WASHINGTON STATE DEPARTMENT OF ECOLOGY

February 18, 2005
(Updated March 2008, October 2009, March 2010, November 2011)

GENERAL USE LEVEL DESIGNATION FOR EROSION AND SEDIMENT CONTROL

For

Water Tectonics' Wave Ionics™ Electrocoagulation Subtractive Technology (ECST)

<u>Ecology's Decision</u>:

Based on Water Tectonics' application documents, Ecology is hereby issuing:

- **A general use level designation (GULD) for the iron-based automated electrocoagulation subtractive technology (ECST) as part of a treatment train designed, fabricated, and operated by Water Tectonics, Inc..**

This designation has no expiration date, but it may be amended or revoked by Ecology and is subject to all conditions contained in this use level designation.

<u>Ecology's Conditions of Use</u>:

1. **Ecology hereby approves the Water Tectonics' Quality Assurance Project Plan (QAPP), Version 3, dated January 13, 2006.**

2. **Discharges from the system under these conditions are expected to achieve performance goals of a maximum of 10 NTU turbidity, 300 ppb iron above background, and a discharge pH within a range of 6.5-8.5.**

3. **Source control procedures shall be implemented to the maximum extent feasible to minimize the need for the use of the system.**

4. **During system operation, water quality influent and effluent shall be continuously monitored and recorded for pH, turbidity, and flow. Influent and effluent total iron shall be monitored to verify that the system is not releasing iron (i.e., the effluent concentration is not 300 ppb above the influent concentration).**

5. **The discharge flowrate shall be continuously metered and recorded.**

6. **The following information will be downloaded from the system on a weekly basis:**

   - **Date range**
   - **Influent pH**
   - **Effluent pH**
   - **Influent turbidity**
   - **Effluent turbidity**
   - **Conductivity**
   - **Discharge flowrates**
   - **Record of equipment calibration**

7. **At the end of the operating period, a delegated responsible person shall record their assessment of the operational efficiency of the electrocoagulation process, any upsets, and any other relevant observations that relate to system operation. They must also certify the acceptability of the discharges to surface water.**

8. **Discharges from the system shall not cause or contribute to receiving water quality violations and shall comply with the discharge requirements of the State of Washington Construction Stormwater General Permit, AKART, and local government requirements for turbidity and other applicable pollutants. This designation document must be used as the basis for Stormwater Pollution Prevention Plans (SWPPPs) for all construction sites where electrocoagulation is planned.**

9. **The ECST system shall only be operated by a trained technician certified through a training program that includes classroom and field instruction. Only Water Tectonics trained operators may operate systems. The ECST operator must remain on-site during system operation or have the system set to remote notification (via text to mobile phone). In remote notification mode the operator must be within a distance to provide response within a reasonable time period. The technician must have the following minimum requirements:**

   Prerequisites:
   - **Current certification as a Certified Erosion and Sediment Control Lead (CESCL), through an Ecology-approved CESCL training course.**
   - **Advanced knowledge of installation, maintenance, and troubleshooting pressurized water pumping and piping systems.**
   - **Experience with, and working knowledge of, pressurized sand filters.**
   - **Basic knowledge of stormwater discharge regulations pertinent to the site.**
   - **Basic knowledge of water quality testing procedures for parameters pertinent to the site.**
   - **Basic working knowledge of electronics and programmable logic systems.**

Classroom (4 hours)

- **Overview of applicable stormwater regulations.**
- **Overview of applicable basic water chemistry (including the influences of suspended sediment loads, pH, and conductivity on stormwater treatment)**
- **Flow-through Wave Ionics™ system components and operation**
- **Troubleshooting the system**

In the field (20 hours)

- **System operation/hydraulics**
- **Accessing and retrieving water quality data from the data loggers**
- **Familiarization with Control Panel operation and set points. Review of integrated safety controls and alert notification system**
- **Calibrating in-line monitoring equipment**
- **Maintenance**
- **Troubleshooting**

Design Criteria for EST Systems:

1. **Systems must be designed using relevant portions of the most current version of BMP C251 of the Western Washington Stormwater Management Manual. The most recent versions can be found: http://www.ecy.wa.gov/programs/wq/stormwater/manual.html. System design must consider downstream conveyance system integrity.**

2. **The facility shall employ a minimum of three (3) sand filter pods to ensure adequate backwashing capacity. The backwash slurry from the sand filters must be discharged to a holding cell that is separate from the temporary storage cell for the incoming turbid stormwater. The overflow from the backwash slurry detention cell can overflow into the detention basin for the incoming turbid stormwater. Filters shall be sized to meet the normal flow rate through the ECST system with a peak flow rate greater than or equal to 120% of the normal flow rate.**

3. **The ECST system shall include a flow-regulating valve on the input to and output of the filter. These regulating valves will reduce the maximum output of the pump as required and facilitate proper backwash.**

4. **The ECST system treated water output shall be equipped with an automatic integrated turbidity and pH sensor capable of recirculating water to the source if the output turbidity or pH exceeds preset values. The system will also be equipped with sensors in the source and settling tanks (or equivalent detention structures) that will shut-off the system prior to overflow. An audible alarm with warning light and/or a text notification to a mobile phone shall be installed on the treatment system to alert the operator in the event of a system failure.**

Applicant: Ms. Liisa Doty
Watertectonics, Inc.

Applicant's Address: 6300 Merrill Creek Parkway, Suite C-100
Everett, WA 98203

Application Documents:

- "Notice of Application for "Conditional Use of Electrocoagulation Subtractive Technology for Continuous Water Treatment Applications at Construction Sites", James Mothersbaugh, Water Tectonics, Inc., September 22, 2003.
- "Electrocoagulation Treatment of Construction Stormwater", City of Redmond and EES Consulting, Inc., February, 2003.
- "Electrocoagulation – The Process", James Mothersbaugh, Water Tectonics, February 10, 2004.
- "Technical Overview", James Mothersbaugh, May 2004.
- Letter from James Mothersbaugh responding to 6/4/04 comments by Ecology, June 24, 2004.
- Letter from James Mothersbaugh responding to 7/14/04 comments by Ecology, August 31, 2004.
- Letter by Roger Cecil, P. E., recommending a CUD for the Water Tectonics ECST technology, August 26, 2004.
- ECST Specifications letter from Water Tectonics dated October 2, 2009
- Operations Information letter from Water Tectonics dated November 17, 2009
- Water Tectonics Specification Sheet sent to Ecology via email December 21, 2009
- Water Tectonics memo dated Feb 10,2010

Applicant's Use Level Request:

Conditional use level designation, as defined in Ecology's CTAPE protocol, for the Electrocoagulation Subtractive Technology (ECST) for continuous water treatment applications at construction sites.

Applicant's Performance Claims:

The Water Tectonics ECST generates proper amounts of iron in stormwater to provide coagulation and flocculation for enhanced removal of small particulate turbidity such as colloidal turbidity. The ECST is used as part of a treatment train that includes sedimentation, pH control, and filtration. The discharge from the treatment train can achieve turbidities below 10 NTU, 0.3 mg/L iron, and pH within 6.5-8.5.

Note: Descriptions of the ECST and the entire treatment train are provided at the end of this designation document.

Findings of Fact:

1. ECST is emerging as a convenient source of iron and aluminum coagulant aids for the removal of extremely small particulates in stormwater. Several companies are currently developing this technology nationwide. Water Tectonics, Inc. has used the ECST at 5 construction sites in WA.

2. WT conducted field studies during 11/2001-6/2002 on runoff from an 8.3 acre and a 23 acre construction site in Redmond WA*. The runoff was treated using an ECST-based treatment train and monitored with the following results and conclusions reported by WT:

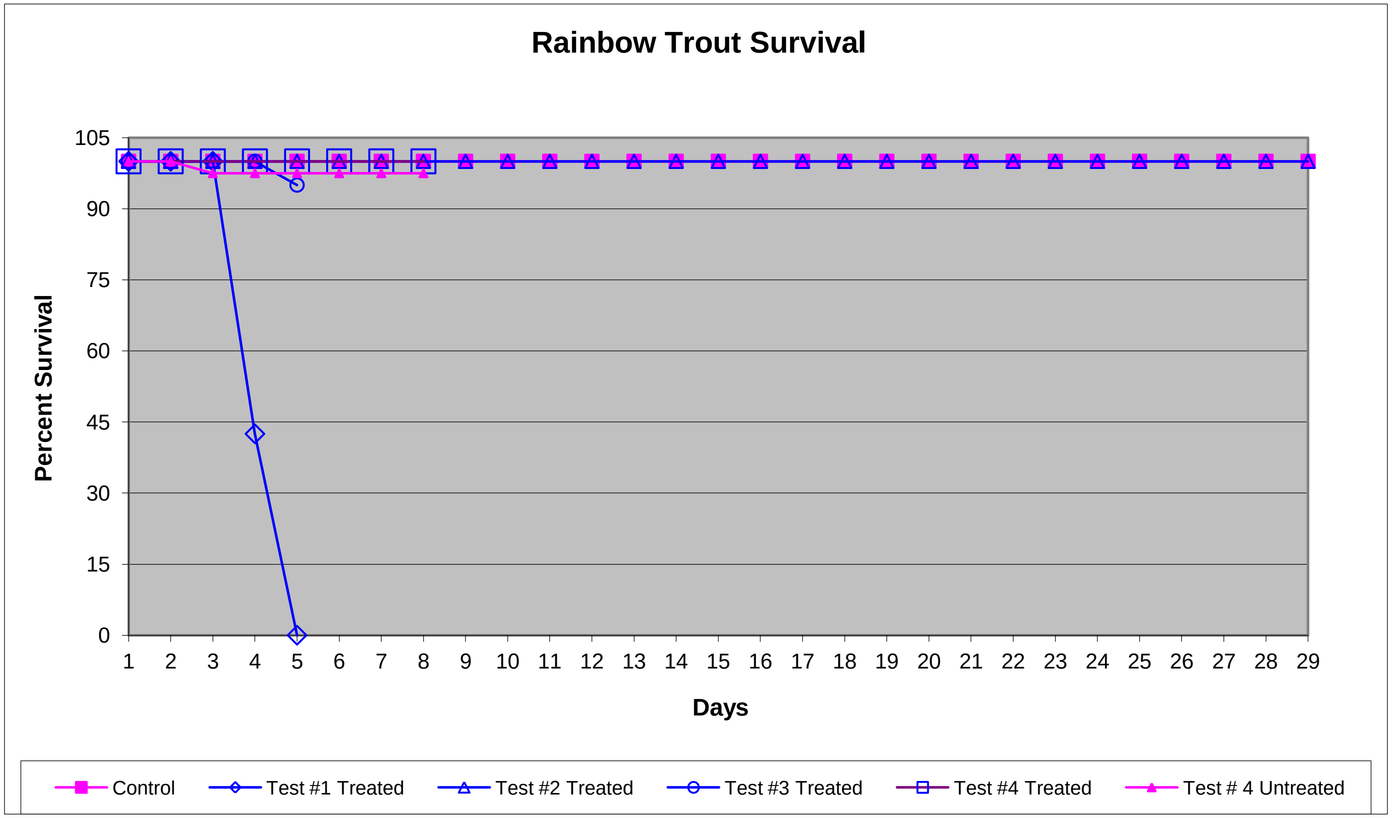
a. ECST is capable of reducing turbidity below 10 NTU and frequently below 5 NTU. (See summary of performance data for Redmond Sites 1 and 2)

b. A carbon dioxide and/or caustic injection and control system can be part of the treatment train to produce treated water within an acceptable pH of 6.5-8.5.

c. Bioassay testing shows that the effluent from the ECST treatment train meets toxicity requirements (see graph below)

** The report on the studies at the two Redmond sites, "Electrocoagulation Treatment of Construction Stormwater", City of Redmond and EES Consulting, Inc., February, 2003, can be obtained by contacting Water Tectonics, Inc. (see back page)*

Redmond Sites Summary of Performance Data										
	Site 1					**Site 2**				
		Final Polishing Pond		**Cartridge Filter**			**Final Polishing Pond**		**Cartridge Filter**	
Water Quality Parameter	**Sedimentation Pond**	**Value**	**% Removal**	**Value**	**% Removal**	**Sedimentation Pond**	**Value**	**% Removal**	**Value**	**% Removal**
Turbidity, NTU:										
Median	35.8	11.7	67.3	4.73	86.8	143	3.34	97.7	3.4	97.6
Range	10.7 – 595	4.46 – 23.9	--	3.28 – 7.14	--	2.04 - ~2,500	0.59 – 9.97	--	0.49 – 5.56	--
pH:										
Median	9.43	7.36	--	7.76	--	7.5	7.2	--	7.3	--
Range	6.7 – 11.89	6.7 – 10.55	--	7.0 – 8.3	--	6.6 – 8.8	6.6 – 8.0	--	6.8 – 7.8	--



Rainbow Trout Survival Over Time – Tests #1, #2, #3 and #4
Additional data is presented in Appendix A.

Discussion of Toxicity Results (see above graph)

Four individual tests were performed. The control survival was 100% in all cases. Treated survival in Test #1 was 0% by day 5. This was the result of a copper bulb placed in the reservoir to control filling of the chamber. The copper bulb was replaced with rubber and the entire test system cleaned out.

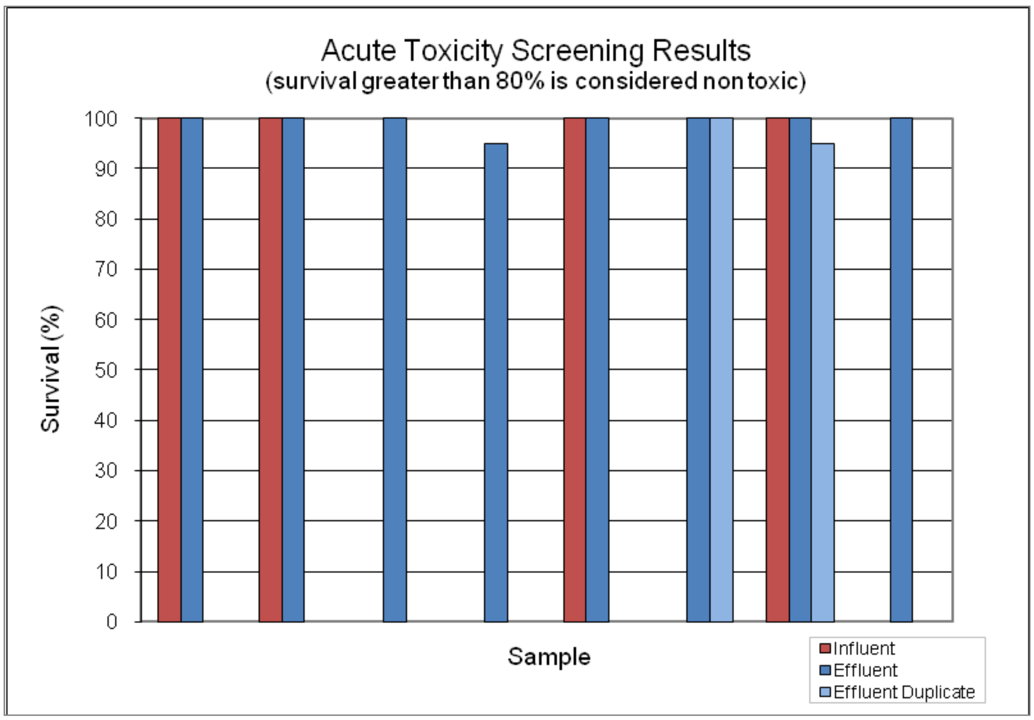
Test #2 showed 100% survival through 28-days. Test #3 showed 95% survival after 4days, meeting the acute toxicity criteria. Test #4 compared treated stormwater to untreated stormwater in the detention pond. This was the only test not performed with the flow through set-up. Samples for Test #4 were collected from the site and a static chronic test was performed in a lab environment, as temperatures were fluctuating significantly in the flow-through trailer. Survival was 100% in the treated water and 97.5% in the untreated water after 7 days. From the data it appears that no chronic toxicity was observed after 28 days of continuous exposure to stormwater treated by the EC process.

In the future it is imperative that the test system plumbing not include any copper or galvanized plumbing. It would also be wise to set up the test system in a separate area from the EC treatment trailer. Excessive heat from the EC system may have an impact on the test results.

Updated Toxicity Information (ECST TEER August 2008)

No acute toxicity was detected in any of samples submitted to Nautilus Environmental as presented in Figure 1. This corroborates the past toxicity testing which showed no acute or chronic toxicity to aquatic macro-invertebrates or juvenile fish.

Figure 1. ECST Toxicity Results



Survival rates for 48-hr D. *pulex* acute survival test as performed by Nautilus Environmental. Survival of greater than 80% indicates no acute toxicity.

Advantages over other technologies:

Water Tectonics, Inc. claims that the ECST offers the following advantages over other chemical coagulant aid systems:

- The WaveIonics™ ECST system can reliably reduce turbidity to 10 ntu or less. To date no upper influent turbidity limit has been found other than that that would physically clog the system.
- The WaveIonics™ ECST system reliably reduces high pH influent to the acceptable discharge range of 6.5 to 8.5 with integrated CO2 sparging.
- The WaveIonics™ ECST system does not increase total iron concentrations above background levels by more than 0.3 mg/L
- The WaveIonics™ ECST system is nontoxic to aquatic life (macro-invertebrates and juvenile fish).

Description of the treatment train:

Stormwater Detention

This may be a temporary or permanent detention/retention pond, vault or mobile detention tank(s). Ponds are equipped with a riser cone pump point. In vaults and tanks the pump (if submersible) is secured at least 12 inches from the bottom of the structure to prevent pumping sediment or if suction hose is used the inlet is floated to decant from the surface of the water. Pressure sensors are used to determine detention volume and start system based on pre-set levels.

Piping

PVC or flexible suction hose conveys water through the system.

Primary Influent Pump(s)

An electric submersible pump with float controls is typically used; however other types of pumps (gas/diesel/suction) can be used. Pump(s) size is based on system flow rates and head pressure calculations.

WaveIonics ECST Unit

The WaveIonics ECST unit, manufactured by Water Tectonics, includes cell housings, treatment cells, rectifier, programmable logic controller (PLC), water quality data monitoring and recording unit, water quality probes, and CO_2 controller/dispersal apparatus. System management, operational status, water quality monitoring, and discharge/recirculation control are controlled by means of a Water Tectonics Automated Operator (WTAO). To ensure proper operation of the WTAO, system inspection, calibration, and maintenance were performed on a routine basis by trained WT technicians.

Note: Cell configuration, cell spacing, methods of rectification, details of software for PLC operation and remote control are considered proprietary and will not be discussed in this report.

- Programmable Logic Controller

  A programmable logic controller (PLC) continuously reads, records, and provides visual readout of influent and effluent pH and effluent turbidity. The PLC unit controls the dosage of CO_2 in order to manage the pH level of the discharged water. The PLC controls the conductivity adjustment based on reading from an influent conductivity probe. A three-way valve is controlled by the PLC controls the discharge of treated effluent. The valve will direct treated effluent to discharge off-site or back to the source tank/pond/vault (recirculation) based on the predetermined turbidity and pH set-points. Continuous influent turbidity reading is not necessary for system performance and was only done where required for QAPP data collection. To date we have not found an upper turbidity limit other than when the influent becomes too thick with sediment (i.e., mud – greater than 3000 ntu) to pass through the cells. If such a situation would occur, the Water Tectonics Automated Operator (WTAO) would shut-down systems operations and provide visual alerts to its stated condition as well as remotely notify critical personnel if a high water condition existed.

- pH Adjustment

  CO_2 is used to lower the pH to acceptable levels as construction site stormwater often has a high pH due to fresh concrete. This process is automated. The pH probes signal the system to activate the inline CO_2 sparging system based on preset numeric values.

  Note: The ECST process is not limited by pH – the neutralization of pH is strictly to meet discharge standards.

- Conductivity Adjustment

  On sites where the influent conductivity is very low (<100 µS) a saline solution may be used prior to treatment to enhance the reaction. Low influent conductivity situations typically occur during the early grading phase of the construction project when working in the A soil horizon (duff and topsoil). Run-off coming in contact with soils in the A horizon typically has low conductivity. Run-off coming in contact with the B soil horizon (which typically has ionic constituents) or run-off coming in contact with fresh concrete has higher conductivity and no longer needs adjustment.

  Note: There is currently no general freshwater conductivity discharge standard, however EPA (Doc: EPA 841-B-97-003) states that "streams supporting good mixed fisheries have a [conductivity] range between 150 and 500 µmhos/cm" When conductivity adjustment is necessary the influent stream is typically amended to 300 µS/cm on average (micromhos per centimeter abbreviated µmhos/cm = microsiemens per centimeter abbreviated µS/cm).

Settling Tank

Portable tank(s) may be used to enhance flocculation prior to filtration. Size and/or number of tanks depend on desired flow rates. Pressure sensors are installed in the settling tank(s) and will shut off the system to prevent the tank(s) from overflowing.

Media Filter

Sizing and capacities depend on desired flow rates. High-quality clean, variegated, and crushed silicate is used as filter media. The media filter system requires a pump that can deliver adequate flow rates and produce a minimum of 30 pounds per square inch (psi) of pressure at the filter.

Media Filter Backwash

Backwash discharge will be routed to a separate detention cell isolated from the primary detention allowing for decanted water to return to primary influent source.

The filtration units incorporate an automatic backwash control system enabling the setting of backwash cycles. The backwash cycles are automated: Preset intervals are triggered by differential pressure across each filtration unit (as the filter pod accumulates sediment, the pressure drop across the filter increases, triggering the backwash cycle at a preset pressure value). Backwash cycle frequency and duration vary with influent turbidity and flow rate.

Backwash water contains coagulated sediments that form prior to entering the media filter which generally settle quickly to the bottom of the backwash discharge retention structure. The rate of sediment loading and sludge accumulation is directly related to the turbidity of the influent and system flow rate. Collected sludge and sediment from the treatment process are considered non-toxic as they are a product of the site soils. This material can be recycled into onsite soils.

Contact Information:

Applicant: Liisa Doty
Watertectonics, Inc.
6300 Merrill Creek Parkway, Suite C-100
Everett, WA 98203
Tel. (425) 349-4200
liisa@watertectonics.com

Applicant's Website: www.watertectonics.com

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

Ecology: Douglas C. Howie
(360) 407-6444
douglas.howie@ecy.wa.gov