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Boatyard Stormwater Treatment Technology Cost Analysis

DRAFT REPORT

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Boatyard Stormwater Treatment Technology Cost Analysis

Rhiannon L. Parmelee, E.I.T.
Environmental Engineer

Barry L. Kellems, P.E.
Principal Engineer

Philip A. Spadaro, L.G.
Senior Vice President

Prepared for:
Northwest Marine Trade Association
Puget Soundkeeper Alliance
Washington State Department of Ecology

Prepared by:
ARCADIS
2300 Eastlake Avenue East
Suite 200
Seattle
Washington 98102
Tel 206.325.5254
Fax 206.325.8218

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Acronyms and Abbreviation

BMP	best management practice
Ecology	Washington State Department of Ecology
ft	foot/feet
ft^2	square foot/feet
ft^3	cubic foot/feet
gpm	gallon(s) per minute
GAC	granular activated carbon
O&M	operations and maintenance
WWIX	Wastewater Ion Exchange
USEPA	U.S. Environmental Protection Agency

1. Introduction

The Boatyard Stormwater Treatment Technology Study (Taylor Associates 2008) presents the pilot study treatment results for three stormwater technologies: StormwateRx® Aquip™, Siemens Water Technologies, Inc. Wastewater Ion Exchange System (WWIX), and Water Tectonics, Inc. Wave Ionics™ Electro-Coagulation System. Cost estimates for each technology must be developed in order to determine if they can be considered suitable for classification as "all known, available and reasonable methods by industries and others to prevent and control the pollution of the waters of the State of Washington" (this statutory requirement is generally known by an acronym – AKART). This report presents the cost estimates for each treatment technology plus necessary site drainage improvements for a typical boatyard to comply with the Boatyard General Stormwater Permit. The results will be used by the Washington State Department of Ecology (Ecology) to determine AKART for the Boatyard General Permit.

The level of accuracy of these estimated costs is "Order of Magnitude," as defined by the American Association of Cost Engineers. The accuracy of an Order of Magnitude estimate is plus 50% and minus 30%. Cost estimates at this level may be used to compare alternatives, but should not be used to plan, finance, or develop projects.

1.1 Typical Boatyard Description

To be useful to the overall boatyard industry in Washington State, the cost estimate was based on a typical boatyard. The typical boatyard is assumed to be 2 acres of flat, impervious surface with one stormwater outfall.

Boatyards have varying extents of stormwater infrastructure. A number of boatyards were surveyed for existing conditions. Approximately 60% do not have stormwater collection infrastructure. Of the boatyards that do not currently have stormwater infrastructure, 50% to 75% would need significant re-grading in order to effectively drain and collect stormwater.

1.2 Common Basis of Costing

Because the purpose of this report is to provide a reasonable cost estimate, but a completed design of a stormwater treatment system has not yet been done, assumptions were made regarding the components of a typical stormwater treatment

system based on previous designs. Where possible, design considerations that could increase the cost reported here are included.

The treatment processes assumed for the cost estimate are as follows:

1. Collection in a terminal catch basin from stormwater piping.
2. Diversion of the volume of water to be treated based on the design storm and conveyance of the remaining overflow to the stormwater outfall.
3. Settling of solids to remove particulates larger than 100 microns.
4. Gravity flow to a wet well sump.
5. Pumping to the inlet of the above-ground treatment system.
6. Removal of fine particulates using a filtration system.
7. Removal of dissolved metals using one of the three candidate stormwater treatment technologies.
8. Conveyance to an outfall pipe that discharges to the receiving water.

The contaminants of concern in the stormwater from a typical boatyard are copper, lead and zinc. It is assumed that each of the three stormwater treatment technologies is effective in treating these contaminants.

The water quality design flow rate was calculated using the Western Washington Hydrology Model, which is an approved continuous runoff model described in the Western Washington Stormwater Management Manual (2005). The manual indicates that the flow rate at or below 91% of the total runoff volume, should be treated for water quality. This is equivalent to the 6-month, 24-hour design storm estimated using a single hydrograph method. Model results for King, Snohomish and Whatcom County indicate a range of peak runoff flow rates between 60 to 80 gallons per minute (gpm) for an off-line best management practice (BMP). Therefore, a 70 gpm flow rate was assumed for the stormwater treatment cost estimate.

The total annual volume of water to be treated can be approximated by multiplying the annual precipitation by the size of the boatyard by 91%. The annual precipitation in Seattle typically ranges from 37 inches to 39 inches. Therefore, the annual volume of water to be treated is approximately 1,900,000 gallons.

1.3 Cost Analysis Organization

The body of the report details the assumptions and results of the cost estimates for each technology and for typical boatyard site improvements. The assumptions for both capital costs and operations and maintenance (O&M) are presented. The results section provides a net present value analysis for each cost estimate and a summary of the cost per acre to install each stormwater technology.

Section 2: Assumptions for Stormwater Treatment Technologies

Section 3: Assumptions for Typical Site Improvements

Section 4: Cost Analysis Results

2. Assumptions for Stormwater Treatment Technologies

To install any stormwater technology, an engineering report is required to comply with the General Boatyard Permit. It is assumed that a lump sum of $5,000 would be required to cover this task. The following three sections discuss the cost assumptions associated with each of the three candidate technologies.

2.1 StormwateRx® Aquip™

The StormwateRx® Aquip™ is a passive adsorptive filtration technology designed for reduction of stormwater pollutants such as suspended solids, turbidity, heavy metals and oils from stormwater. Aquip™ uses a pre-treatment chamber followed by a series of inert and adsorptive (depending on configuration) filtration media to trap pollutants. Pollutant removal within the pre-treatment chamber occurs by gravity settling and pollutant removal in the filtration chamber occurs through a combination of chemical complexing, adsorption, micro-sedimentation and filtration.

2.1.1 Construction Cost Assumptions

The Aquip™ capital costs were established assuming that stormwater would be collected in a terminal catch basin, the volume to be treated would flow by gravity to a wet well sump, the water in the sump would be pumped to the beginning of the above-ground treatment chamber and then flow by gravity to the outfall. Since the Aquip™ system provides solids settling, filtration and metals removal (processes 3, 6 and 7 in Section 1.2); additional devices are not needed for this cost estimate. The cost estimate is presented in Table 1 and the vendor quote is included in Appendix A.

The Aquip™ elements include:

- **Aquip™ Model 80SB packaged filtration system.** The prepackaged system is contained in a steel, water-tight chamber that is 17 feet (ft) by 6 ft by 6 ft high. The filtration chamber includes a 27-inch depth of layered sorptive and inert filtration media. The vendor quote provided in Appendix A for the packaged system is $48,500 which includes O&M training for the owner.

Additional equipment needs for installation of this stormwater treatment technology include:

- **Wet well sump.** A 60-inch-diameter manhole with a total depth less than 8 ft which costs approximately $2,500.

- **Submersible pump.** A submersible pump with a flow rate of 70 gpm with automatic float switch that costs approximately $800.

- **Wet well sump, piping, and pump installation.** Includes the excavation and placement of the wet well sump, placement and start up of pump, and any necessary plumbing required to tie into the stormwater collection system. This is estimated to cost $2,500.

Additional installation support costs include:

- **System delivery.** It is assumed that the delivery costs from Portland, Oregon, to the site are $1,500.

- **Placement and assembly.** It is assumed that a total of 16 labor hours are needed for placement and installation of the treatment technology. The boatyard would also receive training provided by the vendor. Assuming $30/hour, this cost is $480.

- **Forklift rental.** A forklift is needed for one day to unload the system from the delivery truck and place in the final location. This cost is $200 per day.

2.1.2 O&M Cost Assumptions

The Aquip™ O&M costs are classified as routine, seasonal, and full maintenance. Routine maintenance occurs every year. Full maintenance is required every two years and seasonal maintenance occurs during the other years (i.e., years 1, 3, 5, … receive seasonal maintenance; years 2, 4, 6, … receive full maintenance). The description of each maintenance type is as follows:

- **Routine.** Rake the top layer of media to regenerate the filter media and regain capacity. Typically, routine maintenance should be performed every quarter depending on the frequency of rainfall. This requires three labor hours per quarter. Additionally, the system should be inspected and general upkeep tasks performed. This requires three labor hours per month. All routine maintenance is assumed to require 48 hours per year and will cost $1,440 annually. Additionally, sampling for metals breakthrough is assumed to occur monthly. One sample per month would be sent to an analytical laboratory for testing of copper, lead, and zinc. Each

sample would cost approximately $200 to collect, ship to an analytical laboratory, and test.

- **Seasonal.** Remove and replace the very top layer of inert filtration media and the top filter fabric. This is typically performed at the end of the wet season in the years when the full media depth is not replaced. The cost of the new media is $2,000 from the vendor. Spent media removal and new media placement requires approximately eight labor hours, which cost $240. The disposal of spent media in a landfill cost approximately $150.

- **Full.** Remove and replace the full depth of inert filtration media and filter fabric. Full maintenance should typically be performed every two years. The cost of the new media is $9,500 from the vendor. Spent media removal and new media placement requires approximately 16 labor hours which cost $480. The disposal of spent media cost approximately $450.

- **Part replacement.** The submersible pump is estimated to be replaced every five years which is equivalent to $160 per year.

2.2 Siemens Water Technologies WWIX

The Siemens Water Technologies WWIX system utilizes ion exchange resins and other media to remove specific ionic contaminants such as metals from stormwater and wastewater. A WWIX system sized for a typical 2-acre boatyard would require four 30 cubic foot (ft^3) tanks, all in series. The first tank contains carbon to remove organics and/or oxidizers prior to the ion exchange tanks. The second tank includes a resin to specifically remove lead using ion exchange. The third and fourth tanks contain resins that remove the remaining dissolved solids and metals.

2.2.1 Construction Cost Assumptions

The WWIX capital costs were established assuming the stormwater would be collected in a terminal catch basin, the volume to be treated would flow by gravity to a pre-treatment chamber for solids removal and then to a wet well sump. The water within the wet well sump would be pumped to above-ground bag filters, flow through each of the WWIX tanks in series, and then flow by gravity to the outfall.

Siemens Water Technologies does not sell the ion exchange tanks and instead it is presented as an annual rental fee in Section 2.2.2. The cost estimate is presented in Table 2 and the vendor quote is included in Appendix B.

WWIX installation elements include:

- **Sample analysis and waste profiling.** As part of a final design for a site, the vendor performs a sample analysis and waste profiling of the site stormwater for $650. The results of this analysis affect the resin selection and cost.

- **Inlet, outlet and interconnecting hoses.** The vendor will provide the miscellaneous piping between the tanks which costs $5,833 in total.

- **Bag filters housing.** The vendor will provide and install the bag filter. The bag filter housing and one case of replacement filters costs $2,000.

- **Regeneration and delivery of the first tanks.** The first set of four tanks needs to be regenerated and delivered to the site. The regeneration costs approximately $17,135 and the delivery costs $4,800. All shipping and handling of ion exchange tanks is handled by Siemens Water Technologies as detailed in Section 3.1 of the vendor quote in Appendix B.

- **Installation labor by vendor.** The vendor provides labor support for installation, start up, and training the owner. The cost provided in the vendor quote is $1,033.

Additional equipment needs for installation of this stormwater treatment technology include:

- **Hydrodynamic separator.** A pre-treatment chamber, such as an ecoStorm or Stormceptor, sized to remove particulates larger than 100 microns. The estimated cost, including installation, is $9,000.

- **Wet well sump.** A 60-inch-diameter manhole with a total depth less than 8 ft, which costs approximately $2,500.

- **Submersible pump.** A submersible pump with a flow rate of 70 gpm with automatic float switch that costs approximately $800.

- **Wet well sump, piping, and pump installation.** Includes the excavation and placement of the wet well sump, placement and start up of pump, and any necessary plumbing required to tie into the stormwater collection system. This is estimated to cost $2,500.

- **Storage building.** To prevent freezing of the tanks, a storage building will be required. A typical cost to purchase and install a pre-engineered storage building that has a 10-ft by 12-ft footprint is $3,000.

Additional installation support costs needed from the boatyard, including:

- **Placement and assembly.** It is assumed that a total of 24 labor hours are needed to set up the storage building, receive training provided by the vendor, and assist with the start up of the treatment system. Assuming $30/hour, this cost is $720.

- **Forklift rental.** A forklift is needed for one day to unload the system from the delivery truck and place in the final location. This cost is $200 per day.

2.2.2 O&M Cost Assumptions

The size, configuration, and replacement frequency of the WWIX tanks were based on a stormwater sample from a boatyard collected during the pilot study. Although the influent concentrations will change between each boatyard, it should reasonably represent stormwater quality for a typical boatyard. This sample was used to predict the resin regeneration costs and delivery of new tanks to the site. The testing results for the stormwater sample used are shown on Page 12 of Appendix B.

WWIX tank rental costs include:

- **Granular activated carbon (GAC) tank (rental).** One 30-ft^3 GAC tank to remove oil/grease, organics and/or oxidizers prior to the ion exchange tanks. The annual rental cost is $3,300.

- **Lead media tank (rental**). One 30-ft^3 ion exchange tank (with CSO resin) to remove lead. The annual rental cost is $3,300.

- **Metals media tanks (rental**). Two 30-ft^3 ion exchange tanks (with SCC resin) to remove the remaining targeted dissolved metals and other salts. The annual rental cost for each tank is $9,900.

Regeneration of the resin is required for proper operation. These costs include:

- **GAC tank regeneration.** The GAC should be replaced every six months. Each regeneration cost is $3,360.

- **Lead media tank regeneration.** Based on a boatyard stormwater sample collected during the pilot study, the lead media tank can treat 920,000 gallons of stormwater before breakthrough of lead occurs. Assuming an annual volume of 1,900,000 gallons, the lead media tank will need to be replaced twice a year. Each regeneration cost is $2,875.

- **Metals media tank regeneration.** Based on the boatyard stormwater sample collected during the pilot study, each metals media tank can treat 1,800,000 gallons of stormwater before breakthrough of copper and zinc occurs. Assuming an annual volume of 1,900,000 gallons, each metals media tank will need to be replaced once a year. Each regeneration cost is $5,450.

- **Delivery of new tanks and pickup of spent tanks.** Each tank has an estimated freight cost of $1,200 for delivery and pickup. All shipping and handling of ion exchange tanks is handled by Siemens Water Technologies, as detailed in Section 3.1 of the vendor quote in Appendix B.

Routine maintenance elements include:

- **Monthly inspections and maintenance.** The system should be inspected and general upkeep tasks performed. This requires two labor hours per month which costs $720 annually.

- **Metals breakthrough monitoring.** Replacement of the tanks is based on when a metal is detected in effluent samples. It is assumed that two samples are collected monthly, one for lead in the effluent from the lead media tank and one for copper and zinc in the effluent from the first metals media tank. Each sample would cost approximately $200 to collect, ship to an analytical laboratory, and test. The annual cost for monitoring is $4,800.

- **Part replacement.** The submersible pump is estimated to be replaced every five years which is equivalent to $160 per year.

2.3 Water Tectonics, Inc. Wave Ionics™

The Water Tectonics, Inc. Wave Ionics™ is an electro-coagulation system that uses electrical current to coagulate particles by forcing contaminated water to flow between closely spaced metal plates, across which an alternating, direct or pulsing electrical potential is applied. The particles agglomerate into larger particles and either rise to the top or settle to the bottom of the water column.

The smallest flow rate that the Wave Ionic™ systems treat is 100 gpm. Therefore, the cost estimate assumes a treatment flow rate of 100 gpm, which is slightly higher than the 70 gpm assumed for the other two technologies.

2.3.1 Construction Cost Assumptions

The Wave Ionics™ electro-coagulation capital costs were established assuming the stormwater would be collected in a terminal catch basin, the volume to be treated would flow by gravity to a pre-treatment chamber for solids removal and then to a wet well sump. The water within the wet well sump would be pumped to the above-ground electro-coagulation cells, pumped through the sand filters, and then flow by gravity to the outfall. The cost estimate is presented in Table 3 and the vendor quote is included in Appendix C.

The Wave Ionic™ Electro-coagulation system elements include:

- **Electro-coagulation system.** The packaged electro-coagulation system is quoted by Wave Tectonics, Inc. at $80,000 for a 100 gpm peak flowrate. This price includes an 8-ft by 10-ft steel container with security doors to house the influent pump, two electro-coagulation cells, and control panels. Outside of the steel container, the water from the cells is sent to a sand filter with pump and automated backwash system that has an approximate footprint of 2 ft by 8 ft. The system has a location for an electric utility hookup to supply electricity to pumps, cells and the lights within the steel container.

Additional equipment needs for installation of this stormwater treatment technology include:

- **Hydrodynamic separator.** A pre-treatment chamber, such as an ecoStorm or Stormceptor, sized to remove particulates larger than 100 microns. The estimated cost, including installation, is $9,000.

- **Wet well sump.** A 60-inch-diameter manhole with a total depth less than 8 ft, which costs approximately $2,500.

- **Wet well sump and piping installation.** Includes the excavation and placement of the wet well sump, and any necessary plumbing required to tie into the stormwater collection system. This is estimated to cost $2,000. The pump is included in the Water Ionic™ prepackaged system.

Additional installation support costs needed from the boatyard include:

- **Placement and assembly.** Installation and training costs from the vendor are included in the cost of system. Additional installation costs for the boatyard are estimated to require 16 hours. Assuming $30/hour, this cost is $480.

- **Forklift rental.** A forklift is needed for one day to unload the system from the delivery truck and place in the final location. This cost is $200 per day.

2.3.2 O&M Cost Assumptions

The O&M cost for the Wave Ionics™ electro-coagulation system were provided based on gallons of stormwater treated. This has been converted to a yearly rate based on the assumption of treating 1,900,000 gallons annually.

- **Electricity.** Electricity for the electro-coagulation cells is estimated to cost $0.16 per 1000 gallons treated. The equivalent annual cost is $304.

- **Electro-coagulation cells.** The cells are replaced after treatment of 1,000,000 gallons. This means the cells will be replaced approximately twice a year, which is a $2,660 annual replacement cost.

- **Conductivity.** The annual cost to maintain the conductivity is based on a cost of $0.02 per 1000 gallons, or $38 per year.

- **Monthly inspections and maintenance.** The system should be inspected and general upkeep tasks performed. This requires 2 labor hours per month, which costs $720 annually.

- **Parts replacement.** The sand filter control, the pumps, and miscellaneous parts will need to be replaced every 5 to 10 years. The equivalent total annual cost $375.

3. Assumptions for Typical Site Improvements

As described in Section 1.1, the typical boatyard description is based on a survey of boatyards within the Puget Sound region. Although the range of conditions at the boatyards varies greatly, the assumptions detailed in the following sections attempt to find a median of the existing conditions.

Permitting and surveying are required for all site work. These cost assumptions are shown below.

- **Permitting.** A lump sum of $1,000 in permitting costs will be assumed for the building, grading, and permits.

- **Survey.** For construction purposes, survey costs are estimated to be $5,000.

3.1 Drainage Improvements Cost Assumptions

The necessary drainage improvements range greatly between the boatyards surveyed. Some boatyards have sufficient drainage and minimal re-grading and resurfacing would be needed to install a stormwater collection system. Of the boatyards that would need stormwater collection systems installed, more than half would need significant re-grading and resurfacing. For the purpose of this cost estimate, it is assumed that 50% of a typical boatyard requires re-grading and resurfacing.

All of the cost estimates provided in this section are from an engineering cost guide, (RSMeans 2007).

- **Asphaltic berm.** To prevent stormwater from directly flowing into the receiving water, an asphalt berm is installed along the edge of the boatyard that assumed to be 350 ft long. A typical berm is approximately 12 inches wide and less than 4 inches high.

- **Re-grading.** In some locations, re-grading the surface may be required to promote surface water runoff. It is assumed that 50% of a site, or one acre, will need re-grading.

- **Asphalt resurfacing.** Asphalt resurfacing will be needed if re-grading is necessary. Resurfacing consists of a crushed stone layer and asphalt layer that provides sufficient thickness for the boatyard activities.

3.2 Infrastructure Cost Assumptions

The sizing and quantities developed here have been approximated for the purpose of this report and do not constitute a stormwater design.

All of the cost estimates provided in this section are from an engineering cost guide, (RS Means 2007).

- **Trenching.** Excavation of a 4-ft-wide and 4-ft-deep trench is required to install the stormwater collection pipe. The unit cost includes excavation using a backhoe, backfill, compaction, and disposal of excess spoil.

- **HDPE piping.** An 8-inch diameter HDPE pipe is assumed. The total length of piping is assumed to be 500 ft with three 90-degree elbows.

- **Asphalt patching.** Along the trench, the pavement needs to be replaced. A 2-inch thick layer is assumed.

- **Catch basins.** It is assumed that four catch basins are needed for a stormwater collection. Typical catch basins have a 48-inch inner diameter and are 4 ft deep. The unit price includes excavation, installation and removal of excess spoil.

3.3 O&M Cost Assumptions

There will be minimal O&M costs associated with the site improvements. Catch basins will need to be cleaned out regularly for accumulated debris. It is assumed that this will take 1 hour each and be performed monthly.

4. Cost Analysis Results

The total costs for the three candidate stormwater treatment technologies and typical site improvements are presented in Tables 1 through 4. A net present value (NPV) analysis was conducted to compare the technologies. The project life is assumed to extend for 15 years. The annual O&M costs are assumed to be constant over the 15 years. A discount rate of 7% is assumed, based on U.S. Environmental Protection Agency (USEPA) guidance on cost estimates for feasibility studies (2000). The following table presents a summary of the capital, annual, and net present value of each option.

Total Costs and Net Present Value for Typical 2-Acre Boatyard

Present Value Analysis	StormwateRx® Aquip™	Siemens Water Technologies WWIX	Water Tectonics Wave Ionics™	Site Improvements
Capital Costs (Year 0)	$91,000	$81,000	$148,000	$233,000
Annual O&M Costs (Year 1-15)	$14,000	$70,000	$5,200	$3,000
Present Value of O&M Costs	$128,000	$638,000	$48,000	$27,000
Net Present Value	**$219,000**	**$719,000**	**$196,000**	**$261,000**

Since the boatyards range in sizes from 0.2 acres to 5 acres, the total cost and net present values were calculated per acre. In general, for boatyards larger than 2 acres, the cost per acre will decrease and for boatyards smaller than 2 acres, the cost per acre will increase. This is due to some capital and O&M costs that are similar for every boatyards, regardless of size. However, the per-acre cost may be used to calculate an order of magnitude cost for boatyards in the 0.2- to 5-acre range.

Total Costs and Net Present Value per Acre for a Typical Boatyard

Present Value Analysis	StormwateRx® Aquip™	Siemens Water Technologies WWIX	Water Tectonics Wave Ionics™	Site Improvements
Capital Costs (Year 0)	$46,000/acre	$41,000/acre	$74,000/acre	$117,000/acre
Annual O&M Costs (Year 1 to 15)	$7,000/acre	$35,000/acre	$2,600/acre	$1,500/acre
Present Value of O&M Costs	$64,000/acre	$319,000/acre	$24,000/acre	$13,500/acre
Net Present Value	**$110,000/acre**	**$360,000/acre**	**$98,000/acre**	**$131,000/acre**

The costs per acre show a large variation in annual O&M costs for the Siemens Water Technologies WWIX. However, the system is rented from the company on an annual basis, instead of purchased in Year 0 and maintained for Years 1 to 15. This annual rental is captured in the O&M cost.

The space required for each technology will vary and could impact each boatyard differently. The footprint of the Aquip™ is approximately 100 square feet (ft^2). There will be some additional room needed for the pump. The footprint of the storage building for the WWIX is approximately 120 ft^2. The footprint of the storage container and sand filter for the Wave Ionic™ is approximately 100 ft^2. It was assumed that an equalization tank beyond the storage that could be provided in a wet well sump was not needed for each of the technologies. During a design, it may be cost effective to include additional equalization so that a smaller treatment system can be installed.

4.1 Discussion

Some key findings of the cost analysis are:

- The StormwateRx® Aquip™ and the Water Tectonics Wave Ionics™ systems had similar net present values of approximately $200,000 to $220,000 for a typical 2-acre boatyard.

- The Siemens Water Technologies WWIX system net present value was over three times the cost of the other two technologies.

- Site improvements for a typical 2-acre boatyard will contribute to approximately one-half of the total cost to install a stormwater treatment technology.

- The Siemens Water Technologies WWIX and the Water Tectonics Wave Ionic™ systems require additional pretreatment for solids removal and fine particulate filtration. The StormwateRx® Apuip™ incorporates these processes in the same tank as the metals removal.

- All three technologies have similar footprints if an above-ground equalization tank is not required.

- The net present value for site improvements and stormwater treatment technologies compare well with previous cost estimates for small sites. The Cost Analysis prepared for Ecology and the Washington State Department of Transportation (Herrera Environmental Consultants 2001) estimated $570,000 capital costs for constructing stormwater BMPs on a 1-acre commercial site. The differences in presented costs in this analysis result from the selection of BMPs and that the development cost estimate assumes only 50% of the site requires re-grading and resurfacing.

There are some costs that have not been considered in this report. Some of these costs may significantly increase the cost of installing a technology and making necessary site improvements. These include:

- Washington State Sales Tax. This is assumed to be proportional for all cost estimates.

- Additional monitoring required for regulatory compliance according to the General Boatyard Permit. This is assumed to be the same for all technologies.

- Additional site improvements costs incurred when the water level at the point of discharge is very close to the boatyard ground level.

- Additional site improvement costs incurred to promote effective stormwater drainage and collection.

The largest variable in this cost estimate is the extent of the site improvements required at each boatyard. The assumptions made herein are meant to provide a measure of the impact on overall cost. The actual fraction of the total cost that will be

required at each boatyard will range from 0% to greater than 50%. An engineering design will be required to determine the actual extent of site improvements required.

ARCADIS does not endorse or recommend a stormwater treatment technology. This cost analysis has been prepared to provide necessary cost data for Ecology to utilize, along with the performance data from the Boatyard Stormwater Treatment Technology Pilot Study (Taylor Associates 2008), in determining AKART for the Boatyard General Permit.

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TABLE 1
StormwateRx AQUIP™ COST ESTIMATE

BOATYARD STORMWATER TREATMENT TECHNOLOGY COST ANALYSIS

CAPITAL COSTS:

DESCRIPTION	UNIT	QTY	UNIT COST	TOTAL	NOTES
Capital costs for Aquip™					
Aquip Model 80SB Filtration System	1	LS	$48,500	$48,500	See Note 2
Capital costs for additional equipment needs					
Wet well sump	1	EA	$2,500	$2,500	Material costs only
Submersible pump	1	EA	$800	$800	Material costs only
Wet well sump, piping, and pump installation	1	LS	$2,500	$2,500	Excavation, placement, disposal
SUBTOTAL				$5,800	
Capital costs for additional installation support					
System delivery	1	EA	$1,500	$1,500	Transport form Portland, OR to site
Placement and assembly	16	HR	$30	$480	Labor provided by boatyard
Forklift Rental	1	day	$200	$200	Equipment rental only
SUBTOTAL				$2,180	
SUBTOTAL				$56,480	
Mobilization and demobilization	10%			$5,648	
SUBTOTAL				$62,128	
Contingency	25%			$15,532	
SUBTOTAL				$77,660	
Engineering report	1	EA	$5,000	$5,000	
Design cost	10%			$7,766	
TOTAL CAPITAL COST				**$91,000**	

ANNUAL O&M COSTS:

DESCRIPTION	UNIT	QTY	UNIT COST	TOTAL	NOTES
Routine (occurs every year)					
Monthly inspections and maintenance	36	HR	$30	$1,080	3 labor hours per month
Metals breakthrough monitoring	12	EA	$200	$2,400	1 sample per month, includes collection and sampling
Raking top layer of media	12	HR	$30	$360	2 labor hours per quarter
SUBTOTAL				$3,840	
Seasonal (occurs every other year, assume 1/2 cost annually)					
Partial media replacement	0.5	LS	$2,000	$1,000	Material cost only
Spent media disposal	0.5	LS	$150	$75	Landfill disposal fee
Labor	0.5	LS	$240	$120	8 labor hours
SUBTOTAL				$1,195	
Full (occurs every other year, assume 1/2 cost annually)					
Full media replacement	0.5	LS	$9,500	$4,750	Material cost only
Spent media disposal	0.5	LS	$450	$225	Landfill disposal fee
Labor	0.5	LS	$480	$240	16 labor hours
SUBTOTAL				$5,215	
Parts Replacement	1	LS	$160	$160	Pump replaced every 5 years
SUBTOTAL				$10,410	
Contingency	25%			$2,603	
TOTAL ANNUAL O&M COST				**$14,000**	

Notes:

1. Costs developed for typical 2-acre boatyard.

2. Includes packaged treatment system in 17 ft x 6 ft x 6 ft steel structure with filter media and all necessary piping and valves. Also includes startup support (8 hours maximum) and O&M training for owner.

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TABLE 2
SIEMENS WATER TECHNOLOGIES WWIX COST ESTIMATE

BOATYARD STORMWATER TREATMENT TECHNOLOGY COST ANALYSIS

CAPITAL COSTS:

DESCRIPTION	UNIT	QTY	UNIT COST	TOTAL	NOTES
Capital costs for WWIX					
Sample analysis and waste profiling	1	LS	$650	$650	
Inlet, outlet and interconnecting hoses	5	EA	$1,167	$5,833	All piping for WWIX tanks
Bag filters housing	1	LS	$2,000	$2,000	Includes installation by vendor
Regeneration of first set of tanks	1	LS	$17,135	$17,135	
Delivery of first set of tanks	4	EA	$1,200	$4,800	All handling and installation of tanks provided by vendor
Installation labor provided by vendor	1	LS	$1,033	$1,033	See Note 2
SUBTOTAL				$31,451	
Capital costs for additional equipment needs					
Hydrodynamic separator and installation	1	EA	$9,000	$9,000	Installation included
Wet well sump	1	EA	$2,500	$2,500	Material costs only
Submersible pump	1	EA	$800	$800	Material costs only
Wet well sump, piping, and pump installation	1	LS	$2,500	$2,500	Excavation, placement, disposal, and plumbing
Storage building and installation	1	LS	$3,000	$3,000	Pre-engineered 10'x12' steel
SUBTOTAL				$17,800	
Capital costs for additional installation support					
Placement and assembly	24	HR	$30	$720	Labor provided by boatyard
Forklift rental	1	day	$200	$200	Equipment rental only
SUBTOTAL				$920	
SUBTOTAL				$50,171	
Mobilization and demobilization	10%			$5,017	
SUBTOTAL				$55,188	
Contingency	25%			$13,797	
SUBTOTAL				$68,986	
Engineering report	1	EA	$5,000	$5,000	
Design cost	10%			$6,899	
TOTAL CAPITAL COST				**$81,000**	

ANNUAL O&M COSTS:

DESCRIPTION	UNIT	QTY	UNIT COST	TOTAL	NOTES
WWIX Tank Rental					
GAC tank rental	1	EA	$3,300	$3,300	
Lead media tank rental	1	EA	$3,300	$3,300	
Metals media tank rental	2	EA	$9,900	$19,800	
SUBTOTAL				$26,400	
WWIX Tank Regeneration					
GAC tank resin regeneration	2	EA	$3,360	$6,720	See Note 3
Lead media tank regeneration	2	EA	$2,875	$5,750	See Note 4
Metals media tank regeneration	2	EA	$5,450	$10,900	See Note 5
Delivery per tank	6	EA	$1,200	$7,200	Includes install at site
SUBTOTAL				$23,850	
Routine Maintenance					
Monthly inspections and maintenance	24	HR	$30	$720	2 labor hours per month
Metals breakthrough monitoring	24	EA	$200	$4,800	2 samples per month, includes collection and sampling
Parts replacement	1	LS	$160	$160	Pump replaced every 5 years
SUBTOTAL				$55,210	
Contingency	25%			$13,803	
TOTAL ANNUAL O&M COST				**$70,000**	

Notes:

1. Costs developed for typical 2-acre boatyard.
2. Cost provided by vendor to install system, start up pumps and provide training to owner.
3. Vendor recommends regenerating GAC tank every 6 months, or 2 times per year.
4. Each tank is estimated to treat 900,000 gallons before breakthrough occurs. Since the annual volume of stormwater is approximately 1,900,000 gallons, this tank will be changed 2 times per year.
5. Each tank is estimated to treat 1,800,000 gallons before breakthrough occurs. Since the annual volume of stormwater is approximately 1,900,000 gallons, this tank will be changed approximately 1 time per year.

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TABLE 3
WATER TECTONICS WAVE IONIC™ ELECTRO-COAGULATION COST ESTIMATE

BOATYARD STORMWATER TREATMENT TECHNOLOGY COST ANALYSIS

CAPITAL COSTS:

DESCRIPTION	UNIT	QTY	UNIT COST	TOTAL	NOTES
Capital costs for Water Ionics™ Electro-coagulation system					
Electro-coagulation unit (8'x10' container)	1	LS	$62,000	$80,000	See Note 2
Capital costs for additional equipment needs					
Hydrodynamic separator and installation	1	EA	$9,000	$9,000	Installation included
Wet well sump	1	EA	$2,500	$2,500	Material costs only
Wet well sump and piping installation	1	LS	$2,000	$2,000	Excavation, placement, disposal, and plumbing
SUBTOTAL				$13,500	
Capital costs for additional installation support					
Placement and assembly	16	HR	$30	$480	Labor provided by boatyard
Forklift rental	1	day	$200	$200	Equipment rental only
SUBTOTAL				$680	
SUBTOTAL				$94,180	
Mobilization and demobilization	10%			$9,418	
SUBTOTAL				$103,598	
Contingency	25%			$25,900	
SUBTOTAL				$129,498	
Engineering report	1	EA	$5,000	$5,000	
Design cost	10%			$12,950	
TOTAL CAPITAL COST				**$148,000**	

ANNUAL O&M COSTS:

DESCRIPTION	UNIT	QTY	UNIT COST	TOTAL	NOTES
System operations					
Electrical	1	LS/YR	$304	$304	Assumes $0.16 per 1000 gallons treated
Cells	1	LS/YR	$2,660	$2,660	Assumes $1.40 per 1000 gallons treated
Conductivity	1	LS/YR	$38	$38	Assumes $0.02 per 1000 gallons treated
Monthly inspections and maintenance	24	HR	$30	$720	2 labor hours per month
SUBTOTAL				$3,722	
Parts replacement (based on 15 year project)					
Sand filter control	1	LS	$100	$100	
Pumps	1	LS	$175	$175	
Miscellaneous parts	1	LS	$100	$100	
SUBTOTAL				$375	
SUBTOTAL				$4,097	
Contingency	25%			$1,024	
TOTAL ANNUAL O&M COST				**$5,200**	

Notes

1. Costs developed for typical 2-acre boatyard.

2. The packaged electro-coagulation system is based on a 100-gpm peak flowrate. Price includes an 8 ft x10 ft steel container with security doors to house the influent pump, 2 electro-coagulation cells, and control panels. Installation and training support included in price.

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TABLE 4
TYPICAL SITE IMPROVEMENTS FOR STORMWATER COLLECTION COST ESTIMATE

BOATYARD STORMWATER TREATMENT TECHNOLOGY COST ANALYSIS

CAPITAL COSTS:

DESCRIPTION	UNIT	QTY	UNIT COST	TOTAL	NOTES
Permitting	1	LS	$1,000	$1,000	Building, re-grading and stormwater permit
Survey	1	LS	$5,000	$5,000	
Capital costs for drainage improvements					
Asphalt berm	350	LF	$2.75	$963	Includes materials and construction
Re-grading	4,840	SY	$2.75	$13,310	50% of site (Note 2), includes materials and construction
Asphalt resurfacing (aggregate base and asphalt)	4,840	SY	$25.75	$124,630	50% of site (Note 2), includes materials and construction
SUBTOTAL				$138,903	
Piping and Catch Basin Installation					
Trenching, 4' wide, 4 ft deep	500	LF	$7.15	$3,575	Includes excavation, backfill and removal of spoi
8" HDPE pipe	500	LF	$17.00	$8,500	Includes materials and installation
8" HDPE elbows	3	EA	$230.00	$690	Includes materials and installation
Asphalt patching of 4' wide trench	222	SY	$30.00	$6,667	Includes materials and installation
Catch basin, 48" riser, 4 ft deep	4	EA	$2,575.00	$10,300	Includes excavation, installation and removal of spoi
SUBTOTAL				$29,732	
SUBTOTAL				$174,634	
Mobilization and demobilization	10%			$17,463	
SUBTOTAL				$192,098	
Contingency	10%			$19,210	
SUBTOTAL				$211,307	
Design Cost	10%			$21,131	
TOTAL CAPITAL COST				**$233,000**	

ANNUAL O&M COSTS:

DESCRIPTION	UNIT	QTY	UNIT COST	TOTAL	NOTES
Catch Basin Cleanouts	48	HR/YR	$40	$1,920	Clean 4 catch basins once monthly
SUBTOTAL				$1,920	
Contingency	10%			$192	
TOTAL ANNUAL O&M COST				**$3,000**	

Notes:
1. Costs developed for typical 2-acre boatyard.
2. Costs assume that 50% of boatyard area requires improved stormwater drainage and 50% of area does not.

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Appendix A

StormwateRx® Aquip™ Cost Estimate Quote

Budgetary Estimate

Date:	May 13, 2008
Project:	Washington State Sample Boatyard
Application:	Boatyard Stormwater Runoff Treatment BMP
Product:	Aquip™ Model 80SB, Site Integration Design
Prepared by:	Calvin Noling, PE; StormwateRx LLC, 122 Southeast 27th Avenue, Portland, OR 97214 800.680.3543, fax 800.407.2914, caln@stormwaterx.com

System Design Parameters:

1. Drainage Area = 2.0 acres, 100% Impervious
2. Treatment Design Flow:
   i. Calculated using Western Washington Hydrology Model
   ii. Project Location = Whatcom, Snohomish or King County, Washington
   iii. Water Quality Flow Rate (off-line BMP, 15 minute) = 60 – 80 gpm
3. Pollutants of Concern = total suspended solids; copper, zinc, lead – particulate and dissolved

Qty	Part Number	Description of Goods Quoted	Unit Price	Extended
Section 1) Stormwater Reclamation System				
1	A - Aquip™ Model 80SB	Stormwater filtration system with an operating rate of 80 gpm. StormwateRx will provide the following: Packaged Filtration System: - 17' x 6' x 6' high 10 gage steel, water tight structure, bottom and top perimeter rails, structural cross members, corner posts, up-rights, box legs, sandblasted / painted - Inlet piping manifold, 3-inch dia, Sch 40 PVC - Inlet check valve and sample collection port - Buffer rack and contactor, interlocking - Buffering media, 3-inches depth, granular - Filter inlet flow distributor, Sch 40 PVC - Internal flow distribution piping, Sch 40 PVC - Underdrain manifold, Sch 40 PVC, with cleanouts - Filter bay energy dissipation system - Layered sorptive and inert filtration media, 21-inch depth - Geotextile media support layers (2) - Underdrain gravel, 6-inch depth - External outlet manifold pipe, 6-inch, Sch 40 PVC - Internal overflow pipe, 4-inch, integrated to outlet manifold - Outlet sample collection port	$48,500.00	$48,500.00
1	B	Filtration System Integration Design: - Onsite design scoping meeting (4 hrs) - Specification and layout drawing of required infrastructure improvements for gravity conveyance of site stormwater to single treatment location and outfall, design includes: • Integration of 60" diameter manhole wet-well with 4 foot sump, total depth less than 8 feet, installed in-	$4,000.00	$4,000.00

		line to existing buried storm drain pipe. • Simplex pump for wet well, 230VAC, 1-phase, 1-HP submersible pump rated at 80 gpm with 20 ft TDH with automatic float switch and 15-foot electrical cord, pre-packaged controls • Pressure pipeline from sump pump to Aquip, above-ground • Gravity discharge pipeline from Aquip to existing buried storm drain outfall pipe, above-ground		
1	C	Startup & Training: - On-site work performed by factory technician: - Onsite installation supervision (8 hour maximum) - Operational / maintenance training Note: Equipment startup and training must be completed during the same visit.	(Included)	(Included)
Section 2) Customer Responsibilities				
		Customer's Responsibilities Include: - Aquip site preparation including but not limited to providing level and firm foundation, minimum dimensions 7' x 18', foundation load rating of 45,000 lbs total weight at bypass water depth. Required vertical equipment clearance of 8' or greater. - Provide forklift for offloading and placing equipment. - Receiving, unloading, storing, and installing the equipment. - Two laborers, 8-hours for equipment assembly onsite - Seismic design and restraints, if required. - Provide and install all sumps, piping, pumps and appurtenances per StormwateRx design configuration and specifications. - Installation of electrical and plumbing components in conformance with applicable codes. - Water testing labor and lab fees, if required - Obtaining all city, county, state, federal government and/or other permits for the site construction and operation of proposed system.		
Total: FOB StormwateRx LLC, Portland, Oregon				**$52,500.00**

Estimate is FOB StormwateRx (Portland, Oregon) and excludes taxes. Normal equipment lead time is 6 – 8 weeks from drawing approval. This budgetary estimate is to be used for estimating purposes only; for site specific quotations please contact StormwateRx LLC @ 800.680.3543.

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Appendix B

Siemens Water Technologies WWIX
Cost Estimate Quote

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2300 Eastlake Avenue East, Suite 200
Seattle, WA. 98102

PREPARED BY:

SIEMENS

960 Ames Avenue
Milpitas, CA. 95035

David Whelan
Sales Engineer
Milpitas CA. 95035
Ph: 408 935-6244
Fax: 408 935-6232
David.Whelan@Siemens.com

Proposal #CD4 0508 001 01

May 14, 2008

May 14, 2008

ARCADIS
2300 Eastlake Avenue East, Suite 200
Seattle, WA. 98102

Proposal #CD4 0508 001 01

Ms. Rhiannon Parmelee:

Siemens is pleased to provide ARCADIS with this **budgetary** proposal for portable Wastewater Ion Exchange Service. Based on information you have provided, we have proposed a system that will meet your technical requirements simply and economically.

1.0 SIEMENS RECOVERY SERVICES – A Leader in Environmental Service

Siemens through its Recovery Services facility is the only company in the United States that has the technology and, more importantly, all of the necessary permits to regenerate resins from any industrial rinse water process, including those that are determined to be hazardous waste. These two factors--technology and permitting--enable USFRS to provide ARCADIS with the peace of mind, knowing that you are in full compliance with federal, state and local regulations.

Here are some very important points to consider before choosing Siemens:

- Siemens maintains an EPA approved facility for the regeneration of ion exchange resins used for the removal of hazardous heavy metals.
- All Siemens Ion Exchange tanks are approved as transportable hazardous waste containers by the US Department of Transportation.
- Siemens is an approved carrier for transportation of Hazardous Waste.
- Siemens can provide manifesting of all waste transported by Siemens.
- Siemens can provide the proper labels for marking hazardous ion exchange resin containers.

No other company in the water treatment business can offer a full turnkey service for the handling of ion exchange tanks containing hazardous heavy metals. We are certain that you will agree that our unique wastewater service will provide your business with many operating advantages compared to other methods of handling your wastewater.

We look forward to providing our quality products and services to ARCADIS. If you have any questions, please contact me at 425 244-0345.

Regards,

David Whelan
Environmental Services
Business Development Manager

2.0 BASIS OF DESIGN

Rainwater run off from a boatyard will be captured and treated for metals removal prior to discharge. The system will be designed to treat 1,900,000 gallons per year at a peak flow of 70 gallons per minute (gpm).

2.1 Treatment Goal:

Treat rainwater runoff containing metals.

2.2 Influent Parameters:

Peak Flowrate:	70 gpm
pH:	6.0 – 8.0
Oil & Grease:	< 1 ppm
TSS:	<10 ppm

The Ion Exchange Systems Engineering Report, included with this proposal, provides analytical information based on the representative sample submitted. Please direct attention to the observations and comments at the bottom of page one. ***The Engineering Report included in this report is an example.***

2.3 Effluent Quality Requirements

Discharge limits:

10 ppb Copper
100 ppb Lead
100 ppb Zinc.

If any of this information is inaccurate, please contact me immediately.

2.1. System Description:

Siemens will provide ARCADIS with portable ion exchange tanks to treat rainwater runoff.

Siemens will provide one 30 cubic foot carbon tank, and three 30 cubic foot ion exchange tanks. The ion exchange tanks will remove dissolved metals and other salts.

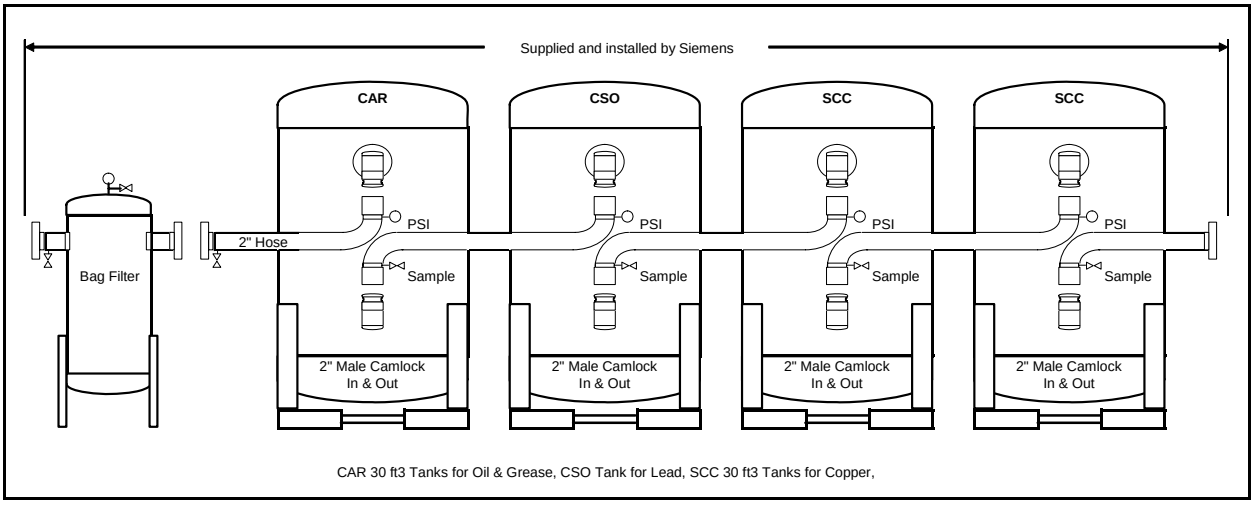
Siemens will deliver the following system components:

2.1.1. Carbon Tank(s) – Rental Tanks:
One (1) each SWT 30 cubic foot carbon tank to remove oil/grease, organics and/or oxidizers prior to the ion exchange tanks. *SWT does not sell the exchange tanks.*

2.1.2. Ion Exchange Tanks – Rental Tanks:
One (1) each SWT 30 cubic foot CSO ion exchange tank to remove Lead. *SWT does not sell the exchange tanks.*

2.1.3. Ion Exchange Tanks – Rental Tanks:
Two (2) each SWT 30 cubic foot SCC ion exchange tanks to remove Zinc and Copper. *SWT does not sell the exchange tanks.*

Siemens will provide any required interconnecting hose & fittings as found on the following drawing.



3.0 SCOPE OF WORK

3.1. Siemens Responsibilities:

- Siemens will provide rental tanks found in section 2.0.
- Siemens will deliver all equipment to the site in Seattle, WA.
- Under normal operating conditions Siemens will have available fresh replacement wastewater ion exchange tanks ready for delivery to ARCADIS within 3 working days from the date of request. All fresh tanks delivered are non-hazardous.
- Siemens will pick up all spent tanks from ARCADIS and transport the spent tanks to Siemens Recovery Services, Roseville, Minnesota facility for processing.
- All tanks will be processed at Siemens's fully permitted RCRA Part B facilities.
- All fresh tanks will be verified for proper flow, pressure tested for leaks and returned to the fresh tank float.
- All tanks are approved by US Department of Transportation for shipment of hazardous spent media.
- Siemens maintains consistent resin quality through rigorous quality assurance testing and resin replacement as required.

4.0 CUSTOMER RESPONSIBILITIES:

The Customer shall provide the following:

- Any civil work required.
- All utilities as required for system installation/operation.
- All permits, permit fees, and inspections as required, including approval for the double containment plan.
- Free and clear access to treatment site to change the portable tanks. Loading dock access or material handling equipment capable of safely handling specified ion exchange tanks. See attached tech sheet for tank specifications.
- System operation, including maintenance and wastewater quality monitoring.

5.0 GETTING STARTED

The following documents are required by Siemens or the USEPA where applicable, to be on file at Siemens prior to delivery of equipment.

- Siemens Waste Treatment Service Agreement
  - Exhibit A - Signed Waste Profile Sheet, please include your EPA ID number
  - Exhibit B - Siemens Lab Analysis
  - Exhibit C - Compensation to Processor
  - Exhibit D - Prohibited Wastes
- PO FOR SYSTEM INSTALLATION OR PARTS
  BLANKET PO for Rent, Regeneration and Transportation
  Please reference the attached Siemens Exhibit C (Compensation to Processor) on your purchase order.

Payment Terms:

Net 30 days.
Applicable taxes are not included in the above prices.

6.0 DELIVERY

Initial shipment will occur within 7-14 working days after receipt of the completed documents in Section 6.0.

7.0 COMMERCIAL TERMS AND CONDITIONS

WASTE TREATMENT, METALS RECOVERY,WATER RE-USE PROCESSING, TRANSPORTATION AND DISPOSAL SERVICES AGREEMENT

This agreement is entered into this _____ day of _____ by and between Siemens Water Technologies Corp.
("Processor") and_____ Industrial ("Generator").
WHERAS, Processor has a facility located at 2430 Rose Place, Roseville, MN. ("Processor's Facility") and the necessary licenses and permits to recover, treat, transfer, transport, and temporarily store (collectively "Handle") certain regulated and unregulated hazardous/industrial waste; and
WHEREAS, Generator desires Processor to Handle certain waste material generated by Generator at its facility at _____
("Generator's address") which waste material is described in the Waste Profile Sheet included in Exhibit A, attached hereto and made a part hereof. NOW, THEREFORE, the parties agree as follows:

I. Processor Services

1.1 Processor shall handle the Waste Material in a careful, workmanlike, and lawful manner, and in accordance with all applicable state and federal regulations.

II. Compensation for Services

2.1 Compensation to Processor shall be as specified in Exhibit C attached hereto and made a part hereof.
2.2 Generator shall pay Processor within ten (10) days after the date of each invoice. Generator shall pay interest on any unpaid balance at the rate of one and one-half percent (1-1/2%) per month, commencing upon the expiration of such thirty (30) day period.
2.3 Processor may adjust prices specified in Exhibit C on the Agreement's anniversary date or with thirty (30) days notice.

III. Waste Analysis

3.1 For all Waste Material to be Handled by Processor, Generator shall: (1) provide a detailed written physical and chemical description or analysis of the waste material (the waste profile sheet included in Exhibit A), (2) package, mark, label and placard each shipment and provide to Processor appropriate shipping documents,
manifests, or other such documentation as prescribed by Processor, or required by law , and (3) maintain all records with respect to the Waste Material as required by law.
3.2 Generator shall immediately communicate to Processor any changes in the composition of the Waste Material and any additional information obtained by Generator at any time during the term of this Agreement indicating that the Waste Material may present a hazard or risk to persons or the environment which is not set forth in Exhibits A or B (if included with this agreement) or was not generally known as of the date of this Agreement.
3.3 At any time and at its own expense, Processor shall have the right to perform analysis of Waste Material delivered by Generator hereunder.

IV. Nonconforming Waste Material

4.1 Waste Material shall be considered nonconforming if: (1) it has constituents, characteristics, components or properties not specified in Exhibits A or B (if included with this agreement), (2) it has constituents, characteristics, components or properties designated as unacceptable to the Processor in Exhibit D, or (3) if constituents therein exceed designated concentration levels specified in Exhibits A or B.
4.2 If Processor determines within thirty (30) days after delivery of Waste Material from Generator's Facility that the Waste Material is nonconforming pursuant to 4.1 above, Processor shall immediately notify Generator, and shall, at Processor's election, either arrange with Generator for the satisfactory disposition of such Waste Material upon mutually agreeable terms and conditions, or reject and return such nonconforming Waste Material to Generator without further obligation. If Processor elects to reject and return the Waste Material, Generator shall promptly arrange for its return and shall pay reasonable charges for Processor's Handling and time involved up to the time of the return.
4.3 At any time, Processor may, upon reasonable grounds to believe that Waste Material furnished by Generator is nonconforming, so notify Generator and require that Generator have a sample or samples thereof chemically analyzed by a qualified, reputable, independent laboratory acceptable to Processor. The results of such chemical analysis shall be furnished to Processor. If the chemical analysis demonstrates that the Waste Material is not nonconforming, Processor shall pay the costs of the analysis. If the chemical analysis demonstrate that the waste material is nonconforming, Generator shall pay the cost of the analysis.

4.4 Any waste containing any of the Prohibited Wastes as specified in the Processor's RCRA Part B Operating Permit, and in Exhibit D to this agreement shall be considered non-conforming.

V. Ion Exchange Resin

5.1 Processor shall supply to Generator such ion exchange resin canisters as the parties determine are appropriate after inspection and analysis by Processor of Generator's process and waste. Generator shall be responsible for utilizing each canister only on the process for which it is intended. Generator acknowledges the necessity of segregating rinse tank wastes as agreed with Processor. Generator agrees to monitor its use of the canisters and employ a fresh canister promptly as each canister's resin is exhausted. Any and all costs (including increased processing costs or replacement costs) incurred by Processor's Facility as a result of Generator's intentionally wrought or negligent use of any ion exchange resin canister shall be solely the responsibility of Generator; provided such costs shall not exceed the replacement cost of such ion exchange resin and/or canister.
5.2 Processor will conduct periodic ion exchange capacity tests on resin processed at Processor's Facility, and all canisters supplied to Generator, at the time of delivery, shall contain resin having an acceptable ion exchange capacity.
5.3 Resin canisters supplied hereunder shall be free from defects in material and workmanship. Processor shall not be liable for any incidental or consequential damages for any breach of warranty. PROCESSOR MAKES NO WARRANTY, EXPRESS OR IMPLIED, EXCEPT AS IS EXPRESSLY SET FORTH HEREIN. Processor's liability and Generator's exclusive remedy are expressly limited to removal from Generator's Facility and disposal of any defective canister and replacement thereof with another resin canister within a reasonable time period.

VI. Title

6.1 Title to and liability for conforming Waste Material shall pass from Generator to Processor when the loading operation of the Waste Material onto vehicles provided by the Processor has been completed and said vehicles are ready to leave the facility of the Generator. If transportation is provided by the Generator, then title passes from Generator to Processor when unloaded at Processor's site.
6.2 Title and liability for non-conforming Waste Material shall at all times remain with the Generator, unless, upon the discovery that the Waste Material is non-conforming, Processor agrees in writing to perform services under this Agreement.
6.3 Should Processor revoke acceptance of any nonconforming Waste Material as provided in IV above, title to and liability for such Waste Material shall revest in Generator at the time such revocation is communicated to Generator, regardless of who has physical possession of such Waste Material. Processor shall take all reasonable steps appropriate to protect the Waste Material until Generator can properly retake possession thereof.
6.4 Processor shall have title to all materials recovered from Generator's waste material.

VII. Collection and Transportation

7.1 The party providing transportation for the Waste Material from Generator's Facility to Processor's Facility shall comply with all federal, state, and local statutes, rules, regulations and ordinances applicable to the moving, handling, securing and transporting of such Waste Material. Generator is legally responsible to provide the proper Department of Transportation and Resource Conservation and Recovery Act shipping papers and labels, and/or any other such papers and labels required by applicable law, which shall accompany the Waste Material. Processor will assist Generator in determining proper labeling and shipping documentation.
7.2 Generator shall provide safe, satisfactory roadways and approaches to the point of loading at Generator's Facility. To the extent that Waste Material to be shipped from Generator's Facility is contained in canisters, totes or drums, Generator shall be solely responsible for loading the Waste Material onto vehicles provided by Processor, and Generator assumes full risk of loss to all equipment and premises of both parties, to the extent that such loss results from the negligence of its employees, officers, agents or subcontractors ("Generator Personnel"). To the extent that Processor's employees, officers, agents or subcontractors ("Processor's Personnel") engage in loading of canisters of Waste Material or in connecting of piping from Generator's process equipment to vehicles supplied by Processor, Processor assumes full risk of loss to all equipment and premises of both parties, to the extent that such loss results from the negligence of Processor's Personnel. Each of Generator and Processor shall indemnify, defend and hold harmless the other (and in the case of Processor, its partners and affiliates) from any and all costs and expenses (including attorney's fees) relating to: (1) liability, claims and demands arising from personal injury or death of personnel of any persons, including the other party's employees, officers, agents, or subcontractors, arising out of the negligence of Generator's Personnel or Processor's Personnel respectively while engaged in such loading activities, and (2) loss or damage to any property arising out of or in any manner connected with such loading activities.
7.3 To the extent that Processor Personnel enter Generator's Facility in performance of services hereunder, Generator shall ensure such Processor Personnel a safe working environment.
7.4 If an emergency should occur at Generator's Facility while Processor Personnel are on the premises, Generator shall make available to such Processor Personnel its emergency services, including first aid, to the same extent that emergency services would be available to an employee, agent or subcontractor of Generator at the same facility.

VIII. Insurance, Liability, Indemnification

8.1 Processor shall maintain adequate general liability insurance; Worker's Compensation Insurance in accordance with the laws of the State of Minnesota; adequate automobile personal injury and property damage insurance; and environmental insurance covering bodily injury and property damage caused to third parties by a sudden accidental occurrence in such amounts as may be legally required.
8.2 Processor shall indemnify, save harmless and defend Generator against any and all claims, liabilities, penalties, forfeitures, suits and costs and expenses incident thereto (including costs of investigation, defense, settlement and reasonable attorney's fees), resulting from death or bodily injuries to any person, destruction or damage to any property, contamination of or adverse effects on the environment, or any violation of governmental regulations or orders to the extent such results from the imposition of strict liability with respect to Waste Material delivered to Processor by Generator.
8.3 Generator shall indemnify, save harmless and defend Processor against any and all claims, liabilities, penalties, forfeitures, suits and the costs and expenses incident thereto (including costs of investigation, defense, settlement and reasonable attorney's fees), resulting from death or bodily injuries to any person, destruction or damage to any property, contamination of or adverse effects on the environment, or any violation of governmental regulations or orders to the extent (1) such is caused by the negligence or intentional wrongdoing of Generator or any of its agents or employees, (2) such is caused by Generator's delivery to Processor of nonconforming Waste Material.

IX. LIMITATION OF LIABILITY

9.1Notwithstanding anything else to the contrary, Processor shall not be liable for any consequential, incidental, special, punitive or other indirect damages, and Seller's total liability arising at any time from the sale or use of the Processor's services shall not exceed the purchase price paid for processors services. These limitations apply whether the liability is based on the contract, tort, strict liability or any other theory.

X. Representations and Warranties

10.1 Processor warrants and represents to Generator that: (1) it will during the term hereof possess the equipment, plant and employee resources required to perform this
Agreement; and (2) it will be at all times while the services hereunder are being performed by it, duly licensed and authorized to Handle the Waste Material; and (3) it will comply with all applicable federal, state and local laws, regulation, rules, orders, decisions and ordinances pertaining to its Handling of the Waste Material.
10.2 Generator warrants and represents to Processor that: (1) the composition of all Waste Material to be delivered to Processor conforms to Exhibits A and B; (2) Generator will during the term of this Agreement communicate to Processor any and all changes in the composition of its Waste Material and any additional potential hazards and risks associated with the Waste Material learned of by Generator; and (3) Generator will hold clear title to all Waste Material to be transferred hereunder; and
(4) the Waste Material will conform to the shipping papers and labels which accompany it; and (5) Generator is under no legal restraint or order and shall be under no legal restraint or order which would prohibit transfer by it of possession or title of the Waste Material to Processor for Handling; and (6) Generator will comply with all applicable federal, state and local laws, regulations, rules, orders, decisions and ordinances pertaining to its activities pursuant to this Agreement.
XI. Excuse of Performance

XI. Excuse of Performance

11.1 The parties agree that any delay or failure of either party to perform its obligations hereunder, except for the payment of money for services already rendered, shall be excused if and to the extent caused by acts of God, strikes, action of regulatory agencies (including loss by Processor of any license, permit or other authorization necessary for fulfilling its obligations hereunder), fire, flood, windstorm, explosion, riot, war, sabotage or other cause or causes beyond reasonable control of the party affected ("Force Majeure"), provided that prompt notice of such delay is given by such party to the other and each of the parties hereto shall be diligent in attempting to remove such cause or causes. In the event that the Force Majeure is not rectified within thirty (30) days of the date of such notice, each of the parties shall have the right to terminate this Agreement effective immediately upon written notice to the other party.

XII. Term of Agreement

12.1 The term of this agreement shall be from the date hereof and automatically renewed on the anniversary date thereof for a like period until such time as either party terminates the agreement in accordance with the provisions contained herein.

XII. Termination of Agreement

13.1 Either party may terminate this Agreement if the other party (1) has been adjudicated a bankrupt, or (2) has filed a voluntary petition in bankruptcy, or (3) has made an assignment for the benefit of creditors, or (4) a receiver has been appointed for such party.

13.2 Furthermore, either party may terminate this Agreement without cause by giving the other party thirty (30) days written notice of termination.

XIV. Miscellaneous

Generator acknowledges that Processor is required to comply with applicable export laws and regulations relating to the sale, exportation, transfer, assignment, disposal and usage of the services provided under the Contract, including any export license requirements. Purchaser agrees that such services shall not at any time directly or indirectly be used, exported, sold, transferred, assigned or otherwise disposed of in a manner which will result in non-compliance with such applicable export laws and regulations. It shall be a condition of the continuing performance by Processor of its obligations hereunder that compliance with such export laws and regulations be maintained at all times. GENERATOR AGREES TO INDEMNIFY AND HOLD PROCESSOR HARMLESS FROM ANY AND ALL COSTS, LIABILITIES, PENALTIES, SANCTIONS AND FINES RELATED TO NON-COMPLIANCE WITH APPLICABLE EXPORT LAWS AND REGULATIONS.

IN WITNESS WHEREOF, the parties have caused this Agreement to be executed by the duly authorized representatives.

Siemens Water Technologies Corp.

NAME: _____

SIGNATURE: _____

TITLE: _____

DATE: _____

GENERATOR

NAME: _____

SIGNATURE: _____

TITLE: _____

DATE: _____

EXHIBITS:

A: Waste Profile Sheet

B: Siemens Lab Report

C: Quotation for Compensation to Processor

D: Prohibited Wastes

EXHIBIT A

Waste Profiles will be provided at the time of the order.

SIEMENS

EXHIBIT B
SIEMENS LAB REPORT

GENERATOR:
Boatyard (Seattle, WA)

Sales Representative:

SAMPLE DESCRIPTION:
-
Stormwater

Part #: **WXCAR3000FSWVD**
WXCSO3000FSWFD
WXSCC3000SWFR

Cations	*ppm Ion*	*ppm $CaCO_3$*
Aluminum	BDL	BDL
Antimony	BDL	BDL
Barium	BDL	BDL
Beryllium	0.06	0.67
Cadmium	BDL	BDL
Calcium	3.09	7.73
Chromium(+3)	BDL	BDL
Copper	4.65	7.30
Iron	BDL	BDL
Lead	0.010	0.005
Magnesium	0.65	2.68
Manganese	BDL	BDL
Nickel	0.032	0.054
Potassium	0.66	0.84
Sodium	4.88	10.6
Titanium	BDL	BDL
Zinc	2.44	3.76
TOTAL CATIONS		33.7

Anions	*ppm Ion*	*ppm $CaCO_3$*
Chloride	NA	NA
Fluoride	NA	NA
Hydroxide	NA	NA
Nitrate	NA	NA
Phosphate	NA	NA
Sulfate	NA	NA
Arsenic	0.073	0.15
Chromium(+6)	BDL	BDL
Molybdenum	0.01	0.01
Selenium	BDL	BDL
Vanadium	BDL	BDL
Bicarbonate	NA	NA
Carbonate	NA	NA
Cyanide	BDL	BDL
TOTAL ANIONS		0.15

pH	6.90	units (by meter)
Silica	0.92	mg/L SiO_2
TOC	7.00	mg/L
Conductivity	90.0	µmhos/cm
Mercury	BDL	mg/L
Silver	BDL	mg/L
Thallium	BDL	mg/L
Color	None	
Odor	dirt	

Current Process Information:	
Flowrate (gpm)	70
Operating Temp. (°F)	60
Hours/Day	
Days/Week	
Process Water Source	Stormwater
Water Reuse/Discharge	Discharge
Process Water Quality	Not Given
Discharge Water Quality	See comments

Observations and Comments:

1) Sample submitted via (Seattle, WA).
2) Discharge limits: 10 ppb Cu, 100 ppb lead, 100 ppb Zn.
3) Results above are soluble metals. Sample also contained particulate metals: 0.18ppm Al, 1.5ppm Cu, 0.19ppm Fe, 0.43ppm Pb, 0.33ppm Si and 3.1 ppm Zn.
4) Bench-scale SCC testing resulted in effluent concentrations of 31ppb Cu, 32ppb Zn, 2ppb Pb.
5) Stepped prefiltration (10µm --> 1µm) required to remove particulate metals.
6) Estimated media usage based on total troughput of 2,000,000 gallons per year.
7) Spent CSO assumed D008 (lead) hazardous waste; TCLP recommended.

SIEMENS

ION EXCHANGE SYSTEM ENGINEERING REPORT

GENERATOR:	***Part Numbers:***	**WXCAR3000FSWVD**
Example		**WXCSO3000FSWFD**
Boatyard (Seattle, WA)		**WXSCC3000FSWFR**

Suggested Treatment System

Pretreatment

Maximum Temperature:	120	^{o}F
Optimum pH Range:	4 to 8	S.U.
Prefiltration Required:	10 --> 1	micron

Ion Exchange Treatment

Type	Size, cu. ft.	Number	Resin	Tmt. Code
Carbon	30	1	CAR	23
Cation	30	1	CSO	89
Spec. Cation	30	2	SCC	25

The suggested ion exchange system is based on the process information and sample analytical results shown on page 1 of this report.

Post Treatment

Post-filtration Required:	NA	micron

Estimated Canister Life Expectancy

Type	Gallons	Days	Changes/Yr.
Carbon	1,762,491	321	1
SCC	1,815,942	331	1
CSO	920,331	167	2

Carbon and resin service life is estimated based upon the sample and system shown above

ION EXCHANGE SYSTEM ENGINEERING REPORT

GENERATOR:	***Part Numbers:*** **WXCAR3000FSWVD**
Example	**WXCSO3000FSWFD**
Boatyard (Seattle, WA)	**WXSCC3000FSWFR**

Hazardous Waste Indicators

Toxic	***USEPA Code***
Characteristic Waste	
Lead*	***D008****
Listed Waste	
None Applicable	
State Waste	
None Applicable	

* CSO only

Highlighted toxics in the box at the left indicate that exhausted carbon and ion exchange resin from the treatment system is considered a RCRA hazardous waste for those components and is subject to all RCRA and DOT rules and regulations governing handling and transportation of hazardous wastes.

The absence of hazardous waste indicators is not to be interpreted to mean that Siemens Water Technologies Corp. implies or warrants that spent carbon and ion exchange resin resulting from waste water treatment is not a hazardous waste. The U.S. Environmental Protection Agency requires the generator of the waste to determine whether a waste is a hazardous waste according to regulations found in the Code of Federal Regulations, see 40 CFR 260. Siemens Water Technologies Corp. testing is for the purposes of treatability and compatibility with its treatment systems. Analytical methods are in accordance with Siemens Water Technologies Corp. standard operating procedures and may not strictly adhere to EPA or equivalent test methods.

EXHIBIT C
QUOTATION FOR COMPENSATION TO PROCESSOR

INITIAL INSTALLATION & ACCESSORIES

Part Number	Description	Quantity	Unit	Rate	Amount
RSLABSDI	Sample analysis and waste profile approval	1	NA.	$650.00	$650.00
	FSI Bag Filter Housing 316 SS Housing	1	Lot	$2,000.00	$2,000.00
	Filter Housing includes 1 cs 1 mic filters				
	Inlet, Outlet and Interconnecting Hoses	5	Ea.	$1,166.67	$5,833.33
	Installation Labor includes:	1	Lot	$1,033.29	$1,033.29
	5 Hrs. Set Up Labor				
	2 Hrs. Start Up Labor				
	2 Hrs. Training Labor				
	Initial Regeneration of First Set of Tanks			SEE BELOW	$17,135.00
RSDELVCHG	Delivery of First Set of Tanks			SEE BELOW	$4,800.00
		TOTAL START UP COSTS			**$31,451.62**

TANK RENTAL

Part Number	Description	Quantity	Rate	Amount
WXCAR3000CSWVD	30 ft3 Carbon Tanks	1	$275.00	$275.00
WXSCC3000CSWPD	30 ft3 CSO Lead Tanks	1	$275.00	$275.00
WXSCC3000CSWFR	30 ft3 SCC Copper Tanks	2	$825.00	$1,650.00
			MONTHLY RENTAL TOTAL:	**$2,200.00**
			ANNUAL RENTAL TOTAL:	**$26,400.00**

RESIN REGENERATION & MEDIA PROCESSING

Carbon tanks will be changed out on a minimum of every six (6) months.

Part Number	Description	Qty / Yr	Rate	Annual Cost
WXCAR3000CSWVD	30 ft3 Carbon Tanks	1	$3,360.00	$3,360.00
WXSCC3000CSWPD	30 ft3 CSO Lead Tanks	1	$2,875.00	$2,875.00
WXSCC3000CSWFR	30 ft3 SCC Copper Tanks	2	$5,450.00	$10,900.00
			ESTIMATED RESIN TOTAL	**$17,135.00**

Usage estimates above are based on lab analysis and/or industry knowledge. It is important to remember that ion exchange loading rates can vary significantly based on any process changes made or fluctuations in influent contaminant concentrations.

TRANSPORTATION

Part Number	Description	Qty / Yr	Rate	Annual Cost
RSDELVCHG		4	$1,200.00	$4,800.00
			ESTIMATED FREIGHT TOTAL	**$4,800.00**

TOTAL ESTIMATED ANNUAL SERVICE FEES

Annual Service Cost **$48,335.00**

Notes:

1. Siemens requires a hard copy Purchase Order in the amount listed as 'ESTIMATE - 1st Year Total.

2. Media Processing and Transportation charges will be incurred as tanks are delivered.

3. All annual quantities of units in Media Processing and Transportation sections are estimates.

4. All charges are plus any applicable taxes. This quote is good for 90 days.

EXHIBIT D
PROHIBITED WASTES

1. **Waste Oil**

Waste oil of any kind including but not limited to: waste hydraulic oil, waste emulsified oil, waste cutting oil, oil laden metal shavings, oil laden "floor dry" compounds, grinding swarf, waste cooling or cutting oils, transformer oil, waste lubricants, used oil coating baths, water soluble oils and paint strippers, unless previously approved by Processor.

2. **Organic Solvents**

Organic solvents of any kind including but not limited to: trichloroethane, trichloroethylene, dichloromethane (methylene chloride), naptha, kerosene, gasoline, alcohols, methylethyl ketone (MEK), acetone, benzene, toluene, tetrachloro-ethane and carbon tetrachloride, unless previously approved by Processor.

3. **Toxic Organics**

Toxic organic compounds of any kind which contain toxic organics in higher than nominal concentration. Toxic organics shall be defined as those compounds listed in 40 CFR 433.11, as it may be amended. Total toxic organics (TTO) is the sum of all toxic organics as defined in 40 CFR 433.11, as it may be amended. The CTRF will not accept contamination in wastes by TTO in a concentration equal to or greater than 2.13 mg/l. Concentrated toxic organics will not be accepted for treatment at the CTRF. Specific examples of unacceptable toxic organics include but are not limited to: vapor degreasing compounds (chlorinated hydrocarbons), cresylic acid emulsion cleaners, and vapor degreaser sludge.

4. **Radioactive Materials**

Any material exhibiting radioactivity above background levels, including artificial radioisotopes and naturally occurring radioisotopes; any material which is exposed to radioisotopes or radiation which becomes radioactive from such exposure; radiation sources used for thickness gauging; and equipment used to contain radiation sources.

5. **Reactive Compounds**

Any compounds which cause or could possibly cause undesirable reactions when mixed with other wastes in either Generator's holding tanks or the Processor's holding tanks and chemicals that are unstable alone or that can react with common contaminants listed for each Waste Category to cause a highly exothermic reaction or release explosive gases. Prohibited compounds include but are not limited to: reducing agents in chrome or sulfate copper etch wastes; oxidizing agents in chelated wastes; and powerful reducing or oxidizing agents of any type other than those specifically listed as acceptable in Exhibit A. Examples of unacceptable reactive compounds are: hydrazine, sodium hydrosulfite, sodium borohydride, chlorate compounds and perchlorate compounds.

6. **Mercury**

Elemental mercury and all compounds of mercury.

7. **Scrap Materials**

All solid scrap including but not limited to: circuit board scrap, scrap or ruined plating work, drums, equipment or components (tanks, liners, etc.), anodes, anode baskets and chemical containers, unless previously approved by Processor.

8. **Particulate Material**

Particulate material larger than 1/4 inch diameter in any liquid waste is unacceptable to the Processor. Such material includes but is not limited to: lost parts in process bath dumps (screws, nuts, etc.); cigarette butts, mop strings and rags in floor wash water; and sludge or crystal particles that may not be broken up by the agitation caused by pumping.

ARCADIS

Appendix C

Water Tectonics, Inc. Wave Ionics™
Cost Estimate Quote

Capital Budget for a 100 gpm System

System Unit Design		
	Electo-coagulation System 8' X 10' Ocean seagoing Steel container with new finished coating **2-treatment cells with a life expectancy of 1,000,000 gallons** Double Security Doors Exterior Disconnect Interior Lights Interior Outlet Influent Pump Automatic Controls Automatic Sandfilter Controls Sandfilter Pump Sandfilter 3 pod	
	Total Estimate	$ 80,000.00

Operations and Maintenance		Consumables	per 1000 gallons	per year
	electrical	$ 0.16	per 1000 gallons	$ 304.00
	cells	$ 1.40	per 1000 gallons	$ 2,660.00
	conductivity	$ 0.02	per 1000 gallons	$ 38.00
	labor	$ 0.25	per 1000 gallons	$ 475.00
				$ -
	Total	$ 1.83	per 1000 gallons	$ 3,477.00
Sandfilter Control Replacement 15 years				$ 100.00
Pump replacment based on 15 years				$ 175.00
Misc Part replacement based on 15 years				$ 100.00
Estimated number of gallons for a 2 acre site during a 6 month storm		1,900,000	gallons per year	
	Total O&M	$ 3,477.00	per year	$ 3,852.00

Exclusions	
	WSST Permits Site work Pretreatment