

Approved Chemicals for Stormwater Chemical Treatment facilities

C-TAPE

The Washington State Department of Ecology (Ecology) evaluates stormwater Chemical Treatment Facilities through the Chemical Technical Assessment Protocol – Ecology (C-TAPE) program. Ecology has approved several Chitosan Enhanced Sand Filtration (CESF) devices through this program. Each of the approved devices specifies a single type of Chitosan as the flocculent chemical. Varieties of Previously approved Chitosan include:

- FloccClear
- 1.0% ChitoVan™
- 1.5% ChitoVan™
- StormKlear®LiquiFloc® 1% solution
- StormKlear®LiquiFloc® Maximum Strength 3% solution

Ecology received requests for approval of chemicals as an alternative to the approved chemicals.

Ecology created a Whole Effluent Testing protocol for applicants to follow if they want Ecology to evaluate them for approval. The protocol is located in Appendix G of the *Laboratory Guidance and Whole Effluent Toxicity Test Review Criteria* (Publication W-R-95-80). You can obtain a copy of this document at:

<https://fortress.wa.gov/ecy/publications/summarypages/9580.html>

Ecology approved the chemical described in the attached Approval Document following completion of the toxicity testing procedures. You may use this chemical in a CESF system as a replacement of one of the five Chitosan products listed above. You must follow the requirements in the General Use Level Designation document for the remainder of the CESF system including sand filter, monitoring, backwash, and maximum flow rate.

Use of this chemical in CESF operation requires submittal of the Request for Chemical Treatment form (<https://fortress.wa.gov/ecy/publications/summarypages/ecy070258.html>). The applicant must list the alternative chemical in the space for “Other” in the “Check Chemical Being Requested” item.

**EXPANDED APPROVAL OF CESF TREATMENT USING LIQUIFLOC 1% TO ALLOW
ADDITION OF BHR-P50
August 28, 2014**

The chitosan-enhanced sand filtration (CESF) stormwater treatment system using HaloKlear LiquiFloc containing 1% chitosan acetate has been granted General Use Level Designation in Washington State. Natural Site Solutions, LLC submitted the original Intended Use Plan dated November 18, 2004 to describe how the LiquiFloc concentration will be kept below its toxic threshold to key species. The intended use plan describes how a CESF system is operated so that the chitosan dose concentration is always below the most sensitive toxic threshold. After being dosed to a concentration that is below the toxic threshold, the chitosan concentration in the stormwater will be reduced further by binding to suspended solids and then binding to the sand filter before being discharged.

The following list includes the toxicity tests and species that were performed and has added the results from the mysid 7-day survival and growth test. The approval is now expanded to include discharges to any surface water in the state, including lakes and marine waters.

A second list of toxicity tests and results has been added for BHR-P50. HaloKlear BHR-P50 is a blended biopolymer and polyaluminum chloride formulation. This approval allows the use of BHR-P50 in a CESF with HaloKlear LiquiFloc™ containing 1% chitosan acetate. LiquiFloc 1% may also be used in a CESF without BHR-P50 or with LBP-2101 as per the February 11, 2013 approval for LBP-2101.

Toxicity Tests and Results

Toxicity Testing Results for LiquiFloc 1% (as mg/L of chitosan acetate)

Test	Endpoint	EC₅₀ (mg/L)	EC₂₅ (mg/L)
<i>Daphnia pulex</i> 48-hr acute	survival	23.2	18.3
rainbow trout 96-hr acute	survival	1.73	1.28
fathead minnow 96-hr acute	survival	6.42	1.26
rainbow trout 7-day survival & growth	survival	1.54	1.21
	weight	> 2.5	> 2.5
fathead minnow 7-day survival & growth	survival	> 10	9.32
	weight	> 10	6.88
rainbow trout embryo viability	viability	> 10	> 10
fathead minnow embryo-larval survival & teratogenicity	survival	> 10	> 10
	development	10	10
mysid 7-day survival & growth	survival	> 4	> 4
	weight	> 4	0.98

Toxicity Testing Results for HaloKlear BHR-P50 (as mg/L of product)

Test	Endpoint	EC₅₀ (mg/L)	EC₂₅ (mg/L)
Daphnid 48-hr acute	not done	NA	NA
rainbow trout 96-hr acute	not useable	NA	NA
fathead minnow 96-hr acute	not useable	NA	NA
<i>Ceriodaphnia</i> 7-day survival and reproduction	not useable	NA	NA
rainbow trout 7-day survival & growth	survival	1389	1157
	biomass	1199	573
	weight	> 1000	618
rainbow trout embryo viability	survival	> 2000	> 2000
	viability	> 2000	> 2000
mysid 7-day survival & growth	survival	> 500	> 500
	biomass	> 500	> 500
	weight	> 500	> 500

Intended Discharge Concentration

The intended discharge concentration is conservatively estimated to be 0.1 mg/L chitosan acetate. The Residual Chitosan Field Screening Test has been performed hundreds of times on treatment system effluent. The detection limit of this procedure is 0.1 mg/L and no chitosan has ever been detected in effluent. In addition, clean water containing 2 mg/L of chitosan was passed through a sand filter in a bench scale test and no chitosan was detected in the filtrate using a procedure with a detection limit of 0.03 mg/L.

BHR-P50 does not have an intended discharge concentration reported in the intended use plan. Instead the dose rate is reported. The BHR-P50 dose will be determined by a treatability test. BHR-P50 will be dosed at 300 mg/L or lower. BHR-P50 doses above 300 mg/L might be approved on a case-by-case basis. Dosing at 500 mg/L or higher will not be allowed. All toxic thresholds are above 500 mg/L product. There is an inherent safety margin because the treatment dose will be below the toxic threshold and BHR-P50 will subsequently be reduced by solids removal.

Safety Margin for the Most Sensitive Response (mysid weight)

The LiquiFloc 1% toxic thresholds are all greater than three times the intended discharge concentrations. Therefore, the safety margins are not considered to be narrow. In addition, 14-day flow-through toxicity testing with rainbow trout was done in 2004 at a construction site in Redmond, Washington with the result of 100% survival. No confidence building period of flow-through or *in-situ* toxicity testing is needed. The data support the future approval of chitosan concentrations above 1.06 mg/L in very turbid stormwater prior to sand filtration without needing to change the goal of the intended use plan of keeping the dose concentration below the toxic threshold.

Maintenance of Safety Margin

Chitosan acetate can effectively treat stormwater turbidity up to 600 NTU without using a concentration above 1.06 mg/L. 1.06 mg/L chitosan is below its toxic threshold of 1.21 mg/L in clear water. In addition, chitosan will be removed from solution by binding to solids and by being withheld in the sand filter. The safety margin will certainly be maintained if the treatment concentration is kept to 1.06 mg/L or below. Any mechanical failure of the positive displacement metering pump will immediately cause a reduction in LiquiFloc dosing so pump failure is only a problem for treatment effectiveness and not safety margin maintenance.

The following dose rate table shall be used to ensure both treatment plant effectiveness and a chitosan concentration below 1.06 mg/L prior to sand filtration.

LiquiFloc (1% chitosan acetate) Dose Based on Flow and Turbidity			
turbidity	stormwater flow rate	LiquiFloc dose rate	chitosan concentration
50 - 200 NTU	200 gpm	20 ml/min or 0.32 gph	0.26 mg/L
	300 gpm	30 ml/min or 0.48 gph	
	400 gpm	40 ml/min or 0.64 gph	
	500 gpm	50 ml/min or 0.8 gph	
	600 gpm	60 ml/min or 0.96 gph	
	700 gpm	70 ml/min or 1.11 gph	
200 - 400 NTU	200 gpm	40 ml/min or 0.64 gph	0.53 mg/L
	300 gpm	60 ml/min or 0.96 gph	
	400 gpm	80 ml/min or 1.27 gph	
	500 gpm	100 ml/min or 1.6 gph	
	600 gpm	120 ml/min or 1.91 gph	
	700 gpm	140 ml/min or 2.23 gph	
400 - 600 NTU	200 gpm	80 ml/min or 1.27 gph	1.06 mg/L
	300 gpm	120 ml/min or 1.91 gph	
	400 gpm	160 ml/min or 2.54 gph	
	500 gpm	200 ml/min or 3.17 gph	
	600 gpm	240 ml/min or 3.81 gph	

700 gpm

280 ml/min or 4.45 gph

Checking formula:

chitosan concentration in mg/L = (ml/min LiquiFloc x 0.01 x 1 g/ml x 1000 mg/g)/system flow rate in liters/min
liters/min = gpm x 3.78 liters/gal

Safety Margin Checklist

- This approval and checklist are based upon the HaloKlear BHR-P50 Intended Use Plan submitted as an e-mail attachment on August 27, 2014.
- Only HaloKlear LiquiFloc containing 1% chitosan acetate shall be used under this approval.
- HaloKlear BHR-P50 doses of 300 mg/L or lower are allowed.
- No more than 500 mg/L of HaloKlear BHR-P50 may be dosed to any construction stormwater wastestream.
- Treatment using between 300 mg/L and 500 mg/L of HaloKlear BHR-P50 may be approved on a case-by-case basis.
- No more HaloKlear BHR-P50 or LiquiFloc may be added than is needed to provide adequate treatment.
- The ratio of HaloKlear BHR-P50 to LiquiFloc shall be determined based on the results of bench/jar testing using site stormwater.
- Metering pumps for the treatment chemicals shall be positive displacement and have anti-siphon valves.
- Metering pumps shall be calibrated at startup using a calibration cylinder and every time that the HaloKlear LiquiFloc or BHR-P50 dose rate needs changed. The calibration shall be recorded in the log. The stroke frequency shall be set as high as possible and the stroke length adjusted to provide the correct dosing.
- The system flow rate and the turbidity of both influent and effluent shall be measured hourly and recorded in the log.
- No chitosan-treated water shall be discharged to surface water without first being sand-filtered.
- Secondary containment for the LiquiFloc and BHR-P50 storage containers and the metering pumps shall be at least equal to the volume of the storage container.
- Spill adsorbent material shall be readily available to immobilize any spill of LiquiFloc or BHR-P50 during handling.
- If the treatment system or storage areas are located less than 50 feet from surface water, a 1-foot high earthen berm shall be constructed and maintained down-gradient as additional spill containment.
- The occasional use of the Residual Chitosan Field Screening Test to confirm a discharge concentration below 0.1 is encouraged in order to further build confidence in CESF system safety.