see example in this document) the following:

Record on Maintenance Report the following:

Standing Water	yes | no
Damage to Box Structure	yes | no
Damage to Grate	yes | no
Is Bypass Clear	yes | no

If yes answered to any of these observations, record with close-up photograph (numbered).

2. Removal of tree grate and erosion control stones

- Remove cast iron grates for access into Filterra® box.
- Dig out silt (if any) and mulch and remove trash & foreign items.

Record on Maintenance Report the following:

Silt/Clay	yes | no
Cups/ Bags	yes | no
Leaves	yes | no
# of Buckets Removed	________

3. Removal of debris, trash and mulch

- After removal of mulch and debris, measure distance from the top of the Filterra® engineered media soil to the bottom of the top slab. If this distance is greater than 12", add Filterra® media (not top soil or other) to recharge to a 9" distance

Record on Maintenance Report the following:

Distance of Bottom of Top Slab (inches)	________
# of Buckets of Media Added	________

4. Mulch replacement

- Please see mulch specifications.
- Add double shredded mulch evenly across the entire unit to a depth of 3”.
- Ensure correct repositioning of erosion control stones by the Filterra® inlet to allow for entry of trash during a storm event.
- Replace Filterra® grates correctly using appropriate lifting or moving tools, taking care not to damage the plant.

5. Plant health evaluation and pruning or replacement as necessary

- Examine the plant’s health and replace if dead.
- Prune as necessary to encourage growth in the correct directions

Record on Maintenance Report the following:

Height above Grate	(Feet)
Width at Widest Point	(feet)
Health	alive | dead
Damage to Plant	yes | no
Plant Replaced	yes | no

6. Clean area around Filterra®

- Clean area around unit and remove all refuse to be disposed of appropriately.

7. Complete paperwork

- Deliver Maintenance Report and photographs to appropriate location (normally Contech during maintenance contract period).
- Some jurisdictions may require submission of maintenance reports in accordance with approvals. It is the responsibility of the Owner to comply with local regulations.

Maintenance Checklist

Drainage System Failure	Problem	Conditions to Check	Condition that Should Exist	Actions
Inlet	Excessive sediment or trash accumulation.	Accumulated sediments or trash impair free flow of water into Filterra.	Inlet should be free of obstructions allowing free distributed flow of water into Filterra.	Sediments and/or trash should be removed.
Mulch Cover	Trash and floatable debris accumulation.	Excessive trash and/or debris accumulation.	Minimal trash or other debris on mulch cover.	Trash and debris should be removed and mulch cover raked level. Ensure bark nugget mulch is not used.
Mulch Cover	"Ponding" of water on mulch cover.	"Ponding" in unit could be indicative of clogging due to excessive fine sediment accumulation or spill of petroleum oils.	Stormwater should drain freely and evenly through mulch cover.	Recommend contact manufacturer and replace mulch as a minimum.
Vegetation	Plants not growing or in poor condition.	Soil/mulch too wet, evidence of spill. Incorrect plant selection. Pest infestation. Vandalism to plants.	Plants should be healthy and pest free.	Contact manufacturer for advice.
Vegetation	Plant growth excessive.	Plants should be appropriate to the species and location of Filterra.		Trim/prune plants in accordance with typical landscaping and safety needs.
Structure	Structure has visible cracks.	Cracks wider than 1/2 inch or evidence of soil particles entering the structure through the cracks.		Vault should be repaired.

Maintenance is ideally to be performed twice annually.

CONTECH ENGINEERED SOLUTIONS

Skupe Sizing Schematic

3

by Al Pagan, P.E., L.S.

Detention basin sizing—quick & dirty

Many civil engineers who design and/or review detention basins have their own quick and dirty method for coming up with a fast answer — a curbstone opinion — when asked the question: "Approximately how large a detention basin will be needed to achieve zero increase in the flow rate leaving a site, after development, for a 100-year storm?"

In my own practice I know of about half a dozen "methodologies" which answer the question, some of which I devised myself. But recently I ran across a method that an engineer friend of mine uses which, based on my own review of it, works very well.

My colleague, Joe Skupien, P.E., practices primarily in New Jersey and uses the methodology outlined below. "Skupe" (as many of us in the state know him) apparently developed this method on his own, but it is certainly possible that other engineers in a parallel universe may be using a similar approach to getting a fast answer to an often asked question.

Skupe cautioned me that this is definitely an approximate method. For more accurate results and a detailed design, an inflow hydrograph should be developed and the storage indication (or other) routing procedure utilized. However, it has been my experience that Skupe's procedure works very well and I recommend it (used with caution) to anyone who needs a fast, approximate answer.

Probably the simplest solution to the quick and dirty detention basin problem is to provide a site-specific depth of runoff, spread throughout the area to be paved, or otherwise made impervious. In New Jersey, which is a relatively humid state, through experience and countless detailed detention basin designs, I have found that two inches of depth over the total proposed newly-paved area is almost always sufficient to assure zero increase in the runoff rate leaving a site (for the 100-year storm). Here is how it works:

Assume you have a 10-acre site and that 100,000 square feet, or slightly more than two acres, of it will be newly-paved after you construct a small subdivision on it. A two-inch depth (one-sixth of a foot) over 100,000 square feet equals a volume of 16,667 cubic feet.

My experience in New Jersey (it must be emphasized that the two-inch value is geographically specific) confirms that providing 16,667 cubic feet of storage will prove to be adequate to assure zero increase in runoff.

However, one should be cautioned that in some places (heavy rainfall areas such as the southeastern United States come to mind), it is likely that a depth greater than two inches would be needed.

Similarly, in semi-arid climates, such as the southwest, almost certainly less than two inches of depth would be required.

I intend to write a follow-up on this subject, so if anyone has his, or her, own way of solving the quick-answer problem relating to detention basins (or any other engineering subject) please let me know. ■

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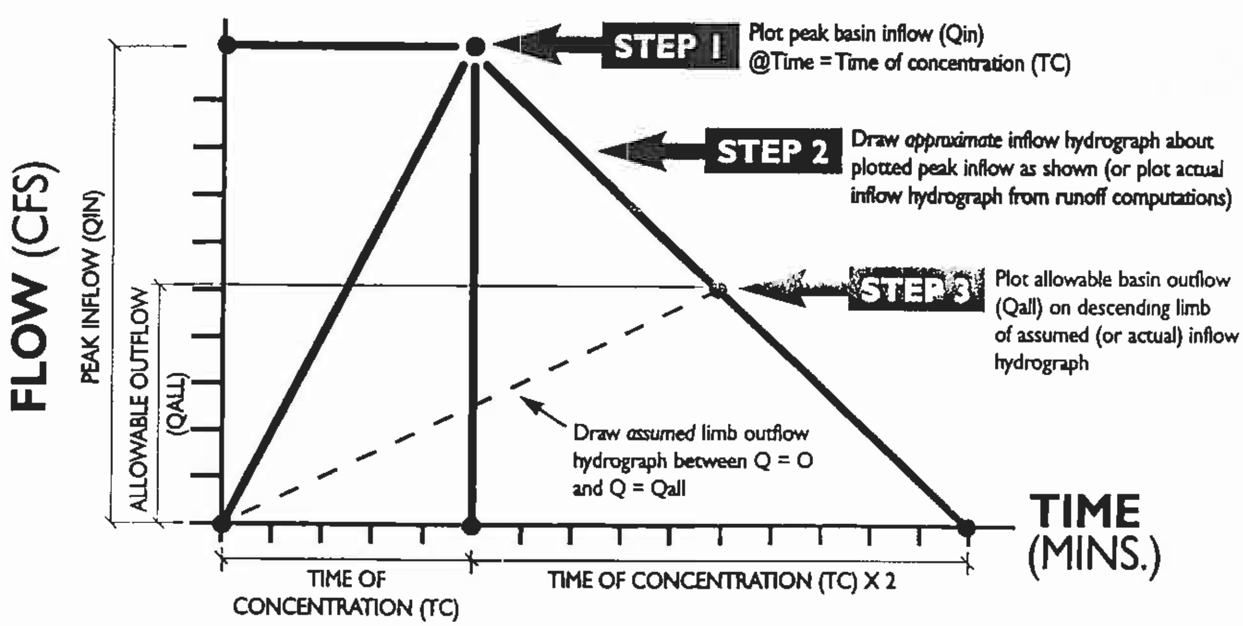
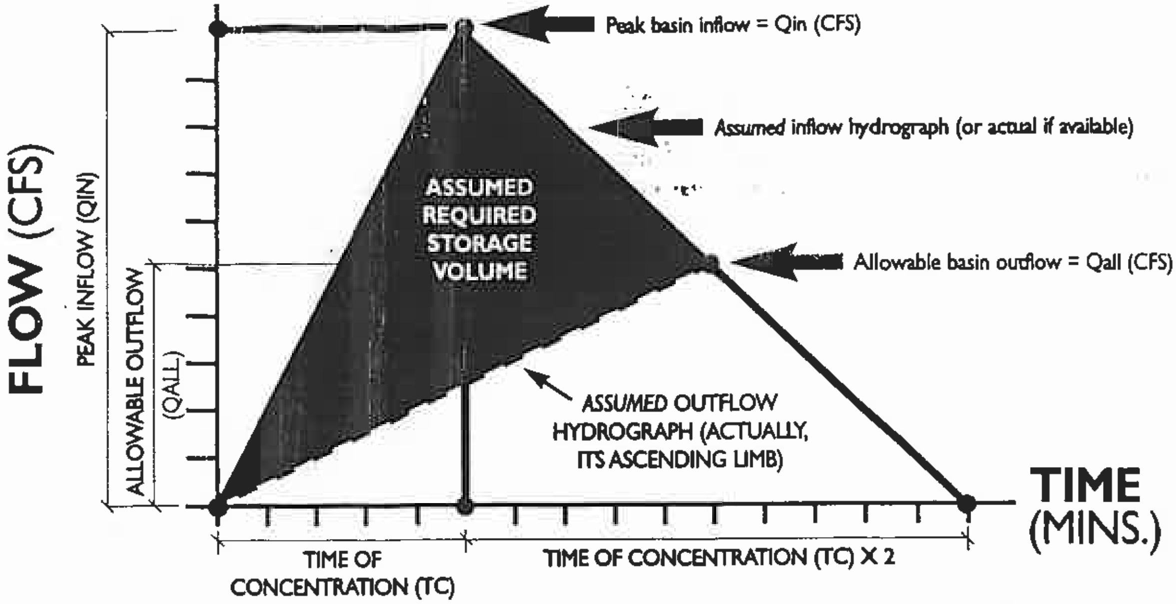
Estimating Required Detention Basin Storage Volume





From theory and geometry: Required storage volume = Difference in area of two triangles
From theory and experience: Approximate required storage volume = (Qin-Qall)(3)(TC)(0.5)(60sec/min)(K) ~ CF
Where: Qin = Peak basin inflow (in CFS)
Qall = Allowable peak outflow (in CFS)
TC = Time of concentration (in mins.)
K = Factor to account for nonlinearity of actual hydrographs; Normal range = 1.2 to 1.5 w/o stormwater quality, 1.5 to 2.0 w/stormwater quality
Note: Do not use for SCS methodology flows where Qall < 0.2 Qin

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