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September 2, 2011

Lawrence Lee
Waste and Environmental Technologies, Inc.
6256 Spring Mountain Road
Suite 100-A
Las Vegas, NV 89146

RE: Waste and Environmental Technologies Inc. (WetSep)
Functionally Equivalent (BMP C250)

Dear Mr. Lee:

The Washington State Department of Ecology (Ecology) finds WetSep system is functionally equivalent to a rapid sand filter for use in Chitosan Enhanced Sand Filtration (BMP C250).

The WetSep system must adhere to the guidelines in the enclosed specifications.

Contractors may use the WetSep system at project sites without seeking additional Ecology approval, though Ecology cannot endorse this product or its manufacturer.

For more information, you may contact me at (360) 407-6444, or email at douglas.howie@ecy.wa.gov.

Sincerely

Douglas C. Howie, P.E.
Program Development Services
Water Quality Program

Enclosure

cc: Kurt Marx, TAPE Technical Lead, Washington Stormwater Center

Construction Stormwater Chemical Treatment Using Waste and Environmental Technologies Inc. (WetSep) Filtration System (Functionally Equivalent to rapid sand filter in BMP C250)

Purpose

This BMP[1] applies when using Waste and Environmental Technologies Inc. (WetSep) filtration where stormwater is treated by using chemicals in flow-through treatment.

Turbidity is difficult to control once fine particles are suspended in stormwater runoff from a construction site. Sedimentation ponds are effective at removing larger particulate matter by gravity settling, but are ineffective at removing smaller particulates such as clay and fine silt.

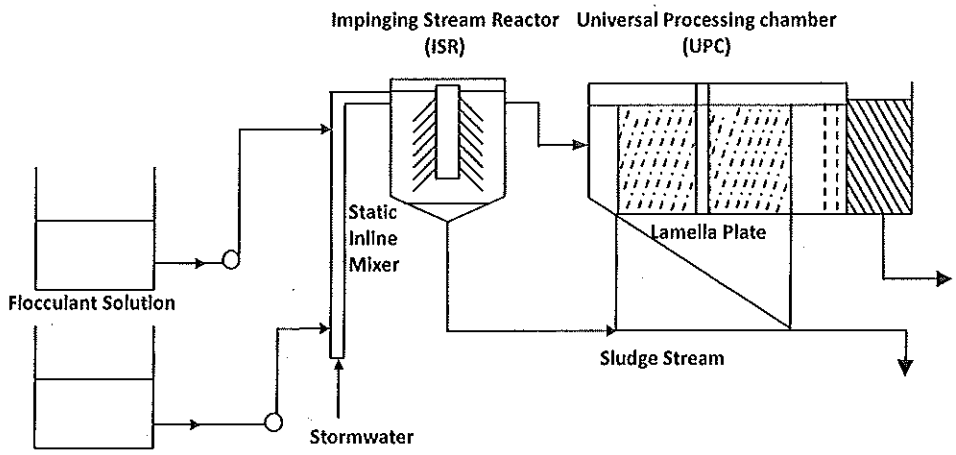
Traditional erosion and sediment control BMPs may not be adequate to ensure compliance with the water quality standards for turbidity in receiving water.

Chemical treatment can reliably provide exceptional reductions of turbidity and associated pollutants. Chemical treatment may be required to meet turbidity stormwater discharge requirements, especially when construction is to proceed through the wet season.

Description

The water and wastewater filtration system (WetSep) is designed for construction runoff and other effluent from construction activities, and has been employed in construction works in the North America, Singapore, and Hong Kong using a flow-through chemically enhanced primary treatment (CEPT). For construction site stormwater runoff with a turbidity of less than 1000 NTU (influent), the WetSep filtration system will remove greater than 99 % of the turbidity. For construction site stormwater runoff with a turbidity of less than 5000 NTU (influent), a properly engineered and deployed WetSep filtration system can still remove greater than 99 % of the turbidity. Turbidity of the treated water can be as low as 5 NTU. The WetSep system removes suspended solids in stormwater using different technologies, including coagulation, flocculation, impinging stream reaction, conical separator, and lamella plate. The patented impinging stream reactor (ISR) makes use of turbulence and centrifugal force provided by the spiral path to enhance the collisions between the particles and flocculants and hence enhance the formation of larger flocs for settlement. The flocs are separated from the streams according to density. Oil rises to the top of the chamber, suspended solids to the bottom and clearer water leaves via a cone filter to the next chamber, lamella plate. The oil can then separate from the surface. The Figure below is a schematic diagram of the WetSep system.

[1] BMP=Best Management Practice



A significant amount of suspended solids is removed after entering the inverted cone filter. In order to further polish the stormwater, lamella plates are installed in the Universal Processing Chamber (UPC) to enhance of the settling characteristics of the suspended solids. The separation speed can be increased by tilting the lamella plate compared to a conventional clarifier. The theory assumes that settling depends on the settling area rather than detention time. Clarification is achieved in the lamella plate if the upstream velocity is low enough to allow solids to report to the lamella plate. The area above the feed point is used for clarification and the area below the feed point is used for thickening.

The Universal Processing Chamber (UPC) has also been designed to accommodate various means of filter media and absorbents such as zeolite, silica sand, and activated carbon.

Conditions of Use

Formal written approval from Ecology is required for the use of chemical treatment regardless of site size. The Local Permitting Authority may also require review and approval. When approved, the chemical treatment system must be included in the Stormwater Pollution Prevention Plan (SWPPP).

The WetSep system can only be used with chemicals that are approved by Ecology. Operation must follow all pertinent requirements for chemically enhanced flow-through treatment systems as outlined in use-level-designation documents (www.ecy.wa.gov/programs/wq/stormwater/newtech/construction.html)., including monitoring for aquatic toxicity or residual chemical.

See Appendix II-B in the Stormwater Management Manual for Western Washington (SWMMWW) or Appendix 7C in the Stormwater Management Manual for Eastern Washington (SWMMEW) for background information on chemical treatment.

Design and Installation Specifications

Criteria for Chemical Treatment Product Use: Chemically treated stormwater discharged from construction sites must be nontoxic to aquatic organisms. The Chemical Technology Assessment Protocol (CTAPE) must be used to evaluate chemicals proposed for stormwater treatment. Only chemicals approved by Ecology under the CTAPE may

be used for stormwater treatment. You can find the approved chemicals, their allowable application techniques (batch treatment or flow-through treatment), allowable application rates, and conditions of use at the Department of Ecology Emerging Technologies website: http://www.ecy.wa.gov/programs/wq/stormwater/newtech/index.html.

Treatment System Design Considerations: The design and operation of a chemical treatment system should take into consideration the factors that determine optimum, cost-effective performance. It is important to recognize the following:

- Only Ecology approved chemicals may be used and must follow approved dose rates.
- The pH of the stormwater must be in the proper range for the polymers to be effective, which is typically 6.5 to 8.5. The WetSep system has a pH controlling system to adjust the pH to meet this requirement.
- A flocculation step is important to increase the rate of settling, to produce the lowest turbidity, and to keep the dosage rate as low as possible. The WetSep system provides both a coagulation and flocculation stage in the system located in the ISR.
- Too little energy input into the water during the flocculation phase results in flocs that are too small and/or insufficiently dense. Too much energy can rapidly destroy floc as it is formed.
- Care must be taken in the design of the withdrawal system to minimize outflow velocities and to prevent floc discharge. The sludge can be discharged automatically through electric actuated valves and sludge pumps controlled by timer. Discharge from a batch treatment system should be directed through a physical filter such as a vegetated swale that would catch any unintended floc discharge.
- System discharge rates must take into account downstream conveyance integrity. The WetSep has a gravity discharge effluent system.

Polymer Flow-Through Treatment Process Description

At a minimum, a flow-through chemical treatment system consists of the stormwater collection system (either temporary diversion or the permanent site drainage system), an untreated stormwater storage pond, and the chemically enhanced primary treatment (CEPT) system.

Stormwater is collected at interception point(s) on the site and is diverted by gravity or by pumping to an untreated stormwater storage pond or other untreated stormwater holding area. The stormwater is stored until treatment occurs. It is important that the holding pond be large enough to provide adequate storage.

Stormwater is then pumped from the untreated stormwater storage pond to the chemically enhanced WetSep filtration system where polymer is added. Adjustments to pH may be necessary before chemical addition. The system continually monitors the stormwater for turbidity and pH. If the discharge water is ever out of an acceptable range for turbidity or pH, the water is recycled to the untreated stormwater pond where it can be retreated.

For WetSep flow-through treatment, the following equipment items are located in a lockable shed:

- the chemical injector and chemical mixing system;
- secondary non-corrosive containment for acid, caustic, buffering compound, and treatment chemical;
- emergency shower and eyewash, and
- monitoring equipment.

The chemical system has been designed to minimize the potential for overdosing chemicals and discharging the residual into the effluent stream. The PLC/Controller has six (6) inputs to allow control of the chemical dosing based on monitoring of the parameters. The WetSep system monitors the following parameters: influent and effluent turbidity, influent and effluent pH, and effluent flow. The coagulant and flocculant are dosed proportional to turbidity and/or flow, and pH adjustment is proportional to the pH readings. This system minimizes the amount of chemicals that are released in the effluent.

System Sizing

Four capacities of WetSep filtration systems are provided for treating different volumes of construction runoff. The treatment capacity of WetSep WS10, WS20, WS40, and WS100 are 20-40, 70-90, 220-260 and 350-440 gallons per minute, respectively. The sizing chart for various models of WetSep is listed in the table below. In general, WS 10, WS 20 and WS 60 are used for roadwork (40 GPM), building project (100 GPM) and site formation (250 GPM) respectively. WS100 is used for tunnel project and bore pile discharge (500 GPM). However, the selection of WetSep also depends on the rainfall and the size of the construction site.

WetSep filtration system sizing table

WetSep Model	ISR Diameter (ft)	Water Inlet (inches)	Water Outlet (inches)	Water Quality Treatment Flow (GPM)
WS10	5.1	3	3	20-40
WS20	7.1	3	3	70-90
WS40	7.9	3	4	220-260
WS100	8.0	6	8	350-440

Certain sites are required to implement flow control for the developed sites. These sites must also control stormwater release rates during construction. Generally, these are sites that discharge stormwater directly, or indirectly, through a conveyance system, into a fresh or marine water. System sizing is dependent on flow control requirements.

Sizing Criteria for Batch Treatment Systems for Flow Control Exempt Water Bodies:

The total volume of the untreated stormwater storage pond and treatment ponds or tanks must be large enough to treat the volume of stormwater that is produced during multiple day storm events. It is recommended that at a minimum the untreated stormwater storage

pond be sized to hold 1.5 times the runoff volume of the 10-year, 24-hour storm event. Bypass should be provided around the chemical treatment system to accommodate extreme storm events. Runoff volume shall be calculated using the methods presented in Volume 3, Chapter 2. Worst-case land cover conditions (i.e., producing the most runoff) should be used for analyses (in most cases, this would be the land cover conditions just prior to final landscaping).

Primary settling should be encouraged in the untreated stormwater storage pond. A forebay with access for maintenance may be beneficial.

There are two opposing considerations in sizing the treatment cells. A larger cell is able to treat a larger volume of water each time a batch is processed. However, the larger the cell the longer the time required to empty the cell. A larger cell may also be less effective at flocculation and therefore require a longer settling time. The simplest approach to sizing the treatment cell is to multiply the allowable discharge flow rate times the desired drawdown time. A 4-hour drawdown time allows one batch per cell per 8-hour work period, given 1 hour of flocculation followed by two hours of settling.

If the discharge is directly to a lake, flow control exempt receiving water listed in Appendix E of Volume I, or to an infiltration system, there is no discharge flow limit.

Ponds sized for flow control water bodies must at a minimum meet the sizing criteria for flow control exempt waters.

Sizing Criteria for Flow-Through Treatment Systems for Flow Control Exempt Water Bodies:

When sizing storage ponds or tanks for flow-through systems for flow control exempt water bodies, the treatment system capacity should be a factor. The untreated stormwater storage pond or tank should be sized to hold 1.5 times the runoff volume of the 10-year, 24-hour storm event minus the treatment system flowrate for an 8-hour period. For a chitosan-enhanced sand filtration system, the treatment system flowrate should be sized using a hydraulic loading rate between 6-8 gpm/ft^2. Other hydraulic loading rates may be more appropriate for other systems. Bypass should be provided around the chemical treatment system to accommodate extreme storms. Runoff volume shall be calculated using the methods presented in Volume 3, Chapter 2. Worst-case land cover conditions (i.e., producing the most runoff) should be used for analyses (in most cases, this would be the land cover conditions just prior to final landscaping).

Sizing Criteria for Flow Control Water Bodies:

Sites that must implement flow control for the developed site condition must also control stormwater release rates during construction. Construction site stormwater discharges shall not exceed the discharge durations of the pre-developed condition for the range of pre-developed discharge rates from ½ of the 2-year flow through the 10-year flow as predicted by an approved continuous runoff model. The pre-developed condition to be matched shall be the land cover condition immediately prior to the development project. This restriction on release rates can affect the size of the storage pond and treatment cells.

The following is how WWHM can be used to determine the release rates from the chemical treatment systems:

1. Determine the pre-developed flow durations to be matched by entering the land use area under the "Pre-developed" scenario in WWHM. The default flow range is from ½ of the 2-year flow through the 10-year flow.
2. Enter the post-developed land use area in the "Developed Unmitigated" scenario in WWHM.
3. Copy the land use information from the "Developed Unmitigated" to "Developed Mitigated" scenario.
4. While in the "Developed Mitigated" scenario, add a pond element under the basin element containing the post-developed land use areas. This pond element represents information on the available untreated stormwater storage and discharge from the chemical treatment system. In cases where the discharge from the chemical treatment system is controlled by a pump, a stage/storage/discharge (SSD) table representing the pond must be generated outside WWHM and imported into WWHM. WWHM can route the runoff from the post-developed condition through this SSD table (the pond) and determine compliance with the flow duration standard. This would be an iterative design procedure where if the initial SSD table proved to be inadequate, the designer would have to modify the SSD table outside WWHM, re-import in WWHM, and route the runoff through it again. The iteration will continue until a pond that complies with the flow duration standard is correctly sized.

Notes on SSD table characteristics:

The pump discharge rate would likely be initially set at just below ½ of the 2-year flow from the pre-developed condition. As runoff coming into the untreated stormwater storage pond increases and the available untreated stormwater storage volume gets used up, it would be necessary to increase the pump discharge rate above ½ of the 2-year. The increase(s) above ½ of the 2-year must be such that they provide some relief to the untreated stormwater storage needs but at the same time will not cause violations of the flow duration standard at the higher flows. The final design SSD table will identify the appropriate pumping rates and the corresponding stage and storages.

When building such a flow control system, the design must ensure that any automatic adjustments to the pumping rates will be because of changes to the available storage in accordance with the final design SSD table.

1. It should be noted that the above procedures would be used to meet the flow control requirements. The chemical treatment system must be able to meet the runoff treatment requirements. It is likely that the discharge flow rate of ½ of the 2-year or more may exceed the treatment capacity of the system. If that is the case, the untreated stormwater discharge rate(s) (i.e., influent to the treatment system) must be reduced to allow proper treatment. Any reduction in the flows would likely result in the need for a larger untreated stormwater storage volume.
2. If the discharge is to a municipal storm drainage system, the allowable discharge rate may be limited by the capacity of the public system. It may be necessary to clean the municipal storm drainage system prior to the start of the discharge to prevent

scouring solids from the drainage system. If the municipal storm drainage system discharges to a water body not on the flow control exempt list, the project site is subject to flow control requirements.

3. If system design does not allow you to discharge at the slower rates as described above and if the site has a retention or detention pond that will serve the planned development, the discharge from the treatment system may be directed to the permanent retention/detention pond to comply with the flow control requirement. In this case, the untreated stormwater storage pond and treatment system will be sized according to the sizing criteria for flow-through treatment systems for flow control exempt water bodies described earlier except all discharge (water passing through the treatment system and stormwater bypassing the treatment system) will be directed into the permanent retention/detention pond. If site constraints make locating the untreated stormwater storage pond difficult, the permanent retention/detention pond may be divided to serve as the untreated stormwater storage pond and the post-treatment flow control pond. A berm or barrier must be used in this case so the untreated water does not mix with the treated water. Both untreated stormwater storage requirements, and adequate post-treatment flow control must be achieved. The post-treatment flow control pond's revised dimensions must be entered into the WWHM and the WWHM must be run to confirm compliance with the flow control requirement.

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Maintenance Standards

Monitoring:

At a minimum, the following monitoring shall be conducted. Test results shall be recorded on a daily log kept on site.

Additional testing may be required by the NPDES permit based on site conditions

Operational Monitoring

- Total volume treated and discharged

- Flow must be continuously monitored and recorded at not greater than15-minute intervals
- Type and amount of chemical used for pH adjustment, if any
- Quantity of chemical used for treatment

Compliance Monitoring

- Influent and effluent pH and turbidity must be continuously monitored and recorded at not greater than 15-minute intervals.
- pH and turbidity of the receiving water

Biomonitoring

Treated stormwater must be non-toxic to aquatic organisms. Treated stormwater must be tested for aquatic toxicity or residual chemical content. Frequency of biomonitoring will be determined by Ecology.

Residual chemical tests must be approved by Ecology prior to their use.

If testing treated stormwater for aquatic toxicity, you must test for acute (lethal) toxicity. Bioassays shall be conducted by a laboratory accredited by Ecology, unless otherwise approved by Ecology. Acute toxicity tests shall be conducted per the CTAPE protocol.

Discharge Compliance:

Prior to discharge, treated stormwater must be sampled and tested for compliance with pH and turbidity limits.

The Construction Stormwater General Permit or a site-specific discharge permit may establish these limits. Sampling and testing for other pollutants may also be necessary at some sites. pH must be within the range of 6.5 to 8.5 standard units and not cause a change in the pH of the receiving water of more than 0.2 standard units.

Treated stormwater samples and measurements shall be taken from the discharge pipe or another location representative of the nature of the treated stormwater discharge. Samples used for determining compliance with the water quality standards in the receiving water shall not be taken from the treatment pond prior to decanting. Compliance with the water quality standards is determined in the receiving water.

Operator Training:

An experienced contractor on an active site shall train each contractor who intends to use chemical treatment. Installation and optimization of WetSep filtration systems will be provided for each installation and commissioning. The operation of the WetSep should take into consideration the following in order to determine the optimum and cost effective performance of the treatment system:

Prior to authorization for field use, jar tests shall be conducted in order to demonstrate that turbidity reduction necessary to meet the receiving water quality criteria can be achieved. Test conditions, particularly the dosage and raw water quality, should be indicative of field conditions. Although these small-scale tests cannot be expected to reproduce actual

performance under all field conditions, they are indicative of treatment capability and indicative of various chemical dose rates required for effective treatment. The jar tests also help to minimize the potential for chemical overdose in the treatment system.

Standard BMPs:

Surface stabilization BMPs should be implemented on site to prevent significant erosion. All sites shall use a truck wheel wash to prevent tracking of sediment off site.

Sediment Removal and Disposal:

- The sludge collected from the WetSep filtration system can be collected automatically by setting the time for turning on the actuator in the control system. Based on the solid removal efficiency of the WetSep filtration system, the amount of sludge collected per unit time can be estimated by a mass balance between the total solid concentration in the influent and effluent solution. Then the time for sludge drainage can be estimated.
- Sediment shall be transferred from the WetSep to dewatering tank by sludge diaphragm pump.
- Sediment that is known to be non-toxic may be incorporated into the site away from drainages.