



February 18, 2005  
(Updated March 2008, October 2009)

## **CONDITIONAL USE LEVEL DESIGNATION FOR EROSION AND SEDIMENT CONTROL**

**For**

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

### **Ecology's Decision:**

Based on Water Tectonics' application documents and recommendations by the Chemical Technical Review Committee (CTRC) and Mr. Cecil, Ecology is hereby issuing:

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

**This CULD shall expire on October 15, 2010 unless extended by Ecology and is subject to the conditions specified herein.**

### **Ecology's Conditions of Use:**

- 1. Ecology hereby approves the Water Tectonics' Quality Assurance Project Plan (QAPP), Version 3, dated January 13, 2006.**
- 2. All required testing must be completed and a technology evaluation engineering report (TEER) in support of a general use level designation must be submitted by November 1, 2008.**
- 3. 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.**
- 4. Source control procedures shall be implemented to the maximum extent feasible to minimize the need for the use of the system.**
- 5. During system operation, water quality influent and effluent shall be continuously monitored 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).

6. The discharge flowrate shall be continuously metered and recorded.
7. A Daily Operations Log shall be completed for each operating period. At a minimum, the form shall include the following:
  - Operators Name
  - Date
  - Influent pH
  - Effluent pH
  - Influent turbidity
  - Effluent turbidity
  - Conductivity
  - Wave Ionics™ control panel information – digital display data
  - Record of equipment calibration
8. 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.
9. 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.
10. 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. 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.
- At least 1 year of experience with, and documented 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 (36 hours)**

- System operation
- Recording data in the operations log
- Setting automated logic controller
- 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.
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 shutting the system down if the output turbidity, pH exceed preset values. An audible alarm and warning light shall be installed on a treatment system to alert the operator in the event of a system failure.
5. Water Tectonics agrees to warranty all electrocoagulation installations against defects at no additional cost to the purchaser during the duration of this CULD. Upon discovery and implementation of system improvements the warranty will also apply to all previously installed facilities in Washington State.

**Applicant:** Mr. James Mothersbaugh, President  
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**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.

**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.*

**Chemical Technical Review Committee's Recommendation:**

The CTRC recommends issuance of a conditional use level designation for the WT electrocoagulation based treatment train for the removal of small particulate turbidity in stormwater runoff at construction sites to meet Ecology discharge requirements.

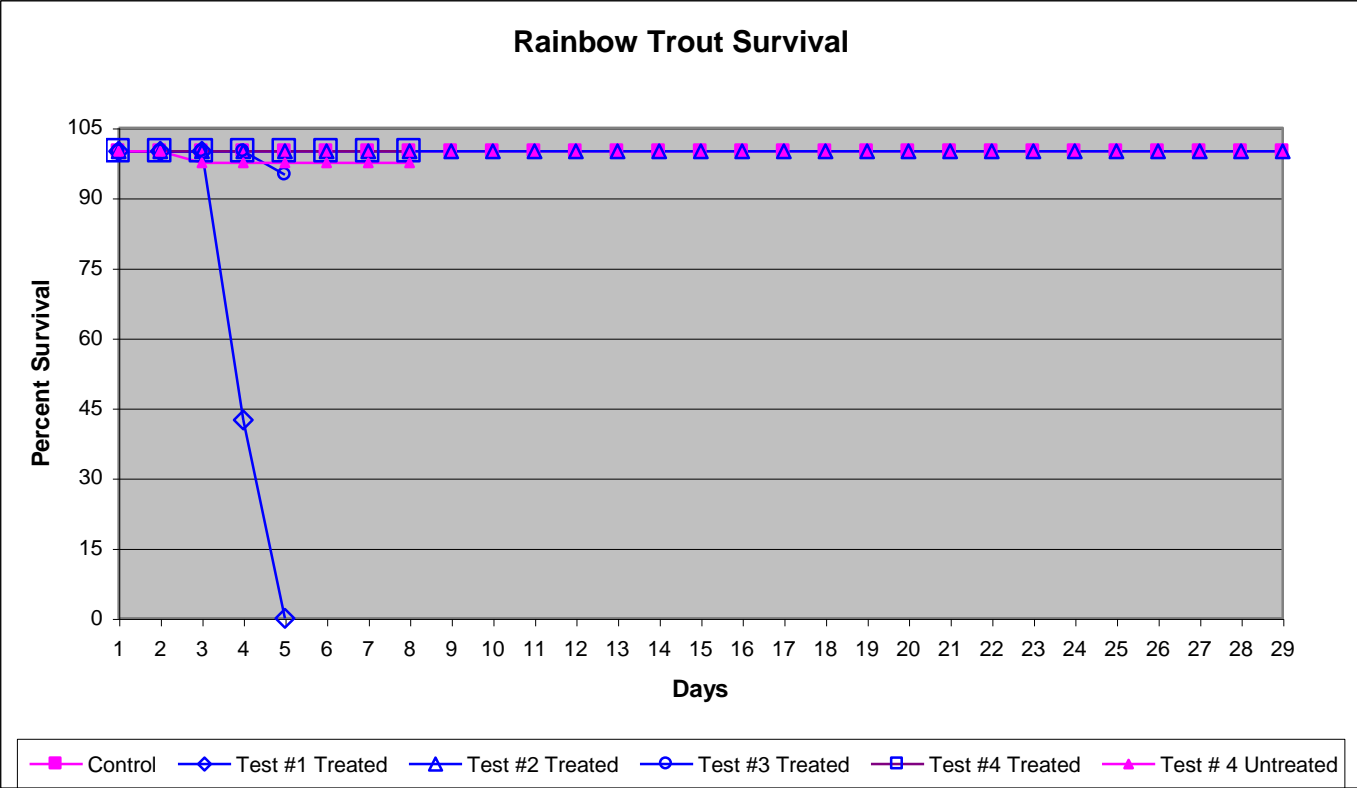
**Findings of Fact:**

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.

### **Advantages over other technologies:**

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

- Simplified electronic control of dosages with less operation and maintenance needs
- Controller logic can be calibrated to optimize dosage depending on influent conductivity, turbidity, pH, and flow more precisely.
- Includes pH control.

### **Description of the treatment train:**

Attached Figure: “Generic- EC Process Train” is a schematic of an ECST treatment train that can include all or some of the eight components described below. The selection of treatment train components can vary depending on site-specific conditions.

1. Stormwater Sedimentation. This component accumulates untreated stormwater generated during construction and provides pre-settling of larger particles. At one field site a permanent, post-construction pond was used for presedimentation during construction. At another site a temporary sedimentation pond was used initially, but was replaced with a permanent, post-construction detention vault during the latter stages of construction. Regardless of facility type, the term “sedimentation pond” will be used herein to refer to the storage facility that accumulates and pre-settles untreated stormwater generated on-site.

Pre-settled stormwater is pumped to the electrocoagulation unit at discrete flows depending on the site-specific situation. Pumps capable of delivering 70 gpm were used at recent test sites.

2. Electrocoagulation Unit. A Wave Ionics™ electrocoagulation unit manufactured by Water Tectonics, Inc. was used at the two Redmond field test sites. The primary function of the electrocoagulation unit was to destabilize colloids present in pre-settled stormwater (colloids are ultra-fine sediment particles held in a stable “mix” that prevents settling within a reasonable time period). To accomplish destabilization, the electrocoagulation unit generates an electrical field between two

electrodes (anode and cathode) immersed in the pre-settled stormwater. Micro-size particles (precipitates) that are formed during destabilization begin to aggregate and grow in size to produce “flocs” which could ultimately be removed by gravity settling (see Item 3) to clarify the turbid stormwater.

The type of precipitate that forms during electrocoagulation depends on the material used as the anode. An iron precipitate forms if steel anodes are used; an aluminum precipitate forms if aluminum is used. It is believed that steel anodes are preferable because of the possibility of aluminum toxicity.

Typically, a constant flow rate up to 120 gpm per cell is used. Ferric ion is released at the anode and hydroxide and/or carbonate is formed at the cathode which agglomerates the turbidity for filtration downstream. The voltage and current are adjusted to obtain the proper concentration of iron at the anode based on Faraday’s Law of Electrolysis. The conductivity of the stormwater is also monitored to ensure proper control of the voltage and current. Proper venting of hydrogen at the cathode is provided for safety. Cell replacement frequency can be projected based on the throughput of stormwater and turbidity and the current to influent stormwater conductivity relationship. Attached is a schematic of a typical ECST.

3. Tube Settler. To effectively clarify turbid stormwater, flocs generated during electrocoagulation treatment must be separated from treated stormwater. At the Redmond field sites this was accomplished by using tube settlers. Tube settlers essentially consist of one or more rectangular-shaped tanks fitted with tube settler modules containing numerous passageways much like a honeycomb. As electrocoagulated stormwater passes through the settler modules, small flocs generated initially in the electrocoagulation unit grow larger and heavier and are ultimately separated by gravity. At Sites 1 and 2 settled floc accumulated within the tube settler unit; thus, the incoming suspension mixed with previously settled material prior to flowing through the settler module.
4. Surge Tank. A surge tank was employed prior to pressure sand filters described under Item 5 below. This tank served two purposes. First, it provided for pressurization of the filters, since the tube settlers operate under atmospheric conditions. Secondly, at both Redmond sites the surge tanks contained diffusers for carbon dioxide dispersion and pH control, as described under Item 8, below.
5. Pressure Sand Filter Unit. The pressure sand filter units used at the Redmond sites differed in size, but were of similar design and application. Each unit consisted of two pressure tanks equipped with automatic controls for alternating filtration/backwash cycles. The filter medium was uniformly graded sand. Backwash water at both sites was returned to the sedimentation pond. Filtered water was discharged to the final holding pond.

6. Final Holding Pond. As previously noted, this pond provided for intermittent monitoring and testing prior to discharge through the cartridge filter.
7. Cartridge Filter. Treated water was pumped periodically, as needed for site stormwater management, from the final holding pond through 10 micron cartridge filters prior to release to the receiving waters.
8. pH Control. WT reports that the performance of the process itself is not sensitive to pH. However, on-site activities can and did alter stormwater pH. Therefore, facilities were required to maintain pH within permit limits. At the Redmond sites facilities for adjusting the pH of stormwater having above-neutral values consisted of carbon dioxide dispersion equipment; sodium hydroxide feed equipment was provided for adjustment of low pH stormwater (Figure: pH Trailer). At Site 1, carbon dioxide dispersion equipment was located in the sedimentation pond, the surge tank and in the final holding pond. At Site 2, this equipment was located only in the sedimentation pond and the surge tank.

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