



Commonwealth of Virginia

VIRGINIA DEPARTMENT OF ENVIRONMENTAL QUALITY

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Matthew J. Strickler
Secretary of Natural Resources

David K. Paylor
Director
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January 16, 2020

Mr. Chris French
National Regulatory Manager
BioClean, a Forterra Company
10364 Design Road
Ashland, VA 23005

Transmitted electronically to: chris.french@forterrabp.com

Re: Assignment of Percent Removal Efficiencies for Total Phosphorus

Dear Mr. French:

The Department of Environmental Quality (DEQ) has reviewed the General Use Level Designation (GULD) certification from the Washington State Technology Assessment Protocol – Ecology (TAPE) for the Kraken™ Membrane Filter Device received on December 10, 2019. **In accordance with § 62.1-44.15:28 of the Stormwater Management Act, 9VAC25-870-65 C of the Virginia Stormwater Management Program Regulation, and DEQ Guidance Memo No. 14-2009, the Kraken™ Membrane Filter is hereby approved.**

Section 62.1-44.15:28 A.9 of the Stormwater Management Act requires the Department to “provide for reciprocity with programs in other states for certification of proprietary best management practices.” This approval is based on reciprocity with the Washington State TAPE program’s GULD. The GULD approval from Washington State TAPE program is attached.

The Kraken™ Membrane Filter is approved with a 50 percent total phosphorous pollutant removal efficiency. This information will be posted on the Virginia Stormwater Clearinghouse website. This device and the assigned removal efficiency can be manually added into Virginia Runoff Reduction Method (VRRM) spreadsheet to demonstrate compliance with the VRRM.

If you have any questions regarding this information, please contact Robert E. Cooper, P.E. at (804) 698-4033 or e-mail at Robert.Cooper@deq.virginia.gov.

Sincerely,

A handwritten signature in blue ink, appearing to read "AJH".

Andrew J. Hammond, II
Acting Manager, Office of Stormwater Management

Appendix A
Certification letters from
Washington State, Department of Ecology



December 2019

GENERAL USE LEVEL DESIGNATION (GULD) FOR BASIC (TSS) AND PHOSPHORUS

For

**BioClean Environmental Services, Inc's
The Kraken™ Membrane Filter**

Ecology's Decision:

Based on BioClean Environmental Services, Inc's application submissions for the Kraken™ Membrane Filter, Ecology hereby issues the following use level designations:

1. **General Use Level Designation (GULD) for Basic Treatment and Phosphorus Treatment, at the following water quality design hydraulic loading rates:**
 - **Basic Treatment: Sized at a hydraulic loading rate of no more than 0.05000 gpm/ft² per cartridge.**
 - **Phosphorus Treatment: Sized at a hydraulic loading rate of no more than 0.04353 gpm/ft² per cartridge.**

Table 1. Kraken Membrane Filter cartridge design flow rates,

Effective Cartridge Height (in)	Surface Area (ft²)	Basic Treatment Cartridge Flow Rate (gpm)	Phosphorus Treatment Cartridge Flow Rate (gpm)
30.75	170	8.5	7.40
19.5	90	4.5	3.92
9.625	40	2.0	1.74

2. **Ecology approves the Kraken™ Membrane Filter systems at the hydraulic loading rates shown in Table 1, to achieve the maximum water quality design flow rate. The water quality design flow rates are calculated 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 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.

3. The GULD has no expiration date, but may be amended or revoked by Ecology.

Ecology's Conditions of Use:

The Kraken™ Membrane Filter shall comply with these conditions:

1. Design, assemble, install, operate, and maintain the Kraken™ Membrane Filter installations in accordance with Bio Clean Environmental Services, Inc.'s applicable manuals and the Ecology Decision.
2. Each site plan must undergo Bio-Clean Environmental Service's review and approval before site installation. This will ensure that site grading and slope are appropriate for use of a Kraken™ unit.
3. The Kraken™ Membrane Filter cartridges shall conform to the specifications submitted to and approved by Ecology
4. **Maintenance:** The required inspection/maintenance interval for stormwater treatment devices is often dependent on the efficiency of the device and 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 filter treatment device.

- The Kraken™ Membrane Filter is designed for a target maintenance interval of 12 months. Maintenance includes oil removal, sediment removal, and washing or replacing the filter cartridges.
- A Kraken™ Membrane Filter tested at the Lake Union Ship Canal Test Facility in Seattle, WA required servicing after 8.3% of a water year. Monitoring personnel observed similar cases of early blinding with other systems evaluated at the Test Facility. The runoff from the Test Facility may be unusual and service needs of systems installed at the Test Facility may not be indicative of other, more typical, sites.
- Hydraulic testing results provided to Ecology from a Kraken™ Membrane Filter evaluated in the field in Tacoma, WA indicated the unit is capable of a maintenance cycle that is equivalent to 36 - 56% of a water year.
- Test results provided to Ecology from a Kraken™ Membrane Filter evaluated in a lab have indicated the Kraken™ Membrane Filter is capable of longer maintenance intervals. This evaluation was done in accordance with the New Jersey Department of Environmental Protection (NJDEP) Laboratory Protocol to Assess Total Suspended Solids Removal by a Filtration Manufactured Treatment Device.

- **Owners/operators must inspect the Kraken™ Membrane Filters for a minimum of twelve months from the start of post-construction operation to determine site-specific service needs of the system. Owners/operators must conduct inspections monthly during the wet season, and every other month during the dry season. (According to the SWMMWW, the wet season in western Washington is October 1 to April 30. According to the SWMMEW, the wet season in eastern Washington is October 1 to June 30.) After the first year of operation, owners/operators must conduct inspections based on the findings during the first year of inspections.**
- **Conduct inspections by qualified personnel, follow manufacturer’s guidelines, and use methods capable of determining either a decrease in treated effluent flow rate and/or a decrease in pollutant removal ability.**

- 5. Install the Kraken™ Membrane Filter in such a manner that you bypass flows exceeding the maximum operating rate and you will not resuspend captured sediment.**
- 6. Discharges from the Kraken™ Membrane Filter shall not cause or contribute to water quality standards violations in receiving waters.**

Applicant: Bio-Clean Environmental, Inc.

Applicant’s Address: PO Box 869
Oceanside, CA 92049

Application Documents:

Application for Pilot Use Level Designation, The Kraken™ Membrane Filter, Bio-Clean Environmental Services, Inc. November 2015

NJCAT Technology Verification: Kraken™ Membrane Filtration System, Bio-Clean Environmental Services, Inc. October 2015

Application for Conditional Use Level Designation, The Kraken™ Membrane Filter, Bio-Clean Environmental Services, Inc. June 20, 2017

Quality Assurance Project Plan, The Kraken™ Membrane Filter, Bio-Clean Environmental Services, Inc. August 22, 2017

Technical Evaluation Report, The Kraken™ Membrane Filter, Bio Clean Environmental Services, Inc. December 9, 2019

Applicant’s Use Level Request:

- General Use Level Designation as a Basic and Phosphorus Treatment device in accordance with Ecology’s *Stormwater Management Manual for Western Washington*

Applicant's Performance Claims:

- Based on field testing, at a hydraulic loading rate of 0.05 gpm/sq. ft. (8.5 gpm/cartridge for a 30.75" tall cartridge), the Kraken™ Membrane Filter is able to remove 80% or greater of total suspended solids (TSS) for influent concentrations greater than 100 mg/L and achieve less than a 20 mg/L effluent for influent concentrations less than 100 mg/L.
- Based on field testing, at a hydraulic loading rate of 0.04 gpm/sq. ft. (7.4 gpm/cartridge for a 30.75" tall cartridge), the Kraken™ Membrane Filter is able to remove 50% or greater total phosphorus for influent concentrations 0.1 to 0.5 mg/L.

Ecology's Recommendations:

Ecology finds that:

- Bio-Clean Environmental, Inc. has shown Ecology, through laboratory and field testing, that the Kraken™ Membrane Filter is capable of attaining Ecology's Basic and Phosphorus treatment goals.

Findings of Fact:

Field Testing

1. Herrera Environmental Consultants, Inc. conducted monitoring of the Kraken™ Membrane Filter at the Lake Union Ship Canal Test Facility in Seattle, WA. Herrera collected flow-weighted composite samples during 12 storm events between October 2016 and April 2017. They also collected peak flow grab samples from an additional two storm events.
 - Samples from 13 storm events met the TAPE influent concentration requirements for TSS. Influent concentrations from these 13 samples ranged from 31 to 162 mg/L, with a mean concentration of 77.9 mg/L. The bootstrap estimate of the upper 95 percent confidence limit (UCL95) of the mean TSS effluent concentration was 10.1 mg/L. A regression analysis of effluent concentration versus average treated flow rate show that the Kraken met the TAPE effluent goal of 20 mg/L at the design hydraulic loading rate of 0.05 gpm per square foot of filter area.
 - Samples from 14 storm events were used in the total phosphorus removal analysis. Influent concentrations from these 14 samples ranged from 0.062 to 0.290 mg/L, with a mean concentration of 0.151 mg/L. The bootstrap estimate of the lower 95 percent confidence limit (LCL95) of the mean total phosphorus percent reduction was 64.2 percent. A regression analysis of the percent removal versus average treated flow rate show that the Kraken met the TAPE 50% removal goal at a design hydraulic loading rate of 0.04 gpm per square foot of filter area.
 - The D₅₀ of the influent PSD ranged from 2 to 450 microns, with an average D₅₀ of 22 microns.
 - The system was subjected to atypical sediment loading and needed to be serviced after 8.3% of a water year. Monitoring personnel observed similar sediment loading and blinding issues with other systems evaluated at the Test Facility. The runoff from the Test Facility is not expected to be characteristic of other urban runoff applications. Future inspections will be used to supplement these findings regarding cartridge longevity.

Laboratory Testing

2. Good Harbour Laboratories conducted laboratory testing in August 2015 at their site in Mississouga, Ontario. Good Harbour Laboratories is an independent water technology-testing lab. The laboratory set up tested a commercially available Kraken™ Membrane Filter, model KF-4-4. This unit has a total sedimentation area of 11.72 sq. ft. and contains 16 filters, which allowed for a hydraulic loading rate of 0.303 cfs (136 gpm). Based on the lab test results:

- Bio-Clean evaluated the system using a custom blended test sediment consisting of a 50:7 ratio of 1- to 1,000-micron Silica blended with Min-U-Sil® 30. The test sediment had a mean particle size of 52 microns, with an overall particle size distribution of 43 percent sand, 46 percent silt, and 11 percent clay.
- Bio-Clean evaluated removal efficiency over 16 events using an influent SSC concentration of 200 mg/L. The Kraken™ Membrane Filter model KF-4-4, operating at 100% of the hydraulic flow capacity with an average influent SSC concentration of 200 mg/l, had an average removal efficiency of 83 percent.
- Bio-Clean evaluated sediment mass loading capacity over an additional 17 events using an influent SSC concentration of 400 mg/L. The Kraken™ Membrane Filter model KF-4-4, operating at 100% of the hydraulic flow capacity with an average influent SSC concentration of 400 mg/l, had an average removal efficiency of 89 percent.
- Bio-Clean terminated the sediment mass loading capacity test once the mass of the captured sediment exceeded 1.5 times the recommended minimum amount for filter maintenance. The total mass of sediment captured was 434 pounds.
- Bypass conditions did not occur during the removal efficiency or sediment mass loading capacity tests.

Other Kraken™ Membrane Filter Related Issues to be Addressed By the Company:

1. Conduct hydraulic testing to obtain information about maintenance requirements on a site with runoff that is more typical of the Pacific Northwest.

Technology Description:

Download at <http://www.biocleanenvironmental.com/>

Contact Information:

Applicant:

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BioClean A Forterra Company.
(760) 433-7640
Zach.kent@forterrabp.com

Applicant website:

<http://www.biocleanenvironmental.com/products/>

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
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Revision History

Date	Revision
January 2016	PULD Granted
July 2017	Revised Manufacturer Contact Information
September 2017	Upgrade certification to a CULD
March 2019	Revised TER and Expiration dates
December 2019	GULD Granted